THE NORWEGIAN

NORTH POLAR EXPEDITION 1893—1896

SCIENTIFIC RESULTS

VOLUME II

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SCIENTIFIC RESULTS

EDITED BY

FRIDTJOF NANSEN

VOLUME II

PUBLISHED BY THE FRIDTJOF NANSEN FUND
FOR THE ADVANCEMENT OF SCIENCE

CHRISTIANIA
JACOB DYBWAD

LONDON,
NEW YORK, BOMBAY
LONGMANS, GREEN, AND CO.

LEIPZIG
F. A. BROCKHAUS

1901

PRINTED BY A. W. BRØGGER. CHRISTIANIA. 1901.

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PREFACE TO VOL. II.

The astronomical, magnetic, and pendulum observations affording the material for the three important Memoirs contained in this volume, were nearly all of them, with the exception of the observations from the sledge-journey, made by Capt. SIGURD SCOTT-HANSEN. In my preface to Vol. I of this Report, I have gratefully acknowledged his important share in the results of the expedition. The present volume containing some part of his work, will testify to the astonishing quantity of multifarious observations he has been able to accomplish, and to the intelligent care and accuracy with which he made them, notwithstanding the often trying circumstances.

Memoir VI, containing the Astronomical Observations made during the expedition, and their Results, has been prepared by Prof. H. GEELMUYDEN. Before our start, Prof. GEELMUYDEN gave the expedition his important assistance by aiding in our equipment with astronomical instruments and chronometers, and giving us instruction in the best methods of making observations for determining our position in high latitudes. After our return, he had the great kindness to undertake the troublesome and slow work of arranging and supervising the computation of our numerous observations, and preparing the report for the press. He has also constructed and drawn the two valuable charts accompanying this volume, of the Fram's route and the sledge-journey, in which he has set forth the results of his work that has been of such importance to the expedition. These charts give highly interesting information of the drift of the ice during the several seasons of the year. The relation of this drift to winds and currents will be discussed in a later Memoir on the Oceanography, which will shortly appear in Vol. III.

Memoir VII, on Terrestrial Magnetism, has been prepared by Mr. Aksel S. Steen, Sub-director of the Meteorological Institute of Christiania, and contains Scott-Hansen's Magnetic Observations and their results. As mentioned by Mr. Steen, Prof. G. Neumayer gave the expedition his valuable assistance by taking charge of our magnetic equipment. He had the instruments made according to his orders, and partly according to his special design; and he also gave Capt. Scott-Hansen careful instruction in the use of the instruments, and in the methods of making observations. I hope it may give him some satisfaction to see how well his instruction has been utilized, and to see the important results of Scott-Hansen's observations, which have been so ably and carefully worked up by Mr. Aksel S. Steen. Prof. Ad. Schmidt of Gotha has much increased the scientific interest of these results by kindly calculating theoretically the values of the magnetic elements for all localities where magnetic observations were made during the expedition.

Memoir VIII, on the Results of Scott-Hansen's Pendulum Observations, has been prepared by Prof. O. E. Schiøtz, who has also added some interesting conclusions with regard to the constitution of the earth's crust, which he thinks may be drawn from these observations. When I planned the expedition, I considered it not impossible that we might meet with unknown land in high latitudes; and as in such a case it would be of great importance to be able to take pendulum observations, Prof. O. E. Schiøtz kindly undertook to equip us for this purpose. It was decided to order a pendulum apparatus of Colonel von Sterneck's pattern from Vienna, and Von Sterneck himself had the great kindness to determine the constants of the two pendulums. We met with no land in the North Polar Basin, and thus the ordinary conditions for making pendulum observations did not exist. But SCOTT-HANSEN thought that the strong ship frozen firmly into the drifting ice, or the ice itself, might possibly afford a sufficiently solid base for the pendulum apparatus, and decided to make some observations as an experiment. Thus the first series of pendulum observations, which, to my knowledge, have ever been made over the sea, were made over the deep North Polar Basin. We had some doubt as to the value of the observations taken under such extraordinary circumstances; but thanks to Prof. SCHIØTZ's able elaboration and discussion of the material, it now appears that these observations afford perhaps some of the most important results of the expedition.

I desire here to convey my hearty thanks to the contributors to this volume, and to Prof. G. NEUMAYER, Prof. AD. SCHMIDT, and Colonel VON STERNECK, for their valuable assistance and contributions.

GODTHÅB, LYSAKER. *January*, 1901.

FRIDTJOF NANSEN.

I

VI.

ASTRONOMICAL OBSERVATIONS

ARRANGED AND REDUCED

UNDER THE SUPERVISION OF

H. GEELMUYDEN,

PROFESSOR OF ASTRONOMY AT THE UNIVERSITY OF CHRISTIANIA.

WITH TWO CHARTS.

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ADDITIONS AND CORRECTIONS.

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4. The following observations were taken ashore at Khabarova:

1893		Oc.	Watch	Vertical Circle		Level	Watch	Hw—W
			h m s	° ′ ″	′ ″		h m	m s
Aug. 1	Sun L. L.	W	22 4 29	306 36 8.5	36 27	N 1.2 S 9.7	23 45	− 5 46.7 July 29
	Terr. Mark	S	—	270 18 28	17 59	—	23 52	− 6 2.7 Aug. 2
	"	N	—	89 41 32	41 12.5	—		

The watch was in this case the chronometer Iversen. — Cloudy.

Page

7. *For* Remarks 8) and 9) *read*: Assumed star δ Persei and + 10′ to circle Oc. N.
8. July 5. Assumed U. L. for L. L.
17. Remark 4). *For* the *read* be.
24. The following observations are to be inserted:

1896		Oc.	Watch	Vertical Circle		Level
			h m s	° ′ ″	′ ″	
May 8	Sun [U. L.]	S	19 10 44	289 53 45	53 5.5	E 10.8 W 16.4
	—"—	N	17 5	69 57 11	56 26.5	E 13.1 W 13.3

26. Among the days of determination of Index error is to be inserted: 1894 May 20.
30. September 28. Remark: Ass. corr. + 10′ to the fourth altitude.

The following observations are to be inserted:

1893		Hor.	Watch	Sextant	Watch	Hw—W
			h m s	° ′ ″	h m	m s
Nov. 22	α Cygni	Merc.	21 28 53.5	109 54 35	19 36	+ 7 4.3
	Jupiter L. L.	"	21 47 48	42 14 45	23 47	+ 7 6.3

31. March 30. Hw—W *for* 1m 39s.2 *read* 1m 39s.7.
32. April 23. Sextant *for* 2° 12′ *read* 3° 12′.
47. May 23. Col. Remarks, cancel [Omitted].
64. April 25. Col. A, *for* 268° 5′ 11″ *read* 268° 28′ 45″.
65. August 2. Last observation of C, *for* 182° *read* 181°.
74. November 1. Magn. Decl. *for* 27°.4 *read* 26°.65.
77. Line 5 from bottom, *for* must *read* had to.
88. October 2. M. T.—Hw *for* 44s *read* 46s; N. Lat. *for* 78° 52′.2 *read* 78° 51.′8.
107. Aug. 8. N. Lat. *for* 80° 55.′0 *read* 81° 5.′0.
117. April 26, last observation, LT—I, *for* 43s *read* 53s (gives the E. Long. 1′ greater).
119. June 4, third line, *for* some *read* same.

INTRODUCTION.

Astronomical and Nautical Instruments.

The following is an enumeration and brief description of the instruments used for astronomical observations.

Altazimuth by C. H. G. Olsen in Christiania. The horizontal and vertical circles, of 21 cm. diameter, are graduated on platinum to 10′ and read off by two microscopes placed diametrically reading to 10″, the single seconds being easily estimated. The microscopes for the horizontal circle follow the instrument in the motion about the vertical axis, the horizontal circle being fixed, while the vertical circle follows the telescope in the motion about the horizontal axis, the corresponding microscopes being fixed at the ends of the horizontal diameter. The alidade bearing these microscopes is provided with a fixed level, adjustable by screw and spring working on an arm going downwards from the centre. Both circles being graduated from left to right, as seen from the centre, the correction to the reading of the vertical circle is positive when the right end of the level is the higher. The level is divided from the middle and the angular value of a part was given by the maker as 4″, which was found to be sufficiently accurate; consequently the difference between the readings of the two ends of the bubble, multiplied by 2, gives the correction to the circle-reading in seconds. The degrees and tens of minutes are for both circles read off by an index, which is, for the vertical circle, placed at the top.

The microscopes of both circles were always pointed to two adjacent division lines, one on each side of the central notch marking the zero of single minutes in the field of the microscope. Generally the two readings did not differ by more than the accidental error of pointing, a few seconds;

during the last year (from the autumn of 1895) the right microscope for the vertical circle seems, however, to have got somewhat out of adjustment, the difference between the two readings being generally about 20″ and in some cases reaching 30″. As there are not sufficient data to take this difference into due consideration it has been necessary to take the simple mean in all cases. When it happened that a division-line was near the middle of the field of the microscope, the observer often pointed the micrometer wires to a line on each side, and the mean of the three was then taken.

The telescope has an aperture of about 5 cm. and 42 cm. focal length. It was provided with two eyepieces giving magnifying powers of about 30 and 40. The optical axis is broken by a reflecting prism and the eyepiece placed at one end of the horizontal axis. The illumination of the field comes from a lamp at the other end of the axis. The wires in the focus are fine lines engraved on glass. There was a set of 13 wires (vertical in the horizontal position of the telescope) but only the middle wire and the horizontal wire were used for the observations.

The striding level of the horizontal axis is divided from the middle; one division = 4″. As this level must always be read off in the two opposite positions, the sum of the two differences will give the inclination of the axis in seconds.

1896, May 6, it was noticed by Capt. SVERDRUP that the motion of the telescope about the horizontal axis was not quite independent of that of the alidade; when the screw working on the arm of the latter was turned (in order to get the bubble of the level in a convenient position) it had an effect of some seconds on the pointing of the telescope. Lieutenant SCOTT-HANSEN took the instrument on board, loosened the parts and cleaned them, but the error was still perceptible in some positions of the instrument. It is of course only when the screw is touched between the pointing of the star and the reading of the microscopes and level, that this can introduce an error in the observation, but Mr. SCOTT-HANSEN is of opinion that such an error may occur in some of the observations from the winter 1895—96. Before the cleaning of the instrument he made some experiments in order to ascertain the amount, and found the maximum effect to be about 50″.

This instrument is at present on board the *Fram* on Capt. SVERDRUP's expedition to Greenland.

A *small altazimuth* by Olsen. The circles have diameters of 10 cm. and are graduated to half degrees, two opposite verniers giving the single minutes. The relative movement of circles and reading-apparatus is the same as in the larger instrument. A fixed level, placed parallel to the vertical circle, was read off on measuring altitudes, but its position was not such that it can be considered as an alidade-level. It is divided from the middle in parts of 0′.8. The telescope, whose axis is broken by a reflecting prism, has an aperture of 2 cm, a focal length of 16 cm., and a magnifying power of 12. The wires in the focus consist of one horizontal and two vertical lines (about 4′ apart) engraved on glass.

This instrument was not much used on board but followed Mr. Nansen on his sledge expedition.

A *sextant* by Hechelmann, of the usual construction, giving the angles to 10″. Usually the altitudes were measured from the ice as a natural horizon or over a basin of mercury as an artificial horizon. On some few occasions a glass horizon by Negretti & Zambra was used; the level which was read off in its two positions, when placed in the vertical plane of the celestial object, was divided to 2′.6. There was also another glass horizon with aluminium mounting, by Porter, which was only used 1893 September 28 and October 2; its level was divided to 3′.9. Occasionally a trough of tar or a pool of water on the ice was used as an artificial horizon.

The astronomical telescope was almost invariably used.

A small *pocket sextant* by Cary, London, was used by Mr. Nansen on his sledge expedition. The limb, of radius 4.5 cm., is divided to half degrees, the vernier giving single minutes. The instrument is made of aluminium which did not, however, prove to be a good metal for this purpose, the screws becoming immoveable from oxidation.

Several *compasses*, among them an azimuth-compass by Hechelmann with 8 small needles suspended by silk wires. The card, divided to degrees, has a diameter of 21 cm. The reading of the card was always made both ways, the eye being held in the plane through the vertical and the horizontal wire of the diopter-apparatus, either before the thread or before the slit.

This compass was often used on the ice at a convenient distance from the ship. It was provided with a mirror, placed before the wire-vane of the sight, and moveable about a horizontal axis.

Besides the steering compass, which was placed before the wheel, behind the mizzen mast, and which could be provided with sights, there was an azimuth dial on the bridge, suspended in gimbals; diameter 15.5 cm., distance between the sights 12.5 cm. This was often used to take the bearing of the Sun or a star in order to determine the combined magnetic declination and deviation on board.

Two small compasses by Olsen with sharp needles pointing to the rim which was divided into degrees. The suspension is by agate cups on steel pins. The one is mounted in a brass box and has a needle of 64 mm. length, the other an aluminium box and needle of 59 mm. length. Both were used by Mr. Nansen on the sledge-expedition, and on some few occasions by Mr. Scott-Hansen before Nansen's departure.

A *telescope* by Negretti and Zambra, with an aperture of 7.4 cm., the astronomical eyepiece giving a power of 65. The principal use of this instrument was the observation of eclipses of Jupiter's Satellites. A smaller telescope of aluminium was used by Mr. Nansen on the sledge-expedition.

The *chronometers* and their installation will be mentioned in another paragraph.

Lieut. Scott-Hansen, who has made by far the most of the observations, has expressed a desire to acknowledge, on this occasion, the good services of his assistants, Mr. Johansen and Mr. Nordahl, the latter after Johansen's departure with Nansen on the sledge-expedition.

Determination of Latitude and Local Time.

Latitude and local time were always determined by observation of altitudes. The altazimuths, especially the larger instrument, were almost invariably used for stars, in many cases also for the sun. They were then mounted near the ship on an ice pillar, surmounted by a slab of slate. After levelling, the time of pointing on the star was noted by a watch (generally compared before and after with the standard chronometer) and then the vertical circle and its level read off. With few exceptions every star was observed in the two positions of the instrument, with the object glass to the right and to the left of the observer placed at the end of the horizontal axis. The general rule was to determine the latitude and local time simultaneously by taking two stars in azimuths differing about 90°.

As the zenith point for the vertical circle of the large altazimuth never differed more than some seconds from 0°, the circle-reading for a point above the horizon was either between 0° and 90°, when the object glass was to the left of the observer, or between 270° and 360°, when it was to the right. For the sake of brevity these two cases shall be distinguished by the notation "small numbers" and "great numbers". Supposing the zenith point to be exactly 0° 0′ 0″, the apparent altitude will be

Circle-reading — 270° 0′ 0″ for great numbers

and 90° 0′ 0″ — Circle-reading for small numbers,

when the circle-reading includes the correction for level in the sense right—left. When the zenith point differs from 0° 0′ 0″, the numbers 90° 0′ 0″ and 270° 0′ 0″ are subject to the same change.

For the reduction to true altitude Bessel's refraction was used, as given in Albrecht's "Formeln und Hülfstafeln für geographische Ortsbestimmungen", with an extension of the temperature table down to — 50° C., calculated by Bessel's formula.

On taking the mean of the two altitudes of the same star, as shown above, the result is free from any error in the assumed zenith point; but as the mean of the altitudes does not always correspond, with sufficient accuracy, to the mean of clock-times, it is necessary to apply a correction on this account, when the observations are treated in this manner.

When one star was taken near the meridian, the other near the prime vertical, which was frequently the case, the first could be used for the latitude, the other for the clock error. In some cases the reduction was accordingly made in this manner. But as the calculation of one of these quantities requires the knowledge of the other, and the drift of the ship from the time of the last observation was unknown, it was always necessary to apply corrections afterwards by a differential formula. For the great mass of these observations of two stars it was therefore preferred to deduce the definitive latitude and clock error at once by means of the two given altitudes and declinations, the difference of right ascensions and the difference of clock times, reduced to sidereal time. It will not be necessary to reproduce here the formulæ used, the method being well known. As a control on the computation as well as on the observations, the computation was generally carried out in duplicate, the two altitudes taken in the same position of the instrument (both with "great numbers" or both with "small numbers") being combined together. Both results are then affected by a possible error of the assumed zenith point, but in contrary directions, so that in the mean of the two the error will be very nearly eliminated, as may be seen from the following differential formulæ, where h and h' are the altitudes of the two stars taken in the same position of the instrument, a and a' the corresponding azimuths, φ the latitude and θ the clock correction (i. e. local time minus clock time):

$$d\varphi = \frac{\sin a \,.\, dh' - \sin a' \,.\, dh}{\sin (a' - a)}$$

$$d\theta = \frac{\cos a' \, dh - \cos a \, dh'}{\sin (a' - a) \cos \varphi} \,.$$

When the altitudes are subject to no other errors than that of the assumed zenith point, $dh = dh'$ for the one position of the instrument and likewise for the other, but then with opposite sign; and as the coefficients depending on the azimuths are nearly the same in both combinations, the errors of the two results are nearly equal and opposite. The same formulæ may of course also serve to compute the correction to the zenith point when required.

If one of the altitudes, or both, are the means of a series, and the mean of the clock times (T or T') requires a sensible correction in order to correspond to the mean of altitudes, the corrections to the latitude and hour angle, as computed by the original numbers, will be:

$$d\varphi = \frac{\sin a \sin a' \cos \varphi}{\sin (a' - a)} \, d(T' - T)$$

$$dt = -\frac{\sin a' \cos a}{\sin (a' - a)} \, d(T' - T) \quad \text{and } d\Theta = dt - dT.$$

It happened sometimes that one star was observed in both positions of the instrument, but the other only in one. In order to utilise the latter it was necessary to deduce the zenith point from the first. If x is the correction to the assumed zenith point, h_1 and h_2 the two altitudes of the *same* star, as following from this assumption, t_1 and t_2 the corresponding hour angles (suffix 1 and 2 corresponding to small and great numbers) d the declination, the following exact formula

$$\cos \frac{h_1 + h_2}{2} \, . \sin \left(\frac{h_1 - h_2}{2} + x \right) = \cos \varphi \cos d \sin \frac{t_2 + t_1}{2} \, . \sin \frac{t_2 - t_1}{2}$$

may be safely replaced by

$$x = \frac{h_2 - h_1}{2} + \cos \varphi \cos d \sec \frac{h_2 + h_1}{2} \sin \frac{t_2 + t_1}{2} \, . \, \frac{t_2 - t_1}{2} \, ,$$

$t_2 - t_1$ being the difference of clock times reduced to sidereal time, and of course expressed in the same units as $h_2 - h_1$. When approximate values of latitude and clock error have been computed from the altitudes of the two stars, measured in the same position of the instrument, x can be computed by this formula, after which the differential formulæ above give the required corrections to the preliminary results.

The few altitudes of stars taken with the small instrument have been treated in the same manner, only that the mean of altitudes and mean of clock times have been used without further correction. The zenith point of this instrument was generally 180° but was found on one occasion to be about 179° 30′.

During the time of the year with no Sun or only a very low Sun, but no stars visible to the naked eye, which interval may be rather long in high latitudes, Lieut. SCOTT-HANSEN made preliminary calculations in order to find the stars in the telescope of the large altazimuth.

In summer time only the Sun was available for observation. These altitudes were mostly taken with the sextant, but some also with the altazimuth. The results of these observations, especially the clock error, are generally subject to greater uncertainty than those of the winter observations, by reason of the interval of several hours between the determinations of latitude and time. While in many cases the time could be safely computed by means of the latitude deduced from the nearest meridian altitude, it was in other cases necessary to allow for the drift of the ice, and the interpolation necessary for this purpose is of course always somewhat uncertain. When the latitude was determined by extra-meridian altitudes the same remark applies, so that sometimes repeated corrections were necessary. Only in a few cases was the clock error determined by equal altitudes of the Sun, which were, for the same reason, generally treated as absolute altitudes. In some cases when a series of circum-meridian altitudes had been taken, the moment of apparent noon could be deduced with sufficient approximation from the differences, and thus the time be determined as well as the latitude. In some few cases, when two or more altitudes of the Sun had been taken near the prime vertical, one of the computers, Mr. ALEXANDER, has with advantage employed the differences for determination of latitude.

Some observations taken with the altazimuth during the last summer (1896) have been treated in the same manner as the star observations, thus neglecting the drift in the interval.

Occasionally altitudes of very low stars or a low Sun were measured in connection with the ordinary determination of time and latitude, especially during severe cold, in order to determine the refraction.

For the reduction of altitudes measured with the sextant from the natural horizon it was deemed most correct to form a table for the dip, adapted to the peculiar circumstances, though the difference from the values ordinarily used are not of importance. The expression for the dip of the horizon may be written

$$D = S\sqrt{\frac{2H}{\varrho}(1-k)}$$

where $S = 206\,265''$, H is the height of the eye, ϱ the average radius of curvature for the part of the earth under consideration, and k the constant of terrestrial refraction. The theoretical expression for this constant contains the factor $\frac{273}{273 + t}$, where t is the centrigrade temperature; consequently two values k and k' corresponding to the temperatures t and t' are connected by the equation

$$\frac{k}{k'} = \frac{273 + t'}{273 + t}.$$

The tables in use among our sailors, which are adapted to a certain curvature ϱ' and a certain mean temperature t', give $D = 600''$ for a height of 100 feet (norw.) = 31.37 metres; consequently k' may be deduced from the equation

$$600 = S \sqrt{\frac{62.75}{\varrho'}} (1 - k').$$

Supposing ϱ' to give the average curvature for latitude 50° ($\log \varrho' = 6.8049$), this equation gives

$$k' = 0.139,$$

and supposing further this value to be adapted to a temperature $t' = 10°$ C., the value corresponding to $t = -20°$, which may be taken as a mean temperature in the polar regions, is

$$k = \frac{283}{253} k' = 0.156.$$

Taking finally the curvature for 80° of latitude ($\log \varrho = 6.8060$) the expression for the normal dip of the horizon in the polar regions will be

$$D = 106''.0 \sqrt{\text{height in metres}},$$

from which a table was formed. Casual irregularities may of course considerably surpass the difference between this and the mean value for temperate regions. Observations of the midnight Sun in 1894, as compared with southern altitudes taken over an artificial horizon, seem to indicate a smaller value of the dip.

During the voyage along the coast of Siberia the Sun's altitude was sometimes measured from a coast line at a given or estimated distance. Supposing the depression of this coast line, as seen from the height H, to be the sum of the dip for an eye's height H' having the coast line in the apparent horizon, and the angle between the two straight lines, issuing from the points in heights H and H' to the point in question, the expression will be

$$x = \frac{C^2 H}{\gamma \varrho} + \tfrac{1}{2}\gamma (1 - k)$$

where γ is the given distance in miles (or minutes of arc) and C is the number of minutes in an arc of circle equal to the radius (3438). Using the above values of k and ϱ and multiplying by 60, this gives

$$x = 110''.8 \, \frac{H}{\gamma} + 25''.3 \, \gamma$$

when H is expressed in metres.

On taking the altitude of a star with an artificial horizon it happened twice that one star was combined with the reflected image of another nearly in the same vertical (α and γ Cygni, Castor and Pollux). These observations were utilised in the following manner. As soon as it was detected which stars had been observed, a preliminary calculation would give with sufficient accuracy their difference of azimuth. If H and h are the true altitudes of the two stars, D and d their declinations, R and r their right ascensions, A and a their azimuths, and P the measured angle diminished by a quantity corresponding to the sum of refractions, which could be found by the same preliminary calculation, the true altitudes are given by the following equations:

$$\cos (H + h) = \cos P + 2 \cos H \cos h \sin^2 \frac{A - a}{2}$$

$$\sin^2 \frac{H - h}{2} = \sin^2 \frac{D - d}{2} + \cos D \cos d \sin^2 \frac{R - r}{2} - \cos H \cos h \sin^2 \frac{A - a}{2}$$

where approximate values of H and h will suffice on the right.

The determinations of time and latitude near the observations of Lunar Distances and of Solar Eclipses, the observations taken at sea in 1893 and on the sledge expedition, and some few others, have been computed by the writer, all the others by Mr. A. ALEXANDER, teacher of mathematics at the Royal Military Academy, and Mr. A. GRAARUD, assistant at the Norwegian Meteorological Institute, both in Christiania.

The present volume contains all that is necessary for the reduction, except the meteorological data. An approximate value of the temperature may be inferred from the length of the level-bubble for the vertical circle of the large altazimuth (List A of Observations) the length being about 20 for 0° and about 38 for —50° C.

Determination of Azimuth.

The astronomical foundation for the determination of magnetic declination was furnished either by the altazimuth or by an azimuth-compass, or in some cases by a magnetic theodolite.

In the first case the telescope was first pointed to the magnetic observatory (either a centered mark or the objective of the magnetic theodolite, illuminated from behind) and the horizontal circle read off on both microscopes; then to the Sun or a star (either one of the stars whose altitudes were measured for time and latitude, or, more frequently, a lower one) and the horizontal circle and striding level read off after the noting of the time. Sometimes the observations were repeated in the other position of the instrument.

If C_r and C_l are the circle readings for a terrestrial mark in or near the horizon, respectively with obj. right and obj. left, and the error of collimation (c) is defined by the condition that the objective end of the optical axis forms the angle $90° + c$ with the ocular end of the instrument's horizontal axis, then

$$c = \frac{1}{2}\,(C_r - C_l)$$

of course neglecting the difference of 180°.

If R and L are the readings of the right and left end of the striding level, as seen by an observer facing the same way as the object glass, and if further the inclination of the axis is defined as positive when the right end is the higher, then

$$i = \frac{1}{2}\,p\,(R - L)$$

p being the value of a division of the level. As remarked before, the sum of the two differences $R - L$, corresponding to the two positions of the level, will for this instrument give the inclination in seconds of arc.

If a be the azimuth of the star at the moment of observation, reckoned from south through west, as computed from the given declination, latitude and clock error,

$$A = 180^\circ + a + i \text{ tg } h \pm c \sec h$$

will be the azimuth, from north through east, corresponding to the circle reading S for the star; here h is the apparent altitude of the star, the double sign of c corresponding to obj. right and obj. left.

It has not been necessary to take account of the collimation. For the high stars the effect is eliminated in the mean, as the observations were taken in both positions of the instrument and the altitudes were nearly the same on both occasions. This is, however, not visible from the circle-readings, which ought to differ by about 180°, but do not do so, the observer having always added 180° to the second circle-reading. When the small altazimuth was used the difference of 180° has been retained.

For some low stars, observed only in one position of the instrument, the effect of collimation will be very nearly the same as for the terrestrial mark, supposing both to have been observed in the same position of the objective relative to the observer, which has not always been expressly stated.

The accuracy of angle-measuring with the magnetic theodolite being inferior to that of the large altazimuth, a few seconds of arc are of no importance in the determination of azimuth.

The values of the angle $C - S + A$, where C is the circle-reading for the mark in the magnetic observatory, were transmitted to Mr. STEEN for application in the reduction of the observations of declination.

On several occasions the Sun was observed directly with the magnetic theodolite.

Lieut. SCOTT-HANSEN also made a great number of independent determinations of the magnetic declination by means of the azimuth compass, which was for this purpose mounted on the ice at a distance of at least 60 paces from the ship. The observations then consisted in simply noting the time when the Sun or a star passed the plane of the sights, and reading off the card of the compass. The reduction of these observations does not call for any further remark.

Most of the azimuth-observations have been computed by Mr. ALEXANDER and Mr. GRAARUD.

Longitude, and Rate of Chronometers.

The expedition was equipped with 3 Mean Time chronometers: *Kutter* 24, belonging to the ship, *Hohwü* 639 lent by the University Observatory in Christiania, and *Iversen* 961, lent by the maker, Mr. Iversen in Bergen. A fourth box chronometer, *Frodsham* 3555, lent by the Norwegian Meteorological Institute, was regulated to Sidereal Time some time before the departure and began with a small losing rate, which, however, continually increased during the first winter, and reached the inconveniently large value of between 5 and 7 seconds a day. It was not used for the observations of stars but only for some magnetical observations, and served for the daily comparisons by coincidences. These four chronometers will be designated in what follows by *Kt, Hw, Iv* and *Fr* respectively.

There were also on board a number of pocket chronometers and watches, one of which was always used for the astronomical observations and compared with *Hw*, generally before and after each observation. The observation watch was also compared daily with *Hw* at the time of comparison for the box chronometers.

The box chronometers were placed on two shelves in Lieut. SCOTT-HANSEN's cabin, *Hw* and *Fr* only 16 cm., *Kt* and *Iv* 60 cm. above the deck. A thermometer which was placed in the lower shelf with the bulb 17 cm. above the deck, was read off at the time of the daily comparisons. In the same cabin was also a thermograph, 80 cm. above the deck, which was working almost continuously from 1893 July 5 to 1896 August 10. The thermograph was compared daily with a thermometer placed by its side and with the thermometer in the lower chronometer shelf. By means of this last comparison and the daily reading of the thermometer in the shelf, which can be compared with the thermograph-sheets for the same time, the mean temperature of the two lower chronometers can be determined with sufficient accuracy.

Between the last Time Signal from the Christiania Observatory received at Vardö 1893 July 19 and the first after the return, received at Tromsö 1896 August 23, a good many observations were taken which can be used to determine the Greenwich Time. It was necessary to utilise them all, not only for the sake of longitude, but also to get a sufficiently accurate determination of the rate of the chronometers which were used for the pendulum observations with the Sterneck-apparatus. The ordinary determinations of local time are quite useless for this purpose, because the ship was continually drifting and even a small drift east or west will have a considerable influence on the Local Time in these high latitudes.

The observations for the determination of Greenwich Time were, however, very different in point of accuracy. They shall now be considered.

Solar Eclipses.

1894 April 5 (April 6 on board). The greatest phase of this eclipse, which took place about 2 o'clock in the afternoon, was 0·58. The same evening, about 11 o'clock, altitudes of α Cassiopeiæ and γ Draconis gave the latitude 80° 13′ 5″ and the error of *Hw* $8^h\ 18^m\ 9^s$ slow on Local M. T. As Mr. Scott-Hansen had made an approximate calculation of the moments of contact, 3 observers were ready with the telescope of Negretti and Zambra and the altazimuth, viz. NANSEN, SCOTT-HANSEN and JOHANSEN. As they were of course on the look-out in good time before the calculated time of 1st contact they shifted positions; at the time of observation Nansen happened to be at the clock, Scott-Hansen at the telescope and Johansen at the altazimuth. At first contact both observers called out at the same moment, which was (reduced to *Hw*)

April 5, $16^h\ 35^m\ 43^s$.

As nothing is to be seen at the moment of geometrical contact, this is of course some seconds late. At the second contact the observer at the altazimuth called out at

1) $18^h\ 31^m\ 25^s$

when the little notch was estimated to be of the same size as at 1st contact. Scott-Hansen noted the time as

2) $18^h\ 31^m\ 36^s$

when the last trace vanished in the telescope. He adds the remark that the image was very sharp.

The observations have been calculated with the Besselian elements given in the *Connaissance des Temps,* and the results have been combined as follows:

1st contact,	*Hw* — Gr. M. T.		=	42m	12s
2nd —	[1]	—»—	=	41	27
	Mean			41	49.5
2nd —	[2] *Hw* — Gr. M. T.		=	41	38
	Definitive mean		=	41	44

On account of Mr. Scott-Hansen's remark about his observation of the 2nd contact it was deemed reasonable to give it the same weight as the mean of the two others. If the two notches which were estimated alike had been exactly so, the first mean would be nearer the truth, but the difference is not of any importance.

1895 March 25 (March 26 on board). The circumstances of this eclipse which took place about 6 in the afternoon were much less favorable than the former. The greatest phase was only 0.045, and the limb of the very low sun was so boiling, especially at 2nd contact, that the observations were very difficult.

No stars were observed the same day, but altitudes of η Ursæ Majoris and α Cygni were taken the day before and the day after; the mean of the results, which differ only 24″ in latitude and 54s in time, was latitude 84° 8′ 22″ and *Hw* 5h 58m 51s slow on Local Mean Time.

The observers were Scott-Hansen at the telescope and Sverdrup at the altazimuth. At 2nd contact both observers took care to note, as nearly as possible, the moment when the notch was apparently of the same magnitude as at 1st contact. The moments, reduced to *Hw,* were

1st contact	23h	36m	49s	Hansen
	23	36	54	Sverdrup
2nd —	0	13	42	Sverdrup
	0	14	39	Hansen
Last trace in the boiling limb	0	14	54	Sverdrup

The calculation by means of the Connaissance des Temps gave the results

Hansen	1st contact, *Hw* — Gr. M. T. = 40^m 58^s		39^m 53^s
	2nd — . —»— = 38 48		
Sverdrup	1st contact, *Hw* — Gr. M. T. = 41 3		39 27
	2nd — . —»— = 37 51		
Sverdrup, last trace	. . . .		39 3

In this case it was not deemed safe to use the last as an independent observation, because it was made with the small instrument and a very boiling limb. The mean of the two others is

$$Hw - \text{Gr. M. T.} = 39^m\ 40^s.$$

Preparations were also made for observing the Eclipse of 1895 Aug. 20 which was calculated to have a duration of about 33^m. Three circummeridian altitudes of the sun the same day (some 6 hours before) gave the latitude 84° 17′ 49″ and the error of *Hw* approximately 4^h 31^m 0^s late, but the ship had a considerable south-easterly drift in these days. There was, however, a gale blowing with snow almost the whole afternoon. A clear interval, beginning some minutes after 1st contact, made it possible to follow the eclipse until a moment which was estimated to be 4—6 minutes before 2nd contact. A calculation has shown that this estimate was a couple of minutes too small.

Lunar Distances.

On some occasions the Moon's distance was measured from the Sun (once), Jupiter (5 times), Mars or Pollux (once each). According to nautical usage the altitudes of the two objects were measured before and after the distances in order to get, by interpolation, the altitudes at the moment of the mean of the distances; it was, however, preferred to calculate these altitudes and to use the measured altitudes as a means of completing the determinations of time and latitude. In most cases these altitudes were taken with the altazimuth, but only in one position of the instrument; the zenith point of the vertical circle was then deduced from neighbouring observations.

The measured distances will be found among the other observations with the sextant. In the computation due regard was taken to the elliptical figure of the disc due to refraction and to the small effect of the Moon's parallax in azimuth. For the determination of the apparent altitudes the refraction corresponding to the meteorological conditions was of course used; while an error affecting the true and the apparent altitude alike has only an insensible effect on the calculation of the true distance (being multiplied by the Sine of the difference between true and apparent altitude) an error in the refraction or parallax would affect the true distance by a quantity of the same order as the error itself.

The results are not satisfactory. In some cases when the observations have been taken with intervals of a few days or weeks, the chronometers are unanimous in protesting against the deduced Greenwich times. As the temperature during these observations was only once (1896 April 22) as high as —16° C., and on all the other occasions between —27° and —43°, it is probable that the sextant was affected with errors that would not have been of great importance for ordinary altitudes of the Sun, but which proved fatal to the delicate operation of determining the longitude by Lunar Distances. It is also to be remarked that the index error was not determined on each occasion but for some time considered as constant, because a determination in August 1893 in the Barents Sea and another off the mouth of Lena shortly before the enclosure in the ice had given identical results.

It would of course have been better to use the altazimuth for determining the difference of azimuth between the Moon and a star or the Sun, and thence deduce the Moon's right ascension. But as it happened that the planet Jupiter was circumpolar during all the 3 years of enclosure in the ice and so was always at hand when the Sun was absent, it was found to be a much more ready means of getting an approximate longitude to observe the eclipses of Jupiter's Satellites and compare with the predicted times in the Nautical Almanac.

The results of the Lunar Distances are included in a table below (Tab. c) containing the results of these Eclipses.

Eclipses of Jupiter's Satellites.

The observed moment of commencement or end of an eclipse of a Satellite is dependent on many circumstances, the aperture of the telescope being perhaps the most important. As the predicted times are sometimes seriously in error, especially for the outer Satellites, it was thought at first that a sufficient number of the more than 80 phenomena observed on board the *Fram* would be found to have been observed also in other places with known longitudes, in which case the error of theory could be eliminated. But only a few such cases could be found, and in two of these is turned out that the same phenomenon had been observed in 2 or more places in Europe, but with such discordances that evidently no reliable result could be obtained in this way.

But as a great number of observations made in Europe and Australia in the years 1893—96 have been published it was thought possible to utilise the whole mass as a means of deducing empirical corrections to the predicted times for the periods of observation on board the *Fram.* This has been tried in the manner explained hereafter.

It should be stated that the imperfection of prediction is not so much due to theory proper; for the theory of LAPLACE with the small additions of SOUILLART and ADAMS would certainly be amply sufficient; but the difficulty is with the determination of the numerous constants, required by theory, but necessarily deduced from observations. In this respect nothing has been done, so for as I know, since the times of DELAMBRE and DAMOISEAU; at all events the predictions of the Nautical Almanac are based on the Tables of Damoiseau, continued and corrected, for Tables I and III, by Adams (Scientific Papers, Vol. I, p. 113). But the old determination of the constants is far from satisfactory. Thus Damoiseau states in the introduction to his Tables that the adopted value of the inclination of Jupiter's equator to his orbit, 3° 4′ 5″, was determined from observations of eclipses of Sat. III, but that Sat. IV gave another value, smaller by 2′ 47″, and that this smaller value has been used for this Satellite. In this connection it may be remarked, that if the coefficient of the equation tabulated in Damoiseau's Table XXIII for Sat. IV be multiplied by 1.015, corresponding to an augmentation by 2′ 47″ of the said angle, the eclipse of 1895 January 17, which was predicted to have a duration of more than half an hour, would disappear; and in point of fact the Satellite was observed by Mr. Scott-Hansen during a large part of the predicted time of eclipse without any sensible diminution of its brightness. Of course I do not mean to say that Damoiseau's Tables can be corrected in this rough manner; the remark is made only to adduce an example of a weak point in the numerical part of the foundations. It is also expressly stated by Damoiseau that some of his constants require further investigation.

In order to deduce empirical corrections which can be used for the *Fram*-observations it was first necessary to reduce the continental observations to some common standard in regard to extraneous circumstances. It is well known that the treatment of observations of these eclipses is difficult. Some 25 years ago Professor DE GLASENAPP of St. Petersburg made an elaborate investigation principally with the intention of deducing the light-equation from a large series of observations of Sat. I. By the courtesy of the author I am in possession of the original memoir, but as I am quite unacquainted with the Russian language, my knowledge of its contents rests on a very clear abstract given by Mr. DOWNING in "*The Observatory*", Vol. XII. It was necessary for the author's purpose to take into consideration: the aperture of the telescope, the absorption of light by the atmosphere and its dependence on the altitude, the Planet's distance from the Earth, the excentricity of Jupiter's orbit, the phase, the Satellite's angular distance from the Planet at the time of reappearance or disappearance, and the effect of the penumbra. The final result is not encouraging for the treatment of such observations. After having deduced the light-equation and two other quantities from the observations, reduced to a common standard in regard to the circumstances named above, Mr. de Glasenapp had the happy idea to solve his equations afresh, using the observed times as they stand. The probable errors in this latter case are not much greater than in the first, which means that the discordances between the predicted and the observed times of disappearance and reappearance of Sat. I may, to a large extent, be considered as accidental.

For the purpose of utilising the *Fram*-observations the case is so far different that there is no question about the absolute moment of the Satellite's centre being on the limb of the shadow, and that the outer Satellites are of the same importance as Sat. I. As the telescope used on board was considerably smaller than those generally used in observatories for the same observations, it was necessary to take account of the aperture; and it must also be admitted that the Planet's distance from the Earth may have a sensible effect on the magnitude of the "invisible segment", i. e. the illuminated portion of the Satellite's disc which is at the limit of visibility for a given telescope. As to the absorption of light at different altitudes, the writer was in some doubt whether it would be safe to neglect it, but finally it was decided to put it in the great bag of accidental errors, the most important of which is, perhaps, the difference in the keenness of sight for the different observers. It is true that the difference of absorption may have an effect of systematic character, because the Planet's altitude in the high latitudes of the *Fram* was of course on the average smaller than in Europe and Australia; but as this effect will be of contrary sign for disappearance and reappearance, it might be expected to make itself manifest and thus give the means for elimination from the whole mass of observations.

The problem to be solved is firstly to find, by pairs of observations of the same phenomenon, made with telescopes of different aperture, the breadth of the invisible segment corresponding to a standard aperture and an arbitrarily chosen distance; then to apply the values found for disappearance (D) and reappearance (R) of the different Satellites to all the continental observations taken during the period of polar observations, in order to deduce such corrections to the predicted times that they will correspond to the telescope of the *Fram*. A convenient form for the calculations has been found by the following considerations.

As the connection between the variation of the illuminated portion of a Satellite, crossing the surface of the shadow, and the time, depends on the position of the chord described by the Satellite's centre during the eclipse, certain quantities must be taken out of Damoiseau's Tables, the foundation of which is the theory of Laplace contained in *Mécanique Céleste,* Livr. VIII. For the quantities taken from this theory the notation of Laplace has been retained as far as convenient.

The signification of the letters employed below is:

x the breadth of the invisible segment, as seen with a telescope of the standard aperture A, when Jupiter is at the standard distance D from the Earth. x may be expressed in parts of the Satellite's radius or in some other convenient unit.

T_1 and T_2 the times for the same phenomenon observed by means of telescopes of aperture A_1 and A_2 but as far as possible in similar circumstances in other respects.

D' Jupiter's distance from the Earth at the time of observation (known from the ephemerides).

ϱ the ellipticity of the section of the shadow traversed by the Satellite (a little different for the different Satellites).

α the semi major axis of the same section, corresponding to the mean distances of Satellite and Planet.

β the jovicentric angular value of α.

s the Satellite's jovicentric latitude above the plane of Jupiter's orbit at the moment of heliocentric conjunction. In the case of the shadow Laplace neglects the angle between Jupiter's equator and the plane of his orbit, because its effect would be of the same order as the square of the ellipticity, which is also neglected.

γ the angle between the Satellite's relative motion at conjunction and the circle of latitude (towards the north). Owing to the small inclinations γ is never much different from 90°.

w the Satellite's jovicentric motion in one second of time, expressed in some convenient unit.

The quantities s and γ may be calculated by means of Damoiseau's Tables in the following manner. According to Laplace

$$s = \frac{\beta}{1+\varrho}(M-K)$$

where M is the number so designated by Damoiseau and taken out of his Tables by means of the arguments given in Adams' continuation; K is the sum of constants added in order to make all tabular numbers positive[1]. $M-K$ is the quantity called ζ by Laplace.

The angle γ is given by the equation

$$\cos\gamma = \frac{ds}{d\nu}$$

where $d\nu$ is the Satellite's jovicentric motion in its orbit. This can be found by means of the quantity called "reduction" in Damoiseau's Tables, but more readily and in some cases more accurately by the following consideration. $M-K$ is of the form

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[1] In the case of Sat. II, K is given by Damoiseau as 0.6400, but has been here applied as 0.6415, because the numbers of his Table XXIV are 0.0015 too great.

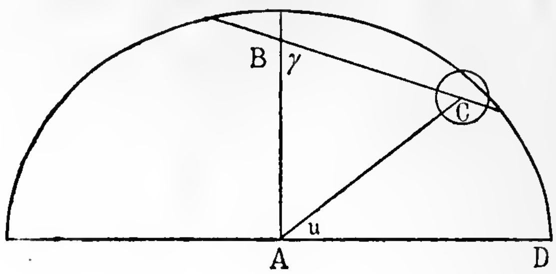
$$M - K = h \sin H + i \sin I + \text{etc.}$$

where the rate of change of the arguments H, I etc. is so little different from the rate of change of ν that they may be considered as equal during an eclipse. Consequently

$$\frac{ds}{d\nu} = \frac{\beta}{1+\varrho} (h \cos H + i \cos I + \text{etc.}) =$$

$$\frac{\beta}{1+\varrho} [h \sin (H + 90°) + i \sin (I + 90°) + \text{etc.}].$$

Or the arguments which have already served for finding s will, when they are all augmented by 90°, give $\cos \gamma$.



In the figure A is the centre of the elliptic shadow, $AD = \alpha$, C the centre of the Satellite, CB the line of its relative motion, $AB = \frac{s}{\beta} \cdot \alpha$, $ABC = \gamma$. The Satellite is supposed to be in such a position that a certain fraction σ of its radius r is outside the shadow. The connection between the difference of observed times of a disappearance (or reappearance) and the variation of the breadth of the invisible segment depends on the angle $DAC = u$. This of course varies during the observations, but may here with sufficient accuracy be considered as constant for a given phenomenon, corresponding to a given value of the fraction σ. It would not be difficult to take account of the phase of the Satellite, which can never exceed $0.02\ r$, but it is also easily seen that it is of no importance in this connection. The angle u can be determined by the triangle ABC, where the angle $ACB = 90° + u - \gamma$ and

$$\frac{\cos (\gamma - u)}{AB} = \frac{\sin \gamma}{AC}.$$

Now as the elliptic radius corresponding to the direction u is, neglecting the square of the ellipticity, $\alpha\,(1-\varrho \sin^2 u)$ it follows that $A\,C = \alpha\,(1-\varrho \sin^2 u) -(1-\sigma) r = \alpha\,[1-\varrho \sin^2 u-(1-\sigma) b]$, when b is the Satellite's radius expressed as a fraction of α; from observations in recent years this is sufficiently well known. Consequently

$$\cos\,(\gamma - u) = \frac{s \,.\, \sin \gamma}{\beta\,[1-(1-\sigma) b - \varrho \sin^2 u]} \quad . \, . \, . \; (1)$$

Here all quantities, except u, are known as soon as a convenient choice of the fraction σ is made. The equation gives 2 values of $\gamma-u$, one for D, the other, with contrary sign, for R. The angle u is considered as negative on the south side of AD.

It is seen from the same figure that if the breadth h of the segment outside the shadow is measured along the elliptic normal through C, and ζ is the angle between this normal and $A\,C$, where, with the same accuracy as before,

$$tg\,\zeta = \varrho \sin 2u \quad . \, . \, . \; (2)$$

then the angle between the normal and the direction of relative motion is $90^\circ + u - \gamma + \zeta$, and consequently, if dt is the increment of time and $dh = -k \,.\, dt$,

$$k = w \,.\, \sin\,(\gamma - u - \zeta) \quad . \, . \, . \; (3)$$

The same equation holds good for reappearance, where h increases with the time, for then $\gamma-u$ and k are negative.

The quantity of light received from the Satellite at a given moment may be supposed to be proportional to the apparent size of the illuminated segment. As the dimensions of the Satellites are between $^1/_{25}$ and $^1/_{44}$ of the dimensions of the shadow-section, the curvature of the small part of the contour intercepted by the satellite during the observations (which can easily be taken into consideration) has been neglected in the following, because its small influence is very nearly constant for each Satellite and will not disturb the final results. The most extreme eclipses of Sat. IV, where observations of the same D or R made with different instruments may extend over several minutes, the Satellite almost grazing the shadow, must be left out of consideration as unfit for our purpose.

The segment Σ being thus considered as an ordinary segment of a circ e it can be expressed as a function of the breadth h by the series

$$\Sigma = \tfrac{4}{3}\sqrt{2\,r}\,.\,h^{\frac{3}{2}}\left\{1 - \tfrac{3}{20}\,\frac{h}{r} - \tfrac{3}{224}\left(\frac{h}{r}\right)^2 - \ldots\right\} \ldots (a)$$

the convergence of which will be sufficiently rapid for admissible values of h.

If Σ and h correspond to an observation at the distance D, Σ' and h' to another distance D', then according to the above supposition

$$\frac{\Sigma}{D^2} = \frac{\Sigma'}{D'^2},$$

from which it follows that

$$\frac{\Sigma}{\Sigma'} = \left(\frac{D}{D'}\right)^2 = \left(\frac{h}{h'}\right)^{\frac{3}{2}}\left(1 + \tfrac{3}{20}\,\frac{h' - h}{r} + \ldots\right)$$

and

$$\frac{h'}{h} = \left(\frac{D'}{D}\right)^{\frac{4}{3}}\left(1 + \tfrac{1}{10}\,\frac{h' - h}{r} + \ldots\right)$$

or, if for a moment $\left(\frac{D'}{D}\right)^{\frac{4}{3}}$ is called f,

$$h' = f\,h\left(1 + \frac{f-1}{10}\,.\,\frac{h}{r} + \ldots\right).$$

Now, when D is the mean distance of Jupiter from the Sun, which is also a mean distance from the Earth, the numerical value of the coefficient of $\frac{h}{r}$ can never exceed 0.04, and as h is certainly only a fraction of r for all but the smallest telescopes, the second term may safely be neglected. Consequently an observation at the distance D' can be reduced to the distance D by writing $\left(\frac{D'}{D}\right)^{\frac{4}{3}}\,.\,h$ for h'.

If a disappearance or reappearance at the distance D is observed at the moment T by means of a telescope of aperture A (in which case $h = x$) and the same phenomenon occurred at the moment T_1 for an aperture A_1 giving the invisible segment Σ_1, it is assumed that the quantity of light is proportional to the square of the aperture, or

$$\Sigma\,.\,A^2 = \Sigma_1\,.\,A_1{}^2,$$

and further that the difference between the segments may be found with sufficient accuracy by a differential formula, or $\Sigma_1 - \Sigma = \mathrm{d}\,\Sigma$, where

$$\mathrm{d}\,\Sigma = 2\sqrt{2\,hr\left(1 - \frac{h}{2r}\right)}\,.\,\mathrm{d}h \text{ and } \mathrm{d}h = -k\,.\,\mathrm{d}t = k\,(T - T_1).$$

If this last supposition should in some cases prove insufficient, the series (a) will give the means for further corrections. The accuracy aimed at in the reduction depends of course on the accuracy of the observations, but as this is manifestly not great no such refined corrections have been found necessary.

Now

$$\Sigma_1 - \Sigma = \left[\left(\frac{A}{A_1}\right)^2 - 1\right] \Sigma = 2\sqrt{2\,rx\left(1 - \frac{x}{2r}\right)} \,.\, k\,(T - T_1)$$

and on division by

$$\Sigma = \tfrac{4}{3}\, x \sqrt{2rx}\left(1 - \tfrac{3}{20}\,\frac{x}{r} - \ldots\right)$$

$$\left(\frac{A}{A_1}\right)^2 - 1 = \frac{3}{2}\,\frac{k\,(T - T_1)}{x}\left(1 - \tfrac{1}{10}\,\frac{x}{r} - \ldots\right)$$

or, neglecting the second term and multiplying by x

$$\left[\left(\frac{A}{A_1}\right)^2 - 1\right] x = \tfrac{3}{2}\, k\,(T - T_1).$$

Similarly for another observation of the same phenomenon, made with a telescope of aperture A_2 at the moment T_2

$$\left[\left(\frac{A}{A_2}\right)^2 - 1\right] x = \tfrac{3}{2}\, k\,(T - T_2)$$

and by subtraction

$$\left[\left(\frac{A}{A_1}\right)^2 - \left(\frac{A}{A_2}\right)^2\right] x = \tfrac{3}{2}\, k\,(T_2 - T_1).$$

If the two observations have been made with the Planet at the distance D' instead of D, x is to be replaced by $\left(\frac{D'}{D}\right)^{\frac{4}{3}} x$, and consequently if

$$c = \tfrac{3}{2}\left(\frac{D}{D'}\right)^{\frac{4}{3}} \quad \ldots\ldots\ldots \quad (4)$$

$$a = \left(\frac{A}{A_1}\right)^2 - \left(\frac{A}{A_2}\right)^2 \quad \ldots\ldots\ldots \quad (5)$$

then x may be found by the equation

$$ax = c\, k\,(T_2 - T_1) \quad \ldots\ldots\ldots \quad (6)$$

expressed in the same units as w, $T_2 - T_1$ being given in seconds.

As soon as x has been determined in this manner by pairs of observations, every observed moment T' found by means of an aperture A' at distance D' may be reduced to the standard aperture and distance by the formula

$$T - T' = \left[\left(\frac{A}{A'}\right)^2 - 1\right] \frac{x}{c\,k} \cdot \quad . \; . \; . \; . \; . \; . \; . \; (7)$$

As to the application of the equations (1) . . . (6) only a few remarks are necessary. The standard distance D was taken as 5.20 and a small table formed for the function c (equation (4)) with the argument $\log D'$ from 0.60 to 0.80. The standard aperture was taken as that of the *Fram* telescope which is 7.4 cm., and the quantity $\left(\frac{7.4}{A'}\right)^2$ tabulated from $A' = 6.0$ to 26 cm., the last being the largest aperture employed for the present observations. The fraction σ in equation (1) was taken as 0.2; evidently the choice is not of great importance, the function k having a period equal to the time of revolution of Jupiter.

The ellipticity of the different sections of the shadow has been calculated by Laplace in the chapters of Livre VIII containing the special theories for each Satellite, on the supposition that the ellipticity of Jupiter is 0.07130, the reciprocal of which is 14.025; but as Damoiseau states in the introduction to his Tables that he has employed the value 13.492, the numbers of Laplace were multiplied by 1.0395. More recent observations give a somewhat smaller ellipticity, but when using Damoiseau's Tables his values should clearly be retained.

The diameters of the Satellites employed were those determined by Mr. Barnard with the great Lick refractor (Monthly Notices of the R. A. S., Vol. 55) compared with his value of Jupiter's equatorial diameter (Astronomical Journal, Vol. 14). As the values of a for the four satellites, the equatorial semidiameter of Jupiter being taken as unity, are given by Damoiseau in the appendix to his Tables (p. 196), the fraction b could be calculated for the different Satellites.

As it will be convenient to have x, the breadth of the standard invisible segment, expressed in terms of the Satellite's radius, w must be expressed in the same units. If t is the half duration of a central eclipse, as given by Damoiseau, and expressed in seconds,

$$w = \frac{1}{t}$$

is the relative velocity of the Satellite, expressed in parts of a, and as $r = b \cdot a$,

$$w = \frac{1}{b \cdot t}$$

will give w, k and x in parts of the Satellite's radius.

If S is the time of synodic revolution of the Satellite, β is determined by the equation

$$\beta = \frac{t}{S} \cdot 2\pi.$$

The following Table contains these several quantities which formed the basis of the calculation; it gives 10 w instead of w because it was convenient to multiply both sides of equation (6) by 10. Barnard's value of Jupiter's equatorial diameter at the distance 5.20 is 38″.522.

	I	II	III	IV
ϱ	0.0745	0.0747	0.0751	0.0758
log β	9.2236	9.0227	8.8132	8.5701
a	0.9951	0.9923	0.9877	0.9783
$2r$	1″.048	0″.874	1″.521	1″.430
b	0.0273	0.0229	0.0400	0.0379
log 10 w	8.9533	8.9291	8.5913	8.4883

The projected velocity k was calculated for the three inner Satellites at intervals of about half a year (a whole number of synodical revolutions in every case) from 1893.0 to 1898.5; for Sat. IV whose latest period of eclipses began in 1895 it was calculated with intervals of 67 days (4 synodical revolutions) from 1895.2 to 1897.1. The values which are given below were plotted on cross-ruled paper and curves drawn, from which the value could easily be taken out for any given eclipse. The Table gives 10 k.

Sat. I.			Sat. II.		
	D	R		D	R
1893.00	0.0839	−0.0838	1893.00	0.0678	−0.0675
93.50	832	832	93.50	640	639
94.00	836	837	94.00	641	643
94.50	848	850	94.49	679	683
95.00	866	868	94.99	738	742
95.50	882	884	95.49	795	799
96.00	894	895	95.98	835	838
96.50	898	898	96.48	849	849
97.00	894	893	96.98	836	833
97.49	883	881	97.47	799	795
97.99	868	866	97.97	747	743
98.49	0.0853	−0.0850	98.46	0.0695	−0.0691

Sat. III.			Sat. IV.		
	D	R		D	R
1893.02	0.01666	—0.01657	1895.23	0.01139	—0.01142
93.51	1182	1172	95.41	1738	1751
94.00	1399	1392	95.60	2163	2180
94.49	2059	2065	95.78	2491	2508
94.98	2762	2781	95.96	2738	2755
95.47	3348	3372	96.15	2916	2929
95.96	3740	3757	96.33	3028	3035
96.45	3899	3902	96.51	3077	3078
96.94	3819	3806	96.70	3063	3058
97.43	3518	3494	96.88	2987	2978
97.92	3035	3012	97.06	0.02852	—0.02837
98.41	0.02429	—0.02414			

For the determination of the breadth of the invisible segment all observations of disappearances and reappearances in the years 1893—98, published in the *Monthly Notices* and in the *Astronomische Nachrichten*, were examined, and those selected where the same phenomenon had been observed by means of two or more telescopes of different aperture. Each pair of such observations gave an equation, which was retained in the form of equation (6) with a (which depends on the apertures) as coefficient of x, though it was an unfavorable circumstance that most of the observations had been taken with instruments so far superior to that of the *Fram* in regard of size, that the weight of an equation was often much smaller than would have been the case with a somewhat larger standard aperture. Some few observations with large apertures differing only 1 or 2 cm. have been omitted.

In the second column of the following Table **a**, containing the places of observation, the following abbreviations have been used: Bs Bermerside, Ch Christiania, Gr Greenwich, Gt Göttingen, Jn Jena, Ks Kasan, Ly Lyons, Po Pola, Uc Uccle, Ut Utrecht. In some cases two observations with telescopes of nearly the same aperture have been combined into one, which is indicated by an added 2 or by a + between the places when they were different. Next follow the apertures A_1 and A_2 in centimetres. Owing to the not uncommon custom of giving, in astronomical publications, the aperture in inches of the different countries, even where the metrical system has been introduced, the last figure may in some cases be inaccurate; the fraction of cm. has been retained here only when certain. The last column contains the quantity 10 $ck\ (T_2—T_1)$ which is designated by τ.

No distinction has been made between observations designated by the observers as good or bad.

TABLE a.

			A_1	A_2	c	10 k	T_2-T_1	10 a	
					Sat. I D.				
1893	Nov. 6	Gr, Gr	17.	25.	1.95	.0834	13s	1.05	2.02
1895	Nov. 14.	Gr, Ut	17.	26.	1.60	.0891	1	1.09	0.14
	Nov. 30.	Gr, Bs	17.	24.	1.71	.0892	—11	0.93	—1.68
1898	Jan. 20	Ch, Ch	7.4	18.8	1.57	.0866	16	8.45	2.18
	Febr. 14	Ch, Ch	7.4	18.8	1.72	.0865	12	8.45	1.78
	March 9	Ch, Ch	7.4	18.8	1.82	.0864	26	8.45	4.07
					Sat. I R.				
1893	Febr. 5	Gr, Bs	17.	24.	1.45	—.0835	14	0.93	—1.72
	Febr. 28	Gr, Gr	5(?)	25.	1.35	—.0834	—36	20.0	4.08
	March 23	Gr, Gr	17.	25.	1.29	—.0833	16	1.05	—1.71
	Dec. 10	Ks 2, Ks	8.8	24.4	2.05	—.0836	—38	6.22	6.59
	Dec. 10	Ks, Ks	8.1	9.6	2.05	—.0836	15	2.40	—2.58
1894	Jan. 2	Jn, Bs	10.	24.	1.91	—.0837	—20	4.09	3.18
	Jan. 23	Gr, Gr + Bs	17.	24.5	1.74	—.0837	— 9.5	0.99	1.38
	Febr. 8	Jn, Bs	10.	24.	1.63	—.0838	—16	4.09	2.17
	Febr. 24	Gr, Bs	17.	24.	1.52	—.0840	—15	0.93	1.92
	March 12	Ks 2, Ks	9.0	24.4	1.43	—.0841	—23	5.93	2.78
	March 12	Ks, Ks	8.4	9.6	1.43	—.0841	— 4	1.82	0.48
1895	Jan. 28	Gr, Bs	17.	24.	1.89	—.0872	3	0.93	—0.50
	Febr. 13	Jn, Bs	16.	24.	1.78	—.0873	13	1.25	—2.03
	Febr. 20	Ly, Bs	16.	24.	1.73	—.0874	4	1.12	—0.60
	March 1	Ks 2, Bs	8.3	24.	1.66	—.0875	—14	7.08	2.04
	March 1	Ks 2, Ks	8.3	9.6	-	-	—22	2.11	3.21
	March 1	Ks 2, Ks	8.3	24.4	-	-	—19	7.13	2.77
	March 31	Ks, Ks	10.8	24.4	1.46	—.0877	—75	3.78	9.68
1896	Febr. 25	Gr, Ut	9.	26.	1.84	—.0896	—82	5.26	13.45
	April 2	Gr, Bs	17.	24.	1.60	—.0896	—24	0.93	3.45
	April 2	Po, Bs	16.	24.	-	-	—18	1.25	2.59
	May 11	Uc + Po, Gr	15.	17.	1.37	—.0897	— 8	0.43	0.98
	May 11	Uc + Po, Bs	15.	24.	-	-	—36	1.35	4.42
1897	March 22	Po, Gr	16.	21.	1.81	—.0887	7	0.93	—1.13
1898	May 19	Ch, Ch	7.4	18.8	1.65	—.0854	—20	8.45	2.82
					Sat. II D.				
1894	Febr. 18	Gr, Bs	17.	24.	1.56	0.0648	— 9	0.93	—0.91
	Nov. 15	Gr + Jn, Bs	16.	24.	1.91	.0725	65	1.09	8.97
1895	Nov. 23	Gr, Ut	17.	26.	1.66	.0829	— 9	1.09	—1.24
1898	Jan. 27	Ch, Ch	7.4	18.8	1.62	.0736	25(?)	8.45	2.97
	Febr. 3	Ch, Ch	7.4	18.8	1.66	.0735	39	8.45	4.76

Table **a** (continued).

			A_1	A_2	c	$10\ k$	$T_2 - T_1$	$10\ a$	τ
				Sat. II R.					
1893	Dec. 9	Gr, Gr	17.	25.	2.06	—.0641	—12s	1.05	1.58
	Dec. 16	Gr, Bs	17.	24.	2.02	—.0642	—11	0.93	1.43
1894	Jan. 3	Ks, Ks	8.1	24.4	1.90	—.0643	—62	7.42	7.56
	Jan. 17	Jn, Gr	10.	17.	1.79	—.0646	+ 4	3.16	—0.46
	Febr. 18	Gr, Bs	17.	24.	1.56	—.0651	—14	0.93	1.41
1895	Jan. 11	Ks 2, Ks	8.0	24.4	1.98	—.0749	—52.5	7.71	7.77
	Febr. 12	Jn + Gt, Bs	16.	24.	1.79	—.0758	—30	1.20	4.08
	March 16	Ks 2, Bs	10.1	24.	1.56	—.0770	— 5.5	4.35	0.66
	March 16	Ks 2, Jn	10.1	16.	-	-	+ 6.5	3.10	—0.78
1896	Febr. 13	Gt, Jn	8.	16.	1.89	—.0844	—28.5	6.78	4.56
	March 16	Gr, Bs	17.	24.	1.72	—.0846	—27	0.93	3.92
	March 16	Uc, Ut	15.	26.	-	-	—33.5	1.62	4.85
	April 10	Po, Bs	16.	24.	1.55	—.0847	+21	1.25	—2.75
	April 17	Gr, Bs	17.	24.	1.50	—.0847	—27	0.93	3.45
	May 19	Gr, Ut	17.	26.	1.49	—.0848	—13	1.09	1.65
1897	May 20	Gr, Ut	17.	26.	1.46	—.0803	—33.5	1.09	3.92
				Sat. III D.					
1893	Nov. 10	Gt, Uc	9.2	15.	2.11	0.0126	112	4.04	2.97
1894	March 12	Ks 2, Jn + Ks	8.2	10.	1.43	.0162	—18	2.55	—0.42
	March 12	Ks 2, Ks	8.2	24.4	-	-	14.5	7.13	0.34
1895	Nov. 11	Ks 2, Ks	8.8	10.8	1.59	.0366	— 9(?)	2.44	—0.52
	Nov. 11	Ks 2, Ks	8.8	24.4	-	-	20	6.22	1.16
	Nov. 18	Gr, Ut	17.	26.	1.63	.0368	45	1.09	2.72
1896	March 19	Gr, Bs	17.	24.	1.70	.0385	42	0.93	2.74
1898	Jan. 7	Ch, Ch	7.4	11.8	1.49	.0290	30	6.07	1.30
				Sat. III R.					
1894	Jan. 28	Jn, Gr 2	10.	20.	1.71	—.0147	—27.5	3.69	0.69
	Jan. 28 . . .	Gr, Gr	17.	25.	-	-	—49	1.05	1.23
	March 12	Ks, Jn + Ks	8.1	10.	1.43	—.0161	—38	2.84	0.87
	March 12	Ks, Jn + Ks	8.4	10.	-	-	—69	2.26	1.59
	Octbr. 13 . . .	Ks, Ks	9.6	24.4	1.68	—.0251	—52	5.02	2.19
1896	March 12 . .	Jn, Bs	16.	24.	1.74	—.0385	—29	1.25	1.95
1897	Febr. 26	Po, Ut	16.	26.	1.87	—.0367	+16	1.41	—1.10
	April 10	Jn + Po, Bs	16.	23.	1.71	—.0360	— 3	1.16	0.18
				Sat. IV D.					
1895	Nov. 14	Gr, Ut	17.	26.	1.60	0.0261	0	1.09	0.00
1896	April 13 . . .	Gr, Bs	17.	24.	1.53	0.0300	—16	0.93	—0.73
	April 13	Jn + Uc, Ut	15.	26.	-	-	+40.5	1.52	1.86
				Sat. IV R.					
1896	Febr. 23	Gt, Gr	8.	17.	1.85	—.0294	— 44	7.10	2.40
	Febr. 23	Gt, Bs	8.	24.	-	-	—104	8.03	5.66

When the equations are solved according to the method of least squares, but separately for I D, I R, etc. they give the results contained in the following table, where n is the number of equations, the final columns giving x in seconds of arc for the distance 5.20, adopting Barnard's values of r as above.

	n		$\frac{x}{r}$		x	
	D	R	D	R	D	R
Sat. I . . .	6	25	0.315	0.447	0.″165	0.″234
- II . . .	5	16	0.499	0.815	0. 218	0. 356
- III . . .	8	8	0.208	0.378	0. 158	0. 288
- IV . . .	3	2	0.49	0.54	0. 35	0. 39

An inspection of these numbers gives two results:

1. For all Satellites the numbers are greater for R than for D. This is only what might be expected, because it is quite natural that the quantity of light necessary for enabling the observer to catch the first glimpse of an emerging Satellite must be on the average greater than what is necessary when he is following a vanishing point of light.

2. For the three inner Satellites the fraction of the radius that must be outside the shadow at the moment of observation is greater for a smaller Satellite than for a bigger one, which is also what might be expected when the albedo of their surfaces is not much different.

If the albedo had been the same for all three, the product $x \sqrt{2rx}$, with x expressed in seconds, should be nearly constant (but of course different for D and R). An inspection of the last two columns of Table **a** shows that the values of x are too uncertain to give any information on this delicate point, but it was desirable, in order to diminish the effect of accidental errors, to combine the equations for these three Satellites. The values of x expressed in seconds are not more different than is compatible with the assumption of their identity. For I and II this is not very different from supposing the same albedo, but for III, which is the largest, it would imply the supposition of a somewhat inferior albedo. In this respect it is interesting to compare the relative values of the diameters as found by Pickering by photometric measurements, on the supposition of the same albedo, with those of Barnard and also with those of Michelson which were determined by an entirely different method. The table below contains these numbers.

	Pickering	Barnard	Michelson
I.	1.00	1.00	1.00
II.	0.94	0.83	0.92
III.	1.18	1.46	1.34
IV.	0.70	1.37	1.28

It is apparent that the albedo of III is really somewhat smaller than that of I and II. For IV the difference is very considerable; the above values of x point in the same direction, but by reason of the paucity of the observations they are too uncertain to permit any comparison with Pickering's results.

The solution of the equations for I, II and III on the supposition named above gave the results:

$$\text{For I, II, III D}: x = 0.''178 \pm 0.''038$$
$$\text{- I, II, III R}: x = 0.''263 \pm 0.''034$$

For combination with the already calculated values of the velocity k they were again converted into parts of the Satellite's radius as follows:

	D	R
I.	0.340	0.501
II.	0.408	0.601
III.	0.234	0.345

For Sat. IV the values of x must be retained as they stand. They are not of much importance for the present purpose.

The next step was to apply the values of x to the observations of 1893—96 in order to reduce them to the aperture of the *Fram*-telescope by means of equation (7) and to compare the reduced times with the predictions of the Nautical Almanac. The results are contained in Table **b** where A' is the aperture employed, a' means the function $\left(\frac{7.4}{A'}\right)^2 - 1$, $T'—NA$ is the difference between the observed and the predicted time, $T — T'$ the reduction as calculated by equation (7), and $T—NA$ the correction which must be applied on the times of the Nautical Almanac in order to make them applicable to the *Fram* instrument. The list contains all the published observations excluding only those in the years 1893 and 1896 which fall quite outside the arctic observations of the phenomenon in question. The remarks which in many cases are added to the original observations, were omitted; only a: after the number indicates some source of uncertainty as haze, bad images, twilight etc. The places of observation are the same as before with addition of Windsor in New South Wales. An asterisk indicates a phenomenon which was also observed on the *Fram*.

TABLE b.

				A'	$10\,a'x$	c	$10\,k$	T'-NA	T-T'	T-NA
				Sat. I D. $x = 0.340$.						
1894	Octbr.	12 . . .	Kasan	24.4	−3.08	1.67	0.0857	+51s	−21s	+30s
	Nov.	11 . . .	Bermerside	24.	−3.07	1.88	860	+30	−19	+11
	Dec.	20 . . .	—	24.	−3.07	2.02	864	+30	−18	+12
1895	Octbr.	29 . . .	—	24.	−3.07	1.50	890	+21:	−23	− 2:
	Nov.	14 . . .	Greenwich	17.	−2.76	1.60	891	+31	−19	+12
	Nov.	14 . . .	Utrecht	26.	−3.13	1.60	891	+32	−22	+10
	Nov.	30 . . .	Greenwich	17.	−2.76	1.71	893	+36:	−18	+18:
	Nov.	30 . . .	Bermerside	24.	−3.07	1.71	893	+25:	−20	+ 5:
	Dec.	7 . . .	Greenwich	17.	−2.76	1.75	893	+15	−17	− 2
	Dec.	16 . . .	Utrecht	26.	−3.13	1.81	893	+17:	−19	− 2
1896	Jan.	17 . . .	Greenwich	10.	−1.34	1.93	895	+87:	− 8	+79:
	Jan.	22 . . .	—	17.	−2.76	1.93	0.0895	+ 6	−16	−10
				Sat. I R. $x = 0.501$.						
1893	Dec.	10 . . .	Kasan	24.4	−4.55	2.05	−0.0836	−39s	+26s	−13s
	Dec.	10 . . .	—	8.1	−0.83	2.05	836	− 8	5	− 3
	Dec.	10 . . .	—	9.6	−2.04	2.05	836	+ 7	12	+19
	Dec.	15 . . .	Greenwich	17.	−4.05	2.03	836	−23	24	+ 1
	Dec.	17 . . .	Bermerside	24.	−4.52	2.01	836	−141:	27	−114:
	Dec.	17 . . .	Jena	10.	−2.48	2.01	836	−14	15	+ 1
1894	Jan.	2 . . .	Bermerside	24.	−4.52	1.91	837	−83:	28	−55
	Jan.	2 . . .	Jena	10.	−2.48	1.91	837	−63	15	−48
	Jan.	23 . . .	Greenwich	25.	−4.58	1.74	838	−14	32	+18
	Jan.	23 . . .	—	17.	−4.05	1.74	838	− 7:	28	+21:
	Jan.	23 . . .	Bermerside	24.	−4.52	1.74	838	−19	31	+12
	Jan.	25 . . .	Jena	10.	−2.48	1.73	838	−10	17	+ 7 *
	Febr.	8 . . .	Bermerside	24.	−4.52	1.63	839	−24	33	+ 9
	Febr.	8 . . .	Jena	10.	−2.48	1.63	839	− 8	18	+10
	Febr.	24 . . .	Greenwich	17.	−4.05	1.52	840	− 5	32	+27
	Febr.	24 . . .	Bermerside	24.	−4.52	1.52	840	−20:	35	+15:
	March	3 . . .	Jena	10.	−2.48	1.48	840	+24 ?	20	+44 ?
	March	12 . . .	Kasan	24.4	−4.55	1.43	841	− 5	38	+33
	March	12 . . .	—	9.6	−2.04	1.43	841	+16	17	+33
	March	12 . . .	—	8.4	−1.13	1.43	841	+20	9	+29
	March	19 . . .	Jena	10.	−2.48	1.39	842	+40	21	+61
	Dec.	27 . . .	Bermerside	24.	−4.52	2.02	868	− 1	26	+25
	Dec.	29 . . .	—	24.	−4.52	2.01	868	−10	26	+16
1895	Jan.	5 . . .	—	24.	−4.52	2.00	869	−67	26	−41
	Jan.	14 . . .	Göttingen	16.1	−3.95	1.96	870	+82:	23	+105: *
	Jan.	21 . . .	Bermerside	24.	−4.52	1.93	870	−24	27	+ 3
	Jan.	28 . . .	Greenwich	17.	−4.05	1.89	871	−18	24	+ 6
	Jan.	28 . . .	Bermerside	24.	−4.52	1.89	871	−15	27	+12

Table **b** (continued).

				A'	$10\,a'x$	c	$10\ k$	T'-NA	T-T'	T-NA
1895	Febr.	8 . . .	Windsor	20.	−4.34	1.81	−0.0872	−33s	+27s	− 6s
	Febr.	11 . . .	Greenwich	17.	−4.05	1.79	873	+ 4	26	+30
	Febr.	13 . . .	Bermerside	24.	−4.52	1.78	873	− 2:	29	+27:
	Febr.	13 . . .	Jena	16.	−3.90	1.78	873	−15	25	+10
	Febr.	20 . . .	Bermerside	24.	−4.52	1.73	874	−16	30	+14 *
	Febr.	20 . . .	Lyons	16.	−3.97	1.73	874	−20	26	+ 6 *
	Febr.	23 . . .	Windsor	20.	−4.34	1.70	874	−27	29	+ 2
	March	1 . . .	Bermerside	24.	−4.52	1.66	875	−11:	31	+20:
	March	1 . . .	Kasan	9.6	−2.04	1.66	875	−19	14	− 5
	March	1 . . .	—	24.4	−4.55	1.66	875	−16	31	+15
	March	1 . . .	—	8.1	−0.83	1.66	875	+ 2	6	+ 8
	March	1 . . .	—	8.4	−1.13	1.66	875	+ 4	8	+12
	March	8 . . .	Jena	16.	−3.90	1.62	876	− 9	27	+18
	March	8 . . .	Uccle	15.	−3.79	1.62	876	−12	27	+15
	March	11 . . .	Windsor	20.	−4.34	1.59	876	−36	31	− 5
	March	18 . . .	—	20.	−4.34	1.54	876	−30	32	+ 2
	March	22 . . .	Utrecht	26.	−4.60	1.52	876	−12	35	+23
	March	31 . . .	—	26.	−4.60	1.46	877	−24	36	+12
	March	31 . . .	Kasan	24.4	−4.55	1.46	877	− 7	36	+29
	March	31 . . .	—	10.8	−2.66	1.46	877	+68	21	+89
	April	3 . . .	Windsor	20.	−4.34	1.45	877	−24	34	+10
	April	7 . . .	Bermerside	24.	−4.52	1.42	877	−12	36	+24
	April	7 . . .	Utrecht	26.	−4.60	1.42	877	−20	37	+17
	April	23 . . .	Greenwich	17.	−4.05	1.35	878	+ 3	35	+38
	April	26 . . .	Windsor	20.	−4.34	1.33	879	−14	37	+23
	May	12 . . .	—	20.	−4.34	1.27	880	−18:	39	+21:
1896	Jan.	27 . . .	Windsor	11.	−2.90	1.93	896	+24	17	+41
	Jan.	31 . . .	Pola	10.	−2.47	1.92	896	+ 4	14	+18
	Febr.	4 . . .	Windsor	20.	−4.34	1.92	896	−10	25	+15 *
	Febr.	9 . . .	Bermerside	24.	−4.52	1.91	896	−29	26	− 3
	Febr.	16 . . .	Jena	16.	−3.90	1.88	896	−15	23	+ 8 *
	Febr.	19 . . .	Windsor	20.	−4.34	1.87	896	−19	26	+ 7
	Febr.	25 . . .	Greenwich	10.	−1.97	1.84	896	+61	12	+73
	Febr.	25 . . .	Utrecht	26.	−4.60	1.84	896	−21	28	+ 7
	Febr.	27 . . .	Windsor	20.	−4.34	1.83	896	−11	26	+15
	March	1 . . .	Greenwich	17.	−4.05	1.81	896	0	25	+25
	March	3 . . .	Jena	16.	−3.90	1.80	896	−54:	24	−30:
	March	6 . . .	Windsor	20.	−4.34	1.78	896	−19	28	+ 9
	March	19 . . .	Greenwich	17.	−4.05	1.70	−0.0897	+ 1	26	+27

Sat. II D. $x = 0.408$.

1893	Aug.	24 . . .	Greenwich	10.	−1.61	1.64	0.0637	−43s	−15s	−58s
	Sept.	25 . . .	—	17.	−3.30	1.88	637	−119	−28	−147
	Oct.	27 . . .	—	17.	−3.30	2,07	637	− 9:	−25	−34:
	Nov.	14 . . .	Lyons	16.	−3.22	2.11	638	−35	−24	−59 *
1894	Jan.	24 . . .	Jena	10.	−2.01	1.74	645	−112	−18	−130
	Febr.	18 . . .	Greenwich	17.	−3.30	1.56	649	−44:	−33	−77:
	Febr.	18 . . .	Bermerside	24.	−3.68	1.56	649	−53:	−36	−89:

Table **b** (continued).

				A'	$10\,a'x$	c	$10\ k$	T'-NA	T-T'	T-NA
1894	Nov.	15 . . .	Greenwich	17.	−3.30	1.91	0.0725	+78^s	−24^s	+54^s
	Nov.	15 . . .	Bermerside	24.	−3.68	1.91	725	+132 :	−27	+105 :
	Nov.	15 . . .	Jena	16.	−3.17	1.91	725	+56	−23	+33
	Nov.	22 . . .	Greenwich	17.	−3.30	1.94	726	+30	−23	+ 7
	Dec.	10 . . .	Jena	16.	−3.17	2.01	0.0730	+60	−21	+39
1895	Oct.	29 . . .	Bermerside	24.	−3.68	1.51	0.0824	+52	−30	+22
	Nov.	16 . . .	Utrecht	26.	−3.75	1.62	829	+65 :	−28	+37 :*
	Nov.	23 . . .	Greenwich	17.	−3.30	1.66	830	+107	−24	+83
	Nov.	23 . . .	Utrecht	26.	−3.75	1.66	830	+98 :	−27	+71 :
1896	Jan	22 . . .	Windsor	11.	−2.39	1.93	0.0839	+35	−15	+20 *

Sat. II R. $x = 0.601$.

				A'	$10\,a'x$	c	$10\ k$	T'-NA	T-T'	T-NA
1893	Dec.	16 . . .	Greenwich	17.	−4.87	2.02	−0.0642	0^s	+37^s	+37^s
	Dec.	16 . . .	Bermerside	24.	−5.43	2.02	642	−11	42	+31
1894	Jan.	3 . . .	Kasan	24.4	−5.46	1.90	643	−29	45	+16
	Jan.	3 . . .	—	8.1	−1.00	1.90	643	+33	8	+41
	Jan.	17 . . .	Greenwich	17.	−4.87	1.79	645	+ 8	42	+50
	Jan.	17 . . .	Jena	10.	−2.97	1.79	645	+ 4	26	+30
	Jan.	24 . . .	—	10.	−2.97	1.73	647	+11	26	+37 *
	Febr.	11 . . .	Pola	16.	−4.67	1.61	650	−39 :	45	+ 6 :
	Febr.	18 . . .	Greenwich	17.	−4.87	1.56	652	+ 4	48	+52
	Febr.	18 . . .	Bermerside	24.	−5.43	1.56	652	−10	53	+43
	March	15 . . .	Kasan	9.6	−2.45	1.41	657	+28	26	+54
	March	22 . . .	Uccle	15.	−4.55	1.38	658	−32	50	+18
1895	Jan.	4 . . .	Bermerside	24.	−5.43	2.00	−0.0745	−34	36	+ 2
	Jan.	11 . . .	Kasan	24.4	−5.46	1.98	748	−52	+37	−15
	Jan.	11 . . .	—	6.6	+1.55	1.98	748	− 7	−10	−17
	Jan	11 . . .	—	10.8	−3.18	1.98	748	+ 8	+21	+29
	Jan.	18 . . .	Greenwich	17.	−4.87	1.95	751	−44	33	−11
	Febr.	5 . . .	Jena	16.	−4.67	1.84	757	−43	34	− 9
	Eebr	12 . . .	Bermerside	24.	−5.43	1.79	759	−76	40	−36 *
	Febr.	12 . . .	Jena	16.	−4.67	1.79	759	−59	34	−25 *
	Febr.	12 . . .	Göttingen	16.1	−4.75	1.79	759	−32	35	+ 3 *
	Febr.	12 . . .	Lyons	16.	−4.76	1.79	759	+ 6	35	+41 *
	Febr.	15 . . .	Windsor	20.	−5.20	1.76	760	−77	39	−38 *
	Febr.	19 . . .	Greenwich	17.	−4.87	1.73	760	−65	37	−28
	March	16 . . .	Bermerside	24.	−5.43	1.56	769	−57	45	−12
	March	16 . . .	Jena	16.	−4.67	1.56	769	−45 ?	39	− 6
	March	16 . . .	Kasan	10.8	−3.18	1.56	769	−66	27	−39
	March	16 . . .	—	9.6	−2.45	1.56	769	−37	20	−17
	April	17 . . .	Jena	16.	−4.67	1.37	779	−64	44	−20
	April	20 . . .	Windsor	20.	−5.20	1.36	780	−71	49	−22
	April	24 . . .	Greenwich	17.	−4.87	1.34	781	−47	46	− 1
1896	Febr.	6 . . .	Greenwich	25.	−5.50	1.91	−0.0843	−26	34	+ 8
	Febr.	6 . . .	Bermerside	24.	−5.43	1.91	843	+13 :	34	+47 :
	Febr.	13 . . .	Jena	16.	−4.67	1.89	844	−34	29	− 5
	Febr.	13 . . .	Göttingen	8.	−0.60	1.89	844	− 5	4	− 1
	March	9 . . .	Bermerside	24.	−5.43	1.76	846	−34	36	+ 2

Table **b** (continued).

				A'	$10a'x$	c	$10\,k$	T'-NA	T-T'	T-NA
			Sat. III D. $x = 0.234$.							
1893	Nov.	10 . . .	Uccle	15.	−1.77	2.11	0.0126	+244s	−67s	+177s
	Nov.	10 . . .	Göttingen	9.2	−0.82	2.11	126	+132:	−31	+101:
	Dec.	16 . . .	Bermerside	24.	−2.12	2.02	136	+163	−77	+ 86
	Dec.	23 . . .	Greenwich	17.	−1.89	1.98	137	+119:	−70	+ 49:
1894	Jan.	28 . . .	Jena	10.	−1.16	1.71	150	+188	−45	+143*
	Febr.	4 . . .	Greenwich	17.	−1.89	1.66	151	+158	−76	+ 82
	March	12 . . .	Jena	10.	−1.16	1.43	162	+107	−50	+ 57
	March	12 . . .	Kasan	9.6	−0.95	1.43	162	+106	−41	+ 65
	March	12 . . .	—	8.1	−0.39	1.43	162	+122	−17	+105
	March	12 . . .	—	8.4	−0.52	1.43	162	+127	−23	+104
	March	12 . . .	—	24.4	−2.13	1.43	162	+139	−92	+ 47
1895	Jan.	21 . . .	Greenwich	17.	−1.89	1.93	0.0287	− 48:	−34	− 82:
	Febr.	12 . . .	Windsor	20.	−2.03	1.79	294	+ 96	−39	+ 57
	Febr.	26 . . .	Bermerside	24.	−2.12	1.69	299	+ 74	−42	+ 32
	April	10 . . .	—	24.	−2.12	1.41	314	+ 77	−48	+ 29
	Nov.	11 . . .	Kasan	10.8	−1.24	1.59	0.0367	+ 57?	−21	+ 36?
	Nov.	11 . . .	—	8.1	−0.39	1.59	367	+ 65	− 7	+ 58
	Nov.	11 . . .	—	9.6	−0.95	1.59	367	+ 67	−16	+ 51
	Nov.	11 . . .	—	24.4	−2.13	1.59	367	+ 86	−36	+ 50
	Nov.	18 . . .	Greenwich	17.	−1.89	1.63	368	+ 83	−31	+ 52
	Nov.	18 . . .	Utrecht	26.	−2.15	1.63	368	+128	−36	+ 92
	Dec.	31 . . .	Greenwich	17.	−1.89	1.88	375	+ 75	−27	+ 48
			Sat. III R. $x = 0.345$.							
1894	Jan.	28 . . .	Greenwich	17.	−2.80	1.71	−0.0147	−304s	+112s	−192s
	Jan.	28 . . .	—	25.	−3.17	1.71	147	−353	127	−226
	Jan.	28 . . .	Jena	10.	−1.70	1.71	147	−301	68	−233
	March	12 . . .	—	10.	−1.70	1.43	162	−200	73	−127
	March	12 . . .	Kasan	8.1	−0.58	1.43	162	−103	25	− 78
	March	12 . . .	—	9.6	−1.40	1.43	162	− 82	60	− 22
	March	12 . . .	—	8.4	−0.77	1.43	162	− 72	33	− 39
	Oct.	13 . . .	Kasan	24.4	−3.14	1.68	−0.0252	−181	74	−107
	Oct.	13 . . .	—	9.6	−1.40	1.68	252	−129	33	− 96
1895	Febr.	4 . . .	Windsor	20.	−2.99	1.84	294	−142	55	− 87*
	Febr.	19 . . .	Greenwich	17.	−2.80	1.73	298	−135	54	− 81
	Febr.	26 . . .	Bermerside	24.	−3.12	1.68	300	−131:	62	− 69:
	April	24 . . .	Windsor	20.	−2.99	1.34	331	−101	67	− 34
	Nov.	18 . . .	Utrecht	26.	−3.18	1.64	−0.0370	− 64	52	− 12
1896	Jan.	29 . . .	Greenwich	17.	−2.80	1.93	381	+131	38	+169
	Jan.	29 . . .	Jena	16.	−2.69	1.93	381	−158?	37	−121?
	Febr.	26 . .	Windsor	20.	−2.99	1.83	384	− 42:	43	+ 1:
	March	12 . . .	Bermerside	24.	−3.12	1.74	385	− 26:	46	+ 20:
	March	12 . . .	Jena	16.	−2.69	1.74	385	+ 3	40	+ 43
	March	19 . . .	Greenwich	17.	−2.80	1.70	386	+ 21	43	+ 64
	April	24 . . .	Bermerside	24.	−3.12	1.46	−0.0388	+ 46:	+55	+101:

Table **b** (concluded).

			A'	$10\,a'x$	c	$10\,k$	T'-NA	T-T'	T-NA
					Sat. IV D. $x = 0.49$.				
1895	Febr. 19	Greenwich	17.	−3.97	1.73	0.008	+23m 30s	− 4m 46s	+18m 44s *
	March 8	Jena	16.	−3.82	1.61	0.010	+19 9	− 3 58	15 11
	March 8	Uccle	15.	−3.72	1.61	0.010	+21 58	− 3 51	18 7
	Nov. 14	Greenwich	17.	−3.97	1.60	0.0260	+ 5 56	− 1 35	4 21
	Nov. 14	Utrecht	26.	−4.51	1.60	260	+ 5 56	− 1 48	4 8
1896	Jan. 20	—	26.	−4.51	1.93	284	+ 2 38 :	− 1 22	1 16 :
	March 27	Greenwich	17.	−3.97	1.64	297	+ 1 54 :	− 1 22	0 32 :
	April 13	—	17.	−3.97	1.53	300	+ 2 58	− 1 27	1 31
	April 13	Bermerside	24.	−4.43	1.53	300	+ 2 42	− 1 37	1 5
	April 13	Jena	16.	−3.82	1.53	300	+ 4 18	− 1 23	2 55
	April 13	Utrecht	26.	−4.50	1.53	300	+ 4 47 :	− 1 38	3 9 :
	April 13	Uccle	15.	−3.71	1.53	300	+ 3 55	− 1 21	2 34
	May 16	Windsor	20.	−4.25	1.34	0.0305	+ 3 17	− 1 44	+1 33
					Sat. IV R. $x = 0.54$.				
1895	March 8	Jena	16.	−4.23	1.61	−0.010	−19m 58s	+ 4m 22s	−15m 36s
	March 8	Uccle	15.	−4.12	1.61	−0.010	−18 33 :	4 16	−14 17 :
	April 10	Windsor	20.	−4.70	1.41	−0.0136	−13 17	4 6	− 9 11
	Dec. 1	Bermerside	24.	−4.91	1.72	−0.0270	− 4 31 :	1 46	− 2 45 :
1896	Febr. 6	—	24.	−4.91	1.91	290	− 4 9	1 29	− 2 40 *
	Febr. 23	Greenwich	17.	−4.40	1.85	293	− 2 35 :	1 21	− 1 14
	Febr. 23	Bermerside	24.	−4.91	1.85	293	− 3 35	1 31	− 2 4
	Febr. 23	Göttingen	8.	−0.54	1.85	293	− 1 51	0 10	− 1 41
	March 11	Windsor	20.	−4.70	1.75	− 0.0296	− 3 46	+ 1 31	− 2 15

An inspection of the last column of Table **b** shows that it is no easy matter to deduce corrections to the predicted times. It is evident that the correction cannot be considered as constant for any length of time; it was therefore necessary to make some combination of the results surrounding the *Fram*-observations, but in making such combinations some arbitrariness is scarcely avoidable. In the few cases where the eclipses observed on board had also been observed elsewhere the deduced correction could, for some of them, be applied without alteration, but for others a combination was preferred when sufficient surrounding material was at hand. The corrections deduced from such combinations were often rounded to the nearest 5 or 10 seconds.

The adopted values are given in the column *T—NA* of the following Table **c**, which contains the *Fram*-observations. Only in some few cases the space for correction had to be left blank owing to want of material. After the date and the observed phenomenon comes the time of observation, reduced to chronometer Hohwü, and the difference between Hw and the predicted time. The correction *T—NA*, applied with contrary sign, gives the error Hw—Gr. Mean Time *(Hw—Gr.)*. Any special cause of uncertainty, mentionned in Mr. Scott-Hansen's notes, has been accentuated by a : added to the numbers. The results of the Lunar Distances are included in the same Table, designated by ☾.

TABLE c.

	Sat.	*Hw*	*Hw—NA*	*T—NA*	*Hw—Gr.*	Remarks
1893						
Nov. 14	II D	$8^h\ 5^m 17^s$:	$+39^m 35^s$:	$-\ 1^m\ 0^s$:	$+40^m 35^s$:	Sat. close to limb. Telescope without stand.
Nov. 24	☾	21 23			42 33	
Nov. 26	I R	2 24 58	41 52	0 0	41 52	
Nov. 27	I R	20 54 6	42 8	0 0	42 8	
Dec. 6	I R	17 18 49	42 43	0 0	42 43	Observer Johansen.
Dec. 13	I R	49 13 21	41 46	0 0	41 46	Clear and calm.
Dec. 19	I R	2 39 45	41 27	0 0	41 27	
Dec. 29	I R	17 32 45:	40 54:	0 0	40 54:	High wind, telesc. trembling.
Dec. 31	I R	12 2 48	42 5	0 0	42 5	Clear, calm. Good obs.
1894						
Jan. 7	I R	13 58 56	42 25	+ 0 10	42 15	Observer Johansen.
Jan. 11	I R	2 56 11	41 44	+ 0 10	41 34	A sharp observation.
Jan. 20	II D	20 42 19:	40 42:	− 1 30	42 12:	Sat. already disappeared.
Jan. 20	II R	22 58 46	41 57	+ 0 35	41 22	
Jan. 21	III D	2 2 25				Difficult, see note 1.
	—	2 3 50	43 17	+ 1 50	41 27	Barely visible till now.
Jan. 21	III R	3 39 15:	37 57:	− 3 40	41 37:	Some seconds late, see note 2.
Jan. 24	II R	12 16 52:	42 3:	+ 0 37	41 26:	Some haze.
Jan. 25	I R	6 47 53	41 40	+ 0 10	41 30	A good observation.
Jan. 27	I R	1 16 56	41 40	+ 0 10	41 30	A good observation.
Jan. 28	III D	6 4 18				Some haze, image not sharp.
		5 28	43 38	+ 1 50	41 48	Barely visible, see note 3.
Febr. 19	I R	1 33 37	41 47	+ 0 15	41 32	
March 5	III D	2 11 8	42 29	+ 1 20	41 9	Last glimpse.
March 5	III R	3 56 58	40 53	− 1 5	41 58	First glimpse.
Oct. 7	II D	8 1 23	41 50	+ 1 5	40 45	
Oct. 7	II R	10 29 42:	41 53:	?	—	See note 4.
Nov. 3	III D	17 50 32	40 14:	?	—	Note 5.
Nov. 3	III R	20 24.4	41.5	?	—	First glimpse.
	—	24.9				See Note 6.

Table **c** (continued).

	Sat.	*Hw*	*Hw−NA*	*T−NA*	*Hw−Gr.*	Remarks
1894						
Nov. 6	I D	3^h 23^m 57^s				Same br. as usual at R.
		24 26	$+41^m$ 38^s	$+$ 0^m 15^s	$+41^m$ 23^s	[Last glimpse?].
Dec. 13	I D	7 22 8:	40 35:	+ 0 15	40 20:	Some haze, not a good obs.
Dec. 18	I D	14 47 31	40 11	+ 0 15	39 56	Good observation.
Dec. 25	I R	18 55 26	41 29	+ 0 20	41 9	First glimpse. Se note 7.
Dec. 31	I R	2 21 29	41 19	+ 0 20	40 59	Hansen. Very good obs.
		21 43				Nansen, alum. tel. (5.3 cm.).
Dec. 31	III R	4 26 18:	40 10:	?		See note 8.
Dec. 31	II R	17 37 25	41 48	0 0	41 48	
1895						
Jan. 10	I R	17 14 6:	41 22:	+ 0 20	41 2:	Some cirrostratus. See note 9.
Jan. 14	☾	1 46			38 53	
Jan. 14	I R	6 11 24	41 5	+ 0 20	40 45	Uncommonly clear.
Jan. 14	II R	22 46 46	40 28	0 0	40 28	A very good obs. Note 10.
Jan. 15	I R	24 40 49:	41 45:	+ 0 20	41 25:	Telesc. somewhat trembling.
Jan. 17	IV D	No eclipse				See note 11.
Jan. 17	IV R					
Jan. 19	I R	13 38 32	41 48	+ 0 20	41 28	Good obs.; a little cirrostr.
Jan. 24	I R	21 4 3	40 46	+ 0 20	40 26	First glimpse?
		4 43				Bright. Not a good obs.
Jan. 28	III D	17 43 54	40 19	+ 0 40	39 39	
Jan. 28	III R	20 31 8:	39 53	− 1 25	41 18:	Telescope trembling.
		31 13				Surely visible.
Febr. 1	II R	17 14 44	40 4	− 0 10	40 14	First glimpse.
		15 24				Full brightness.
Febr. 2	IV D	Probably				See note 12.
Febr. 2	IV R	no eclipse				
Febr. 4	III D	21 44 20	40 36	+ 0 40	39 56	Last glimpse.
Febr. 4	III R	24 32 6	39 24	− 1 25	40 49	First feeble glimpse. Note 13.
Febr. 5	☾	22 33			39 22	
Febr. 8	☾	17 28			39 57	
Febr. 12	II R	9 8 24	40 40	− 0 10	40 50	A good obs. Note 14.
Febr. 15	II R	22 25 48	40 23	− 0 15	40 38	Possibly ca. 5^s late. Note 15.
Febr. 16	I R	21 19 22	40 35	+ 0 10	40 25	A good observation.
Febr. 18	I R	15 48 51:	41 6:	+ 0 10	40 56:	Some rime on the eyepiece.
Febr. 19	III D	5 44 26:	40 26:	+ 0 40	39 46:	Ditto. Not a good obs.
Febr. 19	IV D	14 23.5	59.4	+18 44	40.7	Brightness as usual at R.
		30.2	66.1		47.4	Barely vis. till now. Note 16.
Febr. 20	I R	10 17 28	40 52	+ 0 10	40 42	A good observation.
Febr. 22	I R	4 46 28	40 53	+ 0 10	40 43	Very good observation.
March 9	☾	1 35			37 57	
March 27	III R	4 45.5	41.9 :	?		Twilight too strong.
Oct. 15	I D	11 58 57	37 44:	+ 0 5	37 39:	Except some cirrostr., tole-
Oct. 15	II D	12 1 12	37 39:	+ 0 20	37 19:	rably good obs.
Oct. 19	I D	0 55 16	37 30			Some cirrostratus.
		55 46	38 0:	+ 0 5	37 55:	Absolutely vanished.
Oct. 19	II D	1 20 16	38 3	+ 0 20	37 43	More marked.
Oct. 22	I D	13 51 59	37 43	+ 0 5	37 38	A good observation.

Table **c** (concluded).

	Sat.	*Hw*	*Hw*−*NA*	*T*−*NA*	*Hw*−*Gr.*	Remarks
1895						
Oct. 22	II D	14h 37m 55s	+38m 9s:	+ 0m 20s	+37m 49s:	Some haze.
Oct. 28	III D	1 15.0 :	38.0	+ 0 50	37.2	Sat. gone; earlier than exp.
Nov. 2	I D	4 41 4:	37 12:	+ 0 5	37 7:	Sat. gone.
Nov. 2	II D	6 32 56	38 21	+ 0 30	37 51	Very good observation.
Nov. 4	☾	0 24			36 9	
Nov. 16	I D	8 27 48	37 49	+ 0 5	37 44	A good observation.
Nov. 16	II D	11 45 28	38 42	+ 0 35	38 7	A good observation.
Nov. 25	III D	17 7 11	38 14	+ 1 0	37 14	± 5s.
Dec. 1	IV D	8 22 30				Very slow decrease.
		23 35	41 50	+ 4 0	37 50	Sat. seen till now. Note 17.
Dec. 4	II D	6 13 56	37 44	+ 0 50	36 54	
Dec. 5	I D	19 38 50	37 40	0 0	37 40	Very good observation.
Dec. 7	II D	19 32 45	38 9	+ 0 50	37 19	Observer Mogstad.
Dec. 29	II D	3 19 49	37 50	+ 0 50	37 0	Very good observation.
1896						
Jan. 10	I D	5 6 7	37 14	− 0 5	37 19	Very good observation.
Jan. 11	I D	23 34 29	37 4	− 0 5	37 9	Good observation.
Jan. 22	II D	24 22 57:	36 21:	+ 0 20	36 1:	Sat. close to limb; not good.
Febr. 4	I R	2 1 32	37 32	+ 0 15	37 17	A good observation.
Febr. 5	I R	20 30 16	37 36	+ 0 15	37 21	
Febr. 6	IV R	12 52 13	34 54	− 2 40	37 34	Ditto.
Febr. 7	I R	14 58 46	37 30	+ 0 15	37 15	Ditto.
Febr. 16	I R	11 22 16	37 34	+ 0 10	37 24	Ditto.
Febr. 19	III R	20 19 22	37 27	0	37 27	
Febr. 19	☾	22 17			38 6	
Febr. 23	I R	13 17 4	37 30	+ 0 10	37 20	
Febr. 27	II R	16 11 56	37 28	0 0	37 28	A good observation.
April 22	☾	4 19			36 23	

NOTES TO TABLE c.

1. Decrease of brightness very slow; took the moment when it was as usually at R.
2. Was not prepared for so early a reappearance, but Sat. very feeble when the time was noted.
3. Sat. now so feeble that I was not sure of its visibility.
4. Sat. close to Planet's limb, and some haze, perhaps $^1/_4$ or $^1/_2$ minute late as compared with D.
5. Sat. barely visible when I knew that it was there. Perhaps visible $^1/_2$—$^3/_4$ min. longer.
6. About same brightness as at D; R sharper than D, but, on the whole, observation of this Satellite uncertain, owing to the slow motion.
7. Followed the Sat. further, as I was not quite sure; 30s later nearly of the same brightness as the other Satellites.
8. Saw the Satellite very feeble in the moment I put the eye to the telescope. Could perhaps have seen it 10s before.
9. Not a good observation; too late.

10. Increase of brightness very slow. 1.^{m}4 later Sat. tolerably bright.
11. Calculated time for D $2^h\ 17^m\ 42^s$. Observed continually till $2^h\ 28^m$, but no decrease of brightness perceptible. Ceased for a while, but between $2^h\ 42^m$ and $2^h\ 45^m$ Sat. as bright as before — after which we left the Satellite to its fate.
12. Calculated time for D Hw $20^h\ 6^m\ 5^s$. Observed til $20^h\ 10^m$, unchanged, somewhat feebler than the other Satellites. Calculated time for R Hw $21^h\ 16^m\ 29^s$; observed $21^h\ 11^m - 20^m$, but no increase of brightness.
13. 26^s later brightness estimated as 40^s before the moment noted for D. At $24^h 34^m\ 27^s$ the Sat. approached to the usual brightness.
14. First glimpse. $1^m\ 33^s$ later same brightness as the Satellite to the left of Jupiter [Sat. IV].
15. Had just moved the telescope; as soon as it had come to rest, the Sat. was seen.
16. Observation begun at $14^h\ 3^m$.
17. Waited for R till $12^h\ 40^m$, but Sat. not visible; cirrostratus.

Influence of Temperature.

As there were in each of the three years of the expedition periods of several months without any determination of the Greenwich Time, it was necessary to examine the general rate of the chronometer and its dependence on temperature. For this purpose the two other chronometers must also be taken into consideration. From the journal of daily comparisons the following Table **d** was formed, containing the difference *Kt—Hw* and *Iv—Hw* together with the daily relative rate of each. The last column (*t*) gives the mean temperature (Centigrade) of the interval. From the curves registered by the thermograph in Mr. Scott-Hansen's cabin the mean temperature for every day was taken out by inspection and reduced to the chronometer-shelf by means of the daily comparisons with the lower thermometer. The temperatures in Table **d** are means for 10 days (the intervals between the comparisons are in some few cases 9 or 11 days). As the thermograph was taken down 1896 Aug. 10 the temperature for the last 11 days is more uncertain.

TABLE d.

			Gr. T.		*Kt—Hw*		Rel. Rate	*Iv—Hw*		Rel. Rate	t C.
1893	July	18	18h	37m	−47m	43.s7	0.s48	+ 5m	16.s2	3.s18	14.°73
		28	23	50	−47	38. 8	0. 60	5	48. 6	2. 91	13. 77
	Aug.	7	22	13	−47	32. 8	0. 62	6	17. 7	3. 14	15. 42
		17	20	0	−47	26. 6	0. 12	6	49. 1	2. 17	12. 67
		26	19	48	−47	25. 6	−0. 57	7	8. 6	1. 40	10. 39
	Sept.	6	18	51	−47	31. 9	−0. 03	7	24. 0	2. 55	13. 60
		16	19	7	−47	32. 2	0. 02	7	49. 5	2. 65	14. 67
		26	12	29	−47	32. 0	−0. 40	8	15. 3	1. 90	10. 80
	Oct.	6	12	33	−47	36. 0	−0. 08	8	34. 3	2. 21	10. 11
		16	12	20	−47	36. 8	−0. 20	8	56. 4	2. 15	8. 20
		26	12	10	−47	38. 8	−0. 42	9	17. 9	1. 68	7. 16
	Nov.	5	12	8	−47	43. 0	−0. 52	9	34. 7	1. 40	7. 43
		15	12	9	−47	48. 2	−0. 21	9	48. 7	0. 67	6. 98
		25	12	10	−47	50. 3	0. 38	9	55. 4	0. 54	6. 30
	Dec.	5	12	9	−47	46. 5	0. 46	10	0. 8	−0. 20	5. 56
		15	12	9	−47	41. 9	0. 82	9	58. 8	0. 03	5. 10
		25	12	13	−47	33. 7	1. 69	9	59. 1	0. 59	6. 77
1894	Jan.	4	12	12	−47	16. 8	2. 10	10	5. 0	0. 41	6. 55
		14	12	12	−46	55. 8	2. 26	10	9. 1	0. 47	6. 69
		24	12	11	−46	33. 2	2. 14	10	13. 8	0. 33	5. 91
	Febr.	3	12	11	−46	11. 8	2. 51	10	17. 1	0. 38	6. 32
		13	12	44	−45	46. 7	2. 64	10	20. 9	0. 57	6. 75
		23	12	42	−45	20. 3	2. 65	10	26. 6	0. 73	7. 17
	March	5	12	40	−44	53. 8	2. 66	10	33. 9	0. 79	7. 02
		15	12	31	−44	27. 2	2. 10	10	41. 8	0. 49	6. 35
		25	12	19	−44	6. 2	2. 21	10	46. 7	0. 80	6 96
	April	4	12	19	−43	44. 1	2. 19	10	54. 7	0. 99	8. 23
		14	12	38	−43	22. 2	2. 04	11	4. 6	1. 16	7. 28
		24	12	39	−43	1. 8	1. 75	11	16. 2	0. 85	6. 60
	May	5	12	38	−42	42. 5	1. 33	11	25. 6	0. 89	6. 39
		14	12	36	−42	30. 5	1. 83	11	33. 6	1. 37	7. 30
		24	12	57	−42	12. 2	2. 04	11	47. 3	1. 33	10. 02
	June	3	12	58	−41	51. 8	2. 52	12	10. 6	2. 88	11. 51
		13	13	16	−41	26. 6	2. 80	12	39. 4	3. 27	13. 00
		23	13	14	−40	58. 6	2. 09	13	12. 1	2. 60	11. 33
	July	3	13	14	−40	37. 7	1. 72	13	38. 1	2. 43	10. 44
		13	13	15	−40	20. 5	2. 15	14	2. 4	2. 30	12. 04
		23	13	15	−39	59. 0	1. 63	14	25. 4	1. 81	10. 67
	Aug.	2	13	12	−39	42. 7	1. 95	14	53. 5	2. 61	12. 41
		12	13	15	−39	23. 2	1. 56	15	19. 6	2. 88	12. 11
		22	13	13	−39	7. 6	0. 54	15	48. 4	1. 85	9. 50
	Sept.	1	12	54	−39	2. 2	0. 19	16	6. 9	2. 03	8. 70
		11	13	14	−39	0. 3	0. 22	16	27. 2	2. 06	10. 09
		21	13	15	−38	58. 1	0. 00	16	47. 8	2. 40	9. 23
	Oct.	1	13	13	−38	58. 1	−0. 22	17	11. 8	2. 15	9. 60
		11	13	12	−39	0. 3	−0. 87	17	33. 3	2. 17	10. 00
		21	13	50	−39	9. 0		17	55. 0		

Table **d** (continued).

			Gr. T.	*Kt—Hw*	Rel. Rate	*Iv—Hw*	Rel. Rate	*t* C.
1894	Oct.	21	13h 50m	—39m 9.s0	—0.s90	+17m 55.s0	1.s78	+ 8.°47
		31	13 50	—39 18. 0	—0. 95	18 12. 8	1. 81	8. 65
	Nov.	10	13 52	—39 27. 5	—1. 38	18 30. 9	0. 89	7. 00
		20	13 49	—39 41. 3	—0. 48	18 39. 8	2. 13	9. 89
		30	13 51	—39 46. 1	—0 90	19 1. 1	1. 73	9. 03
	Dec.	10	13 52	—39 55. 1	—0. 68	19 18. 4	1. 94	8. 93
		20	14 23	—40 1. 9	—0. 55	19 37. 8	2. 14	9. 82
		30	14 25	—40 7. 4	—0. 60	19 59. 2	1. 98	8. 56
1895	Jan.	9	14 26	—40 13. 4	—0. 42	20 19. 0	2. 54	10. 79
		19	14 25	—40 17. 6	—0. 43	20 44. 4	2. 44	10. 22
		29	14 26	—40 21. 9	—0. 49	21 8. 8	1. 81	8. 75
	Febr.	8	14 23	—40 26. 8	—0. 25	21 26. 9	1. 96	11. 24
		18	14 26	—40 29. 3	—0. 53	21 46. 5	1. 41	10. 12
	March	1	14 31	—40 35. 1	—0. 21	22 2. 0	1. 80	10. 78
		10	14 24	—40 37. 0	—0. 18	22 18. 2	1. 89	11. 41
		20	14 13	—40 38. 8	—0. 96	22 37. 1	1. 66	9. 89
		30	14 14	—40 48. 4	—0. 42	22 53. 7	2. 28	11. 72
	April	9	14 54	—40 52. 6	—0. 36	23 16. 5	2. 80	12. 91
		19	14 52	—40 56. 2	—0. 94	23 44. 5	2. 64	12. 41
		29	14 55	—41 5. 6	—0. 47	24 10. 9	3. 40	13. 18
	May	9	15 17	—41 10. 3	—0. 64	24 44. 9	2. 94	13. 75
		19	15 29	—41 16. 7	—0. 77	25 14. 3	2. 96	13. 52
		29	15 33	—41 24. 4	—0. 69	25 43. 9	2. 65	13. 37
	June	8	15 33	—41 31. 3	—0. 17	26 10. 4	3. 28	14. 57
		18	15 56	—41 33. 0	—0. 57	26 43. 2	2. 89	13. 76
		28	15 53	—41 38. 7	—0. 11	27 12. 1	3. 43	15. 20
	July	8	16 5	—41 39. 8	—0. 48	27 46. 4	3. 05	14. 59
		18	16 18	—41 44. 6	—0. 45	28 16. 9	3. 25	14. 01
		28	16 33	—41 49. 1	—0. 52	28 49. 4	3. 25	14. 45
	Aug.	7	16 17	—41 54. 3	—0. 65	29 21. 9	2. 94	14. 32
		17	16 13	—42 0. 8	—0. 49	29 51. 3	2. 31	14. 72
		27	15 56	—42 5. 7	—0. 52	30 14. 4	2. 57	14. 37
	Sept.	6	15 57	—42 10. 9	—0. 44	30 40. 1	2. 56	14. 63
		16	15 56	—42 15. 3	—0. 89	31 5. 7	1. 85	13. 29
		26	15 55	—42 24. 2	—1. 07	31 24. 2	1. 78	11. 79
	Oct.	6	16 4	—42 34. 9	—0. 95	31 42. 0	1. 76	11. 67
		16	15 55	—42 44. 4	—1. 09	31 59. 6	1. 18	10. 90
		26	16 19	—42 55. 3	—0. 97	32 11. 4	1. 26	11. 35
	Nov.	5	16 28	—43 5. 0	—1. 18	32 24. 0	0. 96	10. 95
		15	16 57	—43 16. 8	—1. 23	32 33. 6	0. 87	9. 76
		25	16 57	—43 29. 1	—1. 13	32 42. 3	1. 62	10. 95
	Dec.	5	17 19	—43 40. 4	—1. 27	32 58. 5	1. 18	9. 74
		15	17 33	—43 53. 1	—1. 29	33 10. 3	1. 25	8. 92
		25	18 13	—44 6. 0	—1. 58	33 22. 8	0. 62	7. 94
1896	Jan.	4	17 57	—44 21. 8	—1. 99	33 29. 0	0. 12	6. 01
		14	18 45	—44 41. 7	—1. 40	33 30. 2	0. 76	10. 16
		24	18 39	—44 55. 7	—1. 73	33 37. 8	0. 29	9. 50
	Febr.	3	19 25	—45 13. 0		33 40. 7		

Table **d** (concluded).

			Gr. T.		*Kt—Hw*		Rel. Rate	*Iv—Hw*		Rel. Rate	*t* C.
1896	Febr.	3	19h	25m	—45m	13.s0	—2.s09	33m	40.s7	0.s47	+ 8.°64
		13	19	44	—45	33. 9	—2. 11	33	45. 4	1. 75	9. 38
		23	19	44	—45	55. 0	—2. 07	34	2. 9	2. 95	10. 56
	March	4	19	46	—46	15. 7	—1. 83	34	32. 4	2. 78	11. 63
		14	19	43	—46	34. 0	—1. 61	35	0. 2	3. 29	13. 05
		24	19	41	—46	50. 1	—1. 56	35	33. 1	3. 56	13. 46
	April	3	19	43	—47	5. 7	—2. 13	36	8. 7	3. 12	11. 94
		13	20	5	—47	27. 0	—2. 08	36	39. 9	2. 97	11. 34
		23	20	23	—47	47. 8	—1. 73	37	9. 6	3. 39	12. 40
	May	3	20	24	—48	5. 1	—1. 88	37	43. 5	3. 03	12. 47
		12	20	22	—48	22. 0	—1. 56	38	10. 8	3. 55	12. 95
		23	20	16	—48	39. 2	—0. 82	38	49. 8	4. 12	15. 72
	June	2	20	16	—48	47. 4	—1. 26	39	31. 0	3. 68	14. 22
		12	20	20	—49	0. 0	—1. 67	40	7. 8	3. 40	12. 97
		22	20	37	—49	16. 7	—1. 71	40	41. 8	3. 40	12. 84
	July	2	20	31	—49	33. 8	—1. 63	41	15. 8	3. 32	12. 85
		12	20	36	—49	50. 1	—1. 52	41	49. 0	3. 26	12. 76
		23	1	12	—50	5. 6	—1. 67	42	22. 3	2. 63	12. 26
	Aug.	1	0	55	—50	20. 6	—1. 68	42	46. 0	2. 77	11. 78
		11	2	9	—50	37. 4	—0. 32	43	13. 7	3. 75	12. 9
		22	20	4	—50	41. 1		43	57. 6		

The column of rates for *Kt—Hw* shows some considerable irregularities which cannot be explained by any progressive term and which almost completely mask the effect of temperature. In the rate of *Iv—Hw* the effect of temperature is very prominent (between 0s.2 and 0s.3 per degree) and the casual irregularities are smaller and of a different character, from which it follows that the irregularities in the column *Kt—Hw* are due to Kutter. After the return of the expedition all the three chronometers were kept going for some time in the Christiania Observatory without being touched; for *Hw* and *Iv* a series of comparisons were available also from the the time immediately preceding the departure in 1893. Kutter arrived from Germany only some few days before the departure, but by the courtesy of Professor NEUMAYER the writer is in possession of a series of comparisons made from the beginning of 1893 in the *Deutsche Seewarte.*

This material was examined on the supposition that the rate could be represented in the form

$$\text{Daily rate} = x + ty$$

where t is the temperature. For *Hw* after the return an attempt was also made to introduce a term proportional to the time, but it was found quite insensible. The results are contained in the following synopsis, where n is the number of equations employed.

		n	x	y	$\frac{\Sigma v^2}{n-2}$
Hohwü	1893	16	$+ 2.^s21 \pm 0.^s165$	$- 0.^s172 \pm 0.^s0127$	0.053
	1896, 97	79	$+ 2.00 \pm 0.048$	$- 0.192 \pm 0.0056$	0.073
Kutter	1893	15	$- 0.88 \pm 0.194$	$+ 0.056 \pm 0.0325$	0.100
	1896, 97	79	$- 1.93 \pm 0.054$	$+ 0.022 \pm 0.0062$	0.091
Iversen	1893	22	$- 0.45 \pm 0.245$	$+ 0.236 \pm 0.022$	0.400
	1896	14	$- 0.76 \pm 0.445$	$+ 0.270 \pm 0.040$	0.157

It will be seen that *Kt* has the smallest temperature-coefficient, but that its constant term has changed considerably more from 1893 to 1896 than the constant term for the other two. From Table **d** it is also apparent that a similar change in the opposite direction has taken place in the interval. The relatively large probable errors of the constant terms depend chiefly on the choice of 0° as the standard temperature, the mean temperature during the comparisons being of course considerably higher.[1] The last column gives the mean of the squares of residuals (v) as a good means for comparing the qualities of the three chronometers.

Hohwü is evidently the best of the three and it was deemed safest to rely solely upon it for the intervals without observations. A formula deduced from comparisons ashore is of course not immediately applicable on board, because the exterior conditions, especially the humidity, in a narrow ship's cabin are very different from those of an observatory room. That these different conditions affect not only the constant term but also the temperature

[1] For *Kt* in 1893 it was found more convenient to count the temperatures from 10°, and the constant term was found as $-0.^s32 \pm 0.^s194$ for this temperature, so that the probable error for 0° should have been considerably higher than that given above; but as the mean temperature during the comparisons in Hamburg had been higher than in Christiania, the value for 10° was retained in order not to prejudice the chronometer as compared with the other two.

coefficient, is apparent from the fact that the relative temperature coefficient of *Iv—Hw* on board is sensibly smaller than the difference between the above values of y for *Iv* and *Hw*, both in 1893 and in 1896.

Some trials were made in order to throw some light on this point. If the values of the clock error as determined 1) by the telegraphic signals before and after the expedition, 2) by the two solar eclipses observed on board, and 3) by the eclipses of Jupiter's Satellites and by Lunar Distances, are called 1) the signal points, 2) the solar points, and 3) the satellite points respectively, the problem to be solved may be expressed thus: To draw a curve going exactly through the signal points, through or very near the solar points and among the satellite points which are rather widely dispersed, especially during the two first winters; the whole time with due regard to temperature.

As it happened that the mean temperature in the intervals between the signal and the solar points was somewhat different, an attempt was first made to determine the constant term x separately for the three intervals by introduction of the temperature coefficient —0.ˢ189, the mean of the values found in Christiania with due regard to weight; that is to say

$$x = \text{daily rate} + 0.^{s}189\ t.$$

The result was:

	Gr. T.	Hw—Gr.	Mean Rate	t	x
1. 1893 July 18. . . .	20h 0m	42m50s			
			−0.ˢ253	+ 8.°822	1.ˢ415
2. 1894 April 5. . . .	16 51	41 44			
			−0. 350	9. 722	1. 487
3. 1895 March 25. . .	23 15	39 40			
			−0. 479	12. 246	1. 835
4. 1896 Aug. 22. . . .	21 0	35 33			

It may have some interest to compare the mean rate of *Hw* with those of *Kt* and *Iv* for the same intervals:

	Kt—Gr.	Rate	Iv—Gr.	Rate
1.	— 4m54s		+48m 6s	
		+0.ˢ677		+1.ˢ05
2.	— 1 57		52 40	
		+0. 144		+1. 65
3.	— 1 6		62 24	
		—1. 63		+2. 08
4.	—15 8		79 31	

The increasing value of x for *Hw* with increasing temperature seems to indicate that the temperature coefficient had a smaller numerical value on board than ashore. It was next tried to form some means of the satellite points, by which the number of intervals was increased from 3 to 7; and by putting $y = -0.^s10$ it was found that x could be made approximately constant for all the intervals except one (1894 November—1895 March) where it was sensibly (about $0.^s4$) smaller. No pendulum observations were made during this period. The means of the satellite points being, however, rather uncertain, these numbers are not reproduced here.

As it was apparent from these trials that the second solar eclipse, whose conditions were much less favorable than those of the first, introduced some constraint if the satellite points of the preceding winter were not to be entirely neglected, it was lastly tried to leave it out and to use the two remaining equations for a direct determination of x and y, viz:

1893 July 18—1894 April 5, $x + 8.822\ y = -0.^s253$

1894 April 5—1896 Aug. 22, $x + 11.202\ y = -0.\ 4265$

which give $x = 0.^s390$ and $y = -0.^s073$ and would imply a correction of $+ 12^s$ to the result of the second solar eclipse, corresponding to a somewhat early observation of the second contact as compared with the first, particularly for Sverdrup's observation with the smaller instrument.

By putting in round numbers

$$y = -0.^s080$$

and determining x from the mean temperature of the whole time (10.°656 C) and the mean rate ($-0.^s3864$) viz:

$$x = +0.^s466,$$

only 3 seconds were sacrificed from the first solar eclipse, which brings the result nearer to the mean of 1st and 2nd contact, estimated as corresponding.

As these values seemed to be slightly more concordant with the satellite points, the formula

$$\text{Daily rate} = 0.^s466 - 0.^s080\ t$$

was finally adopted. On this basis the first table of the "Results", containing the error of chronometer Hohwü for every 10th day, has been calculated.

It may be noticed that the rate of Hw during the 11 series of pendulum observations, with temperatures between +5° and +15° C, as calculated by this formula, nowhere differs more than $\pm 0.^s1$ from the values obtained in the manner mentioned above, with $y = -0.^s10$ and x only approximately constant during the several intervals; in most cases the values obtained by both methods are practically identical.

If the adopted values of the clock error Hw—Gr. are compared with the corresponding values following from the eclipses of Jupiter's Satellites (Table **c**), and the differences are grouped by D and R, the mean value, in the sense obs.—comp., is $-14.^s2$ for D and $+13.^s4$ for R, according well with the expectation that there would be a greater absorption of light in these high latitudes, where the planet's average altitude is smaller than in Europe and Australia. When the three periods of observation of Jupiter's Satellites are considered separately, the mean difference R—D is always positive; but it must be added that the symmetrical division holds good only for the whole mass of observations; if the same condition were to be fulfilled for each period separately, the curve ought to be shifted about 17^s downwards at the beginning of 1894 and 11^s upwards at the beginning of 1895. But during both these winters the observations of D were so far less numerous than the observations of R that no correction could safely be deduced from this consideration. For the last winter, where the observations of D are in excess and the satellite points are on the whole much less dispersed, the condition of symmetry is nearly fulfilled.

The calculated values of *Hw* — Gr. M. T. may of course be several seconds in error and it is possible that this error may in some places reach the amount of $\pm 20^s$. An error of 20^s or $5'$ in longitude represents 1.6 km. in latitude 80° and 0.8 km. in 85°.

Voyage along the Coast of Siberia.

The astronomical observations taken before the enclosure in the ice have all been reduced, not only because the track of the ship in these difficult regions has an interest in itself, but also as forming the foundation for the determination, by compass bearings, of the situation of numerous islands and some points on the continent not to be found on previous maps.

The compass is, however, not a very trustworthy instrument in these high latitudes. Owing to the feeble intensity of the horizontal component of the earth's magnetism the local influence on board, as well as its variations, attain relatively greater importance than in lower latitudes. Between the departure from Vardö 1893 July 21 and the enclosure in the ice on September 22 Mr. SCOTT-HANSEN took in all 65 compass-bearings of the Sun or a star, giving the sum of magnetic declination and local deviation, and 4 direct determinations of the deviation by mutual settings between the compass on board and another compass placed at a convenient distance ashore or on the ice. In order to separate the declination and deviation it was necessary to examine the declination first. Professor NEUMAYER's isogonic chart for 1895 extends to 75° of latitude, but by means of three determinations made by Mr. Scott-Hansen during the voyage, and a good many taken during the following years on the ice, it was possible to continue the curves and join the separated branches on a polar map.

An inspection of the values of the deviation thus found showed that it could not be considered as constant for a given course during the whole voyage. On putting the deviation in the usual form

$$A + B \sin \alpha + C \cos \alpha + D \sin 2\alpha + E \cos 2\alpha$$

where α is the compass-course from north through east, the constants were determined separately for the following three periods, containing respectively 20, 22 and 26 observations (one of the 69 being omitted) taken between the limits given in the table below.

Per.	Limits of			
	Date 1893	Lat.	Long.	Decl.
I.	July 22	69°37′	41°55′ E	10° E
	Aug. 9	71 20	66 44	20
II.	Aug. 11	72 11	68 25	23
	Aug. 28	76 54	95 2	29
III.	Sept. 7	73 52	100 40	28
	Sept. 22	78 50	137 8	7

On solving the equations by the method of least squares the observations of period II proved insufficient to determine the quadrantal deviation, most of the observations having been taken in the first and the adjoining part of the fourth quadrant, but only 4 in the second and none in the third. On putting the constants D and E for this period equal to the mean of the values found for periods I and III, the following values were calculated and tables formed from them:

	A	B	C	D	E
I.	−1.°72	−0.°98	+ 5.°68	+3.°46	−0.°10
II.	+1. 16	−0. 84	+10. 40	+2. 20	−1. 13
III.	+3. 51	−3. 47	+11. 13	+0. 96	−2. 15

Another difficulty in the determination of the situation of new islands etc. arose from the necessity of using dead reckoning. Owing to the difficult navigation, frequently hindered by fog or ice and often conducted between unknown banks and islands and in strong currents, the dead reckoning was often seriously in error, especially in longitude. The difference of east longitude found by dead reckoning being almost invariably too great, it was necessary to introduce a proportional reduction, which of course gives rise to some uncertainty when the interval from the nearest astronomical observation was considerable. Apart from some days spent in harbour there were, however, only few days without astronomical observations.

On one occasion the difference of east longitude deduced from the astronomical observations was considerably in excess over that of the dead reckoning, viz. on 1893 August 29 when the ship had encountered dead water in the afternoon and arrived in the evening at the ice border near Cape Laptev. This would seem to indicate an easterly motion of the fresh water forming the upper layer, relatively to the sea below through which the bulk of the ship was going, thus making the speed only apparently so small as given in the log book (for the last hours 1 or 2 knots with calm weather and the engine going full speed). In sailors' parlance it looks as if the ship was dragging some miles of sea with her. But other observations show that such a current would not suffice as a sole cause, and both Mr. Nansen and Mr. Scott-Hansen are of opinion that the dead reckoning under these circumstances is not sufficiently trustworthy to form the basis of an explanation of this curious phenomenon.

The present volume contains all astronomical observations made at sea between the departure from Vardö and the enclosure in the ice in 1893, but their application to the determination of the position of new islands etc. will be given in another volume.

The Sledge Expedition.

After a preliminary trial in the last days of February and the first days of March NANSEN and JOHANSEN started northwards 1895 March 14, turned southwestwards April 8, and got the first glimpse of land on July 23. It is a matter of course that the observations during this expedition, where the principal work of the travellers was very often a struggle for life, and where the instruments had to be handled in temperatures down to $-40°$ C with no other source of heat than the observer's own body, could not attain any high degree of accuracy. The instrumental equipment for astronomical observations were the small altazimuth, the pocket sextant, and the two small compasses mentioned before; a glass horizon for the sextant was only used once, the level having been found to be cracked later on. The altazimuth was mounted on three fixed brass plates with radial furrows on the upper side of its box, with the latter standing on the hard packed snow, which was found to give a sufficient stability. The observer had to lie on the ice. On comparing the readings of the vertical circle of the altazimuth during this expedition with those taken on board an apparent difference will be found; while Mr. Scott-Hansen always noted the degrees by the vernier to the left, Mr. Nansen used for the same purpose the vernier on the opposite side to the object glass. In this manner half the difference between the readings in the two positions of the instrument, the telescope being in both cases pointed to the same fixed object, will give the altitude. The horizontal point of the circle differed only some minutes from 90°. It should be mentioned that the lines ruled on glass, forming the cross wires in the focus, are rather broad, between 1′ and 2′; while this introduces no difficulty for the observation of stars which can easily be set between the borders of the line, the Sun's limb must be set tangent to one of them, and when the edge used is apparently the same (e. g. the upper) in both positions, they are really different; thus the horizontal point of the circle will be different in the two positions, unless the semidiameter is given a constant correction. In the mean the effect will of course be eliminated.

Both the travellers carried pocket chronometers which will be designated in the following by I and II. The first, carried by Nansen, was marked "Johannsen 6455", the other, carried by Johansen, was denoted in the journals of the *Fram* as „No. 19787"; it was Nansen's watch from the Greenland expedition. Both were carefully compared with chronometer Hohwü by Lieut. Scott-Hansen during several months before starting, and under varying conditions which differed, however, considerably from those of the sledge expedition. The mean daily rate of I on Mean Time during periods of a week or more varied between $3.^s9$ and $5.^s2$ fast, of II between $1.^s2$ and $3.^s3$ slow. During the days February 26—March 6, including the first trial expedition, the rate of II was $-2.^s42$, and during the next eight days which were spent on board, it was $-2.^s35$. Watch I was not compared with Hw on returning to the ship (Nansen returned on March 3, Johansen on March 4) but the mean rate during Febr. 26—March 14 was $+5.^s0$. The relative rate of I—II was thus $+7.^s4$. During the expedition it was more irregular, but on the average greater, about 10—13 seconds. Both watches appear to have been going faster, but I more than II.

It happened several times that one of the watches ran down. Unfortunately it happened also once, when the working day of the men had been longer than that of the watches, that both ran down. The astronomical observations between which the stopping occured (1895 April 12) were 5 days apart. As the weather was clear and the ice good, the dead reckoning for this interval will probably not be much in error; but the drift of the ice is of course unknown.

There is, however, another difficulty which for a certain period of the expedition is more serious than the stopping of the watches. During the months of April and May all altitudes were measured with the sextant, and, with one exception, from the natural horizon. In the afternoon of April 2 a series of 6 altitudes was taken, the first three with glass horizon, the rest with natural horizon. The two sets give a difference of nearly ten minutes in the clock error. It was first believed that the glass horizon had got out of adjustment after levelling; a comparison with the result of a series of 5 altitudes taken in the morning of April 4 seems, however, to indicate another explanation, viz. a constant error in the altitudes measured from the natural horizon, evidently due to irregular terrestrial refraction causing the correction for dip to be nearly as large positive as it should be negative under ordinary circumstances for the given height of the eye. On both days the sky was clear, the Sun above the horizon all day long, and the weather mostly calm, but the temperature of the air below —30° C. There is some probability that a similar anomaly may have taken place also an other occasions under the same meteorological conditions; but the assumption that the horizon has on all occasions been elevated to the same amount must necessarity be affected by a considerable uncertainty. The same phenomenon (to a smaller extent) made itself manifest later on at the winter hut though the temperature was then much higher.

Considering that in the high latitudes reached during this expedition an error of 1′ in an altitude measured near the prime vertical, that is to say under the most favorable conditions, gives an error of a minute of time in the clock correction, it will be understood that the determination of local time by the means at hand was no easy task.

On two occasions Mr. Nansen took Lunar Distances, one on the ice, the other at the winter hut. After the stopping of the watches he was often on the look out for the Moon during the periods of her visibility, but could not perceive her with the naked eye on the pale sky with the strong reflection of light from the immense white surface of the ice, till August 10; and even then the Moon disappeared in the haze after the measuring of a single distance. The cutting out of the tables of Lunar Distances from the English Nautical Almanac having been forgotten he had no other data for the Moon than the mean time and the declination for upper culmination at Greenwich, by which means the computation on the spot was of course rather difficult.

The uncertainty of the Greenwich Time deduced from the Lunar Distances is not much greater than that of the Local Time. An approximate determination of the longitude of the winter hut at Franz Joseph Land may also be obtained by a combination of Mr. Nansen's observations in 1896 on the way to Mr. Jackson's station at Cape Flora. The writer does not know the particulars of the determination of the longitude of this place; but in a letter from Professor SCHIAPARELLI he is kindly informed that according to a private letter from a member of the expedition of H. R. H. the DUKE OF THE ABRUZZI, which had an excellent equipment of instruments, Lieut. CAGNI had made a new determination of the longitude of Cape Flora and found a displacement of 10′ towards the east, which is not of importance in this connection. The duke having left Arkhangel only 9 days before reaching Cape Flora, it is very likely that a good determination could be made by means of the chronometers.

The two Charts,

showing the track of the ship and of the sledge expedition, are constructed on the stereographical projection. The scale indicated on the charts is valid for latitude 81°17′, but the difference for other latitudes is nearly insensible. The magnetic declination, which is indicated by arrows in some places where they could be inserted without inconvenience, is mostly taken from the observations by compass on the ice, but some values have also been furnished by Mr. STEEN from observations in the magnetic observatory.

The writer is under obligation to Professor H. H. TURNER of Oxford who has had the great kindness to read a proof of this Introduction.

In conclusion the writer cannot withhold an expression of admiration for the activity and ability with which the men of the *Fram* have — under most trying circumstances and in a great measure with instruments and by methods lying far outside their practice in former life — collected so many important scientific results.

August, 1900.

No. 6

OBSERVATIONS.

A. Altitudes measured with the Altazimuths.

Observer: Lieutenant *Scott-Hansen,* when not otherwise stated.

The small instrument, which was but seldom used on board, is indicated by the circle-reading only to tenths of a minute.

The date here given is astronomical, the hours being counted from Noon of a meridian not very different from that of Greenwich (the chronometer *Hohwü* being about 40 minutes in advance of Gr. M. T.). Owing to the great eastern longitude of the ship during the most part of the voyage the civil date on board was very often greater by 1 than that here given.

The position of the observer before the ocular is as a rule not stated in the original, but may be inferred from other considerations and is added here in the column "Oc." in order to facilitate the application of the level-correction. The level-reading is reproduced here as given in the original; the correction to the circle-reading is in the direction Right—Left, the sign of which may be concluded from the above remark.

As to the approximate bearing of the star it may be remarked that when the circle-reading is between 270° and 360°, the object glass was to the right of the observer, standing before the ocular; when between 0° and 90° to the left. (In the case of the small instrument, whose zenith-point is about 180°, the corresponding limits are 90°—180° for the right, and 180°—270° for the left).

The two columns of circle-reading correspond to the two microscopes (or verniers for the small instrument). For the great instrument each number of seconds is the mean of two or sometimes three readings, corresponding to adjacent divisions of the circle.

The two last columns before "Remarks" give the comparisons between the chronometer Hw and the observer's watch, in some cases supplemented from the Journal of daily comparisons.

See also explanation to List B (sextant-observations).

1893	Star	Oc.	Watch	Vertical Circle		Level	Watch	Hw—W.	Rem.
			h m s	° ′ ″	′ ″		h m	m s	
Aug. 6	Sun L. L.	N	3 4 45	101 38.5	36.8	—	21 12	— 0 33.9	1)
	"	S	8 23	258 39	37	—	21 2	— 0 35.5	
Oct. 5	Polaris	E	1 24 58.5	169 32.5	32.3	S 0.5 N 1.7	0 26	+ 1 28.5	
	"	W	45 38	190 23	20	N 0.7 S 1.2			
	Jupiter	N	1 56 27.5	247 4.5	6	E 0.5 W 1.7			
	"	S	2 7 46	113 28.0	27.5	E 0.2 E 2.5	2 59	+ 1 28.7	2)
Oct. 5	α Ursæ Maj	W	23 54 11	218 24	21.5	N 1.1 S 1.3	22 44	+ 1 36.5	
" 6	"	E	0 8 6.5	141 26.5	20.0	S 0.6 N 1.6			
	Jupiter	S	0 19 11	108 20.0	18.5	W 0.9 E 1.4			
	"	N	26 18	251 22.0	17.0	W 2.0 E 0.3	1 31	+ 1 37.7	
Oct. 8	Vega	N	0 59 7.3	133 48.5	45.0	E 0.4 W 2.0	0 31	+ 1 38.5	
	"	S	1 13 1	226 56.2	54.0	W 2.5 W 0.2			3)
	Polaris	W	1 27 10.3	190 38.2	34.5	N 0.35 S 2.0			
	"	E	43 35.5	169 27.5	24.5	N 1.4 S 0.9	2 3	+ 1 39.3	
Oct. 12	α Ursæ Maj.	E	1 2 42	140 34	33.5	N 1.4 S 0.7	0 51	+ 2 6.5	
	"	W	13 44	219 26.5	26.0	N 0.35 S 1.8			
	Vega	S	1 40 49	229 2.5	4.0	W 2.55 W 0.4			4)
	"	N	2 0 38	129 59.5	58.5	W 1.0 E 1.2	2 35	+ 2 7.1	
Oct. 17	α Ursæ Maj.	E	1 16 41	320 44 16.0	43 54.5	N 9.0 S 20.6	23 45	+ 2 41.2	5)
	"	W	34 49.2	39 8 41.0	8 40.0	N 13.0 S 16.5			
	Capella	N	1 48 37.8	42 44 49.5	44 32.0	W 13.4 E 16.1			
	"	S	2 2 29.3	317 57 0.5	56 36.5	W 14.0 E 15.6	2 35	+ 2 41.5	
Oct. 18	α Ursæ Maj.	E	23 9 34.0	321 17 55.5	17 41.0	N 16.4 S 14.0	22 45	+ 2 53.6	
	"	W	23 22.6	38 53 11.0	52 51.0	N 18.3 S 12.1			
	Capella	N	23 36 53.8	48 45 56.0	45 40.5	W 14.8 E 16.0			
	"	S	50 51.9	311 51 36.0	51 28.5	E 14.7 W 16.1	24 15	+ 2 54.5	
Oct. 23	α Ursæ Maj.	E	0 7 27.8	320 38 53.0	38 50.0	N 16.2 S 14.8	23 27	+ 3 11.1	
	"	W	19 21.2	39 22 40.0	22 23.5	S 12.2 N 18.8			
	Capella	N	0 32 7.7	45 34 17.5	34 5.5	E 20.6 W 10.0			
	"	S	41 24	314 53 59.5	53 34.5	E 13.0 W 17.1	25 8	+ 3 11.5	
Oct. 25	α Cygni	W	21 17 37.8	326 26 50.5	26 28.0	S 18.8 N 11.5	20 52	+ 3 23.5	6)
	"	E	28 6.7	33 28 15.0	27 56.5	N 15 S 15			
	α Persei	N	21 45 2.2	44 3 11.5	3 24.5	E 11.2 W 19.5			
	"	S	53 34.5	316 20 24.5	20 18.0	E 14.4 W 16.1	22 6	+ 3 23.5	
Oct. 27	α Cass.	S	21 33 33.8	329 49 33.0	49 13.0	W 16.0 E 15.0	20 50	+ 3 34.5	
	"	N	47 17.2	29 29 4.0	29 15.5	W 16.5 E 15.0			
	α Cygni	E	21 59 57.5	33 26 56.0	26 29.0	S 16.5 N 14.9			
	"	W	22 9 27	326 29 45.0	30 8.0	N 15 S 16	22 27	+ 3 34.3	
Oct. 29	α Ursæ Maj.	W	22 10 58.2	38 31 1.5	30 45.5	N 16.0 S 15.8	21 41	+ 3 44.2	
	"	E	22 28	321 17 26.0	17 55.5	S 16.5 N 15.3			
	Capella	S	22 36 48.8	310 20 20.0	20 43.0	E 13.0 W 19.0			
	"	N	46 17.5	49 14 54.0	14 27.0	E 16.7 W 15.2	23 26	+ 4 45.5	7)
Oct. 31	ε Cass.	N	20 59 14.8	28 21 28.5	21 55.5	E 16.6 W 15.5	20 26	+ 3 55.8	
	"	S	21 7 47.0	332 3 13.5	3 53.0	W 16.7 E 15.3			
	Deneb	W	21 20 47.7	326 50 59.0	50 27.0	N 16.0 S 16.0			
	"	E	34 8	33 7 21.0	7 49.0	N 16.6 S 15.5	23 23	+ 3 57.6	
Nov. 2	ε Cass.	N	21 9 48.3	27 25 35.0	26 13.5	E 18.0 W 15.5	20 23	+ 4 10.5	8)
	"	S	45 24	334 23 0.5	23 30.0	W 16.5 E 17.3			
	α Cygni	W	22 5 12.5	326 39 38.0	39 10.0	N 18.0 S 15.5			
	"	E	17 50	33 31 41.0	31 6.5	S 19.6 N 14.0	22 36	+ 4 13.5	
Nov. 6	ε Cass.	N	21 8 16.3	26 5 49.0	5 0.5	E 14.0 W 15.2	20 22	+ 4 49.8	
	"	S	27 21.5	334 55 12.5	54 23.0	W 13.5 E 16.5			
	α Cygni	W	21 43 24	326 44 38.0	45 23.0	S 17.5 N 12.8			
	"	E	58 54	33 29 56.0	30 32.0	S 13 N 17.2	22 20	+ 4 50.6	
Nov. 9	ε Cass.	S	21 1 3	334 10 30.5	9 55.5	E 15 W 14	12 48	+ 5 12.0	
	"	N	22 41.7	24 43 12.0	42 28.0	E 14.5 W 14.5			

1) Comparison Aug. 5. 2) Level assumed W.—0.2. 3) Lev. E.—0.2. 4) Lev. E.—0.4. 5) Comp. Oct. 16. 6) Level a little uncertain, as there was some motion in the ice. 7) Assumed Hw—W. = 3 45.5. 8) Observer Johansen.

1893	Star	Oc.	Watch	Vertical Circle		Level	Watch	Hw−W.	Rem.
			h m s	° ′ ″	′ ″		h m	m s	
Nov. 9	α Cygni	E	21 37 50	33 27 6.0	27 51.0	S 15.5 N 13.5			
	"	W	46 57	326 23 23.5	24 11.0	S 12.5 N 16.5	21 59	+ 5 14.6	
Nov. 12	ε Cass.	S	20 41 3.5	333 54 25.0	53 38.0	E 15.2 W 16.0	19 43	+ 5 35.5	
	"	N	54 50	25 24 18.0	23 31.0	E 16.3 W 14.9			
	α Cygni	E	21 10 4.3	33 21 11.0	21 55.0	S 15.5 N 15.5			
	"	W	29 54	326 21 18.0	22 0.0	N 17.1 S 13.3	21 57	+ 5 36.5	
Nov. 16	ε Cass.	N	20 53 28.8	24 27 9.0	26 24.0	E 15.4 W 15.5	19 33	+ 6 5.5	
	"	S	21 4 21.5	336 6 33.5	5 45.0	E 17.0 W 14			
	α Cygni	W	21 18 28	325 51 7.5	51 40.5	S 17.2 N 13.2			
	"	E	27 10	34 19 26.0	18 51.0	S 15.7 N 15.2	22 12	+ 6 6.1	
Nov. 20	ε Cass.	N	20 54 10.2	23 33 59	34 44	E 15.5 W 17.4	19 56	+ 6 46.5	
	"	S	21 15 3	337 28 28	28 57.5	E 15.4 W 17.5			
	α Cygni	W	21 35 32	325 5 50	6 37	S 13.0 N 20.0			
	"	E	48 3.5	35 16 13	15 25	S 20.2 N 12.7	22 26	+ 6 48.2	
Dec. 4	ε Cass.	N	20 9 54.2	23 15 17	16 2	E 17.0 W 16.5	19 9	+ 8 57.2	1)
	"	S	41 54.0	338 25 45	24 53	E 16.5 W 17.5			2)
	α Ursæ Maj.	E	21 4 6.0	321 12 31	13 25	N 14.7 S 19.5			
	"	W	19 22.5	38 48 30.5	49 7.5	N 16.0 S 18.0	21 46	+ 8 57.8	
Dec. 8	ε Cass.	N	20 5 55.0	23 11 41	12 6.5	E 18.0 W 14.9	18 51	+ 0 14.0	
	"	S	16 33.5	337 19 28.5	19 6.5	E 16.0 W 17.0			
	α Ursæ Maj.	E	20 31 31	321 26 55.5	27 33	S 19.1 N 13.5			
	"	W	45 30	38 37 24.5	37 54	N 16.1 S 16.4	21 17	+ 0 14.5	
Dec. 11	ε Cass.	S	20 10 1	337 35 15	34 44	E 16.2 W 16.0	19 34	+ 0 37.5	
	"	N	22 59	21 49 1	49 34.5	E 15.1 W 17.2			
	α Ursæ Maj.	E	20 42 26	321 29 38.5	29 10	N 17.0 S 15.6			
	"	W	55 32.5	38 32 59.5	32 27.5	N 16.9 S 15.5	21 34	+ 0 38.2	
Dec. 17	ε Cass.	S	19 5 18.5	25 40 52.5	40 26	W 16.0 E 13.9	18 18	+ 1 30.0	3)
	"	N	14 1.2	23 55 14	54 29.5	E 17.3 W 13.5			
	α Ursæ Maj.	W	19 34 2.2	38 14 56.5	15 38	N 15.3 S 15.3			
	"	E	52 31.0	321 34 51	35 30.5	N 15.0 S 15.6	20 26	+ 1 30.6	1)
Dec. 19	ε Cass.	S	18 44 17.5	335 3 0	2 31.3	E 15.4 W 16.1	18 17	+ 1 51.5	
	"	N	55 4	25 27 16.5	26 36	E 15.0 W 17.5			4)
	α Ursæ Maj.	W	19 5 58.7	37 59 0.5	59 31	N 16.4 S 16.8			
	"	E	12 32	321 55 13.5	55 55	N 18.4 S 15.2	19 38	+ 1 52.0	
Dec. 21	γ Cass.	N	19 45 20	22 12 13.5	11 52	E 17.0 W 15.3	19 17	+ 2 10.2	5)
	"	S	54 28	338 8 38	8 23.5	E 18.0 W 14.5			
	ζ Cygni	W	20 9 55	312 45 5.5	45 33.5	S 16.2 N 16.9			6)
	"	E	26 24.0	47 42 55.5	43 15.0	N 15.0 S 17.6	20 49	+ 2 11.0	
Dec. 23	ε Cass.	S	18 48 9.4	335 56 29	55 57.5	E 16.5 W 15.0	18 25	+ 2 24.5	
	"	N	19 1 4	23 27 20	26 47.5	E 16.5 W 16.9			
	α Ursæ Maj.	W	19 9 20.0	38 12 5	12 36.5	N 15.0 S 18.6			
	"	E	16 3.5	321 43 45	44 15	N 15.1 S 19.0	19 40	+ 2 25.0	
Dec. 26	α Persei	S	20 30 53	324 9 8	8 51	E 18.8 W 13.1	19 58	— 1 11.5	
	"	N	39 1.5	35 28 50	29 15	E 17.0 W 15.0			
	α Ursæ Maj.	W	20 48 32	38 30 38	30 55.5	N 15.2 S 16.8			
	"	E	56 25	321 32 26	32 57	S 15.5 N 16.5	21 24	— 1 11.0	
Dec. 28	ε Cass.	N	18 53 35	22 59 50	59 37	E 15.0 W 15.3	18 25	— 0 54.5	
	"	S	19 1 23.5	337 22 39	22 18	E 14.4 W 17.0			
	α Ursæ Maj.	E	19 9 24	321 29 2	28 34.5	N 11.2 S 20.4			
	"	W	16 21.5	38 34 56.5	34 25	N 15.1 S 16.9	19 32	— 0 54.0	
Dec. 30	ε Cass.	S	18 59 42	337 35 23.5	34 54.5	E 13.9 W 16.1	18 44	— 0 38.8	
	"	N	19 7 59	22 1 40.5	1 19	E 16.0 W 16.0			
	α Ursæ Maj.	W	19 15 3	38 35 40	35 3.5	N 20.0 S 12.7			
	"	E	21 36.5	321 23 18.5	22 54.5	S 17.2 N 16.0	19 34	— 0 36.7	
1894									
Jan. 1	ε Cass.	N	19 18 58	21 6 51.5	6 11.5	E 18.7 W 13.9	18 53	— 0 24.0	
	"	S	26 13.0	339 13 11	13 37	E 16.0 W 17.8			

1) Observer Johansen. 2) Ass. corr. to circle — 10′. 3) Circle ass. 335°. 4) Circle ass. 24°. 5) Hazy. 6) Star ass. ε Cygni.

1894	Star	Oc.	Watch	Vertical Circle		Level	Watch	Hw—W.	Rem.
			h m s	° ' "	' "		h m	m s	
Jan. 1	α Ursæ Maj.	E	19 45 58.5	321 16 39.5	15 55.5	N 17.5 S 17.5			
	"	W	54 43	38 43 39.5	43 4.5	N 17.0 S 18.0	20 11	− 0 24.0	
Jan. 4	ε Cass.	S	18 55 31	338 25 53.5	25 11	E 16.5 W 17.0	18 30	0 0.0	
	"	N	19 4 12	21 10 55	10 36	W 16.3 E 18.0			
	α Ursæ Maj.	W	19 12 23	38 41 37.5	41 11	N 17.3 S 17.3			
	"	E	21 0	321 17 47	17 19	N 16.9 S 18.0	19 38	+ 0 0.5	
Jan. 7	ε Cass.	S	19 11 17.7	339 40 26	40 6.5	E 16.7 W 17.3	18 45	+ 0 23.5	
	"	N	18 5.0	20 3 0.5	2 24	E 18.3 W 16.3			
	α Ursæ Maj.	W	19 27 4.0	38 35 16	34 35.5	N 18.2 S 16.7			
	"	E	38 12.0	321 27 0.5	26 10.5	N 16.5 S 18.5	20 14	+ 0 24.0	
Jan. 9	α Ursæ Maj.	W	19 57 35.1	38 23 15	22 41	N 15.5 S 17.5	19 20	+ 0 38.1	1)
	"	E	20 12 37.5	321 44 53.5	44 12.5	N 18.5 S 15.5			
	δ Draconis	N	20 29 48	337 37 11	36 22	E 19.0 W 16.5			
	"	S	38 52.5	22 48 50	48 22	W 19.4 E 16.2	20 55	+ 0 39.0	
Jan. 12	γ Draconis	N	19 54 18.0	320 17 18.5	17 50.5	W 16.0 E 16.6	19 17	+ 1 0.9	
	"	S	20 1 31.6	40 2 43	2 14	E 16.2 W 17.0			
	α Ursæ Maj.	W	20 11 4.5	37 60 3	59 35	S 17.0 N 16.5			
	"	E	20 14	322 6 34	7 17.5	N 18.1 S 15.6	20 37	+ 1 1.5	
Jan. 15	α Ursæ Maj.	E	18 46 14.5	321 36 22.5	35 32.5	S 17.7 N 14.8	18 25	+ 1 29.6	
	"	W	52 30	38 24 40	23 55	S 18.3 N 15.1			
	γ Draconis	S	18 59 58.5	37 47 59	48 45.5	W 21.2 E 13.2			
	"	N	19 9 7	321 46 15	47 2	E 18.5 W 15.9	19 35	+ 1 30.0	
Jan. 18	γ Draconis	N	18 59 30	321 46 29	45 52.5	E 16.4 W 16.3	18 30	+ 1 58.0	
	"	S	19 9 11	38 40 17.5	40 43	W 18.0 E 13.8	20 20	+ 1 58.8	2)
Jan. 21	α Ursæ Maj	E	18 21 51	322 0 36	0 14	N 16.1 S 15.9	17 57	+ 2 26.5	
	"	W	29 26.5	38 0 18.5	0 0	N 17.1 S 14.7			2)
	α Cygni	N	22 52 27.5	312 2 12.5	2 48.5	W 14.9 E 16.6			
	"	S	23 0 4	48 17 11	16 31.5	W 16.5 E 14.7	23 29	+ 2 29.5	
Jan. 22	α Cass.	W	19 42 21	336 12 37.5	13 20	S 17.1 N 16.7	17 45	+ 2 35.8	
	"	E	51 27	23 45 29	44 48	S 19.0 N 15.0			
	α Cephei	S	20 4 43.5	22 38 19.5	37 51	W 18.0 E 16.0			
	"	N	13 46.5	336 59 3.5	59 31	W 11.9 E 17.1	20 38	+ 2 37.0	
Jan. 25	ε Ursæ Maj.	E	20 5 7	316 17 29.5	16 50.5	N 17.4 S 18.0	19 38	+ 3 5.0	
	"	W	14 38	43 43 15	42 38	N 19.3 S 15.8			
	α Cephei	S	20 22 25	23 51 54.5	52 30.5	W 19.0 E 15.6			
	"	N	29 47.5	335 48 44	49 13.5	E 19.0 W 16.0	20 48	+ 3 5.3	
Jan. 27	α Ursæ Maj.	E	18 49 51.5	322 12 49	13 35	N 17.0 S 18.6	18 38	+ 3 24.2	
	"	W	19 6 0	37 40 52.5	40 20	N 20.7 S 14.0			
	γ Draconis	S	19 13 52	40 4 40	3 55	W 17.5 E 16.9			
	"	N	22 46	319 32 54.5	33 44.5	W 17.0 E 17.4	19 40	+ 3 24.5	
Jan. 29	α Ursæ Maj.	E	18 40 6	322 13 22	12 53	N 16.1 S 17.9	18 18	+ 3 44.4	
	"	W	47 56	37 44 26	43 50	N 17.6 S 16.4			
	γ Draconis	S	18 57 12	39 42 45.5	42 9.5	W 18.1 E 15.5			
	"	N	19 4 56	319 57 57.5	58 30.5	E 18.6 W 15.0	19 30	+ 3 45.0	
Feb. 1	Vega	W	14 3 22	318 32 35	33 11	N 17.2 S 14.0	13 36	+ 4 11.5	
	"	E	9 37.5	41 30 57.5	31 20	N 16.2 S 14.8			
	α Cass.	N	14 22 47	32 50 53	51 20.5	E 14.8 W 16.2			
	"	S	33 59	327 35 53.5	35 12	W 13.0 E 18.0	14 50	+ 4 12.0	
Feb. 4	α Ursæ Maj	E	18 36 48	322 33 54	34 49.5	N 20.0 S 16.6	18 13	+ 4 44.8	
	"	W	44 43.5	37 21 52.5	21 8	N 18.3 S 18.3			
	γ Draconis	S	18 51 33	40 26 3	26 50.5	W 16.4 E 18.7			
	"	N	19 0 51	319 11 4.5	10 16	W 18.0 E 18.6	19 23	+ 4 45.7	
Feb. 8	Vega	N	19 33 19.5	306 15 54	15 17.5	W 15.6 E 13.0	18 19	+ 5 21.5	
	"	S	40 29	54 2 10	2 41	E 16.0 W 13.5			
	α Cass.	E	19 48 35	24 20 4	20 34.5	S 15.1 N 15.1			
	"	W	55 25	335 34 31	33 55	N 18.0 S 13.0	20 10	+ 5 22.0	

1) Observer Johansen. 2) Cloudy.

1894	Star	Oc.	Watch	Vertical Circle		Level	Watch	Hw—W.	Rem.
			h m s	° ' "	' "		h m	m s	
Feb. 11	α Cephei	N	19 30 13.5	335 27 5.5	26 19.5	W 15.4 E 20.2	19 8	+ 5 50.0	
	"	S	37 39	24 53 20.5	52 43	W 20.1 E 15.5			
	Polaris	W	19 49 47	8 44 38.5	45 22	N 19.0 S 16.9			
	"	E	58 32	351 15 23	14 45	S 19.5 N 16.2	20 33	+ 5 50.5	
Feb. 13	Polaris	E	19 35 48	351 15 30	14 58.5	N 18.0 S 16.6	18 55	+ 6 11.5	
	"	W	42 6	8 45 15	44 38	N 16.0 S 19.0			
	α Cephei	S	19 59 41	26 6 20.5	5 41.5	W 19.5 E 15.7			
	"	N	20 22 7	332 55 18	55 54	W 16.2 E 18.5	22 23	+ 6 13.0	
Feb. 19	α Cephei	N	21 3 35	330 9 33.5	9 9	W 15.3 E 18.3	20 40	+ 7 10.7	
	"	S	10 1.0	30 5 55	6 38.5	W 16.0 E 18.0			1)
	β Ursæ Min.	E	21 19 5	334 48 30	48 14.5	S 19.5 N 14.5			
	"	W	26 31.5	25 9 29	9 7	N 16.0 S 18.0	21 45	+ 7 11.5	
Feb. 21	Capella	W	21 29 55	325 12 8	12 29.5	N 15.0 S 15.8	20 39	+ 7 27.7	
	"	E	41 48.5	34 37 57	37 33.5	N 15.1 S 15.0			
	"	E	22 10 52	34 21 14.5	20 57.5	S 16.0 N 14.3			
	"	W	17 30	325 41 28.5	41 13.5	S 17.4 N 13.0	23 48	+ 7 29.0	
Feb. 22	α Cass.	N	0 25 39	323 52 9	51 50	W 15.5 E 18.0			
	"	S	34 5	36 28 52.5	28 39.5	W 16.0 E 16.6	1 3	+ 7 29.9	2)
Feb. 23	α Cephei	N	21 1 2	329 37 34.5	36 46.5	E 18.9 W 16.5	20 35	+ 7 43.1	
	"	S	9 19	30 33 23	32 32	W 16.9 E 18.4			3)
	Capella	E	21 39 32	34 29 27.5	28 46.5	S 18.6 N 15.6			
	"	W	49 27	325 37 12.5	37 57.5	N 18.2 S 16.7	22 1	+ 7 44.0	
Feb. 26	Capella	W	22 53 20	325 37 22	37 41.5	N 15.0 S 15.7	22 23	+ 8 12.7	
	"	E	23 0 10	34 26 22	26 45.5	N 15.7 S 15.0			
	α Cass.	S	23 13 1.5	34 17 0.5	16 32	W 16.0 E 15.0			
	"	N	19 41	325 26 17.5	25 48	W 17.0 E 16.0	23 36	+ 8 13.3	
Mar. 3	γ Draconis	E	22 51 12	311 27 21	26 8.5	N 18.6 S 16.0	22 35	— 0 3.5	
	"	W	56 32.5	48 33 30.5	33 59.5	N 18.6 S 16.0			
	α Ursæ Maj	N	23 3 9	26 15 20	14 19.5	W 20.4 E 14.3			
	"	S	9 39	334 3 39	2 35	W 19.0 E 15.0	23 25	— 0 3.0	
Mar. 5	α Lyræ	E	23 10 31	118 6.5	2.5	N 1.0 S 2.0	13 25	+ 0 12.3	
	"	W	18 13	240 55.0	55.5	N 0.7 S 2.2			
	γ Ursæ Maj.	N	23 31 54	213 55.0	53.0	W 0.6 E 2.3			
	"	S	39 26	145 27.5	24.5	W 0.3 E 2.6	24 15	+ 0 17.0	4)
Mar. 10	α Cygni	W	0 23 5	235 12	10	N 1.5 S 1.4	23 52	+ 0 59.0	5)
	"	E	29 28	124 44.7	40.5	N 2.0 S 1.0			
	α Persei	N	0 36 24.5	141 24.5	20.5	W 2.2 E 0.7			
	"	S	43 2	218 52.5	51.0	W 1.6 E 1.3	13 24	+ 1 5.0	
Mar. 13	α Persei	S	0 22 36	218 25.5	24.5	W 1.3 E 1.6	13 28	+ 1 25.0	6)
	"	N	29 11	141 15.5	10.0	W 2.5 E 0.3			
	α Cygni	E	0 39 29	124 33.5	30.5	N 1.8 S 1.0			
	"	W	46 32	235 23.5	20.5	N 1.4 S 1.5	1 1	+ 1 28.5	
Mar. 15	α Persei	N	0 19 0	321 20 6	19 13.5	W 16.0 E 19.2	23 53	+ 1 47.0	7)
	"	S	26 59	39 3 0.5	2 2	W 17.0 E 18.2			
	α Cygni	W	0 33 26	55 25 57.5	25 5.5	N 18.0 S 17.2			
	"	E	40 55	304 34 53.5	33 52.5	N 16.7 S 19.0	1 1	+ 1 47.5	
Mar. 18	α Cygni	E	21 51 1	304 42 0.5	41 8.5	N 19.3 S 16.6			
	"	W	58 11.5	55 20 54	21 47	N 17.6 S 18.3			
	α Persei	S	22 7 48	38 58 14	57 17	W 17.6 E 18.3			
	"	N	17 7	320 37 36.5	36 41	W 18.7 E 17.0	22 34	+122 35.0	
Mar. 22	α Persei	N	23 58 40	319 38 37.5	37 40.5	W 18.0 E 16.0	23 24	+ 0 19.2	8)
23	"	S	0 13 16	40 50 35	49 42	E 19.5 W 14.4			9)
	α Cephei	W	0 31 47	37 48 1	48 58	N 17.4 S 16.7			
	"	E	40 26	322 11 11	10 11	N 15.4 S 18.8	1 23	+ 0 20.0	
Mar. 26	α Persei	N	0 3 3	320 12 39.5	11 54.5	W 20.4 E 14.6	23 27	+ 0 49.5	10)
	"	S	8 2.5	40 0 52	1 32	W 19.0 E 15.7			

1) Some motion in the level. 2) Cloudy, stars often invisible. 3) Ass. corr. to circle + 10'. 4) Zenith-point about 179° 30'. 5) Comp. March 9. 6) Comp. March 12. 7) Comp. March 14. 8) Ass. corr. to circle + 1° 10'. 9) Ass. corr. to circle — 1°. 10) Comp. March 25.

1894	Star	Oc.	Watch	Vertical Circle		Level	Watch	Hw−W.	Rem.
			h m s	° ′ ″	′ ″		h m	m s	
Mar. 26	α Cephei	W	0 15 0	37 45 43.5	46 42	N 19.0 S 15.7			
	"	E	21 37.5	322 13 11	12 24.5	N 17.5 S 17.1	0 33	+ 0 49.8	
Mar. 31	α Persei	N	0 0 36	319 24 51.5	24 7	W 18.0 E 15.2	23 31	+ 1 39.7	1)
	"	S	10 4	40 59 21	60 1	W 14.3 E 19.0	13 2	+ 1 46.0	2)
Apr. 6	γ Draconis	S	2 56 0.5	321 24 32	23 53	E 14.0 W 19.7	19 32	+ 2 37.7	3)
	"	N	3 1 35	38 22 32	22 2.5	E 18.0 W 15.7			
	α Cass.	W	3 8 14	43 48 46	48 32.5	N 18.0 S 15.6			
	"	E	13 5	316 12 0	11 34	N 14.9 S 18.7	3 25	+ 2 40.5	
May 4	Sun U. L.	N	21 58 14	286 1 29.5	1 31.5	W 8.7 E 15.8	13 16	+ 7 36.5	
	"	S	22 3 44.5	74 12 0.5	11 49.5	W 14.0 E 12.0	22 28	+ 7 40.0	
May 25	Sun L. L.	W	14 45 45	298 32 50	32 22.5	S 10.6 N 12.5	13 47	+ 2 7.0	
	"	E	51 48.3	61 21 39.5	21 21	S 10.5 N 12.7			
	Sun U. L.	N	21 39 26	291 5 46	5 19	W 14.0 E 8.8	20 55	+ 50 24.5	4)
	"	S	46 58	69 9 55.7	9 45	W 12.0 E 11.0	22 3	+ 50 25.0	
June 3	Sun L. L.	S	13 14 24.7	297 33 32.5	33 15.5	E 12.4 W 11.4			
	"	N	18 34	62 19 15.5	18 59	E 12.2 W 11.6	13 42	— 0 17.8	
June 4	Sun L. L.	N	12 37 29.5	63 28 4.5	27 55.5	E 9.0 W 14.0	12 2	— 0 9.0	
	"	S	42 11.5	296 40 52	40 53	E 10.4 W 12.8	14 0	— 0 8.2	
June 6	Sun L. L.	S	12 25 23.5	296 22 31	22 17.5	E 12.1 W 7.0	11 53	+ 0 34.3	4)
	"	N	12 32 20.5	63 24 0	23 42	E 11.7 W 8.8	13 56	+ 0 35.0	
	Sun U. L.	N	22 31 56	292 46 17	46 31.5	W 10.0 E 11.8			
	"	S	37 36	67 25 51	25 31.5	W 12.7 E 9.5	22 55	+ 0 38.7	
June 7	Sun L. L.	S	13 16 38	298 4 58	4 30	E 5.0 W 16.0			
	"	N	21 30	61 46 46.5	46 29	E 8.6 W 12.3	13 55	+ 0 44.2	
June 12	Sun L. L.	S	13 30 11	298 37 59	37 45.5	E 10.4 W 10.4			
	"	E	35 15.5	61 13 57.5	13 38.5	S 10.8 N 9.9	13 46	+ 1 25.5	
	Sun U. L.	N	21 47 29	294 49 57	49 49.5	W 9.0 E 12.0			
	"	S	53 53	65 23 54.5	23 35.5	W 11.0 E 10.3	22 6	+ 1 27.5	5)
Ju. (16)	Sun U. L.	W	Noon	301 46 43.2	46 26.5	N 11.0 S 8.1			
	Terr. Obj.	S	—	270 17 44.3	17 52	E 10.2 W 9.3			
		N	—	89 41 44.7	41 42.3	E 10.5 W 9.1			
June 22	Sun L. L.	S	13 22 57	298 35 47.5	35 32.5	E 9.4 W 11.0	11 54	+ 2 42.5	
	"	N	27 46.5	61 16 5.5	15 50	E 13.3 W 6.9	14 1	+ 2 42.5	
July 5	Sun L. L.	S	12 29 36.8	297 13 23	13 1	E 14.8 W 6.1	11 57	+ 4 38.1	
	Terr. Obj.	N	—	270 14 26.5	14 22	E 15.6 W 6.5			
		S	—	89 44 54	44 36	E 10.5 W 11.4			
July 10	Sun L. L.	S	12 37 13	296 31 48	31 57.5	E 8.7 W 11.6	11 54	+ 5 23.0	
	"	N	41 23.4	63 19 51	19 48.5	E 9.9 W 10.8	13 55	+ 5 24.0	
July 14	Sun U. L.	N	1 28 15.6	285 41 38	41 29.5	E 4.6 W 15.7	13 55	+ 5 51.2	6)
	"	S	33 31.4	74 25 2	24 45	W 8.4 E 12.1	1 59	+ 5 56.5	
July 27	Sun U. L.	N	21 35 47.5	290 34 34	34 51	W 7.9 E 14.9	21 13	+ 7 55.5	
	"	S	40 45	69 36 29	36 7.5	W 10.4 E 11.5	25 4	+ 7 57.7	
Aug. 25	Sun L. L.	S	14 34 50	288 26 55.5	26 25	E 13.5 W 9.7	13 56	+ 1 25.2	
	"	N	40 15.5	71 27 16.5	27 41	E 11.0 W 12.0	14 57	+ 1 25.5	7)
	Sun U. L.	N	21 2 54	283 13 9.5	12 45	W 12.0 E 11.0			
	"	S	10 27.2	77 4 22.5	3 54	W 12.9 E 10.2	22 38	+ 1 28.3	
Sep. 3	Sun U. L.	S	12 46 48.8	282 42 13	41 47.5	E 16.3 W 7.3	11 52	+ 2 51.3	
	"	N	51 59	77 8 18	7 55	E 13.0 W 11.4	13 34	+ 2 52.0	
	Sun U. L.	N	20 57 56	280 36 49.5	36 19	W 11.7 E 12.1			
	"	S	21 3 17.6	79 34 50.5	34 19	W 12.0 E 11.3	22 7	+ 2 57.0	
Sep. 12	Sun U. L.	S	12 59 24.8	279 20 5.7	19 25	E 9.2 W 14.8	12 31	+ 4 32.5	
	"	N	13 7 27.4	79 57 12.7	56 21	E 10.2 W 10.2	13 55	+ 4 32.2	
Sep. 15	α Ursæ Maj.	W	3 55 56.7	36 20 39.5	19 56	N 12.8 S 13.1	13 56	+ 0 7.5	8)
	"	E	4 3 36.4	323 41 18.5	40 19.5	N 14.1 S 12.7			
	γ Draconis	N	4 14 54	321 44 5.5	43 15.5	W 15.5 E 12.0			9)
	"	S	21 28	38 31 9.5	32 0.5	W 15.0 E 13.0			
	α Lyræ	S	4 25 26.8	49 52 15	51 28	W 17.6 E 10.5	5 4	+ 0 14.7	

1) Comp. March 30. 2) Cloudy. 3) Comp. April 5. 4) Watch had stopped shortly before. 5) Ice-pillar loosened, but instrument steady during the observation. 6) Comp. July 13. 7) Image not sharp. 8) Comp. Sept. 14. 9) Must be another star.

1894	Star	Oc.	Watch	Vertical Circle		Level		Watch	Hw − W.	Rem.
			h m s	° ′ ″	′ ″			h m	m s	
Sep. 17	α Cephei	E	2 13 51.4	19 16 52	15 53.5	S 14.0	N 13.5	1 50	+ 0 33.8	
	„	W	20 29	340 42 36	41 46	N 16.0	S 12.9			
	? Persei	S	2 46 26.0	318 38 4.5	37 12	E 15.7	W 12.1			1)
	„	N	52 18.5	41 9 55	9 7	E 14.0	W 14.0			
	α Persei	N	2 58 31.5	38 53 30	52 34.5	E 13.2	W 15.0	13 58	+ 0 39.0	
Sep. 20	α Cephei	W	2 3 49	340 55 1	53 55	S 14.6	N 12.2	1 39	+ 1 7.5	
	α Persei	N	2 23 48.6	39 48 4	46 53	E 15.0	W 12.4			
	„	S	31 0	320 30 10	29 9.7	E 15.0	W 13.0	3 13	+ 1 8.5	
Sep. 24	η Ursæ Maj.	E	4 59 57	311 27 34	26 31	S 20.0	N 8.0	4 17	+ 1 55.5	
	„	W	5 6 37	48 36 48	35 53.5	S 13.5	N 14.2			
	β Aurigæ	N	5 17 32	43 2 45	2 4	W 14.5	E 13.7			
	„	S	29 41	317 25 20.5	24 24	W 15.5	E 13.0	5 57	+ 1 56.5	
Sep. 28	α Cephei	W	0 59 27	340 54 22	53 34.5	S 17.1	N 12.6	0 10	+ 2 34.5	
	„	E	1 5 54.5	19 5 30.5	4 29.5	S 14.5	N 15.3			
	α Persei	N	1 18 47	41 15 10.5	14 13	E 13.8	W 16.3			
	„	S	23 56.7	318 57 27.5	56 28	E 17.8	W 12.2			
	α Cephei	W	1 55 49.5	340 45 58	44 57	S 15.5	N 14.5	2 12	+ 2 35.5	
Oct. 1	α Cephei	W	0 30 41.0	340 55 59	54 46	S 16.0	N 14.0	0 10	+ 2 19.2	
	„	E	37 0.5	19 2 53	1 53.5	S 17.0	N 13.1			
	α Persei	N	0 45 48.3	42 5 23.5	4 26	E 16.0	W 14.0			
	„	S	53 2	318 12 20	11 22.5	E 15.0	W 15.6	1 16	+ 2 20	2)
Oct. 3	α Cephei	W	0 35 26.7	341 1 20.5	0 36	S 16.2	N 15.0	0 11	+ 2 43.5	
	„	E	41 44.0	18 58 5.5	57 6	S 14.7	N 16.7			
	α Persei	N	0 48 26	41 40 11.5	39 25.5	E 14.7	W 16.2			
	„	S	55 1.5	318 35 54.5	34 58	E 15.5	W 15.5	1 15	+ 2 44.8	
Oct. 7	α Cephei	W	0 13 23.5	340 42 50.5	41 53.5	S 15.0	N 15.8	23 56	+ 3 26.0	3)
	„	E	18 1	19 16 56.5	15 34.5	N 14.1	S 16.8			
	α Persei	N	0 25 42.0	42 6 20.5	7 24.5	E 16.2	W 14.8			
	„	S	31 28.3	318 6 50	5 34.5	E 15.0	W 16.0	1 26	+ 3 27.0	
Oct. 8	Sun L. L.	W	16 54 46.0	272 29 0.5	28 13	S 14.0	N 17.0	13 53	+ 3 46.2	
	„	E	17 0 43.7	87 34 40.5	33 39.5	S 14.2	N 17.2			
Oct. 10	α Ursæ Maj.	E	1 19 23.0	323 49 42	48 49	N 19.0	S 12.0	13 58	+ 3 57.7	4)
	„	W	25 17.5	36 13 41	12 38.5	N 17.2	S 15.0			
	α Persei	N	1 34 38	39 7 10.5	6 4.5	E 15.0	W 17.8			
	„	S	42 34.3	321 11 40.5	10 48	E 14.9	W 18.3	2 8	+ 4 2.5	
Oct. 13	α Cygni	W	0 6 27	323 22 0	21 7	S 14.0	N 16.0	0 53	+ 4 34.2	5)
	„	E	12 57.5	36 40 19	39 30.5	S 16.0	N 14.1			
	α Aurigæ	N	0 20 50.0	48 52 2.5	51 18	E 15.5	W 15.0			
	„	S	26 59.0	311 19 54.5	18 58.5	E 16.0	W 14.0	0 58	+ 4 35.2	
Oct. 15	α Cephei	W	0 14 53	340 31 21.5	30 23.5	S 13.4	N 16.8	23 54	+ 4 56.3	6)
	„	E	20 11.3	19 28 59	28 10	S 14.3	N 16.3			
	α Persei	N	0 27 58.0	41 19 40	18 57	E 13.3	W 17.2			
	„	S	34 18.5	318 56 29.5	55 28.5	E 17.6	W 13.2	1 3	+ 4 57.0	
Oct. 16	α Cephei	W	23 58 39	340 21 26	20 43.5	S 13.8	N 16.0	23 44	+ 5 19.7	
„ 17	„	E	0 3 13.5	19 38 5	37 3	S 14.0	N 15.8			
	Moon U. L.	N	0 10 15	68 12 9.5	11 30	E 16.3	W 13.4			
	„	S	16 26.5	292 2 5.5	1 31.5	E 14.1	W 15.5	0 43	+ 5 20.5	
Oct. 20	β Aurigæ	W	8 32 0	322 55 36	54 44	S 10.2	N 19.0	8 9	+ 5 59.4	
	„	E	41 50	37 4 4	3 6	S 16.0	N 14.0			
	α Ursæ Maj.	N	9 0 0	26 29 21	30 8.5	E 12.5	W 17.5			
	„	S	9 34	333 50 32.5	49 47	E 15.0	W 15.4			
	Jupiter U. L.	W	9 19 20	300 60 15	59 35.5	N 15.9	S 14.7	10 5	+ 6 0.0	
Oct. 25	α Cass.	W	2 34 50	333 45 58.5	44 56	S 14.0	N 16.0	2 19	+ 6 50.4	
	„	E	40 21.5	26 12 28	11 39	N 15.6	S 14.4			
	α Lyræ	S	2 46 21	50 49 15.5	48 42	W 16.2	E 14.0			
	„	N	51 17.0	309 1 31.5	0 48	E 17.2	W 13.0	3 13	+ 6 50.7	

1) Probably σ Persei. 2) Watch dropped on deck yesterday. 3) Comp. Oct. 6. 4) Comp. Oct. 9. 5) Comp. probably an hour earlier. 6) Comp. Oct. 14.

1894	Star	Oc.	Watch	Vertical Circle		Level		Watch	Hw−W.	Rem.
			h m s	° ′ ″	′ ″			h m	m s	
Oct. 27	α Ursæ Maj.	E	0 51 18	324 29 21.5	28 38	N 18.0	S 15.6	0 32	+ 7 11	
	"	W	56 39.5	35 32 50.5	31 54.5	N 16.2	S 17.1			
	α Persei	N	1 17 55.5	38 4 38.5	3 44.5	E 16.8	W 16.8			
	"	S	23 59.3	322 8 8.5	7 5.5	E 17.6	W 16.0	1 44	+ 7 11.5	
Oct. 29	α Ursæ Maj.	E	0 34 40	324 40 52	40 2.5	N 15.0	S 16.2	0 16	+ 7 36.0	
	"	W	40 26.5	35 22 15.5	21 22.5	N 17.0	S 14.0			
	α Lyræ	S	0 47 34.5	47 17 12	16 25	W 16.0	E 15.2			
	"	N	51 44	312 35 46.5	34 50.5	W 16.5	E 15.0	1 39	+ 7 36.9	
Oct. 30	α Cygni	W	22 32 40	322 44 36.5	43 36	S 15.7	N 17.0	22 17	+ 8 1.5	
	"	E	36 52.5	37 14 58.5	14 1.5	S 16.4	N 16.3			
	ε Cass.	N	22 45 0	26 45 36.5	44 43.5	W 15.7	E 17.3			
	"	S	52 18.5	333 30 8.5	29 17	W 16.9	E 16.2	23 14	+ 8 2.2	
Nov. 1	ε Cass.	S	21 57 41.3	331 51 16.5	50 28.5	E 15.0	W 15.0	21 11	+ 8 27.3	
	"	N	22 6 45.7	27 51 28.5	50 45	E 14.0	W 16.0			
	α Cygni	E	22 15 16.0	37 19 40.5	19 1	S 17.0	N 13.3			
	"	W	22 13	322 43 58.5	43 5.5	S 14.3	N 15.7	22 39	+ 8 28.5	
Nov. 4	η Ursæ Maj.	N	21 48 28	319 22 6	21 10.5	W 15.8	E 17.0	21 27	+ 9 3.5	
	"	S	54 38.5	40 51 11.5	51 57.5	W 17.5	E 15.3			
	α Cygni	E	22 2 55.0	37 21 25.5	20 38.5	N 17.8	S 14.6			
	"	W	8 43	322 42 15	41 15.5	N 16.7	S 15.5	22 55	+ 9 4.5	
Nov. 7	α Cygni	W	22 49 49	322 45 43.5	44 47.5	S 16.0	N 18.0	22 25	+ 9 37.0	
	"	E	55 55	37 16 45.5	15 43.5	S 17.7	N 16.6			
	ε Cass.	N	23 6 4.5	25 5 22.5	4 26.5	E 17.8	W 16.6			
	"	S	12 42.0	335 8 33.5	7 37.5	E 16.8	W 17.4	23 37	+ 9 38.0	
Nov. 10	γ Draconis	N	0 53 2.5	322 34 59.5	33 56.5	W 17.0	E 17.7	0 32	+10 4.0	
	"	S	57 30.7	37 36 5	37 11.5	W 17.2	E 17.2			
	α Ursæ Maj.	W	1 5 34.0	35 27 4.5	28 0.5	N 18.7	S 15.2			
	"	E	11 50.7	324 33 57.5	32 59	N 16.5	S 18.0	1 58	+10 4.9	
Nov. 12	α Cygni	W	22 34 58.5	322 46 24.5	45 20	S 18.5	N 16.4	22 9	+10 36.8	
	"	E	40 42.5	37 15 48	14 48	S 17.2	N 18.0			
	α Persei	N	22 47 42.3	41 25 0	24 5	E 17.0	W 18.4			
	"	S	53 59.5	318 48 19	47 23.5	E 17.9	W 17.6	23 21	+10 37.8	
Nov. 17	α Lyræ	S	1 45 44.5	50 48 25	47 43	E 15.0	W 14.6	0 55	+11 21.7	1)
	"	N	31 7.0	309 1 21	0 30	E 16.6	W 12.6			
	α Cass.	W	1 36 39.5	333 51 31	50 50	N 15.0	S 15.0			
	"	E	42 13.0	26 8 18	7 30	N 15.0	S 15.0	1 55	+11 22.5	
Nov. 21	β Ursæ Min.	W	16 4 0	352 31 47	31 10.5	S 14.0	N 15.9	14 37	+12 16.5	
	"	E	12 22	7 32 25	31 41.5	S 12.0	N 18.2			
	α Cygni	N	16 21 51	43 55 45	54 52	W 16.3	E 14.4			
	"	S	27 58	316 17 28	16 34	E 14.4	W 16.6	20 35	+12 19.2	
	α Cephei	W	22 25 55	340 7 59.5	6 54	S 14.0	N 18.3			
	"	E	31 38	19 54 21	53 14	N 16.5	S 16.3			
	α Persei	N	22 38 54	40 11 44	10 57.5	E 16.7	W 16.3			
	"	S	45 13	320 2 39	1 45.5	E 16.5	W 16.3	23 27	+12 21.7	2)
Nov. 24	β Aurigæ	S	1 12 55.6	315 36 17.5	35 25	E 16.2	W 15.2	0 58	+12 50.5	
	"	N	17 8.2	44 15 27	14 28.5	W 15.0	E 16.7			
	α Cass.	E	1 23 7.8	25 59 56.5	59 7.5	S 16.0	N 15.6			
	"	W	28 38	333 60 49	59 58.5	S 15.6	N 16.2	1 56	+12 51.5	
Nov. 26	α Persei	S	22 57 20	321 4 29.5	3 35	E 17.0	W 17.1	22 17	+13 24.5	
	"	N	23 3 11	38 44 23	43 35	E 17.0	W 16.9			
	α Ursæ Maj.	W	23 8 1.5	35 28 25	29 24	N 17.3	S 17.0			
	"	E	13 10	324 30 46	29 52.5	N 16.0	S 18.1	14 21	+13 33.6	3)
Nov. 28	α Ursæ Maj.	E	22 45 28	324 36 18	35 8	N 17.0	S 17.5	14 20	+13 43.7	
	"	W	49 23.6	35 25 51	24 45	N 17.9	S 16.7			
	γ Draconis	S	22 55 0.4	36 8 0.5	7 3	W 17.7	E 16.8			
	"	N	23 0 39	323 41 52	40 44.5	W 18.0	E 16.5	23 20	+13 48.2	

1) Watch assumed 25m. 2) Two sets of observations, our ice-island having loosened. 3) Comp. Nov. 27.

1894	Star	Oc.	Watch	Vertical Circle		Level		Watch	Hw − W.	Rem.
			h m s	° ′ ″	′ ″			h m	m s	
Nov. 30	α Persei	S	22 47 42.5	321 11 50	10 45	E 17.0	W 17.4	22 34	+14 9.0	
	„	N	52 16	38 40 11	39 23.5	E 16.7	W 17.4			
	α Ursæ Maj.	W	22 56 41.4	35 28 54.5	27 54.5	N 19.0	S 15.1			
	„	E	23 1 53.6	324 31 35	30 30	S 17.0	N 17.3	23 13	+14 9.3	
Dec. 3	α Persei	S	22 35 27	321 5 13	4 7	W 14.8	E 19.0	22 16	+14 41.0	
	„	N	40 23	38 43 46	42 41	E 16.5	W 17.8			
	α Cephei	E	22 47 47.5	20 40 52	39 48.5	S 17.0	N 17.4			
	„	W	53 21	339 15 11	14 5.5	S 15.0	N 19.3	14 21	+14 49.0	1)
Dec. 5	α Ursæ Maj.	E	22 52 40	324 40 57.5	39 56	N 16.3	S 17.0	22 27	+15 2.2	
	„	W	23 1 2.5	35 20 58	19 49	N 17.0	S 16.7			
	γ Draconis	S	23 5 4.5	37 14 29	13 12.5	W 16.0	E 17.5			
	„	N	10 35	322 35 33	34 27	E 17.0	W 16.6	23 22	+15 3.0	
Dec. 7	α Ursæ Maj.	E	22 32 47.5	324 43 32.5	42 25	N 16.5	S 18.6	22 17	+15 22.8	
	„	W	38 20.5	35 18 52	17 34.5	S 17.4	N 18.0			
	γ Draconis	S	22 44 47	36 46 42	45 27	W 19.0	E 16.1			
	„	N	51 46	322 60 34.5	59 31.5	W 19.5	E 16.0	23 16	+15 24.2	
Dec. 11	α Ursæ Maj.	E	22 35 26.7	324 51 1	50 6	N 15.6	S 16.5	22 10	+16 3.5	2)
	„	W	42 17.2	35 10 11.5	9 19.5	N 15.5	S 16.5			
	α Aurigæ	N	22 52 46	44 41 27.5	40 35.5	E 19.8	W 12.4			
	„	S	59 19	315 32 53	31 55	E 14.4	W 17.6	23 25	+16 4.2	
Dec. 14	α Ursæ Maj.	E	22 36 35	324 54 2	52 56.5	N 16.0	S 17.6	22 13	+16 35.0	
	„	W	41 26	35 6 46.5	5 42.5	N 15.0	S 18.6			
	γ Draconis	S	22 46 24	37 38 50.5	37 57.5	W 15.4	E 18.3			
	„	N	52 41	322 9 49.5	8 54	W 16.2	E 17.5	23 31	+16 36.5	
Dec. 16	α Ursæ Maj.	E	22 38 50	325 10 24.5	9 10.5	N 17.5	S 18.0	22 9	+16 56.7	
	„	W	44 38.4	34 50 45	49 30	N 18.7	S 16.9			
	γ Draconis	S	22 50 9	37 49 4.5	48 8.5	W 19.0	E 16.3			
	„	N	57 8	321 59 16	58 5.5	E 18.7	W 16.9	23 17	+16 58.0	
Dec. 18	α Ursæ Maj.	E	23 2 38	325 14 32.5	13 21	N 15.7	S 19.6	22 42	+17 19.0	
	„	W	8 8.4	34 45 38	44 28	N 18.0	S 17.1			
	γ Draconis	S	23 17 54.2	338 47 46	46 48	W 16.6	E 18.6			3)
	„	N	23 15	21 3 31.5	2 19	W 16.6	E 18.6	24 13	+17 20.8	4)
Dec. 21	α Cass.	W	1 47 57.5	332 53 54	52 46.5	S 16.9	N 19.0	0 24	+17 42.8	5)
	„	E	53 11	27 10 23	9 17.5	S 19.0	N 16.6			5)
	β Aurigæ	N	1 2 23	42 19 2.5	18 0.5	W 18.0	E 17.7			
	„	S	9 0	317 53 55.5	52 48	E 16.5	W 19.2	1 35	+17 43.5	
Dec. 24	γ Draconis	W	16 0 15	327 29 14.5	28 34	S 16.8	N 15.0	15 10	− 2 0.5	6)
	α Ursæ Maj.	N	16 52 20	331 11 46.5	11 7	E 17.0	W 15.2			
	Capella	W	17 12 8	50 39 40.5	39 11.5	N 15.6	S 16.6			
	„	E	18 20	309 21 43	21 10	N 15.6	S 16.6	17 39	− 1 59.0	
	α Ursæ Maj.	E	21 58 16	325 38 16.5	37 31	N 17.4	S 15.5	21 49	− 1 57.5	7)
	„	W	22 5 9	34 13 52	12 58.5	N 17.0	S 16.2			
	γ Draconis	S	22 11 27.5	36 36 33	35 26.5	W 14.0	E 19.0			
	„	N	18 47	323 11 54.5	11 5.5	W 14.5	E 19.0	22 29	− 1 57.5	
Dec. 26	α Ursæ Maj.	E	22 18 8	325 42 44	41 41	N 17.0	S 17.0	22 1	− 1 38.5	
	„	W	24 44	34 19 7.5	18 9.5	N 17.0	S 16.7			
	γ Draconis	S	22 33 33	37 33 22	32 20	W 17.0	E 16.7			
	„	N	41 10	322 24 44	23 46.5	E 17.0	W 17.0	23 1	− 1 37.7	8)
Dec. 28	α Ursæ Maj.	E	22 46 16.4	325 40 56	40 11.5	N 15.0	S 17.0	15 9	− 1 17.8	
	„	W	52 12	34 18 42.5	17 54	N 14.2	S 18.0			
	γ Draconis	S	23 0 21	38 30 31.5	29 40.5	W 17.8	E 17.4			
	„	N	5 20	321 22 6	21 7.5	W 15.0	E 17.0	23 47	− 1 15.0	
Dec. 30	α Ursæ Maj.	E	22 9 53	325 41 7.5	40 20.5	N 15.0	S 21.1	15 9	− 0 58.1	
	„	W	14 53	34 19 58.5	18 59.5	S 19.0	N 17.0			
	γ Draconis	S	22 21 38	37 40 35	39 46	W 18.6	E 17.5			
	„	N	27 10	322 10 44.5	9 44.5	W 19.3	E 17.0	22 53	− 0 54.0	

1) Comp. Dec. 4. 2) Cirrostratus, star invisible to the naked eye, but β Ursæ Maj. found in the field 4°–5° lower. 3) Circle ass. 38°. 4) Circle ass. 321°. 5) Watch ass. 0h. 6) Cloudy, observation very difficult. 7) Circle-correction + 10′ ass. by the observer. 8) Corr. to circle ass. − 10′.

1895	Star	Oc.	Watch	Vertical Circle		Level	Watch	Hw—W.	Rem.
			h m s	° ′ ″	′ ″		h m	m s	
Jan. 2	Capella	N	22 4 13	43 56 3.5	55 15	E 18.0 W 14.5			
	″	S	9 17	316 13 28	12 32	E 16.0 W 16.4			
	α Ursæ Maj.	E	22 14 46	325 50 42	49 54.5	N 16.0 S 16.4			
	″	W	20 11	34 8 30	7 52.5	N 16.0 S 16.3	22 52	+22 18.3	[1]
Jan. 5	γ Draconis	N	21 26 18	323 6 36.5	5 56	W 16.2 E 14.9	21 12	− 1 8.0	
	″	S	33 58	37 5 14.5	4 23	W 16.0 E 14.9			
	α Ursæ Maj.	W	21 40 21	34 6 50	5 57.5	N 15.7 S 15.5			
	″	E	47 14	325 54 6	53 15	N 15.0 S 16.1	22 2	− 1 7.0	
Jan. 8	α Ursæ Maj.	E	21 14 13	326 1 34.5	0 29	S 14.6 N 15.6	21 3	− 0 28.5	
	″	W	19 37	33 60 11	59 5.7	N 15.6 S 16.0			
	γ Draconis	S	21 25 34	37 12 51.5	11 41.5	E 15.1 W 17.5			
	″	N	32 4	322 37 56.5	36 31.5	W 18.8 E 14.8	21 59	− 0 17.0	[2]
Jan. 11	α Ursæ Maj.	E	21 31 44.5	326 2 9.5	1 6.5	N 17.5 S 14.8	21 7	+ 0 4.0	
	″	W	35 42	33 59 0.5	57 53.5	N 16.9 S 16.0			
	γ Draconis	S	21 42 12.5	37 58 39.5	57 35	W 12.4 E 20.6			
	″	N	46 39.0	321 54 27.5	53 15	W 19.6 E 13.6	22 17	+ 0 4.7	
Jan. 13	α Ursæ Maj.	E	21 30 43	325 48 44	47 32.5	N 16.9 S 17.0	21 0	+ 0 28.5	
	″	W	37 26.5	34 11 26.5	10 19	N 17.0 S 17.5			
	β Pegasi	W	21 45 7.5	320 1 26	0 17	S 20.0 N 15.1			[3]
	″	E	49 23.5	56 1 22	0 22.5	S 18.0 N 17.0			
	γ Draconis	N	22 0 29	321 12 54	11 39	W 15.4 E 19.8			
	″	S	4 30	38 55 40	54 26.5	W 17.5 E 17.5	22 47	+ 0 30.4	
Jan. 14	Moon L. L.	S	1 19 28	275 11 58	10 55	E 20.0 W 15.2			
	Jupiler U. L.	W	1 25 37	298 17 11.5	16 5.5	S 20.4 N 15.0			
	Jupiter U. L.	W	1 56 8	298 49 40	48 42.5	S 16.5 N 18.0			
	Moon L. L.	S	2 2 0	276 4 37.5	3 30.5	E 16.9 W 17.9	2 31	+ 0 32.5	
Jan. 16	α Ursæ Maj.	E	21 29 25	325 46 40	45 20.5	S 19.2 N 17.4	15 7	+ 0 59.0	
	″	W	33 59	34 13 54	12 35.5	S 18.6 N 17.9			
	γ Draconis	S	21 46 47.5	38 44 45.5	43 33	W 22.2 E 14.4			
	″	N	52 18.4	321 7 15	5 54.5	E 15.0 W 21.6	22 45	+ 1 3.5	
Jan. 18	α Ursæ Maj.	E	20 47 6.5	325 46 4	45 2	N 19.5 S 15.8	20 29	+ 0 22.7	[4]
	″	W	51 7	34 15 6.5	13 57.5	N 17.7 S 17.6			
	γ Draconis	S	20 58 23	37 28 1.5	26 55.5	W 20.5 E 14.6			
	″	N	21 5 4.5	322 21 3	22 9	W 17.7 E 17.8	21 28	+ 1 22.5	
Jan. 20	Polaris	E	23 23 3	354 37 59	36 55.5	N 16.0 S 18.0	23 0	+ 1 47.9	
	″	W	26 32.5	5 23 38	22 36.5	N 18.0 S 16.6			
	α Cygni	S	23 32 22	43 56 13	55 11	W 20.5 E 14.0			
	″	N	37 2	315 57 8	55 45	W 17.5 E 17.0	23 59	+ 1 48.5	
Jan. 22	Polaris	E	22 54 9	354 39 6.5	38 17.5	N 16.7 S 19.0	22 33	+ 2 7.5	
	″	W	59 0	5 22 25	21 27	N 19.9 S 16.0			
	α Cygni	S	23 6 51	43 27 0	25 46	W 18.3 E 17.7			
	″	N	11 39	316 25 53	24 35.5	E 17.6 W 18.5	23 49	+ 2 8.4	
Jan. 25	Polaris	E	22 13 15.5	354 39 29.5	38 35	N 18.0 S 17.5	21 52	+ 2 39.5	
	″	W	17 52	5 21 37	20 39	N 18.0 S 17.6			
	α Cygni	S	22 25 10	42 38 16.5	37 14	W 18.0 E 17.7			
	″	N	30 28.5	317 14 18.5	13 6.5	E 18.0 W 17.7	22 49	+ 2 40.3	
Jan. 27	Polaris	E	23 1 44	354 44 48	43 43.5	N 16.7 S 16.0	22 48	+ 3 8.5	
	″	W	5 31	5 16 34	15 28	N 17.0 S 15.5			
	α Cephei	S	23 11 35	26 15 17.5	14 10	W 15.9 E 16.8			
	″	N	15 51.5	333 38 41	37 35	E 16.5 W 16.2	23 33	+ 3 9.4	
Jan. 30	Polaris	E	22 27 29.5	354 56 29.5	55 29.5	N 16.1 S 15.0	22 11	+ 3 50.0	
	″	W	32 12	5 5 11	4 5	N 23.1 S 8.0			
	α Cygni	S	22 38 45	43 46 6.5	45 2	W 14.7 E 16.8			
	″	N	43 31	316 7 12	5 56	E 16.0 W 15.3	23 18	+ 3 51.0	
Feb. 1	Polaris	E	22 35 31.5	354 58 28	57 33	N 18.4 S 16.0	22 23	+ 4 15.4	
	″	W	40 8	5 3 12	2 3.5	N 18.2 S 16.1			

[1]) Walch slopped shorlly before. [2]) Probably Hw—W. = − $0^m 27^s.0$. [3]) Probably another star in this position of the instrument. [4]) Hw—W. ass. $1^m 22^s.7$.

1895	Star	Oc.	Watch	Vertical Circle		Level	Watch	Hw—W.	Rem.
			h m s	° ′ ″	′ ″		h m	m s	
Feb. 1	α Cygni	S	22 46 23.5	44 10 3	9 5.5	W16.9 E 17.7			
	"	N	50 40	315 44 29	43 9.5	E 16.2 W18.1	23 5	+ 4 15.9	
Feb. 4	Polaris	E	22 9 9	354 48 57.5	48 2.5	N 13.0 S 20.4	15 3	+ 4 52.0	
	"	W	14 11.5	5 12 49.5	11 50	N 18.2 S 15.1			
	α Cygni	S	22 24 26.5	43 54 17.5	53 15.5	W16.2 E 17.3			
	"	N	30 56	315 56 10.5	54 53	W16.5 E 17.1	22 50	+ 4 56	
Feb. 5	Regulus	S	21 32 39	277 51 17	50 16.5	E 17.3 W17.0	21 9	+ 5 11.0	
	Mars U. L.	W	21 38 0	294 1 12	0 13	S 17.4 N 17.0			
	Moon U. L.	S	21 42 47	299 36 18	35 5.5	E 17.2 W17.1			
	Mars U. L.	W	22 2 7	294 20 21	19 12	N 18.0 S 16.9			
	Moon U. L.	S	22 6 15	300 13 16	12 1	W18.0 E 17.0			
	Moon U. L.	S	22 41 54	301 6 9	5 1	W18.9 E 16.0			
	Mars U. L.	W	22 49 36	294 45 15	44 9	S 18.9 N 16.0	23 6	+ 5 13.5	
Feb. 6	α Cephei	N	23 18 40	332 23 2.5	21 45	W17.0 E 18.5	22 48	+ 5 27.0	
	"	S	23 25	27 45 35	44 18.5	E 18.0 W17.5			
	β Ursæ Min.	W	23 28 32	21 53 48	52 28.5	N 18.0 S 17.5			
	"	E	32 29.5	338 7 58.5	6 36.5	S 21.2 N 14.2	23 59	+ 5 28.0	
Feb. 8	Jupiter U. L.	S	16 53 23.5	288 25 26	24 13.5	E 17.0 W18.0	15 57	+ 5 52.0	
	"	N	57 24	71 31 36.5	30 24	E 19.8 W16.2			
	Moon U. L.	W	17 3 4	76 47 5	45 46	N 16.5 S 19.5			
	"	E	8 6	283 12 1.5	10 53.5	S 18.0 N 18.0			
	Moon U. L.	E	17 31 4.5	283 4 59.5	3 46	N 16.7 S 19.4			
	"	W	34 52	76 57 0	55 47.5	N 18.7 S 17.5			
	Jupiter U. L.	N	17 39 35	70 11 22	10 13.5	E 15.4 W20.7			1)
	"	S	44 50	289 25 10	24 0	W17.0 E 19.3			
	α Ursæ Maj.	E	17 48 14	326 21 54.5	20 36	N 16.3 S 19.8			
	"	W	52 41	33 42 37	41 14.5	S 16.5 N 19.5	18 52	+ 5 54.0	
Feb. 12	α Persei	W	0 20 15	325 54 6	52 43.5	S 17.0 N 15.0	0 6	+ 6 37.2	
	"	E	25 48	34 10 5.5	8 57	S 17.4 N 14.5			
	α Cephei	S	0 39 21	30 28 19.5	26 57.5	W16.2 E 15.5			
	"	N	43 18	329 26 44.5	25 35	E 15.0 W16.9	0 57	+ 6 37.5	
Feb. 13	Polaris	E	21 21 2	354 41 59	40 48.5	N 15.0 S 20.5	21 8	+ 6 59.5	
	"	W	23 50	5 20 14.5	19 11	N 19.3 S 16.2			
	α Cygni	S	21 28 26	43 21 58.5	20 49	W18.0 E 17.9			
	"	N	31 56.5	316 33 42.5	32 24.5	E 18.0 W17.9	22 14	+ 7 0.5	
Feb. 17	α Cephei	N	22 20 23	332 41 42	40 30.5	W18.6 E 17.3	21 50	+ 7 51.7	
	"	S	26 7.5	27 29 17	28 7	W18.0 E 18.3			
	β Ursæ Min.	W	22 32 10	21 53 24	52 0	N 19.8 S 16.5			
	"	E	37 14	338 8 1.5	6 43	N 20.0 S 16.1	22 55	+ 7 53.5	
Feb. 20	α Cephei	N	22 15 53	332 28 53.5	27 44.5	W16.6 E 19.7	21 50	+ 8 28.5	
	"	S	20 40	27 40 47.5	39 41.5	W21.2 E 15.0			
	β Ursæ Min.	W	22 25 57	21 45 54.5	44 40	N 19.0 S 17.5			
	"	E	32 52	338 15 40.5	14 21.5	S 18.0 N 18.4	23 28	+ 8 30.5	
Feb. 23	β Ursæ Min.	E	22 13 19	338 23 7	21 49	S 20.0 N 15.1	21 48	+ 9 7.5	
	"	W	19 6.0	21 39 2	37 53.5	N 19.7 S 15.5			
	α Cephei	S	22 27 38	28 5 51	4 39.5	W17.0 E 18.4			
	"	N	32 18	331 47 46	46 33	W17.0 E 18.4			
	α Gemin.	S	22 41 58	304 46 3	44 54.5	W15.5 E 19.7			2)
	"	N	45 19.5	55 8 24	7 25	E 19.4 W15.6			
	α Persei	E	22 50 38	34 17 9.5	15 56.5	S 17.2 N 17.9			
	"	W	55 50	325 43 44	42 29	N 18.2 S 16.9	23 27	+ 9 10	
Feb. 24	β Ursæ Min.	E	22 7 43.5	338 23 13.5	21 55.5	N 19.0 S 16.5	21 57	+ 9 20.5	
	"	W	12 25	21 38 14.5	37 6	N 19.0 S 16.9			
	α Cephei	S	22 16 9	27 53 46.5	52 31.5	E 19.2 W16.7			
	"	N	21 16	331 59 13	58 1	E 17.2 W18.7	22 33	+ 9 21	
Feb. 26	β Ursæ Min.	E	22 5 9	338 28 41.5	27 26	S 17.0 N 17.5	21 48	+ 9 46.4	
	"	W	11 53	21 32 44.5	31 30.5	S 16.5 N 18.2			

1) Circle-correction + 30′ ass. by the observer. 2) Watch ass. 40m.

1895	Star	Oc.	Watch	Vertical Circle		Level	Watch	Hw−W.	Rem.
			h m s	° ′ ″	′ ″		h m	m s	
Feb. 26	α Cephei	S	22 18 14	28 8 12.5	7 3	W 16.0 E 18.7			
	„	N	24 5	331 44 10	42 56.5	E 21.0 W 13.5	15 1	+ 9 55.2	1)
Mar. 2	γ Draconis	E	1 3 39	315 35 17	34 5	N 16.4 S 18.2	0 48	− 2 27.8	
	„	W	8 13.5	44 26 9.5	25 1.5	N 18.5 S 16.5			
	α Ursæ Maj.	N	1 14 33.5	26 41 37.5	40 32	E 16.4 W 18.6			2)
	„	S	20 0	333 27 53.5	26 35.5	W 18.8 E 16.4	1 46	− 2 27.7	
Mar. 4	γ Draconis	E	1 2 14.5	315 36 15.5	34 52.5	N 15.0 S 19.9	0 49	− 2 7.0	
	„	W	6 31	44 25 18.5	24 9	N 18.0 S 16.9			
	α Ursæ Maj.	N	1 10 32.5	26 36 41	35 30	E 19.0 W 15.9			
	„	S	15 26	333 32 8.5	30 57.5	W 16.0 E 19.0	1 29	− 2 6.5	2)
Mar. 6	γ Draconis	E	1 22 54	315 36 49	35 28.5	N 15.7 S 18.1	0 51	− 1 41.5	
	„	W	26 22	44 23 52	22 39	N 16.4 S 17.5			
	α Ursæ Maj.	N	1 30 4	25 50 53.5	49 55.5	E 19.0 W 15.0			
	„	S	33 53	334 16 12.5	15 1	W 16.0 E 17.8	1 48	− 1 41.0	
Mar. 9	γ Draconis	E	0 58 23	315 31 21	30 15.5	N 12.3 S 21.0	0 46	− 1 4.2	
	„	W	1 2 10	44 29 56.5	28 59.5	N 17.0 S 16.6			
	α Ursæ Maj.	N	1 5 57	26 5 37.5	4 27	E 19.9 W 13.9			
	„	S	9 8.5	333 60 42	59 39	W 16.0 E 17.8			
	Jupiter U. L.	W	1 22 14	299 17 28.5	16 13	S 14.3 N 19.5			
	Moon U. L.	S	1 26 8.5	288 21 12	20 11	E 18.6 W 15.2			
	Moon U. L.	S	1 43 53	288 37 8	36 4	E 19.0 W 15.0			
	Jupiter U. L.	W	1 47 35	299 5 40.5	4 30.5	S 16.4 N 17.0	2 8	− 1 3.7	
Mar. 10	Sun U. L.	N	21 2 43	271 17 4	16 13	W 14.5 E 19.8	20 39	− 0 38.5	
	„	S	9 6	88 49 59	49 7.5	W 16.8 E 17.6			3)
	„	S	20 47	88 60 18.5	59 34	W 16.0 E 18.4			
	„	N	25 44	270 55 21	54 28.5	W 16.6 E 17.2			
	„	N	34 45	270 46 58.5	46 9.5	E 19.0 W 15.3			
	„	S	40 58	89 18 37.5	17 46.5	W 18.2 E 16.1			
	„	S	46 0	89 23 20.5	22 18.5	W 18.0 E 16.5			4)
	„	N	22 0 0	270 24 47.5	23 45.5	W 18.0 E 16.7			4)
	False Hor. E.	N	—	89 40	39.5	E 17.0 W 17.5			
	Horizon East	N	—	89 47.5	46.5	E 16.2 W 18.2	22 44	− 0 37.0	
Mar. 11	γ Draconis	E	0 47 36	315 31 38	30 24.5	S 19.5 N 15.1	0 36	− 0 36.0	
	„	W	52 9	44 28 44	29 34	N 18.0 S 16.6			
	α Ursæ Maj.	N	0 59 41	26 1 57	0 49.5	W 18.8 E 16.0			
	„	S	1 3 35	334 5 24.5	4 12	W 17.1 E 17.7	1 29	− 0 35.8	
Mar. 13	γ Draconis	E	0 46 49.5	315 37 5.5	35 41	N 17.5 S 15.2			
	„	W	50 14	44 24 3.5	22 56	N 18.4 S 14.4			
	α Ursæ Maj.	N	0 56 15.5	26 1 32	0 22.5	E 18.2 W 14.8			
	„	S	59 59.5	334 5 13	4 6.5	E 16.7 W 16.3	1 14	− 2 15.0	
Mar. 16	γ Draconis	E	0 51 44	315 43 20	41 59.5	N 16.6 S 16.3	15 10	− 1 45.3	5)
	„	W	56 18	44 17 3	16 0	N 17.0 S 16.4			
	α Ursæ Maj.	N	1 3 57	25 37 40	36 30	E 18.4 W 15.0			
	„	S	8 55	334 31 9	29 59	W 17.6 E 16.0	2 14	− 1 40.5	
Mar. 19	η Ursæ Maj.	S	2 31 9	320 23 34	22 14.5	E 20.5 W 14.7	2 13	− 2 10.5	
	„	N	35 26	39 31 17.5	30 12.5	E 19.3 W 16.4			
	α Cygni	W	2 41 3	50 55 55	54 46.5	N 18.0 S 17.6			
	„	E	45 15.2	309 5 0.5	3 50.5	S 18.0 N 17.6	3 7	− 2 11.3	
Mar. 21	η Ursæ Maj.	S	2 16 47.5	320 16 28	15 16.5	W 18.0 E 17.1	2 11	− 0 20.5	
	„	N	20 30	39 39 3.5	38 8	W 17.6 E 17.7			
	α Cygni	W	2 28 3	50 55 38.5	54 37.5	N 18.1 S 17.1			
	„	E	32 15	309 5 1.5	3 59	S 17.8 N 17.3	2 50	− 0 21.0	
Mar. 23	η Ursæ Maj.	S	2 18 9	320 28 50.5	27 18.5	E 17.4 W 18.0	2 2	− 0 22.5	
	„	N	22 32	39 25 59	24 59.5	E 18.0 W 17.5			
	α Cygni	W	2 28 22	50 56 3.5	55 3	N 17.0 S 18.2			
	„	E	32 31	309 4 38	3 34	N 17.8 S 18.0	0 47	− 0 22.5	6)

1) Comp. Feb. 27. 2) Level unsteady. 3) Limb very boiling and uneven. 4) Between these two observations the limb was hidden by a stratus-cloud. 5) Comp. March 15. (Watch regulated several times March 16–24). 6) Comp. probably at $2^h 47^m$.

1895	Star	Oc.	Watch	Vertical Circle		Level	Watch	Hw − W.	Rem.
			h m s	° ′ ″	′ ″		h m	m s	
Mar. 25	η Ursæ Maj.	S	2 10 45	320 27 30.5	26 21	W 20.5 E 14.0	1 54	− 0 17.5	
	”	N	14 49	39 27 31.5	26 39	E 18.0 W 16.5			
	α Cygni	W	2 22 12.2	50 56 16.5	55 18.5	N 17.3 S 17.4			
	”	E	26 32	309 4 19	3 17	N 18.0 S 16.9	2 38	− 0 17.5	
Mar. 27	η Ursæ Maj.	S	2 8 49.2	320 35 34.5	33 59.5	E 16.0 W 19.0	15 2	− 0 14.7	1)
	”	N	13 45	39 18 31	17 38	E 18.5 W 16.9			
	α Cygni	W	2 18 31	50 56 51	55 50	N 18.0 S 17.5			
	”	E	26 28	309 4 6.5	3 3	N 18.0 S 17.6	2 35	− 0 14.0	
Mar. 29	α Cygni	E	2 2 5.5	309 3 44	2 31.5	S 16.0 N 18.4			
	”	W	6 30	50 57 33	56 32.5	N 19.4 S 15.0			
	η Ursæ Maj.	N	2 17 48	39 2 14.5	1 17	E 16.0 W 19.0			
	”	S	23 49	321 7 59.5	6 50	E 16.0 W 19.0	2 32	− 0 10.8	
Apr. 1	α Cygni	E	2 1 33	309 6 46.5	5 43	N 16.3 S 16.0	14 56	− 0 10.3	2)
	”	W	7 20	50 54 5.5	53 2.5	S 15.3 N 17.0			
	α Lyræ	S	5 53 52	308 23 19	22 19.5	W 16.0 E 16.7			
	”	N	6 0 21	51 27 50	26 57.5	W 15.6 E 17.0	0 11	− 0 9.8	3)
Apr. 3	γ Ursæ Maj.	E	5 40 41.5	30 2 43.5	1 49.5	S 16.0 N 16.9	15 2	− 0 8.0	4)
	”	W	46 26	329 56 34	55 36	N 16.4 S 16.5			
	α Lyræ	S	5 54 50.5	308 32 1.5	31 11	E 15.0 W 17.2			
	”	N	59 19	51 22 43	21 47.5	E 20.0 W 12.6	6 14	− 0 6.2	
Apr. 6	α Lyræ	S	5 32 17.5	308 5 56	4 54.5	E 18.2 W 15.9	0 4	− 0 8.5	
	”	N	35 25.5	51 50 8	49 15.5	E 15.5 W 18.6	5 55	− 0 8.5	
Apr. 8	α Lyræ	S	5 54 16	308 50 45	49 54.5	E 15.1 W 17.8			
	”	N	58 46	51 3 50.5	2 46.5	W 15.8 E 17.3	6 17	− 0 6.8	
Apr. 10	α Lyræ	S	5 23 45	308 16 11	15 10	E 16.5 W 15.7			
	”	N	27 0	51 38 3.5	37 4.5	E 16.4 W 16.1	5 40	− 0 9.5	
Apr. 13	Sun U. L.	N	23 40 31	280 31 11	30 26.5	W 15.8 E 13.3	15 38	− 0 17.5	
	”	S	46 8	79 37 12	36 21.5	W 13.0 E 16.0	15 37	− 0 24.5	5)
Apr. 21	Sun U. L.	N	23 30 5	283 40 29	39 50.5	W 15.9 E 15.0	16 9	+ 1 28	
	”	S	35 33.5	76 27 44.5	26 50.5	W 15.5 E 15.4	23 55	+ 1 29.8	
May 11	Sun U. L.	N	0 32 54	288 12 56	12 12	W 11.8 E 15.0	16 0	+ 0 5.8	6)
	”	S	36 49	71 53 22	52 36	W 13.0 E 13.3	0 50	+ 0 7.0	
May 24	Sun U. L.	N	3 33 47	287 52 51	52 13	W 9.0 E 17.0			
	”	S	39 13	62 13 54	13 16.5	E 10.0 W 16.0	3 56	+ 0 5.5	7)
Sep. 1	Sun U. L.	S	15 44 20	280 52 50	53 22.5	E 12.0 W 11.5	14 57	−18 54.5	8)
	Terr. Obj.	S	—	270 7 26	8 15	E 17.5 W 6.5			
	”	N	—	89 52 44.5	53 26.5	E 9.5 W 14.5			
	Sun U. L.	N	16 2 10	78 46 40	47 7	W 10.0 E 14.0	16 59	−18 55.0	9)
Sep. 1	Sun U. L.	S	23 55 32.5	280 43 34.5	43 51	W 11.4 E 11.5	23 43	−18 55.0	
Sep. 2	”	N	0 0 54	79 23 30.5	23 55	W 13.0 E 9.8	1 44	−18 55.2	
Sep. 3	Sun U. L.	W	19 58 30	282 41 17.5	41 49.5	S 14.0 N 10.0			10)
	”	W	20 20 30	282 38 41.5	39 3	S 11.2 N 12.5			
	”	E	26 30	77 23 15.5	23 25.5	S 11.0 N 12.6			
	Sun U. L.	N	23 59 45	279 48 21.5	48 26	E 9.0 W 14.2	23 39	−18 57.0	
Sep. 4	”	S	0 15 3	80 30 48.5	31 17.5	W 13.0 E 10.2			
	”	N	0 8 5.5	279 26 34.5	26 27.5	W 10.2 E 13.1			
Sep. 4	Sun U. L.	N	23 0 1	280 30 46	31 18	W 10.5 E 13.2	18 3	−18 56.7	
	”	S	4 57	79 34 52.5	34 55	W 11.0 E 13.0			
Sep. 5	Sun U. L.	N	23 52 27	279 7 56.5	8 14.5	W 8.5 E 9.8	23 40	−18 53.5	11)
	”	S	55 25	80 56 14	56 18.5	W 12.0 E 12.0	27 1	−18 54.0	
Sep. 10	Sun U. L.	W	20 53 30	279 45 33.5	45 39	S 9.4 N 15.0			
	”	E	57 13	80 17 11	17 18	S 13.0 N 11.0	21 5	−18 47.5	
	Sun U. L.	N	23 48 40	277 17 59	18 30.5	W 12.7 E 11.9	23 34	−18 48.0	12)
Sep. 14	Sun U. L.	W	17 55 24.5	277 33 56.5	33 35.5	S 15.0 N 13.2	17 38	− 0 5.5	13)
Sep. 15	Sun U. L.	W	17 59 30	277 43 42	43 47.5	S 11.6 N 12.4	15 38	− 0 9.0	14)
Sep. 16	Sun U. L.	S	16 53 20	276 48 12.5	48 20.5	E 10.5 W 17.0	16 44	− 0 13.5	
	”	N	59 34	83 8 6.5	8 26	E 14.0 W 13.0	17 37	− 0 13.5	

1) Comp. March 26. 2) Comp. March 31. 3) Hour of comparison ass. by the observer to be 6^h. 4) Comp. April 2. 5) Comp. April 14. 6) Comp. May 10. 7) Circle ass. 72^0. 8) Sept. 1—10 the clock times have been diminished by 4 hours, the watch giving approximately local time. 9) Sun only visible in glimpses, both observations not good. 10) Cloudy. 11) Lev. W. 13.5? (Rem. of the observer). 12) Cloudy. 13) Cloudy, obs. not good. 14) Obs. not good.

1895	Star	Oc.	Watch	Vertical Circle		Level	Watch	Hw—W.	Rem.
			h m s	° ′ ″	′ ″		h m	m s	
Sep. 18	Sun U. L.	N	1 27 9.5	272 9 5	9 30	W 6.3 E 20.0			
	"	S	31 15.5	87 56 33.5	56 48	W 10.7 E 16.0	2 50	— 0 15.5	
Sep. 19	Sun U. L.	W	21 24 25	275 43 1.5	43 12.5	S 10.7 N 16.5	16 32	— 0 17.5	
	"	E	28 24	84 21 18.5	21 45.5	S 13.0 N 14.0			
Sep. 21	α Aurigæ	S	6 6 31	315 17 24.5	17 35.5	E 13.0 W 13.6	5 29	— 0 18.5	1)
	"	N	15 30	44 31 36	31 36.5	E 13.6 W 13.0	6 43	— 0 18.5	
	Sun U. L.	W	19 59 55	275 37 33	37 28.5	S 16.5 N 12.3	16 55	— 0 18.5	
	"	E	20 7 50	84 25 46.5	25 50	S 15.0 N 14.4			
Sep. 22	α Ursæ Maj.	E	5 56 0	327 27 18.5	27 38	N 17.6 S 12.8	5 41	— 0 20.5	
	"	W	6 1 12	32 33 53	33 52	N 14.8 S 16.0			
	α Aurigæ	N	6 8 22	44 37 6.5	37 33.5	E 15.0 W 15.1			
	"	S	13 35.5	315 30 36.5	30 56.5	E 15.0 W 16.1	6 33	— 0 20.0	2)
Sep. 24	α Ursæ Maj.	E	6 7 48	327 27 44	27 29.5	N 16.2 S 14.2	5 58	— 0 20.5	
	α Aurigæ	N	6 17 36	44 19 43	19 33.5	E 17.8 W 13.5			
	"	S	21 33	315 46 37.5	46 44.5	E 17.6 W 13.7			
	α Ursæ Maj.	W	6 30 18.5	32 33 5	32 44.5	N 13.9 S 17.5	6 42	— 0 20.0	
Sep. 28	α Ursæ Maj.	E	5 46 0	327 28 16.5	27 51.5	N 15.3 S 14.3	5 16	— 0 17.0	
	"	W	54 53	32 33 54	33 40	N 17.5 S 12.6			
	Capella	N	6 3 26	44 13 16.5	13 2.5	E 13.0 W 17.3			
	"	S	12 29	315 58 23.5	58 6.5	E 20.0 W 10.4	6 40	— 0 16.5	3)
Oct. 3	α Cygni	W	3 12 38	319 44 19	43 59	S 14.5 N 14.7	3 3	— 0 12.4	
	"	E	14 53	40 16 38	16 27	S 14.3 N 15.0			
	β Ursæ min.	N	3 23 13	343 55 2.5	54 42.5	W 15.5 E 16.0			
	"	S	26 10	16 9 44.5	9 35	W 19.5 E 9.8	3 38	— 0 12.5	
Oct. 6	Sun U. L.	W	19 13 30	270 27 41	27 40	S 13.1 N 16.3	16 53	— 0 9.5	
	"	E	19 20	89 33 12	33 3.5	S 16.7 N 13.5			
	"	E	19 35 5	89 34 46.5	34 36	S 18.7 N 12.0			
	"	W	39 52	270 25 0.5	24 47.5	S 18.5 N 12.3	23 57	— 0 9.2	
Oct. 7	γ Draconis	W	0 19 18	326 26 11.5	25 47.5	S 15.6 N 16.0			
	"	E	24 4	33 35 6.5	34 43	S 19.3 N 12.0			
	β Ursæ Maj.	S	0 33 31	34 57 28	57 0	W 16.0 E 15.5			
	"	N	38 3	324 58 19	58 4	E 17.0 W 14.1	1 4	— 0 9.5	
	β Ursæ Min.	N	2 56 48.5	344 8 38	8 24	E 15.0 W 16.5			
	"	S	3 2 22	15 59 11.5	59 4.5	W 15.7 E 16.0			
	α Cygni	E	3 8 28	40 10 32	10 19	S 15.5 N 16.0			
	"	W	13 33	319 50 11	50 11	S 15.0 N 16.5	3 40	— 0 10.0	
Oct. 8	α Aurigæ	S	4 47 11	314 57 14	56 34.5	E 14.2 W 13.6	4 36	— 0 8.0	
	"	N	51 14.5	44 58 57	58 51.5	E 14.5 W 13.4			
	α Ursæ Maj.	W	4 56 19.5	32 32 58.5	32 48.5	N 15.6 S 12.1			
	"	E	5 1 6	327 27 57.5	27 37	N 12.1 S 15.6	5 32	— 0 7.5	
Oct. 11	α Ursæ Maj.	E	4 50 3	327 33 32.5	33 10.5	N 15.5 S 12.4	4 39	— 0 6.0	
	"	W	53 34	32 27 50.5	27 39.5	N 15.0 S 13.5			
	α Aurigæ	N	4 57 41	44 34 32.5	33 44.5	E 13.0 W 15.4			
	"	S	5 1 58	315 31 20.5	31 12.5	E 15.8 W 13.0	5 40	— 0 6.0	
Oct. 14	α Cephei	W	2 54 22.5	336 44 48	44 25	S 15.8 N 14.9	2 16	+ 0 3.0	
	"	E	59 48	23 15 30.5	15 12.5	S 15.5 N 15.5			
	α Persei	N	3 3 44	40 49 27	49 20.5	E 16.4 W 14.3			
	"	S	7 17	319 16 52	16 28	E 15.5 W 15.4	3 21	+ 0 3.0	
Oct. 16	α Ursæ Maj.	N	22 49 29.5	331 48 27.5	48 31	W 13.6 E 16.0	22 24	+ 0 10.0	
	"	S	55 57	28 19 36	19 43.5	W 14.0 E 15.7			
	α Aurigæ	W	23 2 21	48 28 36.5	27 58.5	N 15.5 S 14.6			
	"	E	6 58	311 33 12	33 9.5	S 13.0 N 16.5	23 28	+ 0 10.6	
Oct. 18	α Cass.	E	18 14 7	321 44 22	44 25	S 16.5 N 14.7	16 48	+ 0 16.2	
	"	W	18 17	38 16 33	16 12.5	N 17.7 S 13.8			
	α Lyræ	N	18 23 34	51 8 45.5	8 33	E 16.5 W 15.2			
	"	S	27 41	308 56 40.5	56 9.5	W 15.5 E 16.2	21 31	+ 0 16.5	

1) Cirrostratus and hoar frost, α Ursæ Maj. invisible. 2) Visible to the naked eye to day.
3) Heavy hoar frost, circle wiped for every reading.

1895	Star	Oc.	Watch	Vertical Circle		Level	Watch	Hw − W.	Rem.
			h m s	° ′ ″	′ ″		h m	m s	
Oct. 19	η Ursæ Maj.	N	2 1 47	318 53 10.5	52 48.5	W 14.9 E 17.0			
	"	S	4 45	41 11 33.5	11 31	W 16.0 E 15.3			
	α Cygni	E	2 9 45.5	40 50 13.5	50 17	S 17.0 N 15.0			
	"	W	14 29	319 10 52.5	10 48	S 15.0 N 17.5	2 40	+ 0 16.2	
Oct. 21	α Persei	S	3 4 9	319 44 31	44 7.5	E 10.2 W 21.5	2 59	+ 0 22.0	1)
	"	N	12 52	40 13 18.5	13 3	E 20.5 W 11.5			
	α Ursæ Maj.	W	3 26 26	31 47 0	46 38.5	N 16.0 S 16.3			
	"	E	30 45	328 12 43.5	12 24	S 15.5 N 16.8	3 41	+ 0 22.0	
Oct. 22	ε Cass.	E	19 7 5	328 57 21	57 6.5	N 14.8 S 16.4	16 41	+ 0 24.5	2)
	"	W	11 34	31 3 23.5	3 6	N 12.5 S 19.0			
	α Draconis	E	19 27 28	20 53 59.5	53 43	S 13.5 N 17.8			
	"	W	31 52	339 6 57.5	6 22.5	S 15.0 N 16.3			
	α Lyræ	S	19 38 17	310 14 33.5	14 12.5	E 19.0 W 12.5			
	"	N	42 31	49 41 46	41 41.5	E 16.0 W 15.5			
	Jupiter Ct.	N	19 49 18	289 15 13	15 29.5	E 16.0 W 15.5	20 15	+ 0 24.5	
Oct. 24	ε Cass.	E	18 37 7	329 0 44	0 39.5	N 15.5 S 17.0	16 44	+ 0 23.5	
	"	W	41 22	31 1 15	0 55.5	N 19.0 S 13.3			
	α Draconis	W	18 50 0.5	339 1 10.5	1 8	S 17.8 N 14.5			
	"	E	53 51.5	20 58 29	58 18	S 15.5 N 16.8			
	ι Ursæ Maj.	S	19 0 35	40 11 32.5	11 39	W 18.0 E 14.4			
	"	N	5 27.5	319 44 33	44 12.5	W 15.2 E 17.1			
	α Cygni	N	19 10 58	46 17 50	17 45	E 18.8 W 13.5			
	"	S	13 48	313 45 54	45 29.5	E 16.5 W 16.0	20 15	+ 0 23.5	
Oct. 28	ε Cass.	S	1 4 25	332 54 29.5	53 53.5	E 14.8 W 16.2	0 42	+ 0 31.5	
	"	N	8 41	27 3 36.5	2 59	E 16.5 W 14.0			
	α Draconis	S	1 29 48	25 40 25	39 44.5	W 9.0 E 21.5			
	"	N	35 13	334 15 1	14 22.5	W 12.0 E 19.0			
	α Cygni	W	1 42 45	319 10 16.5	9 38	S 13 N 18			
	"	E	46 18	40 51 41.5	51 5.5	S 18.5 N 12.5	3 1	+ 0 31.5	3)
Oct. 29	η Ursæ Maj.	W	18 54 39	324 6 11.5	5 31.5	N 17.4 S 13.3	17 11	+ 0 31.5	
	"	E	58 28	35 54 20	53 46.5	S 14.0 N 16.8			
	α Cygni	N	19 4 22	46 15 17.5	14 49.5	E 16.0 W 14.9			
	"	S	8 7	313 51 1	50 41	W 13.8 E 17.5	19 26	+ 0 32	
Oct. 31	ε Cass.	E	18 59 10	325 23 49	23 12.5	N 14.8 S 17.7	17 1	+ 0 36.0	4)
	"	W	19 4 34	34 37 45.5	37 5	N 21.5 S 11.2			
	α Cygni	N	19 7 31	46 4 4.5	3 34	E 15.0 W 17.0			
	"	S	12 18	314 1 14.5	0 47.5	E 16.7 W 16.4			
	ι Ursæ Maj.	S	19 16 39	40 46 34.5	45 58	W 17.0 E 16.1			
	"	N	20 22	319 10 31.5	10 4	W 17.4 E 16.0	19 39	+ 0 36.2	
Nov. 3	ε Cass.	E	18 54 56	328 53 43.5	52 53.5	N 13.5 S 17.6	17 4	+ 0 36.5	
	"	W	58 59	31 8 5.5	7 16.5	N 16.1 S 15.2			
	α Draconis	W	19 5 55	339 11 46.5	10 36	N 18.7 S 12.9			
	"	E	9 56	20 50 44.5	50 9.5	S 14.8 N 17.0			
	α Cygni	N	19 13 35	45 50 24.5	49 35.5	E 18.4 W 13.5			
	"	S	21 50	314 21 7	20 29.5	E 15.6 W 16.2			
	ι Ursæ Maj.	S	19 26 34	41 7 4.5	6 16.5	W 20.0 E 12.0			
	"	N	30 19	318 50 34	49 39.5	W 16.2 E 15.6	19 51	+ 0 36.5	
Nov. 4	Jupiter U. L.	E	0 5 41	284 48 2.5	47 10	N 18.5 S 14.0			
	Moon U. L.	E	0 9 9	292 9 33.5	8 52	N 15.0 S 17.5			
	"	E	0 34 0	292 32 32.5	31 54	N 16.0 S 16.9			
	Jupiter U. L.	E	0 37 10	284 35 13.5	34 26.5	S 19.0 N 13.5	1 39	+ 0 36.5	
Nov. 5	β Ursæ Min.	W	20 3 52	348 54 34	53 32.5	S 16.3 N 15.0	17 10	+ 0 39.5	
	"	E	7 20	11 8 16	7 12	S 14.0 N 17.7			
	α Cygni	N	20 10 47	44 44 27.5	43 28	E 17.4 W 14.2			
	"	S	14 27	315 22 53	21 47	W 14.1 E 17.6	20 41	+ 0 40.5	
Nov. 7	ε Cass.	E	19 5 37	328 53 18.5	52 21	N 14.0 S 17.1	17 18	+ 0 40.5	
	"	W	9 18	31 10 18	8 17.5	N 20.5 S 10.8			5)

1) Watch ass. 9ᵐ. 2) Ice somewhat unsteady during the first two observations. 3) Ice in motion, level unsteady. 4) Star. ass. to the δ Cass. 5) First microscope ass. 9′ instead of 10′

1895	Star	Oc.	Watch	Vertical Circle		Level		Watch	Hw—W.	Rem.
			h m s	° ′ ″	′ ″			h m	m s	
Nov. 7	α Cygni	N	19 12 46	45 54 4.5	53 7.5	E 13.0	W 18.6			
	"	S	16 3	314 12 7.5	11 13.5	E 12.8	W 19.0			
	ι Ursæ Maj.	S	19 20 10	40 56 58.5	56 0.5	W 17.5	E 14.4			
	"	N	23 30	319 1 41.5	0 45.5	E 17.5	W 14.4	21 20	+ 0 40.5	
Nov. 9	α Ursæ Maj.	E	4 0 35	328 3 21.5	1 53.5	N 17.0	S 17.6	17 39	+ 0 39.5	1)
	"	W	5 8	31 59 48	58 9.5	N 16.0	S 18.6			
	γ Draconis	S	4 11 43	37 48 46.5	47 14.5	W 16.0	E 19.0			
	"	N	17 27.5	322 7 33.5	5 52	W 17.2	E 17.6	4 54	+ 0 39.2	
Nov. 11	β Ursæ Min.	E	7 4 20	340 31 18.5	30 26	N 12.0	S 17.6	17 37	+ 0 42.5	2)
	"	W	7 20	19 33 12.5	32 9.5	N 18.0	S 11.5			
	α Cygni	S	7 10 15	44 53 55.5	53 0	W 14.0	E 16.0			
	"	N	12 40	315 5 41	4 25	W 13.8	E 16.1	7 43	+ 0 42.5	
Nov. 13	β Ursæ Min.	N	1 31 54	344 4 51	3 41	E 14.0	W 17.0	1 15	+ 0 41.5	
	"	S	40 49	16 7 45	6 34	E 16.0	W 15.7			
	"	N	44 0	343 51 28	52 31	W 17.0	E 14.7			
	α Cygni	W	1 47 59	318 60 26.5	59 6.5	N 16.0	S 15.7			
	"	E	51 3	41 2 52.5	1 58.5	S 16.0	N 15.6			
	ι Ursæ Maj.	E	1 55 4	314 24 42.5	23 40	N 17.5	S 14.0			
	"	W	58 41	45 37 12	36 5	N 16.9	S 14.9	17 43	+ 0 40.0	
Nov. 14	ι Ursæ Maj.	E	1 40 42	314 24 58.5	24 20	S 15.6	N 16.4			
	"	W	44 15	45 36 52	35 42.5	S 14.6	N 17.5			
	α Cephei	W	1 53 12	336 15 0	13 52.5	S 14.5	N 18.0			
	"	E	57 8	23 47 44.5	46 28.5	S 16.0	N 16.8			
	α Persei	N	2 0 47	40 32 31	31 29	E 16.5	W 16.4			
	"	S	3 49	319 33 17.5	32 6.5	E 14.4	W 18.5	2 18	+ 0 39.5	
Nov. 15	α Cygni	W	1 21 54	318 61 13	59 42.5	S 15.0	N 17.0	18 45	+ 0 39.5	3)
	"	E	25 27	41 1 51	0 49.5	S 16.1	N 15.9			
	α Persei	N	1 28 42	41 5 2	3 49	E 16.5	W 15.6			
	"	S	33 56	319 2 35	1 20	E 15.4	W 16.6	2 6	+ 0 40.0	
Nov. 18	ε Cass.	S	0 52 54	333 35 58	34 41.5	E 17.0	W 16.2	0 39	+ 0 47.0	
	"	N	57 19	26 21 36.5	20 33.5	E 17.0	W 16.5			
	α Draconis	N	1 4 15	333 57 28.5	56 6.5	W 14.5	E 19.4			
	"	S	7 43	26 8 36	7 17.5	W 16.4	E 17.7			
	α Cygni	E	1 11 49	40 58 56.5	57 40	S 18.0	N 16.2			
	"	W	14 55	319 3 21.5	2 5.5	S 17.0	N 17.4			
	ι Ursæ Maj.	W	1 19 19	45 39 31	38 21.5	N 16.0	S 18.4			
	"	E	22 8	314 23 15.5	22 1.5	N 16.2	S 18.2	3 16	+ 0 47.0	
Nov. 19	β Draconis	W	21 18 1	326 31 10	30 5	S 16.6	N 18.7	17 38	+ 0 45.0	
	"	E	21 17	33 30 56	29 26.5	S 16.6	N 18.7			
	γ Ursæ Maj.	S	21 24 24	35 7 24.5	5 54	W 18.4	E 16.9			
	"	N	27 44.5	324 51 30.5	50 24.5	W 19.0	E 16.4	21 48	+ 0 45.5	
Nov. 22	α Persei	S	2 2 30	319 54 39	53 34	E 20.0	W 16.2	17 37	+ 0 51.5	4)
	"	N	6 40	40 2 44.5	1 57	W 18.5	E 17.6			
	α Ursæ Maj.	W	2 9 57	31 46 1.5	44 58	N 18.0	S 18.2			
	"	E	12 8	328 14 53	13 57	N 19.4	S 16.9	4 15	+ 0 52.2	
	η Draconis	W	20 50 57	335 57 45	56 44.5	S 15.4	N 19.8	19 36	+ 0 52.8	
	"	E	54 55	24 4 46.5	3 58	S 19.0	N 16.3			
	α Ursæ Maj.	S	20 57 53	27 45 26.5	44 39.5	W 16.0	E 19.0			
	"	N	21 1 56	332 11 43	11 0	W 20.0	E 15.4	24 5	+ 0 51.5	
Nov. 24	η Draconis	W	20 30 17	335 58 58.5	58 17	N 20.0	S 13.4	17 36	+ 0 56.0	
	"	E	33 21	24 3 3.5	2 20	S 18.9	N 15.2			
	α Ursæ Maj.	S	20 37 13	27 25 49.5	24 58.5	W 16.0	E 17.9			
	"	N	40 13	332 32 8	31 28	W 18.0	E 16.0	21 18	+ 0 55.5	
Nov. 27	α Ursæ Maj.	E	1 42 47	328 8 1.5	7 19	N 16.3	S 16.0	17 35	+ 0 55.8	5)
	"	W	47 9	31 55 22.5	54 40.5	N 14.0	S 16.0			
	α Aurigæ	N	1 53 34	45 53 56	53 24.5	E 14.1	W 16.0			
	"	S	57 34	314 12 9	11 34.5	E 15.0	W 15.0	2 18	+ 0 56.5	

1) Comp. Nov. 8. 2) Comp. Nov. 10. 3) Comp. Nov. 14. 4) Comp. Nov. 21. 5) Lev. S 14.0? (Observer's remark). Comp. Nov. 26.

1895	Star	Oc.	Watch	Vertical Circle		Level	Watch	Hw−W.	Rem.
			h m s	° ′ ″	′ ″		h m	m s	
Nov. 28	α Persei	S	1 23 57	319 15 10	14 29	W 18.0 E 12.8			
	„	N	27 28	40 42 45	42 19.5	E 17.4 W 13.5			
	α Cephei	E	1 31 22	23 19 24	19 7	S 18.0 N 13.0			
	„	W	35 15	336 41 47.5	41 18.5	N 13.1 S 18.0	3 2	+ 0 56.5	
Nov. 30	β Draconis	N	2 13 9	323 44 17.5	43 20	W 17.8 E 17.0	17 57	+ 1 5.7	1)
	„	S	17 17	36 21 55.5	21 14	W 17.0 E 17.9			
	α Ursæ Maj.	W	2 21 4	32 9 21.5	8 26	N 17.0 S 17.5			
	„	E	24 18	327 51 59.5	51 13	N 16.5 S 18.2	3 22	+ 1 6.5	
Nov. 30	α Aurigæ	E	21 4 37	311 24 19.5	23 1	S 16.1 N 18.4			
	„	W	8 44	48 37 59.5	37 3	N 18.0 S 16.5			
	γ Ursæ Maj.	S	21 17 37	35 19 12	18 12	W 17.6 E 17.4			
	„	N	21 52	324 37 34	36 25	W 16.8 E 18.0			
	α Cass.	N	21 32 34	35 32 2	31 10.5	E 18.1 W 16.7			
	„	S	37 23	324 35 19	34 16	E 17.5 W 17.5	21 45	+ 1 6.0	
Dec. 1	β Draconis	N	2 3 45	323 52 37	51 29.5	W 17.0 E 17.5			
	γ Draconis	N	2 8 11	323 24 35.5	23 22	E 17.5 W 16.6	18 0	+ 1 4.7	
Dec. 3	β Cephei	W	1 46 2	344 37 35.5	36 27.5	S 14.0 N 19.5	17 56	+ 1 5.5	2)
	„	E	50 27	15 24 47	23 54	S 18.0 N 15.7			
	α Persei	N	1 55 20	39 55 10	54 14.5	E 17.8 W 16.0			
	„	S	58 55	320 10 55	9 38	W 19.0 E 14.7	2 35	+ 1 4.7	
Dec. 4	η Draconis	W	19 53 49	336 14 2.5	13 9	S 17.0 N 16.5	18 20	+ 1 7.8	
	„	E	58 5	23 46 27.5	45 28.5	S 18.6 N 14.9			
	γ Ursæ Maj.	S	20 3 2	33 59 14.5	58 21.5	W 18.0 E 16.5			
	„	N	7 13	325 57 10.5	56 11.5	W 16.6 E 17.2			
	α Aurigæ	E	20 10 59	311 32 9.5	31 22.5	N 16.6 S 17.4			
	„	W	14 15	48 29 34.5	28 45	N 17.0 S 16.9			
	α Tauri	W	20 21 27	78 7 31.5	6 36	N 16.5 S 17.5			3)
	„	E	28 14	281 53 48	53 0	N 16.2 S 18.0	23 31	+ 1 8.0	
Dec. 6	β Draconis	W	21 20 27	326 57 22	56 14	N 18.3 S 17.0	17 59	+ 1 7.3	
	„	E	25 40	33 4 3	2 55.5	S 17.0 N 18.3			
	γ Ursæ Maj.	S	21 30 7	35 42 38.5	41 35	W 19.0 E 16.6			
	„	N	33 52	324 14 45	13 30	W 19.0 E 16.5	22 0	+ 1 7.5	
Dec. 9	α Cephei	W	1 15 23	336 44 22	43 27.5	S 15.6 N 19.0	1 1	+ 1 1.0	
	„	E	19 29	23 17 7	16 3	N 17.5 S 17.2			
	α Persei	N	1 24 42	40 20 38	19 37.5	E 17.5 W 17.2			
	„	S	28 31	319 45 29	44 28	W 16.0 E 18.8			
	η Draconis	S	1 34 7	27 49 23	48 28	W 16.3 E 18.5			
	„	N	37 23	332 6 22.5	5 19.5	E 18.2 W 16.5	1 53	+ 0 59.5	
Dec. 11	η Draconis	W	20 29 44	336 19 34.5	19 6.5	N 18.2 S 12.8	18 26	+ 0 56.5	
	„	E	34 3	23 42 4	41 47.5	S 17.2 N 13.6			
	γ Ursæ Maj.	S	20 41 45	34 48 24.5	47 52.5	W 17.4 E 13.5			
	„	N	48 10	325 4 17	3 46	W 14.5 E 16.3			
	Capella	E	20 59 2	311 20 39	20 31	N 15.0 S 15.9			
	„	W	21 6 6	48 40 14.5	39 43	N 17.6 S 13.0	21 32	+ 0 56.5	
Dec. 14	α Persei	S	0 18 18	318 23 46	23 15.5	E 17.6 W 14.5	18 19	+ 0 2.2	4)
	„	N	21 52	41 32 30	32 35.5	E 16.8 W 15.7			
	α Cephei	E	0 25 45	23 19 17.5	18 47	N 16.0 S 16.7			
	„	W	29 55	336 41 40.5	41 15.5	N 16.0 S 16.9			
	η Draconis	N	0 33 44	333 19 12.5	18 40	E 15.6 W 17.5			
	„	S	37 0	26 44 28.5	43 54	W 17.1 E 16.0	0 50	+ 0 3.0	
Dec. 17	α Cephei	W	0 49 4	336 47 38	46 42	S 16.0 N 18.0	0 31	+ 0 0.8	
	„	E	52 54	23 13 5	12 24.5	S 17.7 N 16.5			
	α Persei	N	1 0 22	40 38 41.5	38 32.5	E 18.5 W 15.8			
	„	S	5 32	319 27 44.5	26 51	E 16.8 W 17.7			
	α Leonis	E	1 9 36	278 1 48.5	1 11	N 16.0 S 18.8			3)
	„	W	13 37	81 59 26.5	58 40	N 18.0 S 17.0	1 34	+ 0 1.0	

1) Comp. Nov. 29. 2) Comp. Dec. 2. 3) Observed for refraction. 4) Comp. Dec. 13. The minute-hand of the watch had become loose the day before.

1895	Star	Oc.	Watch	Vertical Circle		Level	Watch	Hw−W.	Rem.
			h m s	° ′ ″	′ ″		h m	m s	
Dec. 19	α Cephei	E	1 17 56	23 10 54	10 25	S 18.5 N 15.5	0 35	+ 0 5.0	
	"	W	21 45	336 49 10.5	48 28	N 17.1 S 16.6			
	Capella	S	1 30 15	314 15 56.5	15 9.5	W 17.0 E 16.6			
	"	N	35 18	45 38 33	37 55	E 15.7 W 18.0	1 48	+ 0 5.0	1)
Dec. 20	η Ursæ Maj.	N	21 43 14	321 25 1	24 17.5	E 16.0 W 16.6	18 38	+ 0 7.5	
	"	S	46 49	38 38 41.5	37 58.5	E 15.3 W 17.5			
	α Lyræ	E	21 52 22	46 33 5	32 32	S 16.4 N 16.6			
	"	W	55 50	313 27 39.5	26 58	S 15.0 N 17.3			
	α Cass.	S	22 0 18	325 38 54	38 17.5	W 18.0 E 15.0			
	"	N	5 6	34 15 41	15 31.5	E 14.6 W 18.9	22 17	+ 0 7.5	
Dec. 24	α Lyræ	W	21 33 1	313 22 18	21 25	N 17.0 S 17.5	20 59	+ 0 16.5	2)
	"	E	56 58	46 38 35	38 7	S 17.0 N 17.0			3)
	η Ursæ Maj.	S	22 11 58	39 32 14	31 38.5	W 18.4 E 16.0			
	"	N	17 5	320 22 29	21 53.5	W 18.4 E 16.0			
Dec. 27	α Lyræ	W	21 28 6	313 18 37	18 5	S 17.4 N 17.0			
	"	E	31 5	46 41 57.5	41 24.5	S 17.0 N 17.4			
	α Cass.	N	21 38 32	34 11 44	11 7	E 16.8 W 17.7			
	"	S	42 2	325 53 8	52 25	E 16.3 W 18.2			
	η Ursæ Maj.	N	21 48 38	320 41 25	42 22	W 17.6 E 17.0			3)
	"	S	22 1 50	39 33 24	34 12.5	W 17.0 E 17.6	22 16	+ 0 15.7	
Dec. 29	α Lyræ	W	21 21 42	313 18 45.5	18 13	S 20.0 N 14.5	18 36	+ 0 13.0	
	"	E	28 4	46 40 51	40 35	S 18.0 N 16.8			
	η Ursæ Maj.	S	21 32 51	39 5 19.5	4 35.5	W 18.4 E 16.5			
	"	N	36 9	320 51 57	51 17	W 17.0 E 18.0	22 43	+ 0 13.0	
1896									
Jan. 2	α Ursæ Maj.	E	1 28 32	327 38 34.5	37 32	N 19.0 S 16.5			
	"	W	32 37	32 22 37	21 43	N 19.0 S 16.5			
	γ Draconis	S	1 38 32	37 25 9.5	24 19.5	W 19.5 E 16.3			
	"	N	43 14	322 30 4	28 58.5	W 18.4 E 17.4	2 1	+ 0 13.0	
Jan. 3	α Lyræ	W	20 57 17	313 25 5.5	24 25.5	S 16.2 N 19.6	18 40	+ 0 15.5	
	"	E	21 3 12	46 35 6	34 6.5	S 17.1 N 18.6			
	α Cass.	N	21 8 32	34 30 15.5	29 15.5	E 17.5 W 18.5			
	"	S	12 58	325 35 38	34 45	W 16.5 E 19.5	21 34	+ 0 15.5	
Jan. 5	α Lyræ	W	20 42 45	313 24 15.5	23 20.5	S 15.9 N 20.1	18 41	+ 0 24.0	
	"	E	46 59	46 36 5	35 4.5	S 18.0 N 18.5			
	α Cass.	N	20 53 6	34 39 47	38 45.5	E 19.0 W 17.7			
	"	S	52 55	325 26 53	25 47	E 18.8 W 18.0			4)
	η Ursæ Maj.	S	21 2 36	38 49 30.5	48 38.5	W 18.0 E 18.8			
	"	N	6 41	321 6 15	5 20	W 16.0 E 20.9	21 26	+31 25.5	5)
Jan. 6	γ Draconis	N	1 47 48	322 8 28	7 25	W 14.1 E 22.0	1 30	+ 0 25.5	
	"	S	51 11	37 56 35.5	55 38.5	E 18.5 W 18.0			
	γ Ursæ Maj.	W	1 55 39	40 24 37.5	24 26	N 19.1 S 17.5			
	"	E	59 24	319 35 46	34 47.5	N 18.7 S 18.0	2 15	+ 0 25.5	
Jan. 7	α Lyræ	W	20 44 20	313 28 54.5	28 19	S 18.5 N 17.8	18 39	+ 0 31.5	
	"	E	48 14	46 31 36.5	30 45	N 17.7 S 18.7			
	α Cass.	N	20 52 46	34 41 54	40 53	E 20.0 W 16.6			
	"	S	56 56	325 24 38.5	23 31	E 19.0 W 17.4			
	η Ursæ Maj.	S	21 1 17	38 46 37.5	45 21	W 19.2 E 17.5			
	"	N	4 34	321 10 43.5	9 19	W 17.6 E 19.0	23 48	+ 0 32.0	
Jan. 9	α Lyræ	W	20 50 2	313 43 57	52 42.5	N 17.0 N 19.6	18 43	+ 0 33.0	6)
	"	E	53 19	46 17 7.5	15 52	S 18.0 N 18.7			
	η Ursæ Maj.	S	21 8 30	38 55 26	54 13	W 18.2 E 18.6			
	"	N	11 37	321 2 10.5	1 6.5	E 19.0 W 18.0	21 42	+ 0 33.5	
Jan. 12	α Lyræ	W	20 22 52	313 46 43	45 29	S 17.6 N 18.0	18 41	− 0 1.0	7)
	"	E	27 12	46 13 44.5	12 37	S 18.0 N 18.0			
	α Cass.	S	20 49 15	325 26 40	25 20.5	E 17.6 W 19.1			
	"	N	52 52	34 29 45	28 32.5	E 19.3 W 17.8			

1) Cirrostratus, stars difficult to find. 2) Watch ass. 53m instead of 33m. 3) Observer Sverdrup. 4) Watch 57m ass. by the observer. 5) Watch probably stopped after the observation; Nordahl carried it in his fur pocket for some 20 minutes after. 6) Ass. by the observer: second circle-reading 42′ and Level S 17.0. 7) A different watch.

1896	Star	Oc.	Watch	Vertical Circle		Level	Watch	Hw−W.	Rem.
			h m s	° ′ ″	′ ″		h m	m s	
Jan. 12	η Ursæ Maj.	N	20 57 43	321 8 15	6 54	W 17.7 E 19.2			
	„	S	21 2 32	38 59 7.5	58 14	W 19.6 E 17.4	21 18	+ 0 59.0	1)
Jan. 15	γ Ursæ Maj.	E	2 4 55	319 9 48.5	8 43.5	S 17.4 N 19.5	19 26	− 0 1.8	2)
	„	W	8 41	40 51 22.5	50 30	N 19.2 S 17.9			
	γ Draconis	S	2 12 53	38 51 7	50 16.5	W 18.0 E 19.2			
	„	N	17 11	321 4 35.5	3 26.5	W 17.7 E 19.6			
	δ Virginis	E	2 22 15	276 41 19.5	40 25.5	N 19.3 S 18.0			3)
	„	W	26 31	83 21 28	20 26	N 19.0 S 18.6	2 59	− 0 0.5	
Jan. 16	γ Ursæ Maj.	E	2 9 55	319 10 4.5	9 20	N 18 S 18.1	1 50	− 0 4.0	
	„	W	12 2	40 51 5.5	50 20.5	N 17.9 S 18.0			
	γ Draconis	S	2 16 8	38 58 25.5	57 15	W 17.4 E 18.8			
	„	N	21 0	320 56 6.5	54 58.5	W 18.6 E 17.7	2 48	− 0 4.2	
Jan. 19	α Lyræ	N	1 37 27	309 53 26.5	52 50	W 16.4 E 14.5	19 22	− 0 5.5	4)
	„	S	43 36	50 15 1.5	14 23.5	W 16.0 E 14.6			
	γ Ursæ Maj.	W	1 55 30	40 45 27.5	44 52.5	N 16.0 S 15.0	19 25	− 0 10.5	5)
Jan. 20	α Lyræ	W	20 44 50	313 43 4.5	42 27	S 15.1 N 16.3	19 27	− 0 14.0	
	„	E	48 32	46 17 45.5	17 10	S 16.7 N 15.0			
	η Ursæ Maj.	S	20 53 33	39 16 43	16 2	W 18.0 E 14.0			
	„	N	55 55	320 39 22	38 37.5	W 16.1 E 16.0			
	α Cass.	N	21 0 12	33 49 7.5	48 18.5	E 16.0 W 16.2			
	„	S	3 30	326 15 43	14 53	W 18.0 E 14.3	21 35	− 0 14.0	
Jan. 22	α Lyræ	W	20 39 15	313 44 23.5	43 39.5	N 17.0 S 16.0	19 46	− 0 23.0	
	„	E	42 20	46 16 30.5	15 42.5	S 17.2 N 15.9			
	η Ursæ Maj.	S	20 48 37	39 14 38	13 55	W 17.1 E 16.1			
	„	N	53 42	320 40 57	39 56	W 16.6 E 17.0	21 6	− 0 23.5	
Jan. 24	α Lyræ	W	20 30 8	313 45 38.5	44 53	S 13.8 N 19.0	19 20	− 0 0.5	6)
	„	E	35 3	46 15 15	14 34	S 18.0 N 15.0			
	η Ursæ Maj.	S	20 39 51	38 53 45	52 54.5	W 14.0 E 19.0			
	„	N	44 48	320 60 33	59 27	E 16.6 W 16.6	21 19	− 0 1.5	
Jan. 26	α Lyræ	W	20 37 31	314 2 4	1 27	S 16.3 N 18.2	19 37	− 0 7.5	
	„	E	41 28	45 58 42	57 59	S 20.0 N 15.0			
	η Ursæ Maj.	S	20 47 28	38 60 29.5	59 40	W 17.5 E 17.8			
	„	N	52 25	320 53 22	52 36.5	W 17.4 E 18.0	21 30	− 0 7.0	
Jan. 28	α Cygni	W	22 48 22	320 13 21.5	12 26.5	S 16.0 N 17.0	19 35	− 0 14.5	
	„	E	52 31	39 48 26.5	47 28.5	S 16.2 N 16.7			
	Capella	N	23 7 55	46 53 50.5	53 4	E 18.0 W 14.6			
	„	S	13 1	313 13 36	12 40.5	E 13.0 W 19.6	23 44	− 0 14.0	
Jan. 30	α Persei	S	22 42 31	318 35 42.5	34 48	E 13.2 W 17.5	19 37	− 0 18.5	
	„	N	47 52	41 18 17.5	17 21.5	E 17.2 W 13.5			
	η Draconis	S	22 52 29	26 48 10.5	47 15	E 14.3 W 16.5			
	„	N	57 19	333 7 16.5	6 15	E 14.0 W 16.8			
	α Cephei	W	23 2 53	337 18 10	17 10	S 12.7 N 18.0			
	„	E	7 10	22 43 5.5	42 20	S 17.5 N 13.3	25 5	− 0 18.5	
Feb. 2	α Cephei	W	23 5 54	337 22 30	21 23.5	S 13.3 N 19.8	20 1	− 0 23.0	
	„	E	9 48	22 39 45.5	38 28.5	S 15.7 N 17.8			
	α Persei	N	23 14 20	40 55 20.5	54 10.5	E 17.1 W 16.3			
	„	S	19 27	319 13 27.5	12 18.5	W 17.8 E 16.0	20 10	− 0 24.5	7)
Feb. 4	α Cephei	W	22 51 55	337 28 48	27 16	S 18.7 N 16.1	19 59	− 0 27.7	
	„	E	55 23	22 32 0.5	30 57	S 17.2 N 17.6			
	α Persei	N	23 5 5	41 2 17	1 15	E 17.8 W 17.5			
	„	S	10 56	319 7 40.5	6 17.5	E 15.5 W 19.9	23 31	− 0 28.5	
Feb. 7	ε Cass.	S	21 49 39	333 2 21.5	1 15	E 18.5 W 16.6	20 7	− 0 35.5	
	„	N	53 25	26 53 56	52 44	E 17.0 W 18.3			
	α Draconis	N	21 59 18	334 7 37.5	6 15.5	W 18.0 E 17.4			
	„	S	22 2 29	25 57 53.5	56 35.5	W 16.9 E 18.8			

1) Hw−W. ass. − 0m 1s.0. 2) Comp. Jan. 14. 3) Star ass. ε Virginis (observed for refraction). 4) Comp. Jan. 18. 5) Cloudy, obs. uncertain, star and wire could not be seen at the same time. 6) Watch ran down yesterday. 7) Comp. Febr. 3.

1896	Star	Oc.	Watch	Vertical Circle		Level	Watch	Hw−W.	Rem.
			h m s	° ′ ″	′ ″		h m	m s	
Feb. 7	α Cygni	E	22 5 34	39 44 25.5	43 15	S 17.5 N 18.2			
	"	W	9 38	320 17 35	16 12	S 17.4 N 18.4			
	ι Ursæ Maj.	W	22 13 7	46 52 57	51 56	N 16.5 S 19.4			
	"	E	16 43	313 7 47	6 27.5	N 16.8 S 19.0	22 54	− 0 35.7	
Feb. 10	α Cygni	W	21 36 51	320 18 19.5	17 0.5	N 17.0 S 17.6	20 27	− 0 43.5	
	"	E	41 4	39 41 44	40 38	S 18.0 N 17.0			
	α Persei	N	21 44 52	42 28 46	27 31	E 18.1 W 17.0			
	"	S	48 50	317 37 30.5	36 12	W 18.0 E 17.6	22 39	− 0 44.3	
Feb. 12	α Cephei	W	23 21 30	337 48 15	47 32.5	S 18.5 N 17.5	20 18	− 0 49.5	
	"	E	26 46	22 14 3.5	12 57.5	S 18.4 N 18.0			
	α Persei	N	23 34 39	39 46 15	45 36.5	E 19.0 W 17.7			
	"	S	40 3	320 23 15	22 12	E 17.0 W 19.5	24 11	− 0 50.0	
Feb. 14	α Cygni	W	21 59 0	320 34 57.5	34 1.5	S 17.8 N 16.5			
	"	E	22 2 17	39 26 6	24 58	S 18.5 N 16.0			
	α Persei	N	22 5 45	41 44 13	43 9.5	E 18.2 W 16.2			
	"	S	9 22	318 22 22.5	21 23.5	W 18.0 E 16.7	23 15	− 0 51.5	
Feb. 18	γ Andr. pr.	W	3 10 52	317 41 15	40 25.5	S 19.3 N 15.9	20 20	− 0 50.5	1)
	"	E	14 38	42 19 41.5	18 45	S 18.0 N 17.4			
	α Cygni	S	3 18 6	44 29 50.5	28 59	W 18.0 E 17.4			
	"	N	21 56	315 25 24	24 17	E 19.0 W 16.5	3 36	− 0 50.0	
Feb. 19	Jupiter L. L.	E	21 48 57	284 50 56.5	50 16	N 17.0 S 18.0	20 31	− 0 48.2	
	Moon L. L.	S	21 52 47	289 55 30	54 34	E 17.6 W 17.4			
	Moon L. L.	S	22 35 43	291 7 2.5	5 53.5	E 18.3 W 18.0			
	Jupiter L. L.	E	22 38 47	285 8 55.5	8 25	N 17.5 S 18.6	23 12	− 0 48.0	
Feb. 23	α Lyræ	E	7 27 6	302 45 45.5	44 42	N 17.0 S 14.5	20 20	− 0 46.5	2)
	"	W	30 49	57 14 57	13 59	N 19.0 S 12.5			
	γ Ursæ Maj.	N	7 35 40	34 34 44.5	33 44.5	E 16.0 W 16.0			
	"	S	38 35	325 30 36	29 25.5	E 16.0 W 16.0	7 47	− 0 44.5	
Feb. 25	α Cygni	N	4 1 9	313 36 10.5	35 15	E 16.1 W 13.5	20 16	− 0 42.5	3)
	"	S	6 31	46 33 6.5	32 26	W 16.0 E 13.5			
	α Persei	E	4 15 21	34 42 37.5	41 55	S 16.0 N 13.5			
	"	W	20 1	325 17 40.5	16 39.5	S 14.2 N 15.2	20 20	− 0 43.5	
Feb. 27	α Cygni	N	3 41 1	313 44 58	44 6	W 15.8 E 17.3	20 26	− 0 42.3	4)
	"	S	46 14	46 24 5	23 4.5	W 17.3 E 15.9			
	α Persei	E	3 49 26	34 42 4	41 9.5	S 15.8 N 17.7			
	"	W	54 27	325 18 52.5	17 38	N 18.0 S 15.5	4 32	− 0 41.5	
Feb. 29	α Cygni	N	3 19 48	313 59 37.5	58 12	W 16.0 E 17.8			
	"	S	23 9	46 7 12.5	5 42	W 17.0 E 16.5			
	α Persei	E	3 28 0	34 36 43.5	35 14	S 15.5 N 18.5			
	"	W	32 52	325 25 5.5	23 35.5	S 17.4 N 16.7	4 7	− 0 39.7	
Mar. 3	Sun U. L.	W	22 59 15	270 40 16.5	38 36	S 16.9 N 17.0	20 21	− 1 17.8	5)
	"	E	23 4 10	89 21 47	20 17.5	S 15.0 N 18.9			
Mar. 4	β Aurigæ	W	5 52 33	320 51 57.5	50 17	N 17.1 S 17.5			
	"	E	56 15	39 10 56.5	8 55.5	S 16.6 N 18.1			
	α Cass.	S	6 0 46	33 34 19	32 29.5	W 17.2 E 17.5			
	"	N	5 14	326 21 27	19 24	W 17.6 E 17.1	6 17	− 0 31.5	6)
Mar. 7	β Aurigæ	W	5 56 38	320 58 43.5	56 49	S 15.2 N 18.2	5 49	− 0 52.0	
	"	E	6 0 10	39 4 4.5	2 34	S 17.2 N 16.2			
	α Ursæ Maj.	N	6 6 28	26 26 1.5	24 26.5	E 16.0 W 17.7			
	"	S	9 53	333 45 55	40 23.5	W 17.0 E 16.7	6 41	− 0 53.2	7)
Mar. 9	β Aurigæ	E	5 53 2	38 61 13	59 57	S 15.6 N 15.0	5 39	− 1 12.0	
	"	W	56 54	320 60 48.5	59 4	S 16.0 N 15.0			
	α Cass.	N	6 2 34	326 10 2	8 20	W 15.0 E 16.0			
	"	S	7 7	33 59 42	58 4	W 14.4 E 16.9	6 18	− 1 12.5	
Mar. 12	α Cygni	E	8 4 48	308 54 25.5	53 28.5	N 11.5 S 16.5	20 21	− 1 36.5	8)
	"	W	9 42	51 7 32	6 29	N 15.2 S 12.5			

1) Comp. Febr. 17. Watch regulated some days before. 2) Comp. Febr. 22. 3) Comp. Febr. 24. 4) Comp. Febr. 26. 5) Declining of the Sun just perceptible. Clear sky. 6) Watch run down this afternoon before the observation. 7) Ass. 40′ for first circle-reading. 8) Comp. March 11.

1896	Star	Oc.	Watch	Vertical Circle		Level	Watch	Hw−W.	Rem.
			h m s	° ' "	' "		h m	m s	
Mar. 12	η Ursæ Maj.	N	8 14 9	39 18 24.5	17 27.5	E 14.0 W 13.5			
	„	S	19 24	320 51 3	50 14	W 13.9 E 13.9	8 45	− 1 40.3	
Mar. 17	α Cygni	E	8 1 22	309 12 2.5	11 11.5	N 16.5 S 11.3	7 50	− 0 35.4	1)
	„	W	6 16	50 46 53.5	45 49	N 14.0 S 14.0			
	η Ursæ Maj.	N	8 13 6	38 35 39.5	34 36.5	E 13.2 W 15.2			
	„	S	17 44	321 33 1	31 57.5	W 16.0 E 12.6			
	Jupiter Ct.	W	8 20 52	296 46 49	45 39	S 12.8 N 15.9	8 29	− 0 36.5	
Mar. 21	α Ursæ Maj.	W	10 9 28	338 14 28.5	13 23	S 12.4 N 16.4	20 17	+ 1 5.5	2)
	„	E	13 7	21 47 45	46 31	S 16.5 N 12.4			
	α Aurigæ	S	10 16 33	44 36 56	35 51.5	W 16.5 E 12.4			
	„	N	21 30	315 16 40.5	15 25.5	W 15.0 E 14.0	10 57	+ 1 4.0	
Mar. 24	α Ursæ Maj.	W	9 46 55	338 11 11.5	10 25	S 15.0 N 16.0	9 34	+ 1 8.0	
	„	E	52 30	21 50 17	49 10	S 14.4 N 17.5			
	α Aurigæ	S	9 55 54	44 19 20	18 31	W 15.0 E 17.0			
	„	N	59 16	315 36 7	34 51	W 16.0 E 16.2	10 8	+ 1 7.5	
Mar. 27	α Ursæ Maj.	W	9 38 5.5	338 6 6	5 23	N 14.0 S 12.0	20 22	+ 1 3.0	3)
	„	E	41 5	21 54 32	53 48	S 12.5 N 13.5			
	α Aurigæ	S	9 46 9	44 27 55	27 14	W 14.0 E 11.9			
	„	N	50 44	315 26 53	26 33	W 16.1 E 9.9	10 6	+ 1 0.5	
Mar. 30	α Ursæ Maj.	W	9 24 49	338 4 12.5	3 37	S 10.0 N 16.0	20 22	+ 0 46.5	4)
	„	E	29 13	21 56 32	55 41.5	S 13.5 N 12.5	20 19	+ 0 41.3	5)
Apr. 4	Sun U. L.	S	3 14 35	80 57 0	56 21.5	W 13.0 E 14.3	20 21	+ 0 18.0	6)
	„	N	18 33	278 57 49.5	57 10.5	W 14.3 E 13.0	4 1	+ 0 13.5	
Apr. 6	Sun U. L.	W	22 56 0	282 55 41	54 59	S 14.0 N 13.0	20 16	+ 0 16.5	
	„	W	23 10 35	282 57 8.5	56 32.5	S 13.8 N 13.0			
	„	E	16 5	77 3 2.5	2 27.5	S 9.5 N 17.5			
Apr. 7	Sun U. L.	S	19 47 28	281 3 40.5	3 9.5	E 15.6 W 11.0			
	„	N	53 2	78 49 51	49 30	E 14.3 W 12.6	20 21	+ 0 24.5	
	Sun U. L.	W	23 40 35	283 16 55	16 12.5	S 13.5 N 13.3			
	„	E	46 20	76 44 13	43 33	N 14.0 S 13.0	20 41	+ 0 32.2	7)
Apr. 10	Sun U. L.	E	22 40 19	75 35 40.5	34 58	S 13.3 N 15.4	20 37	+ 0 28.0	
	„	W	23 3 18	284 30 42.5	30 22	S 15.7 N 13.0			
	„	E	8 36	75 28 40	28 11	S 15.7 N 13.2			
	Sun U. L.	E	23 59 44	75 29 7.5	28 38	S 11.0 N 18.0			
Apr. 11	„	W	0 3 40	284 29 53.5	29 20	S 15.0 N 13.9			
	Sun U. L.	N	3 23 29	281 53 58.5	53 28	W 15.0 E 14.5			
	„	S	27 6	78 9 32	9 0.5	W 14.6 E 15.0	4 5	+ 0 27.0	
Apr. 12	Sun U. L.	S	18 47 55	281 30 2	29 20.5	E 15.6 W 16.0	18 32	+ 0 26.5	
	„	N	55 1	78 20 20	19 33.5	W 16.0 E 16.3	20 38	+ 0 25.8	
	Sun U. L.	W	23 27	285 27 18	26 34.5	S 17.0 N 15.0			8)
	„	E	34 45	74 33 27.5	32 41	S 16.0 N 15.6	20 43	+ 0 27.0	9)
Apr. 14	Sun U. L.	S	18 43 31	282 4 39	3 56.5	E 15.9 W 16.0	18 30	+ 0 27.5	
	„	N	48 42	77 48 45	48 1.5	E 16.1 W 16.0	20 38	+ 0 27.5	
	Sun U. L.	W	23 20 55	286 14 28.5	13 38.5	S 12.5 N 19.0			10)
	„	E	34 0	73 45 19	44 37	S 15.8 N 15.8			
Apr. 15	Sun U. L.	S	3 51 22	77 5 1.5	4 7.5	W 16.0 E 16.1			10)
	„	N	58 24	282 46 3.5	45 22	W 16.2 E 15.2	4 11	+ 0 27.2	
Apr. 16	Sun U. L.	S	19 2 45	283 8 38.5	8 15	W 16.0 E 15.4	18 50	+ 0 28.0	
	„	N	8 40	76 42 47.5	42 20.5	E 13.8 W 17.7			
	Sun U. L.	W	23 30 10	287 0 31	0 24.5	S 15.6 N 14.8			
	„	E	39 3.5	72 60 3.5	59 31	S 19.5 N 11	20 40	+ 0 27.3	
Apr. 17	Sun U. L.	E	23 29 20	72 37 44	37 24	S 15.0 N 17.5	20 41	+ 0 28.8	
	„	W	39 3	287 22 56.5	22 27	S 13.5 N 15.5			
Apr. 18	Sun U. L.	N	4 18 9	283 27 44	27 22	W 16.8 E 16.8			10)
	„	S	25 28	76 42 34	42 7	W 15.0 E 13.8	4 38	+ 0 28.4	
Apr. 19	Sun U. L.	W	23 22 40	288 4 16.5	3 15	S 14.2 N 14.2	21 1	+ 0 32.0	
	„	W	29 38	288 4 23.5	3 50	S 15.5 N 13.2			

1) Star ass. to be δ Cygni. 2) Comp. March 20; watch run down yesterday. 3) Comp. March 26. 4) Comp. March 29. 5) Cloudy, got only a glimpse of Capella. 6) Comp. April 3. 7) Comp. April 8. Watch regulated several times during these days. 8) Greatest altitude. 9) Comp. April 13. 10) Observer Sverdrup.

1896	Star	Oc.	Watch	Vertical Circle		Level	Watch	Hw—W.	Rem.
			h m s	° ' "	' "		h m	m s	
Apr. 19	Sun U. L.	E	23 34 28	71 55 8.5	54 47	S 14.4 N 14.4			
Apr. 20	Sun U. L.	N	5 10 58	282 51 35.5	51 16.5	W 13.4 E 15.3			
	"	S	14 26	74 14 9.5	13 37	W 14.8 E 13.9	6 15	+ 0 33.0	1)
	Sun U. L.	W	23 40 36.5	288 22 43	22 7	S 14.5 N 13.5	21 0	+ 0 35.0	2)
	"	E	47 5	71 37 46	36 58.5	S 14.8 N 8.2			3)
Apr. 21	Sun U. L.	E	23 51 47	71 20 49	20 19.5	S 14.0 N 13.0	20 58	+ 0 35.0	
	"	W	58 48	288 39 12.5	38 36.5	S 13.0 N 14.0			2)
Apr. 22	Sun U. L.	N	3 53 38	285 30 38	30 27	W 14.5 E 13.8	3 33	+ 0 34.5	
	Moon U. L.	W	3 57 29.5	286 45 13	44 46	S 13.5 N 13.5			
	Moon U. L.	W	4 36 10.5	287 29 42	29 2	S 13.2 N 14.0			4)
	Sun U. L.	N	4 41 22	284 22 51	22 18.5	E 12.8 W 14.6			
	"	S	45 54	75 44 18	43 41.5	W 14.2 E 13.0	5 11	+ 0 34.5	
Apr. 24	Sun [U. L.]	S	19 3 58	285 35 48.5	35 15	S 12.4 N 14.9			5)
	"	N	9 54	74 15 20	14 52.5	S 12.8 N 14.5	20 59	+ 0 38.5	5)
	Sun U. L.	W	23 48 15	289 29 16	28 53	S 18.0 N 8.4			
	"	E	56 5	70 30 47	30 45.5	S 16.6 N 9.6			6)
Apr. 25	Sun U. L.	W	23 43 0	289 47 43.5	47 6	S 13.4 N 13.5	21 8	+ 0 41.0	2)
	"	E	53 23	70 12 52.5	12 4.5	S 13.5 N 13.5			
Apr. 26	Sun U. L.	E	23 55 15	69 54 24	53 57.5	S 14.2 N 12.8	21 0	+ 0 42.7	
Apr. 27	"	W	0 0 0	290 5 26.5	4 55	S 13.4 N 13.6			
	Sun U. L.	N	5 22 35	284 56 23	55 50.5	W 12.0 E 15.5			
	"	S	28 0	75 12 13	11 50	W 15.5 E 12.0	5 38	+ 0 43.0	
	Sun U. L.	E	23 35 ca.	69 35 18	34 55	S 13.0 N 13.0	21 2	+ 0 40.8	2)
Apr. 28	Sun U. L.	E	11 43 18	279 11 22	10 48.7	N 15.0 S 15.0			
	"	W	49 6	80 48 41	48 22	N 15.0 S 15.1			
	Sun U. L.	E	23 18 27	69 14 15	13 7	S 14.3 N 14.3			
	"	W	12 58	290 47 25	45 49	S 14.2 N 14.8			7)
Apr. 29	Sun U. L.	N	4 51 55.5	286 19 14	18 46.5	W 14.8 E 14.5			2)
	"	S	58 37	73 50 43.5	50 18	W 14.5 E 15.0	5 39	+ 0 42.0	
	Sun U. L.	E	11 44 18	279 26 16	25 33	N 13.9 S 17.3			
	"	W	48 15	80 34 14.5	33 34.5	N 19.5 S 11.5			
	Sun U. L.	W	23 46 25	291 7 2.5	6 21.5	S 13.5 N 14.0			
	"	E	52 10	68 53 8.5	52 42	S 14.0 N 13.7			
Apr. 30	Sun U. L.	N	4 46 13	286 45 54.5	45 22	W 14.8 E 15.2			8)
	"	S	49 57	73 19 56	19 27	W 15.0 E 15.0			
May 1	Sun U. L.	W	23 54 37	291 45 33	44 53	S 14.8 N 14.2			8)
	"	E	58 27	68 14 54.5	14 19.5	S 14.5 N 14.2			
May 2	Sun U. L.	N	4 43 8	287 28 50	28 15	W 14.0 E 14.0			8)
	"	S	47 24	72 37 41	36 54	W 14.0 E 14.2	4 56	+ 0 51.5	
May 5	Sun U. L.	W	23 57 35	292 59 10.5	58 48.5	S 13.3 N 15.7	21 8	+ 0 55.0	
May 6	"	E	0 1 12	67 1 33.5	1 20	S 15.0 N 14.0			
	Sun U. L.	S	4 58 9	71 42 14.5	41 42.5	W 11.9 E 17.6	4 47	+ 0 56.0	
	"	N	5 2 13	288 12 20	11 47.5	W 15.0 E 14.4	6 8	+ 0 56.2	
	Sun U. L.	W	23 46 58	293 18 52	18 2	S 14.2 N 13.8	21 5	+ 0 57.5	2)
	"	E	52 8	66 41 52	41 16.5	S 14.0 N 14.0			
May 8	Sun U. L.	W	0 12 52	293 40 0	39 26	S 15.5 N 13.0	0 45	−19 45.0	9)
	Sun U. L.	N	19 25 6.5	69 45 27	44 48	E 13.8 W 12.5			
	"	S	29 32	290 21 41.5	21 11.5	E 13.5 W 12.9	21 2	+ 1 3.8	
May 9	Sun U. L.	W	23 50 17	294 15 14.5	14 55	S 12.5 N 13.0	21 7	+ 1 3.5	
	"	E	55 43	65 45 7.5	44 48.5	S 13.0 N 12.8			
May 10	Sun U. L.	S	19 18 5	290 38 44.5	38 33.5	E 13.6 W 13.4			
	"	N	22 39.5	69 14 40.5	14 15	E 14.5 W 12.0	21 1	+ 1 4.3	
	Sun U. L.	W	23 46 15	294 31 44	32 13	S 13 N 12.8			2)
	"	E	54 0	65 28 18.5	28 18.5	S 12.5 N 13			
May 13	Sun U. L.	W	0 9 26	294 59 51.5	59 17	S 6.6 N 16.6	21 0	+ 1 5.2	10)
	"	E	12 10	65 2 14.5	1 49	S 14 N 9.5			

1) Circle ass. 77°. 2) Observer Sverdrup. 3) Level ass. N 13.2. 4) Ass. corr. to circle-reading — 10'. 5) Level ass. E for S and W for N. 6) Watch also noted as $23^h 53^m 45^s$. 7) Watch ass. 22^m. 8) Observer Sverdrup. During the days April 30—May 2 Scott-Hansen was absent on a trip southwards on the ice. 9) Observer Sverdrup; not the same watch as usual. 10) Comp. May 12.

1896	Star	Oc.	Watch	Vertical Circle		Level	Watch	Hw − W.	Rem.
			h m s	° ′ ″	′ ″		h m	m s	
May 13	Sun U. L.	N	5 16 19	289 32 14.5	31 42.5	W 13.5 E 12.4			
	"	S	20 11	70 34 46	34 12	W 12.0 E 13.5	5 31	+ 1 5.2	
May 15	Sun U. L.	S	19 15 47	291 53 53	53 17	E 16.0 W 11.0	18 56	+ 0 59.7	
	"	N	21 41.5	67 57 29.5	57 0.5	E 13.5 W 12.6	20 59	+ 0 59.0	1)
	Sun U. L.	E	23 36 20	64 11 5	10 50	N 14.0 S 11.0			
	"	W	43 30	295 49 52.5	49 22	S 12.6 N 12.4	21 1	+ 0 58.5	2)
May 17	Sun U. L.	W	23 44 5	296 13 3.5	12 18.5	S 8.2 N 18.0	21 2	+ 1 0.5	
	"	E	48 15	63 48 10.5	47 28	S 13.5 N 12.7			
May 18	Sun U. L.	E	23 46 25	63 34 14	33 30	S 12.5 N 13.0	20 59	+ 1 0.5	
	"	W	51 10	296 26 38.5	25 43	S 9.0 N 16.5			
May 19	[Sun U. L.]	N	5 1 5	291 23 25.5	22 40	W 16.1 E 8.1			
	"	S	4 40	68 42 53	42 10.5	W 12.4 E 12.3	5 49	+ 1 1.0	
May 22	Sun U. L.	E	22 58 5	63 4 7	3 35	S 12.4 N 9.9	21 4	+ 1 9.5	
	"	W	23 3 15	296 57 28.5	56 53	S 11.9 N 9.5			
	Sun U. L.	W	23 39 45	297 3 34.5	3 5	S 8.4 N 13.0			
	"	E	44 50	62 56 59	56 20	S 13.0 N 8.5			
May 23	Sun U. L.	S	19 17 41	293 33 31	32 52	E 9.0 W 13.2			
	"	N	23 22.5	66 18 50	18 17.5	E 8.0 W 13.8	20 53	+ 1 13.0	
May 24	Sun U. L.	W	0 16 55	297 6 54	6 10.5	S 11.1 N 11.0			3)
	Sun U. L.	S	5 8 50	68 2 45	2 24.5	W 11.0 E 9.4			
	"	N	13 9.5	291 51 18	51 1	W 8.0 E 12.8	5 43	+ 1 14.5	4)
May 27	Sun U. L.	S	19 18 5	294 15 25	15 0	E 10.4 W 11.8			
	"	N	22 28	65 38 6.5	37 43.5	E 9.6 W 12.1	20 58	+ 1 16.7	
May 28	Sun U. L.	E	23 35	61 52 54.5	52 38.5	S 11.5 N 11.5	20 59	+ 1 13.0	5)
June 2	Sun U. L.	E	1 18 3	61 21 9	20 57	S 9.2 N 14.6			
	"	W	28 26	298 31 32.5	31 18	S 10.5 N 13.0	1 52	+ 0 48.0	6)
	Sun U. L.	W	23 53 15	299 24 32.5	24 14.5	S 4.8 N 18.0	20 55	− 0 4.5	7)
June 3	Sun U. L.	E	1 15 37	61 7 11	6 52.5	S 9.1 N 13.5			
	"	W	18 59	298 50 0	49 42	S 11.9 N 11.0			
	Sun U. L.	N	5 39 4.5	292 44 7	43 44.5	W 10.0 E 13.0			
	Sun U. L.	N	7 33 53	289 31 39.5	31 31	W 12.3 E 11.0			
	"	S	37 47	70 34 11.5	33 52	W 10.4 E 12.7	10 23	− 0 8.0	
June 6	Sun U. L.?	S	19 23 44	295 52 49	52 22.5	E 16.9 W 7.9	18 50	− 0 20.5	
	"	N	28 55.5	63 58 17.5	57 50	E 9.9 W 14.9	21 1	− 0 22.5	
Aug. 7	Sun U. L.	S	17 14 32	284 46 9.5	45 49	E 13.4 W 4.5	2 50	+ 0 15.5	
	"	N	18 23	75 3 52	3 36	W 10.5 E 9	2 9	+ 0 14.5	8)

1) Cirro-stratus; limb not sharp. 2) Comp. May 16. 3) Cloudy. 4) The funnel raised, and the rudder hung in its pit, ready for the hinges. 5) Watch carried in the pocket during much activity. 6) Watch hung in the cabin during blasting in the ice about noon. 7) Watch ran down the day before. 8) Comp. Aug. 9. Level somewhat unsteady. Cloudy soon after.

B. Observations with the Sextant.

Observer: Lieutenant *Scott-Hansen,* when not otherwise stated.

The date is astronomical and the hours are counted from the same noon as in list A, except for the meridian-altitudes of the Sun, where "Noon" or "Midnight" are local, in which case the date of local noon, when different from that of the clock, is enclosed in brackets.

U. L. and L. L. signify upper and lower limb.

The column "Hor." either gives the height of the eye (in metres) when the natural horizon was used, or indicates the kind of artificial horizon (mercury, glass, tar, water) when double altitudes were measured. In the case of a glass-horizon the level reading is added in the column of Remarks.

The index error was only rarely determined in the beginning (1893, August and September, 1894, February 18, April 17 and July 23) but after 1895, February 5, very frequently.

The comparisons between the chronometer Hohwü and the observer's watch are either taken from the journal of observations, when there noted, or from the journal of daily comparisons.

What is here called a mile is, in the original, after the custom of our sailors, called a quarter mile, and means 1′ of great circle.

1893	Star	Hor.	Watch	Sextant	Watch	Hw—W.	Remarks
		met.	h m s	° ′ ″	h m	m s	
July 22	Sun L L.	3.5	20 25 8.5	34 53 30	2 32	— 43 49.6	Index correction — 2′ 5″, assumed after concordant determinations in August and September.
			27 10.5	59 40			
			29 15	35 6 10	20 56	— 43 47.9	
July (24)	Sun L. L.	4.5	Noon	38 28 45			
July 24	Sun L. L.	4.9	16 26 35	19 20 0	1 34	— 43 45.3	
			27 4	24 0			
			27 46	30 0			Observer Sverdrup.
	" "	3.5	19 6 39.5	31 33 40			
			8 38	41 40			
			10 38	39 30	19 16	— 43 43.9	[Assumed + 10′].
July (25)	Sun L. L.	4.5	Noon	38 3 40			
July 26	Sun L. L.	3.5	18 12 30.5	32 23 0	—	— 0 41.4	
July 27	Sun U. L.	Merc.	18 21 32	68 36 30			[Ship stopped for fog].
			26 10	69 11			
			27 35	69 23 10	—	— 0 39	
Aug. 5	Sun U. L.	Merc.	22 19 58	68 30 20	21 12	— 0 33.9	[Aug. 6—9 the ship was fastened to an ice-floe aground off the west coast of Yalmal].
			22 18	17 40			
Aug. 6	Sun L. L.	Merc.	15 31 11	42 20 12			
			32 22	32 0			
			34 22	53 5			
			37 18	43 23 4	—	— 0 35	
	Sun U. L.	Merc.	20 43 14.5	73 52 5			
			44 29.5	50 35			
			45 34	49 10	21 2	— 0 35.5	
Aug. 9	Sun L. L.	3.6	16 9 26	23 24 15			At sea.
			11 15	34 10			
			13 1	41 45			
	"	3.6	20 6 0	35 14 5	—	— 0 31.5	
Aug. 11	Sun L. L.	3.6	18 24 35	30 15			Bad image.
	"	4.2	19 18 48	31 49			
			20 44	50			
			22 14	51			
Aug. (12)	Sun L. L.	4.2	Noon	32 16 50			
Aug. 11	Sun L. L.	4.2	21 56 57.5	30 10 45			
			58 38.0	7 20	23 43	— 0 29.5	

1893	Star	Hor.	Watch	Sextant	Watch	Hw−W.	Remarks
		met.	h m s	° ′ ″	h m	m s	
Aug. 13	Sun L. L.	4.2	1 32 51	16 18 55	21 30	− 0 29.0	Comparison Aug. 12.
			33 59.5	13 0			
			35 25.5	8 5	21 32	− 0 26.5	
Aug. 14	Sun L. L.	4.5	17 0 40.5	24 16 13			
			2 19	21 8			
			3 30	25 10			
	Sun L. L.	3.6	20 27 15.5	29 3 50			
			29 50	2 20			Watch 28m? [Adopted].
			30 5	1 10	21 20	− 0 25.4	
Aug. 15	Sun L. L.	3.6	16 32 26	23 25 0	21 34	− 0 23.3	Bad image.
Aug. 16	Sun L. L.	4.5	16 32 32	23 23 30			
			34 37	29 0			
		4.5	16 49 7	24 8 50	—	− 0 22.5	
			50 54	13 30			
			51 53	16 20	21 13	− 0 21.8	
Aug. 17	Sun L. L.	4.4	0 39 7.5	15 48 20			
			39 50	46 10			
			40 34	43 40			
			41 25	41 15			
	Sun L. L.	4.4	0 59 15	14 32 0			
	Sun L. L.	3.6	15 12 39	19 23 0			
			13 49	26 30			
			15 2	31 5	20 49	− 0 21.2	
Aug. (18)	Sun L. L.	3.6	Noon	28 24 10			
Aug. 18	Sun L. L.	3.6	1 39 39	11 16 50			
			40 39	11 30			
			42 11	5 40			
			44 6	10 57 15			
			45 0	55 40			
			45 54	50 0			
	Sun L. L.	3.6	15 18 26.5	20 5 0			
			20 55	13 15			
			22 44	20 30			
	Sun L. L.		16 44 55	24 52			
			52 35	25 15	20 38	− 0 20.2	
Aug. (19)	Sun L. L.	3.6	Noon	28 38 0			
Aug. 19	Sun L. L.	3.6	0 58 48	13 14 25			
			59 45	10 25			
			1 0 37	7 0			
			1 38	2 45			
			2 36	12 58 35			
			3 37	54 35	—	− 0 19.5	
	Sun L. L.	4.2	14 19 38	16 18 10			
			21 8	23 40			
			22 7	27 15			
			23 39	33 0			
			25 5	38 45			
	Sun L. L.	4.2	14 42 55	17 45	20 46	− 0 18.4	
Aug. (20)	Sun L. L.	3.6	Noon	27 14 35			
Aug. 20	Sun L. L.	3.6	1 3 50	11 43 0			
			5 11	37 30			
			6 7	34 10			
			7 15	29 20			
			7 55	27 30	20 21	− 0 13.8	
Aug. (21)	Sun L. L.	3.6	Noon	27 9 10			Horizon dist. ca. 2 miles.
Aug. 24	Sun L. L.	4.2	21 57 8.5	20 47 0	20 22	+ 0 3.4	
			59 9	41 20			
			22 1 5	35 30			
Aug. 25	Sun L. L.	4.2	0 36 29	11 42 0			
			37 25	38 45			
			38 24	35 40			

1893	Star	Hor.	Watch	Sextant	Watch	Hw−W.	Remarks
		met.	h m s	° ′ ″	h m	m s	
Aug. 25	Sun L. L.	3.6	14 45 54	16 50 45			Bad image, foggy.
			47 48	57 10			
			49 0	17 0 50			
		3.6	16 13 57	21 19 10			
	Sun L. L.	3.6	19 56 2	24 5 5			
			57 59	3 40			Watch 56^m? [Rej.].
			59 9	1 20	20 13	+ 0 6.4	
Aug. 26	Sun L. L.	4.2	0 31 41	10 57 20			
			32 33	53 40			
			33 35	50 0			
			34 36	46 35			
			35 7	43 40	2 27	+ 0 7.0	
	Sun L. L.	3.6	14 10 58.5	15 9 10			
			12 6	13 10			
			13 17.5	17 15			
			14 0.5	19 35			
			14 59	23 5	14 30	+ 0 8.1	
Aug. (28)	Sun L. L.	3.6	Noon	22 44 50			Bad horizon.
Aug. 27	Sun L. L.	4.2	21 14 16	19 57 35			[Assumed 18°].
			15 8	55 35			
			16 14	52 25			[The obs. of Sep. 1, taken
			17 16	50 5			when at anchor near
			18 47	46 20			Cape Laptev, was ori-
	Sun L. L.	3.6	23 47 34	11 13 40	23 12	+ 0 13.0	ginally rejected in ex-
			48 43.5	9 50			pectation of a better
			49 49	6 15			one; the date, which
			50 35	3 30			was not noted, has
			51 31	0 35			been inferred from the
			52 19	10 57 40			clock-comp.].
			53 10	55 5	23 57	+ 0 13.2	
Sep. [1]	Sun L. L.	Merc.	15 23 21.5	34 56	—	+ 0 31.0	
Sep. 5	Sun L. L.	3.6	16 0 14	17 43 0			Hor. dist. ca. $^1/_3$ mile.
			1 23.5	45 20			[At anchor in Colin Ar-
			2 13	46 40	16 4	+ 0 12.6	cher's Harbour].
	Sun L. L.	3.6	18 12 55	20 15 35	19 18	+ 0 13.6	Hor. dist. ca. $^3/_4$ mile.
Sep. (6)	Sun L. L.	3.6	Noon	20 22 20			Hor. dist. ca. $^1/_3$ mile.
Sep. 6	Sun L. L.	3.6	14 11 36	12 47 30			Ice in horizon.
			12 53	50 10			
			13 50	52 20			
	Sun L. L.	3.6	18 15 25	19 19 30	18 20	+ 0 8.5	
	Sun L. L.	3.5	22 37 36.5	10 25 20			
			38 53	21 5			
			39 41	18 15			
			40 42	14 15			
			41 34	11 50			
			42 26	9 10	22 47	+ 0 9.0	
Sep. 7	Sun L. L.	Merc.	14 57 49	29 48 50			[Ship fastened to the ice
			59 16	56 10			in v. Toll's Bay].
			15 0 14	30 0 30			
			0 58	4 35			
			1 40	8 25	15 9	+ 0 9.8	
	Sun L. L.	Merc.	17 53 20	37 46 0			
			18 8 29	43 30	19 17	+ 0 10.7	
Sep. (9)	Sun L. L.	4.2	Noon	18 11 30			
Sep. 8	Sun L. L.	3.6	18 42 6	17 50 0			
			43 23	48 50			
			44 1.5	48 20			
			44 47.5	47 35			
			45 28	47 10	20 53	+ 0 12.0	
	Sun L. L.	?	22 43 55	8 40 20			[Height of eye ass. 3.6].
			45 8	36 50			
			45 56	33 30			

1893	Star	Hor.	Watch	Sextant	Watch	Hw−W.	Remarks
		met.	h m s	° ′ ″	h m	m s	
Sep. 8	Sun L. L.		22 46 41	8 31 10			
			47 12	29 45			
			47 45	28 0	22 50	+ 0 12.5	
			23 17 15	6 51			
Sep. 9	Jupiter L. L.	2.3	8 48 7	30 28 0	9 22	+ 0 14.8	Hor. dist. 4 miles.
	Sun L. L.	3.6	14 8 59.5	12 13 30			
			10 6.5	16 50			
			11 9	19 30			
			14 24 16	12 52 45	20 25	+ 0 13.0	
Sep. (10)	[Sun L. L.]	2.3	Noon	17 8 30			
Sep. 11	Sun L. L.	3.6	14 27 54	14 45 40			
			28 50	48 35			
			29 53	50 50			
			30 43	53 5			
			31 26	54 45			
			32 11	56 30			
			14 44 32	15 24 50	14 48	+ 0 8.2	
Sep. (12)	Sun L. L.	4.5	Noon	17 58 25			
Sep. 13	Sun L. L.	2.3	12 17 38.5	8 14 20			Ice in horizon.
			26 55	49 0			
	Sun L. L.	5.9	12 39 20	9 36 50			
			40 27	41 10	14 14	+ 0 11.3	
	Sun L. L.	3.7	18 37 20 ?	17 46 25			
			38 3	45 0			
			38 37 ?	44 0			
			40 4.5	41 0			
			41 3.5	39 35			
			42 9.0	37 25			
	Sun L. L.	4.5	21 46 3.5	8 3 55			
			47 2.5	7 59 40			
			48 38	53 20			
			22 0 30	7 6 0	22 11	+ 0 11.8	
Sep. 14	Sun L. L.	3.8	17 49 49.5	18 20 40			Foggy.
		3.8	18 17 34	17 41 40			
			18 42	39 30			
			19 30	38 30			
			20 26	36 50	21 50	+ 0 15.2	Index corr. − 2′ 5″.
Sep. 15	Sun L. L.	3.8	12 48 43.5	11 14 25			
			49 34	17 0			
			50 46	21 0			
			56 30	40 30	13 13	+ 0 16.3	Uncertain horizon.
	Sun L. L.	3.8	16 7 45	17 58 55			
Sep. (16)	Sun L. L.	?	Noon	18 1 0			
Sep. 16	Sun L. L.	3.8	13 35 31	14 8 35			Index corr. − 2′ 5″.
	Sun L. L.	3.8	13 54 20	14 52 30			
			55 5	53 45			
			55 54	55 35			
			57 7	58 5			
			57 45	59 40	14 1	+ 0 17.5	
			14 11 0	15 27 0			
	Sun L. L.	3.8	15 48 6	17 11 25			
	Sun L. L.	4.5	19 25 34.5	11 9 0	19 36	+ 0 18.5	
Sep. 17	Sun L. L.	4.5	19 17 49	10 18 35			
			18 35	15 50			
			19 23	13 25			
			20 13	10 20			
			20 53	8 15	19 37	+ 0 18.3	
Sep. 18	Polaris	3.8	0 16 46	75 31 10			
	Sun L. L.	3.8	15 51 47	15 14 0			
			53 44	13 35			} Good obs.
			54 50	13 0	16 0	+ 0 19.2	}
	Sun L. L.	3.8	19 6 29	9 30 5			

1893	Star	Hor.	Watch	Sextant	Watch	Hw−W.	Remarks
		met.	h m s	° ′ ″	h m	m s	
Sep. 18	Sun L. L.		19 7 7	9 28 30			
			7 47	26 30			
			17 25	8 57 20	19 21	+ 0 19.8	
Sep. (20)	Sun L. L.	3.8	Noon	13 7.5			
Sep. 19	Sun L. L.	3.8	19 27 47	6 53 10			
			28 40	50 45			
			29 58	47 30			
			31 4	45 0			
			43 34	6 10 30	19 47	+ 0 22.5	
Sep. 21	Jupiter	4.5	0 46 10	16 19 45			
			48 12	24 20			
			49 16	27 45			Hor. ca. 4 miles off.
	Polaris	4.5	1 0 29	79 20 45	1 7	+ 0 25.6	
	Sun L. L.	3.8	12 3 36	6 41 35			
			4 47	44 35			
			5 34	46 5			
			12 48	7 2 45	12 18	+ 0 26.0	
	Sun L. L.	4.5	13 41 18	9 50 50			
			42 21	52 35			
			43 40	54 15	13 48	+ 0 26.0	
Sep. (22)	Sun L. L.	4.5	Noon	11 19 55			
Sep. 21	Sun L. L.	3.8	19 11 43	6 57 20			
			12 32	55 15			
			13 11	53 40			
	Sun L. L.	3.8	19 58 18	5 1 30	20 54	+ 0 27.8	
Sep. (24)	Sun L. L.	Glass	Noon	20 56 55			Level S 11.6 N 11.4.
Sep. 24	Jupiter L. L.	Merc.	2 24 8.5	42 47 30	2 41	+ 0 42.0	
Sep. (26)	Sun L. L.	"	Noon	19 26 50			
Sep. 25	Sun L. L.	"	15 56 20	19 23 50	16 0	+ 0 52.7	
Sep. 26	Jupiter L. L.	"	1 51 6.5	40 19 40			
			52 41	28 20			
			54 3.5	36 10	2 2	+ 0 55.0	
Sep. 28	Sun L. L.	Glass	16 10 33	16 39 0	13 19	+ 1 5.8	
			11 40	37 30			
			12 55	36 30			Level S 2.33 N 2.25.
	Sun L. L.	9.0	16 24 31	8 9 50	16 31	+ 1 6.3	Ice horizon, not a good obs.
Oct. 2	α Cygni	Glass	1 15 21.5	104 1 10			Level S 1.57 N 1.15 [α and γ Cygni combined].
	Jupiter	"	1 29 44	41 36 20			
			34 9.5	42 1 50	1 45	+ 1 15.5	Level E 1.48 W 1.22; Ind. corr. − 2′ 0″.
Oct. (5)	Sun L. L.	11.5	Noon	6 35 25			Ice horizon, somewhat uneven.
Nov. 24	Pollux	Merc.	20 30 6.5	40 27 5	19 52	+ 7 23.3	[Castor and Pollux combined].
		"	32 23.7	33 5			
		"	35 1	42 40			
	Moon L. L.	"	20 43 46.5	41 55 15			
		"	47 27	42 11 50			
		"	50 0	25 0			
	Moon and Pollux distances (inner limb)		21 3 0	25 21 50			
			7 19.3	19 25			
			12 54.5	15 5			
	Moon L. L.	Merc.	21 17 48	44 44 35			
		"	21 27.5	45 2 0			
		"	23 33.7	15 0			
	Pollux	"	21 39 9	48 23 45			[Must be Castor].
		"	43 9.5	40 30			
		"	47 45.5	58 45			
	α Lyræ	"	21 51 51.5	85 36 0			
		"	55 6.7	16 50			
		"	57 50	1 10	22 18	+ 7 24.0	

1893	Star	Hor.	Watch	Sextant	Watch	Hw—W.	Remarks
		met.	h m s	° ′ ″	h m	m s	
Nov. 27	α Cygni	Merc.	Meridian	112 34 35	18 33	+ 7 45.0	
	α Aurigæ	„	20 28 59	81 30 40			
			32 2	47 0			
			33 46.2	55 15			
			35 32	82 3 35			
			37 11	11 45			
			56 54.5	83 55 35			
			59 6.5	84 7 0			
			21 1 5.0	15 55	21 33	+ 7 47.0	
Dec. 2	Jupiter	Merc.	Meridian	58 21 0			[Assumed L. L.].
	α Lyræ	„	2 45 51.5	79 9 0			[Assumed α Cygni].
			49 34	78 51 51			
			51 7.2	40 40			
			52 47	36 10			
			54 49.5	24 10			
			57 9.5	15 10	3 4	+ 8 32.1	
1894					12 53	+ 2 5.5	Comp. January 19.
Jan. 20	Moon U. L.	Merc.	2 39	74 53	12 55	+ 2 14.5	Clouds, not good obs.
Feb. 15	Jupiter	Glass	Meridian	55 38 15			Level N 14.05 S 14.9.
Feb. 17	Jnpiter	Glass	Meridian	55 44 50			Level N 12.6 S 14.7.
Feb. 18	Jupiter	Glass	2 7 7	40 49 10			
			8 50	40 55			
			10 41.5	31 35	2 22	+ 6 54.0	Index corr. — 2′ 30″.
Mar. (8)	Sun L. L.	5.0	Noon	5 19			
Mar. 7	Vega	Merc.	23 22	57 3	13 29	+ 0 33.7	Bad, rime on art. hor.
Mar. (9)	Sun L. L.	5.0	Noon	5 45.6			[Watch ass. 0h 22m
Mar. (18)	Sun L. L.	5.0	Noon	9 20			March 8].
Mar. (23)	Sun L. L.	5.0	Noon	10 54			
Mar. (27)	Sun L. L.	5.0	Noon	12 24 5			Observer Johansen.
Mar. (28)	Sun L. L.	5.0	Noon	12 48			— » —
Mar. (30)	Sun L. L.	5.0	Noon	13 29 30			— » —
Mar. (31)	Sun L. L.	5.0	Noon	13 56			
Mar. 30	Sun L. L.	5.2	19 23 24	9 45 30	13 4	+ 1 34.3	
			25 12	42 0			
			27 0	37 50			
			28 30	34 30			
			30 23.5	31 0	23 31	+ 1 39.2	
Apr. (2)	Sun L. L.	5.0	Noon	14 34 30			Observer Johansen.
Apr. 1	Sun L. L.	5.2	20 0 33	9 6 40			
			2 5	2 45			
			3 23	8 59 35			
			4 52.5	56 30			
			7 4.5	51 10	20 18	+ 1 57.0	
Apr. (3)	Sun L. L.	5.0	Noon	15 1 30			Observer Johansen.
Apr. 3	Sun L. L.	?	13 56 53.5	14 20 0	13 1	+ 2 13.3	
			14 1 29	25 0			
			5 31	29 40			
Apr. (4)	Sun L. L.	5.0	Noon	15 23 40			Not a good observation.
Apr. 3	Sun L. L.	5.0	17 21 12.5	14 29 40			
			25 30	25 0			Bad observations, horizon foggy.
			30 40	20 0	37 1	+ 2 23.1	
Apr. 8	Sun L. L.	Merc.	12 16 40	26 40 0			
			19 14	50 0			
			21 36.5	27 0 0			
			24 0	10 0			
			26 45.3	20 0	13 22	+ 3 6.8	
Apr. (9)	Sun L. L.	5.0	Noon	17 11			
Apr. 8	Sun L. L.	5.2	19 6 48.3	13 29 30			
			7 42.5	27 30			
			8 25.5	26 0			
			12 51	13 16 50			Observer Johansen.
			15 10.4	12 20			— » —

1894	Star	Hor.	Watch	Sextant	Watch	Hw−W.	Remarks
		met.	h m s	° ′ ″	h m	m s	
Apr. 8	Sun L. L.		19 16 31.8	13 9 30	37 21	+ 3 18.8	Observer Johansen.
Apr. (10)	Sun L. L.	5.6	Noon	17 31 20			—»—
Apr. 14	Sun L. L.	?	12 8 27.5	15 15 40			[Assumed 5.6 metr.].
			9 37	18 0			
			10 20	20 20			
			11 13.3	22 10			
			12 0	23 30	12 16	+ 4 9.0	
	Sun L. L.	5.6	15 35	19 25 40			
Apr. 16	Sun L. L.	Merc.	12 42 7	33 39 30			
			43 31	44 0			
			44 27	48 20			
			45 25.3	52 10			
			46 35	57 10			
			47 22	59 5			
			48 13	34 2 20	13 20	+ 4 29.2	
	Sun L. L.	Merc.	15 48	39 47			
Apr. 17	Sun L. L.	?	Midnight	1 17 35			
	Sun L. L.	Merc.	11 58 6	31 10 0	11 34	+ 4 38.0	The three last obs. best.
			12 0 28.7	20 0			
			2 49.5	30 0			
			5 10	40 0			
			7 35	50 0			
			9 55	32 0 0	12 16	+ 4 38.2	Index corr. − 2′ 18″,
Apr. (18)	Sun L. L.	Merc.	Noon	40 21 15			after a correction of the
Apr. (19)	Sun L. L.	Merc.	Noon	40 57 30			small mirror − 1′ 26″.
Apr. 19	Sun L. L.	Merc.	12 5 10.3	32 50 0	11 44½	+ 4 59.8	
			7 15.5	33 0 0			
			9 35.0	10 0			
			12 9.0	20 0			
			14 26.0	30 0	12 25	+ 4 0.2	[Hw−W. ass. $5^m 0^s.2$].
Apr. (20)	Sun L. L.	Merc.	Noon	41 36 35			
Apr. 19	Sun L. L.	Merc.	19 27 16.3	33 30 0	18 50	+ 5 3.0	
			29 15.7	20 0			
			32 9.5	10 0			
			34 25.0	33 0 0			
			36 48.0	32 50 0	19 52	+ 5 3.5	
Apr. 20	Sun L. L.	5.6	3 47	2 16 20			
Apr. (21)	Sun L. L.	Merc.	Noon	42 18 0			
Apr. 20	Sun L. L.	Merc.	20 39 48	28 52 20	13 16	+ 5 10.1	
			42 55	36 50			
			45 35	24 20			
			48 49	28 13 40			
			51 39	27 56 0	22 3	+ 5 14.5	
Apr. 21	Sun L. L.	5.6	Midnight	2 34 10			
			3 53	34 40			
			55	34 55			
Apr. (22)	Sun L. L.	5.6	Noon	21 34			
Apr. 22	Sun L. L.	?	Midnight	2 52			2° 51′?
Apr. (23)	Sun L. L.	Merc.	Noon	43 39 30			
Apr. 22	Sun L. L.	Merc.	20 17 8.3	31 47 0	19 57	+ 5 32.0	
			18 19	41 30			
			19 48	34 40			
			20 47.5	30 0			
			21 50.5	25 30			
			22 37	21 40			
			24 15.5	31 14 10	20 42	+ 5 32.5	
Apr. 23	Sun L. L.	5.8	Midnight	2 12			
Apr. (24)	Sun L. L.	Merc.	Noon	44 16 10			
Apr. 25	Sun L. L.	Merc.	11 30 37.5	34 20 0	11 8	+ 5 58.1	
			32 46.0	30 0			
			34 54.5	40 0			
			37 12.0	50 0			

1894	Star	Hor.	Watch	Sextant	Watch	Hw—W.	Remarks
		met.	h m s	° ′ ″	h m	m s	
Apr. 25	Sun L. L.		11 39 22.0	35 0 0	11 49	+ 5 58.5	
Apr. (26)	Sun L. L.	5.6	Noon	22 46 20			
Apr. 25	Sun L. L.	Merc.	19 57 6	35 0 0	13 16	+ 5 59.0	Watch 58m? [Adopted].
			20 0 22	34 50 0			
			2 38.5	40 0			
			4 53.5	30 0			
			7 5	20 0	20 11	+ 6 2.3	Observer Johansen.
Apr. 26	Sun L. L.	5.8	Midnight	4 13 30			
Apr. (27)	Sun L. L.	Merc.	Noon	45 59 30			Observer Johansen.
Apr. 27	Sun L. L.	5.8	Midnight	4 36 40			Refr. variable.
Apr. (28)	Sun L. L.	Merc.	Noon	46 28			Observer Johansen.
Apr. 27	Sun L. L.	?	21 21 44.3	14 50 15	13 16	+ 6 21.7	[Eye's height ass. 5.8 met.]
			22 41.7	48 20			
			23 36.0	44 50			
			24 26.0	43 40			
			25 24.0	41 30			
			27 15.5	37 0			
			28 0.5	35 30			
			28 44.7	33 30			
			30 42.8	28 50			Observer Johansen.
			31 47	26 10			—»—
			32 46	24 10	21 37	+ 6 25.0	—»—
Apr. 28	Sun L. L.	5.8?	Midnight	4 56 35			Good.
Apr. (29)	Sun L. L.	Merc.	Noon	47 1 5			
Apr. 29	Sun L. L.	5.8?	Midnight	5 17 5			
	Sun L. L.	Merc.	11 56 44.5	38 40 0			
			59 2	50 0			
			12 1 28.5	39 0 0			
			3 50	10 0			
			6 22.3	20 0	12 13	+ 6 41.0	
Apr. (30)	Sun L. L.	Merc.	Noon	47 34 0			
Apr. 29	Sun L. L.	Merc.	19 28 12.0	39 20 0	19 5	+ 6 44.1	
			30 32.7	10 0			
			33 1.0	0 0			
			35 27.7	38 50 0			
			37 46.5	40 0	19 54	+ 6 44.6	
Apr. 30	Sun L. L.	5.8	Midnight	5 36			
			3 53.5	5 36 35			Clear horizon.
May (1)	Sun L. L.	Merc.	Noon	48 7 35			
May 1	Sun L. L.	5.8	Midnight	5 55 30			Very clear.
May (2)	Sun L. L.	Merc.	Noon	48 41 45			
May 1	Sun L. L.	Merc.	21 1 36	33 40 20	13 16	+ 7 3.6	
			2 44	35 0			
			3 41	30 20			
			4 44	25 30			
			6 5	19 10			
			7 13.5	13 45			
			7 50.5	10 50	21 39	+ 7 7.6	
May 2	Sun L. L.	5.8	Midnight	6 15 0			Clear, horizon bright.
May (3)	Sun L. L.	Merc.	Noon	49 16 10			Observer Johansen.
May 3	Sun L. L.	5.8	Midnight	6 33 0			Cloudy.
	Sun L. L.	Merc.	11 57 21	40 50 0	11 39	+ 7 25.0	
			59 46	41 0 0			
			12 2 9.5	10 0			
			4 37	20 0			
			7 3.5	30 0	12 15	+ 7 25.0	
May (4)	Sun L. L.	5.6	Noon	24 57 30			Observer Johansen.
May 3	Sun L. L.	Merc.	19 32 15	41 30 0	19 4	+ 7 28.0	
			34 40.5	20 0			
			37 7	10 0			
			39 27	0 0			+4s?
			41 58	40 50 0	19 48	+ 7 28.4	

1894	Star	Hor.	Watch	Sextant	Watch	Hw—W.	Remarks
		met.	h m s	° ′ ″	h m	m s	
May 4	Sun L. L.	5.8	Midnight	6 49 35			Very clear.
May (5)	Sun L. L.	Merc.	Noon	50 22 50			
May 5	Sun [L. L.]	5.8	Midnight	7 6 10			Clear, temp. — 15°.9; measured from lowest horizon, false hor. ca. 50″ above.
May (6)	Sun L. L.	Merc.	Noon	50 56 25			
May 7	Sun L. L.	Merc.	12 2 53.5	43 20 0	11 54	+ 8 8.0	
			5 16.0	30 0			
			7 49.7	40 0			
			10 19.3	50 0			
			12 47.0	44 0 30	12 22	+ 8 8.1	
May (8)	Sun L. L.	Merc.	Noon	51 55 10			Observer Johansen.
May 8	Sun L. L.	5.6	15 44	26 17 0	13 14	+ 8 18.3	Cloudy, bad image.
May (10)	Sun L. L.	5.6	Noon	26 33 30			
May 10	Sun L. L.	5.8	Midnight	8 31 20			Clear, hor. sharp.
	Sun L. L.	Merc.	12 21 36.3	46 10 10	12 13	+ 8 38.3	
			24 8.0	20 0			
			26 47.0	30 0			
			29 24.0	40 0			
			32 6.3	49 45			
			34 50.7	47 0 20			
			37 23.5	10 0			
			40 13.0	20 0			
			43 57.0	30 30			
			45 37.0	40 0			
			48 29.0	50 0	12 55	+ 8 38.1	
May (11)	Sun L. L.	Merc.	Noon	53 32 30			Observer Johansen.
May 10	Sun L. L.	Merc.	19 5 28.5	47 0 0	15 11	+ 8 39.0	
			8 3.0	46 50 0			
			10 47.0	39 45			
			13 17.7	30 20			
			16 1.3	20 0			
			18 27.0	10 10	19 29	+ 8 40.1	
May (12)	Sun L. L.	Merc.	Noon	54 4 10			Observer Johansen.
May 11	Sun L. L.	6.0	21 12 51	19 32 20			—»— ; hazy.
			15 24	26 30			
			16 42	23 40			
			18 4	20 20			
			19 21	17 20	21 26	+ 0 44.0	A different watch.
May 12	Sun L. L.	5.8	Midnight	9 2 10			Some clouds.
	Sun L. L.	Merc.	15 58	54 32 35	13 26	— 0 7.9	
			16 4	32 5			
May 13	Sun L. L.	5.8	Midnight	9 16 30			Clear.
May (14)	Sun L. L.	Merc.	Noon	54 59 50			Mercury unsteady.
May 13			12 12 30	54 58 40	13 26	+ 0 2.7	[Watch ass. 16h].
May 14	Sun L. L.	Merc.	12 24 14.5	47 15 45	12 4	+ 0 13.1	Bad image.
			27 42	29 40			
			28 56	34 30			
			29 54	38 30	12 42	+ 0 13.2	
May 16	Sun L. L.	Merc.	21 15 40	42 5 0	21 4	+ 0 37.1	
			16 20.5	1 30			
			17 8	41 58 0			
			18 19.5	52 30			
			19 8	48 50			The four last observations best.
			19 39.3	46 20			
			20 8.7	43 50			
			20 53.5	40 40	21 36	+ 0 37.5	
May (20)	Sun L. L.	Merc.	Noon	57 4 15			
May 20	Sun L. L.	5.8	Midnight	11 13 20			Some cum. clouds near horizon.
	Sun L. L.	Merc.	12 22 59.5	48 50 0	12 11	+ 1 13.5	
			25 26.0	49 0 0			
			27 55.7	10 0			
			30 37.0	20 10			
			33 15.3	30 0	12 44	+ 1 13.5	Good observations.

1894	Star	Hor.	Watch	Sextant	Watch	Hw−W.	Remarks
		met.	h m s	° ′ ″	h m	m s	
May (21)	Sun L. L.	5.6	Noon	28 41 10			Observer Johansen; cloudy, not good.
May 20	Sun L. L.	Merc.	19 54 24.0	49 30 0	19 33	+ 1 16.0	
			56 56.0	20 0			
			59 32.0	10 0			Ind. corr. − 1′27″; Joh.
			20 2 4.7	0 0			
			4 38.0	48 50 0	20 24	+ 1 16.7	Good observations.
May (22)	Sun L.·L.	?	Noon	28 49 50			Johansen [ass. 5.6 met.].
May 22	Sun L. L.	5.6	16 11 (12?)	28 57 30	13 20	+ 1 36.0	
			19	59 30			Perhaps 30″ too great.
May 23	Sun L. L.	6.0	17 39 20	28 36.5	13 40	+ 1 46.2	Bad image.
	Sun L. L.	Merc.	22 48 7	38 39	13 42	+ 1 56.0	Comp. May 24.
May 25	Sun L. L.	Merc.	10 9 23.5	40 11 50	9 55	+ 2 5.1	
			10 36.0	16 30			
			12 26.5	25 30			
			13 11.0	27 50			
			14 30.0	34 10			
			15 57.5	40 50			
			17 0	45 10			
			18 11	50 30			Best.
			19 20	55 40	10 37	+ 2 5.5	
May (26)	Sun L. L.	Merc.	Noon	58 46 15			Observer Johansen.
May (27)	Sun L. L.	Merc.	Noon	59 3 50			—»—
May (28)	Sun L. L.	5.6	Noon	29 44 10			
May 27	Sun L. L.	Merc.	16 53 0	59 15 45	13 43	− 1 19.8	Watch run down yesterday.
			59 30	12 20			
			17 1 19	10 50			Hazy.
	Sun L. L.	Merc.	22 3 52.7	43 59 50	21 35	− 1 17.5	
			5 27.5	53 0			
			6 29.0	47 50	22 41	− 1 17.0	
May 31	Sun L. L.	6.0	20 28 24	26 3 20	13 42	− 0 45.0	
			29 21	1 30			
			30 18	25 59 30			
			31 14.5	58 0			
			32 17	56 40			
June 1	Sun L. L.	Glass	4 18 24	26 52 40			Level N 11.3 S 10.05.
			19 29	51 40			Glass horizon not plain.
			20 46	51 40			
			21 48	51 0			
			22 34	50 40			
			23 24	50 40			
			24 53	50 30			
			26 28	50 30	4 43	− 0 40.5	
June (3)	Sun L. L.	Merc.	Noon	61 10 10			
June (4)	Sun L. L.	5.6	Noon	30 46 20			Johansen.
June 4	Sun L. L.	Tar	4 14 32	27 38 40			
		5.8	4 20 11	13 52 10			Watch also 21m 1s.
		5.8	Midnight	13 51 40			
	Sun L. L.	Tar	16 44	61 38 40	14 0	− 0 8.2	Mercury horizon in disorder.
	Sun L. L.	Tar	19 9 52	57 34 0			
			10 44.7	31 0			
			11 28.7	29 10			
	Sun L. L.	Tar	22 52 0.5	42 55 20			
			54 15	38 10			
			55 42.7	32 30			
			56 38.5	28 40			
			58 15.5	20 0			
	Sun L. L.	6.0	23 2 12.7	21 2 50			
			2 55.0	1 30			
			3 25.8	0 30			
June 5	Sun L. L.	Tar	16 39 ca.	61 53 40	13 59	+ 0 0.5	
	Sun L. L.	Merc.	17 14 37.5	61 35 0			
			15 17	34 20			

1894	Star	Hor.	Watch	Sextant	Watch	Hw—W.	Remarks
			h m s	° ′ ″	h m	m s	
June 5	Sun L. L.		17 16 35	61 33 10			
			19 6.5	30 30			
			20 20	29 15			
	Sun L. L.	Merc.	23 45 54	39 1 40			
			49 28	38 46 50			} One of these alt. some-
			52 57	37 10			what great.
			54 15	27 10			
			55 17	23 25			Watch run down since
			56 25	18 40	24 38	+ 0 32.0	last comp.
June (7)	Sun L. L.	Merc.	Noon	62 7 50			
June (8)	Sun L. L.	Merc.	Noon	62 18 40			
June 7	Sun L. L.	Merc.	16 42.8	17 5	13 55	+ 0 44.2	
			46.0	15 45			
	Sun L. L.	Merc.	17 15 39	61 58 5			
			16 43	57 35			
			17 37	56 45			
			18 46	55 30			
			20 4	53 55			
			21 51.5	51 30	13 58	+ 0 53.0	Comp. June 8.
	Sun L. L.	Merc.	22 28 36.5	45 2 30	14 1	− 0 9.0	A different watch.
			29 54	44 57 30			
			31 5	52 20			
			32 19	46 40			
			33 47	40 0	22 45	− 0 9.7	
June 9	Sun L. L.	Merc.	22 23 38.5	45 40 15	13 58	+ 1 1.0	
			25 4	34 0			
			26 14.5	29 0			
			27 21	23 50			
			28 21	19 45	22 45	+ 1 4.0	
June 10	Sun L. L.	Merc.	4 14 16.5	28 58 15			
			15 15.5	58 5			
			15 52.5	57 55			
			18 30	57 5			
			19 34.5	56 35	4 37	+ 1 6.0	
	Sun L. L.	Merc.	16 35	62 27 0	13 57	+ 1 9.5	
			16 52 56	62 22 10			
			55 30	21 0			
			57 27	19 25			
			59 17	18 50			
			17 0 42	17 45			
June 11	Sun L. L.	Merc.	17 28 17.0	61 54 35	14 2	+ 1 17.0	
			32 2.0	49 10			
			33 43.5	47 0			
			35 39.0	44 30	13 54	+ 1 25.5	Comp. June 12.
June (13)	Sun L. L.	Merc.	Noon	62 26 40			Observer Johansen.
June 15	Sün L. L.	Merc.	12 13 52.5	52 44 20	11 46	+ 1 48.0	
			12 29 17.6	53 44 0			
			31 32.8	53 15			
			35 38.8	54 17 45	12 50	+ 1 48.2	
	Sun L. L.	Tar	13 50 30	58 17 20			Observer Johansen.
			52 50	24 0			
			53 52	26 10			
			54 50	30 10	14 7	+ 0 5.0	A different watch.
June (16)	Sun L. L.	Water	Noon	62 32 45			Johansen; hor. a pool of
June 16	Sun L. L.	Tar	22 38 52	45 42 0			water on the ice.
			40 21.5	36 30			
			44 29	18 20	23 3	+ 0 6.0	Observer Johansen.
June (18)	Sun L. L.	Merc.	Noon	62 39 0			
June 20	Sun L. L.	Merc.	17 4 18	62 39 40	12 56	+ 2 26.0	
			5 50	39 5	13 58	+ 2 26.3	
			6 49	38 30			
			7 45	38 0			

1894	Star	Hor.	Watch	Sextant	Watch	Hw−W.	Remarks
			h m s	° ′ ″	h m	m s	
June 20	Sun L. L.		17 9 20	62 37 10			
			10 42.5	35 40			
			11 50.5	34 20			
June 21	Sun L. L.	Merc.	20 29 48	54 31 10	13 58	+ 2 34.5	
			31 10	26 0			
			32 24	22 10			
			32 56.7	18 40			
			33 53.5	15 40			
			35 33.5	9 10	20 42	+ 2 37.0	
	Sun L. L.	Merc.	22 27 52.5	46 23 35			} Very good.
			28 46	19 45	22 53	+ 2 38.0	
June (23)	Sun L. L.	Merc.	Noon	62 59 0			Johansen; good.
June 23	Sun L. L.	Merc.	16 24 0	62 59 40	13 57	+ 2 51.8	
June (24)			Noon	63 1 0			
June 23			16 43.5	63 0 35			
			46.0	62 59 45			
June 24	Sun U. L.	Merc.	12 29 41.2	54 39 20			+ 10′? [Adopted].
			31 37.6	57 30			
			32 26.4	55 4 30			
			35 9.0	15 10			
			36 51.4	21 30			
	Sun U. L.	Merc.	13 4 4.6	57 3 30			
			5 10	7 15			
			6 18	11 30			
			7 6	14 20			
			8 24	19 0	13 57	+ 2 58.5	
June (25)	Sun L. L.	Merc.	Noon	63 3 30			Observer Johansen.
June 25	Sun L. L.	Merc.	17 7 22.2	62 55 10			Perhaps too great.
June 26	Sun L. L.	Merc.	21 43 26.2	49 32 30	21 35	+ 3 18.5	
			44 32.6	27 30			
			45 38.0	23 0			
			46 26.2	19 20			
			47 33	15 10			
	Sun L. L.	Merc.	21 52 32.8	48 52 45			
			53 25.8	48 50			
			54 23.4	44 50			
			55 20.8	40 30			
			56 13.0	36 55			
	Sun L. L.	Merc.	21 59 18.6	48 23 50			Observer Johansen.
			22 0 16.0	19 35			
			1 12.4	15 30			
			2 9.2	11 20			
			2 54.8	8 0	22 26	+ 3 19.0	
June 27	Sun L. L.	Merc.	4 5 4.0	29 34 45			Sun-glass before the ocular.
			6 12.6	34 25			
			7 10.0	33 45			
			8 18.0	32 55			
			9 5.7	32 35			
			14 5	29 30 45			Sun-glass before the mirrors.
			16 6	30 5			
			17 5.5	29 30	4 28	+ 3 21.5	
June 30	Sun U. L.	Merc.	10 7 44.5	44 49 50	9 55	+ 3 52.0	
			9 1.5	55 30			
			9 50	58 50			
			10 41	45 2 30			
			16 33.5	28 15			
			20 9	44 15	10 35	+ 3 52.2	
July (1)	Sun L. L.	Merc.	Noon	62 42 10?			
June 30	Sun L. L.	Merc.	16 45 8	62 39 45	13 55	+ 3 53.0	
			47 11	38 45			
			48 9	38 25			
			50 10.5	37 35			

1894	Star	Hor.	Watch	Sextant	Watch	Hw−W.	Remarks
			h m s	° ′ ″	h m	m s	
June 30	Sun L. L.		16 51 1.5	62 37 15			
			51 54	37 0			
	Sun L. L.	Merc.	23 24 52	41 13 30	23 15	+ 3 56.5	
			25 40.5	10 15			
			26 27.0	6 45			
			27 13.5	4 0			
			28 11	0 0	23 55	+ 3 56.7	
July (2)	Sun L. L.	Merc.	Noon	62 37 10			Very good.
July 2	Sun L. L.	Merc.	20 22 18.5	53 48 35	13 54	+ 4 11.0	
			23 26.0	44 20			
			24 4.5	42 10			
	Sun L. L.	Merc.	23 50 10	39 9 5			
			51 2	6 5			
			51 37	4 5			
			52 15.5	1 0			
			52 55	38 58 20			
July 3	Sun L. L.	Merc.	4 16 32	28 42 20	0 13	+ 4 15.0	
			17 14	42 20			
			18 18	42 0			
			20 0	41 20			
			20 51	41 15	13 56	+ 4 21.0	
July (4)	Sun L. L.	Merc.	Noon	62 14 0			
July 4	Sun L. L.	Merc.	1 41 0.8	32 18 0			
			45 25.2	14 30			
			47 5.6	9 35			
			48 9.8	7 5			
			49 44.8	2 35			
			1 54 44.4	31 49 45			
			55 53.4	46 30			
			56 45.8	44 45			
			57 42.4	42 10			
			59 7.6	38 0			
			2 12 12.8	31 6 55			
			13 11.2	4 25			
			14 40.6	1 5			
			16 2.6	30 57 45			
			17 1.2	55 55	2 24	+ 4 25.5	
	Sun U. L.	Merc.	13 5 2.4	46 46 30	12 55	+ 4 30.0	
			9 43.8	47 3 5			
			10 50.0	7 0			[Ass. + 10°].
			11 52.2	10 25			
			12 57.0	14 25			
			14 5.2	18 30	13 54	+ 4 30.5	
July (5)	Sun L. L.	Merc.	Noon	62 5 10			
July 4			16 15.0	62 2 30			
			16 34.0	62 4 10			
	Sun L. L.	Merc.	22 41 22.5	43 25 5			
			42 15	21 10			
			42 56	18 20	11 57	+ 4 38.1	Comp. July 5.
July (6)	Sun L. L.	Merc.	Noon	61 57 5			Observer Johansen.
July 6	Sun L. L.	Merc.	1 15 14.2	33 5 15	1 32	+ 4 43.8	
July 7	Sun U. L.	Merc.	12 12 12.2	53 4 35	12 0	+ 4 57.5	
			13 34.8	10 25			
			12 19 29.8	53 34 0			
			20 40.4	38 30			
			21 41	43 5			
			22 57.2	48 0			
			23 59	52 15	13 54	+ 4 58.0	
July (8)	Sun L. L.	Merc.	Noon	61 49 5			Observer Johansen.
July 7	Sun L. L.	Merc.	22 25 17	44 6 55			
			27 16	43 58 0			Uncertain; cloudy.
			29 29	52 15	24 20	+ 0 45.5	A different watch.

1894	Star	Hor.	Watch	Sextant	Watch	Hw−W.	Remarks
			h m s	° ′ ″	h m	m s	
July (9)	Sun L. L.	Merc.	Noon	61 40 35			Observer Johansen.
July 9	Sun U. L.	Merc.	13 9 15.2	56 22 0			
			10 41.6	27 0			
			16 12.0	46 15			
			17 29.4	50 45			
			18 58.6	55 45	13 54	+ 5 16.0	
	Sun L. L.	Merc.	16 36 40	61 27 20	14 4	+ 0 49.7	A different watch.
July (11)	Sun L. L.	Merc.	Noon	61 11 45			Observer Johansen.
July 11	Sun L. L.	Merc.	16 25	60 49 0	13 59	+ 5 33.5	
			16 39 54	60 45 10			
			41 22	44 50			
			44 34	43 15			
			46 4	42 50			
			46 58.4	42 15			
			48 0	41 30			
	Sun L. L.	Merc.	23 19 40.8	38 47 15	23 11	+ 5 37.0	
			20 39.8	43 45			
			21 57.6	37 55			
			23 24 47.6	38 25 30			
			25 44.0	21 40			
			26 48.0	17 0			
			27 42.2	13 30			
			28 39.0	9 40			
July 12	Sun U. L.	Merc.	12 18 20.6	52 13 40	12 11	+ 5 41.8	
			19 42.6	19 5			
			20 40	22 50			
			21 49	27 40			
			22 46.8	32 10	13 54	+ 5 42.0	
July 13	Sun U. L.	Merc.	12 6 6.8	51 9 5	11 51	+ 5 51.0	
			7 21.6	14 20			
			8 39.6	19 10			
			9 47.8	24 0			
			10 59.6	28 45			
			12 14 15.8	51 41 50			
			15 19.6	46 10			
			16 21.4	50 10	13 55	+ 5 51.2	
July (14)	Sun L. L.	Merc.	Noon	59 54 10			Observer Johansen.
July 14	Sun L. L.	Merc.	16 6	59 31 15			
July (15)			Noon	32 50			Uncertain; no declining.
July 15	Sun L. L.	Merc.	16 2.3	59 14 15	13 56	+ 6 8.8	
			16 5.0	15 10			
July (16)			Noon	17 25			
July 16	Sun U. L.	Merc.	12 18 33.2	51 11 20	12 7	+ 6 17.7	
			19 42.0	15 50			
			20 37.4	19 35			
			21 39.2	23 50			
			22 38.0	28 0	13 55	+ 6 18.9	
	Sun L. L.	Merc.	16 22	59 8 30			Cloudy; a glimpse.
July (18)	Sun L. L.	Merc.	Noon	58 48 10			Observer Johansen.
July 20	Sun L. L.	Merc.	17 44 18.6	56 18 20	13 56	+ 6 52.5	
	Sun L. L.	Merc.	21 44 39.6	43 6 0	14 6	+ 1 10.0	A different watch.
			48 28.0	42 48 55	14 5	+ 1 11.7	Comp. July 21.
July 21	Sun L. L.	Merc.	0 10 11.6	32 19 50			
			11 21.0	15 35			
			12 30.8	11 10			Too great?
			13 31.8	6 55			
			14 35.2	3 35			
			15 42.6	31 59 10			Too small?
			0 20 9	31 42 25			
			21 3.2	39 20			
			21 58.2	35 50			
			23 2.0	32 0			

1894	Star	Hor.	Watch	Sextant	Watch	Hw—W.	Remarks
			h m s	° ′ ″	h m	m s	
July 21	Sun L. L.		0 23 58.2	31 28 35	0 37	+ 6 55.5	
	Sun L. L.	Merc.	21 57 10.4	41 22 30	21 46	+ 7 3.0	
			58 21.4	16 50			
			59 18.4	12 40			
			22 4 57.0	40 47 35			
			5 44.8	44 15			} Best.
			6 40.6	39 55			
July 22	Sun U. L.	Merc.	13 31 43.4	53 20 35	11 37	+ 7 8.0	
			32 52.4	24 10			
			33 37.2	26 35			
			34 26.2	29 0			
			35 19.0	31 35	13 51	+ 7 8.0	
	Sun L. L.	Merc.	15 53 52.4	56 47 40			
July (23)			Noon	56 54 30			Ind. corr. — 1′ 29″.
July 22	Sun L. L.	Merc.	21 35 46.3	42 31 35			
			36 29.5	28 40			
			37 14	25 5			
			38 8	21 20			
			39 2.7	17 10			
			39 42.0	14 25			
			40 27.0	11 5			
			41 14.7	7 25	22 9	+ 7 10.5	
July 23	Sun L. L.	Merc.	16 29 10	56 34 10	14 0	+ 1 13.7	A different watch; Johansen.
July 24	Sun L. L.	Merc.	16 48 4.2	56 4 20	13 51	+ 7 26.5	
			49 28.4	3 40			
			50 35.0	2 35			
			51 48.6	2 0			} Best.
			52 46.8	1 10			
			53 57	0 20			
July 25	Sun L. L.	Merc.	18 10 23	53 38 50	13 51	+ 7 36.0	
			11 10	36 55			
			12 9	34 45			
			12 44.3	33 25			
			13 22.7	32 0	18 19	+ 7 37.5	
	Sun L. L.	Merc.	22 2 2	39 35 50			
			4 53.4	22 25			
			7 5	12 10			
			8 54.6	3 35			
			10 33	38 56 30	23 0	+ 0 5.5	A different watch; had run down since July 23.
July 26	Sun L. L.	Merc.	23 37 41.8	31 26 35	23 7	+ 7 46.5	
			38 56.6	21 35			
			40 13.0	16 15			
			41 22.2	11 10			
			42 32	6 25			
			44 30.8	30 58 0	24 23	+ 7 47.0	
July 27	Sun L. L.	Merc.	15 18 55	54 41 10	13 50	+ 7 53.5	
			19 57	42 20			
			20 29.7	43 0			
	Sun L. L.	Merc.	16 20 40	55 14 20	14 1	+ 0 10.5	A different watch.
			28 0	14 20			Observer Johansen.
			34 30	13 30			
July 28	Sun L. L.	Merc.	15 56 45	54 51 0	13 52	+ 8 3.0	
			59 20	51 50			
July (29)			Noon	54 20			
July 29	Sun L. L.	Merc.	18 34 28.4	51 6 35	13 50	+ 8 13.0	} Best.
			39 34	50 52 15			
			40 45	48 20			Dew on the glass-roof of
			41 56	45 0	18 51	+ 8 14.5	the horizon.
	Sun L. L.	Merc.	22 7 55.2	36 40 0	21 55	+ 8 15.8	
			8 54.2	35 30			
			9 47.2	31 50			Somewhat late.
			10 57.6	26 5	22 31	+ 8 16.0	

1894	Star	Hor.	Watch	Sextant	Watch	Hw − W.	Remarks
			h m s	° ′ ″	h m	m s	
July 30	Sun U. L.	Merc.	11 59 15.8	44 50 0	11 48	+ 8 21.7	
			12 0 46.2	56 35			
			2 7.2	45 2 20			
			4 59.0	14 50			
			5 56.4	18 45			Dew on roof of horizon.
			6 52.2	23 0			
	Sun L. L.	Merc.	19 32 12.6	47 28 20	19 23	+ 8 24.3	
			33 36.6	23 5			
			35 8.8	17 30			
			36 21.6	12 45			
			37 49	7 15			
			19 42 14.6	46 50 20			
			43 44	44 45			
			44 43.2	40 45			
			45 54	37 0			
			47 2	32 20	20 6	+ 8 24.7	
July 31	Sun L. L.	Merc.	16 5 0	53 35 35	13 51	+ 8 31.5	
Aug. 2	Sun U. L.	Merc.	14 54 0	52 34 15	13 50	+ 8 49.5	
			55 20	35 50			
			57 43.3	44 10			Limbs indistinct.
			58 21.5	40 45			
			58 54.7	41 15			
			59 31.0	42 20			
			15 0 7.0	43 10			
Aug. (3)	Sun L. L.	Merc.	Noon	52 29 10			Observer Johansen.
Aug. 2	Sun L. L.	Merc.	22 57 15.6	30 25 25	19 20	+ 8 51.5	
			23 0 50	11 40			
			1 53	6 35			
			2 57.6	2 15			
			4 1.0	29 57 20			
			5 1.8	52 45			
			6 1.8	48 15			
			7 7.2	43 45			
			8 9.6	38 55			
Aug. 3	Sun U. L.	Merc.	12 31 5.6	45 20 0	1 22	+ 8 54.0	
			33 29.8	30 0	12 13	+ 8 59.5	
			36 12.8	40 15			
			38 49.2	50 0			
			41 24.6	46 0 0			
			44 7.8	10 0			
			46 54.0	20 0			
Aug. (4)	Sun L. L.	Merc.	Noon	51 55 30			Good; Johansen.
Aug. 3	Sun U. L.	Merc.	19 35 32	45 50 0			
			38 10	40 15			
			40 46	30 0			
			43 27.3	20 0	19 57	+ 9 2.4	
Aug. (5)	Sun L. L.	Merc.	Noon	51 21 5			
Aug. 5	Sun U. L.	Merc.	11 59 2.4	42 10 0	11 37	+ 9 18.7	The first altitudes probably best.
			12 1 24.8	20 0			
			3 54.8	29 50			
			6 21.0	40 0			
			8 42.6	50 0			
			11 9.6	43 0 0			
			13 38.4	10 0			
Aug. (6)	Sun L. L.	Merc.	Noon	50 47 10			
Aug. 5			16 15 0	46 30			As a test.
	Sun U. L.	Merc.	19 58 37.5	43 10 0	19 34	+ 8 22.2	[Hw − W. ass. 9m 22s.2].
			20 1 6.3	0 0			
			3 33.0	42 50 0			
			6 2.0	40 0			
			8 26.3	29 50			
			10 48.5	20 0			

1894	Star	Hor.	Watch	Sextant	Watch	Hw—W.	Remarks
			h m s	° ′ ″	h m	m s	
Aug. 5	Sun U. L.		20 13 15.0	42 10 0	20 17	+ 9 23.3	
Aug. 7	Sun L. L.	Merc.	15 53 36.4	49 39 55	13 48	+ 9 42.2	
			56 22	40 50			
			59 20.8	41 10			
Aug. (8)			Noon	41 50			Observer Johansen.
Aug. 8	Sun L. L.	Merc.	15 43	49 5 30	13 48	+ 9 50.5	
			46	6 55			
			48.8	8 0			
			53.7	9 30			
Aug. (9)			Noon	11 15			
Aug. 8	Sun L. L.	Merc.	20 21 50	38 51 35			
			22 31.5	48 35			
			23 12.8	45 50			Uncertain.
			23 54.8	42 50			
			24 47.5	38 55			
			25 27	36 5			
			26 16	32 30	20 45	+ 9 52.0	
Aug. (10)	Sun L. L.	Merc.	Noon	48 40 5			
Aug. 9			16 10.2	39 40	13 48	+ 9 58.4	
			11.5	39 35			
			13.5	39 15			
			14.7	39 5			
Aug. 10	Sun U. L.	Merc.	11 55 47.2	39 20 0	11 34	+ 10 7.2	
			58 13.8	30 0			
			12 0 28.2	39 50			
			2 58.2	50 0			
			5 29.0	40 0 10			
	Sun L. L.	Merc.	16 1 30	48 2 25			Observer Johansen.
Aug. (11)			Noon	2 55			—»—
Aug. 10	Sun U. L.	Merc.	20 1 29.8	40 0 10	19 38	+ 10 9.0	
			3 58.8	39 50 0			
			6 19.2	39 50			
			8 43.0	30 0			
			11 5.6	20 0	20 36	+ 10 9.5	Cirro-stratus.
Aug. (12)	Sun [L. L.]	Merc.	Noon	47 27 50			
Aug. (13)	Sun [L. L.]	Merc.	Noon	46 51 30			Image indistinct.
Aug. 13	Sun U. L.	Merc.	12 33 35.8	40 9 0	12 26	+ 10 32.0	Indistinct limbs, snow, glass-roof wiped between the observations.
			36 59	22 0			
			38 7.6	25 45			
			41 49	39 5	13 48	+ 10 32.3	
	Sun L. L.	Merc.	16 26 5.4	46 6 20			
			27 48	5 20			
			29 49.6	4 5			
Aug. 14	Sun U. L.	Merc.	11 36 39.2	35 40 0	11 17	+ 10 39.0	
			38 53.6	50 0			
			41 21.0	36 0 0			
			43 41.8	10 10			
			46 1.4	20 0			
			48 22.4	30 0			
			50 46.0	40 0			
	Sun L. L.	Merc.	18 55 45.6	40 30 15			
			56 53.2	26 30			
			57 55.0	22 50			
			58 51.8	19 50			
			19 0 5.8	15 40	19 6	+ 10 41.5	
Aug. 16	Sun L. L.	Merc.	15 41 2.0	44 8 50	14 1	+ 0 21.7	A different watch.
			42 42.0	9 45			Observer Johansen.
			43 45.5	10 20	14 0	+ 0 20.0	Comp. Aug. 17.
Aug. (17)			Noon	18 10			Observer Johansen.
Aug. 17	Sun U. L.	Merc.	14 51 35	43 40 0	13 56	+ 0 16.4	Watch run down yesterday.
			52 36.4	42 0			
			54 31.4	44 40			

1894	Star	Hor.	Watch	Sextant	Watch	Hw−W.	Remarks
			h m s	° ′ ″	h m	m s	
Aug. 17	Sun U. L.		15 20 54	44 19 30			
			21 53.8	20 40			
			23 3	22 0			
Aug. (18)	Sun L. L.	Merc.	Noon	43 42 25			40′? [not adopted].
Aug. 17	Sun L. L.	Merc.	20 47 35	31 54 10			
			48 38	49 20			
			49 28	45 30	21 36	+ 0 19.3	A different watch.
Aug. (19)	Sun L. L.	Merc.	Noon	43 3 25			
Aug. 20	Sun U. L.	Merc.	12 51 37.2	36 22 10	13 56	+ 0 33.5	Comp. Aug. 19.
			52 46	26 15			
			53 53.8	30 15			
			12 59 28.4	36 50 0			
			13 4 40.6	37 8 5			
			5 33.8	11 25			
			6 36.0	14 45	13 56	+ 0 40.5	
Aug. (21)	Sun L. L.	Merc.	Noon	41 46 0			Observer Johansen.
Aug. 21	Sun L. L.	Merc.	16 27 30	41 8 30	14 2	+ 0 23.5	A different watch.
			30 30	7 20			Observer Johansen.
			32 0	5 50	13 59	+ 0 26.0	Comp. Aug. 22.
Aug. 22	Sun U. L.	Merc.	12 1 45.0	31 52 30	11 45	+ 0 59.2	
			2 49.4	56 55			
			3 50.8	32 1 15			Glass-roof wiped for dew.
			12 8 47.8	32 21 25			
			9 53.8	25 55			
	Sun L. L.	Merc.	15 59 30	40 29 0	13 59	+ 0 26.0	A different watch.
			16 2 0	29 30			Observer Johansen.
			10 30	30 0	14 0	+ 0 28.0	Comp. Aug. 23.
Aug. (23)			Noon	30 0			
Aug. 24	Sun L. L.	6.0	22 22 50	10 1 40	13 56	+ 1 16.7	Bad circumstances.
Aug. 25	Sun L. L.	Merc.	15 58	38 27 15	14 57	+ 1 25.5	
			16 1	27 45			
			6	28 15	22 38	+ 1 28.3	
Aug. (26)			Noon	28 35			
Aug. 27	Sun L. L.	Merc.	13 33 37.0	33 9 50			Observer Johansen.
			37 35.5	21 10	13 58	+ 0 39.0	A different watch.
			40 15.0	31 30			41ᵐ? [rej.]. Bad image.
	Sun L. L.	Merc.	16 2	37 19	13 39	+ 1 44.7	} Bad image Cirro-stratus.
Aug. (28)			Noon	37 19.5			
Aug. 29	Sun L. L.	Merc.	16 22 39	35 25 10	13 34	+ 2 2.8	
			24 55	24 30			
			26 7	23 50			
			27 12	23 35			
			28 14	23 20	19 58	+ 2 5.5	
Sep. 3	Sun L. L.	Merc.	16 32 31	31 34 15	13 34	+ 2 52.0	Name of watch not given in the original.
			36 3.5	33 30			
			37 21	33 10			
			38 4	33 0			
			41 19	31 25			
			42 25	31 0			
			43 20	30 40	22 7	+ 2 57.0	
Sep. 5	Sun L. L.	Merc.	17 5.5	29 54 45	13 49	+ 3 17.0	
			7.0	53			
			10.4	52 20	14 5	+ 3 29.0	Comp. Sept. 6.
Sep. 7	Sun L. L.	6.0	22 36 45	5 8 30	22 45	+ 3 43.8	
Sep. 8	Sun L. L.	Merc.	16 54.6	28 3 30	13 57	+ 3 51.0	
			57 51	1 0			
			59 24	0 5			
			17 1 9	27 59 10			
			2 32	58 5			
			3 47	57 5			
			17 20 54	27 40 0			
			22 18	38 25			

1894	Star	Hor.	Watch	Sextant	Watch	Hw−W.	Remarks
		met.	h m s	° ′ ″	h m	m s	
Sep. 8	Sun L. L.		17 23 34	27 37 0	13 54	+ 4 2.3	Comp. Sept. 9.
Sep. 18	Sun L. L.	?	16 44 0	10 8 30			[Eye's height ass. 6m].
			46 30	7 50			Observer Johansen.
			48 30	6 30	17 7	+ 1 27.0	A different watch.
Oct. 15	Sun L. L.	4.8	16 48 ca.	0 0	13 53	+ 5 3.0	Limb strongly elliptical.
1895							
Jan. 14	Moon and	—	1 31 43	72 11 40	22 47	+ 0 30.4	Comp. Jan. 13.
	Jupiter dis-		35 31	14 30			The first distance pos-
	tances (outer		38 12	15 30			sibly too small [omit-
	limbs)		40 22.5	17 10			ted]. The four last
			42 33.5	18 35			best [double weight].
			44 36	19 35			
			46 52	20 45			21′? [not adopted].
			49 7	22 35			
			51 25	24 15	2 31	+ 0 32.5	
Feb. 5	Moon and	—	22 15 15.5	43 22 45	21 9	+ 5 11.0	
	Mars, dis-		19 52	24 35			
	tances (inner		23 22	27 0			
	limbs)		26 36	29 5			
			35 46	30 40			[Watch ass. 30m].
			33 5	32 50			
			36 8	34 35			
			38 24	36 0	23 6	+ 5 13.5	Index corr. − 1′ 25″.
Feb. 8	Moon and	—	17 16 6.5	46 16 5	15 57	+ 5 52.0	Index corr. − 2′ 13″ de-
	Jupiter dis-		17 59	17 20			termined by 6 point-
	tances (inner		19 50	18 35			ings of Jupiter and 3
	limbs)		21 35	19 50			of Capella. After this
			23 12	20 30			a small tilt of the
			24 34	21 30			mirror was corrected.
			25 46	22 45			
			26 39	23 10			
			27 48	24 5			
			29 3.5	24 40	18 52	+ 5 54.0	
Mar. 9	Moon and	—	1 31 13	59 17 35	0 46	− 1 4.2	
	Jupiter dis-		33 20	18 55			
	tances (inner		35 10	19 55			
	limbs)		36 38	20 55			
			38 13	21 50			
			39 57	22 55			
			41 21	23 45	2 8	− 1 3.7	
Mar. (11)	Sun	—	—	—			Index corr. + 5′ 11″.
Mar. (13)	Sun	—	—	—			Index corr. + 5′ 20″.
Apr. (6)	Sun L. L.	6.0	Noon	11 56 20			I. C. + 1′ 10″ (Nordahl).
Apr. 6	Sun L. L.	Merc.	18 20	24 29 10	15 14	− 0 8.7	I. C. + 1′ 10″; bad image.
Apr. (8)	Sun L. L.	Merc.	Noon	25 14 20			Ind. corr. + 2′ 35″.
Apr. (10)	Sun L. L.	Merc.	Noon	26 42 15			
Apr. 13	Sun L. L.	Merc.	18 14	29 38 45	15 38	− 0 17.5	Bad image.
			25	38 20			Ind. corr. + 1′ 45″.
Apr. (17)	Sun L. L.	Merc.	Noon	31 47 45			
Apr. 16			18 27 45	47 20	15 36	− 0 28.0	Observer Nordahl.
			29 45	46 45			—»—
	Sun L. L.	Merc.	23 10 29	23 41 30			
			11 28.5	38 30			
			12 21	36 15			
			13 10.5	33 50			
			14 3	31 25	23 49	− 0 28.0	Ind. corr. + 1′ 43″.
Apr. (19)	Sun L. L.	Merc.	Noon	33 14 35			Ind. corr. + 3′ 12″.
Apr. 18	Sun L. L.	Merc.	23 50 29	23 21 20	15 39	− 0 14.0	
			51 35	18 30			
			52 31	15 30			
Apr. 19	Sun L. L.	Merc.	0 1 50	22 47 50			
			3 13	44 20			

1895	Star	Hor.	Watch	Sextant	Watch	Hw—W.	Remarks
			h m s	° ' "	h m	m s	
Apr. 19	Sun L. L.		0 5 52.5	22 36 0			
			7 29	31 30			
			8 35	28 10	0 20	− 0 13.8	
Apr. (21)	Sun L. L.	Merc.	Noon	34 40 20			
	Sun U. L.	Merc.	Noon	35 44 20			Ind. corr. + 2' 52".
Apr. (22)	Sun L. L.	Merc.	Noon	35 20 25			Cir. and Cirro-str.
Apr. 21			16 25	20 0	16 9	+ 1 28.0	I. c. + 3' 20". [Ass. 18h].
Apr. (24)	Sun L. L.	Merc.	Noon	36 39 10			Merc. sometimes tremb-
Apr. 23			18 32.1	36 38 35	(Hw	0 0.0	ling slightly, hauling
			35.9	37 50	used)		of lead-line some 300
			38.2	37 35		0 0.0	m. off.
	Sun L. L.	Merc.	21 49 57.5	26 57 40	20 35	+ 174 35	[Hour of obs. ass. as 20
			51 22.5	53 30			by the watch].
			52 28	50 20			
			53 28	47 40			
			54 16	44 50			
			55 3.5	42 30			
			56 3.5	39 30	21 9	+ 174 35	Ind. corr. + 2' 54".
Apr. (27)	Sun L. L.	Merc.	Noon	38 38 35			I. C. + 2' 32" (Nordahl).
Apr. 26	Sun L. L.	Merc.	23 37 53	28 18 35	23 26	+ 20 18.0	Dr. Blessing's watch [6
			39 1	15 15			hours have been added
			39 53	12 35			in both col. Watch].
			40 40	10 10			
			41 29.5	7 55			
			23 47 17	27 50 10			} Observer Nordahl.
			49 18	44 0			} Ind. corr. + 3' 9".
			51 0	39 40	24 8	+ 20 17.5	
Apr. (29)	Sun L. L.	Merc.	Noon	39 48 20			Observer Nordahl.
Apr. 28	Sun L. L.	Merc.	23 40 15	29 23 0	23 35	+ 18 59.0	[Hw—W. ass. 19m 59s].
			41 46	18 45			Dr. Blessing's watch [as
			42 56	15 15			Apr. 26].
			44 8.5	11 5			
			45 8	8 50	24 0	+ 19 58.8	
Apr. 30	Sun [L. L.]	Merc.	13 48 13	33 30 0	13 31	+ 0 8.5	Watch cleaned by Mog-
			51 30	40 0			stad.
			55 6	50 0			
			58 39	34 0 0			
			14 2 17.5	10 0	14 11	+ 0 9.0	
May (1)	Sun U. L.	Merc.	Noon ca.	42 11 20			Observer Nordahl.
May (2)	Sun L. L.	Merc.	Noon	41 39 50			Ind. corr. − 1' 57".
May 3	Sun U. L.	Merc.	14 48 12.6	38 47 20			Ind. corr. + 4' 25".
			52 45	58 10	15 40	+ 0 3.0	Merc. trembling.
	Sun L. L.	Merc.	18 31	42 29 40			New mirrors.
			35	29 10			
			37 5	28 20			
			40 15	28 0			Ind. corr. + 0 47"; small
			41 58.5	27 35			mirror corrected.
			43 58	27 10			
	Sun L. L.	Merc.	23 30 35	33 53 40	23 21	+ 0 4.8	Ind. corr. + 1' 29".
			33 22	45 40			
			34 37	42 10			Good.
			36 30.5	36 40			
			37 32	33 50			Good.
			39 47	27 30			Motion in the ice.
			41 32	22 40	24 4	+ 0 5.0	[2 last obs. omitted].
May (7)	Sun L. L.	Merc.	Noon	43 58 0			
	Sun U. L.		Noon	45 1 50			Ind. corr. + 2' 32".
May 7	Sun U. L.	Merc.	14 3 22.5	38 33 10	15 40	− 0 8.0	Comp. May 6.
			4 24	36 20			
			6 17	41 10			
			6 54.5	42 50			
			7 49	45 0			

1895	Star	Hor.	Watch	Sextant	Watch	Hw−W.	Remarks
			h m s	° ′ ″	h m	m s	
May 7	Sun U. L.		14 8 40	38 47 20			
			9 31	49 30			
			10 19	52 0	15 34	− 0 10.5	Ind. corr. + 3′ 4″.
May (8)	Sun L. L.	Merc.	Noon	44 26 40			Ind. corr. + 2′ 56″.
May 10	Sun U. L.	Merc.	14 11 35	40 20 0	15 59	+ 0 3.0	Comp. May 9.
			12 25.5	22 10			
			13 7	23 40			
			13 57	26 0			
			14 46	27 40	14 35	+ 0 5.5	Ind. corr. + 2′ 42″.
May (11)	Sun L. L.	Merc.	Noon	45 52 30			Ind. corr. + 2′ 42″.
May 13	Sun U. L.	Merc.	14 30 31.5	42 21 0	16 6	+ 0 13.8	Comp. May 12.
			31 57	25 0			Small mirror corrected.
			33 12	28 20			
			34 2	30 40			
			36 10.5	35 30	15 58	+ 0 8.7	
May (14)	Sun L. L.	Merc.	Noon	47 21 0			Ind. corr. + 2′ 34″.
	Sun U. L.	Merc.	Noon	48 24 50			
May 13	Sun L. L.	Merc.	23 15 36	40 34 10			
			16 31	32 10			
			17 13.5	30 20			
			17 43	29 0			
			18 22	27 0			
			19 0	25 35			
			19 39	24 10	23 38	+ 0 8.2	Ind. corr. + 2′ 19″.
May 15	Sun U. L.	Merc.	14 17 7.5	42 40 50	14 2	− 0 2.5	
			17 56.5	43 15			
			18 39.5	44 50			
			19 26	47 10			
			20 17.5	49 30			
			21 11.0	51 50			
			21 58.5	53 40	16 1	− 0 3.0	Ind. corr. + 2′ 17″.
May (16)	Sun L. L.	Merc.	Noon	48 22 10			Ind. corr. + 2′ 20″.
May 16	Sun L. L.	Merc.	0 24 7	38 31 35	0 15	− 0 2.5	
			24 54.5	29 40			
			25 37.5	27 40			
			26 21.5	25 35			
			26 58.8	24 0			
			27 31	22 35			
			28 8	21 0	0 45	− 0 2.5	Ind. corr. + 2′ 20″.
May (18)	Sun L. L.	Merc.	Noon	49 16 20			
May 18	Sun L. L.	Merc.	0 21 19	39 45 20			
			22 15	43 0			
			22 57.5	40 50			
			23 47	38 40			
			24 28	36 50			
			25 25.5	34 20			
			26 7	32 10	0 45	− 0 5.5	Ind. corr. + 2′ 10″.
May 19	Sun U. L.	Merc.	14 51 48.5	45 33 30			}
			53 27	37 30			} Indistinct sun.
			54 41	40 40			}
			56 58.5	46 20			
			57 41.5	48 30			} Good.
			58 25.5	50 5	16 18	− 0 1.0	}
May (20)	Sun L. L.	Merc.	Noon	50 16 25			Ind. corr. + 2′ 5″.
May 21	Sun L. L.	Merc.	21 11 50	49 8 0	16 15	+ 0 0.5	Cloudy, the last four observations indicated as tolerably good.
			13 1.5	6 0			
			13 58	4 40			
			14 50	2 40			
			15 39	2 0			
			17 13	48 59 10			
			19 1	56 30			
			19 42.5	55 40			

1895	Star	Hor.	Watch	Sextant	Watch	Hw—W.	Remarks
			h m s	° ′ ″	h m	m s	
May 21	Sun L. L.		21 20 39	48 53 30			
			22 1	51 50	16 16	+ 0 2.0	Comp. May 22.
May 23	Sun L. L.	Merc.	1 9 4	40 14 30			
			10 0	12 20			
			10 49.5	10 15			
			11 38	8 0			
			12 41	5 20	1 37	+ 0 4.2	
	Sun U. L.	Merc.	6 45	31 19			Cirro-stratus.
			53	31 17			
	Sun Cent.	Merc.	6 55	30 45			Sun visible as a blur.
			57	45.5			[Omitted].
			58	45.5			
	Sun U. L.	Merc.	7 5 20	31 17 0			
			8 0	17 0			
			12 0	17 10			
			13 45	17 30			
			18 30	18 10	16 14	+ 0 4.0	
May (24)	Sun L. L.	Merc.	Noon	51 35 40			Observer Nordahl.
May (25)	Sun L. L.	Merc.	Noon	52 0 20			Ind. corr. + 2′ 2″.
May 27	Sun L. L.	Merc.	0 13 44	44 27 50	16 12	+ 0 4.7	Comp. May 26.
			14 31	25 40			
			15 1	24 30			
			16 39.5	19 45			
			20 13	9 45			
			20 49.5	8 20			
			22 33	3 30	0 55	+ 0 5.5	Ind. corr. + 2 5″.
May 29	Sun L. L.	Merc.	2 46 48	38 5 0	16 2	+ 0 2.3	Comp. May 28.
			51 42	37 52 10			Small mirror corrected before obs.
			52 31	50 10			
			53 9	48 40			
			53 44	47 0			
			54 14	45 50			Bad image.
	Sun U. L.	Merc.	6 8 0	33 4 10			[Hour of obs. ass. to be 7].
	Sun U. L.	Merc.	6 31 55	33 8 30			
			33 25	8 45			Ind. corr. + 1′ 22″.
			35 30	9 30	16 14	− 0 1.0	
May (30)	Sun L. L.	Merc.	Noon	52 52 50			Ind. corr. + 1′ 17″.
May 31	Sun L. L.	Merc.	1 32 47	41 45 10	16 8	− 0 1.3	Comp. May 30.
			33 32	43 20			
			34 11	41 30			
			34 47	39 50			
			35 19	38 0	4 24	− 0 3.0	Ind. corr. + 1′ 42″.
	Sun U. L.	Merc.	14 42 29	49 0 0			
			46 30	10 0			
			48 24	15 0			
			50 11	20 0			
			52 5	25 0			
			53 59	30 0			
			56 5	35 0			
June (1)	Sun L. L.	Merc.	Noon	54 18 10			Ind. corr. + 1′ 50″.
May 31	Sun U. L.	Merc.	23 8 5	49 35 0			
			9 57	30 0			
			12 2	25 0	23 26	− 0 2.5	Cloudy afterwards.
June 3	Sun U. L.	Merc.	14 41 49	49 51 10	16 12	− 0 5.8	Comp. June 2.
			42 29	52 50			
			43 6.5	54 30			
			43 45	56 10			
			44 37.5	58 10	16 18	− 0 2.0	Ind. corr. + 2′ 10″.
June (4)	Sun L. L.	Merc.	Noon	55 11 0			
June 6	Sun U. L.	Merc.	14 30 28	50 0 20	16 9	− 0 7.5	Comp. June 5.
			31 11	2 30			
			31 55.5	4 30			

1895	Star	Hor.	Watch	Sextant	Watch	Hw−W.	Remarks
			h m s	° ′ ″	h m	m s	
June 6	Sun U. L.		14 32 34	50 6 10			
			33 20	8 10	16 17	− 0 10.5	Ind. corr. + 2 10″.
June (7)	Sun L. L.	Merc.	Noon	55 53 20			Observer Nordahl.
June 7	Sun L. L.	Merc.	0 52 12	45 11 55			
			52 49	10 10			
			53 25	8 30			
			54 59.5	7 5			[Ass. 53m].
			54 47	5 0	1 6	− 0 13.3	Ind. corr. + 2′ 10″.
June (8)	Sun L. L.	Merc.	Noon	56 3 25			
June 8	Sun L. L.	Merc.	0 49 54	45 29 30			
			51 3	26 30			
			51 55	24 0			
			52 37	21 30			[Omitted].
			53 30	19 50	1 7	− 0 16.0	
June 10	Sun U. L.	Merc.	14 26 17.5	50 50 30	14 43	+ 17 8.0	
			26 57.5	52 20			
			27 41	54 10			
			28 25	56 0			
			30 31.5	51 0 30	15 59	+ 17 9.3	
	Sun L. L.	Merc.	20 1 0	55 51 0	16 22	+ 1 9.5	Observer Nordahl.
			20 7 13	55 47 0			
			9 43	45 0			
			11 19	43 30			
June 11	Sun L. L.	Merc.	2 50 1	40 56 40	1 36	+ 1 14.3	Observer Nordahl.
	Sun L. L.	Merc.	19 26 30	56 11 20	18 34	+ 3 28.5	—»—
			35 40	9 0	20 24	+ 3 31.0	—»—
	Sun Cent.	Merc.	23 51 49	49 28	23 34	+ 3 33.2	Foggy, no distinct limb.
			52 51	25			[Ind. corr. ass. 0′ 0″].
			53 30	24			
June 12	Sun L. L.	Merc.	2 33 53	41 53 0	2 27	+ 3 38.5	
			34 45	51 0			
			35 30.5	48 50			
			36 17.5	47 10			
			36 53.5	45 40	2 41	+ 3 39.0	
June (13)	Sun L. L.	Merc.	Noon	56 17 50			Ind. corr. − 3 50″ [1].
June 12	Sun L. L.	Merc.	23 49 57	48 57 20	23 37	+ 9 28.5	Watch out of order in
			50 49	55 10			these days [2].
			51 54	52 20			
			52 35	50 30			
			53 26	48 20	24 20	+ 9 29.2	Ind. corr. + 0′ 40″.
June 15	Sun U. L.	Merc.	Midnight	36 55 30			Ind. corr. + 6′ 27″.
	Sun U. L.	Merc.	15 14 42.5	51 45 0	15 2	− 6 30.5	[4 hours added].
			15 22	46 40			
			16 0.5	48 0			
			16 50	50 0			
			17 33.5	51 50	15 48	− 6 30.7	Ind. corr. + 1′ 20″.
June 17	Sun U. L.	Merc.	14 41 11	51 28 20	14 24	+ 15 17.5	[3 hours subtracted].
			43 0	32 45			
			44 40	37 0			
			47 22	44 0	15 4	+ 15 17.5	Ind. corr. + 2′ 30″.
	Sun L. L.	Merc.	19 8 0	56 52 40	18 38	− 6 44.5	
			12 10	53 40	20 29	− 6 42.5	
June (18)			Noon	55 10			Ind. corr. + 1′ 45″.
June 18	Sun L. L.	Merc.	0 42 6	46 43 40	0 28	+ 25 35.8	
			42 42	42 0			
			43 12.2	40 20			

1) A break was found in the holder of the small mirror (possibly dating from May 3, when new mirrors were put in). A cross piece was soldered on.

2) As the watches used during the rest of the summer often differed by several hours from Hw, it was deemed convenient to change the hours of the watch by the same number in the column of observations and the columns of comparison. The change made is noted in every case.

1895	Star	Hor.	Watch	Sextant	Watch	Hw—W.	Remarks
			h m s	° ′ ″	h m	m s	
June 18	Sun L. L.		0 43 42	46 39 10			
			44 22	37 20	1 1	+ 25 36.0	Ind. corr. + 2′ 0″.
June (20)	Sun L. L.	Merc.	Noon	57 19 0			Ind. corr. + 1′ 58″.
June 21	Sun U. L.	Merc.	14 23 58	51 48 50	14 6	+ 32 6.5	[2 hours added].
			25 20	52 10			
			26 50	56 20			Merc. sometimes tremb-
			28 10	59 40			ling slightly.
			29 27	52 3 10	14 42	+ 32 7.2	Ind. corr. + 2′ 30″.
June (22)	Sun L. L.	Merc.	Noon	57 20 40			I. C. + 2′ 20″; Nordahl.
June 22	Sun L. L.	Merc.	0 44 22	47 51 40	0 32	− 0 36.3	[4 hours subtracted].
			45 10	49 30			
			45 47	47 30			
			46 22	46 0			
			47 3.5	44 10	1 19	− 0 36.5	Ind. corr. + 2′ 30″.
June 23	Sun U. L.	Merc.	15 8 1	52 3 30	15 0	− 4 19.0	[6 hours added].
			9 29	7 20	15 18	− 4 19.0	
	Sun L. L.	Merc.	19 45 30	57 19 0	19 32	− 4 20.0	— » —
			47 40	18 20			
			50 10	17 20	20 19	− 4 19.5	Ind. corr. + 2′ 25″.
June 26	Sun U. L.	Merc.	15 18 43	52 0 30	15 4	− 1 33.5	[5 hours subtracted].
			16 19 31	54 24 30	15 45	− 1 33.5	
			24 53	35 50			
			27 20	41 0			
			28 54	44 20	16 51	+ 0 26.8	[Hw—W. = − 1m 33s.2].
	Sun L. L.	Merc.	20 16 53	56 27 10	20 0	+ 25 16.0	[5 hours subtracted].
			18 26	25 30			
			20 41	23 40			
			24 27	20 10			
			26 33	17 40	20 43	+ 25 16.0	Ind. corr. + 3′ 5″.
June 28	Sun L. L.	Merc.	18 48 35	56 51 50	18 39	+ 20 26.0	Cirro-stratus, no distinct
			50 25	52 50			limb.
			51 50	53 30			[3 hours subtracted].
			53 20	53 50			
			54 45	54 40	19 28	+ 20 27.5	
June 29	Sun L. L.	Merc.	3 44 42	38 5 40	2 3	+ 58 4.5	
			46 21	2 30			
			47 31	0 0			
			49 33	37 56 10			
			50 36	54 30			
			51 47	52 30	4 15	+ 58 5.3	Ind. corr. + 3′ 0″.
June 30	Sun L. L.	Merc.	21 25 48	55 44 40			[4 hours subtracted].
			27 1	43 35			
			27 45	42 50			
			28 43.5	41 40			
			29 56	40 35	21 37	− 19 53.0	Ind. corr. + 3′ 15″.
July 1	Sun L. L.	Merc.	1 15 29	47 49 20			[4 hours subtracted].
			16 12	47 30			
			16 45.6	46 0			
			17 24.8	43 45			
			17 59	42 30			
			18 40	40 25	1 34	− 19 57.8	Ind. corr. + 3′ 5″.
July 2	Sun U. L.	Merc.	Midnight	36 0 0			Observer Nordahl.
	Sun U. L.	Merc.	15 23 0	50 46 40	15 5	+ 0 48.5	
			24 25	50 50			
			29 34.5	51 3 30	15 40	+ 0 48.5	
July 4	Sun L. L.	Merc.	3 57 11	39 51 40	3 47	− 13 35.0	[5 hours subtracted].
	Sun U. L.	Merc.	7 44 20	35 45 20	4 13	− 13 35.0	Ind. corr. + 3′ 15″.
			54 30	44 10	8 18	− 13 32.5	
July (5)	Sun L. L.	Merc.	Noon	55 41 50			
July 5	Sun L. L.	Merc.	1 51 41	45 24 50	23 54	− 20 6.8	Comp. July 4.
			56 10	12 40			[4 hours subtracted].
			57 2	10 10	2 4	− 20 8.5	

1895	Star	Hor.	Watch	Sextant	Watch	Hw−W.	Remarks
			h m s	° ' "	h m	m s	
July 6	Sun U. L.	Merc.	18 31 24	55 18 0	18 22	− 20 40.3	[4 hours subtracted].
			33 5	19 10			
			34 18	21 0			
			35 7	21 40			
			37 49	24 40	18 59	− 20 40.5	Ind. corr. + 3' 15".
	Sun L. L.	Merc.	19 48	55 6 50			
July (7)			Noon	8 40			Ind. corr. + 3' 15".
July 7	Sun L. L.	Merc.	1 31 19	46 4 40	1 18	− 20 45.0	[4 hours subtracted].
			32 40	1 10			
			34 16	45 57 20			
			37 22	48 50			
			38 5	46 30			} Best.
			39 46	42 10	2 1	− 20 45.5	
July 8	Sun U. L.	Merc.	15 40 48.5	49 40 10	15 28	− 17 33.0	[3 hours added].
			42 34	44 50			
			44 18.5	49 10			
			47 45.5	57 50			
			48 59	50 0 30			} Best.
			50 10.5	3 30	17 8	− 17 33.0	
July (9)	Sun L. L.	Merc.	Noon	54 46 40			Ind. corr. + 3' 15".
July 11	Sun L. L.	Merc.	3 1 17	40 45 10			Cirro-stratus.
			4 35	36 20			[2 hours subtracted].
			7 31	28 50	3 14	− 20 20.5	Ind. corr. + 3' 20".
	Sun U. L.	Merc.	Midnight	34 6 50			Ind. corr. + 3' 50".
	Sun L. L.	Merc.	20 15 46	54 8 0	20 8	− 21 23.0	[2 hours subtracted].
			17 33	7 30			
			18 38	7 5			Ind. corr. + 3' 40".
July 12	Sun L. L.	Merc.	1 45 53	43 59 40			[2 hours subtracted].
			47 3	56 20			Minute-hand not corres-
			47 51	54 10			ponding with second-
			48 26	52 30			hand. Corrected.
			49 5	50 30	2 14	− 21 23.0	Ind. corr. + 3' 30".
	Sun L. L.	Merc.	3 6 40.5	40 17 40			[2 hours subtracted].
			8 4.5	13 50			
			9 26.5	10 0	3 22	− 21 23.0	
July (13)	Sun L. L.	Merc.	Noon	53 52 15			Ind. corr. + 3' 52".
July 13	Sun L. L.	Merc.	2 50 37	40 43 10			Small mirror corrected.
			52 2	39 30			
			53 9.5	36 30			[2 hours subtracted].
			54 22.5	33 0			
			55 28	30 20	3 7	− 21 22.0	Ind. corr. + 3' 45".
July 16	Sun U. L.	Merc.	10 18 22	34 32 20	7 3	− 12 29.5	[3 hours subtr.]. Best.
			27 0	45 50	10 40	− 12 29.5	Ind. corr. + 3' 40".
	Sun U. L.	Merc.	16 21 15	49 12 50			[3 hours subtracted].
			22 23	15 30			Dew on hor.
			24 57	21 0			Ice in motion.
			27 42	27 15			
			28 48	29 30			
			30 53	34 20			
			31 47	36 10			
			32 52	39 0	17 46	− 12 30.5	Ind. corr. + 3' 45".
July (17)	Sun L. L.	Merc.	Noon	52 34 20			
July 18	Sun U. L.	Merc.	16 56 8	49 10 20	15 36	− 25 32.3	[1 hour subtracted].
			57 32	13 20			Dew on horizon.
			17 0 1.5	18 30			
			1 1.5	20 40			
			2 8.5	23 10	17 24	− 25 32.5	Ind. corr. + 3' 45".
	Sun L. L.	Merc.	20 5 0	51 55 30			
July (19)			Noon	56 0			
July 19	Sun L. L.	Merc.	1 39 13	42 41 15	1 30	− 25 34.0	[1 hour subtracted].
			40 27	37 50			
			41 25.5	35 10	2 8	− 25 34.0	Ind. corr. + 3' 45".

1895	Star	Hor.	Watch	Sextant	Watch	Hw−W.	Remarks
			h m s	° ′ ″	h m	m s	
July 21	Sun U. L.	Merc.	14 40 50	45 23 10	14 27	+ 46 48.5	
			42 2	26 30			
			43 42.5	30 30			
			45 11	34 30			
			46 20.5	37 50	16 16	+ 46 48.5	
July (22)	Sun L. L.	Merc.	Noon	50 56 10			
July 23	Sun U. L.	Merc.	14 58 13	44 21 40	14 46	+ 25 59.5	[4 hours added].
			59 19	24 50			
			15 5 1.5	44 40 0			
			6 32	44 10			
			7 39	47 0			Ind. corr. + 3′ 30″.
July (24)	Sun L. L.	Merc.	Noon	50 16 30			
July 24	Sun L. L.	Merc.	1 20 19	39 35 0			[4 hours added].
			21 17	32 20			
			22 26.5	29 0	1 34	+ 25 57.2	
July 26	Sun U. L.	Merc.	15 13 25.5	44 44 20	15 5	+ 42 51.8	Tolerable.
	Sun L. L.	Merc.	18 57 15	49 2 40	16 38	+ 42 51.5	[2 hours added].
			19 11 50	3 20	24 34	+ 42 50.5	Tolerable.
July 28	Sun Cent.	Merc.	20 7 0	48 31	19 56	+ 2 8.5	[4 hours subtr.].
			9 0	31 50			
			10 30	30 10			
			12 15	29 50			No distinct limb.
July 29	Sun U. L.	Merc.	16 34 38	44 57 50	16 13	+ 2 4.0	[4 hours subtracted].
	Sun L. L.	Merc.	19 50 40	47 31 30			Uncertain. Sun visible in glimpses.
			54 0	30 20			
			20 23 30	47 21 0			Tolerable.
			29 10	18 10			
			33 40	15 10			
			37 30	12 20			
July 30	Sun U. L.	Merc.	15 33 28.5	42 23 0	15 21	+ 2 0.3	[4 hours subtracted].
			39 15	37 30			
			41 5.5	42 40			
			44 16.5	50 10			
			46 26	55 30			
			49 51.5	43 4 10			
			50 57	7 15	17 19	+ 1 59.8	Ind. corr. + 3′ 40″.
	Sun L. L.	Merc.	19 28 30	47 12 20			[4 hours subtracted].
			40 0	13 0			
			51 30	11 40			
			54 30	11 20			
			57 30	10 20			
July 31	Sun L. L.	Merc.	1 37 50.5	35 56 30			[4 hours subtracted].
			38 41.5	54 25			
			39 19	52 40			
			39 54	50 40			
			40 25.5	49 10	2 9	+ 1 58.5	Ind. corr. + 3′ 25″.
Aug. (2)	Sun L. L.	Merc.	Noon	46 7 10			
Aug. 1			19 39	6 50			[4 hours subtracted].
			45 30	5 40			Ind. corr. + 3′ 50″.
Aug. 2	Sun L. L.	Merc.	1 27 25	35 6 50			[4 hours subtracted].
			27 55	4 30			
			28 49	1 50			
			29 37	34 59 40			
			30 13	58 0	2 10	+ 1 58.5	Ind. corr. + 4′ 0″.
Aug. (3)	Sun L. L.	Merc.	Noon	45 28 35			Ind. corr. + 3′ 55″.
Aug. 3	Sun L. L.	Merc.	1 27 59	34 31 10	1 13	+ 1 56.8	[4 hours subtracted].
			28 53	28 25			
			29 51	25 45			
			30 55	22 50			
			31 54.5	20 10	2 5	+ 1 56.5	
Aug. 5	Sun L. L.	Merc.	22 47 25.5	40 25 35	22 37	− 12 45.5	[4 hours subtracted].
			48 55.5	22 30			

1895	Star	Hor.	Watch	Sextant	Watch	Hw−W.	Remarks
			h m s	° ′ ″	h m	m s	
Aug. 5	Sun L. L.		22 54 44	40 10 40			
Aug. 6	Sun L. L.	Merc.	3 30 32	28 7.5	3 37	− 12 45.7	[4 hours subtracted].
	Sun U. L.	Merc.	16 7 26.5	39 41 0	14 5	− 12 46.5	—»—
			8 37	43 30			
			12 17	52 0			
			13 19.5	54 20			
			14 29	56 50			Ind. corr. + 3′ 50″.
	Sun L. L.	Merc.	23 9 53.5	39 7 40	22 33	− 12 46.5	[4 hours subtracted].
			11 7	5 0			
			12 5	3 0			
Aug. 7	Sun L. L.	Merc.	19 28 0	42 38 0	1 21	− 12 46.5	—»—
			36 0	39 5			
Aug. (8)			Noon	39 35			
Aug. 8	Sun L. L.	Merc.	1 42 31	31 56 20	1 17	− 12 46.5	—»—
			45 39	47 30			
			46 35	45 0			Tolerably good.
			50 2	35 0			
			50 31.5	34 0	3 20	− 12 46.7	
Aug. 9	Sun U. L.	Merc.	16 6 1.5	37 56 10	15 51	− 12 50.5	[4 hours subtracted].
			7 8	58 30			
			8 6	38 1 0			
			9 7	3 10			
			10 3.5	5 30	17 20	− 12 51.0	Ind. corr. + 3′ 40″.
Aug. (10)	Sun L. L.	Merc.	Noon	41 38 30			
Aug. 9			19 58 10	37 45			Ind. corr. + 3′ 55″.
Aug. 10	Sun L. L.	Merc.	1 37 54	31 2 30			
			38 59	30 59 40			
			39 46	57 30	2 33	− 12 52.0	[4 hours subtracted].
Aug. 12	Sun L. L.	Merc.	19 58 40	39 56 40			—»—
			20 3 20	56 10			
			4 45	55 50			
			6 45	55 30	21 3	− 12 54.5	Ind. corr. + 3′ 55″.
Aug. 13	Sun L. L.	Merc.	1 30 54	29 40 50	1 19	− 12 54.5	[4 hours subtracted].
	Sun U. L.		42 21	30 12 30			
			44 22	7 0			
			49 35	29 51 40			Good.
			50 41	48 20			
			51 41	45 10	2 1	− 12 54.5	
Aug. 14	Sun U. L.	Merc.	15 28 29	33 19 40	15 12	− 13 1.0	[4 hours subtracted].
			29 27	22 10			
			30 31.5	25 0			
			31 32.5	27 30			
			32 46.5	30 50	16 57	− 13 1.5	Ind. corr. + 4′ 0″.
Aug. (15)	Sun L. L.	Merc.	Noon	38 49 10			Observer Nordahl.
Aug. 16	Sun U. L.	Merc.	15 42 1	34 10 0	14 46	+ 23 44.0	[2 hours subtr.]. Cloudy.
	Sun L. L.	Merc.	18 58 0	37 37 40	25 7	+ 23 43.5	
Aug. (17)			Noon	39 25			Ind. corr. + 3′ 50″.
Aug. 18	Sun U. L.	Merc.	15 52 0	31 40 20	15 28	− 21 20.8	[4 hours subtr.]. Bad, cirro-stratus.
			55 50	50 30			Tolerably good.
			57 12	53 40	17 21	− 21 21.0	
	Sun L. L.	Merc.	19 51 0	36 33 55			[4 hours subtracted].
			56 30	34 30			
			20 10 50	33 0			Changing cirro-stratus.
			13 20	32 10			Ice in motion.
			20 0	30 20			
Aug. 19	Sun L. L.	Merc.	19 54 40	35 57 50			
			20 9 10	55 40			
			12 40	55 10	20 47	− 21 20.5	[4 hours subtracted].
Aug. 21	Sun L. L.	5.9	3 16 18	9 40 30	2 42	− 18 42.0	—»—
			17 44	37 50			
			23 12	30 30			Best.

1895	Star	Hor.	Watch	Sextant	Watch	Hw−W.	Remarks
		met.	h m s	° ′ ″	h m	m s	
Aug. 21	Sun L. L.	5.9	3 24 1	9 29 10			
			25 49	26 0	3 47	− 18 42.0	Bad horizon.
	Sun U. L.	Merc.	16 19 36	31 34 30			[4 hours subtracted].
			22 56	42 10			
			23 52	44 20			
			25 17	47 30			
			27 52.5	53 30			
			29 17	56 40			
			31 0	32 1 0	17 15	− 18 41.0	Ind. corr. + 3′ 57″.
	Sun L. L.	Merc.	19 24 0	34 53 50			
			45 30	56 0			
			51 10	55 15			
			54 15	54 30			
			59 50	53 50	20 20	− 18 41.0	[4 hours subtracted].
Aug. 22	Sun L. L.	Merc.	19 55 0	34 11 50			—»—
Aug. 23	Sun L. L.	Merc.	19 21 0	33 25 10			—»—
			24 15	25 50			
			28 50	26 30			
Aug. (24)			Noon	27 30			
Aug. 24	Sun L. L.	Merc.	19 14 0	32 31 40			—»—
			22 0	34 10			
			30 30	35 40	23 43	− 18 45.5	
Aug. (25)			Noon	36 20			Ind. corr. + 4′ 10″.
Aug. 25	Sun L. L.	Merc.	0 10 4.5	25 33 30			[4 hours subtracted].
			11 0	30 45			
			12 0.5	27 50			
			12 56	25 10			
			13 55	22 40			
			15 6	19 30			
			16 11	16 20			
	Sun U. L.	Merc.	0 17 44	26 15 40			
			20 48	6 50			
			21 49	4 0			
			22 49	1 15	1 23	− 18 46.0	Ind. corr. + 4′ 10″.
Sep. 1	Sun L. L.	Merc.	19 22 0	25 54 20	16 59	− 18 55.0	[4 hours subtracted].
			29 30	55 40			
			37 0	57 0			
Sep. (2)			Noon	57 30			Ind. corr. + 4′ 0″.
Sep. (5)	Sun L. L.	Merc.	Noon	23 36 50			Ind. corr. + 4′ 10″.
Sep. (6)	Sun L. L.	Merc.	Noon	22 52 0			I. C. + 3 45″; Nordahl
Nov. 4	Moon and	—	0 13 49	64 41 0			} Less good [omitted].
	Jupiter dis-		16 31	39 10			
	tances (inner		19 22	38 10	17 4	+ 0 36.5	Comp. Nov. 3.
	limbs)		20 49	37 30			
			22 27	37 0			
			24 7	36 10			
			25 30	35 25			
			26 45	34 40			
1896			28 1	33 50	1 39	+ 0 36.5	Ind. corr. + 3′ 37″.
Feb. 19	Moon and	—	22 3 27	76 47 20	20 31	− 0 48.2	
	Jupiter dis-		7 0	45 25			
	tances (outer		10 28	44 10			
	limbs)		14 5	42 0			
			17 17	40 20			
			20 34	38 45			
			24 38	36 45			
			28 2	34 40			
			31 46	33 35	23 12	− 0 48.0	Ind. corr. + 4′ 27″.
Mar. 10	—	—	—	—			I. C. − 0′ 13″ [after corr.].
Mar. 11	Sun U. L.	5.4	0 5	3 12	20 21	− 1 23.5	Comp. March 10.
Mar. (18)	Sun L. L.	5.4	Noon	5 7 20			I. C. − 15″; obs. Bentsen.
Mar. 28	Sun L. L.	5.4	23 3 0	9 20 10	20 18	+ 0 56.0	Ind. corr. + 0′ 25″.

1896	Star	Hor.	Watch	Sextant	Watch	Hw—W.	Remarks
		met.	h m s	° ′ ″	h m	m s	
Mar. 28	Sun L. L.		23 11 30	9 19 40			
			17 0	19 40			
			24 0	19 10	20 22	+ 0 46.5	Comp. March 29.
Mar. (31)	Sun L. L.	5.4	Noon	10 1 30			Ind. corr. − 0′ 2″.
Apr. (22)	Sun L. L.	5.4	Noon	18 10 0			Ind. corr. + 1′ 0″.
Apr. 22	Moon and Sun, distances (inner limbs)	—	4 8 50	111 36 0	3 33	+ 0 34.5	Ind. corr. + 0′ 58″.
			10 34	37 10			
			11 37	38 0			
			13 7	38 50			
			14 53	39 30			
			16 32	40 30			
			18 1	41 20			
			29 7	47 20			Observer Sverdrup for the last 3 obs.
			31 40	48 30			
			33 36	49 50	5 11	+ 0 34.5	Ind. corr. + 1′ 5″.
Apr. 27	Sun U. L.	Merc.	23 35 ca.	40 48 0	21 2	+ 0 40.8	
May 9	Sun U. L.	Merc.	0 28 11	47 44 30	21 2	+ 1 3.8	Comp. May 8.
			30 0	43 20			
			31 46	42 30			
			32 54	41 40			
			34 56	40 10	21 7	+ 1 3.5	Ind. corr. + 1′ 5″.
May 10	Sun L. L.	5.4	Noon	23 45 40			Ind. corr. + 0′ 35″.
May 29	Sun L. L.	Merc.	6 47 49	39 28 50	6 35	+ 1 10.5	
			49 9	25 0			
			49 48	23 10			
			50 36	20 30			
			51 31	17 30	6 56	+ 1 10.3	Ind. corr. + 1′ 0″.
June 4	Sun L. L.	Merc.	Noon	58 6 10			Ind. corr. + 0′ 57″.
	Sun L. L.	Merc.	5 25 2	45 20 0	20 58	− 0 12.5	Comp. June 3.
			26 2	16 30			
			26 48	13 50			
			27 32	10 50			
			29 52	2 30			
			30 29	0 35			
			31 6	44 58 40			
			31 39	56 30			
			32 28	53 50	6 53	− 0 13.0	Ind. corr. + 1′ 2″.
June 7	Sun L. L.	Merc.	Noon	58 53 20			Ind. corr. + 1′ 10″.
June 8	Sun L. L.	Merc.	Noon	59 10 40			I. C. + 1′ 0″; Nordahl.
June 9	Sun L. L.	Merc.	Noon	59 28 40			I. C. + 1′ 0″; Nordahl.
	Sun L. L.	Merc.	5 10 32	47 21 40	4 56	− 0 24.0	Observer Nordahl.
			13 3	12 30			
			14 27	7 40			
			15 32	4 0			
			16 26	0 0	6 9	− 0 24.5	Ind. corr. + 0′ 55″.
June 12	Sun L. L.	Merc.	23 15 50	59 55 10	20 59	− 0 41.5	Good.
			18 20	56 40			
			20 30	57 40			
June 13			Noon	60 4 5	21 1	− 0 50.5	Ind. corr. + 1′ 5″.
June 16	Sun L. L.	Merc.	1 33 50	58 49 0	21 7	− 1 8.0	Comp. June 15.
			35 59	45 30			The first 3 obs. not good, the last 3 tolerable.
			39 0	40 0			
			42 19	34 10			
			43 43	31 50			
			44 34.5	30 10			Ind. corr. + 1′ 5″.
	Sun L. L.	Merc.	4 48 27	49 42 15	4 35	− 1 8.2	} Good.
			49 26	37 40	5 27	− 1 8.0	
	Sun L. L.	Merc.	7 30 41	40 6 0			} Best.
			31 40	2 20			
			32 27.5	0 10			
			33 22.5	39 57 30			
			34 18	54 30	8 25	− 1 7.7	

1896	Star	Hor.	Watch	Sextant	Watch	Hw−W.	Remarks
			h m s	° ′ ″	h m	m s	
June 16	Sun L. L.	Merc.	23 28 30	60 21 0	21 5	− 1 11.7	
			50 0	26 10			
June 17			Noon	26 10			Ind. corr. + 1′ 10″.
	Sun L. L.	Merc.	6 15 12	44 33 40	6 6	− 1 11.5	
			16 15	29 50			
			17 9	26 15	21 8	− 1 15.0	Ind. corr. + 1′ 5″.
June 18	Sun L. L.	Merc.	1 38 25	58 56 40			
			39 7	55 30			
			39 44.5	54 10			
	Sun L. L.	Merc.	6 11 14	44 51 10			
			12 20.5	47 10			
			12 54.5	45 0			
			13 31	42 50			
			14 51	37 50			The last 3 observations
			15 36	35 0			best.
			16 8	33 0	8 27	− 1 16.5	Ind. corr. + 1′ 0″.
	Sun L. L.	Merc.	23 17 10	60 23 25	21 3	− 1 19.5	
			19 0	24 25			
			22 5	26 0			
June 19			Noon	33 45			
	Sun L. L.	Merc.	6 11 41.5	44 50 0			
			12 51	45 50			
			17 44.5	28 10			
			18 47.5	24 10			
			19 44	21 0	6 30	− 1 20.5	
June 23	Sun U. L.	Merc.	19 51 38	54 14 30	19 14	− 1 21.5	
			52 53	18 40			
			54 47	24 30			
			56 3	28 50			
			57 3	32 10	21 7	− 1 21.5	
June 24	Sun L. L.	Merc.	1 26 0	59 12 0			} Tolerable.
			27 20	10 30	21 11	− 1 26.5	
June 25	Sun L. L.	Merc.	Noon	60 26 30			Ind. corr. + 1′ 10″.
	Sun L. L.	Merc.	7 0 21	41 40 0			
			1 17.5	36 50			
			2 13	32 50	7 9	− 1 28.0	
June 27	Sun L. L.	Merc.	Noon	60 18 10			Ind. corr. + 1′ 10″.
	Sun L. L.	Merc.	5 22 18	47 26 20	21 4	− 1 55.7	Comp. June 26.
			23 30	21 30			
			24 37	17 40			
			25 26	14 40			
			26 14.5	11 50	6 6	− 1 56.7	
June 29	Sun L. L.	Merc.	Noon	60 5 30			Ind. corr. + 0′ 55″.
	Sun [L. L.]	Merc.	4 56 41	48 45 0	4 43	+ 0 12.5	
			58 44	37 30			
			59 43	33 45			
			5 0 13	31 55			
			0 44	29 55	6 27	+ 0 13.3	
July 1	Sun L. L.	Merc.	Noon	59 43 50			Ind. corr. + 1′ 10″.
	Sun L. L.	Merc.	4 41 8.5	49 35 0	21 9	+ 0 15.0	Comp. June 30; watch
			42 40	33 0			run down yesterday.
			43 14	30 40			The same thing occur-
			43 46	29 0			red several times dur-
			44 25	27 0	4 53	+ 0 22.5	ing the days following.
July 4	Sun L. L.	Merc.	0 57 55	58 33 50			
			59 12	31 50			
			1 2 0	28 50			
			3 14	27 0			
			4 25	25 45	1 13	+ 0 11.5	
	Sun L. L.	Merc.	7 0 41	40 34 10	4 41	+ 0 15.5	
			10 34.5	0 30	7 16	+ 0 17.0	
	Sun L. L.	Merc.	23 22 20	58 54 20	21 13	− 0 15.0	

1896	Star	Hor.	Watch	Sextant	Watch	Hw−W.	Remarks
			h m s	° ′ ″	h m	m s	
July 5	Sun L. L.	Merc.	Noon	59 10 10			Ind. corr. + 1 10″.
	Sun L. L.	Merc.	23 31 45	58 46 0	23 51	+ 0 7.5	
July 6	Sun L. L.	Merc.	5 21 22	46 5 0	5 8	+ 0 9.3	
			22 19	1 30			
			23 21	45 57 50			
			25 12	51 0			
			26 4	47 50			
			27 2	44 15	6 24	+ 0 11.3	
July 7	Sun L. L.	Merc.	23 28 25	58 11 10	23 22	− 0 23.5	
July 8			Noon	15 30			Ind. corr. + 1′ 0″.
	Sun U. L.	Merc.	19 9 5	52 44 20	19 0	+57 21.5	
			10 44	48 50			
			12 8	53 30			
			14 43.5	53 1 20			
			15 43	4 10			
			16 38	7 10	19 23	+57 21.8	
July 9	Sun L. L.	Merc.	Noon	57 55 30			Cloudy; tolerable.
July 11	Sun U. L.	Merc.	18 10 5.5	45 18 40	18 2	− 1 20.0	
			10 52	21 40			
			11 42	24 50			
			12 24	27 30			
			13 1.5	29 30	18 22	− 1 18.8	Ind. corr. + 1′ 10″.
July 12	Sun L. L.	Merc.	11 54 20	29 31 50	12 5	− 1 31.5	
	Sun L. L.	Merc.	23 25 40	56 32 0	21 19	− 1 25.8	
July 13			Noon	35 50			
	Sun [L. L.]	Merc.	5 23 59	43 57 30	5 1	− 1 21.0	
			29 20	38 50			
			30 27	34 30			
			31 4	32 20	5 39	− 1 18.5	
July 14	Sun L. L.	Merc.	23 49 20	55 51 10	21 19	− 0 49.7	
			51 50	50 45			Ind. corr. + 1′ 25″.
			54 30	50 20	21 11	− 0 30.0	Comp. July 15.
July 16	Sun U. L.	Merc.	19 13 35	47 49 30			} Tolerable.
			15 33	55 50			
			16 28.5	59 20	19 26	+ 1 32.0	} Good.
			17 13.5	48 1 30	20 7	+ 1 31.5	
	Sun L. L.	Merc.	23 20 10	55 10 40	21 12	+ 1 30.0	
			25 0	12 10			
July 17			Noon	14 25	21 27	+ 1 42.0	Ind. corr. + 1′ 30″.
July 18	Sun U. L.	Merc.	19 56 17.5	49 27 20			Watch had stopped
			57 36	31 0			shortly before the
			58 54.5	35 20			observation.
			20 1 26	42 40			
			2 38	46 15			
			3 44	49 20	20 10	+ 3 24.0	
	Sun L. L.	Merc.	23 18 20	54 27 10			
			20 22	27 50			
			21 18	28 20			
July 19			Noon	31 0			Ind. corr. + 1′ 8″.
	Sun L. L.	Merc.	8 19 16	31 56 0	7 58	+ 3 25.0	} Tolerable, cirro-stratus
			20 33	52 30			and drizzle.
			21 5	48 30	8 28	+ 3 26.0	
	Sun L. L.	5.3	20 34 57	25 7 0	20 30	+ 3 39.0	
			39 15	14 0			
			42 15	19 0	20 56	+ 3 39.5	Foggy.
	Sun L. L.	Merc.	23 33 45	54 51 25			
			34 45	51 30			
			37 15	51 40			
July 20			Noon	52 0	0 25	+ 3 44.0	Ind. corr. + 1′ 30″.
	Sun U. L.	Merc.	11 47 50	26 51 30			} Not good.
			50 0	51 20			

1896	Star	Hor.	Watch	Sextant	Watch	Hw—W.	Remarks
		met.	h m s	° ′ ″	h m	m s	
July 20	Sun U. L.		11 51 2	26 52 0			} Not good.
			52 20	51 0			
	Sun U. L.	Merc.	12 41 25	27 17 40	12 35	+ 6 55.5	
			43 58	20 10			
			45 10	21 40			
			46 35	22 40			
			47 50	24 30	12 54	+ 6 56.0	Ind. corr. + 1′ 20″.
	Sun U. L.	Merc.	20 0 39	49 23 45	19 50	+ 7 3.5	
			2 1	27 40			Good.
			3 10	31 25	20 10	+ 7 4.0	Ind. corr. + 0′ 55″.
July 21	Sun L. L.	Merc.	Noon	54 50 40			Ind. corr. + 1′ 30″.
	Sun L. L.	5.3	Midnight	12 38 50			
July 23	Sun L. L.	5.3	16 15 32	16 14	15 49	— 0 6.5	
			20 13.5	22.9	16 26	— 0 4.5	
	Sun U. L.	Merc.	18 23 5	41 55 10	18 1	+ 0 2.5	
			23 55	58 40			
			24 42	42 2 0	18 36	+ 0 4.5	Ind. corr. + 1′ 35″.
	Sun L. L.	Merc.	22 27 50	54 47 30	21 55	+ 59 54.5	
July 24	Sun L. L.	Merc.	Noon	54 53 40			Ind. corr. + 1′ 40″.
	Sun L. L.	Merc.	4 37 51.5	39 26 0	4 17	+ 60 4.5	
			39 3	21 0			
			40 10	16 0	5 6	+ 60 6.3	
July 25	Sun L. L.	?	7 44 4	15 21 20	7 31	— 1 45.5	[Height of eye ass. 5.3].
			44 55	19 50			
			45 26	19 0			
			46 15	17 30			
			46 57	16 20	8 7	— 1 43.7	
	Sun L. L.	5.3	Midnight	11 7 30			
July 26	Sun L. L.	Merc.	Noon	54 27 0			Ind. corr. + 1′ 30″.
	Sun U. L.	Merc.	17 46 12	38 7 0	17 35	— 0 1.5	A different watch.
			47 5	10 50			
			47 50	14 10	17 54	— 0 1.5	Ind. corr. + 1′ 23″.
July 27	Sun L. L.	Merc.	Noon	54 7 50			I. C. + 1′ 15″; obs. Bentsen.
	Sun L. L.	[5.3]	6 10 8	17 56 10			
			10 58	54 20			
			11 40	53 0	6 15	— 0 0.5	
	Sun L. L.	[5.3]	Midnight	10 20 40			Ind. corr. + 1′ 30″.
	Sun L. L.	[4.5]	18 14 27	19 19 10	18 2	0 0.0	
			15 56	22 30			
			17 4	25 0			
			18 0	26 50			
			19 0	29 10			
			20 7	32 0			Observer Bentsen.
July 28	Sun [L. L.]	[4.5]	0 47 43	26 46 30			
			48 33	46 0			
			49 31	45 10	1 47	— 0 1.5	
	Sun L. L.	4.5	Midnight	10 5 10			Observer Bentsen.
July 30	Sun L. L.	Merc.	Noon	53 3 ca.			
	Sun [L. L.]	Merc.	0 36 45	52 46 30			
			38 20	44 30			
			39 30	43 30			
			40 45	32 20			[ass. + 42′].
			43 20	38 30	2 5	— 0 1.0	
July 31	Sun L. L.	[5.3]	Noon	26 28 ca.			Bad.
	Sun L. L.	5.3	20 19 35	22 47 30			
			20 16	48 40			
			20 58	50 10			
			21 35	52 0			
Aug. 1	Sun L. L.	[5.3]	0 45 30	25 53			} Bad.
			49 30	50	1 33	+ 0 1.5	
	Sun U. L.	Merc.	20 41 48	47 27 30			
			42 30	29 20			

1896	Star	Hor.	Watch	Sextant	Watch	Hw—W.	Remarks
		met.	h m s	° ′ ″	h m	m s	
Aug. 1	Sun U. L.	Merc.	20 43 11	47 32 30			
			46 59	44 10			
			47 36	47 10			
			48 11	48 0			
			48 58	51 0			
			49 45	54 30	—	+ 0 2.5	Foggy limbs.
Aug. 2	Sun L. L.	Merc.	Noon	51 51 ca.			Ind. corr. + 1′ 15″.
Aug. 3	Sun L. L.	[5.3]	18 23 4	17 55 30	2 3	+ 0 3.5	
			24 24	58 0			
			25 15	18 1 0	2 1	+ 0 12.8	Comp. Aug. 5.
Aug. 7	Sun L. L.	[5.3]	23 18 0	24 35 0	2 50	+ 0 15.5	
			24 30	37 10			
Aug. 8			Noon	41 0			Ind. corr. + 1′ 45″.
Aug. 9	Sun L. L.	5.3	Noon	24 23 30	2 9	+ 0 14.5	
Aug. 17	Sun L. L.	5.3	Noon	27 24 ca.			Ind. corr. + 1′ 30″ [1]).
Aug. 18	Sun L. L.	[5.3]	4 29 47	16 4 50	3 16	+ 0 8.5	
	Sun L. L.	[5.3]	20 40 27	26 25 40	20 16	+ 0 10.0	
			41 22	28 10			
			41 55	30 30			Ind. corr. — 0′ 5″.
Aug. 19	Sun L. L.	5.3	Noon	31 16 50			Ind. corr. 0′ 0″.

[1]) The instrument dropped on deck; the tangent screw somewhat bent, but no damage of importance. Index error corrected.

OBSERVATIONS

AND

RESULTS.

1896	Star	Hor.	Watch	Sextant	Watch	Hw−W.	Remarks
		met.	h m s	° ′ ″	h m	m s	
Aug. 1	Sun U. L.	Merc.	20 43 11	47 32 30			
			46 59	44 10			
			47 36	47 10			
			48 11	48 0			
			48 58	51 0			
			49 45	54 30	—	+ 0 2.5	Foggy limbs.
Aug. 2	Sun L. L.	Merc.	Noon	51 51 ca.			Ind. corr. + 1′ 15″.
Aug. 3	Sun L. L.	[5.3]	18 23 4	17 55 30	2 3	+ 0 3.5	
			24 24	58 0			
			25 15	18 1 0	2 1	+ 0 12.8	Comp. Aug. 5.
Aug. 7	Sun L. L.	[5.3]	23 18 0	24 35 0	2 50	+ 0 15.5	
			24 30	37 10			
Aug. 8			Noon	41 0			Ind. corr. + 1′ 45″.
Aug. 9	Sun L. L.	5.3	Noon	24 23 30	2 9	+ 0 14.5	
Aug. 17	Sun L. L.	5.3	Noon	27 24 ca.			Ind. corr. + 1′ 30″ 1).
Aug. 18	Sun L. L.	[5.3]	4 29 47	16 4 50	3 16	+ 0 8.5	
	Sun L. L.	[5.3]	20 40 27	26 25 40	20 16	+ 0 10.0	
			41 22	28 10			
			41 55	30 30			Ind. corr. − 0′ 5″.
Aug. 19	Sun L. L.	5.3	Noon	31 16 50			Ind. corr. 0′ 0″.

1) The instrument dropped on deck; the tangent screw somewhat bent, but no damage of importance. Index error corrected.

OBSERVATIONS

AND

RESULTS.

C. Determination of Azimuth.

Observer: Lieutenant *Scott-Hansen.*

The hours are counted from the same noon as in the preceding observations. The measurement of azimuth having usually been made in combination with the determination of local time, the comparisons between the watch and chronometer Hohwü are not given in the following list, except in the few cases when they are not to be found in List A or B.

The position of the ocular is given only when noted in the original.

The two columns headed "Horizontal Circle" correspond to the readings of the two microscopes (or verniers) in the same manner as for the vertical circle in List A.

The striding level of the horizontal axis of the great instrument was always read off in its two positions, but here only the *sum* of the numbers is given, the two ends of the bubble being indicated, as in the original, by N, S or E, W. The difference between these numbers will then give the inclination of the axis in seconds of arc.

In the column headed "Object", C indicates the mark in the magnetic observatory. As stated in the introduction, the purpose of these observations was to furnish a line of reference for the determination of magnetic declination. The results, as far as the astronomical part of the work is concerned, are therefore here given at once in the column headed A, which is the azimuth of the celestial object, counted from north through east, and corrected for the inclination of the axis. The direction of the star being given by this number, the sign of the inclination of the axis, as given by the level, is easily found.

In some few cases the small altazimuth bas been used for these observations.

The following list also contains some determinations of azimuth made directly with the magnetic theodolite which was provided, for this purpose, with a mirror, placed before the object glass of the horizontal telescope, and moveable about a horizontal axis; the position of its axis is indicated by M. r. or M. t. (mirror right, or turned) which, in order to save room, is inserted in the column "Level". The mirror could be used with the celestial object in front or behind. When the object was sufficiently low, the telescope could be used without the mirror. As a check on the stability of the instrument, the telescope was also in this case, before and after the observations, pointed to a terrestrial mark, here called m, which gives a sufficient indication of the use of this instrument. While the observations of the magnet could be made without the telescope, this was always used for the celestial object and the terrestrial mark.

Preceding and following limb are indicated by P. L. and F. L.

1893	Object	Oc.	Watch	Horizontal Circle		Level	A	Rem.
			h m s	° ′ ″	′ ″		° ′ ″	
Aug. 8	m			69 57.6	56.6			
	Sun P. L.		1 43 26	295 42.3	41.5		279 0 58	1)
	„ F. L.		45 45					
	Sun P. L.		1 53 0	297 51.8	51.7		281 12 55	1)
	„ F. L.		55 18					
	m			69 52.8	52.3			
Oct. 17	m			266 48.2	46.8			
	Sun P. L.		13 32 47.6	254 56.7	55.4		154 1 8	2)
	„ F. L.		34 52.8					
	m			266 51.5	50.5			
	Sun P. L.		15 52 5	289 24.6	24.2		188 20 16	
	Sun P. L.		15 59 53	291 20.0	20.0		190 15 38	
	„ F. L.		16 2 1					
	m			266 45 0	44.0			3)
Oct. 29	m			99 35.6	33.6			
	Jupiter		19 12 24	168 44.6	40.2		Mean:	
			16 8.8	169 38.5	34.0		35 2 27	
			19 6	170 21.0	17.2			
	Jupiter		20 43 7.0	190 34.5	30.8		Mean:	
			46 50	191 26.6	22.6		56 43 47	
			50 7	192 14.1	10.0			Magn.
	m			99 35.6	33.5			Theod.
	C			340 11 27	11 17			Altaz.
	Jupiter Ct.		23 7 5	285 10 20	10 0	N 33.0 S 36.2	90 40 40	
Nov. 16	C			75 44 45	44 12.5			
	α Ophiuchi	S	21 45 57	26 53 59.5	54 11.5	S 33.2 N 35.0	253 47 51	
Nov. 20	C	N		149 25 57	25 52			
	„	S		149 24 7	24 11			
	ε Cass.	N	20 54 10.2	293 48 45.5	48 40	S 38.5 N 33.7	93 59 11	
	„	S	21 15 3	299 16 41	16 37.5	N 41.0 S 31.3	99 23 34	
	C	S		149 23 34	23 22.5			
Dec. 11	m			263 13.0	8.5			
	Jupiter		15 6 39.5	170 6.0	4.5		Mean:	4)
			8 22.6	170 30.7	28.5		23 14 53	
			10 38.5	171 3.5	1.2			
	„		16 18 56	187 32.5	29.0		Mean:	
			21 31.5	188 8.8	6.5		40 47 37	
			24 14	188 48.5	45.5			4)
	m			263 12.5	8.5			
	C	S		347 44 32	44 31.5			
	ε Cass.	S	20 10 1.0	334 12 25.5	12 25	N 38.6 S 32.5	102 26 0	
	„	N	22 59	337 43 6	43 5	N 34.5 S 36.7	106 0 8	
	C	N		347 46 24	46 27			
1894								
Jan. 22	m			238 11.6	7.6			
	Venus		18 5 34.5	133 55.0	52.5		Mean:	
			8 19.0	134 35.4	33.5		184 31 11	
			10 23.3	135 6.5	4.5			
	Venus		19 7 15	149 18.5	16.5		Mean:	
			9 25	149 50.5	48.5		200 23 46	
			11 28.5	150 21.0	20.0			
	m			238 11.5	7.5			
Feb. 13	C	N		222 51 59.5	52 18.5			
	α Cephei	S	19 59 41	34 24 52.5	24 57.5	S 37.7 N 38.3	269 46 43	
	„	N	20 22 7	39 54 59	55 10	S 37.9 N 37.9	275 13 53	

[1]) The watch in this case was the sidereal chronometer Frodsham, whose correction to Hw, without regard to the hours which are here altered, was + $50^m 48^s.5$ and + $50^m 46^s.9$ resp. for the times of the two circle-readings. The observation was taken on an ice-floe aground off the coast of Yalmal. m was a mark on the shore. Levelling of the instrument (the magnetic theodolite) designated as unsatisfactory. [2]) Magn. Th. on the ice 115 paces from the ship. Hoar-frost. W $12^h 45^m$ Hw—W = + $2^m 48^s.6$, W $19^h 3^m$ Hw—W = + $2^m 48^s.9$. [3]) Foggy, m indistinct. [4]) W $14^h 28^m$ Hw—W = + $0^m 35^s.4$, W $16^h 44^m$ Hw—W = + $0^m 36^s.5$.

1894	Object	Oc.	Watch	Horizontal Circle		Level	A	Rem.
			h m s	° ′ ″	′ ″		° ′ ″	
Feb. 13	C			322 54 11.5	54 13			[Ass. 222°]
Feb. 22	C	S		265 34 26	34 45			
	α Cass.	N	0 25 39	96 24 20.5	25 6.5	Went out on	289 13	
	"	S	0 34 5	98 18 54	19 22.5	turning	291 8	
	C	N		265 31 2	31 8.5			
Mar. 5	m			240 9.5	7.0			
	Sun P. L.		16 32 48	168 59.5	55.5		190 2 9	
	" F. L.		34 53					
	Sun P. L.		17 36 33.5	184 54.0	49.5		206 4 56	
	" F. L.		38 43.0					
	m			240 9.5	7.0			
Mar. 20	m			4 21.8	24.9			
	Sun P. L.		14 46 23	264 32.0	32.0		164 16.5	1)
	" F. L.		48 30					
Mar. 22	C			130 39 9.5	39 35.5			
	α Persei		23 58 40	309 18 7.5	19 18.5	S 43.0 N 31.0	262 8 33	2)
Mar. 23	"		0 13 16	312 56 40.5	57 43	N 41.6 S 32.4	265 49 57	
	C			130 37 55	38 15.5			
Mar. 30	m			3 29.5	32.5			
	Sun P. L.		20 9 7	348 33.3	35.5		247 26 38	
	" F. L.		11 16					
	Sun P. L.		20 14 18	349 50.4	53.5		248 43 55	
	" F. L.		16 26.5					
	Sun P. L.		21 42 35	11 25.0	28.5		270 33 27	
	" F. L.		44 40					
	m			3 29.3	32.4			
Apr. 15	m			112 61.7	59.4			3)
	Sun P. L.		19 56 45	85 52.8	51.2	M. r.	245 7 18	Sun in
	" F. L.		58 57					front.
	Sun P. L.		20 3 40	87 45.4	44.2	M. t.	246 51 31	
	" F. L.		5 53					
	Sun P. L.		21 3 56	282 53.7	55.0	M. r.	261 54 29	Sun back.
	" F. L.		6 25					
	Sun P. L.		21 20 50	288 23.8	24.7	M. t.	266 3 32	Do.
	" F. L.		23 4					
	m			112 62.0	59.8			
Apr. 20	m			113 2.0	0.0			
	Sun P. L.		20 3 8	87 46.5	45.0	M. r.	245 32 58	Sun in
	" F. L.		5 21.5					front.
	Sun P. L.		20 9 48	89 19.0	17.0	M. t.	247 13 27	
	" F. L.		12 1					
	Sun P. L.		21 37 13	292 40.5	42.5	M. r.	268 59 5	Sun back.
	" F. L.		39 30					
	Sun P. L.		21 44 40	293 8.5	9.5	M. t.	270 49 43	Do.
	" F. L.		47 0					
	m			113 3.5	0.5			
Apr. 25	m			114 48.8	46.0			4)
	Sun P. L.		20 19 10	93 32.0	29.3	M. r.	250 41 23	Sun in
	" F. L.		22 2			M. t.		front.
	Sun P. L.		21 10 20	286 19.5	20.0	M. r.	263 21 56	Sun back.
	" F. L.		12 33					
	Sun P. L.		21 16 50	289 17.5	18.5	M. t.	264 58 11	Do.
	" F. L.		19 0					
	Sun P. L.		21 24 18	289 46.5	48.0	M. r.	266 49 27	Do.
	" F. L.		26 30					

1) W $13^h 5^m$ Hw−W = − $0^m 7^s.7$; March 21 W $13^h 4^m$ Hw−W = + $0^m 5^s.5$. 2) Star ass. to be δ Persei. The corrections applied to the altitudes of the same star in List A (p. 7) are erroneous; the altitudes have been computed on the supposition that the star was δ Persei and with a correction of + 10′ to the circle-readings Oc. N. 3) W $13^h 19^m$ Hw−W = + $4^m 19^s.5$. 4) Taken nearly 5 hours before the first obs. of the Sun and 8 hours before the last obs. of m.

1894	Object	Oc.	Watch	Horizontal Circle		Level	A	Rem.
			h m s	° ′ ″	′ ″		° ′ ″	
Apr. 25	Sun P. L.		21 31 0	292 47.5	48.5	M. t.	268 5 11	Sun back.
	„ F. L.		33 12					
	Sun P. L.		21 49 8	295 56.0	57.0	M. r.	272 56 59	Do.
	„ F. L.		51 19					
	m			114 48.5	45.5			
May 4	C	S		51 21 16.5	20 15			
	Sun P. L.	N	22 10 42.3	265 21 16.5	22 7	N 28.6 S 27.9	278 27 42	
	„ F. L.	„	12 55					
May 10	C	S		51 35 24.5	34 35.5			
	Sun P. L.		14 45 25.7	148 13 19	13 42	W 29.7 E 30.7	163 18 53	
	„ F. L.		47 48.5					
	C			51 35 29	34 41.5			
	C	S		51 29 50	30 44.5			
	Sun P. L.		21 55 43.5	257 38 13	39 25.5	N 31.9 S 31.7	272 49 4	1)
	„ F. L.		57 58.5					
	C			51 29 43	30 37.5			
May 25	C	S		51 25 30	24 34.5			
	Sun P. L.	W	14 27 39	144 50 31.5	51 15.5	E 43.5 W 9.5	149 11 25	
	„ F. L.	„	29 54.5					
	C			51 25 37.5	24 47.5			
	C	S		231 27 21.5	26 48.5			
	Sun P. L.	N	21 29 18	87 37 19	36 15.5	N 47.0 S 4.3	271 52 0	2)
	„ F. L.	„	31 35.7					
June 3	C			295 53 30	54 4			
	Sun P. L.	S	13 7 33.5	9 8 9	9 4.5	S 42.9 N 12.4	126 22 49	
	„ F. L.	„	9 50.0					
June 4	C			115 38 3.5	37 21			
	Sun P. L.	N	12 28 35	178 48 41.5	48 56	N 38.2 S 14.5	116 7 20	
	„ F. L.	„	30 55					
June 6	C	S		115 43 35	43 17.5			
	Sun P. L.	S	12 17 48	175 49 34	49 12.5	S 24.7 N 22.9	113 27 49	
	„ F. L.	„	20 4					
	C	S		115 42 57.5	42 35			3)
	Sun P. L.	N	22 25 4.7	334 41 25.5	40 21	N 27.3 S 21.5	272 24 14	
	„ F. L.	„	27 21					
June 12	C			114 41 19.5	40 47.5			
	Sun P. L.		13 23 49.5	194 12 45	12 40.5	S 20.4 N 31.0	130 32 1	
	„ F. L.		26 8.0					
	C			294 39 46	40 45.5			3)
	Sun P. L.		21 41 6	145 15 37.5	15 21	S 45.0 N 4.0	261 24 8	4)
	„ F. L.		43 22.7					
June 22	C			196 13 26.5	13 24			
	Sun P. L.		13 4 7	54 57 23	56 43.5	S 13.7 N 37.4	124 24 47	
	„ F. L.		6 25.7					
	Sun P. L.		13 13 39.3	57 26 14.5	25 31	S 29.0 N 19.0	126 52 49	
	„ F. L.		15 55.0					
	C			196 14 11.5	14 12.5			
July 5	K	S		124 11 19	11 16.5			5)
	Sun P. L.		22 32 15.2	102 30 3.5	30 14	N 45 S 7	276 15 56	6)
	„ F. L.		34 29.4					
July 6	K	N		124 31 44	31 42			
	Sun P. L.		0 3 46.8	125 2 29.5	2 30	N 24.2 S 28.4	298 33 41	
	„ F. L.		5 58.4					
	K			124 32 1.5	31 59			
	C			98 36 40	36 21			

1) Hw—W = + 0m 38s.5 (a different watch). 2) W 20h 55m Hw—W = 50m 24s.5; W 22h 3m Hw—W = 50m 25s.0. Watch stopped shortly before. 3) Taken in combination with the following obs. of the Sun. 4) The pillar for the Altazimuth loosened in the ice, but instrument steady during the observations. 5) K was a mark on the "Storkoss" (a big hummock which followed the ship during most of the drift) used here as a check on the instrument. 6) Bad sun, just visible; dew on one of the microscopes.

1894	Object	Oc.	Watch	Horizontal Circle		Level	A	Rem.
			h m s	° ′ ″	′ ″		° ′ ″	
July 10	C	N		118 8 0.5	8 41			
	Sun P. L.	S	12 25 22.6	324 56 20	57 11.5	N 43.0 S 5.0	117 21 47	
	„ F. L.	„	27 37.6					
	C			118 9 3.5	9 44.5			
July 14	C	N		146 18 52.5	19 35.5			
	Sun P. L.		1 21 16.6	190 9 26.5	8 37.5	S 37.3 N 11.8	317 29 8	
	„ F. L.		23 32.4					
	C	N		146 20 21	20 59			
July 27	C	E		140 49 47	48 51.5			
	Sun P. L.	N	20 59 38.5	49 41 15.5	41 57	N 17.2 S 35.7	254 21 23	
	„ F. L.	„	21 1 53.3					
	C			140 47 28.5	46 39			
	C			140 45 15.5	44 28.5			
	Sun P. L.		21 24 37	55 52 50	53 22.5	N 21.5 S 31.5	260 36 12	
	„ F. L.		26 50					
	C			140 44 22.5	43 40			
July 28	m			150 17.0	12.5			
	Sun P. L.		0 31 18.4	111 14.0	11.0	Direct setting	306 17 44	
	„ F. L.		33 34.2					
	Sun P. L.		0 36 26.6	112 28.0	25.0	„	307 31 55	
	„ F. L.		38 41.2					
	Sun P. L.		0 44 23.6	114 22.5	19.5	„	309 27 0	
	„ F. L.		46 38.2					
	m			150 17.0	12.5			
Aug. 2	C	W		1 35.3	35.3	The small altazimuth used in August		
	Sun P. L.	S	21 14 7	274 25.0	23.0		259 27 50	
	„ F. L.	„	16 22.0					
	Sun P. L.	„	17 51	275 21.0	19.0		260 23 22	
	„ F. L.	„	20 4					
	Sun P. L.	„	21 22	276 14.5	13.0		261 15 50	
	„ F. L.	„	23 33.6					
	C	W		1 38.5	39.5			
	C	E		181 39.0	38.5			
	Sun P. L.	N	21 31 37	98 52.5	52.5		263 48 56	
	„ F. L.	„	33 49.6					
	Sun P. L.	„	35 11.6	99 46.0	47.0		264 41 46	
	„ F. L.	„	37 23.4					
	Sun P. L.	„	39 26.6	100 50.5	50.5		265 45 30	
	„ F. L.	„	41 39.0					
	C	E		182 42.5	41.5			
Aug. 3	C	E		182 31.8	30.0			
	Sun P. L.	N	0 30 14.4	143 24.0	21.0		307 28 12	
	„ F. L.	„	32 20					
	Sun P. L.	„	34 4	144 21.0	18.0		308 24 9	
	„ F. L.	„	36 9.8					
	Sun P. L.	„	36 56.6	144 62.5	59.5		309 5 5	
	„ F. L.	„	38 58.8					
	C	E		182 34.5	33.5			
	C	W		2 34.5	35.3			
	Sun P. L.	S	0 47 35	327 34.5	37.5		311 39 46	
	„ F. L.	„	49 39.8					
	Sun P. L.	„	50 56.0	328 23.5	26.5		312 28 29	
	„ F. L.	„	53 2.0					
	Sun P. L.	„	54 42.2	329 19.5	22.5		313 23 22	
	„ F. L.	„	56 51.2					
	C	W		2 37.5	38.0			
Aug. 14	C	E		202 26.0	25.0			
	Sun P. L.	N	20 28 58.8	76 8.5	11.7		248 58 49	
	„ F. L.	„	31 12.4					
	Sun P. L.	„	33 29.2	77 16.4	19.7		250 6 39	
	„ F. L.	„	35 41.8					

1894	Object	Oc.	Watch	Horizontal Circle		Level	A	Rem.
			h m s	° ′ ″	′ ″		° ′ ″	
Aug. 14	Sun P. L.	N	20 37 40.2	78 19.7	22.0		251 9 54	
	" F. L.	"	39 54.8					
	C	E		202 23.5	23.0			
	C	W		22 24.3	24.7			
	Sun P. L.	S	20 48 22.6	260 57.0	54.8		253 50 41	1)
	C	W		22 23.5	24.0			
Sep. 3	C	W		263 52 26	51 34			
	Sun P. L.	N	13 2 34.4	21 21 7.5	22 10	N 34.2 S 22	129 2 19	
	" F. L.	"	4 42.6					
	C			263 52 14	51 14			
	C	W		85 26 15.5	24 19.5			
	Sun P. L.	S	21 15 57	328 37 18	39 46	S 29.3 N 22.7	254 40 6	
	" F. L.	"	18 7					
	Sun P. L.		21 27 27.6	331 29 12	31 34	S 30.6 N 20.8	257 31 44	
	" F. L.		29 37.0					
	C			85 26 11.5	24 18			
Sep. 24	C	N		213 11 28.5	13 21.5			
	β Aurigæ	N	5 17 32	204 37 34.5	39 43.5	S 37.4 N 25.5	98 59 3	
	"	S	29 41	207 44 57	47 12.5	N 24.3 S 40.4	102 4 39	
	C	S		213 13 22.5	15 22.5			
Sep. 28	C			111 46 44	47 53			
	Mars Ct.		1 20 50.5	114 56 9.5	58 6	S 42.0 N 26.0	110 37 34	[Ass.+20^m; see List A]
	C			111 46 9	47 59			
Oct. 26	m			63 36.5	36.0	Magn. Theod. direct setting		
	Mars Ct.		21 5 57.6	229 10.5	8.0		Mean: 74 11 36	2)
	"		10 22.0	230 15.5	13.5			
	"		14 0.6	231 10.0	7.5			
	Mars Ct.		22 47 25.4	254 18.5	18.5		Mean: 99 8 20	
	"		53 44.6	255 53.0	53.0			
	m			63 35.0	35.0			
Nov. 10	C			334 61 29	59 58.5			
	α Tauri		1 38 56.0	4 39 22.5	27 52	S 41.6 N 32.6	107 28	3)
	C			334 61 13.5	59 44.5			
Nov. 21	C			337 36 51	35 13.5			
	α Pegasi		16 44 30	345 20 48.5	19 0	S 33.5 N 36.3	70 44 53	
	C			337 36 59.5	35 24			
	C			337 34 48.5	33 21			
	α Tauri		22 55 51	356 61 5	59 32.5	N 36.3 S 36.5	80 39 40	
	C			337 34 51	33 22.5			
Nov. 26	C			337 44 50	43 29.5			
	α Tauri		22 40 56.5	352 29 25	27 49.5	N 35.7 S 38.6	81 25 16	
	C			337 44 47	43 22			
Dec. 5	C			337 53 11	51 57			
	α Tauri		22 40 59	1 44 14	42 45.5	S 43.3 N 29.4	88 32 28	
	C			337 53 0	51 38			
Dec. 14	C			337 52 37.5	51 11			
	α Tauri		23 5 21	18 10 48	9 15.5	S 38.5 N 35.5	102 21 0	
	C			337 52 31.5	51 1.5			
Dec. 18	C			337 57 43.5	56 20.5			
	α Tauri		23 36 14	29 44 31.5	43 17.5	N 31.2 S 45.2	111 28 10	
	C			337 57 38	56 11.5			
1895								
Jan. 8	C	N		3 43	5 3	Observations taken for determination of collimation		
	"	S		4 30	5 59			
	"	N		3 38	4 58.5			
	"	S		4 30.5	5 54			
	"	N		3 33.5	4 53.5			
	"	S		4 28	5 50			
Jan. 16	C			87 43 5	41 58			
	α Orionis		22 8 48	170 34 29.5	33 28.5	N 37.5 S 40.9	93 41 45	

1) Cloudy for F. L. and afterwards. W $22^h\ 33^m$ Hw—W = + $10^m\ 42^s.5$. 2) W $20^h\ 10^m$ Hw—W = + $7^m\ 7^s.3$. 3) Second circle-reading 37′ ass. by the observer.

1895	Object	Oc.	Watch	Horizontal Circle		Level	A	Rem.
			h m s	° ′ ″	′ ″		° ′ ″	
Jan. 16	C			87 43 0	41 51			
Mar. 6	C			125 0 13.5	1 40			
	Arcturus		1 15 3	174 44 0.5	45 29	N 27.7 S 45.3	59 40 37	
	C			125 0 12	1 35.5			
Apr. 5	C			196 21 19	23 5			
	Sun P. L.		17 45 52	93 15 25.5	17 0.5	—	263 27	[Ass. 23h] 1)
	„ F. L.		48 0					
	C			196 21 21.5	23 5			
Apr. 21	C			136 49 46.5	51 27.5			
	Sun P. L.		23 20 30.5	25 31 32	33 5.5	N 28.6 S 37.5	257 6 14	
	„ F. L.		22 36.0					
	C			136 49 45	51 29.5			
May 11	C			143 44 59	43 24.5			2)
	Sun P. L.		0 25 49	49 25 41.5	27 20	N 36.7 S 22.7	269 20 4	
	„ F. L.		28 3.5					
	C			143 43 36.5	45 22			2)
May 24	C			294 7 51.5	6 11			
	Sun P. L.		3 24 2	241 16 49	14 47.5	—	306 14	
	„ F. L.		26 19					
	C			294 8 1	6 17.5			
July 5	m			50 19.5	21.0			
	Sun P. L.		0 23 38	24 55.0	57.5	M. r.	248 14	
	„ F. L.		25 50					
	Sun P. L.		0 28 45	25 56.5	59.0	M. t.	249 31 14	
	„ F. L.		30 56					
	Sun P. L.		1 6 23	35 26.0	29.0	M. t.	259 0 53	
	„ F. L.		8 44					
	Sun P. L.		1 10 9	36 38.5	40.5	M. r.	259 57 3	
	„ F. L.		12 26					
	m			50 20.0	22.0			
July 12	m			39 35.0	37.0			
	Sun P. L.		0 24 7	21 24.0	27.5	M. r.	248 15 47	
	„ F. L.		26 28					
	Sun P. L.		0 29 45	22 50.0	53.0	M. t.	249 41 9	
	„ F. L.		32 6					
	Sun P. L.		1 2 56	31 12.0	14.0	M. t.	258 2 16	
	„ F. L.		5 14.5					
	Sun P. L.		1 6 54	31 56.5	58.5	M. r.	258 46 50	
	„ F. L.		9 12					
	m			39 33.5	35.0			
July 13	m			20 56.5	59.5			
	Sun P. L.		0 27 18	12 54	56	M. r.	248 45 55	
	„ F. L.		29 27					
	Sun P. L.		0 30 35.5	14 3.0	6.0	M. t.	249 36 0	
	„ F. L.		32 46.5					
	Sun P. L.		1 46 27	33 17.5	19.5	M. t.	268 38 5	
	„ F. L.		48 44					
	Sun P. L.		1 50 32	34 6.0	8.5	M. r.	269 38 51	
	„ F. L.		52 47					
Aug. 2	m			112 58.5	55.5			
	Sun P. L.		0 20 40	155 57	61	M. r.?	254 13	3)
	„ F. L.		23 26?					
	Sun P. L.		0 24 32	156 37.5	33.5	M. t.	255 9 28	
	„ F. L.		26 44					
	Sun P. L.		0 28 29	157 49.0	44.5	M. r.	256 9 9	
	„ F. L.		30 42.5					
	m			112 36.5	33.5			
	Sun P. L.		1 1 11	165 62.0	57.5	M. r.	264 19 47	
	„ F. L.		3 22					

1) W $15^h 18^m$ Hw − W = − $0^m 9^s.0$. 2) Observation of C not sharp. 3) Ice in motion.

1895	Object	Oc.	Watch	Horizontal Circle		Level	A	Rem.
			h m s	° ′ ″	′ ″		° ′ ″	
Aug. 2	Sun P. L.		1 4 42	166 44.5	40.0	M. t.	265 12 49	
	„ F. L.		6 56					
	m			112 38.0	35.0			
Sep. 6	m			89 18.5	16.5			
	Sun P. L.		0 17 5	116 15.5	11.5		250 2 34	
	„ F. L.		19 10.5					
	Sun P. L.		0 21 11.5	117 16.5	13.0		251 4 22	1)
	„ F. L.		23 18.5					
	Sun P. L.		1 17 49	131 51.0	47.5		265 11 35	
	„ F. L.		19 48.5					
	Sun P. L.		1 20 42	132 37.5	33.0		265 55 5	2)
	„ F. L.		23 45					
	m			89 28.5	27.0			
Sep. 28	C	E		120 26 24.5	25 3.5			
	Capella		6 3 26	311 44 14.5	42 54	—	85 58.5	
	„		12 29	313 57 29	59 3.5	—	88 13.5	
	C̆			120 26 20.5	27 48			
Oct. 14	C			120 32 44.5	34 14.5			
	Arcturus		2 39 38	138 44 49	46 25.5	S 45.5 N 21.5	280 47 49	
	C			120 32 58.5	34 29			
Oct. 24	C			120 38 2	36 12.5			
	Jupiter Ct.		19 35 6	121 41 48.5	43 17.5	N 31.0 S 41.0	262 4 47	
	„		51 59	125 55 8.5	56 48.5	N 34.6 S 36.5	266 18 34	3)
	C̆			120 57 54.5	56 9.5			
Oct. 25	C			120 38 3	39 52			
	Arcturus		1 2 20.5	121 6 22.5	8 6.5	N 34.5 S 36.0	261 34 2	
	„		10 11	123 4 11.5	5 48	N 33.3 S 37.7	263 32 8	
	C̆			120 37 55	39 44.5			
Oct. 29	α Cygni		19 4 22	114 30		—	72 8	
	„		8 7	115 41		—	73 3	4)
	D			339 32				
Nov. 9	C			258 43 30	45 36			
	α Aquilæ		4 33 21	289 58 45.5	60 58.5	—	236 12.1	
	„		36 41	290 49 18.5	51 24	—	237 2.6	
	C̆			258 43 29.5	45 36			
Nov. 19	C			82 58 42.5	60 42.5			
	α Leonis		20 59 44	154 36 55	38 45	N 33.5 S 43.3	279 18 35	
	C			82 58 40.5	60 29			
Nov. 22	C			81 49 4.5	50 53			
	α Tauri		1 53 2	310 28 37	30 35	N 37.0 S 39.5	75 52 20	
	„		55 43	311 8 28.5	10 28	N 35.9 S 41.4	76 32 17	
	C̆			81 49 5.5	50 43			5)
Nov. 30	C	E		264 18 0	15 50			
	„	W		264 17 56	15 47.5			
	β Gemin.		5 5 56	139 55 10.5	53 49.5	N 34.8 S 40.9	78 14 53	
	„		11 45	141 21 44	20 23.5	N 34.1 S 41.6	79 41 25	
	C̆			264 17 50	15 44			
Dec. 6	C			84 23 35.5	25 15.5			6)
	β Leonis		21 9 55	142 55 17	26 54.5	N 36.5 S 39.6	263 53 12	
	„		13 2	143 42 14	43 37	S 40.1 N 36.4	264 40 2	
1896	C̆			84 23 34	25 10			
Jan. 3	C			78 48 10.5	46 23			
	β Leonis		20 45 20	154 50 34	52 4.5	N 36.0 S 41.0	275 43 23	
	„		48 24	155 36 28.5	38 21		276 30 14	
	C̆			78 46 23.5	48 4.5			
Jan. 9	C			258 48 12	50 27			

1) Ice in motion between the two sets of observations. 2) Watch ass. 22m. 3) Circle ass. 37′ and 36′. 4) D was an azimuth-compass on the ice, from which the bearing of the altazimuth was taken some minutes after. 5) Collimation corrected; the box of the instrument had had a shock some time before. 6) Assumed 56′ for second microscope.

1896	Object	Oc.	Watch	Horizontal Circle		Level	A	Rem.
			h m s	° ′ ″	′ ″		° ′ ″	
Jan. 9	β Leonis		20 38 46	335 31 51	30 33	N 44.0 S 34.8	276 30 34	
	〃		42 25	336 25 34.5	27 5	N 45.2 S 32.6	277 25 5	
	C̈			258 50 12.5	47 53.5			
Jan. 28	C	E		79 27 42.5	26 4.5			
	Capella		23 7 55	350 54 28.5	32 46.5	N 40.3 S 31.4	55 53 18	1)
	〃		13 1	306 39 2	36 57.5	N 40.0 S 30.7	57 6 2	
	C̈	W		79 27 54	29 51.5			
Feb. 4	C			79 24 24.5	26 5			
	α Persei		23 5 5	333 11 2	9 17.5	N 44.6 S 31.9	81 7 57	
	〃		10 56	334 38 15	40 3.5	N 40.1 S 36.6	82 34 24	
	C̈			79 26 12	28 1.5			
Feb. 12	C	W		79 21 30	23 0			
	α Persei		23 34 39	350 7 49	6 3.5	N 34.0 S 45.2	93 55 11	
	〃		40 3	351 31 34	30 8.5	N 43.3 S 36.3	95 16 25	
	C̈	E		79 23 49.5	25 17.5			
Feb. 25	C			79 26 13.5	28 9			
	α Cygni		4 1 9	192 15 19.5	17 19	N 33.2 S 33.4	286 0 30	
	〃		6 31	193 31 48	33 43	N 37.8 S 28.7	287 18 39	
	C̈			79 23 53	25 40.5			
Mar. 7	C	W		79 23 34	25 20.5			
	Arcturus	S	6 18 0	335 20 45	22 19	N 34.7 S 38.8	60 36 3	
	〃	N	6 21 31	336 12 14.5	10 46	S 34.8 N 38.8	61 27 49	
	C̈	E		79 21 30	23 7			
Apr. 20	C			83 52 23.5	50 54			
	Sun P. L. 〃 F. L.		5 22 25 24 46	205 51 8	53 23	N 29.9 S 33.4	267 25 35	
	Sun P. L. 〃 F. L.		5 28 34 30 45	207 24 0	26 30.5	N 34.0 S 29.3	268 56 13	
	C			83 52 47.5	54 21.5			
June 19	C			269 1.0	2.5			
	Sun Ct.		4 38 18	317 23.5	25.0	Greenland	Mean:	
	〃		40 3.5	317 49.5	50.5	Theodolite	255 10.5	
			42 2	318 18.5	19.5	(without		
	C̈			268 56.5	58.0	telescope)		
	C			268 58.0	60.0			
	Sun Ct.		5 28 39	330 4.0	5.0		Mean:	
	〃		30 54	330 34.0	35.5		267 49.5	
			32 34	330 56.5	59.0			
	C̈			268 57.5	59.5			

1) First circle reading 305° 34′ ass. by the observer.

D. Determination of Magnetic Declination by Compass.

Observer: Lieutenant *Scott-Hansen,* when not otherwise stated.

Besides the regular observations taken in the magnetic observatory, the declination was frequently determined by the bearing of the Sun or a star, taken with a compass at a convenient distance from the ship. As these observations could not be made the subject of the same discussion as the other magnetical observations, which are contained in another memoir, the results are given here at once, together with the latitude employed for the calculation of the azimuth, and the longitude from the meridian of Greenwich.

The comparisons between the watch and chronometer Hohwü are added only in the few cases when they are not to be found in List A or B. The correction of Hw to local mean time, necessary for the calculation of azimuth, will be found in a subsequent section.

The observations of 1893, August 20 and 28, and the three first observations of 1895, February 20, were taken by means of a small compass by Olsen, divided into degrees on the rim from both ends of the diopter, and both ways to 90°. As more than one observation was always taken, the quadrant may be inferred from the increasing or decreasing of the numbers given in the column "Compass", which are the means of the readings of both ends of the needle. The compass used 1893, September 21, was graduated anti-clockwise from 0° (at the wire end of the diopter) to 360°; the degrees given in the column "Compass" correspond to the north end of the needle, but the fraction of degree is the mean for the two ends.

All the other observations were taken with Hechelmann's Azimuth Compass, divided into degrees on the card. With its gimbals it was suspended in a wooden box (spiked with copper nails) and mounted on the ice; after observation it was generally left there, covered with a canvass cap, unless cracking of the ice or other circumstances made it necessary to remove it. Every number in the column "Compass" is the mean of the readings both ways. The quadrant there given corresponds to the wire end of the diopter. When the Sun was too high for direct setting, the mirror was used, and then always in the two positions of the instrument, with the Sun in front or behind, which is indicated by "Front" or "Back" added in the column "Object". When nothing is added, the bearing was taken directly.

1893	Object	Watch	Compass	Magn. Decl.	Station	Rem.
		h m s	°	°		
Aug. 20	Sun Ct.	4 27 40	62.65	24.9 E	Ashore on *Reindeer Island* one of the *Kjellmann Islands.*	
		29 50	62.25	25.0		
		31 3	61.75	24.8		
		33 5	61.35	24.9	N. Lat. 74° 48′	
		34 33	61.1	25.0	E. Long. 85 45	
		41 45	59.05	24.7	5 altitudes of the Sun (see List B) were taken half an hour before anchoring.	
		43 30	58.8	24.9		
Aug. 28	Sun Ct.	1 41 25	83.5	27.7	On the ice ca. 100 m. from the ship near the north end of the *Nordenskiøld Islands.*	
		43 45	83.75	28.0		
		45 43	84.25	27.95		
		47 30	84.55	28.1		
		48 55	85.0	28.0	N. Lat. 76° 54′	
		51 27	85.6	28.0	E. Long. 95 2	
		52 50	85.85	28.1	7 altitudes of the Sun were taken 2 hours after mooring to the ice-border, 5 at sea half an hour before.	
		54 35	86.3	28.05		
Sep. 21	Sun Ct.	19 34 23	222.45	16.7	Ca. 80 m. from the ship, just after the enclosure in the ice.	
		36 23	222.7	16.9		
		37 49	222.7	17.3		
		38 49	223.0	17.2	N. Lat. 78° 42′	
		40 55	224.0	16.7	E. Long. 133 35	
		42 29	224.2	16.9	The hummock appeared to be turning slightly with the Sun.	
		43 59	225.0	16.45		
1894					° ′	
July 3	Sun Ct. Front	21 47 6.5	S 50.2 W	Mean: 33.8	N. Lat. 81 33.7	
		49 0	50.65		E. Long. 123 52	
		51 23.5	51.25			
	Sun Ct. Back	21 55 16	S 52.2 W			
		57 3.5	52.7	33.8		
		58 49.5	53.15			
July 13	Sun Ct. Front	12 26 0	N 79.65 E	37.9	N. Lat. 81 32.2	80°.35?
		29 5.4	81.25		E. Long. 125 0	
	Sun Ct. Back	12 33 20	N 82.2 E	37.8		
		36 2	82.55			
July 22	Sun Ct. Front	21 44 13	S 50.8 W		N. Lat. 81 26.2	
		47 24	51.35	33.7	E. Long. 125 6	
		49 12.3	51.65			
	Sun Ct. Back	21 52 6	S 52.05 W			
		56 20	53.1	34.2		
		57 42	53.3			
July 26	Sun Ct.	23 52 10	S 85.45 W		N. Lat. 81 13	
		54 35	86.15		E. Long. 125 25	
		57 45	86.5	31.0		
27		0 2 30	87.3			
		4 25	87.6			
Oct. 17	Moon [Ass. Cent. with reduction for phase]	0 26 53	N 43.3 E	37.9	N. Lat. 81 43.5	
		29 21	43.9	37.9	E. Long. 115 40	
		31 14.7	44.35	37.9		

1894	Object	Watch	Compass	Magn. Decl.	Station	Rem.
		h m s	°	°	° ′	
Oct. 20	Mars	9 34 0 38 0 42 5	S 34.15 W 35.0 35.9	Mean: 39.9 E	N. Lat. 82 0.2 E. Long. 114 51	
Oct. 29	Jupiter	1 14 30 18 30 21 0	N 22.4 E 23.55 25.05	39.0	N. Lat. 82 11.2 E. Long. 113 13	
Nov. 4	Arcturus	22 28 55 31 20 34 38	S 56.35 W 56.75 57.45	38.7 38.9 39.0	N. Lat. 82 6.0 E. Long. 110 59	
Dec. 11	Moon Ct.	23 13 10	N 54.85 E	39.4	N. Lat. 82 30.7 E. Long. 108 24	
Dec. 28	Jupiter	23 18 51 31 12 34 23	N 44.7 E 47.45 48.3	41.1 41.3	N. Lat. 83 18.8 E. Long. 101 54	
1895						
Jan. 13	Jupiter	22 27 17 29 57 32 44	N 50.45 E 51.05 51.75	42.3 42.4 42.4	N. Lat. 83 27.0 E. Long. 103 25	
Jan. 22	Jupiter	23 27 3 29 26 31 56	N 75.35 E 76.0 76.55	41.6	N. Lat. 83 23.6 E. Long. 102 14	
Jan. 30	Jupiter	22 56 9 59 36 23 2 20	N 76.9 E 78.05 78.85	42.3	N. Lat. 83 41.0 E. Long. 103 17	
Feb. 6	Jupiter	23 44 30 47 25 49 6	S 83.4 E 82.3 81.7	42.5 42.1 42.0	N. Lat. 83 31.5 E. Long. 102 33	
Feb. 13	Jupiter	21 41 58 43 43 45 53	N 73.3 E 73.95 74.55	42.0	N. Lat. 83 26.0 E. Long. 103 6	
Feb. 17	Jupiter	22 2 42 4 35 6 18	N 83.4 E 84.25 84.75	41.6	N. Lat. 83 32.3 E. Long. 102 57	
Feb. 20	Procyon	22 46 55 49 53 52 14	71.1 71.85 72.4	42.6	Ca. 100 m from the ship on the port bow.	Compass Olsen.
	Procyon	23 4 36 6 20 8 48	N 75.75 E 76.35 76.85	42.3	Ordinary place. N. Lat. 83 40.0 E. Long. 102 59	Hechelmann.
Feb. 23	Jupiter	23 6 36 8 36 10 45	S 74.85 E 73.9 73.5	42.1	N. Lat. 83 46.7 E. Long. 102 7	
Mar. 11	Venus	1 16 36 18 22 20 20	S 44.85 W 45.15 45.75	42.0 42.2 42.1	N. Lat. 83 59.0 E. Long. 102 13	
Mar. 19	Venus	2 54 3 55 48 57 15	S 66.45 W 66.8 67.35	41.8	N. Lat. 84 8.9 E. Long. 100 28	

1895	Object	Watch	Compass	Magn. Decl.	Station	Rem.
		h m s	°	°	° '	
Apr. 16	Sun Ct.	23 31 52	S 39.1 W	Mean:	N. Lat. 84 16.6	
		33 28	39.3	41.1 E	E. Long. 95 50	
		35 39	39.4			
May 27	Sun Ct.	0 34 10	S 49.9 W		N. Lat. 84 37	
		35 46	50.3	33.75	E. Long. 82 1	
		37 20	50.65			
June 6	Sun Ct.	14 46 25	N 72.7 E		N. Lat. 84 32.6	
		48 50	73.95	41.2	E. Long. 84 30	
		50 45	74.7			
June 13	Sun Ct.	0 4 33	S 43.8 W		N. Lat. 84 51.6	68 paces
		6 42	44.2	34.2	E. Long. 81 57	from the
		8 20	44.55			bow.
June 22	Sun Ct.	0 54 0	S 52.1 W		N. Lat. 84 31.7	
		56 20	52.45	34.0	E. Long. 80 26	
		58 45	53.1			
		1 5 30	S 55.7 W			Compass
		7 25	56.1	33.2		removed
		9 5	56.6			ca. 20 paces farther away.
July 19	Sun Ct.	1 53 25	S 58.65 W		N. Lat. 84 40.3	
		55 30	59.2	27.9	E. Long. 73 49	
		56 55	59.6			
July 29	Sun Ct.	17 45 55	S 60.6 E	29.0	N. Lat. 84 33.7	
		50 30	58.25		E. Long. 74 17	
July 31	Sun Ct.	1 50 30	S 64.55 W		N. Lat. 84 28.5	
		53 20	65.25	30.1	E. Long. 75 56	
		55 5	65.7			
Aug. 8	Sun Ct.	2 45 25	S 76.2 W		N. Lat. 84 37.9	Perhaps
		46 20	76.35	29.6	E. Long. 77 6	somewhat
		47 50	76.6			near the ship.
Aug. 10	Sun Ct.	1 46 10	S 60.85 W		N. Lat. 84 34.0	
		51 0	62.15	30.0	E. Long. 76 54	
		57 40	63.4			
Aug. 14	Sun Ct.	15 41 50	N 84.8 E		N. Lat. 84 28.2	
		44 40	85.4	31.3	E. Long. 75 52	
		46 55	85.8			
Aug. 25	Sun Ct.	0 35 40	S 41.55 W		N. Lat. 84 17.9	
		38 20	42.45	32.3	E. Long. 78 45	
		39 45	42.9			
Sep. 2	Sun Ct.	0 7 30	S 33.9 W		N. Lat. 84 47.6	
		9 20	34.6	31.5	E. Long. 77 6	
		10 55	34.8			
Sep. 18	Sun Ct.	2 17 40	S 73.85 W		N. Lat. 85 2	
		19 50	74.4	32.15	E. Long. 79 37	
Oct. 7	Arcturus	3 24 5	S 73.2 W	31.8	N. Lat. 85 5.2	
		28 0	74.3	31.6	E. Long. 78 31	
		30 40	75.1	31.4		

1895	Object	Watch	Compass	Magn. Decl.	Station	Rem.
		h m s	°	°	° ′	
Oct. 19	Arcturus	2 27 10 30 10 32 30	S 71.35 W 71.95 72.4	30.7 E	N. Lat. 85 45.3 E. Long. 77 56	
Oct. 23	Arcturus	3 2 45 5 20 8 0	S 82.35 W 83.2 83.85	28.6	N. Lat. 85 46.3 E. Long. 74 22	
Oct. 29	Pillar of Altazimuth	See List C	N 87.7 E 87.6	29.4	N. Lat. 85 44.7 E. Long. 70 30	
Nov. 1	Arcturus	2 28 40 31 10 32 30	S 81.0 W 81.4 81.8	27.4	N. Lat. 85 38.8 E. Long. 70 19	
Nov. 5	Jupiter	20 24 35 26 45 29 10	S 75.75 W 76.15 76.7	24.4 24.55 24.6	N. Lat. 85 41.6 E. Long. 67 40	
Nov. 7	Jupiter	19 32 25 34 50 36 50	S 64.1 W 64.5 65.2	21.8	N. Lat. 85 41.7 E. Long. 64 32	
Nov. 13	α Tauri	2 9 15 11 0 13 10	N 50.2 E 50.4 49.9	23.9	N. Lat. 85 54.5 E. Long. 66 45	Needle unsteady.
Nov. 15	Arcturus	1 44 10 45 40 48 0	S 84.15 W 84.35 84.9	21.9	N. Lat. 85 55.8 E. Long. 66 8	
Nov. 24	Altair	20 58 20 21 0 25 2 25	S 65.95 E 65.6 65.0	21.1	N. Lat. 85 47.5 E. Long. 62 35	
Nov. 28	Arcturus	2 36 20 39 50 41 30	N 73.05 W 72.6 72.15	18.3	N. Lat. 85 27.9 E. Long. 59 22	
Dec. 3	Arcturus	2 9 10 10 45 12 40	N 75.85 W 75.35 75.4	17.3	N. Lat. 85 28.8 E. Long. 57 27	
Dec. 15	Arcturus	21 28 40	S 41.75 W	13.0	N. Lat. 85 23 E. Long. 48 28	Nordahl; Hw−W = 0
Dec. 17	Aldebaran	2 0 30 9 0 15 20	N 76.1 E 78 80.9	9.8	N. Lat. 85 22.1 E. Long. 48 22	Observer Nordahl.
Dec. 22	Arcturus	1 47 40 55 0 2 1 5	N 65.1 W 63.1 61.5	10.0	N. Lat. 85 16 E. Long. 48 2	Nordahl; Hw−W = + $0^m 9^s$.
Dec. 29	Arcturus	21 47 40 50 0 52 5	S 63.55 W 63.85 64.35	8.9	N. Lat. 85 23.3 E. Long. 47 10	
1896						
Jan. 7	Arcturus	21 41 0	S 69.5 W	5.7	N. Lat. 85 11.9 E. Long. 42 45	High wind.
Jan. 15	α Orionis	2 41 31 45 30 46 58	S 85.5 E 84.55 84.15	3.9 3.9 3.9	N. Lat. 84 51.8 E. Long. 40 53	

1896	Object	Watch	Compass	Magn. Decl.	Station	Rem.
		h m s	°	°	° ′	
Jan. 20	Arcturus	21 19 0 21 20 23 0	S 75.9 W 76.4 76.9	2.5 E	N. Lat. 84 59.1 E. Long. 38 44	
Jan. 24	Arcturus	20 56 40	S 73 W	1.3 W (1.1 ?)	N. Lat. 84 56.8 E. Long. 33 39	Watch 57m ?
Jan. 26	Arcturus	21 7 0 9 10 11 25	S 77.25 W 77.75 78.3	2.9 W	N. Lat. 84 40.4 E. Long. 31 35	
Jan. 31	α Orionis	0 51 0 53 0 55 20	N 80.45 E 80.85 81.55	5.3	N. Lat. 84 51.5 E. Long. 30 30	
Feb. 7	[Arcturus]	22 28 45 30 40 32 5	N 71.9 W 71.4 71.25	8.7	N. Lat. 84 37.5 E. Long. 24 31	
Feb. 14	Arcturus	22 33 30 36 0 37 50	N 64.9 W 64.25 64.05	9.2	N. Lat. 84 20.7 E. Long. 22 58	
Feb. 27	Jupiter	4 11 30 14 0	S 60.9 E 59.95	7.9	N. Lat. 84 12.0 E. Long. 25 43	
Feb. 29	Jupiter	3 43 2 44 37 46 44	S 65.6 E 65.2 64.75	7.4	N. Lat. 84 6.3 E. Long. 26 21	
Mar. 12	Arcturus	8 31 10 33 0 35 40	S 74.65 E 74.4 73.75	8.2	N. Lat. 83 57.2 E. Long. 22 51	
Mar. 21	Jupiter	10 37 50 39 30 41 0	S 63.5 W 63.7 63.95	8.1	N. Lat. 84 4.7 E. Long. 24 13	
Apr. 4	Sun Ct.	3 37 25 38 50 42 20	S 77.95 W 78.45 79.35	10.2	N. Lat. 84 25 E. Long. 22 42	
Apr. 11	Sun Ct.	3 38 35 42 35 46 30	S 79.1 W 80.05 80.85	15.8	N. Lat. 84 22 E. Long. 17 0	
Apr. 24	Sun Ct.	19 22 25 24 12 26 20	S 49.2 E 48.9 48.35	17.5	N. Lat. 84 15.3 E. Long. 12 28	
Apr. 29	Sun Ct.	5 13 15 16 5 18 15	N 76.6 W 75.85 75.6	19.5 19.6 19.3	N. Lat. 84 12 E. Long. 12 16	
May 6	Sun Ct.	5 13 20 16 45 18 55	N 75.85 W 74.85 74.3	21.0	N. Lat. 84 4 E. Long. 11 8	
May 19	Sun Ct.	5 18 45 21 55 23 50	N 73.25 W 72.5 72.1	21.4	N. Lat. 83 48 E. Long. 11 18	

1896	Object	Watch	Compass	Magn. Decl.	Station	Rem.
		h m s	°	°	° ′	
May 24	Sun Ct.	5 22 15 24 20 25 55	N 72.95 W 72.5 72.0	19.3 W	N. Lat. 84 1 E. Long. 12 50	
June 3	Sun Ct.	7 48 40	N 38.2 W	18.4	N. Lat. 83 16 E. Long. 12 40	
June 4	Sun Ct.	5 42 40 43 55 45 20	N 68.3 W 67.95 67.75	18.8	N. Lat. 83 14 E. Long. 13 4	
June 9	Sun Ct.	5 29 45 34 35 38 0	N 73.8 W 72.5 71.5	17.6	N. Lat. 83 1 E. Long. 12 12	Observer Nordahl.
June 16	Sun Ct.	5 10 25 11 30 13 5	N 78.25 W 77.75 77.5	18.8	N. Lat. 82 59 E. Long. 11 51	
June 25	Sun Ct.	5 10 50 12 25 14 30 16 28 17 50	N 79.4 W 78.85 78.4 78.1 77.8	17.4	N. Lat. 82 55 E. Long. 12 25	
June 29	Sun Ct.	5 8 20 9 45 10 50	N 80.4 W 80.15 79.55	16.7	N. Lat. 82 55 E. Long. 12 33	
July 6	Sun Cr.	5 41 20 42 20 43 25	N 72.0 W 71.75 71.4	19.5	N. Lat. 82 59 E. Long. 12 49	
July 24	Sun Ct.	4 44 40 46 45 48 37	N 71.95 W 71.45 70.9	16.9	N. Lat. 82 2 E. Long. 12 40	

E. Determination of Declination and Deviation by Compass on Board.

Observer: Lieutenant *Scott-Hansen*, when not otherwise stated.

Some meteorological observations and observations of northern lights having been referred to the meridian of the compass on board, the following list will be of importance for reducing the directions to the true meridian. In some few cases the bearing of the celestial object was taken directly with the steering compass on deck which could, for this purpose, be provided with a diopter, but when the rigging was in the way, which was generally the case, the bearing was taken with the azimuth-dial on the bridge, the ship's course being read off simultaneously on the compass. After the ship's enclosure in the ice, the compass-box was generally tapped after the first reading; the numbers here given are the means of the readings after tapping when this produced a sensible difference.

The abbreviations used in the column "Bearing" are the following:

S. B. Starboard Bow.	S. Q. Starboard Quarter.
P. B. Port Bow.	P. Q. Port Quarter.

It will be remembered that the angles on the bow and the quarter are counted from the stem and the stern respectively.

The correction of the watch to the chronometer will, in all cases, be found in List A or B.

The resulting sum of magnetic declination and local deviation is given here at once, together with the latitude and longitude. When the results of the regular magnetical observations are known, there will probably be no difficulty in separating the deviation, in which case these observations will furnish further material for the determination of the declination. They are also of interest in showing the gradual change in the ship's direction. After the enclosure in the ice, the angles on the compass are counted continually from north through east. The same is also the case for the few bearings taken directly by compass.

After 1895, August 22, only one observation of this kind was taken, but a supplementing record of the ship's course will be found in the following section.

As to the observations taken at sea in 1893 (before September 22), they are of less interest, but are nevertheless reproduced here as furnishing the material for the determination of deviation, mentioned in the introduction. The three divisions, marked by spaces between the lines, correspond to the three periods there mentioned. It should be observed that the latitudes and longitudes given for this part of the observations are only approximate; as the definitive calculation of the astronomical observations taken at sea could not be effected without application of the dead-reckoning, which again required a knowledge of the deviation, preliminary values of latitude and clock error must be used for these observations by compass. The values here given are those actually employed in the calculation. The inaccuracy thus introduced is smaller than the accidental errors necessarily inherent to observations of this kind in high latitudes, the results of which must in all cases be subject to an adjustment.

Any case of special uncertainty is indicated by the sign :

1893	Object	Watch	Bearing	Compass Course	Decl. + Dev.	N. Lat.	E. Long.	Rem.
		h m s	°	°	°	° ′	° ′	
July 22	Sun Ct.	20 20 ca.	78.2 P. B.	S 32.8 W	5.2 E	71 2	41 55	
		20 35 ca.	79.1 „	S 32.8 W				
July 24	Sun Ct.	19 18 50	59.6 S. B.	N 49 E	21.1	71 17	49 54	
		20 5	43 „	N 72 E	15.0			
July 25	Sun Ct.	3 57 15	46.7 S. B.	S 35.5 W	12.0	71 20	51 30	
		58 35	63.0 „	S 21 W	10.6			
		4 1 55	88.5 „	S 1.5 E	8.3			
		3 18	78.8 S. Q.	S 12.5 E	7.0			
		9 40	65 „	S 24.5 E	6.6			
		17 30	45 „	S 43.0 E	7.0			
		18 12	27 „	S 61.5 E	7.6			
		18 45	10.5 „	S 78.5 E	8.3			
		19 15	5.5 P. Q.	N 80.0 E	13.9			
July 28	Sun Ct.	19 52 50	67 S. B.	N 76 E	18.6	69 50:	59 0:	
July 29	Sun Ct.	1 2 45	26 P. Q.	N 21 E	23.6	69 55:	59 30:	
Aug. 6	Sun Ct.	4 55 40	33.5 S. B.	S 77.5 W	20.2	69 37	66 43	
Aug. 9	Sun Ct.	4 5 36	24.5 S. B.	S 74 W	21.0	69 37	66 43	
	Sun Ct.	16 16 2	24.8 S. Q.	N 51 W	7.1	69 45	66 4	Bear. 34.8?
		21 7	12.8 „	N 75 W	20.4			[omitted].
		23 13	47.5 „	N 37 W	17.6			
		25 46	76 „	N 12 W	21.7			
		28 0	73.5 S. B.	N 14 E	26.8			
Aug. 11	Sun Ct.	17 11 30	80.5 S. Q.	N	29.7	72 11	68 25	
		13 5	85 S. B.	N 10 E	34.6			
Aug. 14	Sun Ct.	17 5 ca.	30.6 S. B.	N 69.5 E	30.7	74 39	71 1	
Aug. 16	Sun Ct.	17 28 0	S 72 E	N 13 E	37.5	75 12	78 17	
Aug. 17	Sun Ct.	0 46 5	71.5 S. Q.	S 47 E	22.1	75 14	79 43	
		48 28	55 „	S 64 E	23.0			
		51 34	90 „	S 25.5 E	20.2			
	Sun Ct.	4 6 30	70 P. Q.	N 22 E	39.8	75 9	80 10	
		8 45	49 „	N 42 E	41.3			
Aug. 18	Sun Ct.	16 47 20	76 S. Q.	N 2.5 W	36.4	73 48	81 14	
		48 28	71.5 S. B.	N 27 E	39.7			
		50 40	62.8 S. Q.	N 12 W	33.6			
Aug. 19	Sun Ct.	14 26 ca.	57.3 S. B.	N 11 E	36.2	74 53	83 37	
		38 48	74.6 S. Q.	N 29 W	31.6	74 54	83 39	Course 23°?
		39 30	67.5 S. B.	N 6 E	34.7			
		40 55	41.8 „	N 24 E	42.7			
	Sun Ct.	20 5 5	90 S. B.	N 78 E	27.8	74 58	84 35	
Aug. 25	Sun Ct.	0 35 ca.	29.8 S. Q.	S 87 E	23.2	75 20	85 50	
		40 ca.	18 „	N 76 E	29.6			
Aug. 26	Sun Ct.	14 9 ca.	55 S. B.	N 13 E	41.6	75 57	91 19	
		16 ca.	60.5 „	N 13 E	37.9			
Sep. 8	Sun Ct.	23 15 10	44.3 P. Q.	N 1 W	38.8	77 32	101 52	
		19 50	50 „	N 4 W	37.3			
Sep. 9	Jupiter	8 50 ca.	69.6 S. B.	N 39.3 E	43.8	77 48	104 0	
	Sun Ct.	14 15 25	8.3 S. B.	S 85 E	24.7	77 45	105 23	
		20 50	22.3 „	N 80 E	27.1			
Sep. 11	Sun Ct.	14 35 0	1.3 „	S 50 E	10.7	76 11	114 15	
		37 25	19.3 „	S 69 E	12.3			
		39 27	22.4 P. B.	S 24 E	9.6			
		42 12	39.8 „	S 4.5 E	8.3			1)
Sep. 13	Sun Ct.	12 21 40	66 P. Q.	S 38 W	4.4	74 25	113 56	
		42 35	60.3 „	S 45.5 W	7.6	74 25	113 57	
	Sun Ct.	21 50 38	27.4 „	N 24 E	23.1	73 52	114 43	
		52 31	5 „	N 47.5 E	22.5			
		57 20	15 S. Q.	N 78.5 E	12.7			

1) After observation, it was noticed that a small grindstone with an iron trough had been placed on the skylight. Moving to and fro with steady course showed no effect on the compass.

1893	Object	Watch	Bearing	Compass Course	Decl. + Dev.	N. Lat.	E. Long.	Rem.
		h m s	°	°	°	° '	° '	
Sep. 15	Sun Ct.	12 53 25	61.3 S. B.	N 40 E	22.6 E	74 20	121 20	
Sep. 16	Sun Ct.	14 7 17	77.4 S. B.	N 63 E	9.4	74 50	128 12	
Sep. 18	Sun Ct.	19 9 57	38.2 P. Q.	N 0.5 W	17.0	76 20	135 4	
		14 55	18.1 "	N 14 E	23.9			
Sep. 19	Sun Ct.	19 33 53	88.4 P. B.	N 63 W	33.9	77 53	137 8	
		36 43	69 P. Q.	N 24 W	18.1			
		38 48	54 P. B.	N 90 W	27.7			
		40 53	89.6 P. Q.	N 47 W	21.6			
Sep. 21	Sun Ct.	12 8 18	24.2 S. B.	N 86 E	15.7	78 50	132 54	
Oct. 17	Vega	2 24 37.5	25.2 S. B.	240.8	13.7	78 19.2	136 15	
Oct. 23	Jupiter	0 52 10	33.2 P. Q.	240.3	15.5	78 17.1	135 27	
Oct. 27	Jupiter	22 18 51	39.6 P. Q.	209.4	8.0	78 20.0	135 46	
Nov. 6	Jupiter	22 12 47	63.3 P. Q.	201.7	3.7	77 50.0	137 55	
Nov. 12	Jupiter	21 49 53	68.1 P. Q.	198.2	4.1	78 2.1	138 24	
Nov. 27	Jupiter	21 16 28	74.7 P. Q.	198.5	6.9	78 38.7	138 54	
Dec. 26	Jupiter	21 4 9	85.3 P. B.	201.8	9.0	79 1.0	137 24	
1894								
Jan. 15	Venus	19 24 51	15.3 P. B.	204.3	10.1	79 15.2	137 28	
Jan. 29	Jupiter	19 10 52	84.5 "	201.3	13.1	79 45.2	134 45	
Feb. 11	Procyon	20 14 30	63.2 P. Q.	201.6	9.7	80 0.3	134 32	1)
Apr. 3	Sun Ct.	14 8 24	41 P. B.	189	7.8	80 9.7	135 7	
May 1	Sun Ct.	21 25 0	74 S. B.	184.8	8.2	80 47	131 3	2)
May 23	Sun Ct.	23 5 25	81.4 S. Q.	173.5	11.2	81 32.5	123 2	
May 25	Sun Ct.	10 27 10	82.6 P. Q.	170.4	14.8	81 31	123 20	
May 27	Sun Ct.	22 33 20	90 S. B.	171	13.8	81 34	122 28	
May 31	Sun Ct.	20 35 24	62.7 S. B.	166.5	15.3	81 31	122 14	
June 6	Sun Ct.	0 7 9	65.5 S. Q.	165.3	17.2	81 29	122 10	
June 9	Sun Ct.	22 33 30	93.9 S. B.	167.2	13.0	81 36	122 8	
June 21	Sun Ct.	22 46 0	83.3 S. Q.	164.6	15.3	81 45	121 40	
June 24	Sun Ct.	13 15 5	52.5 P. B.	161	17.8	81 39	120 59	
June 26	Sun Ct.	22 11 13	86.1 S. B.	165.0	16.3	81 35	121 11	
June 30	Sun Ct.	10 27 7	85.2 P. Q.	166.1	14.6	81 33	122 57	
July 2	Sun Ct.	20 30 45	63.6 S. B.	167.2	13.5	81 35	123 28	
July 7	Sun Ct.	12 30 0	66.5 P. B.	170.7	Mean:	81 22	124 24	3)
		31 30	66.1 "	170.8	13.9			
		32 30	65.7 "	170.7				
July 9	Sun Ct.	13 27 15	50.9 P. B.	169.7	14.3	81 18	124 32	
July 11	Sun Ct.	23 37 40	73.7 S. Q.	171.3	14.2	81 21	124 38	4)
July 12	Sun Ct.	12 30 20	66.7 P. B.	167.6	17.6	81 25	124 33	
July 16	Sun Ct.	12 30 15	67.8 P. B.	171.6	15.5	81 26	125 12	
July 21	Sun Ct.	0 32 4	61.2 S. Q.	169.3	17.2	81 31	125 7	
July 25	Sun Ct.	23 11 54	93.3 S. B.	171.5	20.1	81 17	126 1	
July 28	Sun Ct.	0 59 50	58.5 S. Q.	175.0	16.4	81 10	125 57	
July 29	Sun Ct.	22 26 10	86.3 S. B.	173.5	14.7	81 4	126 2	
July 30	Sun Ct.	12 33	68.5 P. B.	174.3	16.1	81 3	126 17	
	Sun Ct.	19 58 18	48.5 S. B.	174.4	15.9	81 3	126 7	
Aug. 3	Sun Ct.	1 13 30	54.8 S. Q.	179.0	13.5	81 5	127 19	
Aug. 3	Sun Ct.	19 49 35	46.2 S. B.	178.8	12.9	81 6	127 22	
Aug. 5	Sun Ct.	20 24 25	55.4 S. B.	178.7	12.8	81 8	127 28	
Aug. 8	Sun Ct.	20 32 40	56.9 S. B.	178.6	13.4	81 5	127 19	
Aug. 10	Sun Ct.	12 29 10	69.9 P. B.	179.4	14.1	81 5	127 45	
	Sun Ct.	20 25 40	54.1 S. B.	179.5	14.2	81 5	127 50	

1) The zero of the azimuth-dial stood 0°.3 towards Port. 2) The funnel raised. 3) Bearing taken directly with shadow-pin on the circle of the compass-box. 4) The funnel raised since last observation.

1894	Object	Watch	Bearing	Compass Course	Decl. + Dev.	N. Lat.	E. Long.	Rem.
		h m s	°	°	°	° ′	° ′	
Aug. 14	Sun Ct.	12 2 25	74.8 P. B.	178	14.2 E	81 7	127 49	
Aug. 22	Sun Ct.	12 18 50	66.7 P. B.	174.0	12.9	81 2	128 2	
Aug. 25	Sun Ct.	21 32 20	72.8 S. B.	177.2	12.0	81 1	127 29	
Sep. 17	Mars	3 16 50	66.7 P. B.	177.9	12.9	81 22.3	124 2	
	"	18 42	66.3 "	177.8	13.0			
Sep. 20	Mars	2 58 30	66.2 P. B.	180	8.5	81 11.7	123 35	
Sep. 28	Mars	2 24 50	69.8 P. B.	176.4	15.0	81 12.8	122 1	
Oct. 1	Mars	1 4 30	87.8 P. B.	177.9	15.1	81 5.0	122 2	
Oct. 7	Mars	0 42 30	85.8 P. B.	174.8	16.4	81 18.5	120 14	
Oct. 10	Mars	1 53 19	63.7 P. B.	174.8	15.8	81 16.2	119 53	− 0°.2
"	Altair	55 51	33.2 S. B.		15.6			+ 0°.2
Oct. 13	Jupiter	0 44 15	35.5 P. Q.	172.2	15.7	81 32.9	118 12	
Oct. 15	α Tauri	0 47 30	69.5 P. Q.	169,5	14.7	81 36.8	116 28	
Oct. 20	Arcturus	9 52 5	67.4 P. Q.	163.2	17.7	82 0.2	114 51	
Oct. 25	Jupiter	3 2 0	84.1 P. Q.	163.9	17.4	82 4.0	114 38	
Oct. 27	Jupiter	1 33 14	63.3 P. Q.	165.4	16.9	82 4.0	114 35	
Oct. 30	α Tauri	23 5	66.3 P. Q.	157.9	16.7	82 6.5	112 22	
Nov. 7	Mars	23 27 54	53.9 P. B.	157.7	16.7	82 9.0	110 59	
Nov. 12	Mars	23 9 0	55.5 P. B.	159.8	16.5	82 7.8	110 6	
Nov. 21	Jupiter	23 15 35	79.3 P. Q.	139.8	18.2	82 0.1	112 5	
Nov. 24	Jupiter	1 39 20	64.7 P. B.	146.5	12.9	81 57.8	111 58	
Nov. 28	Jupiter	23 11 35	80.3 P. Q.	146.9	15.8	82 9.7	110 50	
Dec. 3	Jupiter	23 3 13	83.8 P. Q.	146.0	15.8	82 13.1	109 56	
Dec. 7	Jupiter	23 2 50	89.5 P. Q.	142.5	16.9	82 20.8	108 43	
Dec. 18	Jupiter	23 55.5	64.7 P. B.	136.5	19.1	82 50.5	104 45	
Dec. 21	Procyon	1 22 0	60.3 P. B.	137.0	18.1	82 54.5	104 3	
Dec. 26	Jupiter	22 51 50	75.6 P. B.	131.8	21.1	83 22.1	102 27:	1)
Dec. 28	Jupiter	23 43 52	50.0 P. B.	120.5	21.5	83 18.8	101 54	Joh.
Dec. 30	Jupiter	22 44 56	62.5 P. B.	123.3	19.2	83 20.9	102 23	
1895								
Jan. 2	Jupiter	22 35 30	57.1 P. B.	123.2	21.2	83 25.4	102 45	
Jan. 6	Mars	19 53 30	40.1 P. B.	129.2	16.2	83 35:	103 6:	2)
Jan. 11	Jupiter	22 9 10	59.8 P. B.	130.6	14.6	83 41.5	102 45	
Jan. 18	Jupiter	21 20 40	63.3 P. B.	131	12.7	83 25.8	102 0	
Jan. 20	α Gemin.	23 47 35	53.5 P. B.	132.5	14.8	83 22.6	102 7	
Jan. 22	Jupiter	23 41 12	23.8 P. B.	132.2	12.2	83 23.6	102 14	
Jan. 27	Jupiter	23 25 16	21.3 P. B.	130	14.0	83 30.0	102 34	
Feb. 4	α Can. Min.	22 40 49	49.4 P. B.	131	14.2	83 33.2	103 6	
Feb. 12	Jupiter	0 52 2	19.3 S. B.	129.7	14.3	83 24.7	103 24	
Feb. 17	Jupiter	22 45 10	6.3 P. B.	129	13.6	83 32.3	102 57	
Mar. 2	Arcturus	1 33 25	82.2 P. B.	130.8	11.3	84 3.7	101 32	
Mar. 6	Arcturus	1 41 24	78.1 P. B.	128.7	15.5	84 2.6	101 45	
Mar. 16	Venus	4 12 15	14.8 S. Q.	125	18.2	84 7.8	100 51	
Mar. 25	Sun Ct.	1 59 45	24 S. Q.	130	12.2	84 8.6	99 49	
Apr. 6	Sun Ct.	14 12 45	22.0 P. B.	124.3	16.3	84 18.5	96 40	
Apr. 13	Sun Ct.	23 59 15	54.9 S. Q.	127.7	14.7	84 17	96 53	
Apr. 27	Sun Ct.	0 2 35	49 S. Q.	126.5	14.0	84 12	93 42	
May 3	Sun Ct.	15 7 0	9.3 P. B.	123.5	15.6	84 25	93 30	
May 10	Sun Ct.	14 25 0	22.3 P. B.	119	18.9	84 38	89 55	
May 13	Sun Ct.	23 32 0	62.2 S. Q.	125	11.4	84 39	88 16	

1) If the assumed correction of − 10′ to the second observation of γ Draconis (see List A) be applied instead to the first, the longitude would be 101° 1′ and Decl. + Dev. 19°.7 E.
2) No altitudes measured the same day.

1895	Object	Watch	Bearing	Compass Course	Decl. + Dev.	N. Lat.	E. Long.	Rem.
		h m s	°	°	°	° ′	° ′	
May 18	Sun Ct.	0 40 10	46.2 S. Q.	125	10.9 E	84 37	86 41	
May 27	Sun Ct	0 41 40	45.4 S. Q.	119.7	11.2	84 37	82 1	
May 31	Sun Ct.	1 42 10	30 S. Q.	116.5	15.6	84 36	83 40	
June 3	Sun Ct,	14 51 30	13.7 P. B.	110.5	19.1	84 34	84 26	
June 6	Sun Ct.	14 55 35	9.6 P. B.	99	27.4	84 33	84 30	
June 10	Sun Ct.	14 37 15	0.2 S. B.	82.7	32.0	84 45	83 5	
June 12	Sun Ct.	0 19 0	31.4 S. Q.	83.5	28.7	84 48	82 34:	
June 15	Sun Ct.	15 41 45	11.4 S. B.	79.5	30.6	84 52	79 30	
June 18	Sun Ct.	0 52 0	19 S. Q.	83	27.6	84 42	79 54	
June 21	Sun Ct.	14 39 0	5.6 S. B.	80.5	30.0	84 32	80 43	
June 26	Sun Ct.	16 33 30	26.3 S. B.	77	30.6	84 34	78 8	
July 2	Sun Ct.	15 34 25	9 S. B.	55	51.2	84 41	74 15	
July 5	Sun Ct.	2 1 30	20.8 S. Q.	68	45.3	84 43	75 44	
July 8	Sun Ct.	16 10 20	10.7 S. B.	59.5	50.3	84 45	75 16	
July 12	Sun Ct.	2 7 45	23 S. Q.	79	37.7	84 41	76 0	
July 18	Sun Ct.	17 9 30	6.7 S. B.	91	34.4	84 40	73 57	
July 23	Sun Ct.	15 26 20	7 P. B.	91.5	32.4	84 32	71 59	
July 29	Sun Ct.	16 40 0	7.4 P. Q.	272	32.6	84 34	74 17	
	Sun Ct.	20 44 30	21 P. B.	202	14.1	84 34	74 17	
July 30	Sun Ct.	16 8 0	106.2	229	19.0	84 28	75 35	
July 31	Sun Ct.	2 2 50	47.5 S. B.	214.5	15.7	84 29	75 56	
Aug. 1	Sun Ct.	2 13 30	59 S. B.	208	14.2	84 30	76 50	
	"	17 30	268.65	207.7	13.5			
	Sun Ct.	16 31 3	114.6	226	18.3	84 31	77 20	
	Sun Ct.	20 4 45	168.6	235.5	19.9	84 31	77 40	
Aug. 2	Sun Ct.	1 41 35	13.1 S. B.	241.7	19.3	84 31	77 40	
Aug. 6	Sun Ct.	16 23 30	104.0	229.5	23.6	84 38	77 23	
Aug. 22	Sun Ct.	6 7 20	315.05	145.5	21.3	84 10	79 6	
Dec. 3	Arcturus	2 22 30	52 S. Q.	173	3.6	85 28.8	57 27	

F. Direct Determination of Deviation.

Observer: Lieutenant *Scott-Hansen.*

The following observations, though not strictly astronomical, are inserted here as a supplement to the preceding. They give the mutual bearings between the compass on the ice, and the azimuth dial on the bridge (or in some few cases the steering compass) on board. The abbreviations are the same as in List E. The resulting deviation of the steering compass is added, together with the latitude and longitude.

In a journal kept by Lieut. Scott-Hansen, the following remark is made under October 5 1893: Deviation for compass course SW½W was changed ½ point more westerly.

1893	Bearing from Ice	Bearing from Ship	Compass Course	Dev.	N. Lat.	E. Long.	Remarks
	°	°	°	°	° '	° '	
Aug. 28	S 33.6 W	29.8 S. B.	N 3.5 W	7.3 E	76 54	95 2	
Sep. 8	N 61.2 W	78.5 S. B.	N 27 E	13.3 E	76 32	100 40	
Sep. 10	N 51.2 W	78.4 P. B. 78.0 ,,	S 33 W S 32.5 W	5.7 W	77 30	106 36	From an island.
Sep. 22	323.75	2 P. B.	S 27 E	7.3 W	78 42	133 35	
Oct. 7	91.2	40.2 S. B.	S 54 W	3.0 W	78 26	136 2	Magn. theod. on ice.
1894							
Aug. 15	S 64.7 W	82.4 P. Q.	179.3	17.0 W	81 6	127 50	Do.
1895							
June 13	N 59 W	42.7 S. B.	84.2	5.9 W	84 52	81 57	
Aug. 9	N 87 E	27.5 P. B.	288	6.5 E	84 36	76 58	
Aug. 23	N 7.6 E	197.4	130.5	9.8 W	84 11	79 1	
Aug. 25	N 13.9 E	206.0	152	12.1 W	84 18	78 46	
Aug. 29	N 18 E	53.8 S. B.	155.7	11.5 W	84 34:	77 49:	
Sep. 2	N 33.4 E	227.2	181.3	13.8 W	84 48	77 6	Ship turning slightly.
Sep. 3	S 73.4 E	51.5 S. Q.	170.5	12.4 W	84 50	77 20	
Oct. 31	S 87.8 E	72 S. Q.	179	14.8 W	85 39	70 19	
Nov. 12	N 87 E	72 S. Q.	173.5	14.5 W	85 53	66 5	
Dec. 30	S 86 E	72 S. Q.	178	12 W	85 23	47 10	
1896							
Jan. 21	S 86.8 E	72 S. Q.	176.7	11.5 W	84 59	38 44	
Feb. 15	S 79.2 E	66 S. Q.	176.5	9.7 W	84 21	22 58	
Feb. 27	N 38.7 E	66 S. B.	163.4	10.7 W	84 12	25 44	
Mar. 11	N 27.8 E	65.7 S. B.	151	8.9 W	83 57	23 10	
Apr. 4	N 19.7 E	66 S. B.	142.5	8.8 W	84 25	22 42	
May 6	N 34.9 E	78.2 S. B.	144.8	8.1 W	84 4	11 8	
May 24	N 17 E	60.6 S. B.	143.5	7.1 W	84 1	12 50	
June 3	N 7 E	59 S. B.	137	9 W	83 16	12 40	
June 16	N 57.1 E	87.8 S. B.	157.5	8.2 W	82 59	11 51	
June 27	N 63.5 E	42.7 S. B.	209	8.2 W	82 55	12 48	
June 29	S 66 W	78.4 P. B.	151	6.6 W	82 55	12 33	
July 4	N 9.2 W	40.5 P. B.	216.5	5.2 W	82 58	12 28	
July 10	S 32.3 E	43 S. B.	279.8	4.9 E	83 6	13 7	
July 19	N 67.8 W	60 P. B.	181.2	9.0 W	83 14	14 39	
July 24	S 28.5 E	44.7 P. B.	3	13.2 E	82 2	12 40	

RESULTS.

G. Greenwich Time.

The following Table contains, for every 10th day, the error of chronometer Hohwü for Greenwich Mean Time. The daily rate is given to 2 places of decimals, as calculated by the formula given in the Introduction. The clock error itself was originally computed for 8 am Gr. T. but being here given in whole seconds, it may be considered as corresponding to Noon of the same civil day either in Greenwich or on board. The uncertainty is generally greater than the small error thus introduced.

	Hw–Gr.	Daily Rate		Hw–Gr.	Daily Rate		Hw–Gr.	Daily Rate
	m s	s		m s	s		m s	s
1893 July 19	+ 42 50	– 0.71	1894 Aug. 3	+ 41 12	– 0.53	1895 Aug. 18	+ 38 27	– 0.71
29	42 43	– 0.64	13	41 6	– 0.50	28	38 20	– 0.68
Aug. 8	42 37	– 0.77	23	41 1	– 0.29	Sep. 7	38 13	– 0.70
18	42 29	– 0.55	Sep. 2	40 58	– 0.23	17	38 6	– 0.60
28	42 23	– 0.36	12	40 56	– 0.34	27	38 0	– 0.48
Sep. 7	42 20	– 0.62	22	40 53	– 0.27	Oct. 7	37 55	– 0.47
17	42 13	– 0.71	Oct. 2	40 50	– 0.30	17	37 51	– 0.41
27	42 6	– 0.40	12	40 47	– 0.33	27	37 47	– 0.44
Oct. 7	42 2	– 0.34	22	40 44	– 0.21	Nov. 6	37 42	– 0.41
17	41 59	– 0.19	Nov. 1	40 42	– 0.23	16	37 38	– 0.31
27	41 57	– 0.11	11	40 39	– 0.09	26	37 35	– 0.41
Nov. 6	41 56	– 0.13	21	40 38	– 0.33	Dec. 6	37 31	– 0.31
16	41 55	– 0.09	Dec. 1	40 35	– 0.26	16	37 28	– 0.25
26	41 54	– 0.04	11	40 33	– 0.25	26	37 25	– 0.17
Dec. 6	41 53	+ 0.02	21	40 30	– 0.32	1896 Jan. 5	37 24	– 0.01
16	41 54	+ 0.06	31	40 27	– 0.22	15	37 24	– 0.35
26	41 54	– 0.08	1895 Jan. 10	40 25	– 0.40	25	37 20	– 0.29
1894 Jan. 5	41 53	– 0.06	20	40 21	– 0.35	Feb. 4	37 17	– 0.23
15	41 53	– 0.07	30	40 17	– 0.23	14	37 15	– 0.28
25	41 52	– 0.01	Feb. 9	40 15	– 0.43	24	37 12	– 0.38
Feb. 4	41 52	– 0.04	19	40 11	– 0.34	Mar. 5	37 8	– 0.46
14	41 52	– 0.07	Mar. 1	40 7	– 0.40	15	37 4	– 0.58
24	41 51	– 0.11	11	40 3	– 0.45	25	36 58	– 0.61
Mar. 6	41 50	– 0.10	21	39 59	– 0.32	Apr. 4	36 52	– 0.49
16	41 49	– 0.04	31	39 55	– 0.47	14	36 47	– 0.44
26	41 49	– 0.09	Apr. 10	39 51	– 0.57	24	36 42	– 0.53
Apr. 5	41 48	– 0.19	20	39 45	– 0.53	May 4	36 37	– 0.53
15	41 46	– 0.12	30	39 40	– 0.59	14	36 32	– 0.57
25	41 45	– 0.06	May 10	39 34	– 0.63	24	36 26	– 0.79
May 5	41 44	– 0.05	20	39 28	– 0.62	June 3	36 18	– 0.67
15	41 43	– 0.12	30	39 21	– 0.60	13	36 11	– 0.57
25	41 42	– 0.34	June 9	39 15	– 0.70	23	36 6	– 0.56
June 4	41 39	– 0.45	19	39 8	– 0.63	July 3	36 0	– 0.56
14	41 34	– 0.57	29	39 2	– 0.75	13	35 55	– 0.55
24	41 29	– 0.44	July 9	38 54	– 0.70	23	35 49	– 0.52
July 4	41 24	– 0.37	19	38 47	– 0.66	Aug. 2	35 44	– 0.48
14	41 21	– 0.50	29	38 41	– 0.69	12	35 39	– 0.57
24	41 16	– 0.39	Aug. 8	38 34	– 0.68	22	35 33	
Aug. 3	41 12		18	38 27				

H. Latitude, Local Time, and Longitude.

The time of observation is given by the hours and minutes of chronometer Hohwü and astronomical date. The Greenwich astronomical date and time is obtained by subtraction of the corresponding hours and minutes of the preceding Table, and the local mean time by addition of the numbers in the next column of the present Table, containing the *correction* of Hw to local mean time. The sum of the numbers of this column and those of the preceding Table will then give the East Longitude in time.

For the latitudes determined by meridian altitudes of the Sun at sea, the date of local Noon is enclosed in brackets.

When latitude and local time were determined simultaneously by means of the great Altazimuth, the latitude is generally given to seconds of arc, the clock correction to seconds of time, and the longitude to minutes of arc or sometimes half minutes. When two pairs of stars were observed, the degree of reliability may be inferred from the concordance of the numbers. For observations with the Sextant or the small Altazimuth, the latitude is generally given to the nearest minute or tenth of a minute.

When only one of the two elements was determined at a time, as was always the case in summer, the assumed value of the other, as used for the computation, is enclosed in square brackets. In this case there is also added a column of differential coefficients, containing either $\frac{d\varphi}{dt}$ or $\frac{dt}{d\varphi}$, where $d\varphi$ is the increment of latitude corresponding to an increment dt of hour angle (or clock correction or east longitude). In order to have the change of clock correction, corresponding to a given change of latitude, expressed at once in seconds of time, when the change of latitude is given in seconds of arc, the differential coefficient in the last case is given in the form $\frac{1}{15}\frac{dt}{d\varphi}$.

For the observations taken at sea, these differential coefficients do not always correspond exactly to the coordinates here given, as they have in many cases already been used for the correction of preliminary values.

When observations of the Sun have been treated in the same manner as observations of two stars, the result will be found between the lines containing the times of observation.

1893	Hw	M. T.−Hw	N. Lat.	E. Long.	$\frac{d\varphi}{dt}$	$\frac{1}{15}\frac{dt}{d\varphi}$	Remarks
	h m	h m s	° ′	° ′			
July 22	19 43	2 2 44	[70 53]	41 23		+ 0.239	
(24)	Noon		71 11.1				
24	15 43	2 34 56	[71 20.7]	49 25		+ 0.014	
24	18 25	2 37 38	[71 22.0]	50 6		+ 0.156	
(25)	Noon		71 23.5				
July 26	18 12	2 52 57	[69 46]	53 55		+ 0.146	
27	18 24	3 5 45	[69 24.5]	57 7		+ 0.183	
Aug. 1	21 59	[3 18 39]	69 41.3	[60 20]	− 0.136		Ashore at Khabarowa.
5 6	22 21 3 6	3 44 15	69 36.6	66 43.2			Moored to the edge of the ice off the coast of Yalmal.
6 6	15 33 20 44	3 44 17	69 36.9	66 43.5			
Aug. 9	16 11	3 41 40	[69 44.4]	66 4		+ 0.070	
9	20 5	[3 39 44]	70 1.5	[65 35]	+ 0.036		
11	18 24	3 50 53	[72 18]	68 22		+ 0.363	
11	19 20	[3 51 1]	72 23.5	[68 23]	+ 0.083		
(12)	Noon		72 28.4				
11	21 57	[3 51 20]	72 38.0	[68 28]	− 0.166		
Aug. 13	1 34	3 56 48	[73 34]	69 50		− 0.017	
14	17 2	4 1 18	[74 37.9]	70 57		+ 0.217	
14	20 28	[4 3 54]	74 39.7	[71 36]	− 0.033		
15	16 32	4 18 16	[74 36]	75 11		+ 0.189	
16	16 33	4 31 18	[75 13.5]	78 27		+ 0.224	
16	16 50	4 31 22	[75 14]	78 28		+ 0.262	
Aug. 17	0 40	4 36 20	[75 15.3]	79 42		− 0.036	
17	0 59	4 36 32	[75 14.5]	79 45		− 0.016	
17	15 13	4 38 29	[74 43]	80 14		+ 0.109	
(18)	Noon		74 28.9				
18	1 43	4 40 2	[74 3]	80 38		+ 0.035	
Aug. 18	15 20	4 42 13	[73 42.7]	81 10		+ 0.113	
18	16 48	4 41 47	[73 45.3]	81 4:		+ 0.268	
(19)	Noon		73 55.6				
19	1 1	4 47 15	[74 9.2]	82 26		− 0.005	
19	14 22	4 52 7	[74 54.5]	83 39		+ 0.063	
19	14 43	4 52 18	[74 55.9]	83 42		+ 0.088	
Aug. (20)	Noon		74 59.5				
20	1 6	5 0 20	[74 50]	85 42		+ 0.017	
(21)	Noon		74 46				Horizon ca. 2 miles off, among the Kjellman Islands.
24	21 59	[4 59 32]	75 29.2	85 29	− 0.268		
25	0 37	5 0 52	[75 23.9]	85 49		− 0.014	
Aug. 25	14 48	5 8 31	[75 25[	87 44		+ 0.124	
25	16 14	5 9 49	[75 24.5]	88 3		+ 0.286	
25	19 58	[5 11 20]	75 28.0	[88 26]	− 0.083		
26	0 34	5 12 1	[75 38.9]	88 36		− 0.008	
26	14 13	5 22 53	[75 56.8]	91 19		+ 0.104	
Aug. (28)	Noon		76 46.2				
27	21 17	[5 37 43]	76 51.9	[95 2]	− 0.232		
27	23 51	5 37 44	[76 53.9]	95 2		− 0.030	
Sep. 1	15 24	5 43 27	[76 25]	96 27		+ 0.282	
Sep. 5	16 1	5 35 9:	[76 8.6:]	94 22:		+ 0.367	Horizon 1/3 mile off.
5	18 13	[5 35 9:]	76 3.7:	[94 22:]	+ 0.011		„ 3/4 mile off.
(6)	Noon		76 8.6:				„ 1/3 mile off.
6	14 13	5 50 38	[76 27.7]	98 14		+ 0.158	
6	18 16	[5 52 0]	76 31.7	[98 35]	− 0.010		

1893	Hw	M. T.−Hw	N. Lat.	E. Long.	$\frac{d\varphi}{dt}$	$\frac{1}{15}\frac{dt}{d\varphi}$	Remarks
	h m	h m s	° ′	° ′			
Sep. 6	22 40	5 57 4	[76 33.2]	99 51		− 0.094	
7	15 0	6 0 22	76 32.3	100 40			
7	18 9						
7	17 54	[6 0 22]	76 32.2	[100 40]	+ 0.004		
(9)	Noon		76 55.8				
8	18 44	[6 0 54]	77 0.4	[100 48]	− 0.049		
Sep. 8	22 46	6 4 27	[77 23.9]	101 41		− 0.084	
8	23 17	6 5 22	[77 26.1]	101 55		− 0.040	
9	8 48	[6 13 58]	77 48.8	[104 4]	+ 0.109		
9	14 10	6 18 25	[77 42.5]	105 11		+ 0.234	
9	14 24	6 18 48	[77 42.3]	105 16		+ 0.266	
Sep. (10)	Noon		77 35.8				
11	14 30	6 53 33	[76 8.7]	113 58		+ 0.340	
11	14 45	6 54 14	[76 8.0]	114 8		+ 0.393	
(12)	Noon		76 1.6				
13	12 22	6 53 29	[74 25.2]	113 56		+ 0.083	
13	12 40	6 53 28	[74 24.3]	113 56		+ 0.105	
Sep. 13	18 40	[6 54 48]	73 57.8	[114 16]	− 0.136		
13	21 47	6 56 38	[73 51.8]	114 43		− 0.070	
13	22 1	6 56 38	[73 52.2]	114 43		− 0.056	
14	17 50	[7 5 44]	73 53.9	[117 0]	− 0.079		
14	18 19	[7 6 17]	73 52.9	[117 8]	− 0.121		
Sep. 15	12 52	7 23 7	[74 20.3]	121 20		+ 0.163	
15	16 8	[7 26 22]	74 25.4	[122 9]	+ 0.024		
(16)	Noon		74 27				
16	13 36	7 50 3	[74 50.1]	128 4		+ 0.320	
16	13 56	7 50 29	[74 50.4]	128 11		+ 0.389	
16	14 11	7 51 6	[74 50.6]	128 20		+ 0.455	
Sep. 16	15 48	[7 52 46]	74 52.4	[128 45]	+ 0.016		
16	19 26	7 57 2	[75 1.1]	129 49		− 0.189	
17	19 20	8 15 24	[74 49.9]	134 24		− 0.168	
18	0 17	[8 18 48]	75 10.4	[135 15]	+ 0.022		
18	15 54	[8 16 21]	76 3.7	[134 38]	− 0.012		
Sep. 18	19 7	8 18 11	[76 18.3]	135 6		− 0.205	
18	19 18	8 18 24	[76 19.2]	135 9		− 0.186	
(20)	Noon		77 46.5				
19	19 30	8 26 50	[77 51.0]	137 15		− 0.173	
19	19 44	8 26 26	[77 51.6]	137 9		− 0.149	
Sep. 21	0 55	8 10 22	78 39.7	133 8			
21	12 5	8 9 20	[78 49.4]	132 53		+ 0.240	
21	12 13	8 9 17	[78 49.4]	132 52		+ 0.260	
21	13 43	[8 9 20]	78 49.4	[132 53]	+ 0.113		
(22)	Noon		78 51.1				
Sep. 21	19 13	[8 12 9]	78 41.9	[133 35]	− 0.267		Hereafter enclosed in the ice.
21	19 59	8 12 9	[78 41.9]	133 35		− 0.157	
23	15 45		78 51.1				
24	2 25	8 7 21	[78 51.1]	132 22		+ 0.049	
25	15 45		78 50.1				
25	15 57	[8 7]	78 50.3				
Sep. 26	1 54	8 6 34	[78 50.1]	132 10		+ 0.012	
28	16 13	[8 5]	79 0.0	[131 46]	− 0.023		
”	16 26	[8 5]	78 59.8	[131 46]	− 0.034		[Ass. corr. + 10′ to altitude].
Oct. 2	1 25	8 17 44	78 52.2	134 57			
4	15 27		78 38.4				

1893	Hw	M. T.—Hw	N. Lat.	E. Long.	$\frac{d\varphi}{dt}$	$\frac{1}{15}\frac{dt}{d\varphi}$	Remarks
	h m	h m s	° ′ ″	° ′			
Oct. 5	1 50	8 22 23	78 35.6	136 6			
6	0 14	8 21 55	78 29.5	136 0			
8	1 22	8 22 17	78 22.5	136 5			
12	1 32	8 21 46	78 13.5	135 57			
17	1 43	8 23 2	78 19 10	136 15			
Oct. 18	23 33	8 23 10	78 19 29	136 17			
23	0 28	8 19 51	78 17 8	135 27			
25	21 39	8 22 51	78 32 23	136 12			
27	21 56	8 21 7	78 20 0	135 46			
29	22 33	8 19 55	78 13 29	135 28			
Oct. 31	21 19	8 17 27	78 2 48	134 51			
Nov. 2	21 54	8 17 52	78 1 21	134 57			
6	21 39	8 29 44	77 50 1	137 55			
9	21 32	8 29 19	77 57 6	137 49			
12	21 10	8 31 43	78 2 4	138 24.5			
Nov. 16	21 17	8 35 8	78 24 42	139 16			
20	21 30	8 35 17	78 24 0	139 18			
22	21 45	8 36 22	78 30 22	139 34			
24	21 23	8 34 6	78 38 0	139 0			
27	20 51	8 33 41	78 38.7	138 54			
Dec. 2	3 0	8 31 51	78 43 57	138 26			
4	20 58	8 29 26	78 51 7	137 50			
8	20 25	8 28 13	78 57 58	137 31.5			
11	20 33	8 28 46	79 7 9	137 40			
17	19 28	8 28 30	79 5 18	137 36			
Dec. 19	19 1	8 27 53	79 7 14	137 27			
21	20 6	8 26 59	79 7 55	137 13			
23	19 6	8 26 44	79 7 9	137 9.5			
26	20 43	8 27 44	79 1 2	137 24.5			
28	19 4	8 27 2	78 56 41	137 14			
30	19 10	8 25 8	78 58 14	136 45.5			
1894							
Jan. 1	19 36	8 25 59	78 56 4	136 58			
4	19 8	8 27 4	78 56 57	137 14			
7	19 24	8 28 25	79 4 30	137 34.5			
9	20 21	8 26 48	79 6 52	137 10			
12	20 8	8 27 20	79 16 1	137 18			
Jan. 15	18 58	8 27 58	79 15 12	137 28			
18	19 6	8 25 32	[79 25]	136 51		+ 0.040	Cloudy.
20	2 41		79 35				Moon on meridian.
21	20 43	8 21 19	79 39 52	135 48			4 hours between the
22	20 1	8 20 18	79 42 16	135 32.5			stars.
Jan. 25	20 21	8 18 55	79 44 7	135 12			
27	19 12	8 17 3	79 44 47	134 44			
29	18 56	8 17 6	79 45 12	134 44.5			
Feb. 1	14 22	8 15 0	79 59 20	134 13			
4	18 54	8 16 40	79 57 13	134 38			
Feb. 8	19 50	8 18 0	79 54 32	134 58			
11	19 50	8 16 15	80 0 21	134 32			
13	20 1	8 14 5	80 0 5	133 59			
15	21 25		80 3 3				} Jupiter on meridian.
17	21 17		80 1 42				

1894	Hw	M. T.—Hw	N. Lat.	E. Long.	$\frac{d\varphi}{dt}$	$\frac{1}{15}\frac{dt}{d\varphi}$	Remarks
	h m	h m s	° ′ ″	° ′			
Feb. 18	2 16	8 13 10	[80 1 42]	133 45		— 0.082	
19	21 22	8 14 7	80 3 44	133 59.5			
21	21 43	[8 13 24]	80 9 39	[133 49]			
21	23 30	8 13 24	80 9 53	133 49			Cloudy, 2 hours between the stars.
23	21 33	8 14 17	80 5 46	134 2			
Feb. 26	23 15	8 20 32	80 4 26	135 36			
Mar. 3	23 0	8 17 3	79 55 38	134 43			
5	23 25	8 17 36	79 51.4	134 51			
7	15 56		79 47.6				
8	0 22	8 14 10	[79 45.0]	134 0		— 0.140	Not a good obs.
Mar. 8	15 56		79 44.0				
10	0 34	8 15 59	79 42.8	134 27			
13	0 36	8 14 25	79 38.9	134 3			
15	0 32	8 18 51	79 38 30	135 10			
17	15 50		79 38				
Mar. 19	0 6	8 18 59	79 39 6	135 12			
22	15 49		80 1				
23	0 21	8 16 56	80 0 35	134 41			See Remark [2]) p. 63.
26	0 13	8 17 39	80 2 13	134 52			
26	15 48		80 4.7				
Mar. 27	15 47		80 4				
29	15 47		80 8.8				
30	15 46		80 5.6				
30	19 29	8 18 16	[80 5.6]	135 1		— 0.254	
31	0 7	8 18 3	[80 5.6]	134 58		— 0.051	Cloudy.
Apr. 1	15 46		80 13.0				
1	20 6	8 17 27	[80 13.0]	134 49		— 0.175	
2	15 46		80 9.2				
3	15 41	8 18 42	80 10	135 7.5			Foggy.
6	3 7	8 18 9	80 13 5	134 59			
Apr. 8	12 25	8 17 0	[80 15.0]	134 42		+ 0.314	
8	15 44		80 15.0				
8	19 14	8 17 7	[80 15.0]	134 44		— 0.286	
9	15 44		80 17.2				
14	12 14	8 12 17	[80 11.1]	133 31		+ 0.273	
Apr. 14	15 39	[8 12 17]	80 11.1	[133 31]			
16	12 50	8 9 35	[80 21.1]	132 50		+ 0.373	
16	15 53	[8 9 38]	80 21.0	[132 51]			
17	12 9	8 6 51	[80 25.0]	132 9		+ 0.251	
17	15 54		80 25.0				
Apr. 18	15 55		80 27.1				
19	12 15	8 4 27	[80 28.3]	131 33		+ 0.262	
19	15 56		80 28.3				
19	19 37	8 4 35	[80 28.3]	131 35		— 0.254	
20	15 56		80 28.1				
Apr. 20	20 51	8 2 49	[80 28.1]	131 8.5		— 0.101	
21	15 56		80 28.6				
22	15 55		80 27.6				
22	20 26	8 3 11	[80 27.6]	131 14		— 0.147	
23	15 54		80 29.1				

1894	Hw	M. T.—Hw	N. Lat.	E. Long.	$\frac{d\varphi}{dt}$	$\frac{1}{15}\frac{dt}{d\varphi}$	Remarks
	h m	h m s	° ′	° ′			
Apr. 25	11 41	8 4 53	[80 34.8]	131 39		+ 0.187	
25	15 53		80 34.8				
25	20 9	8 4 13	[80 34.8]	131 29		– 0.180	
26	15 53		80 35.6				
27	15 52		80 40.4				
Apr. 27	21 33	8 5 58	[80 40.4]	131 55.5		– 0.013	
28	15 52		80 42.6				
29	3 52		80 41.3				Midnight Sun.
29	12 8	8 4 40	[80 44.7]	131 36		+ 0.254	
29	15 53		80 44.7				
Apr. 29	19 40	8 4 23	[80 44.7]	131 32		– 0.247	
30	3 56		80 44.6				Midnight Sun.
30	15 54		80 46.2				
May 1	3 54		80 44.1				Midnight Sun.
1	15 54		80 47.1				
May 1	21 12	8 2 29	[80 47.1]	131 3		– 0.060	
2	3 55		80 46.1				Midnight Sun.
2	15 55		80 47.7				
3	3 56		80 47.0				Midnight Sun.
3	12 10	7 59 44	[80 50.7]	130 22		+ 0.247	
May 3	15 56		80 50.7				
3	19 45	8 1 59	[80 50.7]	130 56		– 0.241	
4	3 56		80 46.3				Midnight Sun.
4	15 56		80 48.4				
4	22 9	8 0 38	80 48.9	130 35.5			
May 5	3 57		80 46.0				Midnight Sun.
5	15 57		80 49.5				
7	12 16	7 59 23	[80 53.1]	130 17		+ 0.263	
7	15 57		80 53.1				
8	15 52	[7 59]	80 54.8	[130 11]			
May 9	15 58		80 54.2				
10	3 58		80 50.9				Midnight Sun.
10	12 44	7 58 26	[80 52.1]	130 2.5		+ 0.337	
10	15 58		80 52.1				
10	19 21	7 58 42	[80 52.1]	130 6.5		– 0.311	
May 11	15 57		80 51.6				
11	21 17	7 58 52	[80 51.6]	130 9		– 0.050	
12	3 58		80 51.5				Midnight Sun.
12	16 1	[7 56 30]	80 52.4	[129 34]			
13	4 1		80 51.1				Midnight Sun.
May 13	16 7	[7 54]	80 53.4	[128 56]			
14	12 28	7 51 56	[80 56]	128 25		+ 0.268	
16	21 19	7 44 54	[81 2]	126 39		– 0.074	
19	16 15		81 12.5				
20	4 15		81 14.6				Midnight Sun.
May 20	12 29	7 43 9	[81 20.7]	126 13		+ 0.266	
20	16 15		81 20.7				
20	20 1	7 40 3	[81 20.7]	125 26		– 0.265	
21	16 16		81 24.0				
22	16 17	[7 30]	81 26.8	[122 56]	+ 0.007		

1894	Hw	M. T. – Hw	N. Lat.	E. Long.	$\frac{d\varphi}{dt}$	$\frac{1}{15}\frac{dt}{d\varphi}$	Remarks
	h m	h m s	° ′ ″	° ′			
May 23	17 41	[7 30 30]	81 32.6	[123 3]	– 0.054		
23	22 50	7 30 26	[81 32.6]	123 2		+ 0.021	
25	10 17	7 30 57	[81 30.6]	123 10		– 0.044	
25	14 51	7 30 26	[81 30.6]	123 2		+ 0.944	
25	16 27		81 30.6				
May 25	22 34	7 30 13	[81 30.6]	122 59		+ 0.041	
26	16 28		81 32.0				
27	16 29		81 34.6				Natural Horizon.
27	16 57	[7 28 20]	81 33.4	[122 30]	– 0.018		Hazy.
27	22 4	7 28 11	[81 34.6]	122 28		– 0.023	
May 31	20 30	7 27 16	[81 30.8]	122 14		– 0.229	
June 1	4 22	[7 27 10]	81 30.8	[122 12]			Midnight Sun.
2	16 31		81 30.2				
3	13 16	7 27 1	[81 31.1]	122 10		+ 0.356	
3	16 31		81 31.1				
June 4	4 23	[7 26 40]	81 28.3	[122 5]	+ 0.009		Midnight Sun.
4	12 40	7 26 32	[81 29.3]	122 3		+ 0.246	
4	16 44	[7 26 30]	81 29.3	[122 2]	– 0.008		
4	19 11	7 26 28	[81 29.3]	122 2		– 0.493	
4	22 55	7 25 12	[81 29.3]	121 43		+ 0.071	
June 4	23 3	7 27 11	[81 29.3]	122 12		+ 0.090	Natural Horizon.
5	16 39	[7 27 0]	81 28.7	[122 10]			
5	17 18	[7 27 0]	81 28.6	[122 10]	– 0.032		
5	23 53	7 27 1	[81 28.6]	122 10		+ 0.195	
6	12 29	7 27 1	[81 27.6]	122 10		+ 0.219	
June 6	16 32		81 27.6				
6	22 35	7 27 1	[81 27.6]	122 10		+ 0.035	
7	13 20	7 26 53	[81 28.1]	122 8		+ 0.362	
7	16 32		81 28.1				
7	16 44	[7 26 50]	81 28.5	[122 7]	– 0.008		
June 7	17 19	[7 26 50]	81 28.2	[122 7]	– 0.034		
7	22 31	7 26 44	[81 28.1]	122 5		+ 0.026	
9	22 27	7 26 55	[81 35.9]	122 8		+ 0.018	
10	4 18	[7 26 40]	81 35.9	[122 4]	+ 0.009		Midnight Sun.
10	16 36		81 38.4				
June 10	16 58	[7 27 0]	81 38.6	[122 9]	– 0.018		
11	17 34	[7 27 0]	81 42.8	[122 9]	– 0.043		
12	13 34	7 27 22	[81 46.2]	122 14		+ 0.428	
12	16 32		81 46.2				
12	21 52	7 27 17	[81 46.2]	122 13		– 0.053	
June 15	12 29	7 25 51	[81 52.0]	121 51		+ 0.223	
15	13 53	7 25 38	[81 52.0]	121 48		+ 0.504	
15	16 35		81 52 3				Altazimuth.
15	16 35		81 51.6				Sextant.
16	22 41	7 24 8:	[81 52.0]	121 25:		+ 0.039	
June 17	16 36		81 52.0				
20	17 11	[7 24 30]	81 48.6	[121 31]	– 0.024		
21	20 35	7 25 8	[81 45.5]	121 40		– 0.236	
21	22 31	7 25 10	[81 45.5]	121 40		+ 0.018	
22	13 28	7 24 32	[81 43.6]	121 30		+ 0.384	

1894	Hw	M. T.—Hw	N. Lat.	E. Long.	$\frac{d\varphi}{dt}$	$\frac{1}{15}\frac{dt}{d\varphi}$	Remarks
	h m	h m s	° ′	° ′			
June 22	16 37		81 43.6				
23	16 27	[7 23 30]	81 41.7	[121 15]	+ 0.008		
23	16 39		81 41.8				
23	16 48	[7 23 30]	81 41.8	[121 15]	— 0.006		
24	12 36	7 22 12	[81 39.2]	120 55		+ 0.219	
June 24	13 9	7 22 27	[81 39.2]	120 59		+ 0.310	
24	16 39		81 39.2				
25	17 11	[7 22 50]	81 36.7:	[121 4]	— 0.021		
26	21 49	7 23 20	[81 35.3]	121 12		— 0.072	
26	21 58	7 23 23	[81 35.3]	121 13		— 0.054	
June 26	22 4	7 23 17	[81 35.3]	121 11		— 0.040	
27	4 11	[7 23 20]	81 34.6	[121 12]	+ 0.019		
27	4 19	[7 23 20]	81 35.2	[121 12]	+ 0.013		
30	10 16	7 30 23	[81 33.3]	122 57		— 0.062	
30	16 33		81 33.3				
June 30	16 53	[7 30 40]	81 33.2	[123 1]	— 0.014		
30	23 30	7 31 0	[81 33.3]	123 6		+ 0.145	
July 1	16 32		81 31.6				
2	20 28	7 32 26	[81 35.1]	123 28		— 0.238	
2	23 56	7 31 57	[81 35.1]	123 21		+ 0.203	
July 3	4 23	[7 32]	81 35.1	[123 21]			
3	16 30		81 33.7				
4	1 51	7 34 5	[81 33.7]	123 52		+ 0.592	
4	2 1	7 34 4	[81 33.7]	123 52		+ 0.646	
4	2 19	7 34 7	[81 33.7]	123 53		+ 0.759	
July 4	13 15	7 34 39	[81 32.7]	124 1		+ 0.358	
4	16 20	[7 34 45]	81 33.6	[124 2]	+ 0.007		
4	16 29		81 32.7				
4	16 39	[7 34 45]	81 32.7	[124 2]	— 0.006		
4	22 47	7 34 59	[81 32.7]	124 6		+ 0.062	
July 5	12 34	7 36 19	[81 31.0]	124 26		+ 0.242	
5	16 28		81 31.0				
6	1 20	7 37 36	[81 31.0]	124 45		+ 0.459	
7	12 18	7 36 16	[81 22.2]	124 25		+ 0.196	
7	12 27	7 36 10	[81 22.2]	124 23		+ 0.217	
July 7	16 28		81 22.2				
7	22 28	7 36 39	[81 22.2]	124 30		+ 0.028	Cloudy.
8	16 28		81 19.5				
9	13 15	7 36 45	[81 18.3]	124 32		+ 0.352	
9	13 23	7 36 46	[81 18.3]	124 32		+ 0.378	
July 9	16 37	[7 36 47]	81 18.3	[124 32]			
10	12 45	7 37 10	[81 18.9]	124 38		+ 0.263	
10	16 28		81 18.9				
11	16 31	[7 37 0]	81 22.1	[124 36]			
11	16 50	[7 37 0]	81 22.3	[124 36]	— 0.016		
July 11	23 26	7 37 5	[81 22.3]	124 37		+ 0.141	
11	23 32	7 36 56	[81 22.3]	124 35		+ 0.153	
12	12 26	7 36 52	[81 25.5]	124 33		+ 0.219	
13	12 14	7 38 40	[81 32.2]	125 0		+ 0.197	
13	12 21	7 38 38	[81 32.2]	125 0		+ 0.214	

1894	Hw	M. T.—Hw	N. Lat.	E. Long.	$\frac{d\varphi}{dt}$	$\frac{1}{15}\frac{dt}{d\varphi}$	Remarks
	h m	h m s	° ′	° ′			
July 13	16 27		81 32.2				
14	1 37	7 38 34	[81 32.2]	124 59		+ 0.594	
14	16 12	[7 39]	81 33.4	[125 5]	+ 0.010		
14	16 27		81 33.7:				
15	16 10	[7 39]	81 31.8	[125 5]	+ 0.012		
July 15	16 27		81 31.8				
16	12 27	7 39 29	[81 26.3]	125 12		+ 0.227	
16	16 28	[7 39 29]	81 26.3	[125 12]			Cloudy.
17	16 27		81 26.2				
20	17 51	[7 39 0]	81 31.5	[125 5]	— 0.061		
July 20	21 48	7 38 51	[81 31.5]	125 2		— 0.053	
21	0 20	7 39 12	[81 31.5]	125 7		+ 0.268	
21	0 29	7 39 11	[81 31.5]	125 7		+ 0.292	
21	22 5	7 38 46	[81 28.0]	125 1		— 0.018	
21	22 13	7 38 46	[81 28.0]	125 1		— 0.004	
July 22	13 41	7 38 49	[81 26.2]	125 1		+ 0.461	
22	16 1	[7 38 49]	81 26.2	[125 1]	+ 0.018		
22	16 27		81 26.2				
22	21 46	7 39 9	[81 26.2]	125 6		— 0.056	
23	16 30	[7 40]	81 23.9	[125 19]			
July 24	16 59	[7 41]	81 21.1	[125 34]	— 0.050		
25	18 20	[7 42 46]	81 17.1	[126 0]	— 0.090		
25	22 7	7 42 48	[81 17.2]	126 1		— 0.008	
26	23 49	7 40 26	[81 13]	125 25		+ 0.229	
27	15 28	[7 42 30]	81 11.0	[125 56]	+ 0.041		
July 27	16 28	[7 42 30]	81 11.0	[125 56]			
27	21 46	7 42 32	[81 11.0]	125 56		— 0.047	
28	16 6	[7 43]	81 7.2	[126 3]	+ 0.012		
28	16 24		81 7.1				
29	18 47	[7 43]	81 3.5	[126 3]	— 0.122		
July 29	22 18	7 42 54	[81 3.5]	126 2		+ 0.012	
30	12 9	7 43 56	[81 3]	126 17		+ 0.188	
30	12 14	7 44 3:	[81 3]	126 19:		+ 0.200	
30	19 43	7 43 14	[81 2.5]	126 7		— 0.325	
30	19 53	7 43 14	[81 2.5]	126 7		— 0.296	
July 31	16 14	[7 45]	81 2.5	[126 33]			
Aug. 2	15 7	[7 48]	81 5.0	[127 18]	+ 0.053		Indistinct limbs.
2	16 18		81 5.2				
2	23 13	7 48 5	[81 5.2]	127 19		+ 0.192	
3	12 48	7 49 0	[81 6.3]	127 33		+ 0.303	
Aug. 3	16 17		81 6.3				
3	19 49	7 48 17	[81 6.3]	127 22		— 0.298	
4	16 17		81 7.4				
5	12 16	7 49 8	[81 8.0]	127 35		+ 0.221	
5	16 17		81 8.0				
Aug. 5	16 24	[7 48 55]	81 8.0	[127 32]			
5	20 15	7 48 41	[81 8.0]	127 28		— 0.227	
7	16 6	[7 48 30]	81 7.3	[127 25]	+ 0.008		
7	16 17		81 7.2				
8	15 58	[7 48 5]	81 5.4	[127 19]	+ 0.014		

1894	Hw	M. T.—Hw	N. Lat.	E. Long.	$\frac{d\varphi}{dt}$	$\frac{1}{15}\frac{dt}{d\varphi}$	Remarks
	h m	h m s	° ′ ″	° ′			
Aug. 8	16 17		81 5.4				
8	20 34	7 48 7	[81 5.4]	127 19		— 0.185	
9	16 16		81 3.6				
9	16 22	[7 49 0]	81 3.6	[127 32]			
10	12 11	7 49 54	[81 4.6]	127 45		+ 0.213	
Aug. 10	16 12	[7 50 0]	81 4.8	[127 47]			
10	16 15		81 4.6				
10	20 16	7 50 13	[81 4.6]	127 50		— 0.241	Cloudy.
11	16 14		81 4.3				
12	16 14		81 4.3				Indistinct image.
Aug. 13	12 48	7 50 41	[81 5.6]	127 57		+ 0.318	Snow drift.
13	16 39	[7 50 41]	81 5.6	[127 57]	— 0.018		
14	11 54	7 50 11	[81 6.6]	127 49		+ 0.181	
14	19 9	[7 50 19]	81 6.6	[127 51]	— 0.157		
16	15 43	[7 51 0]	81 5.0	[128 1]	+ 0.022		
Aug. 16	16 13		81 6.3				
17	14 53	7 51 36	[81 4.9]	128 10		+ 1.136	
17	15 22	[7 51 36]	81 4.8	[128 10]	+ 0.036		
17	16 12		81 5.0				
17	20 49	7 51 26	[81 4.9]	128 7		— 0.145	
Aug. 18	16 12		81 5.0				
20	13 0	7 51 21	[81 4.3]	128 6		+ 0.363	
20	16 12		81 4.3				
21	16 30	[7 51 0]	81 1.5	[128 1]	— 0.013		
22	12 4	7 51 2	[81 2.1]	128 1		+ 0.210	
Aug. 22	12 10	7 51 6	[81 2.1]	128 2		+ 0.225	
22	16 3	[7 51 0]	81 2.1	[128 1]			
22	16 11		81 2.1				
24	22 24	7 50 12:	[81 1.3]	127 48:		+ 0.036	Bad conditions.
25	14 39	7 49 48	[81 1.1]	127 42		+ 0.950	Image not sharp.
Aug. 25	16 3	[7 49 30]	81 1.1	[127 38]			
25	16 12		81 1.1				
25	21 8	7 48 55	[81 1.1]	127 29		— 0.109	
27	13 36	7 49 33	[80 53.6]	127 38		+ 0.498	Bad image.
27	16 4	[7 49 33]	80 53.6	[127 38]			Cloudy.
Aug. 27	16 12		80 53.6				Cloudy.
29	16 28	[7 45]	81 7.7	[126 30]	— 0.009		
Sep. 3	12 52	7 33 36	[81 14.1]	123 38		+ 0.312	
3	16 42	[7 33]	81 14.0	[123 30]	— 0.010		
3	21 4	7 32 42	[81 14.1]	123 25		— 0.154	
Sep. 5	17 11	[7 30 0]	81 10.9	[122 44]	— 0.030		
7	22 40	7 28 7	[81 5]	122 16		+ 0.021	
8	17 4	[7 26 58]	81 3.8	[121 59]	— 0.025		
8	17 26	7 26 58	[81 3.8]	121 59		— 1.602	
12	13 8	7 23 19:	[81 15:]	121 4:		+ 0.343	
Sep. 15	4 13	7 37 26	81 18 52	124 35			
17	2 38	7 35 15	81 22 18	124 2			
18	16 48	[7 34 0]	81 14.6	[123 43]	— 0.019		
20	2 17	7 33 27	81 11 42	123 35			
24	5 15	7 29 11	81 20 44	122 31			

1894	Hw	M. T.—Hw	N. Lat.	E. Long.	$\frac{d\varphi}{dt}$	$\frac{1}{15}\frac{dt}{d\varphi}$	Remarks
	h m	h m s	° ′ ″	° ′			
Sep. 28	1 15	7 27 14	81 12 50	122 1			
28	1 58	[7 27 14]	81 12 52	[122 1]	— 0.038		
Oct. 1	0 44	7 27 17	81 4 59	122 2			
3	0 48	7 27 25	81 4 39	122 4			
7	0 26	7 20 8	81 18 29	120 14			
Oct. 10	1 35	7 18 43	81 16 14	119 53			
13	0 21	7 12 1	81 32 52	118 12			
15	0 29	7 5 7	81 36 51	116 28			
17	0 12	7 1 56	81 43 30	115 40			
20	8 57	6 58 39	82 0 14	114 51			
Oct. 20	9 25	[6 58 39]	82 0 11	[114 51]			
25	2 50	6 57 49	82 4 2	114 38			
27	1 15	6 57 37	82 4 2	114 35			
29	0 51	6 52 9	82 11 13	113 13			
30	22 50	6 48 46	82 6 32	112 22			
Nov. 1	22 19	6 46 16	82 5 31	111 44			
4	22 8	6 43 15	82 6 1	110 59			
7	23 11	6 43 16	82 9 0	110 59			
10	1 12	6 42 4	82 11 30	110 41			
12	22 55	6 39 44	82 7 46	110 6			
Nov. 17	1 45	6 43 0	82 5 35	110 55			
21	16 29	6 48 23	82 0 47	112 15			
21	22 48	6 47 42	82 0 5	112 5			
24	1 33	6 47 15	81 57 46	111 58			
26	23 19	6 45 11	82 9 11	111 27			
Nov. 28	23 6	6 42 42	82 9 44	110 49.5			
30	23 9	6 41 41	82 10 8	110 34			
Dec. 3	22 59	6 39 12	82 13 5	109 56.5			
5	23 17	6 36 16	82 20 8	109 12.5			
7	22 57	6 34 17	82 20 46	108 42.5			
Dec. 11	23 4	6 33 4	82 30 39	108 24			Cirro-stratus.
14	23 1	6 30 0	82 34 25	107 38			
16	23 5	6 23 2	82 50 35	105 53			
18	23 30	6 18 29	82 50 29	104 45			
21	1 16	6 15 44	82 54 28	104 3.5			
Dec. 24	15 58	[6 7 20]	83 23.5	[101 57]	+ 0.060		Cloudy.
24	17 5	6 7 20	83 23 11	101 57			
24	22 6	6 6 31	83 23 46	101 45			
26	22 28	6 9 20?	83 22 7	102 27?			Long. 101° 1′?
28	22 55	6 7 8	83 18 50	101 54			
30	22 17	6 9 5	83 20 52	102 23			
1895							
Jan. 2	22 34	6 10 35	83 25 25	102 45			
5	21 36	6 12 27	83 33 58	103 13			
8	21 22	6 11 41	83 40 29	103 1.5			
11	21 39	6 10 43	83 41 30	102 47			
13	21 49	6 13 19	83 27 0	103 26			
Jan. 14	1 41	6 14 11	83 28 4	103 38.5			
16	21 42	6 11 46	83 23 12	103 2			
18	20 57	6 7 37	83 25 48	101 59.5			
20	23 32	6 8 9	83 22 36	102 7			
22	23 5	6 8 35	83 23 36	102 14			

1895	Hw	M. T.—Hw	N. Lat.	E. Long.	$\frac{d\varphi}{dt}$	$\frac{1}{15}\frac{dt}{d\varphi}$	Remarks
	h m	h m s	° ′ ″	° ′			
Jan. 25	22 24	6 8 20	83 25 1	102 10			
27	23 12	6 9 59	83 29 59	102 34			
30	22 39	6 12 50	83 41 3	103 17			
Feb. 1	22 47	6 11 29	83 43 26	102 56.5			
4	22 25	6 12 10	83 33 15	103 6.5			
Feb. 5	22 10	6 11 30	83 32 2	102 56.5			
6	23 31	6 9 57	83 31 31	102 33			
8	17 35	6 11 8	83 33 31	102 51			
12	0 38	6 13 23	83 24 44	103 24			
13	21 33	6 12 13	83 25 57	103 6.5			
Feb. 17	22 37	6 11 36	83 32 16	102 57			
20	22 32	6 11 46	83 39 59	102 59			
23	22 32	6 8 21	83 46 54	102 7.5			
"	22 57	6 8 20	83 46 40	102 7			
24	22 24	6 8 11	83 47 25	102 5			
Feb. 26	22 25	6 7 14	83 52 53	101 50.5			
Mar. 2	1 9	6 6 2	84 3 40	101 32			
4	1 7	6 5 3	84 4 35	101 17			
6	1 27	6 6 55	84 2 36	101 45			
9	1 3	6 8 38	83 58 24	102 10.5			
Mar. 11	0 55	6 8 51	83 58 58	102 13.5			
13	0 51	6 7 5	84 3 56	101 47			
16	0 59	6 3 22	84 7 50	100 51			
19	2 36	6 1 54	84 8 53	100 28			
21	2 24	6 1 52	84 8 51	100 28			
Mar. 23	2 25	6 0 39	84 8 44	100 9			
25	2 18	5 59 18	84 8 34	99 49			
27	2 16	5 58 24	84 8 10	99 35			
29	2 12	5 56 54	84 7 24	99 12.5			
Apr. 1	4 1	5 57 2	84 11 1	99 15			4 hours between the stars.
Apr. 3	5 50	5 53 33	84 15 14	98 22.5			
5	18 16		84 17.9				
6	5 34	5 46 47	[84 17.8]	96 40		— 0.094	
6	18 20	[5 46 40]	84 18.5	[96 38]	— 0.002		
7	18 15		84 17.5				
Apr. 8	5 56	5 46 53	[84 17.4]	96 41		— 0.005	
9	18 15		84 16.6				
10	5 25	5 47 14	[84 16.7]	96 46		— 0.072	
13	18 19	[5 47 44]	84 16.9	[96 53]			
13	23 43	5 47 44	[84 17.0]	96 53		— 0.075	
Apr. 16	18 16		84 16.6				
16	18 28	[5 43 35]	84 16.6	[95 50.5]	— 0.005		
16	23 12	5 43 35	[84 16.6]	95 50.5		— 0.180	
18	18 21		84 14.2				
18	23 51	5 37 59	[84 14.2]	94 26		— 0.073	
Apr. 19	0 5	5 37 57	[84 14.2]	94 26		— 0.033	
20	18 21		84 12.5				
21	18 20		84 12.6				
21	18 26	[5 38 41]	84 12.7	[94 36]			
21	23 34	5 38 41	[84 12.6]	94 36		— 0.117	

1895	Hw	M. T.−Hw	N. Lat.	E. Long.	$\frac{d\varphi}{dt}$	$\frac{1}{15}\frac{dt}{d\varphi}$	Remarks
	h m	h m s	° ′	° ′			
Apr. 23	18 21		84 13.4				
23	18 35	[5 38 6]	84 13.3	[94 27]	− 0.007		
23	23 48	5 38 6	[84 13.4]	94 27		− 0.077	
26	18 22		84 12.2				
27	0 0	5 35 7	[84 12.2]	93 42		− 0.048	
Apr. 27	0 9	5 35 11	[84 12.2]	93 43		− 0.021	
28	18 20		84 16				Index error not
29	0 3	5 37.0	[84 16.3]	94 10		− 0.033	determined. As-
30	13 55	5 33.1	[84 13.4]	93 12		+ 0.258	sumed 0′ 0″.
30	18 24		84 13				
May 1	18 23		84 16.5				
3	14 51	5 34 21	[84 25.3]	93 30		+ 0.492	
3	18 31	[5 34 21]	84 25.3	[93 30]			
3	18 40	[5 34 21]	84 25.4	[93 30]	− 0.008		
3	23 35	5 32 53	[84 25.4]	93 8		− 0.129	
May 6	18 31		84 31.4				
7	14 5	5 23 17	[84 33.5]	90 43		+ 0.275	
7	14 9	5 23 13	[84 33.5]	90 42		+ 0.288	
7	18 33		84 33.5				
10	14 13	5 20 6	[84 38.3]	89 55		+ 0.297	
May 10	18 36		84 38.3				
11	0 35	5 19 31	[84 38.3]	89 46		+ 0.016	
13	14 33	5 13 30	[84 39.1]	88 15.5		+ 0.348	
13	18 43		84 39.1				
13	23 18	5 13 32	[84 39.1]	88 16		− 0.252	
May 15	14 19	5 12 0	[84 37.3]	87 53		+ 0.288	
15	18 44		84 37.3				
16	0 26	5 11 28	[84 37.3]	87 44.5		− 0.034	
17	18 46		84 37.4				
18	0 24	5 7 17	[84 37.4]	86 41.5		− 0.055	
May 19	14 55	5 1 44	[84 33.3]	85 18		+ 0.380	
19	18 55		84 33.3				
21	21 14	[4 56 0]	84 40.3	[83 51]	− 0.064		
21	21 20	4 55 59	[84 40.3]	83 51		− 0.979	Cloudy.
23	1 11	4 53 24	[84 41.7]	83 12.5		+ 0.050	
May 23	6 49	[4 53 24]	84 41.8	[83 12.5]	+ 0.006		Cirro-stratus.
23	6 57	”	84 41.7	”			Bad image.
23	7 12	”	84 41.6	”			
23	19 6		84 41.4				
24	3 37	4 50 11	[84 41.4]	82 24		+ 0.583	
May 24	19 7		84 40.1				
27	0 18	4 48 42	[84 37]	82 1		− 0.132	
29	2 52	4 50 10	[84 33.5]	82 23		+ 0.375	Bad image.
29	7 8		84 33.5				
29	7 34	[4 50 10]	84 33.6	[82 23]	− 0.011		
May 29	19 5		84 33.8				
31	1 34	4 55 18	[84 36]	83 40		+ 0.126	
31	14 50	4 56 24	[84 38.0]	83 56		+ 0.335	
31	19 1		84 38.0				
31	23 10	4 56 44	[84 38.0]	84 1		− 0.342	

1895	Hw	M. T.—Hw	N. Lat.	E. Long.	$\frac{d\varphi}{dt}$	$\frac{1}{15}\frac{dt}{d\varphi}$	Remarks
	h m	h m s	° ′	° ′			
June 3	14 43	4 58 25	[84 34.4]	84 26		+ 0.310	
3	19 0		84 34.4				
6	14 32	4 58 43	[84 32.7]	84 30		+ 0.266	
6	19 0		84 32.7				
7	0 53	4 58 41	[84 32.7]	84 29.5		+ 0.008	
June 7	19 0		84 33.4				
8	0 51	4 58 48	[84 33.3]	84 31		+ 0.002	
10	14 45	4 53 5	[84 44.7]	83 5		+ 0.303	
10	20 9	[4 53 5]	84 44.7	[83 5]	— 0.026		
11	2 51	4 52 44	[84 44.7]	82 59.5		+ 0.387	
June 11	19 35	[4 52 21]	84 47.5	[82 54]	— 0.012		
11	23 56	4 51 7	[84 47.5]	82 35		— 0.206	Foggy, no distinct limb.
12	2 39	4 52 13	„	82 52		+ 0.339	
12	19 10		84 51.6				
13	0 1	4 48 36	[84 51.6]	81 57		— 0.203	
June 15	7 21		84 52.3				
15	15 10	4 38 51	[84 52.3]	79 30		+ 0.347	
17	14 59	4 38 18	[84 42.3]	79 22		+ 0.298	
17	19 3	[4 39 8]	84 42.3	[79 34]	+ 0.008		
17	19 22		84 42.4				
June 18	1 9	4 40 28	[84 42.3]	79 54		— 0.006	
19	19 19		84 32.3				
21	14 59	4 43 46	[84 31.7]	80 43		+ 0.296	Mercury trembling somewhat.
21	19 15		84 31.7				
22	0 45	4 42 39	[84 31.7]	80 26		— 0.074	
June 23	15 4	4 42 27	[84 29.6]	80 23		+ 0.309	
23	19 43	[4 42 27]	84 29.6	[80 23]	— 0.011		
26	15 17	4 33 50	[84 34.0]	78 13		+ 0.326	A single observation.
26	16 24	4 33 28	[84 34.0]	78 8		+ 0.628	
26	20 46	[4 33 28]	84 34.0	[78 8]	— 0.036		
June 28	19 12	[4 24]	84 32	[75 46]	+ 0.009		No distinct limb.
29	4 44	4 22 13	[84 31.9]	75 19		+ 0.762	
29	4 49	4 22 2	„	75 16		+ 0.787	
30	21 8	[4. 18 35]	84 39.3	[74 24]	— 0.037		
July 1	0 57	4 18 35	[84 39.3]	74 24		— 0.122	
July 2	7 45		84 40.9				
2	15 26	4 17 59	[84 40.9]	74 14.5		+ 0.309	
4	3 44	4 19 45	[84 42.9]	74 41		+ 0.445	A single observation.
4	7 31	[4 19 45]	84 42.9	[74 41]	+ 0.005		
4	7 41	„	84 42.9	„			
July. 4	19 40		84 43.0				
5	1 35	4 24 0	[84 43.0]	75 44		+ 0.011	
6	18 14	[4 19]	84 47.5	[74 29]	+ 0.040		
6	19 27	[4 19]	84 47.5	„	+ 0.008		
6	19 45		84 47.5				
July 7	1 15	4 19 4	[84 47.5]	74 30		— 0.071	
8	15 25	4 22 12	[84 45.1]	75 17		+ 0.317	
8	15 31	4 22 10	„	75 16		+ 0.342	
8	19 43		84 45.1				
11	2 44	4 25 10	[84 40.8]	76 1		+ 0.234	

1895	Hw	M. T.−Hw	N. Lat.	E. Long.	$\frac{d\varphi}{dt}$	$\frac{1}{15}\frac{dt}{d\varphi}$	Remarks
	h m	h m s	° ′	° ′			
July 11	7 40		84 40.8				
11	19 56	[4 25 4]	84 40.6	[75 59]	− 0.007		
12	1 26	4 25 4	[84 40.6]	75 59		− 0.017	
12	2 47	4 25 9	"	76 0		+ 0.242	
12	19 40		84 40.6				
July 13	2 32	4 25 12	[84 40.6]	76 1		+ 0.191	
16	10 10	[4 22 30]	84 42.4	[75 20]	− 0.067		
16	16 9	4 22 3	[84 42.1]	75 13		+ 0.497	Dew on art. horizon.
16	16 12	4 21 58	"	75 12		+ 0.512	Ice in motion.
16	16 16	4 21 59	"	75 12		+ 0.528	
July 16	16 19	4 22 1	[84 42.1]	75 12.5		+ 0.546	
16	19 44		84 42.1				
18	16 31	4 17 3	[84 40.4]	73 57.5		+ 0.579	Dew on art. horizon.
18	16 36	4 17 1	[84 40.4]	73 57		+ 0.601	
18	19 39	[4 17 0]	84 40.4	[73 57]			
July 18	19 49		84 40.3				
19	1 15	4 16 30	[84 40.3]	73 49		− 0.083	
21	15 30	4 11 52	[84 36.3]	72 39.5		+ 0.288	
21	19 54		84 36.3				
23	15 25	4 9 9	[84 31.8]	71 58		+ 0.254	
July 23	15 32	4 9 15	[84 31.8]	72 0		+ 0.281	
23	19 57		84 31.8				
24	1 47	4 8 37	[84 31.8]	71 50		− 0.007	
26	15 56	4 14 58	[84 29.3]	73 25		+ 0.392	
26	19 40	[4 14 58]	84 29.4	[73 25]	+ 0.005		
July 26	19 55	"	84 29.3	"			
28	20 12	[4 17 0]	84 31.9	[73 55]	− 0.010		No distinct limb.
29	16 37	4 18 27	[84 33.7]	74 17		+ 0.604	
29	19 54	[4 18 27]	84 33.4	[74 17]			Sun visible in glimpses.
29	20 33	"	84 33.7	"	− 0.020		
July 30	15 43	4 23 36	[84 28.2]	75 34		+ 0.373	5 altitudes.
30	15 52	4 23 43	"	75 36		+ 0.412	2 altitudes.
30	19 30	[4 24]	84 28.1	[75 40]	+ 0.005		
30	19 42		84 28.1				
30	19 56	[4 24]	84 28.2	"	− 0.006		
July 31	1 41	4 25 4	[84 28.2]	75 56		+ 0.022	
Aug. 1	19 34		84 31.0				
1	19 44	[4 32 2]	84 31.0	[77 40]	− 0.004		
2	1 31	4 32 2	[84 31.0]	77 40		+ 0.012	
2	19 32		84 34.8				
Aug. 3	1 32	4 32 58	[84 34.8]	77 54		+ 0.017	
5	22 38	[4 31 15]	84 38.5	[77 28]	− 0.100		
6	3 18	4 31 15	[84 38.5]	77 27.5		+ 0.366	
6	15 55	4 30 59	[84 37.9]	77 23.5		+ 0.475	
6	16 1	4 30 58	"	77 23		+ 0.500	
Aug. 6	22 58	[4 31]	84 37.9	[77 24]	− 0.121		
7	19 19	[4 31]	84 37.9	[77 24]	+ 0.006		
7	19 35		84 38.0				
8	1 34	4 29 50	[84 38.0]	77 6		+ 0.015	
9	15 55	4 28 51	[84 34.0]	76 51		+ 0.463	

1895	Hw	M. T. − Hw	N. Lat.	E. Long.	$\frac{d\varphi}{dt}$	$\frac{1}{15}\frac{dt}{d\varphi}$	Remarks
	h m	h m s	° ′ ″	° ′			
Aug. 9	19 36		84 34.0				
9	19 45	[4 29]	84 34.0	[76 53]			
10	1 26	4 29 5	[84 33.9]	76 54		− 0.012	
12	19 46	[4 26 33]	84 31.1	[76 16]			
12	19 52	"	84 31.0	"	− 0.006		
Aug. 13	1 18	4 27 6:	[84 31.0]	76 24:		− 0.042	A single observation;
13	1 30	4 26 29	"	76 15		− 0.006	perhaps double alti-
13	1 38	4 26 37	"	76 17		+ 0.016	tude 1′ or 2′ too small.
14	15 18	4 24 58	[84 28.3]	75 52		+ 0.296	
14	19 39		84 28.3				
Aug. 16	16 6	4 23 17	[84 25.4]	75 26		+ 0.481	A single obs. Cloudy.
16	19 22	[4 23 17]	84 25.4	[75 26]	+ 0.008		
16	19 41		84 25.4				
18	15 34	4 26 9	[84 19.4]	76 9		+ 0.355	
18	19 45	[4 26 9]	84 19.4	[76 9]			Cloudy; ice in motion.
Aug. 19	19 44	4 31 0	84 17.8	77 21.5			
21	3 3	4 35 12	[84 12.1]	78 24		+ 0.320	Natural horizon.
21	16 7	4 35 47	[84 10]	78 33		+ 0.509	
21	19 28	4 38 17	84 9.2	79 10			
22	19 36	[4 38]	84 10.6	[79 6]	− 0.005		
Aug. 23	19 6	[4 38]	84 12.6	[79 6]	+ 0.008		
23	19 25		84 12.9				
24	19 3	[4 36 37]	84 17.6	[78 45]	+ 0.010		
24	19 25		84 17.8				
24	23 54	4 36 42	[84 17.8]	78 46		− 0.267	
Aug. 25	0 2	4 36 32	[84 17.8]	78 43.5		− 0.241	
Sep. 1	15 34	4 29 5	[84 47.6]	76 50		+ 0.428	Sun visible in glimp-
1	19 11	[4 29 36]	84 47.5	[76 58]	+ 0.008		ses.
1	19 30		84 47.6				
1	23 39	4 30 7	[84 47.6]	77 6		− 0.371	
Sep. 3	19 40	[4 32 26]	84 53.8	[77 40]	− 0.005		Cloudy.
3	20 5	"	84 53.8	"	− 0.015		
3	23 41	4 32 15	[84 53.8]	77 37.5		− 0.363	
3	23 58	4 32 26	"	77 40		− 0.296	
4	19 25		84 51.9				
Sep. 4	22 44	4 36 0	[84 51.9]	78 34		− 0.607	
5	19 21		84 52.7				
5	23 35	4 36 47	[84 52.7]	78 45		− 0.365	
10	20 37	[4 35 27]	84 58 40	[78 24]	− 0.030		
10	23 30	4 35 27	[84 58 40]	78 24		− 0.396	Cloudy.
Sep. 14	17 55	[4 37]	85 6 44	[78 47]	+ 0.033		Not a good observation.
15	17 59	[4 38]	85 7 39	[79 1]	+ 0.030		Cloudy, not a good obs.
16	16 56	[4 39]	85 3 12	[79 16]	+ 0.061		
18	1 29	4 40 23	[85 3]	79 37		+ 0.053	
Sep. 19	21 26	[4 41 30]	85 2 51	[79 54]	− 0.058		
21	6 11	4 42 18	[85 5 20]	80 5.5		+ 0.119	Cloudy and hoar frost.
21	20 4	[4 41 45]	85 5 27	[79 57]	− 0.020		
22	6 4	4 41 17	85 6 57	79 50			
24	6 19	4 38 0	85 7 9	79 0.5			

1895	Hw	M. T.—Hw	N. Lat.	E. Long.	$\frac{d\varphi}{dt}$	$\frac{1}{15}\frac{dt}{d\varphi}$	Remarks
	h m	h m s	° ′ ″	° ′			
Sep. 28	5 59	4 40 56	85 7 42	79 44			Thick hoar frost.
Oct. 3	3 19	4 37 52	85 11 45	78 57			
7	0 29	4 36 7	85 5 9	78 30.5			
7	3 5	4 36 11	85 5 15	78 31.5			
8	4 54	4 37 40	85 7 38	78 54			
Oct. 11	4 56	4 38 10	85 13 20	79 1			
14	3 1	4 36 34	85 24 3	78 36			
16	22 59	4 35 46	85 36 59	78 24			
18	18 21	4 34 36	85 44 54	78 6.5			
19	2 8	4 33 56	85 45 22	77 56.5			
Oct. 21	3 19	4 29 52	85 46 6	76 55			
22	19 25	4 19 58	85 46 20	74 26.5			} Same star east.
22	19 35	4 20 1	85 46 20	74 27			
22	19 50	4 19 45	[85 46 20]	74 23		— 0.073	A single alt. of Jupiter.
24	18 51	4 13 49	85 46 12	72 54			ε Cass. and ι Ursæ Maj.
Oct. 24	19 3	4 13 44	85 46 7	72 53			α Drac. and α Cygni.
28	1 28	4 16 56	85 46 5	73 40.5			3 stars; ice in motion.
29	19 2	4 4 15	85 44 40	70 30			
31	19 11	4 3 33	85 38 46	70 19			3 stars.
Nov. 3	19 8	3 58 48	85 42 26	69 8			ε Cass. and α Cygni.
Nov. 3	19 19	3 58 53	85 42 28	69 9			α Drac. and ι Ursæ Maj.
4	0 22	3 58 20	85 41.8	69 1			Moon and Jupiter.
5	20 10	3 53 0	85 41 34	67 40.5			
7	19 15	3 40 25	85 41 42	64 32			3 stars.
9	4 9	3 39 46	85 42 27	64 22			
Nov. 11	7 9	3 45 39	85 51 31	65 50			
13	1 49	3 49 21	85 54 28	66 45			3 stars.
14	1 54	3 49 39	85 55 45	66 49.5			
15	1 28	3 46 55	85 55 50	66 8			
18	1 10	3 43 22	85 53 27	65 15			4 stars.
Nov. 19	21 24	3 39 38	85 50 45	64 18.5			
22	2 9	3 39 6	85 47 17	64 10.5			
22	20 57	3 37 46	85 48 11	63 50.5			
24	20 37	3 32 45	85 47 29	62 35			
27	1 51	3 23 13	85 31 45	60 12			
Nov. 28	1 30	3 19 53	85 27 56	59 22			
30	2 20	3 17 10	85 28 32	58 41			
30	21 14	3 16 24	85 28 5	58 29			} Same star north.
30	21 22	3 16 6	85 28 4	58 25			
Dec. 1	2 7	3 14 40	[85 28 4]	58 3			
Dec. 3	1 54	3 12 17	85 28 47	57 27			
4	20 7	3 6 12	85 29 35	55 56			3 stars.
6	21 28	2 59 48	85 26 45	54 20			
9	1 23	2 57 50	85 25 18	53 50			} Same star south.
9	1 28	2 57 27	85 25 21	53 44			
Dec. 11	20 39	2 43 50	85 25 40	50 20			} Same star west.
11	20 55	2 43 50	85 25 24	50 20			
14	0 24	2 37 1	85 24 9	48 37			} Same star south.
14	0 32	2 37 16	85 24 21	48 41			
17	0 57	2 36 2	85 22 6	48 22			

1895	Hw	M. T.—Hw	N. Lat.	E. Long.	$\frac{d\varphi}{dt}$	$\frac{1}{15}\frac{dt}{d\varphi}$	Remarks
	h m	h m s	° ′ ″	° ′			
Dec. 19	1 26	2 33 58	85 17 33	47 51			Cirro-stratus.
20	21 50	2 34 48	85 14 56	48 3.5			} Same star south.
20	21 59	2 34 42	85 14 52	48 2			
24	22 5	2 34 36	85 20 14	48 0.5			
Dec. 27	21 35	2 34 18	85 23 55	47 56			} Same star south.
27	21 43	2 34 25	85 23 54	47 57.5			
29	21 30	2 31 16	85 23 16	47 10			
1896							
Jan. 2	1 36	2 24 4	85 18 13	45 22			
3	21 6	2 22 16	85 16 28	44 55			
5	20 51	2 22 4	85 16 33	44 52			} Same star south.
5	20 55	2 22 5	85 16 31	44 52			
6	1 54	2 21 29	85 16 42	44 43			
Jan. 7	20 55	2 13 34	85 11 55	42 44.5			3 stars.
9	21 1	2 7 44	84 58 7	41 17			
12	20 38	2 6 22	84 52 24	40 56.5			} Same star south.
12	20 43	2 6 25	84 52 24	40 57			
15	2 11	2 6 9	84 51 49	40 53			
Jan. 16	2 15	2 4 40	84 51 56	40 31			
19	1 48	2 0 0:	84 57 53:	39 20:			Cloudy, obs. difficult.
20	20 50	1 57 20	84 59 5	38 40			} Same star south.
20	20 54	1 57 47	84 59 3	38 47			
22	20 45	1 52 0	84 57 58	37 20			
Jan. 24	20 37	1 37 15	84 56 48	33 39			
26	20 45	1 29 1	84 40 23	31 35			
28	23 0	1 29 52	84 42 10	31 48			
30	22 55	1 24 23	84 51 34	30 25			} Same star south.
30	23 0	1 25 0	84 51 32	30 34.5			
Feb. 2	23 12	1 4 7	84 47 23	25 21			
4	23 1	1 1 14	84 39 10	24 38			
7	21 59	1 0 52	84 37 43	24 32			ε Cass. and α Cygni.
7	22 7	1 0 47	84 37 14	24 31			α Drac. and ι Ursæ Maj.
10	21 42	1 2 40	84 31 27	24 59			
Feb. 12	23 30	0 53 43	84 17 33	22 44.5			
14	22 3	0 54 37	84 20 40	22 58			
18	3 15	0 53 35	84 10 16	22 42			
19	22 13	0 57 1	84 2 47	23 33			Moon and Jupiter.
23	7 32	1 1 40	84 2 43	24 43			
Feb. 25	4 10	0 59 25	84 11 34	24 9			
27	3 47	1 5 43	84 12 2	25 43.5			
29	3 25	1 8 16	84 6 21	26 21.5			
Mar. 4	5 58	1 6 46	84 8 40	25 58.5			
7	6 2	0 59 28	84 0 0	24 9			
Mar. 9	5 58	0 57 26	83 57 14	23 38			
12	8 10	0 54 20	83 57 13	22 51			
17	8 9	1 3 9	84 4 57	25 3			} Same star east.
17	8 19	1 3 19	84 4 54	25 5			
17	23 5		84 12.4				

1896	Hw	M. T.—Hw	N. Lat.	E. Long.	$\frac{d\varphi}{dt}$	$\frac{1}{15}\frac{dt}{d\varphi}$	Remarks
	h m	h m s	° ′ ″	° ′			
Mar. 21	10 16	0 59 50	84 4 44	24 12.5			
24	9 55	0 57 50	84 8 38	23 42			
27	9 45	1 1 9	84 13 8	24 31.5			
28	23 14	[0 58]	84 14.3	[23 44]	− 0.004		
30	9 28	[0 55]	84 15 17	[22 58]			Cloudy.
Mar. 30	23 9		84 18.6				
Apr. 4	3 17	0 53 57	[84 25]	22 42		− 0.354	
6	23 8	0 42 6	84 29 33	19 44			
7	19 51	0 41 52	84 29 45	19 40.5		+ 0.523	
7	23 44				− 0.010		
Apr. 10	22 41	[0 31 27]	84 22 22	[17 4]	+ 0.022		
10	23 6	0 31 27	84 22 6	17 4	+ 0.010		
11	0 2					− 4.64	
11	3 26	0 31 12	[84 22 6]	17 0		− 0.394	
Apr. 12	18 52	0 30 8	84 11 43	16 44		+ 0.232	
12	23 31						
14	18 47	0 27 27	84 7 3	16 3		+ 0.201	
14	23 28	0 26 11	84 6 57	15 44			
15	3 55					− 0.283	
Apr. 16	19 6	0 22 17	84 3 17	14 45.5		+ 0.248	
16	23 35						
17	23 35	0 21 0	84 1 56	14 26			
18	4 22					− 0.205	
19	23 30	[0 19 8]	84 0 46	[13 58]			
Apr. 20	5 13	0 19 6	[84 1]	13 57.5		− 0.060	
20	23 44	[0 16 40]	84 3 18	[13 21]			
21	23 56	[0 13 40]	84 6 39	[12 36]			Sextant 84° 7′.3.
22	4 18	0 13 2	84 6 5	12 26			Sun and Moon.
24	19 8	0 13 11	[84 15 18]	12 28		+ 0.234	
Apr. 24	23 53	[0 13 11]	84 15 18	[12 28]			
25	23 49	[0 13 6]	84 16 36	[12 27]			
26	23 58	0 13 3	84 17 8	12 26	− 0.006		
27	5 26					− 0.037	
27	23 36	[0 13]	84 16 57	[12 25]			Sextant 84° 17′.0.
Apr. 28	11 47	[0 13]	84 16 23	[12 25]			
28	23 21	[0 12 25]	84 11 54	[12 16]	+ 0.011		
29	4 56	0 12 25	[84 12]	12 16		− 0.124	
29	11 47	[0 12 20]	84 12 37	[12 15]			
29	23 50	[0 12 18]	84 11 51	[12 14]			
Apr. 30	4 49	0 12 14	[84 11 51]	12 13		− 0.145	
May 1	23 57	0 10 13	84 9 4	11 43	− 0.005		
2	4 46					− 0.155	
6	0 0	0 7 58	84 4 5	11 8.5	− 0.006		
6	5 1					− 0.114	
May 6	23 51	[0 8]	84 1 13	[11 9]			
7	23 53	[0 8]	83 55 58	[11 9]			
8	19 15	0 7 35	[83 53.7]	11 2.5		+ 0.214	
8	19 28	0 7 33	”	11 2		+ 0.259	
9	0 32	[0 7 33]	83 53.7	[11 2]	− 0.021		

1896	Hw	M. T.—Hw	N. Lat.	E. Long.	$\frac{d\varphi}{dt}$	$\frac{1}{15}\frac{dt}{d\varphi}$	Remarks
	h m	h m s	° ′ ″	° ′			
May 9	23 48		83 53.3				
9	23 54	[0 9]	83 52 9	[11 23]			
10	19 21	0 9 2	83 50 39	11 24		+ 0.246	
10	23 51						
May 13	0 12	0 12 27	83 50 51	12 15	— 0.014		
13	5 19					— 0.043	
15	19 20	0 12 10	83 45 2	12 10		+ 0.245	Cirro-stratus.
15	23 41						
17	23 47	[0 10]	83 48 40	[11 38]			
May 18	23 50	0 8 43	83 47 40	11 18			
19	5 4					— 0.094	
22	23 2	0 11 55	83 57 55	12 5.5			
22	23 43						
23	19 22	0 15 39	[84 1]	13 1.5		+ 0.271	
May 24	0 18	[0 15 16]	84 1 9	[12 56]	— 0.018		Cloudy.
24	5 12	0 14 53	[84 1]	12 49.5		— 0.057	
27	19 22	0 15 44	[83 56 30]	13 2		+ 0.265	
28	23 36	[0 13 30]	83 54.4	[12 28]			
29	6 51	0 13 4	[83 54.4]	12 21		+ 0.215	
June 2	1 24	[0 14 0]	83 19 45	[12 35]	— 0.058		
2	23 53	[0 14 0]	83 17 55	[12 35]			
3	5 39	0 13 55	[83 16 18]	12 33		+ 0.015	
3	1 17	0 14 23	83 16 18	12 40	— 0.054		
3	7 36					+ 0.331	
June 3	23 43		83 13.9				
4	5 26	0 15 55	[83 13.9]	13 3		— 0.012	
4	5 31	0 16 0	[83 13.9]	13 4		0.000	
6	19 26	0 15 47	[83 8.6]	13 1		+ 0.236	
6	23 43		83 8.6				
June 7	23 44		83 5.3				
8	23 46		83 1.2				
9	5 14	0 12 33	[83 1.2]	12 12		— 0.048	
12	23 18	[0 12 30]	82 59.0	[12 11]	+ 0.017		
12	23 48		82 59.0				
June 16	1 35	[0 11 29]	82 59.4	[11 55]	— 0.065		Not good.
16	1 42	"	82 59.4	"	— 0.070		Tolerable.
16	4 48	0 11 17	[82 59.4]	11 51.5		— 0.119	
16	7 30	0 11 27	[82 59.4]	11 54		+ 0.287	
16	7 32	0 11 29	"	11 54.5		+ 0.294	Best.
June 16	23 27	[0 10 40]	82 57.3	[11 42]	— 0.013		
16	23 50		82 57.0				
17	6 15	0 10 23	[82 57.0]	11 38		+ 0.087	
18	1 38	[0 10 21]	82 55.5	[11 37]	— 0.067		
18	6 11	0 10 13	[82 55.5]	11 35		+ 0.077	
June 18	6 14	0 10 21	[82 55.5]	11 37		+ 0.085	Best.
18	23 18	[0 10 46]	82 55.4	[11 43]	+ 0.019		
18	23 50		82 55.3				
19	6 11	0 10 47	[82 55.3]	11 44		+ 0.076	
19	6 17	0 10 45	"	11 43		+ 0.092	

1896	Hw	M. T.—Hw	N. Lat.	E. Long.	$\frac{d\varphi}{dt}$	$\frac{1}{15}\frac{dt}{d\varphi}$	Remarks
	h m	h m s	° ′	° ′			
June 23	19 53	0 13 12	82 55.3	12 19		+ 0.289	
24	1 25				− 0.059		
24	23 49		82 55.0				
25	7 0	0 13 35	[82 55.0]	12 25		+ 0.202	
26	23 48		82 54.7				
June 27	5 22	0 15 8	[82 54.7]	12 48		− 0.031	
28	23 49		82 55.0				
29	4 59	0 14 11	[82 55.0]	12 33		− 0.089	
30	23 53		82 57.8				
July 1	4 43	0 10 27	[82 57.8]	11 37		− 0.140	
July 4	0 59	[0 13 53]	82 58.5	[12 28]	− 0.040		
4	1 3	"	82 58.5	"	− 0.043		
4	7 1	0 13 54	[82 58.5]	12 28.5		+ 0.201	
4	7 11	0 13 52	"	12 28		+ 0.228	
4	23 22	[0 15]	82 59.1	[12 45]	+ 0.015		
July 4	23 49		82 59.2				
5	23 32	[0 15 19]	82 58.9		+ 0.010		
6	5 23	0 15 19	[82 58.9]	12 49		− 0.036	
6	5 26	0 15 19	"	12 49		− 0.027	
7	23 28	[0 15 30]	83 2.5	[12 52]	+ 0.012		
July 7	23 49		83 2.2				
8	20 8	0 15 55	[83 4.9]	12 58		+ 0.348	
8	20 13	0 15 57	"	12 58.5		+ 0.365	
8	23 49		83 4.9				Cloudy.
11	18 10	0 17 13	[83 8.0]	13 17		+ 0.027	
July 12	11 53	[0 18 40]	83 8.9	[13 39]			
12	23 24	[0 20 0]	83 11.8	[13 58]	+ 0.012		
12	23 46		83 11.8				
13	5 27	0 20 15	[83 11.8]	14 2		− 0.029	
14	23 51	[0 21 0]	83 15.3	[14 13]			
July 16	19 17	0 22 39	[83 13.5]	14 38		+ 0.216	
16	23 24	[0 22 39]	83 13.5	[14 38]	+ 0.010		
16	23 43		83 13.5				
18	20 1	0 22 43	[83 13.8]	14 38.5		+ 0.354	Steam up.
18	20 6	0 22 45	"	14 39		+ 0.372	
July 18	23 23	[0 22 44]	83 14.0	[14 39]	+ 0.011		
18	23 43		83 13.8				
19	8 24	0 21 33	[83 5]	14 21		+ 0.490	Cloudy and drizzle.
19	20 42	0 16 54	[82 51.8]	13 11		+ 0.492	Foggy; natural horizon.
19	23 39	[0 16 54]	82 51.7	[13 11]	+ 0.006		
July 19	23 49		82 51.8				
20	11 57	0 16 12	82 39.6	13 0.5			
20	12 52						
20	20 9	0 15 39	[82 40.8]	12 52		+ 0.328	
20	23 51		82 40.8				
July 21	11 51		82 32.9				Natural horizon.
23	16 18	[0 14 37]	82 2.7	[12 36]	− 0.286		
23	18 24	0 14 37	[82 2.7]	12 36		+ 0.043	
23	23 28	[0 14 45]	82 2.6	[12 38]	+ 0.015		
23	23 52		82 2.2				

1896	Hw	M. T.−Hw	N. Lat.	E. Long.	$\frac{d\varphi}{dt}$	$\frac{1}{15}\frac{dt}{d\varphi}$	Remarks
	h m	h m s	° ′	° ′			
July 24	5 39	0 14 51	[82 2.2]	12 40		− 0.002	} Natural horizon.
25	7 44	0 14 31	[81 51.6]	12 35		+ 0.221	
25	11 52		81 51.6				
25	23 51		81 49.3				
26	17 47	0 15 48	[81 45.5]	12 54		− 0.030	
July 26	23 51		81 45.5				
27	6 11	0 15 14	[81 40]	12 45		+ 0.063	Natural horizon.
27	11 51		81 31.6				—»—
27	18 17	0 14 20	[81 33.5]	12 31		+ 0.027	—»—
28	0 49	[0 14 20]	81 35.4	[12 31]	− 0.039		—»—
July 28	11 52		81 30.5				—»—
29	23 51		81 35.0				
30	0 40	[0 15]	81 32.4	[12 41]	− 0.034		
30	23 49		81 26.9				Bad.
31	20 21	0 18 15	[81 29.6]	13 30		+ 0.324	
Aug. 1	0 48	[0 18 15]	81 29.6	[13 30]	− 0.041		Bad.
1	20 43	0 19 25	[81 25.6]	13 47		+ 0.397	
1	20 48	0 19 29	„	13 48		+ 0.419	Foggy limbs.
1	23 47		81 25.6				
3	18 24	0 13 48	[81 20]	12 23		+ 0.041	
Aug. 7	17 17	0 14 57	[81 4.6]	12 40		− 0.082	Altazimuth.
7	23 22	[0 15 0]	81 5.3	[12 40]	+ 0.021		
7	23 51		81 4.6				
8	23 51		80 55.0				Aug. 13 in open sea. Aug. 14 at Dane Island, Spitzbergen.
Aug. 16	23 51		75 36.6				
18	4 30	0 40 4	[72 30]	18 55		− 0.035	
18	20 41	0 41 49	[71 6.2]	19 21		+ 0.209	
18	23 24		71 6.2				Aug. 20 at Skjervö, Norway.

I. Refraction.

The following list contains the observed altitudes of low stars or of the Sun's limb, and the true altitudes of the same objects as computed from the given latitude and clock correction, the difference being either the refraction, or, in some cases indicated by an asterisk, refraction + dip of the horizon. For these the height of the eye is given among the observations. It should be remarked that in the case of the Sun, the latitude and clock error was generally not immediately given for the time of observation, but has been interpolated.

1894, April 27, the refraction seemed variable during the observation.

1894, October 15, the Sun's lower limb was seen with the naked eye to touch the apparent horizon shortly after noon. Limb boiling, trembling horizontal stripes across the disc, upper 1/4 hidden in clouds.

1895, March 10, the altitude of the apparent horizon, measured with the altazimuth, was + 0° 13'.

		Object	Assumed N. Lat.	Assumed M.T.−Hw	Altitude obs.	Altitude comp.	Refr.	Bar.	Temp.
			° ' "	h m s	° ' "	° ' "	' "	mm	°
1894	Apr. 17	Sun L. L.	80 23 3	—	1 15 17	0 44 0	31 17 *	759.7	− 18.3 C
	Apr. 20	Sun L. L.	80 28 12	8 4 0	2 14 54	1 51 30	23 24 *	767.2	− 23.3
	Apr. 21	Sun L. L.	80 28 20	8 2 52	2 32 44	2 12 1	20 43 *	768.4	− 24.9
					2 33 14	2 12 5	21 9 *		
					2 33 29	2 12 12	21 17 *		
	Apr. 22	Sun L. L.	80 28 5	—	2 50 34	2 31 58	18 36 *	767.5	− 23.9
	Apr. 23	Sun L. L.	80 28 20	—	3 10 34	2 52 12	18 22 *	762.9	− 22.8
	Apr. 26	Sun L. L.	80 35 13	—	4 12 4	3 57 45	14 19 *	768.4	− 22.0
	Apr. 27	Sun L. L.	80 38 1	—	4 35 14	4 19 41	15 33 *	765.8	− 14.4
	Apr. 28	Sun L. L.	80 41 30	—	4 55 9	4 42 3	13 6 *	769.8	− 17.2
	Oct. 8	Sun L. L.	81 17 14	7 19 21	2 27 7	2 6 8	20 59	763.8	− 25.9
	Oct. 15	Sun L. L.	81 39 8	7 4 1	0 0	− 0 47 16	47 16 *	753.9	− 16.4
1895	Mar. 10	Sun U. L.	83 58 58	6 8 51	1 13 27	0 42 57	30 30	777.2	− 36.0
					0 57 26	0 22 12	35 14		
					0 44 9	0 4 20	39 49		
					0 30 47	− 0 15 9	45 56		
	Oct. 6	Sun U. L.	85 5 9	4 36 7	0 27 16	− 0 14 57	42 13	764.5	− 21.5
					0 25 19	− 0 16 52	42 11		
	Dec. 4	α Tauri	85 29 35	3 6 12	11 53 7	11 47 49	5 18	754.7	− 33.8
	Dec. 17	α Leonis	85 22 6	2 36 2	8 1 11	7 52 54	8 17	763.3	− 36.8
1896	Jan. 15	ε Virg.	84 51 49	2 6 9	6 39 59	6 29 26	10 33	758.3	− 50.0
	Mar. 3	Sun U. L.	84 8 40	1 6 46	0 39 8	− 0 1 48	40 56	760.3	− 35.0
	Mar. 11	Sun U. L.	83 57 13	0 55 40	3 11 45	2 46 56	24 49 *	770.5	− 16.7

THE SLEDGE-EXPEDITION.

Observations 1895.

Civil date is employed in the following. In the table of *comparisons* between the watches I and II given below, the approximate Greenwich Time is given along with the time by Watch I. In some cases, when it is not stated in the original whether it was a.m or p.m, it could generally be inferred from other circumstances; a.m or p.m is then enclosed in square brackets. In order not to change the date for the column of Greenwich Time, the hour is in some few cases given as negative.

1895	Watch I	Gr. T.	I—II	Rel. rate
	h m	h	h m s	s
Mar. 14	3 7	2.3 am	0 9 54.5	
Apr. 1			II stopped	
Apr. 1	1 51	1.0 pm	3 52 50	+10.6
" 6	2 33	1.7 pm	3 53 43	
" 12			I and II stopped	
" 13	2 2	2.1 am	− 2 53 44.5	+13.4
" 19	5 19	5.4 [am]	− 2 52 22	
" 22			I stopped	
" 22	11 14	1.6 am	− 5 10 52	
" 25	9 39	0.0 [pm]	− 5 10 4	+14.0
" 28	10 32	0.9 am	− 5 9 36	+11.1
" 29	7 15	9.6 am	− 5 9 17.5	+13.5
			Mean	+12.9
May 9			I stopped	
" 9	8 7	4.8 am	0 31 1	+10.0
" 13	10 8	6.8 [am]	0 31 42	+11.2
" 14	3 16	−0.1 am	0 31 50	
			Mean	+10.2
May 22			II stopped	

1895	Watch I	Gr. T.	I—II	Rel. rate
	h m	h	h m s	s
May 23	3 13	−0.2 am	0 49 40	
" 26	2 28	−0.9 am	0 50 14	+11.4
" 30	9 32	6.1 pm	0 51 14	+12.5
June 2	3 53	0.5 [am]	0 51 32	+ 8.0
			Mean	+11.2
" 7			II stopped	
" 7	7 10	3.7 pm	3 18 6	
" 8	7 26	4.0 am	3 18 7	+ 2
" 10	5 19	1.9 am	3 18 37	+16
" 16	9 32	6.1 am	3 19 57	+12.9
" 23	4 34	1.1 [pm]	3 21 42	+14.4
			Mean	+13.6
" 24			I stopped	
" 24	1 16	1.0 pm	0 7 22	
" 30			I stopped	
" 30	5 38	5.8 [am]	− 0 19 32	+22
July 3	8 39	8.8 [am]	− 0 18 24	
			II stopped	
July 30	6 25	6.5 pm	6 13 48	+11.5
Aug. 8	2 57	3.0 am	6 15 24	

Some more comparisons, made after June 30, but only after a stopping of II, while I was now going continually, are omitted as being of no use for the determination of relative rate.

The following table contains the changes caused by the stoppings, as computed by means of the relative rate adopted according to the table above. When the loss was more than 6 hours, its complement to 12 hours has been taken as a gaining. As to the change on April 13, when both watches had run down, the data for its calculation will appear further on. Δ is a possible correction to an assumed change of longitude between April 8 and April 13.

	Adopted rel. rate	Change of I		Adopted rel. rate	Change of II
	s	h m s		s	h m s
1895 Apr. 13	—	− 0 57 30 − Δ	1895 Apr. 1	+ 10	− 3 39 51
Apr. 22	+ 13	− 2 19 7	Apr. 13	—	+ 5 50 12 − Δ
May 9	+ 11	+ 5 38 31	May 23	+ 11	− 0 16 11
June 24	+ 14	− 3 14 34	June 7	+ 11	− 2 25 32
June 30	+ 14	− 0 28 14	II was not used for observation after May 15.		

In order to obtain the longitude of the Winter Hut, which was most probable according to the Lunar Distances and the observations taken the next year, it has been supposed that the mean daily rate of I during the whole summer was 12^s fast. For the days April 8—13 the gain is included in the change by stopping given above. Applying also the other changes, the following table was formed, containing the computed error of I to Greenwich Mean Time for the times of observation, exclusive of the meridian altitudes. The value for March 14 was found by comparison with chronometer Hohwü.

1895	Gr. T.	I—Gr.	1895	Gr. T.	I—Gr.
	h	h m s		h	h m s
Mar. 14	2.3 am	0 49 0	June 27	10.0 am	0 16 23 $-\Delta$
25	6.2 am	0 51 14			
Apr. 2	11.5 am	0 52 52	July 1	10.5 am	$-$0 11 3 $-\Delta$
4	1.0 am	0 53 11		2.3 pm	$-$0 11 1 $-\Delta$
8	1.7 am	0 53 59	20	3.5 am	$-$0 7 18 $-\Delta$
			Aug. 1	2.6 pm	$-$0 4 48 $-\Delta$
Apr. 13	2.1 am	$-$0 3 31 $-\Delta$	9	8.4 am	$-$0 3 15 $-\Delta$
18	0.4 am	$-$0 2 31 $-\Delta$		2.1 pm	$-$0 3 12 $-\Delta$
			10	7.5 pm	$-$0 2 57 $-\Delta$
Apr. 26	2.0 pm	$-$2 19 55 $-\Delta$	16	9.4 am	$-$0 1 50 $-\Delta$
May 5	2.5 am	$-$2 18 13 $-\Delta$	17	5.7 am	$-$0 1 40 $-\Delta$
			19	2.4 pm	$-$0 1 12 $-\Delta$
May 9	1.3 pm	3 21 12 $-\Delta$	20	10.0 am	$-$0 1 2 $-\Delta$
15	1.7 am	3 22 18 $-\Delta$	28	8.8 am	0 0 33 $-\Delta$
24	0.5 pm	3 24 12 $-\Delta$			
June 4	2.0 am	3 26 18 $-\Delta$			
14	9.0 am	3 28 22 $-\Delta$			
	2.0 pm	3 28 24 $-\Delta$			
22	3.1 pm	3 30 1 $-\Delta$			

It was not considered necessary to draw up a similar table for Watch II, for which the difference I—II may be employed on the few occasions on which it was used.

The quantity Δ will in course of time include the accumulated errors of the assumed rate, but the numbers obtained on putting $\Delta = 0$ may safely be employed for taking the coordinates out of the ephemeris.

Among the observations given in the following pages are included the readings of barometer and thermometer, necessary for refraction. They were often noted some hours before or after the astronomical observations, but the daily variation of temperature being slight, the difference is of no importance. The expedition had two aneroid barometers; one by Hicks, giving English inches, was used in the beginning, the other by Cary, giving millimeters, after May 15, 1895. A series of comparisons with the normal barometer on board, made by Lieut. Scott-Hansen in February, 1895, gave the following corrections:

Correction to Hicks $= -0.07$ in. $= -1.7$ mm.
Correction to Cary $= +5.3$ mm.

On the arrival at Cape Flora in 1896 the comparisons with Mr. Jackson's barometer gave a somewhat greater correction to Cary, but the difference is of no importance for the present purpose. Hicks had then a very large correction, probably owing to a shock on May 30, 1895.

The uncorrected numbers are given in the following pages.

Local Mean Time is abbreviated to LT.

The point of departure on March 14 was N. Lat. 84^0 4′ and E. Long. 101^0 33′; LT—I = 5^h 57^m 12^s, LT—II = 6^h 7^m 6^s; Magnetic Declination 42^0 E. During the first days the course was set nearly due north, or sometimes a little easterly; even without this a deviation in that direction might be expected by reason of the increasing easterly declination. On the other hand the *Fram* had a considerable westerly drift during the same days; but from Mr. Nansen's observations of a different drift on both sides of an open channel, frequently made both before and later on, it follows that the drift of the travellers can not be supposed to be the same as that of the ship. For the observations taken by watch until the first determination of LT on April 2, the effective course has been assumed as north.

The index correction of the sextant was generally determined by means of the horizon; in some cases when it was not determined, the adopted value has been added by the observer as (. . ?), where the dots stand for a number.

All observations were taken by Nansen, Johansen noting the watch.

1895	Temp.	Bar.	Eye's height	Watch I	Object	Sextant	Ind. corr.	N. Lat.	$\frac{d\varphi}{dt}$
	°	in.	feet	h m s		° ′	′	° ′	
March 22	− 39.5 C	30.22	17	Noon	Sun L. L.	5 18	+ 3	85 10.6	
March 25	− 37	30.18	15	Noon?	Sun L. L.	6 16	+ 3	85 21.7?	
				7 2 0	Sun L. L.	6 13	"	85 18.7	− 0.018

For the last observation LT−I was assumed $= 5^h\ 55^m$; the first altitude of March 25 appears to have been taken somewhat after the culmination, and it was because the observer had the same impression that the second altitude was taken.

1895, March 29. Temperature − 36°.5, Bar. 30.05 inches.

Near noon, the following 4 altitudes were taken with the altazimuth, 2 in each position of the instrument:

Sun U. L. Vertical Circle 81° 45′.5, 98° 1′.0, 97° 59′.0, 81° 51′.5;

then with the sextant, ind. corr. + 3′, height of eye 14 feet:

Watch II $6^h\ 27^m\ 11^s.5$, Sun L. L. 7° 12′.

The first two observations with the altazimuth would give the true altitude of the Sun's centre 7° 44′, the last two 7° 40′; but no times having been noted, they only give the limit:

$$\text{N. Lat.} \gtreqless 85^{\circ}\ 33'.$$

Applying the correction $+ 6^h\ 7^m$ to watch II, whose rate seems to have been insignificant, the sextant observation would give

$$\text{N. Lat. } 85^{\circ}\ 57' \text{ with } \frac{d\varphi}{dt} = -0.009$$

which is incompatible with the limit above. The difference seems too great to be explained by an irregular elevation of the horizon; but whether there is an error of observation, or some accident has occurred to watch II, cannot be settled, as II ran down two days after without any comparison before the stopping. The observation would require a correction to II more than an hour greater than that applied; the possibility of a change of longitude to this extent, is excluded by the following observations.

1895, April 2 and 3. Bar. 30.61 in., Therm. − 31°.5 C.

The meridian altitude of the Sun L. L., measured on April 3 from the apparent horizon with height of eye 16 feet, index correction 0′, was 9° 4′, which gives

N. Lat. 86° 4′.

This observation was taken at the camping-place after a day's travelling, commencing April 2 about 3 p.m. and ending early in the morning of April 3, including a rest for dinner from 9 p.m. For the following observations, taken about 6 in the afternoon of April 2, was assumed $\varphi = 86^{0}\ 0'$. Ind. corr. (0′?).

1895	Watch I	Hor.	Object	Sextant	LT−I	$\frac{1}{15}\frac{dt}{d\varphi}$	$\frac{1}{15}\frac{dt}{dh}$
	h m s			° ′	h m s		
April 2	11 51 45	Glass.	Sun L. L.	10 14.5	5 55 44	− 0.062	− 0.957
	0 2 21	"		9 25	5 54 54	− 0.020	− 0.956
	0 16 30	"		9 22	5 57 27	+ 0.049	− 0.957
		feet					
	0 24 23.5	15?	Sun L. L.	4 29	6 5 24	+ 0.115	− 0.962
	0 31 36			4 22	6 5 19	+ 0.145	− 0.967
	0 35 37			4 16.5	6 6 56	+ 0.169	− 0.970

To the second observation with the glass horizon has been applied the correction + 30′ (the limb being divided to half degrees). These three observations were very difficult.

Supposing that the altitudes measured from the apparent horizon require a correction Δh, owing to irregular terrestrial refraction, and that the assumed latitude is erroneous by the amount $\Delta\varphi$, the two sets of observations give the equation

$$5^{h}\ 56^{m}\ 2^{s} - 0.011\,\Delta\varphi = 6^{h}\ 5^{m}\ 53^{s} + 0.143\,\Delta\varphi - 0.966\,\Delta h, \text{ or } 0.966\,\Delta h - 0.154\,\Delta\varphi = 9.85,$$

and supposing further that the meridian altitude of the next day, taken under the same meteorological conditions, requires the same correction, which gives $\Delta\varphi = -\Delta h$, the result will be:

$$1.12\,\Delta h = 9'.85 \text{ or } \Delta h = +\ 8'.8 \text{ and } \Delta\varphi = -\ 8'.8,$$

and LT−I = $5^{h}\ 56^{m}\ 8^{s}$. Combining this with I−Gr. = $0^{h}\ 52^{m}\ 52^{s}$, given on p. 112, the result is

April 2, 6 p.m., E. Long. = $6^{h}\ 49^{m}\ 0^{s} = 102^{0}\ 15'$
and April 3, Noon, N. Lat. = $85^{0}\ 55'$.

1895, April 4. Bar. 30.58 in., Therm. − 31°.3 C.

After leaving the camp of the preceding day at 3 o'clock in the morning the following observations were taken on the way, about four hours after starting. Assumed Lat. 86° 5′. Height of eye 16 feet, Ind. corr. 0.

Watch I	Object	Sextant	LT−I	$\frac{1}{15}\frac{dt}{d\varphi}$	$\frac{1}{15}\frac{dt}{dh}$
h m s		° ′	h m s		
1 30 15	Sun L. L.	6 44	5 48 25	+ 0.325	+ 1.028
42 25		6 54	5 46 57	0.375	1.046
48 53		6 59	5 45 44	0.401	1.055
55 1		7 7	5 48 13	0.445	1.073
2 12 0		7 22	5 47 37	0.533	1.114
		Compass			
2 0 42	Sun Ct.	70°.6			
8 20		73°.0			

If the altitudes require the correction Δh, and the latitude the correction $\Delta\varphi$, the mean of the five altitudes will give:

$$\text{Watch I } 1^{h}\ 50^{m},\ \text{LT}-\text{I} = 5^{h}\ 47^{m}\ 23^{s} + 0.416\,\Delta\varphi + 1.063\,\Delta h.$$

A comparison of this number with those of April 2 gives a strong corroboration of the assumption there made. The meteorological conditions being nearly the same, the same value of Δh may be employed. As to φ, the value assumed above would correspond to an advance northwards of 10 miles during the 4 hours of travelling, which is certainly too much considering that the ice was very rough; on putting $\varphi = 86^0\ 0'$ or $\Delta\varphi = -5'$, the result is

$$LT-I = 5^h\ 54^m\ 38^s \text{ and E. Long.} = 6^h\ 47^m\ 49^s = 101^0\ 57'.$$

The two observations by compass will then give:

Magnetic Declination 47°.0 and 46°.6, Mean 46°.8 E.

As the course was laid considerably more westerly on one of the first days of April, and certainly not later than April 4, it is, however, possible that the correction Δh should have been somewhat smaller than the day before, which would also give a smaller longitude.

1895, April 7. Bar. 30 in., Therm. − 35°.5. Height of eye 24 feet, Ind. corr. 0.

Meridian altitude of Sun L. L. 10° 27', which gives N. Lat. = 86° 12'.3.

This was the most northern place of observation. Mr. Nansen walked about a mile farther north in order to get a view of the ice before returning. The meteorological conditions being the same as the days before, it is probable that the latitude has been some minutes less.

1895, April 8. Bar. 30.48 in., Therm. − 36°. Height of eye 24 feet, Ind. corr. (0 ?).

The following 3 altitudes were taken on the same place as the day before, and were therefore reduced with the latitude 86° 12'.

Watch I		Sextant	LT−I	$\frac{1}{15}\frac{dt}{d\varphi}$	$\frac{1}{15}\frac{dt}{dh}$
h m s		° '	h m s		
2 33 45	Sun L. L.	8 49	5 23 58	+ 0.546	+ 1.145
2 37 25		8 55	5 27 14	0.585	1.164
2 41 22.5		9 0	5 29 16	0.621	1.182
2 38 am		Mean	5 26.8	+ 0.58	+ 1.16

Employing the same value of Δh as above, and assuming the elevation of the horizon to have been the same at noon as in the morning, or $\Delta\varphi = -\Delta h$, the result is

$$LT-I = 5^h\ 26^m.8 + 5^m.1 = 5^h\ 31^m.9, \text{ and E. Long.} = 6^h\ 25^m.9 = 96^0.5.$$

1895, April 13. Bar. 29.90 in., Therm. − 30°. Height of eye 12 feet, Ind. corr. + 5'.

The following observations were not taken exactly at the same place, the morning observations with sextant and compass having been made at a camping-place reached the preceding day, while the meridian altitude was taken an hour or two after the departure therefrom.

Watch I		Sextant	LT−I	$\frac{1}{15}\frac{dt}{d\varphi}$	$\frac{1}{15}\frac{dt}{dh}$
h m s		° '	h m s		
0 46 51	Sun L. L.	9 28	6 0 16	+ 0.188	+ 0.998
0 56 37		9 40	6 2 33	0.242	1.010
1 0 23		9 43.5	6 2 27	0.259	1.015
1 35 35		10 19	6 4 9	0.437	1.074
Noon		12 39			
		Compass	Magn. Decl.		
1 20 39	Sun Ct.	69°.0	42°.7 E		
1 24 30		68°.7	44°.0	Magn. Decl. Mean = 43°.7 E	
1 29 17		69°.55	44°.4		

The above values of LT—I have been computed with $\varphi = 86^0\ 6'.2$, which follows from the meridian altitude. It is apparent from the increasing values of LT—I with increasing differential quotients that a diminution of φ will give better agreement. Introducing Δh and $\Delta\varphi$ as before, the mean of the four observations gives

$$\text{Watch I } 1^h\ 5^m \text{ a.m., LT—I} = 6^h\ 2^m\ 21^s + 0.281\,\Delta\varphi + 1.024\,\Delta h.$$

For Δh there is no other choice than using the former value; $-\Delta\varphi$ at noon had perhaps the same value, but the latitude being a little higher in the morning before the departure, it has been assumed that φ was $86^0\ 0'$, or $\Delta\varphi = -6'.2$. The result is then:

$$\text{LT—I} = 6^h\ 9^m\ 37^s.$$

The bearings by compass have been calculated by means of these values.

These observations were taken shortly after the stopping of both watches. If x is the diminution of east longitude from April 8, 8 a.m., until April 13, 7 a.m., and y the change of watch I caused by the stopping (including its acceleration during the time it was going), the combination of the two days gives the equation

$$5^h\ 31^m.9 - x - y = 6^h\ 9^m.6 \text{ or } y = -37^m.7 - x.$$

The course set on April 8 and followed during the days following as nearly as hindrances permitted, was S 22^0 W by compass, or, with magnetic declination 45^0 E, S 67^0 W. The distance made during the three days of travelling included in this interval, was estimated by Nansen to be 9 Norwegian sea-miles, or 36 minutes of a great circle, which would give 14′ difference of latitude, and nearly 8^0 difference of longitude. As the course was not, of course, rectilinear, a reduction is necessary, and the latitudes observed show that the reduction in this direction is so considerable that the drift of the ice must have had something to do with it. How the drift has worked in the other direction cannot be decided by this consideration; the assumption of a considerable reduction, viz. from 8^0 to about 5^0, for the longitude also, has been made mainly because the retaining of the 8^0 would imply a greater acceleration of watch I for the rest of the summer than seems likely from other observations. The value $y = -57^m\ 30^s - \Delta$, given on p. 111, would correspond to the change of longitude

$$x = 19^m.8 + \Delta \text{ or nearly } 5^0 + \Delta.$$

The E. Long. on April 13 should then be $91^0.5 - \Delta$.

1895, April 18. Bar. 29.94 in., Therm. -26^0.

Watch I	Eye		Sextant	Ind. corr.	LT—I	$\frac{1}{15}\frac{dt}{d\varphi}$	$\frac{1}{15}\frac{dt}{dh}$
h m s	feet		° ′	′	h m s		
0 13 57	22	Sun L. L.	10 17	+3	5 34 29	−0.055	+0.884
0 22 11			10 29		5 36 50	−0.015	0.883
0 26 42			10 34		5 36 52	+0.003	0.882
Noon	16		14 55	+4			

The morning observations were made during a journey commencing on April 17, at 7.5 p.m.. and ending on April 18, at 10 a.m., consequently about 4 hours before reaching the camping-place where the meridian altitude was taken. The latter gives the N. Lat. 85^0 38′. The course being now S by compass, the morning altitudes were reduced with $\varphi = 85^0\ 40'$. The mean of the three results is

$$\text{Watch I } 0^h\ 21^m \text{ a.m., LT—I} = 5^h\ 36^m\ 4^s - 0.022\,\Delta\varphi + 0.883\,\Delta h.$$

The weather being still clear and calm with severe cold, the former value of $\varDelta h$ may be assumed, and $\varDelta\varphi = - \varDelta h$ for noon; the difference of 2′ from morning to noon assumed above being perhaps somewhat small, the morning latitude has been taken as 85° 34′, or $\varDelta\varphi = - 6'$. As the observations were taken very near the prime vertical, its influence is very small. The result is then:

$$\text{LT}-\text{I} = 5^{\text{h}}\ 44^{\text{m}}\ 0^{\text{s}} \text{ and E. Long.} = 5^{\text{h}}\ 41^{\text{m}}\ 29^{\text{s}} - \varDelta = 85°\ 22' - \varDelta.$$

1895, April 26. Bar. 29.65 in., Therm. − 31°.5.

Watch I	Eye		Sextant	Ind. corr.	LT−I	$\frac{1}{15}\frac{dt}{d\varphi}$	$\frac{1}{15}\frac{dt}{dh}$
h m s	feet		° ′	′	h m s		
Noon	12	Sun L. L.	18 28	+3			
11 24 7	18	Sun L. L.	12 9	+1	7 26 37	+0.187	−0.746
11 26 9			12 6		7 26 49	+0.199	−0.747
11 29 0			12 2		7 27 2	+0.205	−0.750
11 49 8			11 37		7 26 11	+0.272	−0.771
11 54 2			11 30		7 26 43	+0.292	−0.775
			Compass		Magn. Decl.		
11 41 17.5		Sun Ct.	74°.55		34°.2 E		
43 42			75°.25		34°.1	Magn. Decl. Mean = 34°.1 E	
45 8.5			75°.65		34°.1		

The meridian altitude, which gives $\varphi = 84°\ 47'$, was taken at the camp of the preceding day, while the other observations were made nearly 4 hours after the departure from this place. Course nearly S by compass. The above values have been computed with $\varphi = 84°\ 42'$, corresponding to 6 miles advance in the 4 hours.

Though the temperature was still very low, the weather had changed since the last observation. Some days before, snow had fallen, and the sky was now veiled. Assuming therefore $\varDelta h = \varDelta\varphi = 0$, the mean of the results is

$$\text{LT}-\text{I} = 7^{\text{h}}\ 26^{\text{m}}\ 40^{\text{s}} \text{ and E. Long.} = 5^{\text{h}}\ 6^{\text{m}}\ 45^{\text{s}} - \varDelta = 76°\ 41' - \varDelta.$$

The magnetic declination has been computed by means of these values.

1895, May 5. Bar. 29.90 in., Therm. − 22°.

Watch I	Eye		Sextant	Ind. corr.	LT−I	$\frac{1}{15}\frac{dt}{d\varphi}$	$\frac{1}{15}\frac{dt}{dh}$
h m s	feet		° ′	′	h m s		
11 57 37	16	Sun L. L.	17 22	+1	7 0 48	+0.173	+0.723
0 2 29			17 29		7 1 1	0.189	0.727
0 21 56			17 56.5		7 1 42	0.258	0.747
Noon	12		21 30	+1			
			Compass		Magn. Decl.		
0 14 41.5		Sun Ct.	77°.15		31°.1 E		
16 14			77°.7		30°.9	Magn. Decl. Mean = 30°.9 E	
17 37.5			78°.1		30°.8		

The meridian altitude, which gives $\varphi = 84°\ 31'$, was taken an hour and a half after the departure from a resting-place at which all the other observations were taken. For the morning observations, 84° 33′ was assumed. The mean of the above values of LT−I (which was used for the observations by compass), supposing the dip of the horizon to have been normal, is then

LT−I = $7^h\ 1^m\ 10^s$ and E. Long. = $4^h\ 42^m\ 57^s - \varDelta = 70°\ 44' - \varDelta$.

1895, May 9. Bar. 30.02 in., Therm. − 13°.3. Height of eye 13 feet, Ind. corr. + 2′.

Meridian altitude of Sun L. L. 23°4′; gives N. Lat. = 84° 3′.

The following observation was taken nearly three hours after the departure from this place. Course now nearly true S. Assumed latitude 84° 0′.

Bar. 30.03 in., Therm. − 11°. Height of eye 11 feet, Ind. corr. (+ 2′ ?).

Watch II		Sextant	LT−II	$\frac{1}{15}\frac{dt}{d\varphi}$	$\frac{1}{15}\frac{dt}{dh}$
h m s		° ′	h m s		
4 10 36	Sun L. L.	17 13	1 40 54	+ 0.007	− 0.638

"Horizon not quite clear, Sun disappeared in clouds."

The comparison between I and II given on p. 111, which was made 8.6 hours before this observation, will give for the moment of observation I−II = $0^h\ 30^m\ 57^s$, consequently

LT−I = $1^h\ 9^m\ 57^s$ and E. Long. = $4^h\ 31^m\ 9^s - \varDelta = 67°\ 47 - \varDelta$.

1895, May 15. Bar. 30.17 in., Therm. − 12°.7.

Watch I	Eye		Sextant	Ind. corr.	LT−II	$\frac{1}{15}\frac{dt}{d\varphi}$	$\frac{1}{15}\frac{dt}{dh}$
h m s	feet		° ′	′	h m s		
4 19 57	12	Sun L. L.	18 13	+ 1.5	1 27 6	− 0.047	+ 0.603
4 23 37			18 18		1 26 27	− 0.039	0.602
4 28 38			18 28		1 27 24	− 0.023	0.602 Good.
4 36 21			18 40		1 26 52	− 0.004	0.601
4 48 50			19 3		1 28 11	+ 0.032	0.602
Noon	14	Sun L. L.	25 2	(+ 1.5)			
			Compass		Magn. Decl.		
4 41 58		Sun Ct.	64°.2		26°.8 E		
44 28			64°.8		26°.9	Magn. Decl. Mean = 26°.8 E	
46 11			65°.3		26°.8		

The morning observations with sextant and compass were taken on the way, 2 or 3 hours before stopping at the camping-place, where the meridian altitude was taken. As this gives N. Lat. 83° 36′, the former have been reduced with $\varphi = 83°\ 38'$. The mean is LT−II = $1^h\ 27^m\ 12^s$; applying to this the comparison between I and II of May 14, which gives for the time of observation I−II = $0^h\ 32^m\ 1^s$, the result is

LT−I = $0^h\ 55^m\ 11^s$ and E. Long. = $4^h\ 17^m\ 29^s - \varDelta = 64°\ 22' - \varDelta$.

1895, May 24. Bar. Cary 752.6 mm, Temp. − 7°.4.

The following observations were taken at the same place, with height of eye 12 feet.

Watch I		Sextant	Ind. corr.	N. Lat.	$\frac{1}{15}\frac{dt}{d\varphi}$	$\frac{1}{15}\frac{dt}{dh}$
h m s		° ′	′	° ′		
Noon	Sun L. L.	27 41	+ 1	82 52		
				LT−I		
3 47 35	Sun L. L.	22 51	0	$0^h\ 50^m\ 31^s$	− 0.161	− 0.558
3 51 26		22 42		0 51 43	− 0.148	− 0.555
3 54 20		22 37		0 51 36	− 0.141	− 0.553
			Mean	0 51 17		

which gives E. Long. = $4^h\ 15^m\ 29^s - \varDelta = 63°\ 52' - \varDelta$.

1895	Bar.	Temp.	Eye			Sextant	Ind. corr.	N. Lat.
	mm	C	feet			° ′	′	° ′
May 27	752.6	− 8°	18	Noon	Sun L. L.	28 36	(+ 1?)	82 30
May 30	746	− 4	18	Noon	Sun L. L.	29 13	(+ 1?)	82 21.5

For the observation of May 27, the observer makes the remark that the latitude was perhaps a minute or two smaller, as he did not wait for the declining.

1895, June 4. Bar. 754 mm, Temp. − 3° C.

The following observations with the altazimuth were taken during a week's stay at the some place, while making the kayaks ready for sea.

Horizontal point of the vertical circle about 89° 53′.

Watch I		Vert. Circle	LT−I	$\frac{1}{15}\frac{dt}{d\varphi}$	$\frac{1}{15}\frac{dt}{dh}$
h m s		° ′	h m s		
5 3 14		111 58.7	0 58 51	− 0.008	+ 0.497
13 59	Sun L. L.	67 26			
20 48		67 11.5	0 59 10	+ 0.027	+ 0.498
27 39		112 48.5			
32 51		112 58	0 59 6	+ 0.054	+ 0.500
40 46		66 31			
			N. Lat.		
Near noon	Sun L. L.	59 59	82° 17′.8		
		119 46			
		119 44.5	—		
		60 1.5			

It has been assumed that the mean of the first two altitudes of the last series may be considered as the meridian altitude.

The mean result of the morning observations is

$$\text{LT}-\text{I} = 0^h\ 59^m\ 2^s \text{ and E. Long.} = 4^h\ 25^m\ 20^s - \Delta = 66°\ 20' - \Delta.$$

1895, June 14. Bar. 743 mm, Therm. − 0°.2 C. Hor. Point = 89° 52′ + x, LT−I = $0^h\ 42^m + \frac{1}{15}\Theta$.

Watch I		Vert. Circle	N. Lat.	
h m s		° ′	° ′	
0 2 48	Sun L. L.	120 20	82 24.8 + 1.022 x − 0.028 Θ	In all observations the Sun's limb was not sharp.
11 45		120 15	82 25.7 + 1.032 x − 0.034 Θ	
31 43		59 44	82 29.8 − 1.062 x − 0.047 Θ	
35 2		59 49	82 32.4 − 1.068 x − 0.049 Θ	
38 26		59 50	82 31.0 − 1.074 x − 0.052 Θ	

The mean of the first two combined with the mean of the last three give:

$$\text{Watch I } 0^h\ 21^m \text{ p.m.,}\ \varphi = 82°\ 28'.16 - 0.018\,x - 0.040\,\Theta.$$

x is about 2′ and Θ may be determined by the following observations, which were taken about an hour after the departure from the former place, but only with very slow progress on the difficult ice. Assumed Lat. 82° 28′.

Watch I		Vert. Circle	LT−I	$\frac{1}{15}\frac{dt}{d\varphi}$	$\frac{1}{15}\frac{dt}{dh}$
h m s		° ′	h m s		
4 57 6	Sun L. L.	66 24.5	0 44 1	− 0.013	− 0.509
5 3 10		66 34	44 47	− 0.002	− 0.508
8 55		66 48	44 12	+ 0.013	− 0.509
24 58		112 27	42 54	0.046	− 0.511
34 43		112 7.5	43 13	0.068	− 0.513
37 34		112 2.2	43 4	0.074	− 0.514
41 27		111 53.3	43 49	0.085	− 0.516
46 50		68 0	43 12	0.095	− 0.517
50 18		68 6.7	43 18	0.104	− 0.519

The last three observations are denoted as good, but for all the others as well as for the latitude observations, the Sun was veiled and not sharp.

Combining the mean of the 5 and the 4 observations in the two positions of the instrument, by which the error of the assumed Hor. Point is eliminated, the result is:

Watch I $5^h\ 28^m$, LT−I $= 0^h\ 43^m\ 35^s + 0.054\,\Delta\varphi$

from which it appears that Θ in the former equation is 24′. Consequently:

June 14. Watch I $0^h\ 21^m$ p.m., N. Lat. = 82° 27′
and " " 5 28 p.m., LT−I $= 0^h\ 43^m\ 32^s$, E. Long. $= 4^h\ 11^m\ 56^s - \Delta = 62°\ 59' - \Delta$.

1895, June 17. Bar. 761.4 mm, Therm. − 0°.7. Eye 10 feet, Ind. corr. − 3′.

Meridian altitude Sun L. L. Sextant 30° 57′; N. Lat. = 82° 18′.

All the following observations till July 20 were taken during a long stay in the "Camp of Longing". The meridian altitudes will be given first.

1895		Bar.	Temp.	Eye		Sextant	Ind. corr.	N. Lat.
		mm	°	feet		° ′	′	° ′
June 22	Noon	743.8	− 2.2	12	Sun L. L.	31 13	− 1	82 4.4
June 23	"	744.3	+ 0.8	12	"	31 12	− 1	82 5
June 25	"	743.9	− 2.6	12	"	31 10.5	0	82 3
July 2	"	751.1	+ 1.9	15	"	30 45	0	82 8.6
July 19	"	751	+ 1	15	"	28 36	0	82 7.5
July 20	"	750.7	+ 1.8	15	"	28 26	0	82 6.5

1895 June 22. Bar. 745.8 mm, Therm. − 1°.0. Ind. corr. (− 1′?). N. Lat. 82° 4′.4.

Watch I	Eye		Sextant	LT−I	$\frac{1}{15}\frac{dt}{d\varphi}$	$\frac{1}{15}\frac{dt}{dh}$
h m s	feet		° ′	h m s		
6 31 44	12	Sun L. L.	20 35	0 43 53	+ 0.190	− 0.520
35 53	10		20 27	43 54	0.196	− 0.523
38 20	"		20 23	43 36	0.206	− 0.525
41 17	"		20 17	43 49	0.213	− 0.528
			Mean	0 43 48		

E. Long. $4^h\ 13^m\ 49^s - \Delta = 63°\ 27' - \Delta$.

1895, June 27. Bar. 743.9 mm, Temp. − 0°.2. Hor. Point = 89° 52′ + x, LT−I = $3^h\ 50^m + \frac{1}{15}\Theta$.

Watch I		Vert. Circle	N. Lat.
h m s		° ′	° ′
10 5 50	Sun L. L.	59 55	82 9.7 − 1.16 x − 0.079 Θ
9 0		59 59	82 10.5 − 1.17 x − 0.082 Θ
11 24		60 0	82 8.7 − 1.18 x − 0.084 Θ
17 8		60 7	82 9.5 − 1.20 x − 0.089 Θ
23 54		119 29	82 9.7 + 1.22 x − 0.095 Θ
26 58		119 24.7	82 10.5 + 1.23 x − 0.098 Θ
30 9		119 19.5	82 12.2 + 1.25 x − 0.101 Θ
32 50		119 18	82 9.9 + 1.26 x − 0.104 Θ
		Mean	82 10.1 + 0.03 x − 0.091 Θ

x may be neglected, but both the preceding and following observations seem to indicate that LT−I was about $3^h\ 57^m$ (neglecting the drift) or Θ about 100′; the result is then:

N. Lat. = 82° 1′.

1895, July 1. Bar. 747 mm, Temp. + 0°.5; height of eye 15 feet.

Watch I		Sextant	Ind. corr.	
h m s		° ′	′	A combination of the two sets gave
10 20 53	Sun L. L.	28 50	0	N. Lat. = 82° 5′.5.
23 32		28 47		
28 10		28 41.5		Watch I $10^h\ 24^m$, LT−I = $4^h\ 25^m\ 9^s$,
2 4 50	Sun L. L.	21 49	+ 1	E. Long. = $4^h\ 14^m\ 6^s - \Delta = 63° 31' - \Delta$.
6 51		21 44		
8 55		21 40		

1895, July 20. Bar. 750.7 mm, Temp. + 1°.8. Height of eye 15 feet, Ind. corr. 0.

Watch I		Sextant	LT−I	$\frac{1}{15}\frac{dt}{d\varphi}$	$\frac{1}{15}\frac{dt}{dh}$
h m s		° ′	h m s		
3 17 50	Sun L. L.	23 29	4 20 25	+ 0.177	+ 0.517
19 45		23 30.5	4 19 17	+ 0.179	+ 0.518
33 9		23 55.5	4 19 2	+ 0.212	+ 0.530
		Compass	Magn. Decl.		
3 23 1	Sun Ct.	86°.35	24°.8 E		
27 20		89°.35	22°.9	Magn. Decl. Mean = 23°.5 E	
30 5		90°.2	22°.7		

The latitude following from the meridian altitudes of this and the preceding day is 82° 7′ which was adopted. The mean result of the three altitudes is

Watch I $3^h\ 24^m$ am, LT−I = $4^h\ 19^m\ 35^s$ and E. Long. = $4^h\ 12^m\ 17^s - \Delta = 63° 4' - \Delta$.

The drift in longitude during the long stay in the "Camp of Longing", appears to have been small.

From July 22 the travellers were struggling towards land, which first became visible on July 23 in S 10° W by compass, but after some days of tolerable progress, which brought new land into view in S 60° W by compass in the evening of July 25, it was evident on July 31 and August 1, when the weather cleared up, that the drift had been contrary. This is also apparent from the following observations.

1895, August 1.

Watch I	Bar.	Temp.	Eye		Sextant	Ind. corr.	LT−I	$\frac{1}{15}\frac{dt}{d\varphi}$	$\frac{1}{15}\frac{dt}{dh}$
h m s	mm	°	feet		° ′	′	h m s		
2 28 28	756.4	+ 1.7	16	Sun L. L.	15 52	0	4 27 32	+ 0.122	− 0.471
32 3					15 45		4 27 15	0.129	− 0.473
33 18					15 42		4 27 26	0.132	− 0.474
Midnight	756.9	− 0.8	12	Sun L. L.	9 26	(0?)	N. Lat. = 81° 35′.5		

"Latitude perhaps a minute or two smaller, the midnight altitude having been taken a little late."

The first observations have been reduced with $\varphi = 81° 35'$. The result is

$$LT-I = 4^h\ 27^m\ 24^s \text{ and E. Long.} = 4^h\ 22^m\ 36^s - \Delta = 65°\ 39' - \Delta.$$

On August 2, the north point of the land was in S 65° W by compass.

An open channel along the islands of *Hvidtenland,* reached in the morning of August 6, was hereafter used for rowing and sailing.

1895, August 9. On the south side of *Adelaide Island.*

Bar. 756.0 mm, Therm. − 0°.6. Hor. Point = 89° 50′ + x, LT−I = $4^h\ 10^m + \frac{1}{15}\Theta$.

Watch I		Vert. Circle	N. Lat.
h m s		° ′	° ′
8 10 14	Sun L. L.	65 48	81 38.1 − 1.00 x − 0.010 Θ
14 44		65 48.5	81 37.8 − 1.00 x − 0.013 Θ
17 32		65 48	81 36.7 − 1.01 x − 0.015 Θ
20 59		113 50.7	81 37.0 + 1.01 x − 0.017 Θ
27 7		113 47.5	81 38.5 + 1.01 x − 0.021 Θ
31 35		65 55.5	81 40.0 − 1.01 x − 0.024 Θ
33 44		65 57	81 40.6 − 1.02 x − 0.026 Θ

The mean for the two positions of the instrument is $\varphi = 81° 38'.2 - 0.018\,\Theta$. The data necessary for the determination of Θ will be found below.

From the glacier covering the Adelaide Island, the bearing of the south point of *Eva Island* was nearly east (some fog in this direction), *Liv Island* from N to NE^b E, *Freeden Island* from S to SE^b E, all per compass. The distance of the latter island was estimated to be about 4 miles.

After three hours of sailing, the following observations were taken the same day:

Bar. 758 mm, Temp. − 2°. Height of eye 3 feet, Ind. corr. 0, Ass. Lat. 81° 35′.

Watch I		Sextant	LT−I	$\frac{1}{15}\frac{dt}{d\varphi}$	$\frac{1}{15}\frac{dt}{dh}$
h m s		° ′	h m s		
1 58 45	Sun L. L.	15 20.5	4 10 46	+ 0.027	− 0.456
2 4 2		15 10	4 10 13	0.036	− 0.457
2 7 38		15 2.5	4 10 3	0.043	− 0.457
		Mean	4 10 21	+ 0.035	− 0.457

The sailing lasted from 3 p.m. to 8 p.m. and was followed by dragging over a belt of ice; estimated distance about 10 miles. The course seems to have been nearly true SW. Assuming the distance between the two sets of observations to have been 5 miles, the change of latitude would be $-3'.5$, and of east longitude $-24' = -1^m 36^s$, which gives $\Theta = 30'$ nearly, and for the south side of Adelaide Island

$$\text{N. Lat.} = 81^\circ\ 37'.7.$$

For the afternoon observations φ would then be $81^\circ\ 34'$ or $\Delta\varphi = -1'$, and

$$\text{LT}-\text{I} = 4^h\ 10^m\ 19^s,\ \text{E. Long.}\ 4^h\ 7^m\ 7^s - \Delta = 61^\circ\ 47' - \Delta.$$

1895, August 10. Bar. 758.4 mm, Temp. $-3^\circ.6$. Height of eye 6 feet, Ind. corr. (0?).

Meridian altitude Sun L. L. $23^\circ\ 56'$; N. Lat. $= 81^\circ\ 30'$.

After rowing and dragging from 1 p.m. to 10 p.m. in a south-westerly direction (estimated distance 8—10 miles) the following *Lunar Distance* was taken:

Watch I $7^h\ 25^m\ 29^s$, Sun and Moon $122^\circ\ 37'$; Bar. 758.2 mm, Temp. $-5^\circ.3$.

Assuming Ind. corr. 0 as the day before, N. Lat. $81^\circ\ 25'$, $\text{LT}-\text{I} = 4^h\ 5^m$, the result is

$$\text{I}-\text{Gr.} = -0^h\ 11^m.8$$

while the table p. 112 has $-0^h\ 3^m.0 - \Delta$. As the Ind. corr. was not determined on the same occasion, and only a single distance was taken (the Moon disappeared during the observation) the result was not considered sufficiently accurate for a determination of Δ. An index correction of $+4'$ would give accordance, with $\Delta = 0$.

1895, August 16. On *Houen Island.* Bar. 758.5 mm, Temp. $-1^\circ.5$.
Hor. Point of Circle $= 89^\circ\ 51' + x$, $\text{LT}-\text{I} = 3^h\ 50^m + \frac{1}{15}\Theta$.

Watch I		Vert. Circle	N. Lat.		
h m s		° ′	° ′		
9 15 20	Sun L. L.	68 10.2	81 35.5	$-1.04\,x$	$-0.042\,\Theta$
23 58		111 24	81 35.5	$+1.05\,x$	$-0.048\,\Theta$
		Mean	81 35.5		$-0.045\,\Theta$

where Θ may probably be neglected.

1895, August 17. On the ice off *Cape Brögger.* Bar. 753.5 mm, Temp. -1°. Hor. Point ass. $89^\circ\ 51'$.

Watch I		Vert. Circle	LT—I	$\frac{1}{15}\frac{dt}{d\varphi}$	$\frac{1}{15}\frac{dt}{dh}$
h m s		° ′	h m s		
5 40 3	Sun L. L.	109 39	3 46 32	+ 0.519	+ 0.687
43 15		109 42	3 45 32	0.529	0.695
45 3		69 57	3 45 51	0.540	0.703
48 23		69 42.5	3 45 44	0.565	0.723
		Mean	3 45 55	+ 0.538	

A correction of $+10'$ has been applied to the circle reading of the fourth observation.

The assumed latitude, $81^\circ\ 30'$, is somewhat uncertain. On the preceding day and night the travellers were walking and rowing first NW, and then nearly west, but from *Cape Felder* the coast trended more south-west. The longitude is given below on the two suppositions of latitude 81° 30′ and 81° 34′.

With $\varphi = 81° 30'$, LT−I = $3^h 45^m 55^s$ and E. Long. = $3^h 44^m 15^s - \varDelta = 56° 4' - \varDelta$.
" $\varphi = 81\ \ 34$, LT−I = 3 48 4 and E. Long. = 3 46 24 $- \varDelta = 56\ 36 - \varDelta$.

After some hours of rowing from midnight Aug. 17—18 (estimated distance 6—8 miles), towards *Cape Clements Markham*, about SSW by compass, the travellers met the drifting ice and turned more eastwards to the firm ice. As the south-westerly wind freshened up, and the ice closed in, they were detained for several days on the ice off *Cape Helland*, where the following observations were taken.

1895, August 19. Bar. 741 mm, Temp. − 0°.9. Height of eye 18 feet, Ind. corr. + 4′.

Watch I		Sextant	LT−I	$\frac{1}{15}\frac{dt}{d\varphi}$	$\frac{1}{15}\frac{dt}{dh}$
h m s		° ′	h m s		
2 13 20	Sun L. L.	12 27	3 49 23	+ 0.014	− 0.447
19 15		12 13.5	49 33	0.025	− 0.447
21 39		12 7	50 1	0.031	− 0.448
24 1		12 1	50 22	0.036	− 0.448
25 49		11 59	49 29	0.038	− 0.448
		Mean	3 49 46	+ 0.029	− 0.448

The assumed latitude was 81° 25′. Applying the correction $\varDelta\varphi = -1'.5$, according to the following observations, the result is

Watch I $2^h 21^m$, LT−I = $3^h 49^m 43^s$ and E. Long. = $3^h 48^m 31^s - \varDelta = 57° 8' - \varDelta$.

As the dead reckoning gives a somewhat smaller longitude, and the bearing of the two camps of August 17 and 19 had been estimated as nearly true north and south, it is possible that the apparent horizon has been elevated, as was manifest some days later on (see below). Assuming the same value of $\varDelta h = +5'$ as then (though the meteorological conditions were not quite the same, the southerly wind being considerably stronger during this stay), the result would be

LT−I = $3^h 47^m 29^s$ and E. Long. = $3^h 46^m 17^s - \varDelta = 56° 34 - \varDelta$.

1895, August 20. Same place. Bar. 743.5 mm, Temp. − 2°.1. Ass. Hor. Point 89° 51′.

Watch I		Vert. Circle	N. Lat.	$\frac{d\varphi}{dt}$	$\frac{d\varphi}{dh}$
h m s		° ′	° ′		
9 56 25	Sun L. L.	109 50.2	81 23.3	− 0.076	− 1.12
10 0 25		109 46	23.4	− 0.079	− 1.13
10 4 45		70 0.2	22.8	− 0.083	− 1.14
10 7 18		70 4.7	24.8	− 0.085	− 1.15
		Mean	81 23.6	− 0.081	

These values were calculated with the assumed LT−I = $3^h 50^m$. If the second result for August 19 be adopted, LT−I would be $3^h 47^m 19^s$ or $\varDelta t = -2^m 41^s = -40'$ and

N. Lat. = 81° 26′.8

or nearly the same as originally assumed on August 19. The influence on the longitude is insignificant.

1895, August 28. At the place that was chosen for winter quarters.
Bar. 742.7 mm, Temp. − 1°.0 C, Ind. corr. + 6′.

Watch I	Eye		Sextant	
h m s	feet		° ′	The two sets combined give:
8 36 34	4	Sun L. L.	18 11	
8 44 40			18 8	N. Lat. = 81° 17′.5
8 49 50			18 6	
				and for Watch I 8h 44m, LT−I = 3h 42m 37s,
1 25 55	7		11 20	
1 28 34			11 13.5	E. Long. = 3h 43m 10s − Δ = 55° 47′ − Δ.

1895, August 30. Same place. Bar. 742 mm, Temp. − 2° C., height of eye 6 feet.

Meridian altitude Sun L. L. Sextant 17° 30′; Ind. corr. + 6′.
Result: N. Lat. 81° 17′.3.

Though the two determinations of latitude of August 28 and 30 accord well, it must be remarked that a series of altitudes taken the next year with the altazimuth on the same place, gives the latitude nearly 5′ smaller, which can only be explained by an elevation of the apparent horizon on Aug. 28 and 30, similar to that found during the spring of the same year. Assuming a correction of + 5′ for both sets of altitudes of August 28, the result will be for the Winter Hut:

N. Lat. 81° 13′.

and LT−I = 3h 40m 47s, E. Long. = 3h 41m 20s − Δ = 55° 20′ − Δ.

Observations taken at the Winter Hut.

Comparisons between the watches I and II.

1896	I	I−II	Rel. rate	1896	I	I−II	Rel. rate
	h m	h m s	s		h m	h m s	s
April 18	10 15 pm	0 3 58	+ 19	May 3	10 37 pm	1 51 36	+ 24
19	9 43 "	4 17	20	5	1 40 am	52 3	24.5
20	10 54 "	4 39	17	6	5 12 "	52 31	23
22	0 28 am	4 57	24	7	9 15 "	52 58	27
23	0 14 "	5 21	28	8	1 23 pm	53 30	24
24	3 46 "	5 53	23	9	10 56 "	54 3	22
25	7 26 "	6 20	20	11	7 25 am	54 33	31
26	10 14 "	6 42		12	0 5 pm	55 10	20
	II stopped	Mean	+ 21.9	13	8 20 "	55 37	18
				14	10 46 "	55 57	15
April 27	7 15 pm	1 49 23	+ 24	15	11 19 "	56 13	14.4
29	2 28 am	49 54	21	17	3 25 am	56 30	24
30	4 35 "	50 17	16	18	6 1 "	56 57	16
May 1	5 33 [am]	50 34	18	19	3 17 "	1 57 11	
2	11 20 am	50 57	26			Mean	+ 21.8

1896, April 18. Bar. 759.0 mm, Temp. − 23°.5 C. Circle Hor. Point 89° 51′ + x. Ass. Lat. 81° 13′.

Watch I		Hor. Circle	LT−I	$\frac{1}{15}\frac{dt}{d\varphi}$
h m s		° ′	m s	
8 15 10 pm	Sun L. L.	82 4.2	− 52 21 − 0.473 x	+ 0.182
32 45 "	" U. L.	97 33.7	− 52 36 + 0.489 x	0.222
55 15 "	" U. L.	96 53.0	− 55 37 + 0.513 x	0.266
9 4 51 "	" L. L.	83 42.5	− 51 55 − 0.532 x	0.307

"Sun's limbs indistinct. Observation interrupted in the middle hy a bear looking on."

There seems to be an error in the second or third observation, but as a correction cannot be made without arbitrariness, and the limbs of the low Sun were indistinct, the numbers have been retained as they stand. The result is then:

Watch I	8h 40m pm	LT−I	= − 52m 8s − 0.502 x
"	8 44 "	"	= − 54 6 + 0.501 x
Mean "	8h 42m pm	"	= − 53m 7s

1896, April 20. A series of 9 altitudes were taken of the Sun, and are used below for determination of local time, 6 altitudes of the Moon, used for latitude, 4 lunar distances, and 2 bearings of the Sun by compass.

Bar. 756.4 mm, Temp. − 22° C.

Altitudes of the Sun. Circle Hor. Point 89° 52′ + x, Sun's Semidiameter = Tabular Value + y. Ass. Lat. 81° 13′.

Watch I		Vert. Circle	LT−I	$\frac{1}{15}\frac{dt}{d\varphi}$
h m s		° ′	m s m s	
4 59 8 pm	Sun L. L.	105 28.5	− 52 53 + 0.488 $(x-y)$ = − 54 34	− 0.219
5 6 40 "	" "	74 30	− 53 23 − 0.480 $(x+y)$ = − 53 34	− 0.202
6 46 46 "	" "	78 11.2	− 52 47 − 0.437 $(x+y)$ = − 52 58	+ 0.005
7 26 10 "	" "	100 4.2	− 52 39 + 0.444 $(x-y)$ = − 54 11	0.081
32 31 "	" "	79 53.5	− 52 52 − 0.446 $(x+y)$ = − 53 3	0.093
39 35 "	" U. L.	79 31.7	− 55 33 − 0.448 $(x-y)$ = − 54 0	0.102
8 9 10 "	" L. L.	81 12	− 53 11 − 0.468 $(x+y)$ = − 53 22	0.169
18 13 "	" "	98 10	− 51 41 + 0.476 $(x-y)$ = − 53 19	0.192
23 58 "	" U. L.	98 33.2	− 53 26 + 0.480 $(x+y)$ = − 53 12	0.202

Combinations of the 6th and 9th observations with the others give $x = -1'.5$ and $y = +1'.9$, by which the values in the last row have been deduced. The mean is:

Watch I 7h 9m pm, LT−I = − 53m 35s.

Altitudes of the Moon. Circle Hor. Point = 89° 52′ + x. For the coordinates of the Moon assumed Watch 4h 35m in advance of Gr. M. Time, corresponding to East Long. 55° 20′. As for the Sun, the Semidiameter was put = Tabular Value + y; but as the upper and lower limb were not equally suitable for observation, especially for the first two altitudes, during which the lower limb must have been some 15° out of the vertical (as measured from the Moon's Centre) only the last four observations were used for the determination of x and y.

Watch I		Vert. Circle	N. Lat.	$\frac{d\varphi}{dt}$
h m s		° ′	° ′ ° ′	
4 42 50 pm	Moon L. L.	120 19	81 8.1 $+ 1.21\ (x-y) =$ 81 7.5	+ 0.103
4 50 0 "	" "	120 23,2	12.4 $+ 1.18\ (x-y) =$ 11.8	+ 0.096
6 57 43 "	" "	58 24	12.4 $- 1.00\ (x+y) =$ 11.0	− 0.003
7 4 30 "	" U. L.	57 52	10.5 $- 1.00\ (x-y) =$ 11.0	− 0.008
7 12 0 "	" L. L.	121 16.5	12.3 $+ 1.00\ (x-y) =$ 11.8	− 0.013
7 17 15 "	" "	121 16	10.7 $+ 1.01\ (x-y) =$ 10.2	− 0.017

"Horns of the Moon indistinct in the telescope, observations therefore less accurate."

The last four observations give $x + y = + 1'.4$ and $x - y = - 0'.5$.

The mean result is 81° 10'.6 or, with omission of the first, 81° 11'. If the longitude following from the lunar distances below be used, which would give Greenwich Time 5 minutes greater than that used above, the change in the Moon's coordinates would give the latitude 0'.8 smaller.

Lunar Distances. Sun and Moon, inner limbs. Ind. corr. + 5'.4.

Watch I		Sextant	Gr. M. T.	I−Gr.
h m s		° ′	h m s	h m s
5 31 10 pm	Distance	84 28.5	1 1 13	4 29 57
5 53 40 "		84 38	1 21 0	32 40
6 26 0 "		84 56	1 58 26	27 34
6 36 0 "		85 0	2 7 15	28 45

The mean is $4^h\ 29^m\ 44^s$, which, with the correction to local time found above, $- 53^m\ 35^s$, gives the East Longitude $3^h\ 36^m\ 9^s = 54°\ 2'$, but this result is rather uncertain, as will be seen from the numbers in the last column. In order to get the longitude assumed above, it must however be supposed that all the distances have been measured too small.

Magnetic Declination.

Watch I		Compass		Sun's Az.	Decl.
h m s		°	°	°	°
7 51 50 pm	Sun Centre	S 86	N 85	S 106.5 W	21.0 E
59 16		" 85.6	" 84.2	" 108.3 "	23.4

"Needle very unsteady."

If the declination had been constant during the observations, the decreasing numbers on the compass would show that the angle between the north end of the needle and the Sun's vertical plane had been less than 90°, which would give the declination 12°.0 E and 13°.2 E respectively (see explanation p. 70). But it is apparent, from a computation made by the observer, that the reading on the compass has been on the other side of 90°, which gives the values in the last column. The result is at all events uncertain, owing to the unsteadiness of the needle.

1896, April 27. Circum-meridian altitudes of the Sun. Bar. 758.5 mm, Temp. − 13°.8 C.

Assumed Hor. Point 89° 53', including the correction to the Sun's semidiameter, which is eliminated from the mean result. Watch assumed $52^m\ 0^s$ in advance of apparent time (deduced from the preceding and the following determination of local time).

Watch I		Vert. Circle	N. Lat.	
h m s		° ′	° ′	
0 27 42 pm	Sun L. L.	67 21.7	81 14.0	Result:
34 20	" "	67 20	13.8	Sun L. L. (4 obs.) 81° 12′.6
41 39	" U. L.	112 59	13.7	" U. L. (5 obs.) 81° 12′.9
49 55	" "	112 59.5	13.9	
1 4 5	" "	112 59.5	13.3	Mean 81° 12′.8
8 55	" L. L.	67 16.8	11.2	
23 0	" "	67 20.2	11.3	
28 8	" U. L.	112 55	12.0	
39 15	" "	112 50.7	11.6	

The observations themselves seem to require a somewhat greater correction to the watch, but as the altitudes were taken on both sides of the meridian, the result would be essentially the same. This result has been adopted for the latitude of the Winter Hut.

1896, April 29. Bar. 752 mm, Temp. — 11°.5 C. Ass. Hor. Point 89° 52′ + x.

Watch I		Vert. Circle	LT—I	$\frac{1}{15}\frac{dt}{d\varphi}$
h m s		° ′	m s m s	
6 11 52 pm	Sun L. L.	74 0	$-54\ 40\ -0.451\,x = -54\ 56$	-0.059
25 28	" "	74 30.5	$-54\ 44\ -0.438\,x = -55\ 0$	-0.033
32 30	" U. L.	105 30	$-55\ 2\ +0.437\,x = -54\ 46$	-0.020
36 13	" "	105 22	$-55\ 16\ +0.437\,x = -55\ 0$	-0.013
41 14	" L. L.	75 7	$-54\ 27\ -0.437\,x = -54\ 43$	-0.002

The mean result is $x = +0'.6$ and

Watch I 6h 30m, LT—I = — 54m 53s.

1896, May 16. Bar. 758.5 mm, Temp. — 6° C.
Circle Hor. Point = 89° 51′ + x, Sun's Semidiameter = Tabular Value + y.

Watch I		Vert. Circle	LT—I	$\frac{1}{15}\frac{dt}{d\varphi}$
h m s		° ′	m s m s	
8 14 45 pm	Sun L. L.	105 44	$-57\ 43\ +0.474\,(x-y) = -58\ 27$	$+0.184$
23 15	" "	74 18.7	$-56\ 12\ -0.483\,(x+y) = -57\ 24$	0.206
29 0	" U. L.	73 55.5	$-57\ 53\ -0.487\,(x-y) = -57\ 7$	0.215
36 59	" L. L.	104 56.5	$-56\ 43\ +0.497\,(x-y) = -57\ 29$	0.237
42 35	" "	104 45	$-56\ 31\ +0.503\,(x-y) = -57\ 18$	0.251
47 52	" U. L.	74 32	$-58\ 28\ -0.508\,(x-y) = -57\ 41$	0.259

The values $x + y = +149''$ and $x - y = -94''$ were determined with omission of the first observation. If it is also omitted for the clock correction, the result is

Watch I 8h 36m, LT—I = — 57m 24s.

Immediately after these observations, the bearing of the Sun and of a terrestrial mark were taken with the theodolite, and then a series of bearings by compass of the same terrestrial mark and some other points, which were useful for the reduction of the observations taken on the way southwards. The names of the different points and islands are retained here as given in the original journal.

Watch I		Hor. Circle	Azimuth
—	Needle on the "Slotsberg"	6° 55′	S 37° 31′ E
9h 1m 35s	Sun Centre	168 40	S 124 14 W

	Compass
Needle on the Slotsberg	S 55°.7 E
Cape of Good Hope	S 37 W
Hope Island, inner point	S 39 W
" outer point	S 46 W
Black-spotted Island . . . . between	S 74 W and S 78° W
White Island . . . . between	S 85 W and S 97 W
"Slabben" (called "Steinen" on Nansen's map)	N 70 W
Northern Island . . . . between	N 59 W and N 54 W
Needle Cape	N 41 W
Round mountain farther in the fjord	N 86 E

The first three observations give:

Magnetic Declination at the Winter Hut = 18°.2 E.

which value is certainly preferable to that found on April 20 during a period of evident magnetic perturbations.

The points above are probably to be identified with the following points named by Mr. Jackson:

Slotsberg	Cape Brice.
Cape of Good Hope . . .	A little to the north of Cape Mc. Clintock.
Hope Island	Mary Elizabeth Island.
Black-spotted Island . . .	Wm. Neale Island.
White Island	Geo. Harley Island.
Northern Island	Erasmus Ommaney Island.
Needle Cape	Cape Hugh Mill.

The determinations of Local Time give the following values of the clock error and daily rate.

	Watch I	I—M. T.	Daily Rate
	h m	m s	s
1896 April 18	8 42 pm	53 7	
April 20	7 9	53 35	+ 14
April 29	6 30	54 53	+ 8.7
May 16	8 36	57 24	+ 8.8

and the mean acceleration during the whole period = + 9s.2.

The comparisons with Watch II during the same period give for this a daily retardation of 12s.6.

On the way southwards from the Winter Hut.

Comparisons between the watches I and II.

1896	I	I—II	Rel. rate	1896	I	I—II	Rel. rate
	h m	h m s	s		h m	h m s	s
May 19	3 17 am	1 57 11	+ 14	June 1	8 50 pm	2 0 16	+ 11
20	4 13 "	1 57 25	15	2	10 50 "	2 0 28	15
21	1 22 "	1 57 38	16	4	5 25 am	2 0 57	15
22	3 33 "	1 57 56	14	5	10 43 "	2 1 16	15
24	1 11 "	1 58 22	17	7	0 38 "	2 1 39	15
25	5 57 "	1 58 43	10	8	10 0 "	2 2 0	13
26	5 19 pm	1 58 57	15	9	11 4 pm	2 2 20	19
28	0 16 am	1 59 16	18	11	11 9 am	2 2 49	16
"	11 0 pm	1 59 33	10	13	2 40 "	2 3 16	
30	2 31 "	1 59 49	12	17	I stopped	Mean	+ 14.6
June 1	1 29 am	2 0 6	12	June 17	0 31 am	— 2 19 50	

The running down of I took place the day after a struggle with a walrus which had attacked and damaged one of the kayaks. On applying the mean relative acceleration of 14s.6. the reduction to the former state will be:

June 13,	2^h 40^m am	I—II =	+ 2^h 3^m 16^s	
	Rel. Acc. in 4.1 days		+ 1 0	
June 17,	I—II should have been		+ 2 4 16	
	" was		— 2 19 50	
	I lost through stopping		4 24 6	

It will be seen that the relative acceleration during the travelling was in the mean 7 seconds less than during the last month at the Winter Hut. As to the acceleration of I, which was found to be + 9s.2 during the same month, it may be mentioned that a series of comparisons with Mr. Jackson's chronometer in June and July gave an acceleration of 10s relative to this chronometer, which was said to lose 0s.5 daily, consequently I accelerating 9s.5 daily. Some observations on the way southwards which will be found below seem, however, to indicate that the acceleration during the travelling was in the mean somewhat greater, about 12s.5. This value has been used for computing the longitude *West* of the meridian of the Winter Hut, designated below by λ.

In order to utilise the bearings by compass it was necessary to know the magnetic declination. For the Winter Hut the value 18°.2 E, found on May 16, was adopted. In Jackson's *A Thousand Days in the Arctic* is given a table of magnetic declinations at Cape Flora as determined by Mr. *Armitage*. The mean value for the summer 1896 was 15°.1 E. The isogones in this regions running nearly north and south, this would correspond nearly to 0°.6 decreasing of magnetic declination per degree of west longitude.

In some cases the position at the time of observation has been determined by the crossing of such a line of bearing with the line of equal altitudes.

After short walks on the ice on the evenings of May 19 and 20 the following observations were taken during a rest on the following day.

1896, May 21. Bar. 754.9 mm, Temp. − 5°.3 C.

Hor. Point 89° 50′ + x. Assumed LT−I = − 1h 0m 30s.

Watch I		Vert. Circle	N. Lat.	$\frac{d\varphi}{dt}$	
h m s		° ′	° ′		
1 30 47 pm	Sun L. L.	118 40.5	81 8.6 + x	− 0.025	Mean:
36 57 "	" U. L.	60 31.5	81 9.6 − x	− 0.029	81° 9′.5
40 14 "	" "	60 32.0	81 8.8 − x	− 0.032	
44 38 "	" L. L.	118 32.2	81 10.9 + x	− 0.035	

The assumed clock correction is adapted to a bearing of the Winter Hut given below and corresponds to $\lambda = 0°\ 32'$.

From the same station the following observations were taken:

	Vertical Circle
Summit of the Slotsberg	89° 18′ and 90° 30′.5
Glacier behind the Winter Hut	91° 37′ and 88° 11′.5
	Compass
Needle on the Slotsberg	S 89°.2 E
Winter Hut	N 40°.4 E
Cape of Good Hope	S 33° W
Hope Island . . . . between	S 40° W and S 50° W
Black-spotted Island, middle	N 57°.5 W
White Island, middle	N 50°.5 W
Most northern black point	N 7° E (between Needle C. and
Needle Cape	N 10° E C. Cl. Markham).

Applying the declination 18° E the bearing of the Winter Hut is, with due regard to the convergence of meridians, equivalent to the true bearing S 59° W the opposite way.

The above coordinates give the distance from the present station to the Winter Hut 6 miles. The cross-bearings give then the following distances from the Hut: White island 10 miles, black-spotted island nearly 9 miles, Slotsberg 9 miles, Needle Cape 4 miles.

The distance from this station to the Slotsberg is 11.5 miles. The altitude of 0° 36′ measured above will then give the height of this mountain about 250 metres, the summit being 1−2 miles behind the Needle. Assuming the glacier, the altitude of which was 1° 43′, to be 2 miles behind the Winter Hut, its height would be about 440 metres.

The bearings of the Cape of Good Hope and Hope Island cut under too small angles to determine the situation. If the distance of Hope Island be estimated by its angular magnitude, which was 7° from the Winter Hut and 10° from this station (supposing the same points to have been observed on both occasions) its distance would be $^7/_3 \cdot 6 = 14$ miles or 20 miles from the Winter Hut, but this is of course somewhat uncertain.

After a short walk the following observation was taken the same afternoon:

Barometer and Temperature as above. Assumed Lat. 81° 9′.

Watch I		Vert. Circle	LT−I	$\frac{1}{15}\frac{dt}{d\varphi}$	$\frac{1}{15}\frac{dt}{dh}$
h m s		° ′	h m s		
5 22 50	Sun L. L.	66 27	} − 1 0 50	− 0.157	− 0.461
26 3	" U. L.	113 44.5			
28 11	" "	113 40	} − 1 0 27	− 0.143	− 0.456
32 25	" L. L.	66 49			

The mean $-1^h 0^m 38^s$ corresponds to $\lambda = 0° 32'$.

Late in the evening the tent was raised near the Cape of Good Hope. From this point the bearing was taken of two snow-covered islands, a large one (middle) in S 40° W, another not much smaller in S 85° W by compass.

A sketch which was taken in the afternoon of May 21, possibly on the station for the last altitudes of the Sun, has the bearing of a line pointing to the middle of the fjord north of the Slotsberg (Jackson's *Gore Booth Fjord*) N. 72° E, and a mountain somewhat south-east of the Slotsberg N 80°.5 E by compass.

After a day of rest during a snow-storm and a short trip southwards to "The Castle" (Jackson's *C. Mc. Clintock*) from which they returned, the travellers went over to the island. Before leaving the following bearings were taken from the ice off the Cape of Good Hope:

Most southerly point (Jackson's *Cape Fisher*)	S 8° W	by Compass
Point at Cape Athos (*C. Clements Markham*)	N 2 E	"

1896, May 28. From the north side of Hope Island:

White Island	N 8° W	by Compass
Black-spotted Island	N 2 E	"
Cape of Good Hope	N 65 E	"

The position of the two islands being determined by previous cross-bearings, and assuming the magnetic declination to be 17°.5 E, the first two bearings give the position of the station at a distance of 12–13 miles from the Winter Hut. Though the angle of intersection is only 10°, this result is probably to be preferred to the approximate value found above, the lines crossing very nearly in the line giving the direction of the northern border of the island as seen from the Winter Hut and the nearly coincident direction from the ice May 21. The coordinates of the station would then be $\varphi = 81° 7'$ and $\lambda = 1°.2$. The third observation then gives the Cape of Good Hope 9–10 miles from the Winter Hut and $\varphi = 81° 7'.5$, $\lambda = 0°.8$.

1896, June 1. From the south side of Hope Island the most southerly land point was about S 2° W; a small island was seen outside of it. Two larger islands in view about SW and one W or somewhat more northerly.

A sketch has the following bearings, apparently from the same station:

Auk berg (Jackson's *Cape Fisher*)	S 38° E	by Compass.
Point on the south side of the fjord (*C. Richthofen?*)	S 3 E	"

The same sketch has the following bearings from a point on the ice so much south-east of the island that the Winter Hut was just clear of its east point:

Winter Hut	N
Cape of Good Hope	N 46° E
The Castle (*J. C. Mc. Clintock*). . . .	N 52 E

The bearing of Cape Fisher combined with the bearing of the same point from the ice off Cape of Good Hope gives its position $\varphi = 81° 3'$, $\lambda = 1°.1$ and distance from the Cape of Good Hope 5–6 miles.

The bearing of the Winter Hut is evidently erroneous; the observer seems to have written N on the line indicating the direction on the sketch, but forgotten to add the degrees east. As it is, however, apparent from the sketch, that the station is on the line from the Winter Hut through the inner point of Hope Island, the bearing of which was determined on May 16, this direction combined with the bearing of the Cape of Good Hope (magnetic declination ass. 17°.5 E) gives for the station $\varphi = 81° 5'$, $\lambda = 1°.1$ or $1°.2$ and distance from the Cape of Good Hope 4 miles. The bearing of the Castle will then give this point 0.4 mile south of the Cape of Good Hope.

1896, June 3. Sailing on the ice towards Cape Fisher. It is not stated when the departure took place.

Bar. 751.5 mm, Temp. $-$ 1°.5 C.

Circle Hor. Point 89° 51′ $+ x$. Assumed clock correction $-$ $1^h 5^m 30^s$, corresponding to $12^s.5$ daily acceleration and $\lambda = 1°.1$.

Watch I		Vert. Circle	N. Lat.	$\frac{d\varphi}{dt}$	
h m s		° ′	° ′		
1 15 54 pm	Sun L. L.	120 54	81 5.9 $+x$	$-$ 0.009	
19 50	" "	120 53	81 6.1 $+x$	$-$ 0.012	Mean:
24 5	" U. L.	58 16.5	81 4.5 $-x$	$-$ 0.015	81° 5′.1
27 54	" "	58 17.0	81 4.1 $-x$	$-$ 0.018	

The tent was raised in the evening somewhat past Cape Fisher. The travellers went on the next day at 6 p.m, first sailing on the ice, then rowing in the kayaks round Cape Richthofen till 7 a.m June 5.

1896, June 6. Before leaving the tent-place near Cape Richthofen the bearing was taken of "most easterly point of new land" (on the other side of Jackson's *Markham Sound*) in S 68° E; open sea visible in S 75° W, both by compass.

After some six hours of sailing on the ice the following observations were taken with the sextant. Index corr. $+$ 5′, height of eye 4 feet. Bar. 750.5 mm, Temp. $-$ 3° C.

Watch I		
$0^h 23^m 0^s$ pm	Sun L. L.	31° 31′
Noon	" "	31 42

The meridian altitude gives $\varphi = 80° 44'$. If the first altitude be used to seek the hour angle corresponding to 11′ reduction to the meridian, it would give the watch $1^h 6^m 54^s$ in advance of apparent time or $1^h 8^m 25^s$ in advance of mean time; of course with considerable uncertainty.

From the same station the following bearings were taken (noted on a sketch):

West point of island in the north (Jackson's *Cape Richthofen*) .	N 7° E	by Compass
Most southern visible point of the same island	S 90 E	"
North point of another island in the sound (J. *Bromwich Island?*)	S 70 E	"

A small island far east is indicated between the last two bearings.

North point of a third island (J. *Fridtjof Nansen Island?*) . .	S 62 E	"
West point of the same island	S 23 E	"
East point of a fourth island (J. *Reginald Koettlitz Island?*) . .	S 15 E	"
North-west point of the same	S 6 W	"

The tent was raised in the evening near the point of the last bearing.

As the two bearings of C. Richthofen (supposing that this was the point observed from the south side of the Hope Island on June 1) cut under a too small angle, the last named bearing was combined with the parallel of 80° 47′.5, which appears to be the latitude of this point according to an observation of Mr. Armitage taken in the neighbourhood 1895 April 27 during Jackson's expedition. This gives for C. Richthofen $\lambda = 1° 41'$ and for the present station, by means of the bearing above, $\lambda = 1° 52'$. Applying the daily acceleration of $12^s.5$ from May 16, this would give the watch $1^h 9^m 10^s$ in advance of Local Mean Time on June 6, Noon, not more different from the above approximate value, than could be expected.

The following observations were taken before leaving the point near Koettlitz Island, where the travellers stopped on the evening of June 6.

1896, June 7. Bar. 746.9 mm, Temp. – 2°.4 C.
Circle Hor. Point 89° 53′ + x, assumed latitude 80° 40′.

Watch I			Vert. Circle	LT – I	$\frac{1}{15}\frac{dt}{d\varphi}$
h m s			° ′	h m s	
4 26 45 pm	Sun	L. L.	61 25.7	– 1 10 10 – 0.513 x	– 0.307
39 15	"	U. L.	118 28.0	– 1 10 36 + 0.497 x	– 0.279

	Compass
Snow island, southern point	S 58° W
" northern point	N 76 W
The cape we left yesterday (*Cape Richthofen*)	N 6 E

The last bearing may serve to correct the assumed latitude. Applying the magnetic declination 17° E its intersection with the line of equal altitudes gives $\varphi = 80° 39'$; the differential quotients then give the clock correction – $1^h 10^m 23^s + 17^s = - 1^h 10^m 6^s$. The same intersection gives also $\lambda = 8^m 10^s$, or watch I $1^h 1^m 56^s$ in advance of M. T. at the Winter Hut; on May 16 the error was $0^h 57^m 24^s$, consequently an acceleration of $4^m 32^s$ in 21.8 days or $12^s.5$ daily.

After a good sailing on the ice from 7½ p.m June 7, the travellers stopped at 7 a.m June 8 in a snow storm without reaching the land on the other side of the fjord (Jackson's *Allen Young Sound*). A sketch from the following day has the bearing from west point of "low moraine island" (J. *Koettlitz Island*) to west point of "low moraine land" (J. *Hooker Island*) as S 10° E by compass. The stopping place of June 8 in the morning was about midway, but somewhat to the east of this line. The west point of Koettlitz Island was more westerly than the tent-place of June 6–7 on the north side of the island. On the same sketch is indicated a small island about 6 miles west of "low moraine land", and another close to the north of it; probably Jackson's *Eaton Island* and *Scott Keltie Island*.

About 3 hours after leaving this station on the ice the following observation was taken:

1896, June 9. Bar. 747 mm, Temp. ca. 0°. Ind. corr. (+ 5′?), height of eye 4 feet.

Watch I		Sextant	N. Lat.	$\frac{d\varphi}{dt}$	$\frac{d\varphi}{dh}$
h m s		° ′	° ′		
10 3 40 am	[Sun L. L.]	29 0	80 26.4	+ 0.202	– 1.58
18 45 "		29 28	80 26.6	0.176	– 1.46

"Land about 2 miles off."

The latitude is calculated with the assumed clock correction – $1^h 13^m$, corresponding to $\lambda = 2°.7$, when the same acceleration is applied as before.

The sailing on the ice continued till 6 p.m. Before stopping in the neighbourhood of the west point of Hooker Island the travellers had to make a long circuit westwards, the ice beginning to give way under the sledges. After stopping, the following observations were taken:

Bar. 749.5 mm, Temp. + 1°.0 C. Ind. corr. (+ 5 ?), height of eye 7 feet.

Watch I		Sextant	LT – I	$\frac{1}{15}\frac{dt}{d\varphi}$	$\frac{1}{15}\frac{dt}{dh}$
h m s		° ′	h m s		
7 28 15 pm	[Sun L. L.]	21 49	– 1 15 13	+ 0.052	– 0.397
33 30 "		21 34	– 1 14 28	0.062	– 0.398
38 10 "		21 20	– 1 13 32	0.072	– 0.400
41 45 "		21 13.5	– 1 14 28	0.076	– 0.401

The assumed latitude is 80° 17′ (see June 12). The mean of the rather discordant values of the clock error is $1^h\ 14^m\ 25^s$, corresponding to $\lambda = 3°.0$.

After a very good sailing on the ice during the whole night from 7 p.m June 10 till 6 a.m June 11 (distance sailed estimated to be 12 miles at least) the tent was raised before reaching land on the other side of the sound (J. *De Bruyne Sound*). Here the following observation was taken:

1896, June 11. Bar. 753.8 mm, Temp. – 2°.9. Ind. corr. (+ 5′?), height of eye 6 feet.

Midnight [Sun L. L.], Sextant 12° 58′, which gives the latitude 80° 2′.

From the same station the following bearings were taken, noted on a sketch:

Tent place of June 9–10 (near Hooker Island)	N 13° W by Compass
South point of a small island (J. *Etheridge Island?*) . . .	N 62 E ”
South-east point of another island (J. *Cape Barents*) . . .	S 23 W ”
More northern point of the same island (J. *Northbrook I.*) .	N 81 W ”

Applying the magnetic declination 16°.5 E the first bearing gives $\lambda = 3°.1$.

After continuing the sailing on the ice from 4 till 6 in the morning of the following day, now in a more westerly direction than before, the following observations were taken:

1896, June 12. Bar. 754.0 mm, Temp. – 1°.8 C. Ind. corr. (+ 5′?), height of eye 9 feet.

Watch I		Sextant	LT–I	$\frac{1}{15}\frac{dt}{d\varphi}$	$\frac{1}{15}\frac{dt}{dh}$
h m s		° ′	h m s		
7 10 19 am	[Sun L. L.]	22 16	– 1 17 19	– 0.040	+ 0.386
12 52 ”	”	22 22	– 1 17 33	– 0.036	0.386
14 37 ”	”	22 27	– 1 17 23	– 0.033	0.385
16 14 ”	”	22 33	– 1 16 42	– 0.029	0.385

The assumed latitude is 79° 58′, and the mean value of the clock error $1^h\ 17^m\ 14^s$, which gives $\lambda = 3°.6$.

It has been supposed that this station is nearly on the line determined on June 11 by the bearing of Cape Barents, towards which the travellers were steering when the weather had cleared up. The apparently somewhat arbitrary assumption of $\varphi = 80°\ 17'$ for the station of June 9 in the evening, which was combined with the station of June 11 by the first bearing of that day, has been made in order to nearly fulfil this condition.

Shortly after this observation the travellers met the open sea and went into the kayaks, and were henceforth sailing round Cape Barents and westwards along the ice border till the evening. After rowing during the night of June 13–14 the following observations were taken:

1896, June 14. Bar. 754.5 mm, Temp. – 2° C. Ind. corr. + 4′, height of eye 7 feet.

No.	Watch I		Sextant	No.	Watch I		Sextant
	h m s		° ′		h m s		° ′
1	1 40 15 pm	[Sun L. L.]	33 8	5	6 27 20 pm	[Sun L. L.]	25 7
2	47 22 ”	”	33 5	6	30 51 ”	”	24 59
3	51 40 ”	”	33 4	7	33 18 ”	”	24 50
4	56 2 ”	”	33 3	8	35 58 ”	”	24 43

These observations having been taken at the same place they were combined two and two, with due regard to the acceleration of the watch and the change of the equation of time between the two series, and gave the following results:

	N. Lat.	LT−I
	° ′	h m s
1 and 5	79 52.7	− 1 22 54
2 and 6	79 54.1	− 1 23 24
3 and 7	79 53.2	− 1 22 20
4 and 8	79 52.4	− 1 22 16
Mean	79 53.1	− 1 22 43

Assuming the mean acceleration $12^s.5$ this clock error would correspond to $\lambda = 4° 50'$; an acceleration of $9^s.5$ would give $\lambda = 5° 12'$.

This was the last observation. After some hours of rowing on the morning of June 15 and a necessary repairing of one of the kayaks the following day, the travellers met Mr. Jackson on June 17.

On June 18 a comparison with Jackson's chronometer gave:

Watch I 2^h 10^m am   I−Gr. = 0^h 20^m $40^s.7$.

Applying to this the loss through stopping 4^h 24^m 6^s, mentioned above, and acceleration $12^s.5$ daily in 3.7 days, the result will be:

1896 June 14, Watch I 1^h 49^m pm   I−Gr. = 4^h 44^m 1^s

which combined with the above correction to Local Time will give:

Longitude of Station June 14 = 3^h 21^m 18^s = 50° 20′ E
Applying further λ = 4 50

the longitude of the Winter Hut will be 55° 10′ E, or 55° 20′ by application of the correction of + 10′ to the longitude of Cape Flora mentioned in the introduction.

On comparing this result with the longitude of the Winter Hut given on p. 125 as following from the observations of the preceding year, it will be seen that if the mean rate of watch I has not differed sensibly from the then assumed value 12^s a day, which was very nearly the same as that found during the travelling in 1896, the quantity Δ of the preceding year may be neglected.

VII.

TERRESTRIAL MAGNETISM

BY

AKSEL S. STEEN.

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CORRIGENDA.

Page 30.	1894.	May 26.	Lat. N.	81° 30′	read	81° 31′
„ 34.	1894.	June 23.	$4^h\ 45^m$ p. m. *M.*	106° 42·0′	—	106° 46·9′
			D.	37° 19·8′	—	37° 24·7′
			Mean	37° 5·4′	—	37° 5·6′
„ 83.	1894.	July 6.	Long. E.	124° 33′	—	124° 39′
„ 95.	1896.	March 7.	Long. E.	24° 9′	—	24° 11′
„ 115.	1896.	March 19.	Long. E.	24° 40′	—	24° 39′
„ 126.	1896.	March 7.	Long. E.	24° 9′	—	24° 11′
	1896.	March 19.	Long. E.	24° 40′	—	24° 39′

A. INTRODUCTION.

Attempts are continually being made to extend the knowledge we possess regarding the magnetic conditions of our globe, both by regular observations with fixed instruments in observatories specially arranged for that purpose, and by occasional, but systematically prepared observations during scientific journeys. It is of especial importance to obtain determinations of the magnetic elements from the polar regions, because the observations have naturally hitherto been rather scarce from these deserted wastes, containing large tracts where the foot of man has never yet trod, and whose physical conditions place all kinds of difficulties in the way of delicate scientific investigations. They are also important because the action of the earth's magnetic forces in these very regions, judging from the observations that have been obtained, presents peculiarities to which there is no parallel in the temperate and torrid zones.

It was therefore reasonable that investigations of terrestrial magnetism should form an important part of Dr. Nansen's plan for the scientific work of the Norwegian Polar Expedition.

The member of the expedition who was appointed to conduct these investigations was Lieutenant, now Captain R. N. Sigurd Scott-Hansen, who, all through the three years in the ice, made all the observations belonging to this subject with unabated interest and great skill.

During the preparations for the expedition, Professor Mohn applied to the director of 'Deutsche Seewarte' in Hamburg, the famous magnetician, Professor Dr. G. Neumayer, with a request that he would give his valuable assistance in the arrangement of the magnetic part of the expedition's equipment, a request to which Professor NEUMAYER acceded in the most obliging manner. Among other things, he constructed a magnetic apparatus especially adapted to the conditions under which it was to be expected that the observations would have to be carried out, and made under his special supervision by Herr E. A. ZSCHAU, the mechanician of the 'Deutsche Seewarte'.

In a manuscript document[1] also sent to the expedition, containing a description of the several parts of the apparatus, and an account of the determinations of the constants of the instrument made in Hamburg before its despatch, Dr. NEUMAYER expresses himself at some length introductorily as to the fundamental principles followed in the design and construction of the apparatus.

These remarks, comprising 10 separate points, are as follows:

"1. Die astronomischen Bestimmungen sind durch den magnetischen Apparat nicht auszuführen. Die Kollimation des Kreises wird durch ein, von dem Apparate ganz getrenntes Instrument auf den Kreis desselben übertragen. Nur in Fällen, wenn die Beobachtungen eines Gestirnes nahe über dem Horizonte ausgeführt werden können, kann auch mit demselben eine Bestimmung der Kollimation des Kreises erfolgen. Bei der Durchführung astronomischer Beobachtungen sind die von Prof. MOHN in einem besonderen Memoire niedergelegten Ansichten als maassgebend zu erachten.

2. Wenn es auch unwahrscheinlich ist, dass der Gebrauch des Fox'schen Instrumentes an Bord des Expeditionsschiffes „Fram" immer möglich sein wird, so schien es doch zweckmässig, dieses werthvolle Instrument zu Zwecken der relativen Werthbestimmung der Inclination und der Total-Intensität bei der Expedition zu verwenden. Die Bestimmung der Horizontal-Komponente wird selbst bei Anwendung der grössten Umsicht bei dem kleinen Werthe dieses magnetischen Elementes auf erhebliche Schwierigkeiten stossen.

3. Es schien wichtig, im allgemeinen die Form des NEUMAYER-BAMBERG-schen Deklinatoriums beizubehalten, da sich dasselbe in jeder Beziehung bewährt hat und im übrigen gestattete, dass ein Apparat zu Horizontal-Intensitäts-Bestimmungen damit verbunden wurde. Sonach konnte die äussere Form und Aufstellung — wie dieselbe im Handbuche für Instrumentenkunde

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[1] Designated in this paper as Dr. NEUMAYER's manuscript.

dargelegt ist — beibehalten werden. Es kann der Apparat entweder arretirt, oder in der cardanischen Aufhängung schwingend — je nach Umständen — benutzt werden.

4. Zur *Bestimmung der magnetischen Deklination* wird eine Nadel mit Spiegel von nur 29 Gramm Gewicht, auf Spitzen schwingend, angewendet. Da die Nadel zum Umlegen eingerichtet ist, so kann die Kollimation des Spiegels jederzeit ermittelt, beziehungsweise eliminirt werden. Für den Gebrauch auf einer Expedition, wie der bevorstehenden Dr. NANSEN's, kann man nur von der Anwendung einer Spitzen-Aufhängung Erfolg erwarten; Coconfäden werden für einen solchen Zweck nie genügen können, es sei denn, dass es sich um die Beobachtung von Schwingungsdauern handelt. Wichtig ist es bei dem Gebrauche von Spitzen, dass der Beobachter unablässig das korrekte Funktioniren derselben beobachtet, eine schadhaft gewordene Spitze durch eine andere ersetzt, oder zu repariren vermag. Zu diesem Behufe ist ein Spitzen-Schärfungs-Apparat, über dessen Gebrauch sich der Beobachter genauestens zu informieren hat, der Expedition mitgegeben. Es kann die magnetische Deklination mit diesem Apparate in absoluter Weise bestimmt werden.

5. *Die magnetische Inklination* wird mit einem, dem Gehäuse des Fox'schen Apparates ähnlichen in relativer Weise bestimmt. Da nämlich die Nadeln dieses Theiles des Apparates auch zu Intensitäts-Bestimmungen benutzt werden müssen, so dürfen dieselben unter keinen Umständen ummagnetisirt werden. Man hat also an einem Orte, an welchem die Inklination genau bekannt ist, den Indexfehler einer Nadel zu bestimmen und bei der Ableitung des Endresultates in Rechnung zu ziehen. Zu empfehlen ist es auch, ausser den i „Wild's Anleitung zu magnetischen Beobachtungen" gegebenen Winken[1] über die Bestimmung der Inklination — abgesehen von der Ummagnetisirung — noch die Methode der Beobachtung in gleichen Intervallen, wodurch die Lage des magnetischen Meridians eliminirt wird, zur Anwendung zu bringen[2].

6. *Die Bestimmung der erdmagnetischen Kraft* bietet in den von der Expedition zu bereisenden Gegenden ganz erhebliche Schwierigkeiten. Wenn die Expedition — wie man hoffen muss — ihren Plan, von der sibirischen

[1] Siehe Dr. NEUMAYER: „Anleitung zu wissenschaftlichen Beobachtungen auf Reisen"; Bd. I, Seite 304 u. ff.

[2] Siehe „Der Kompass an Bord", Seite 44 u. ff.

Küste über den Pol nach der Franklin-Bay durchzudringen, zu realisiren vermag, so wird die horizontale Komponente bis zu 0.36 der GAUSS'schen Einheit abnehmen, wodurch die Schwierigkeit der Bestimmung derselben erheblich erhöht wird. Es muss aus diesem Grunde Bedacht darauf genommen werden, die Totalintensität bestimmen zu können, so dass man jederzeit die Horizontal-Komponente oder die Totalkraft zu bestimmen vermag. Für den letzten Zweck bietet der Fox'sche Apparat die beste Gewähr. Denn wenn auch zugegeben werden muss, dass an Bord dieser Apparat wegen der anzubringenden Deviationen nicht für alle Fälle genügen kann, so ist doch auf dem Eise jederzeit mit demselben — sei es unter Anwendung der cardanischen Aufhängung, oder bei fester Aufstellung — ein gutes Resultat zu erlangen; vorausgesetzt, dass die Untersuchung desselben an einer Basis-Station entsprechend ausgeführt worden ist. Es wird daher von der Voraussetzung auszugehen sein, dass — wenn immer es möglich ist — die Horizontal-Komponente mittels Ablenkungen und Schwingungen bestimmt und mit ihr zugleich die Totalkraft mittels Deflektoren ermittelt wird. Beide Manipulationen lassen sich mit Leichtigkeit in kurzer Zeit selbst unter den schwierigen Verhältnissen, wie sie bei einer Expedition von der Art der bevorstehenden nicht selten eintreten werden, ausführen. Letzteres gilt besonders für die Ermittelung der Horizontal-Komponente mittels Ablenkung allein, zu welchem Zwecke die Entfernung des ablenkenden Magnets — wie wir später sehen werden — eine den Verhältnissen entsprechende fest bestimmte sein muss.

7. Da es häufig nicht möglich sein dürfte, die genaue Einstellung der freien Nadel mit Spiegel und Telescop zu bewirken, so ist durch entsprechende Marken auf dem Gehäuse des Deklinations-Apparates darauf Bedacht genommen, dass die Einstellung mit freiem Auge mit einiger Sicherheit bewirkt werden kann. Es sind dem Apparate in einem Etui zwei Nadeln beigegeben, welche zur Bestimmung der Lage des magnetischen Meridians in Ermangelung besserer Gelegenheit benutzt werden können. Dass die Kollimation dieser Nadeln, da sie nicht umgelegt werden können, durch Vergleichen mit der umlegbaren Deklinationsnadel zu ermitteln ist, bedarf wohl kaum erst der Erwähnung.

8. Es wurde bei der Anfertigung des NEUMAYER-Fox'schen Apparates die grösste Sorgfalt darauf verwendet, dass das zur Anwendung gelangende

Material vollkommen eisenfrei war. In dem magnetischen Pavillon der Deutschen Seewarte wurde behufs der Untersuchung auf Eisenfreiheit eines jeden Stückes Metall ein magnetisches Variometer aufgestellt, mittels dessen leicht und rasch die Untersuchung ausgeführt werden konnte. Die nachträgliche gründliche Prüfung des fertiggestellten Apparates hat denn auch ergeben, dass derselbe in der bezeichneten Hinsicht als vollkommen einwurfsfrei anzusehen ist.

9. Bevor an die Bestimmung der Konstanten des Apparates geschritten wurde, ist während einer Reihe von Tagen eine eingehende Untersuchung desselben ausgeführt worden, bei welcher Gelegenheit Herr Lieutenant Scott-Hansen, Mitglied der Expedition, zugegen war und sich unter Leitung des Dr. Neumayer an den Untersuchungen betheiligte. Die letzteren wurden in dem magnetischen Pavillon an der Nordost-Seite des Dienstgebäudes der Seewarte und in dessen Nähe ausgeführt. Erst nachdem diese Untersuchungen beendet und mannigfache Veränderungen an dem Apparate bewirkt worden waren, schritt man zur Bestimmung der Konstanten des Apparates im Kompass-Observatorium der Deutschen Seewarte. Diese letzteren Untersuchungen wurden in der Zeit vom 3. bis 9. Juni 1893 von dem Direktor der Seewarte und Herrn Lieutenant Scott-Hansen von der Expedition ausgeführt.

10. Es ist nur gerecht und den Verhältnissen entsprechend zu konstatiren, dass — bevor die Konstruktion des Apparates in Angriff genommen worden ist — ein Versuchs-Apparat konstruiert wurde; erst nachdem die Beobachtungen mittels desselben entsprachen, entschied man sich für den Plan, welcher bei Herstellung des Nansen'schen Apparates zu befolgen war. Der leitende Gesichtspunkt dabei war, die Beobachtungen so rasch als möglich ausführen zu können, ohne die Zuverlässigkeit derselben zu gefährden. Zu einem Urtheile darüber konnte man aber begreiflicherweise erst auf dem Wege des Experiments gelangen, daher denn auch das so eben geschilderte Verfahren eingeschlagen wurde."

As indicated in the above-quoted extract from Dr. Neumayer's manuscript, the magnetic apparatus E. A. Zschau *No. 289,* employed during the expedition, was a combination of the well-known Neumayer-Declinatorium[1] and

[1] Handbuch der nautischen Instrumente. Zweite Auflage. Berlin, 1890, p. 272.

a Fox apparatus[1] for the determination of inclination and intensity, accompanied by a vibration-box with suspension-tube for observations of vibration. On the alhidade of the horizontal circle of the declinatorium, a horizontal brass rod is fixed on each side, for the application of the vibrating magnet as deflector.

The apparatus is thus adapted for the observation of declination, horizontal intensity, inclination and total intensity. The horizontal circle is furnished with two verniers, which allow of direct reading to 0.5′; increasing readings correspond to increasing easterly declination.

As already mentioned, the constants of the apparatus were determined in Hamburg, before its despatch, by a series of observations taken between the 3rd and the 9th June, 1893, in the Compass observatory of the 'Deutsche Seewarte' by Dr. NEUMAYER and Captain SCOTT-HANSEN together. Six months after the return of the expedition, between the 2nd and 7th March, 1897, a new set of constant-determinations was made by Captain SCOTT-HANSEN at the same place; but as electricity had been introduced on the neighbouring tram-line in the mean time, the value of the results of these observations is somewhat doubtful. For the sake of certainty, therefore, the instrument was taken to the Imperial Marine Observatory at Wilhelmshaven, where the observatory assistant, Herr E. STÜCK made a number of observations between the 17th and 20th April, 1897. These observations show that the constants of the apparatus were in the main unchanged from what they had been four years before.

The thermometers belonging to the apparatus were tested during the expedition for the position of their zero, and occasionally also, for other temperatures, compared with the other verified thermometers of the expedition, some of which also were employed in the magnetic observations. All the temperatures quoted in this paper are given in centigrade degrees, and corrected for the error of the instrument; and they may be presumed to be correct to within 0·1° or 0·2° C.

An ordinary anchor escapement watch by Haagensen was generally used in making the magnetic observations, and was constantly compared with the standard watch of the expedition, the Hohwü chronometer. In determining the time of oscillation of the magnetic needle, a Frodsham chronometer was

[1] Handbuch der nautischen Instrumente. Zweite Auflage. Berlin, 1890, p. 275.

employed in addition to the above-named watches. The error and rate of the watches used have been kindly communicated to me by Professor GEELMUYDEN who has also given me a table of the latitude and longitude of the places on the route where the magnetic observations were taken. In every case the hour is given according to local time, and to the nearest whole minute.

After a few preliminary determinations of the terrestrial magnetic elements on the north coast of Siberia, in the beginning of August, 1893, the regular magnetic observations made during the drift in the ice, were commenced on October 7th, 1893, and were continued until July 8th, 1896. During this period, which comprises 33 months, magnetic observations were taken on 194 different days, thus on an average every 5th day. As will be seen from the following tables, however, the observations fall somewhat irregularly, more than a month occasionally elapsing between two determinations, e. g. from December 12th, 1893, to January 23rd, 1894, from January 19th to March 5th, 1895, and from May 24th to July 2nd, 1895, while at other times the observations were made on several successive days. The three above-mentioned periods of cessation in the work of magnetic observation were due to the following circumstances. On the 26th November, 1893, the apparatus was accidentally upset, as it stood upon its stand on deck. The pivot of the horizontal circle was thereby bent a little, and it was not until the middle of January, 1894, after repeated attempts to take out the pivot and place tin foil under it, that everything was brought into such constant order again, that the observations could be continued without any further fear of any inconvenience from the above-named accident.

From the end of January and all through February, 1895, it was the preparations for Dr. NANSEN and JOHANSEN's sledge-expedition, and in June, 1895, pendulum observations, and sharing in the work of fitting out the kajaks, etc., that prevented SCOTT-HANSEN from making magnetic observations.

On the 4th October, 1893, the work of setting up a tent on the ice was completed, and the magnetic observations were made in it; but no later than the 11th October, the instrument had to be taken on board on account of movement in the ice; and on the 15th, the tent also had to be brought on board, as the ship was getting under way in readiness for pushing farther northwards. The ice, however, did not relax, so the Fram remained where she was, and the following day, the 16th October, an inclination determination was taken out on the ice under the open sky. On account of the screwing, the tent could not be put up again until February 10th, 1894, and therefore all magnetic observations in the interval were made under the open sky on the ice, at a distance of about 80 metres from the ship. After this the tent was used from the 10th February until the 9th November, 1894, when the apparatus was transported into a snow hut erected for the purpose, and situated on the port side, about 100 paces from the vessel. In June, 1895, the tent was again taken into use to escape from the effect of the sun's rays. Later on — September 26th, 1895 — a new observatory was erected, this time of blocks of ice, on the starboard side of the ship, at a distance of 135 paces straight out from her. On June 22nd, 1896, this ice observatory fell down, and the last two series of observations, the 7th and 8th July, 1896, were therefore taken under the open sky. The distance of the observation-place from the ship was always so great that its iron could not be supposed to have exerted any disturbing influence upon the magnets of the apparatus.

From the 12th January to June, 1895, an ice house, erected between the vessel and the magnetic snow hut, was employed as a smithy; the distance between the outer walls of the ice house and the snow hut was 55 paces. There was a forge in the smithy and an anvil, and now and then there were other iron things, but never in large quantities, as the store of materials was always on board, and only what was being worked upon was taken to the smithy. It may therefore be assumed that also the proximity of the smithy had no disturbing effect upon the magnetic observations.

The wooden stand belonging to the apparatus was employed as a pedestal for the magnetic instrument until the ice observatory was taken into use on September 26th, 1895. The vibration-box, however, was placed, until May 24th, 1895, upon a stone slab frozen into the ice. The Cardan suspending apparatus of the stand with counter-balance was of course not employed, but was kept screwed fast all the time. The stand was therefore quite firm, as the points of its legs rested immediately on the ice. It sometimes happened, however, that the effect of the sun was so great, that the ice melted a little, so that the stand became a little oblique. This was overcome by placing pieces of board under the legs. When the ice observatory was completed, an ice pillar was introduced into it, 1.4 metres high; and on the top of the pillar a block of wood was frozen fast, and the instrument screwed to it.

As a defence against bears during the taking of observations, a weapon was always at hand, generally a revolver, which was either stuck vertically into a hole in the ice between the legs of the stand, perpendicularly below the centre of the instrument, or lay horizontally in the same place with its butt-end pointing westwards. Several observations were made with the revolver in various positions, without any proof being obtained of any decided influence on the readings. When the ice observatory was taken into use, the revolver was laid on the ice to the north, at a distance of 3 metres from the instrument, on a level with the foot of the pillar, and, as before, with the butt-end towards the west. When Lieut. Scott-Hansen had a different weapon with him, it lay on the ice at a distance of about 30 or 40 paces from the instrument.

B. DECLINATION.

The determination of the magnetic declination was made by the aid of two declination needles belonging to the apparatus, and furnished with mirrors, in a manner similar to that with an ordinary Neumayer-Declinatorium. After the instrument had been duly levelled, the telescope was pointed first at a mark, with subsequent reading of both verniers of the horizontal circle; and then a coincidence was effected, during the constant employment of the ivory disc, between the wire of the telescope and its reflected image in the mirror of the declination needle. From October 20th, 1893, to February 22nd, 1894, and on subsequent rare occasions, the telescope could not be used on account of fog, hoar-frost or unfavorable conditions of light. The setting was then done with the naked eye, a vertical line introduced in the middle of the glass of the magnet box, being employe das wire. The pin on which the declination needle rested, was renewed several times, as there was a reserve supply of pins, and also a special apparatus sent with the instrument, for grinding and polishing the point of the pin, if any injury should befall it.

THE NEEDLES.

THE DOUBLE DECLINATION NEEDLE.

The needle intended for the declination observations proper, was a double one, that is to say, it consisted of two laminæ, between which the mirror was fixed. Its weight was only 29.05 grammes, and as it was made to reverse, there was always an opportunity of determining, or eventually eliminating, its error of collimation. Its two positions, which, during the observations, were noted by the expressions „Skr. op“ (Heads of the screws up) and „Skr. ned“ (Heads of the screws down) will be indicated in the following pages by P_1 and P_2 respectively.

By the determination of the constants of the instrument in Hamburg, in 1893, the needle's total error of collimation (mirror and magnetic axis) was found to equal $\pm 30.90'$, so that the correction $- 30.90'$ would be employed for readings in the position P_1, wich gave too great an east declination, and $+ 30.90'$ for readings in position P_2, which gave too small an east declination.

After the return of the expedition, a value of $\pm 37.74'$ for the error of collimation was deduced by the observations in Wilhelmshaven, in 1897. It appears from this that the position of the mirror, and the direction of the magnetic axis of the needle, have remained relatively almost unchanged; and thus the following constant correction of the error of collimation may be employed for all the observations made with this needle during the expedition:

$$c = \pm \frac{30{\cdot}9' + 37{\cdot}7'}{2} = \pm 34{\cdot}3'$$

There is also, however, a considerable amount of material for the verification of the error of collimation by the aid of these very series of observations made during the expedition; and I have tried to utilise this material in the following manner. The observations of the declination were generally made by taking a longer or shorter series of readings with the needle alternately in position P_1, and in position P_2. The hour was noted by the watch to tenths of a minute; and after each reading, if the needle was not specially restless, there was an interval of only a few minutes for reversing and resetting.

If the readings in the two positions of the needle, P_1 and P_2 are called respectively

$$\begin{array}{ll} & a_1 \;\; a_2 \;\; a_3 \;\; \ldots\ldots \;\; a_n \\ \text{and} & b_1 \;\; b_2 \;\; b_3 \;\; \ldots\ldots \;\; b_n . \end{array}$$

and the corresponding times by the watch,

$$\begin{array}{ll} & \alpha_1 \;\; \alpha_2 \;\; \alpha_3 \;\; \ldots\ldots \;\; \alpha_n \\ \text{and} & \beta_1 \;\; \beta_2 \;\; \beta_3 \;\; \ldots\ldots \;\; \beta_n , \end{array}$$

then approximately, provided the intervals are of about equal length,

$$\frac{\alpha_1 + \alpha_2}{2} = \beta_1 , \quad \frac{\beta_1 + \beta_2}{2} = \alpha_2 , \quad \frac{\alpha_2 + \alpha_3}{2} = \beta_2 , \text{ etc.}$$

and the circle readings

$$\frac{a_1 + a_2}{2} \text{ and } b_1 , \quad \frac{b_1 + b_2}{2} \text{ and } a_2 , \quad \frac{a_2 + a_3}{2} \text{ and } b_2 , \text{ etc.}$$

may be considered to be simultaneous for both positions of the needle. For each such combination, a value is obtained for the error of collimation, $2(n-1)$ values in all. If these values be indicated by c_1, c_2, c_3, etc. we have

$$c_1 = \frac{\frac{a_1 + a_2}{2} - b_1}{2}$$

$$c_2 = \frac{a_2 - \frac{b_1 + b_2}{2}}{2}$$

$$c_3 = \frac{\frac{a_2 + a_3}{2} - b_2}{2}$$

$$\vdots$$

$$c_{2(n-1)} = \frac{a_n - \frac{b_{n-1} + b_n}{2}}{2}$$

and the mean error of collimation

$$c = \frac{c_1 + c_2 + c_3 + \ldots\ldots + c_{2(n-1)}}{2(n-1)}$$

By this formula I have calculated the error of collimation from the series of observations (noted when the disturbance was not very great) for cases in which the difference in time

$$\frac{\alpha_m + \alpha_{m+1}}{2} - \beta_m , \text{ or } \frac{\beta_m + \beta_{m+1}}{2} - \alpha_{m+1}$$

was less than 1 minute. The results obtained are given in the following table.

Error of Collimation.

Date	c	Date	c	Date	c
	′		′		′
1893. Aug. 1	± 30·0	1894. July 14	± 23·0	1895. Sept. 6	± 23·5
— 8	30·0	— 25	[40·6]	— 7	25·3
Oct. 7	35·9	— 28	39·2	— 27	23·1
— 14	34·5	Aug. 3	34·5	— 28	29·5
— 18	36·9	— 15	37·5	Oct. 3	38·5
— 30	32·8	— 18	39·4	— 4	[44·4]
Nov. 9	27·9	Sept. 4	32·3	— 14	30·3
— 17	33·0	— 5	24·8	— 17	29·8
— 18	32·9	— 21	31·2	— 24	31·4
— 21	28·3	— 24	34·3	— 25	39·3
— 25	28·9	Oct. 20	27·8	Nov. 2	34·0
Dec. 12	25·7	— 27	26·6	— 9	35·9
1894. Jan. 23	31·6	Nov. 10	[13·9]	— 20	30·8
Febr. 14	32·6	— 24	[11·6]	— 22	38·6
— 17	26·5	— 27	[12·2]	— 30	36·0
— 22	34·3	Dec. 6	29·1	Dec. 5	36·2
— 27	39·4	— 7	30·5	— 7	37·0
March 6	35·5	— 14	35·3	— 12	34·3
— 21	34·8	— 15	27·9	1896. Jan. 4	34·5
— 23	34·4	— 19	34·4	— 10	31·4
— 30	22·2	— 21	33·3	— 18	35·4
— 31	39·9	1895. Jan. 12	21·7	— 28	33·2
April 14	25·6	— 17	23·9	— 29	40·0
— 16	38·8	— 18	[18·6]	Febr. 4	35·8
— 21	26·5	March 6	26·6	— 5	31·9
— 26	23·8	— 7	26·5	— 13	[41·7]
— 27	24·8	— 10	28·3	— 25	[40·3]
May 5	25·1	April 5	24·4	March 6	[43·2]
— 10	21·1	— 6	22·7	— 7	[43·3]
— 11	25·6	— 20	34·3	— 19	26·9
— 26	23·1	— 22	22·3	April 9	28·1
— 31	32·1	May 9	25·8	— 20	30·4
June 4	24·9	— 11	25·5	— 21	28·9
— 7	21·7	— 22	25·1	May 8	32·9
— 12	[16·8]	— 24	[18·7]	June 3	29·2
— 13	29·9	July 3	25·8	— 18	33·6
— 23	31·3	— 5	22·7	— 19	28·6
— "	31·4	— 12	26·5	July 8	39·4
— 28	[43·7]	— 13	25·7		
July 6	21·4	— 26	25·0	Mean	± 30·1
— 11	23·8	Aug. 2	22·5		
— "	26·3	— 23	24·7		

It will be seen from this table, which contains 122 different determinations, that the values found vary from ± 44·4′ to ± 11·6′, without its being possible to find any decided change with time, if the values are plotted graphically. We may therefore certainly assume that the error of collimation has in reality remained constant all the time, and its most probable value will thus be the mean of the 122 determinations, i. e. ± 30·1′, which accords fairly well with the value found in Hamburg in 1893. If we omit from the table all the values whose difference from the mean is greater than ± 10′, and which are indicated by brackets [ ], this has no effect upon the result, as the mean remains the same, ± 30·1′; and if the values obtained by the determinations in Hamburg in 1893, and in Wilhelmshaven in 1897, be added, ± 30·9′ and ± 37·7′ respectively, the mean still remains unchanged. I have therefore deemed it advisable to take this mean, ± 30·1′, as the constant value of the error of collimation. The sometimes great deviation shown by a few of the figures in the table, may be easily explained by the mobility of the needle owing to the low force of direction, and the magnetic disturbance which constantly prevails in the polar regions. Captain Scott-Hansen has informed me that the needle was always oscillating more or less widely and quickly; and if we moreover consider that the needle was not suspended by a thread, but rested upon a pivot, the results here given may well be deemed as satisfactory as it was possible, under the circumstances, to have them.

THE SMALL NEEDLE.

In the passage from point 7 in Dr. Neumayer's manuscript quoted in the introduction, a case is mentioned containing two reserve needles for declination observations. Only one such needle accompanied the apparatus, and it was moreover intended more especially to act as the deflected magnet in deflection observations for the determination of the horizontal intensity. This needle is a little shorter than the declination needle proper, having a length of 70 mm.; and it weighs 21·2 grammes. As it cannot be reversed, its error of collimation was found during the determination of constants in Hamburg in 1893, by several series of comparative observations with this and the true declination needle (double needle), the result being that a declination determination with the small needle gave a declination that was 8.6′ more easterly than the true one. A correction of — 8·6′ must therefore be added to all readings with this needle, as increasing numbers on the horizontal circle correspond to increasing east declination. There has been no subsequent verification of this determination, and I have therefore been obliged to take $-8.6'$ all through as the constant value of the small needle's error of collimation. In these pages, the small needle will be indicated by *L*.

THE MARK.

All through the time that the vessel was drifting with the ice, the mark used was the objective of the astronomical altazimuth instrument, which was set up on the ice at some distance, or, after the 26th Sept. 1895, when the ice observatory was taken into use, its pillar. As already mentioned, the setting at the mark was always the first step to be taken after the instrument was levelled, whereupon followed a longer or shorter series of settings of the magnetic needle, and finally a sight was once more taken of the mark. In most cases, the first and last mark-readings agree within less than 1′; but sometimes it happened that the relative position of the two instruments changed somewhat during the observation, either because of the movement in the ice, or when the sun had acted upon the ice under the legs of the stand, so that they had been a little displaced. Captain SCOTT-HANSEN was always observant of this, however, and in such circumstances often made supplementary test-settings at the mark.

THE AZIMUTH.

The azimuth determinations necessary for the calculation of the absolute declination, were generally made with the astronomical altazimuth, the magnetic apparatus serving as mark. In the accompanying figure (Fig. 1), the relative position of the two instruments is shown. *T* is the centre of the magnetic apparatus, and *U* the centre of the astronomical altazimuth. The arrow *N* gives the direction of the astronomical meridian, and the arrow *n* the direction of the magnetic meridian. If the east declination be indicated by *D*, then, as will be seen from the figure, we have

$$D = y - x\,.$$

If the reading (corrected for the needle's error of collimation) on the magnetic apparatus, with the telescope directed towards the mirror of the declination needle, be termed M, and the reading on the same apparatus, with the telescope directed towards the mark (U), m, the angle

$$y = M - m .$$

If, in the next place, the reading on the astronomical instrument, with the telescope directed towards a star s, be indicated by S, the reading with the telescope directed towards the mark (T) by C, and the azimuth of the star, calculated from N through E, by A, the angle

$$x = (S - C) - A,$$

and we obtain

$$D = M + (C - S + A) - m$$
$$= M + B . \qquad (1)$$

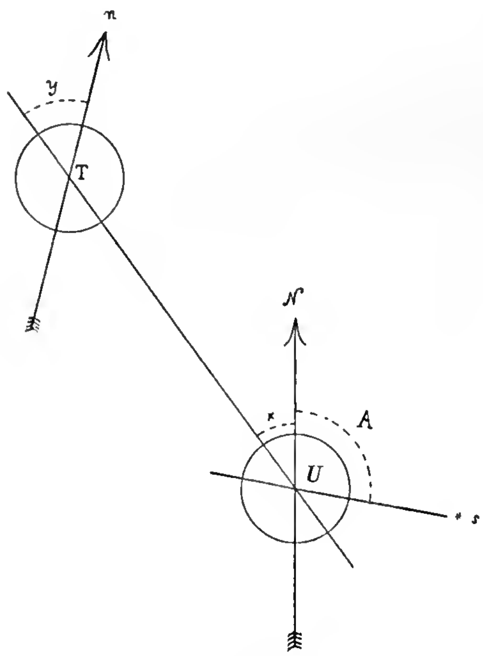

Fig. 1.

Occasionally the azimuth determinations were made directly with the magnetic apparatus by observation of the sun or a planet. In such a case, retaining the same signs as above (see Fig. 2),

$$D = M - S - (180° - A) = M + (A - 180°) - S, \qquad (2)$$

and the setting at the mark only serves as a check upon the stability of the instrument, while the observation was being made. The calculation of the angle $C - S + A$, or $A - 180° - S$, I have received from Professor GEELMUYDEN in whose paper, "Astronomical Observations (Norw. Pol. Exp. No. 6), List C. Determination of Azimuth", all the data for the present observations will be found.

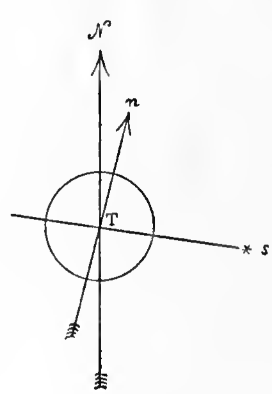

Fig. 2.

THE OBSERVATIONS.

In addition to the direct readings of the position of the free declination needle, the deflection observations taken for the determination of the horizontal intensity, afford an opportunity for the calculation of the declination. The two magnets belonging to the apparatus, which are indicated by the Roman numerals *V* and *VI*, were employed as deflectors at two distances marked on the deflection-rod, $E = 39{\cdot}638$ cm. and $e = 29{\cdot}840$ cm. By the four known positions of the deflecting-magnet perpendicular to the deflected declination needle, the meridian position of the needle is obtained, in addition to the angle of deflection, as the mean of the four readings. These declination determinations, which are not isolated, as readings of the position of the free needle were always taken both before and after the observations for deflection, I have included and duly entered in the series of observations.

The following list contains in chronological order all the declination observations taken during the expedition, with a statement of the manner in which they were made, and the addition of the hour of each single reading, by local time, to the nearest entire minute. In the column headed "Needle", P_1, P_2, and L indicate that the observation was made respectively with the double declination needle in position P_1, or with the same needle in position P_2, or with the small declination-magnet. In the column headed *M*, will be found the mean of the two vernier readings, corrected for the error of collimation, for which, as previously mentioned, the following values are employed:

for P_1 $-30{\cdot}1'$
„ P_2 $+30{\cdot}1'$
„ L $-\ 8{\cdot}6'$

When the figure in column *M* is the result of the calculation of deflection observations, a statement is added in the column "Needle" as to the kind of deflector that has been employed, and the distance. For instance, $L.V_e$ indicates that the small declination needle has been used as deflected magnet together with deflector *V* at the shorter distance; $P_2.VI_E$, that the double declination needle has been employed as deflected magnet together with deflector *VI*, at the longer distance. The double needle, as will be mentioned presently at greater length, was also employed as deflected magnet in intensity determinations instead of the small declination needle, as the mirror of the latter frequently gave an unsatisfactorily indistinct image of the telescope's wire.

All the settings at the mark done before and after the declination readings, are entered under the heading "*Mark*", with figures that are the mean of the two vernier readings. When azimuth observations are taken with the astronomical altazimuth, the value of the angle $C - S + A$ is given, and B calculated, the mean of the figures entered under the heading "*Mark*", before and after the declination readings, being employed as the value of m. If, on the other hand, direct azimuth determinations are made with the magnetic apparatus itself, only the angle $A - 180° - S$ is specified. Lastly, in the column headed D, are placed the values of the absolute declination calculated according to formula (1) or (2), which mean may then approximately be regarded as the mean east declination for that day, at the place indicated by latitude and longitude.

As will be seen from the list, there is a considerable number of days in which the statement of the angle $C - S + A$, or $A - 180° - S$, is wanting. On this account, it has also been impossible to calulate a value for the absolute declination. The reason of the omission is naturally that it has not always been possible to obtain an azimuth determination in immediate connection with the readings of the position of the declination needle. Nor is this necessary on terra firma, as, with a fixed mark, it is only needful now and again to check the azimuth of the mark by astronomical observations. This however, it will be easily understood, is not sufficient when the instruments and mark are set up on drifting ice; for even if the same reading were obtained several days running, by setting at the mark, as the list shows was not unfrequently the case during the Fram expedition, there is no guarantee that the very floe on which the instruments are set up, has not shifted a little, thus causing the connecting-line between the declinatorium and the mark (the astronomical altazimuth) to change its azimuth.

I have thought that in addition to their utilisation in the determination of the double needle's error of collimation, these imperfect declination observations might be employed in judging of the daily variations of the declination needle, and I have therefore represented all the observations graphically on

Pl. I—XVII. In the case of every series of observations, I have placed the deviations from the lowest value of the day in column *D*, or in column *M*, as ordinates according to the scale $1^\circ = 10$ mm., so that every millimetre is equal to 6′, while the hours are marked as abscissæ according to the scale $1^h = 10$ m.m. As the observations were only taken in the daytime, the time-scale extends only from 9 a. m. to 9 p. m.

OBSERVATIONS OF DECLINATION.

1. 1893. August 1. Khabarova. Mark — an indentation in the mountain on the east coast of Yugor Schar.

Lat. N. 69° 41′
Long. E. 60° 20′

Mark: 18° 49·6′

Local time	Needle	*M*
h m		
3 10 p. m.	P_1	137° 27·0′
17	P_2	27·9
24	P_1	28·1
30	P_2	28·7
39	P_1	27·9
50	P_2	26·7
4 3	L	30·8
15	$L.VI_e$	31·6
35	$L.VI_E$	31·2
47	L	32·5

After the observation the mark was hidden by the mist.

2. 1893. August 8. On a grounded ice-floe, to which the *Fram* was moored. Place of observation about 100 metres from the ship. The fixed mark on the shore was not very distinct.

Lat. N. 69° 54′
Long. E. 66° 43′

$A - 180° - S = -196° 39·9′$

Mark: 69° 52·5′

Local time	Needle	*M*	*D*
h m			
7 1 p. m.	P_1	217° 5·2′	20° 25·3′ E
10	P_2	5·3	25·4
14	P_1	5·9	26·0
20	P_2	7·7	27·8
27	P_1	8·5	28·6
35	P_2	9·2	29·3
8 1	L	8·1	28·2
19	$L.VI_e$	12·5	32·6
		Mean	20° 27·9′ E

Mark: 69° 52·4′

3. 1893. October 7. In the tent on the ice.

Lat. N. 78° 25′
Long. E. 136° 2′

Mark: 139° 0·0′

Local time	Needle	*M*
h m		
3 12 p. m.	P_1	219° 2·7′
22	P_2	218 22·5
33	P_1	219 3·0
54	P_2	6·9
4 8	P_1	1·9
29	P_2	12·4

Mark: 138° 59·2′

4. 1893. October 10. In the tent on the ice. Ice to some extent in motion, so that the azimuth-observations could not be taken. The determination of the horizontal intensity was attempted by deflections with the double needle as deflected magnet. The needle disturbed.

Lat. N. 78° 19′
Long. E. 136° 2′

Mark: 230° 15·1′

Local time	Needle	*M*
h m		
10 56 a. m.	P_1	266° 12·7′
11 28	P_2	265 47·7
59	P_1	264 54·5
12 21 p. m.	$P_1.V_E$	52·9
1 9	$P_1.V_e$	48·7
32	P_1	26·5
2 3	$P_1.VI_E$	18·9
34	P_1	3·7

Mark: ?

During the observations, a revolver, taken as a defence against bears, was stuck vertically into a hole in the ice just beneath the instrument. No deviation in the position of the free needle was observed, whether the revolver was there, or whether it was removed.

5. 1893. October 14. Revolver in the same place as before. Thick, damp mist, so that the telescope could not be used; all pointings were therefore made by the aid of the line on the window of the magnet-box.

Lat. N. 78° 15′
Long. E. 136° 1′

Mark: 357° 8·1′

Local time	Needle	*M*
h m		
12 23 p. m.	P_1	319° 16·5′
32	P_2	4·9
59	$P_2.V_e$	318 54·5
1 26	P_2	58·1
40	P_1	319 3·9

Mark: 357° 7·3′

6. 1893. October 18. On the ice, 115 paces from the vessel. Hoar-frost all over the instrument, so that the telescope could not be used.

Lat. N. 78° 19′
Long. E. 136° 15′

$A - 180° - S = -280° 56·1′$

Mark: 266° 47·5′

Local time	Needle	*M*	*D*
h m			
11 2 a. m.	P_1	295° 16·4′	14° 20·3′ E
7	P_2	19·3	23·2
22	P_1	9·7	13·6
28	P_2	7·8	11·7
34	P_1	18·6	22·5
40	P_2	294 33·4	13 37·3
46	P_1	57·2	14 1·1
52	P_2	34·8	13 38·7
		Mean	14° 6·0′ E

Mark: 266° 44·5′

The mark scarcely visible on account of the mist.

7. 1893. October 20. 115 paces from the vessel. Telescope could not be used on account of the mist and hoar-frost. No azimuth.

Lat. N. 78° 19′
Long. E. 136° 5′

Mark: 178° 19′

Local time	Needle	*M*
h m		
11 31 a. m.	P_1	54° 8·1′
42	P_2	10·9
54	L	15·4
12 29 p. m.	$L.V_e$	20·1
1 4	L	26·1

Mark: 178° 40·3′

3 0 p. m.	L	54 54·4
21	$L.V_E$	48·3
43	L	56·3

Mark: 178° 38·5′

8. 1893. October 30.

Lat. N. 78° 13·5′
Long. E. 135° 28′

$C - S + A = 145° 41·9′$
$m = 99° 34·6′$
$B = 46° 7·3′$

Mark: 99° 34·6′

Local time	Needle	*M*	*D*
h m			
3 54 p. m.	P_1	328° 7·4′	14° 14·7′ E
4 6	P_2	3·7	11·0
20	P_1	17·4	24·7
26	P_2	3·7	11·0
32	P_1	3·4	10·7
39	P_2	16·3	23·6
49	P_1	26·4	33·7
56	P_2	12·8	20·1
		Mean	14° 18·7′ E

Mark: 99° 34·6′

9. 1893. November 3.

Lat. N. 78° 1′
Long. E. 134° 57′

Mark: 316° 44·8′

Local time	Needle	M
h m		
11 31 a. m.	P_1	201° 20·2′
44	P_2	20·3
12 9 p. m.	$L.V_e$	52·3
43	$L.V_E$	49·3
59	L	26·7
1 5	P_1	200 51·4
16	P_2	50·1

Mark: 316° 45·0′

10. 1893. November 9.

Lat. N. 77° 54′
Long. E. 137° 52′

Mark: 207° 26·5′

Local time	Needle	M
h m		
11 46 a. m.	P_1	270° 45·4′
54	P_2	48·1
12 14 p. m.	$P_2.V_E$	53·2
58	$P_2.V_e$	43·3
1 20	P_2	271 0·4
31	P_1	270 54·0

Mark: 207° 25·5′

11. 1893. November 17.

Lat. N. 78° 25′
Long. E. 139° 16′

$C - S + A = 302° 38·2′$
$m = 285° 3·1′$
$B = 17° 35·1′$

Mark: 285° 3·2′

Local time	Needle	M	D
h m			
12 45 p. m.	P_1	356° 21·6′	13° 56·7′ E
54	P_2	30·9	14 6·0
1 4	P_1	36·2	11·3
11	P_2	21·7	13 56·8
18	P_1	31·2	14 6·3
29	P_2	34·3	9·4
		Mean	14° 4·4′ E

Mark: 285° 3·0′

12. 1893. November 18.

Lat. N. 78° 25′
Long. E. 139° 16′

Mark: 289° 43·3′

Local time	Needle	M
h m		
12 9 p. m.	P_2	0° 12·7′
16	P_1	23·2
32	L	42·2
37	L	45·8
56	$L.V_e$	51·8
1 14	L	47·2
20	L	49·5
28	P_1	13·5
35	P_2	12·7

Mark: 289° 40·1′

13. 1893. November 21.

Lat. N. 78° 24′
Long. E. 139° 18′

$C - S + A = 309° \ 33{\cdot}4'$
$m = 115° \ 25{\cdot}9'$
$B = 194° \ 7{\cdot}5'$

Mark: 115° 25·6′

Local time	Needle	M	D
h m			
12 30 p. m.	P_1	180° 19·5′	14° 27·0′ E
37	P_2	14·8	22·3
45	P_1	14·8	22·3
52	P_2	12·7	20·2
1 1	P_1	179 57·5	5·0
8	P_2	180 5·0	12·5
		Mean	14° 18·2′ E

Mark: 115° 26·2′

14. 1893. November 25.

Lat. N. 78° 37′
Long. E. 139° 4′

Mark: 352° 40·8′

Local time	Needle	M
h m		
10 59 a. m.	P_1	58° 30·1′
11 5	P_2	16·3
17	L	59 31·4
35	$L.V_e$	15·0
12 9 p. m.	$L.V_E$	15·3
26	L	58 59·7
35	P_2	56 46·6
41	P_1	28·0

Mark: 352° 41·6′

15. 1893. December 12.

Lat. N. 79° 7′
Long. E. 137° 40′

$C - S + A = 116° \ 0{\cdot}8'$
$m = 263° \ 10{\cdot}6'$
$B = - 147° \ 9{\cdot}8'$

Mark: 263° 10·75′

Local time	Needle	M	D
h m			
11 54 a. m.	P_1	164° 57·7′	17° 47·9′ E
12 1 p. m.	P_2	165 0·2	50·4
8	P_1	164 57·2	47·4
15	P_2	165 3·4	53·6
22	P_1	164 57·2	47·4
27	P_2	165 21·6	18 11·8
35	P_1	10·1	0·3
40	P_2	9·8	0·0
		Mean	17° 54·8′ E

Mark: 263° 10·5′

16. 1894. January 23.

Lat. N. 79° 42′
Long. E. 135° 32′

$A - 180° - S = - 129° \ 42{\cdot}7'$

Mark: 238° 9·6′

Local time	Needle	M	D
h m			
2 45 p. m.	P_1	153° 39·1′	23° 56·4′ E
50	P_2	25·7	43·0
56	P_1	13·9	31·2
3 0	P_2	15·6	32·9
8	P_1	27·4	44·7
13	P_2	15·1	32·4
18	P_1	11·4	28·8
		Mean	23° 38·5′ E

Mark: 238° 9·5′

17. 1894. February 14.

Lat. N. 80° 0′
Long. E. 133° 59′

$C - S + A =$ 98° 13·4′
$m =$ 110° 46·3′
$B = -$ 12° 32·9′

Mark: 110° 46·5′

Local time h m	Needle	M	D
5 41 p. m.	P_2	34° 54·1′	22° 21·2′ E
46	P_1	35 2·1	29·2
51	P_2	34 58·3	25·4
55	P_1	35 5·4	32·5
59	P_2	34 58·6	25·7
6 5	P_1	35 12·2	39·4
8	P_2	18·8	45·9
12	P_1	22·0	49·1
		Mean	22° 33·5′ E

Mark: 110° 46·0′

18. 1894. February 17.

Lat. N. 80° 2′
Long. E. 133° 49′

Mark: 125° 3·9′

Local time h m	Needle	M
12 49 p. m.	P_1	45° 48·7′
59	P_2	41·7
1 15	$P_2 . V_e$	43·1
31	P_2	39·5
37	P_1	31·6

Mark: 125° 3·5′

19. 1894. February 22.

Lat. N. 80° 10′
Long. E. 133° 49′

$C - S + A =$ 98° 21·3′
$m =$ 124° 28·2′
$B = -$ 26° 6·9′

Mark: 124° 28·3′

Local time h m	Needle	M	D
11 41 a. m.	P_1	50° 34·8′	24° 27·9′ E
48	P_2	38·3	31·4
57	P_1	57·4	50·5
12 2 p. m.	P_2	48·5	41·6
16	L	51 17·7	25 10·8
21	L	19·4	12·5
37	$L . V_e$	50 41·7	24 34·8
1 7	$L . V_E$	51 14·8	25 7·9
21	L	50 12·6	24 5·7
25	L	48·0	41·1
29	L	51 7·1	25 0·2
32	L	2·0	24 55·1
34	L	50 40·6	33·7
40	P_2	49 51·3	23 44·4
44	P_1	59·0	52·1
47	P_2	49·4	42·5
52	P_2	50 6·5	59·6
57	P_1	7·6	24 1·1
		Mean	24° 30·7′ E

Mark: 124° 28·2′

Telescope employed for the pointing of the needle, except for the last two readings of the double needle, as it had already become too dark.

After February 22, 1894, the telescope is always employed, when not stated otherwise.

20. 1894. February 27.

Lat. N. 80° 4′
Long. E. 135° 27′

Mark: 52° 15·8′

Local time h m	Needle	M
12 5 p. m.	P_2	175° 25·6′ [1])
18	P_1	14·0 [1])
24	P_2	174 38·7 [1])
31	P_1	176 19·7 [1])
54	$P_1 . VI_E$	175 20·2 [2])
1 32	$P_1 . V_E$	15·8 [2])
2 9	$P_1 . V_e$	8·3 [2])
33	P_1	7·9
48	P_2	174 34·5
55	P_1	29·4
59	P_2	26·1
3 3	P_1	21·4

Mark: 52° 16·8′

The needle still very difficult to point; it may be quite properly pointed, when it suddenly begins to move, and then stops for a little in a new position; and when this is going to be read off, there is fresh disturbance.

21. 1894. March 6.

Lat. N. 79° 51′
Long. E. 135° 0′

$A - 180° - S = - 158° 51·1′$

Mark: 240° 8·3′

Local time h m	Needle	M	D
1 1 p. m.	P_2	182° 7·9′	23° 16·8′ E
14	P_1	13·3	22·2
29	P_2	2·9	11·8
35	P_1	7·7	16·6
41	P_2	181 53·9	2·8
48	P_1	182 16·4	25·3
		Mean	23° 15·9′ E

Mark: 240° 8·3′

[1]) The needle much disturbed. [2]) The needle noticeably quieter.

22. 1894. March 21.

Lat. N. 79° 48′
Long. E. 135° 0′

$A - 180° - S = - 280° 15·5′$

Mark: 4° 23·4′

Local time h m	Needle	M	D
11 25 a. m.	P_1	303° 52·2	23° 36·7′ E
35	P_2	56·5	41·0
42	P_1	32·9	17·4
51	P_2	24·7	9·2
57	P_1	28·7	13·2
12 6 p. m.	P_2	26·9	11·4
16	P_1	33·3	17·8
25	P_2	25·0	9·5
35	P_1	37·9	22·4
47	P_2	16·9	1·4
		Mean	23° 18·0′ E

Lat. N. 79° 49′
Long. E. 134° 58′

$A - 180° - S = - 280° 15·5′$

Local time h m	Needle	M	D
3 13 p. m.	P_2	303° 28·9	23° 13·4′ E
30	P_1	13·7	22 58·2
40	P_2	302 54·4	38·9
48	P_1	303 0·7	45·2
4 19	$P_1 . V_e$	53·5	23 38·0
5 20	$P_1 . V_E$	4·2	22 48·7
51	P_1	302 20·7	5·2
6 1	P_2	24·4	8·9
9	P_1	303 46·2	23 30·7
17	P_2	35·9	20·4
		Mean	22° 54·8′ E

Mark: 4° 25·8′

The revolver lay, during the entire series of observations, horizontally upon the ice, below the instrument, across the magnetic meridian.

Needle disturbed and difficult to point.

23. 1894. March 23.

Lat. N. 80° 1′
Long. E. 134° 41′

$C - S + A = 83° 30{\cdot}0'$
$m = 4° 25{\cdot}1'$
$B = 79° 4{\cdot}9'$

Mark: 4° 25·15′

Local time	Needle	M	D
h m			
5 40 p. m.	P_2	303° 6·2′	22° 11·1′ E
49	P_1	57·8	23 2·7
56	P_2	304 26·4	31·3
6 4	P_1	303 7·2	22 12·1
		Mean	22° 44·3′ E

Mark: 4° 25·1′

The revolver as usual. Needle much disturbed and difficult to point.

24. 1894. March 30. New pin put in the box.

Lat. N. 80° 8′
Long. E. 135° 0′

Mark: 3° 30·5′

Local time	Needle	M
h m		
5 9 p. m.	P_1	304° 1·5′
15	P_2	23·7
21	P_1	14·4
37	P_2	14·6
46	P_2	39·3
51	P_2	19·6
6 10	P_2	50·3

Mark: 3° 31·1′

25. 1894. March 31.

Lat. N. 80° 6′
Long. E. 135° 0′

$A - 180° - S = - 281° 7{\cdot}9'$

Mark: 3° 31·0′

Local time	Needle	M	D
h m			
4 49 p. m.	P_2	304° 26·3′	23° 18·4′ E
5 1	P_1	25·9	18·0
6	P_2	23·9	16·0
16	P_1	305 4·9	57·0
22	P_1	304 48·5	50·6
29	P_2	40·5	32·6
37	P_1	47·9	40·0
47	P_2	23·6	15·7
58	P_1	305 6·7	58·8
		Mean	23° 34·1′ E

Mark: 3° 30·8′

26. 1894. April 14. The instrument received a blow in the tent on April 14, which bent the arm supporting the telescope and the counterpoise weight. This is now repaired. Revolver as usual.

Lat. N. 80° 12′
Long. E. 133° 43′

Mark: 149° 47·3′

Local time	Needle	M
h m		
4 31 p. m.	P_1	41° 44·3′
38	P_2	42 6·4
47	P_2	41 55·4
54	P_1	37·9
5 11	$P_1 . VI_E$	41·5
45	$P_1 . V_E$	42 2·3
6 2	P_1	41 59·3
7	P_2	52·1
13	P_2	22·4
17	P_2	48·0
22	P_1	55·4

Mark: 149° 47·3′

27. 1894. April 16.

Lat. N. 80° 18′
Long. E. 133° 5′

$A - 180° - S = - 21° 14·1'$

Mark: 113° 0·5′

Local time	Needle	M	D
h m			
4 30 p. m.	P_1	46° 54·0′	25° 39·9′ E
36	P_2	44·3	30·2
44	P_1	47 9·6	55·5
53	P_2	46 44·1	30·0
5 1	P_1	47 0·7 [1])	46·6
11	P_2	3·2	49·1
		Mean	25° 41·9′ E

Mark: 113° 0·9′

28. 1894. April 21.

Lat. N. 80° 28′
Long. E. 131° 8′

$A - 180° - S = - 22° 34·8'$

Mark: 113° 1·0′

Local time	Needle	M	D
h m			
4 47 p. m.	P_1	48° 11·8′	25° 37·0′ E
57	P_2	27·2	52·4
5 10	P_1	17·7	42·4
23	P_2	27·0	52·2
28	P_1	26·8	52·0
37	P_2	31·1	56·3
		Mean	25° 48·8′ E

Mark: 113° 2·0′

The revolver was placed vertically in the ice with the butt-end up, alternately E and W of the stand. No difference was observed in the readings.

[1]) Needle much disturbed; oscillating about 30′.

29. 1894. April 26.

Lat. N. 80° 35′
Long. E. 131° 29′

$A - 180° - S = - 23° 14·1'$

Mark: 114° 47·4′

Local time	Needle	M	D
h m			
11 58 a. m.	P_2	50° 57·1′	27° 43·0′ E
12 5 p. m.	P_1	30·9	16·8
10	P_2	44·2	30·1
17	P_1	59·7	45·6
30	P_2	51 0·5	46·4
38	P_1	50 8·2	26 54·1
46	P_2	29·8	27 15·7
3 24	P_2	50 30·7	27 16·6
40	P_1	49 43·7	26 29·6
7 0	P_2	48 46·8	25 32·7
13	P_1	49 30·2	26 16·1
23	P_2	37·3	23·2
30	P_1	33·4	19·3
8 0	P_1	49 15·4	26 0·3
4	P_2	41·1	27·0
9	P_1	17·9	3·8
13	P_2	34·3	20·2
		Mean	26° 47·1′ E

Mark: 114° 47·0′

Needle very much disturbed.

30. 1894. April 27.

Lat. N. 80° 36′
Long. E. 131° 40′

Mark: 114° 47·5′

Local time	Needle	M
h m		
10 43 a. m.	P_2	51° 13·6′
52	P_1	50 49·1
11 0	P_2	51 9·3
4	P_1	50 52·9
6	P_1	7·5
10	P_1	50·9
12 9 p. m.	P_1	50 2·7
14	P_2	6·3
33	$P_2 . VI_E$	29·7
53	P_2	6·9
58	P_1	49 54·5
3 3	P_1	50 22·8
9	P_2	49 51·3
28	$P_2 . V_E$	53·3
4 5	$P_2 . V_e$	47·3
22	P_2	50 19·7
31	P_1	1·1

Mark: 114° 47·8′

Needle on the whole disturbed.

31. 1894. May 5.

Lat. N. 80° 49′
Long. E. 130° 35′

$C - S + A =$ 64° 26·8′
$m =$ 86° 12·7′
$B = -$ 21° 45·9′

Mark: 86° 12·8′

Local time	Needle	M	D
h m			
4 0 p. m.	P_1	50° 47·6′	29° 1·7′ E
5	P_2	38·9	28 53·0
13	P_1	10·3	24·4
18	P_2	22·6	36·7
26	L	39·7	53·8
29	L	46·4	29 0·5
42	$L . V_e$	26·9	28 41·0
5 9	$L . V_E$	48·8	29 2·9
23	L	38·5	28 42·6
26	L	46·7	29 0·8
31	P_2	45·4	28 59·5
35	P_1	32·1	46·2
7 40	P_2	55·6	29 9·7
44	P_1	53·7	7·8
49	P_2	50·0	4·1
54	P_1	30·0	28 44·1
		Mean	28° 53·1′ E

Mark: 86° 12·6′

32. 1894. May 10.

Lat. N. 80° 54′
Long. E. 130° 5′

Mark: 86° 12·0′

Local time	Needle	M
h m		
4 9 p. m.	P_1	48° 37·9′
15	P_2	49 4·3
20	P_1	21·2
27	P_2	29·6
37	L	30·7
40	L	29·8
5 12	$L . V_E$	22·0
6 17	$L . V_e$	10·4
50	L	6·2
54	L	19·6
7 1	P_2	12·9
7	P_1	48 42·1
12	P_2	49 5·8
19	P_1	48 0·8
22	P_1	7·3

Mark: 86° 13·4′

33. 1894. May 11.

Lat. N. 80° 52′
Long. E. 130° 6′

$C - S + A =$ 66° 40·4′
$m =$ 86° 13·4′
$B = -$ 19° 33·0′

Mark: 86° 13·5′

Local time	Needle	M	D
h m			
11 29 a. m.	P_1	48° 42·3′	29° 9·3′ E
34	P_2	49 24·1	51·1
41	P_1	36·2	30 3·2
45	P_1	8·7	29 35·7
49	P_1	48 57·9	24·9
55	P_2	49 9·6	36·6
Noon	P_2	10·3	37·3
12 4 p. m.	P_2	12·8	39·8
12	P_1	48 56·8	23·8
16	P_1	49 2·9	29·9
19	P_1	1·4	28·4
24	P_2	20·5	47·5
27	P_2	30·0	57·0
12 56	P_2	49 14·0	29 41·0
1 2	P_2	0·2	27·2
10	P_1	48 48·7	15·7
14	P_1	47·0	14·0
2 50	P_1	48 19·0	28 46·0
55	P_2	23·1	50·1
3 1	P_1	28·1	55·1
5	P_2	30·0	57·0
3 55	P_2	49 3·8	29 30·8
4 2	P_1	48 46·8	13·8
7	P_2	42·8	9·8
17	P_1	36·0	3·0
4 58	P_1	48 29·8	28 56·8
5 4	P_2	34·0	29 1·0
8	P_1	4·9	28 31·9
14	P_2	26·8	53·8
16	P_2	30·5	57·5
		Mean	29° 18·0′ E

Mark: 86° 13·3′

34. 1894. May 22.

Lat. N. 81° 24′
Long. E. 124° 38′

Mark: 86° 14·5′

Local time	Needle	M
h m		
10 47 a. m.	P_1	62° 17·8′ ¹)
52	P_2	63 3·0 ¹)
11 1	P_1	62 57·2 ¹)
9	P_2	64 22·3 ²)
19	L	63 5·3
25	L	62 49·8 ³)
36	$L.VI_E$	63 2·9
12 10 p. m.	$L.V_E$	62 42·3
43	$L.V_e$	32·4
55	L	23·0
58	L	31·2
1 6	P_1	61 38·4
11	P_2	37·8
17	P_1	19·6
20	P_2	62 5·8

Mark: 86° 11·9′

¹) Needle quiet. ²) Needle very much disturbed. ³) The revolver moved in a vertical position alternately E and W of the foot, down upon the ice. No alteration in the readings.

35. 1894. May 26.

Lat. N. 81° 30′
Long. E. 123° 2′

$A - 180° - S = -31° 18{\cdot}4'$

Mark: 87° 4·2′

Local time	Needle	M	D
h m			
10 51 a. m.	P_1	66° 34·5′ 1)	35° 16·1′ E
55	P_2	48·8 2)	30·4
11 2	P_1	41·1 2)	22·7
9	P_2	48·2 2)	29·8
16	P_1	15·9 3)	34 57·5
20	P_2	18·0 2)	59·6
24	P_1	13·6 2)	55·2
32	P_2	38·1 4)	35 19·7
39	P_2	52·0 5)	33·6
45	P_1	16·3 2)	34 57·9

Mark: 87° 4·0

$A - 180° - S = -31° 17{\cdot}9'$

Mark: 87° 4·2′

12 18 p. m.	P_1	65° 55·8′ 2)	34° 37·9′
26	P_2	66 27·8 1)	35 9·9
32	P_1	7·5 1)	34 49·6
37	P_2	26·5	35 8·6
43	P_1	65 54·1 6)	34 36·2
48	P_2	66 12·2 2)	54·3
		Mean	35° 6·2′ E

Mark: 87° 2·9′

Lat. N. 81° 30′
Long. E. 122° 59′

$A - 180° - S = -31° 59{\cdot}4'$

Mark: 87° 40·0′ 7)

Local time	Needle	M	D
h m			
3 24 p. m.	P_2	66° 29·5′ 2)	34° 30·1′ E
31	P_1	22·9 2)	23·5
36	P_2	37·0 2)	37·6
43	P_1	24·8 2)	25·4

Mark: 87° 43·4′ 8)

$A - 180° - S = -32° 2{\cdot}4'$

Mark: 87° 44·6′

4 36 p. m.	P_1	66° 21·9′ 6)	34° 19·5′
42	P_2	34·3 9)	31·9
47	P_1	45·3 1)	42·9
53	P_2	49·1	46·7
58	P_1	27·9 2)	25·5
5 3	P_2	38·6 2)	36·2
		Mean	34° 31·9′ E

Mark: 87° 44·8′

1) Disturbed. 2) Quiet. 3) Quiet. Previous easterly movement. 4) Quiet after a rather disturbed period. 5) Somewhat disturbed. 6) Fairly quiet. 7) The instrument re-levelled; the foot untouched. 8) The displacement is due to the sinking of the foot as the ice thawed beneath it. It was then shaded from the sun. 9) Somewhat disturbed. Possibly uncertain reading; found ahair upon the needle.

36. 1894. May 31.

Lat. N. 81° 32′
Long. E. 122° 18′

Mark: 87° 45·2′

Local time h m	Needle	M
11 11 a. m.	P_1	73° 23·0′ 1)
15	P_2	74 28·4 2)
18	P_2	75 17·8 2)
23	P_1	76 37·0 2)
30	P_1	74 49·1 2)
33	P_1	15·9 2)
37	P_1	73 53·2 3)
44	P_1	30·3 2)
47	P_1	10·8 2)
50	P_2	11·5 2)
55	P_2	14·8 4)
12 1 p. m.	L	35·9
4	L	26·5
25	$L.VI_E$	74 2·0
46	L	72 4·0
50	L	37·6 5)
56	P_2	34·6 2)
1 0	P_1	28·9 2)
3	P_2	9·0 2)
7	P_1	71 56·3 2)

Mark: 87° 44·9′

Mark: 87° 45·0′

Local time h m	Needle	M
3 53 p. m.	P_1	71 59·7
56	P_1	41·2
4 0	P_2	57·8
3	P_2	72 3·3
10	L	43·0
12	L	73 1·2 6)
33	$L.V_E$	72 38·6
5 14	$L.V_6$	24·8
34	L	40·4
36	L	39·8
48	P_2	71 30·0
50	P_2	44·7
54	P_1	51·8
59	P_1	37·7

Mark: 87° 44·9′

1) Fairly quiet. 2) Quiet. 3) Disturbed; reading not exceedingly exact. 4) Quiet. After this reading the revolver was placed alternately E and W of the foot in a vertical position with the butt-end down, without producing any change in the readings. 5) The needle trembled considerably. 6) The mirror dipping during this reading.

37. 1894. June 4.

Lat. N. 81° 31′
Long. E. 122° 8′

$C - S + A =$ 53° 8·0′
$m =$ 87° 42·7′
$B = -$ 34° 34·7′

Mark: 87° 42.5′

Local time h m	Needle	M	D
12 8 p. m.	P_1	73° 40·0′ 1)	39° 5·3′ E
14	P_2	72 12·4 1)	37 37·7
20	P_1	71 28·9 1)	36 54·2
24	P_2	50·5 1)	37 15·8
30	P_1	36·2 1)	1·5
35	P_2	72 20·8 1)	46·1
41	P_1	27·0 1)	52·3
46	P_2	24·7 1)	50·0
49	P_1	22·5 1)	47·8

Mark: 87° 42·5′

Mark: 87° 42·9′

Local time h m	Needle	M	D
3 33 p. m.	P_1	71 6·0′ 2)	36 31·3
38	P_2	21·1 3)	46·4
47	P_1	70 34·3 4)	35 59·6
52	P_2	71 4·7 5)	36 30·0
55	P_2	11·0 3)	36·3
58	P_2	6·7 3)	32·0
4 3	P_1	70 50·3	15·6
7	P_1	46·8	12·1
9	P_1	48·0 3)	13·3
5 0	P_1	69 56·0	35 21·3
4	P_1	46·0	11·3
7	P_1	46·0	11·3
11	P_2	70 16·2	41·5
15	P_2	15·0	40·3
19	P_2	22·1 6)	47·4
23	P_2	32·5	57·8
30	P_1	35·5 2)	36 0·8
34	P_2	46·6	11·9
41	P_1	27·7 2)	35 53·0
44	P_1	58·0 7)	36 23·3
		Mean	36 33·4′ E

Mark: 87° 42·8′

1) The needle quiet at the moment of setting. 2) Somewhat disturbed. 3) Quiet. 4) Quiet; at first disturbed with about 45′ higher reading. 5) Fairly quiet. 6) The needle first made a somewhat marked movement eastwards, then returned, and the setting was made. 7) Disturbed.

38. 1894. June 7.

Lat. N. 81° 28′
Long. E. 122° 10′

$C - S + A =$ 53° 24·0′
$m =$ 87° 47·7′
$B = -$ 34° 23·7′

Mark: 87° 47·5′

Local time h m	Needle	M	D
10 30 a. m.	P_1	69° 5·1′ 1)	34° 41·4′ E
35	P_2	70 3·2 2)	35 39·5
39	P_1	69 27·9 2)	4·2
42	P_2	59·8 3)	36·1
11 5	P_2	70 4·2 4)	40·5
9	P_1	69 48·5 2)	24·8
12	P_2	70 5·5 2)	41·8
18	P_1	69 46·7 5)	23·0
30	L	58·5	34·8
34	L	59·3	35·6
54	$L.V_e$	70 4·9	41·2
12 33 p. m.	$L.V_E$	69 39·4	15·7
53	L	44·2	20·5
58	L	49·9	26·2
1 3	P_1	70 17·6	53·9
6	P_2	21·6	57·9
9	P_1	30·4	36 6·7
13	P_2	38·6	14·9

Mark: 87° 47·9′

Mark: 87° 47·9′

Local time h m	Needle	M	D
4 1 p. m.	P_2	69 15·7	34 52·0
5	P_1	7·2	43·5
15	P_2	34·7	35 11·0
19	P_1	20·5 6)	34 56·8
31	L	38·6	35 14·9
35	L	18·9	34 55·2
51	$L.VI_E$	34·5	35 10·8
5 8	L	55·1	31·4
12	L	70 4·0	40·3
22	P_1	69 48·5	24·8
26	P_2	57·2	33·5
30	P_1	42·9	19·2
34	P_2	39·2 7)	15·5
		Mean	35° 25·4′ E

Mark: 87° 47·5′

39. 1894. June 12.

Lat. N. 81° 43′
Long. E. 122° 13′

Mark: 87° 44·4′

Local time h m	Needle	M
3 19 p. m.	P_2	71° 54·5′
23	P_1	70 58·7
28	P_2	71 43·2
33	P_1	33·9 8)
39	L	73 18·0 9)
43	L	16·6 9)
46	L	10·0 9)
4 18	$L.V_E$	72 37·8 9)

Mark: 87° 43·4′

Local time h m	Needle	M
4 50 p. m.	L	72 44·7 10)
54	L	17·7 11)

Mark: 87° 43·6′

Local time h m	Needle	M
5 16 p. m.	L	72 26·9 10)
19	L	24·9 10)
41	$L.V_E$	73 46·2 10)
6 3	L	18·9 10)
5	L	14·2 10)
10	P_1	71 35·9 12)
13	P_2	72 2·1 12)
16	P_1	71 52·1 12)
19	P_2	72 4·1 12)

Mark: 87° 44·2′

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1) Somewhat disturbed. 2) Quiet. 3) Quiet. After this reading the observer cut the small steel buckles from his trousers, and placed one of them upon the foot of the instrument. The needle did not move. The buckles had been one on each knee, and one on the strap at the back: they were henceforth removed. 4) The needle in motion eastwards. 5) Before this reading a rather marked movement westwards. 6) The needle is more disturbed in the afternoon than in the morning. 7) As the observer had a touch of snow-blindness, he used spectacles, and only discovered, after making the observations, that the net round these was of iron wire. The readings are taken with the right eye, but on trying, it proved that the position of the needle remained unaltered, whether the reading was taken with the right or the left eye: thus no influence.

8) Disturbed. The needle first moved eastwards. 9) The needle much disturbed; the mirror danced up and down. 10) Disturbed. 11) Much disturbed. 12) Comparatively quiet; eastward motion.

40. 1894. June 13.

Lat. N. 81° 46′
Long. E. 122° 14′

$C - S + A =$ 50° 54·6′
$m =$ 87° 35·0′
$B = -$ 36° 40·4′

Mark: 87° 35·1′

Local time	Needle	*M*	*D*
h m			
11 7 a. m.	P_2	73° 5·6′ [1])	36° 25·2′ E
12	P_1	74 22·9 [2])	37 42·5
17	P_2	72 44·6 [3])	36 4·2
22	P_1	16·9	35 36·5
24	P_1	28·2	47·8
30	P_1	27·2	46·8
33	P_2	39·6	59·2
35	P_2	47·3	36 6·9
38	P_2	46·7	6·3
41	P_1	35·9	35 55·5
44	P_2	37·7	57·3
49	P_1	9·4 [4])	29·0
55	P_2	73 32·7 [5])	36 52·3
59	P_2	72 28·2 [6])	35 47·8
12 3 p. m.	P_1	15·4	35·0
12 38 p. m.	P_1	72 10·4	35 30·0
42	P_2	25·1	44·7
46	P_1	71 54·9 [7])	14·5
49	P_2	72 5·1	24·7
54	P_1	8·2 [7])	27·8
57	P_2	40·2 [1])	59·8
1 0	P_1	30·9	50·5
3	P_2	57·6	36 17·2

Mark: 87° 34·9′

Mark: 87° 34·4′

3 38 p. m.	P_2	71° 12·1′	34° 31·7′
43	P_1	23·4 [8])	43·0
47	P_2	72 1·6 [9])	35 21·2
52	P_1	71 58·9 [7])	18·5
54	P_2	72 4·1 [10])	23·7
58	P_1	16·4 [10])	36·0
4 14 p. m.	P_1	72 3·9 [1])	35 23·5
18	P_2	33·0 [8])	52·6
21	P_1	7·4 [10])	27·0
24	P_2	47·6 [9])	36 7·2
28	P_1	2·4 [10])	35 22·0
31	P_2	0·6 [11])	20·2
34	P_2	20·2	39·8

Mark: 87° 34·1′

Mark: 87° 35·5′

5 49 p. m.	P_2	71° 57·4′ [1])	35° 17·0′
53	P_1	49·8 [1])	9·4
56	P_2	53·3 [1])	12·9
6 0	P_1	56·9	16·5
3	P_2	50·8	10·4
7	P_1	14·2	34 33·8
		Mean	35° 39·2′ E

Mark: 87° 35·9′

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[1]) Quiet. [2]) The needle oscillated rapidly backwards and forwards about the position read. [3]) The needle returning from a westerly movement. [4]) First moving towards the W, then towards the E, then towards the W again, and oscillating restlessly backwards and forwards about the position read. [5]) Eastward motion; the reading taken at the most easterly position. [6]) The needle quiet; apparently its most westerly position. [7]) Disturbed.

[8]) Moving eastwards. [9]) Somewhat disturbed. [10]) Fairly quiet. [11]) The most westerly position; moving eastwards after the reading.

41. 1894. June 23.

Lat. N. 81° 44′
Long. E. 121° 28′

$C - S + A =$ 265° 41·1′
$m =$ 335° 6·2′
$B = -$ 69° 25·1′

Mark: 335° 6·7′

Local time h m	Needle	M	D
11 24 a.m.	P_1	107° 27·4′ [1])	38° 2·3′ E
29	P_2	106 18·8 [1])	36 53·7
34	P_1	37·8 [1])	37 12·7
37	P_2	21·1 [2])	36 56·0
42	P_1	105 59·4 [1])	34·3
44	P_1	106 11·4 [1])	46·3
45	P_1	4·9 [3])	39·8
50	P_2	17·6 [3])	52·5
53	P_2	23·1 [4])	58·0
55	P_2	24·3 [5])	59·2
58	P_1	4·2 [3])	39·1
12 2 p.m.	P_2	22·1 [6])	57·0
9	P_1	0·2 [7])	35·1
12	P_2	8·8 [7])	43·7

Mark: 335° 5·7′ [8])

Mark: 335° 5·7′

12 49 p.m.	P_2	106° 11·1′	36° 46·0′
52	P_1	10·9	45·8
55	P_2	13·8 [7])	48·7
58	P_1	1·4 [7])	36·3
1 1	P_2	17·3 [7])	52·2
4	P_1	10·7	45·6
5	P_1	11·2	46·1
		Mean	36° 51·9′ E

[1]) Disturbed. [2]) Disturbed. Laid the revolver aside. [3]) Fairly quiet. [4]) The needle in motion eastwards. [5]) After this reading, put the revolver in its place again. [6]) Quiet. [7]) Somewhat disturbed. [8]) Alteration in the level, on account of the melting of the ice. Corrected the balance of the needle, as its north end hung down a little during the first readings.

Lat. N. 81° 43′
Long. E. 121° 24′

$C - S + A =$ 265° 41·1′
$m =$ 335° 3·3′
$B = -$ 69° 22·2′

Mark: 335° 3·8′

Local time h m	Needle	M	D
3 4 p.m.	P_1	106° 25·2′	37° 3·0′ E
8	P_2	28·8	6·6
13	P_1	108 19·9 [9])	38 57·7
16	P_1	106 25·4	37 3·2
20	P_2	23·3 [1])	1·1
24	P_1	105 51·9 [1])	36 29·7
28	P_2	106 5·6 [3])	43·4
32	P_1	1·2 [7])	39·0
58	L	104 32·9 [10])	35 10·7
4 1	L	103 33·9 [1]) [10])	34 11·7
5	L	104 8·9 [1]) [10])	46·7
7	L	6·9 [1]) [10])	44·7
9	L	105 1·4 [1]) [10])	35 39·2
13	L	106 18·9 [1]) [10])	36 56·7
16	L	107 3·7 [3]) [10])	37 41·5
19	L	21·7 [10])	59·5
21	L	5·2 [10])	43·0
45	$L.V_E$	106 42·0	19·8
5 8	L	107 35·2 [11])	38 13·0
11	L	36·2 [11])	14·0
13	L	36·2 [11])	14·0
20	P_1	7·8 [6])	37 45·6
23	P_2	13·3 [6])	51·1
27	P_1	17·8 [12])	55·6
30	P_2	27·6 [6])	38 5·4
35	P_1	11·9 [7])	37 49·7
38	P_2	23·3 [3])	38 1·1
		Mean	37° 5·4′ E

Mark: 335° 2·8′

[9]) The needle moving eastwards, but stopped suddenly and went back again. The magnet-box was examined, but nothing was found that could prevent the free movement of the needle. [10]) The needle trembled all the time. [11]) The needle danced up and down. [12]) Sudden movements west-wards.

42. 1894. June 28.

Lat. N. 81° 35′
Long. E. 121° 37′

Mark: 359° 8·8′

Local time	Needle	M
h m		
4 46 p. m.	P_2	105° 58·6′
51	P_1	106 58·4 [1]
54	P_2	105 49·6
57	P_1	106 9·4
5 3	L	105 53·2
6	L	40·7
19	$L.V_E$	4·2
43	$L.V_e$	26·4
56	L	104 52·4
59	L	105 9·4
6 9	P_1	40·3
12	P_2	104 33·1
15	P_1	24·9
17	P_2	19·8

Mark: 359° 8·8′

43. 1894. July 6.

Lat. N. 81° 30′
Long. E. 124° 39′

$$C - S + A = 92° \; 4·7′$$
$$m = 291° \; 37·1′$$
$$B = -199° \; 32·4′$$

Mark: 291° 37·7′

Local time	Needle	M	D
h m			
11 38 a. m.	P_2	234° 38·1′	35° 5·7′ E
42	P_1	236 7·4	36 35·0
52	P_2	233 14·3 [2]	33 41·9
59	P_1	234 54·4 [3]	35 22·0
12 3 p. m.	P_1	235 11·2 [4]	38·8
6	P_1	59·7 [5]	36 27·3
12 10 p. m.	P_1	234° 47·7′ [6]	35° 15·3′
12	P_1	39·4 [7]	7·0
14	P_1	30·4 [8]	34 58·0
16	P_1	20·9 [9]	48·5
19	P_1	6·4	34·0
21	P_1	233 44·7	12·3
24	P_1	33·3	0·9
26	P_1	234 34·7	35 2·3
28	P_1	53·2	20·8
30	P_1	36·3	3·9
33	P_1	43·9	11·5
35	P_1	51·7	19·3
38	P_1	31·2	34 58·8
40	P_1	233 49·9	17·5
43	P_1	33·9	1·5
45	P_1	28·3	33 55·9
47	P_1	23·6	51·2
49	P_1	23·9 [10]	51·5
52	P_1	11·9 [10]	39·5
54	P_1	3·9 [10]	31·5
57	P_1	30·7 [10]	58·3
59	P_1	45·1 [10]	34 12·7
1 1	P_1	55·2 [10]	22·8
3	P_1	43·9 [10]	11·5
5	P_1	59·2 [10]	26·8
8	P_1	234 16·7 [10]	44·3
9	P_1	17·9 [10]	45·5

Mark: 291° 36·5′

Mark: 317° 34·5′ [11]

Local time	Needle	M	D
3 56 p. m.	P_1	232° 47·7′	33° 15·3′
59	P_2	233 17·3	44·9
4 3	P_1	232 39·4	7·0
10	P_2	233 19·8	47·4
28	$P_2.V_e$	232 42·9	10·5
5 3	$P_2·V_E$	42·1	9·7
21	P_2	36·6	4·2
24	P_1	40·4	8·0
27	P_2	44·3	11·9
30	P_1	18·7	32 46·3
33	P_2	37·8	33 5·4
35	P_1	23·7	32 51·3
		Mean	34° 17·2′ E

Mark: 317° 36·2′ [11]

[1]) The needle moving westwards; otherwise fairly quiet during the pointing.

[2]) The needle after being reversed, in constant motion westwards; this reading is the most westerly position. [3]) The needle moving eastwards during the pointing. [4]) First a slight movement towards the W, then towards the E; fairly quiet during the pointing. [5]) Somewhat disturbed.

[6]) The needle lively. [7]) Fairly quiet. [8]) Quiet. [9]) Apparently most westerly position; the needle seemed inclined to stop and go eastwards again. [10]) The needle quiet during each separate pointing. [11]) A mark on the „Storkoss“ (a big hummock which followed the ship during most of the drift) used here as a check on the instrument.

44. 1894. July 11.

Lat. N. 81° 19′
Long. E. 124° 38′

$C - S + A =$ 270° 33·9′
$m =$ 327° 52·8′
$B = -$ 57° 18·9′

Mark: 327° 53·4′

Local time	Needle	M	D
h m			
11 42 a. m.	P_1	90° 0·8′ [1]	32° 41·9′ E
46	P_2	32·9 [1]	33 14·0
50	P_1	16·5 [1]	32 57·6
54	P_2	5·0 [1]	46·1
58	P_1	4·4 [1]	45·5
12 2 p. m.	P_2	14·6 [1]	55·7
6	P_1	8·4 [1]	49·5
9	P_2	28·1 [1]	33 9·2
14	P_1	89 56·9 [1]	32 38·0
17	P_2	90 20·3 [1]	33 1·4
21	P_1	2·9 [1]	32 44·0
26	P_2	24·6 [1]	33 5·7
29	P_1	0·9 [1]	32 42·0
32	P_2	28·1 [1]	33 9·2
36	P_1	24·0 [1]	5·1
40	P_2	21·3 [1]	2·4
44	P_1	89 55·2 [1]	32 36·3
47	P_2	57·1 [1]	38·2
51	P_1	47·3 [2]	28·4
54	P_2	37·8 [3]	18·9
59	P_1	27·9 [1]	9·0
1 2	P_2	51·8 [4]	32·9
5	P_2	48·8 [5]	29·9

Mark: 327° 52·2′ [6]

$C - S + A =$ 270° 33·9′
$m =$ 327° 50·6′
$B = -$ 57° 16·7′

Mark: 327° 49·0′ [6]

Local time	Needle	M	D
h m			
3 41 p. m.	P_2	89° 42·8′	32° 26·1′
45	P_1	31·4	14·7
48	P_2	33·8	17·1
51	P_1	2·7	31 46·0
54	P_1	40·4	32 23·7
58	P_2	27·6	10·9
4 1	P_1	23·3	6·6
11	L	23·7	7·0
14	L	32·3	15·6
36	$L.V_E$	39·3	22·6
5 20	$L.V_6$	88 39·1 [7]	31 22·4
42	L	32·7	16·0
45	L	27·9	11·2
47	L	29·2	12·5
54	P_1	18·9	2·2
57	P_2	29·1	12·4
6 1	P_1	26·1	9·4
6	P_2	52·1	35·4
9	P_1	44·4	27·7
12	P_2	89 5·6	48·9
		Mean	32° 18·8′ E

Mark: 327° 52·2′

[1]) Quiet. [2]) Somewhat disturbed. [3]) Quiet. Balanced the needle. [4]) Quiet. Balanced the needle; the north end too low. [5]) The level changed. [6]) The changes in the level and in the setting of the mark are due to the melting of the ice, during which the feet of the stand slowly sink into another position. [7]) Disturbed.

45. 1894. July 14. In the morning, pieces of board were laid under the feet of the stand.

Lat. N. 81° 32′
Long. E. 124° 58′

Mark: 350° 9·0′

Local time	Needle	M	D
h m			
4 23 p. m.	P_1	110° 46·9′	
29	P_2	54·6	
33	P_1	46·4	
36	P_2	53·3	
52	P_1	51·4	
5 17	$P_1.V_E$	37·7	
42	P_1	47·4	
48	P_2	111 4·6	
52	P_1	110 53·4	
56	P_2	111 19·1	
6 1	P_1	110 54·4	
4	P_2	111 19·6	
8	P_1	7·4	
12	P_2	7·6	

Mark: [1])

$$C - S + A = 273° 40·0'$$
$$m = 350° 20·9'$$
$$B = - 76° 40·9'$$

Mark: 350° 19·8′

8 12 p. m.	P_1	110° 52·2′	34° 11·3′ E
16	P_2	42·1	1·2
19	P_1	48·4	7·5
22	P_2	58·6	17·7
25	P_1	49·9	9·0
28	P_2	57·8	16·9
31	P_1	6·2	33 25·3
34	P_1	48·9	34 8·0
36	P_2	111 15·3	34·4
38	P_2	2·1	21·2
		Mean	34° 9·3′ E

Mark: 350° 22·0′

[1]) The mark could not be seen for fog. The stand not quite steady.

46. 1894. July 25.

Lat. N. 81° 20′
Long. E. 125° 47′

Mark: 32° 16·5′

Local time	Needle	M
h m		
4 7 p. m.	P_1	259° 50·7′ [1])
13	P_2	260 9·8 [1])
20	P_1	5·9 [2])
25	P_2	259 21·8 [3])
28	P_1	49·7 [3])
32	P_2	25·6 [3])
35	P_1	59·2 [3])
41	P_2	39·1 [3])

Mark: 32° 13·5′

Mark: 32° 13·5′ [4])

4 54	P_2	259° 46·1′
58	P_1	35·7
5 15	$P_1.V_E$	48·5
50	$P_1.VI_E$	36·8
6 7	P_1	41·9
11	P_2	15·3
18	P_1	47·2
22	P_2	31·1

Mark: 32° 6·8′

[1]) Disturbed. [2]) Disturbed. Balanced the needle. [3]) Quiet. [4]) Levelled afresh.

47. 1894. July 28. New pin put in the box.

Lat. N. 81° 10′
Long. E. 125° 57′

$C - S + A =$ 165° 27·7′
$m =$ 150° 15·0′
$B =$ 15° 12·7′

Mark: 150° 15·2′

Local time h m	Needle	M	D
6 59 p. m.	P_2	14° 30·6′ [1]	29° 43·3′ E
7 3	P_1	13 53·4 [2]	6·1
6	P_2	59·6 [3]	12·3
10	P_1	14 19·4 [4]	32·1
14	P_2	13 56·8 [4]	9·5
18	P_1	27·4 [3]	28 40·1
23	P_2	41·6 [5]	54·3
27	P_1	15 26·4 [6]	30 39·1
29	P_1	13 49·2 [2]	29 1·9
32	P_2	59·1 [3]	11·8
37	P_1	15 51·9 [7]	31 4·6
42	P_2	16 10·3	23·0
47	P_1	48·4	32 1·1
49	P_1	17 11·9 [8]	24·6
52	P_1	16 45·4	31 58·1
55	P_1	18 21·9	33 34·6
58	P_1	17 43·4	32 56·1
8 0	P_1	53·9	33 6·6
4	P_2	15·6 [3]	32 28·3
6	P_2	13·1 [3]	25·8
9	P_2	16 48·3 [3]	1·0
11	P_2	48·3 [3]	1·0
		Mean	30° 56·1′ E

Mark: 150° 14·8′

[1]) Moving westwards. [2]) Fairly quiet. [3]) Quiet. [4]) Disturbed. [5]) First movement eastwards, then westwards. [6]) Disturbed. Most easterly position; went suddenly westwards again. [7]) Balanced the needle. [8]) Disturbed; went westwards again.

48. 1894. August 3.

Lat. N. 81° 5′
Long. E. 127° 19′

$C - S + A =$ 166° 38·4′
$m =$ 36° 30·2′
$B =$ 130° 8·2′

Mark: 36° 30·2′

Local time h m	Needle	M	D
7 33 p. m.	P_1	259° 45·4′ [1]	29° 53·6′ E
36	P_1	58·9 [2]	30 7·1
40	P_2	53·1 [2]	1·3
43	P_2	45·8 [3]	29 54·0
46	P_1	260 7·9 [4]	30 16·1
49	P_1	259 18·6 [4]	29 26·8
54	P_2	24·3 [5]	32·5
56	P_2	13·1 [2]	21·3
59	P_1	28·7 [2]	36·9
8 1	P_1	33·2 [2]	41·4
5	P_2	30·3 [2]	38·5
7	P_2	36·6 [6]	44·8
		Mean	29° 46·2′ E

Mark: 36° 40·2′ (?)

[1]) Somewhat disturbed. [2]) Quiet. [3]) Somewhat disturbed. The image has sunk in the field. [4]) In steady motion westwards. [5]) Moving eastwards. [6]) Fairly quiet.

49. 1894. August 4.

Lat. N. 81° 6′
Long. E. 127° 25′

Mark: 34° 13·8′

Local time	Needle	M
h m		
11 38 a. m.	L	259° 9·7′
43	L	0·2
45	L	3·7
12 12 p. m.	$L.V_E$	42·2
39	L	258 41·9
42	L	259 44·9
44	L	23·2
46	L	55·7
47	L	58·2

Mark: 34° 14·2′

Mark: 34° 12·5′

2 38 p. m.	L	259° 2·2′
40	L	0·7
42	L	2·7
58	$L.V_E$	258 52·8
3 15	L	259 13·7
17	L	14·9
18	L	15·7

Mark: 34° 11·5′

The needle disturbed all the time; a better substratum has been arranged for the feet of the stand.

50. 1894. August 15.

Lat. N. 81° 7′
Long. E. 127° 52′

$C - S + A =$ 15° 16·0′
$m =$ 235° 34·0′
$B = -$ 220° 18·0′

Mark: 235° 35·7′

Local time	Needle	M	D
h m			
5 16 p. m.	P_2	251° 23·8′ [1])	31° 5·8′ E
20	P_2	250 40·3 [1])	30 22·3
24	P_1	22·7 [2])	4·7
27	P_1	30·2 [3])	12·2
30	P_2	35·1 [3])	17·1
32	P_2	31·6 [4])	13·6
38	P_1	26·9 [5])	8·9
39	P_1	30·4 [3])	12·4
44	P_2	249 41·8 [6])	29 23·8
47	P_2	24·6 [7])	6·6
53	P_1	248 41·2 [8])	28 23·2
56	P_1	54·2 [9])	36·2
6 0	P_2	49·6 [3])	31·6
4	P_2	249 6·6 [10])	48·6
9	P_1	251 38·4 [1])	31 20·4
12	P_1	254 14·9 [11])	33 56·9
16	P_1	250 21·2 [3])	30 3·2
20	P_2	1·3 [3])	29 43·3
		Mean	30° 1·7′ E

Mark: 235° 32·3′

[1]) Disturbed. [2]) First 250° 42′; quiet. [3]) Quiet. [4]) First very slight movement eastwards, then westwards; quiet. [5]) Moving eastwards; quiet. [6]) In steady motion westwards; somewhat disturbed. [7]) First very slight movement eastwards, then westwards; disturbed. [8]) Fairly quiet. [9]) At first somewhat more easterly; fairly quiet. [10]) At first rapid motion eastwards, then slowly westwards; the needle quiet during the pointing. [11]) The needle darting backwards and forwards.

51. 1894. August 18.

Lat. N. 81° 5′
Long. E. 128° 7′

Mark: 41° 33·5′

Local time	Needle	M
h m		
3 19 p. m.	P_1	251° 45·1′
21	P_1	34·9
24	P_2	20·3
27	P_2	26·8
38	L	42·7
41	L	46·2
43	L	46·7
4 5	$P_1.V_e$	44·8
33	$P_1.V_E$	57·2
49	P_1	252 6·2
52	P_1	251 55·2
53	P_1	55·2
56	P_2	36·8
58	P_2	38·6
59	P_2	41·1

Mark: 41° 32·3′

52. 1894. September 4.

Lat. N. 81° 14′
Long. E. 123° 26′

$C - S + A =$ 11° 29·6′
$m =$ 174° 48·0′
$B = -$ 163° 18·4′

Mark: 174° 48·2′

Local time	Needle	M	D
h m			
3 25 p. m.	P_1	195° 37·2′	32° 18·8′ E
28	P_1	33·4	15·0
33	P_2	27·3	8·9
35	P_2	27·3	8·9
38	P_1	30·4	12·0
40	P_1	33·4	15·0
44	P_2	23·1	4·7
47	P_2	21·1	2·7
51	P_1	19·7	1·3
54	P_1	23·7	5·3
58	P_2	17·1	31 58·7
4 1	P_2	30·6	32 12·2
		Mean	32° 8·6′ E

Mark: 174° 47·8′

53. 1894. September 5.

Lat. N. 81° 12′
Long. E. 123° 8′

Mark: 62° 37·7′

Local time	Needle	M
h m		
3 53 p. m.	P_1	26° 58·2′
55	P_1	27 18·2
59	P_2	18·3
4 2	P_2	17·6
24	L	52·2 [1]
26	L	47·9 [1]
29	L	42·4 [1]
51	$L.V_E$	38·6 [1]
5 14	L	20·4 [1]
17	L	31·7 [1]
20	L	28·7 [1]
28	P_2	26 33·1
32	P_2	22·3
36	P_1	21·2
39	P_1	11·9

Mark: 62° 37·3′

54. 1894. September 21.

Lat. N. 81° 12′
Long. E. 123° 22′

Mark: 155° 56·8′

Local time	Needle	M
h m		
4 19 p. m.	P_1	83° 28·2′ [2]
23	P_1	43·9 [2]
26	P_2	18·1 [2]
29	P_2	17·1 [2]
33	P_1	29·9 [3]
36	P_1	82 52·9 [2]
39	P_2	35·6 [2]
42	P_2	32·1 [2]
5 0	P_2	81 51·8
14	$P_2.V_E$	82 42·8
42	$P_2.V_e$	85 2·0
57	P_2	83 8·1
58	P_2	11·3
6 2	P_1	84 9·2
5	P_1	83 38·2
9	P_2	84 39·8
10	P_2	37·8
15	P_1	11·2
17	P_1	83 42·2

Mark: 155° 57·2′

[1]) The telescope laid aside, as the reflection of the wire was indistinct.
[2]) Quiet. [3]) Somewhat disturbed.

55. 1894. September 24.

Lat. N. 81° 20′
Long. E. 122° 35′

$C - S + A =$ 107° 32·8′
$m =$ 155° 57·7′
$B = -$ 48° 24·9′

Mark: 155° 58.0′

Local time h m	Needle	M	D
4 56 p. m.	P_1	83° 0·7′	34° 35·8′ E
5 0	P_1	52·9 [1])	35 28·0
4	P_2	49·4 [2])	24·5
6	P_2	35·3 [3])	10·4
10	P_1	52·4 [4])	27·5
15	P_1	29·9 [5])	5·0
19	P_2	82 48·3 [6])	34 23·4
21	P_2	34·1 [6])	9·2
25	P_1	30·4 [7])	5·5
28	P_1	33·7 [7])	8·8
33	P_2	22·3 [7])	33 57·4
37	P_2	17·1 [2])	52·2
41	P_1	27·4 [8])	34 2·5
45	P_1	5·4 [8])	33 40·5
48	P_2	7·8	42·9
52	P_2	24·3	59·4
		Mean	34° 27·1′ E

Mark: 155° 57·5′

[1]) Moving eastwards. [2]) Fairly quiet. [3]) Moving westwards. [4]) Sudden movement westwards. [5]) Sudden movement eastwards; before the pointing, the needle oscillated backwards and forwards. [6]) Quiet. [7]) Somewhat disturbed. [8]) Disturbed.

56. 1894. September 28.

Lat. N. 81° 13′
Long. E. 122° 2′

$C - S + A =$ 107° 27·6′
$m =$ 155° 45·5′
$B = -$ 48° 17·9′

Mark: 155° 45·5′

Local time h m	Needle	M	D
5 22 p. m.	P_1	81° 28·9′	33° 11·0′ E
26	P_1	46·9	29·0
31	P_2	82 43·8	34 25·9
34	P_2	83 29·1	35 11·2
40	P_1	84 41·7	36 23·8
43	P_1	55·3	37·4
47	P_2	0·6	35 42·7
50	P_2	83 49·8	31·9
		Mean	35° 4·2′ E

Mark: 155° 45·5′

. The readings uncertain by a minute or two, on account of the extreme restlessness of the needle.

57. 1894. October 20.

Lat. N. 81° 57′
Long. E. 115° 0′

Mark: 155° 56·7′

Local time h m	Needle	M
11 27 a. m.	P_2	96° 28·3′
35	P_1	30·7
39	P_2	95 27·6
43	P_1	31·4
47	P_2	52·1
52	P_1	32·7
12 3 p. m.	$P_1 . V_e$	96 1·5
24	$P_1 . V_E$	95 37·7 [1])
35	P_1	1·9 [1])
39	P_2	6·1 [1])
44	P_1	94 51·4 [1])
49	P_2	95 36·1 [1])
53	P_1	13·9 [1])
56	P_2	36·1 [1])
59	P_2	96 10·8 [1])

Mark: 155° 55·5′

[1]) The telescope was not used, as there was too little light.

58. 1894. October 27. The telescope not used.

Lat. N. 82° 4′
Long. E. 114° 35′

$A - 180° - S = 24° 1·7$

Mark: 63° 36·2′

Local time h m	Needle	M	D
4 58 p. m.	P_2	14° 51·6′	38° 53·3′ E
5 6	P_1	34·9	36·6
13	P_2	49·8	51·5
19	P_1	58·4	39 0·1
32	P_2	15 11·8	13·5
40	P_1	11·9	13·6
		Mean	38° 58·6′ E

Mark: 63° 35·0′

59. 1894. November 10.

Lat. N. 82° 11′
Long. E. 110° 42′

$C - S + A =$ 77° 50·0′
$m =$ 214° 3·5′
$B = -$ 136° 13·5′

Mark: 214° 3·5′

Local time h m	Needle	M	D
4 23 p. m.	P_1	175° 9·4′	38° 55·9′ E
33	P_2	48·1	39 34·6
38	P_1	3·7	38 50·2
43	P_2	46·3	39 32·8
48	P_1	174 57·2	38 43·7
5 7	$P_1 . V_E$	175 11·6	58·1
26	P_1	12·4	58·9
32	P_2	43·8	39 30·3
36	P_1	15·2	1·7
39	P_2	49·6	36·1
43	P_1	8·4	38 54·9
48	P_2	19·1	39 5·6
51	P_1	0·4	38 46·9
55	P_2	39·8	39 26·3
		Mean	39° 8·3′ E

Mark: 214° 3·5′

60. 1894. November 16.

Lat. N. 82° 6′
Long. E. 110° 42′

Mark: 192° 50·3′

Local time h m	Needle	M
5 5 p. m.	P_1	153° 11·4′
11	P_2	154 10·1
16	P_1	153 22·9
20	P_2	154 13·1
47	P_1	152 32·7
50	P_1	24·4
6 4	$P_1 . V_E$	12·0
18	P_1	8·9
22	P_2	47·1
25	P_1	10·7
28	P_2	153 2·1

Mark: 192° 50·3′

61. 1894. November 22.

Lat. N. 82° 1′
Long. E. 112° 15′

$C - S + A =$ 63° 1·1′
$m =$ 201° 30·5′
$B = -$ 138° 29·4′

Mark: 201° 30·7′

Local time h m	Needle	M	D
12 39 p. m.	P_2	178° 38·8′	40° 9·4′ E
43	P_1	20·2	39 50·8
47	P_2	179 17·8	40 48·4
51	P_1	178 50·4	21·0
56	P_2	179 46·1	41 16·7
1 0	P_1	5·7	40 36·3
		Mean	40 30·4′ E

Mark: 201° 30·3′

Lat. N. 82° 0′
Long. E. 112° 5′

$C - S + A = 61° 13·4′$
$m = 201° 30·3′$
$B = -140° 16·9′$

Mark: 201° 30·2′

Local time h m	Needle	M	D
4 12 p. m.	P_1	178° 51·7	38° 34·8′ E
16	P_2	179 36·6	39 19·7
20	P_1	178 55·7	38 38·8
25	P_2	179 19·8 [1])	39 2·9
30	P_1	178 33·9	38 17·0
35	P_2	179 27·3	39 10·4
40	P_1	178 29·9	38 13·0
44	P_2	179 14·6	57·7
48	P_1	178 24·2	7·3
54	P_2	179 14·3	57·4
		Mean	38° 43·9′ E

Mark: 201° 30·4′

[1]) Movement eastwards.

62. 1894. November 24.

Lat. N. 81° 58′
Long. E. 111° 58′

Mark: 201° 30·7′

Local time h m	Needle	M
4 38 p. m.	P_1	176° 34·2′
42	P_2	177 9·3
45	P_1	176 30·2
5 0	P_2	43·8
5	P_1	57·1
8	P_2	27·1
12	P_1	175 47·7
28	$P_1 . V_E$	39·0
44	P_1	173 39·4
50	P_2	175 0·1 [1])
59	P_2	199 41·6
6 2	P_2	186 39·6
5	P_2	189 36·1
9	P_2	184 48·1
11	P_2	181 5·6
13	P_2	177 47·6
15	P_2	176 28·6 [2])
7 21 p. m.	P_2	176 24·8
27	P_1	175 34·9
31	P_2	176 6·1
34	P_1	175 29·7

Mark: 201° 30·7′

[1]) While the observer was screwing westwards to get the needle pointed, it suddenly began to go rather quickly eastwards. The above-quoted approximate value for the pointing was noted, whereupon the screw was loosened to follow the needle; but an attempt at pointing by the aid of the telescope failed in the rapid motion. The telescope was therefore quickly laid aside, and the following pointings made as nearly as possible coinciding with the line on the window of the box. [2]) As the lamp had gone out, and the needle seemed to have come back almost to its original position, and appeared to be fairly quiet, the observations were discontinued, and not recommenced until after supper. The sky was overcast, but illuminated as if the moon were shining behind the clouds; so there must have been a considerable amount of aurora borealis.

63. 1894. November 27.

Lat. N. 82° 9′
Long. E. 111° 27′

$C - S + A =$ 66° 40·8′
$m =$ 201° 31·4′
$B = -$ 134° 50·6′

Mark: 201° 31·3′

Local time h m	Needle	M	D
3 54 p. m.	P_1	173° 51·4′	39° 0·8′ E
59	P_2	174 20·1	29·5
4 2	P_1	173 36·2	38 45·6
6	P_2	174 15·8	39 25·2
10	P_1	173 49·2	38 58·6
15	P_2	174 19·1	39 28·5
19	P_1	173 52·2	1·6
23	P_2	174 30·3	39·7
28	P_1	173 50·4	38 59·8
33	P_2	174 41·8	39 51·2
38	P_1	2·7	12·1
44	P_2	32·8	42·2
49	P_1	173 55·2	4·6
52	P_2	174 24·1	33·5
56	P_1	173 44·9	38 54·3
5 0	P_2	174 17·6	39 27·0
		Mean	39° 18·4′ E

Mark: 201° 31·5′

64. 1894. November 29.

Lat. N. 82° 10′
Long. E. 110° 50′

Mark: 201° 32·3′

Local time h m	Needle	M
4 13 p. m.	P_2	175° 47·1′
17	P_1	174 18·4
20	P_2	47·1
24	P_1	34·7
42	$P_1 . V_E$	173 48·7
5 1	P_1	48·9
5	P_2	175 1·1
8	P_1	174 6·9
12	P_2	175 17·3

Mark: 201° 32·3′

65. 1894. December 6.

Lat. N. 82° 20′
Long. E. 109° 12′

$C - S + A =$ 64° 41·4′
$m =$ 201° 32·6′
$B = -$ 136° 51·2′

Mark: 201° 32·5′

Local time h m	Needle	M	D
4 16 p. m.	P_2	177° 57·8′ 1)	41° 6·6′ E
22	P_1	27·2 1)	40 36·0
26	P_2	28·8 1)	37·6
30	P_1	29·7 2)	38·5
35	P_2	30·5	39·3
38	P_1	33·9	42·7
46	P_2	172 23·1 3)	
48	P_2	173 33·1 3)	
52	P_2	41·1 3)	
57	P_1	177 27·6 2)	36·4
5 8	P_2	179 12·1 3)	

Mark: 201° 32·7′

Local time	Needle	M	D
7 28 p. m.	P_1	177° 21·4′	40° 30·2′
32	P_2	27·6	36·4
37	P_1	25·4	34·2
41	P_2	34·6	43·4
44	P_1	31·7	40·5
47	P_2	14·6	23·4
51	P_1	16·4	25·2
54	P_2	29·1	37·9
		Mean	40° 37·9′ E

Mark: 201° 32·5′

1) Somewhat disturbed. 2) Quiet.
3) The great variations in the readings were at first supposed to be due to actual magnetic perturbations. Subsequently, however, a few hairs from the observer's gloves were discovered upon the needle, which might have influenced the pointings in the position P_2 of the needle; on the other hand, they can have had no effect in position P_1.

66. 1894. December 7.

Lat. N. 82° 20′
Long. E. 108° 58′

Mark: 201° 32·3′

Local time	Needle	M
h m		
5 20 p. m.	P_2	177° 36·6′
23	P_1	51·2
26	P_2	54·6
29	P_1	49·9
44	$P_1 . V_E$	38·0
6 0	P_1	37·7
3	P_2	36·1
7	P_1	37·2
9	P_2	37·8

Mark: 201° 32·5′

67. 1894. December 14.

Lat. N. 82° 33′
Long. E. 107° 53′

Mark: 201° 32·3′

Local time	Needle	M
h m		
4 23 p. m.	P_2	179° 35·6′
28	P_1	30·9
32	P_2	9·6
36	P_1	39·4
55	$P_1 . V_E$	55·2
5 23	$P_1 . V_E$	36·5
33	P_1	29·9
37	P_2	27·3
43	P_1	32·7
46	P_2	31·3

Mark: 201° 32·5

68. 1894. December 15.

Lat. N. 82° 34′
Long. E. 107° 38′

$C - S + A =$ 62° 2·8′
$m =$ 201° 32·3′
$B = -$ 139° 29·5′

Mark: 201° 32·3′

Local time	Needle	M		D
h m				
3 35 p. m.	P_2	181°	5·3′	41° 35·8′ E
40	P_1		1·2	31·7
44	P_2		9·3	39·8
48	P_1		6·9	37·4
51	P_2	180	59·6	30·1
55	P_1		51·7	22·2
59	P_2		44·3	14·8
4 4	P_1		57·7	28·2
9	P_2	181	5·3	35·8
14	P_1	180	51·9	22·4
19	P_2		59·3	29·8
23	P_1		58·2	28·7
26	P_2	181	20·6	51·1
31	P_1		7·4	37·9
			Mean	41° 31·8′ E

Mark: 201° 32·3′

69. 1894. December 19.

Lat. N. 82° 51′
Long. E. 104° 45′

$C - S + A =$ 59° 41·2′
$m =$ 201° 34·7′
$B = -$ 141° 53·5′

Mark: 201° 35·2′

Local time	Needle	M		D	
h m					
4 25 p. m.	P_1	183°	1·1′	41°	7·6′ E
31	P_2	182	50·6	40	57·1
35	P_1		55·4	41	1·9
40	P_2		43·3	40	49·8
44	P_1		45·7		52·2
47	P_2		42·6		49·1
51	P_1	183	0·7	41	7·2
55	P_2	182	47·8	40	54·3
57	P_2		56·1	41	2·6
			Mean	40°	58·0′ E

Mark: 201° 34·2′

70. 1894. December 21.

Lat. N. 82° 54′
Long. E. 104° 6′

Mark: 201° 25·8′

Local time	Needle	M
h m		
3 37 p. m.	P_2	183° 33·1′ [1])
42	P_1	40·4 [1])
46	P_2	18·1 [1])
49	P_1	26·4 [1])
4 6	$P_1 . V_E$	182 24·0
53	$P_1 . VI_E$	16·8
5 4	P_1	25·4
8	P_2	25·6
13	P_1	19·2
18	P_2	15·6

Mark: 201° 26·0′

71. 1895. January 12.

Lat. N. 83° 41′
Long. E. 102° 47′

Mark: ?

Local time	Needle	M
h m		
4 57 p. m.	P_1	208° 8·2′
5 1	P_2	25·3
5	P_1	10·4
9	P_2	41·1
22	$P_2 . V_E$	59·1
35	P_2	209 15·6
39	P_1	208 54·9
44	P_2	209 5·1
48	P_1	208 48·7

Mark: ?

[1]) The revolver was inadvertently left on one of the shelves on the wall; during the observations for deflection, it was put in its usual place under the stand. Experiments were afterwards made by moving the revolver from the shelf to the place beneath the stand, twice backwards and forwards, without any change being observable in the position of the needle.

72. 1895. January 17.

Lat. N. 83° 23′
Long. E. 103° 2′

$C - S + A = 10° 50·2′$
$m = 9° 3·0′$
$B = 1° 47·2′$

Mark: 9° 3·0′

Local time	Needle	M	D
h m			
5 28 p. m.	P_1	40° 22·9′	42° 10·1 E
33	P_2	50·3	37·5
37	P_1	44·2	31·4
41	P_2	40·1	27·3
45	P_1	22·2	9·4
49	P_2	44·6	31·8
53	P_1	30·4	17·6
56	P_2	37·6	24·8
		Mean	42° 23·6′ E

Mark: 9° 3·0′

73. 1895. January 18.

Lat. N. 83° 25′
Long. E. 102° 30′

Mark: 9° 3·0

Local time	Needle	M
h m		
4 1 p. m.	P_2	43° 12·1′
5	P_1	42 43·2
14	P_2	59·3
19	P_1	30·7
35	$P_1 . V_E$	43 28·7
5 7	$P_1 . VI_E$	1·0
23	P_1	42 18·5
28	P_2	21·8
33	P_1	41 40·2
37	P_2	47·3

Mark: 9° 2·5′

74. 1895. March 6.

Lat. N. 84° 3′
Long. E. 101° 45′

$C - S + A =$ 9° 56·8′
$m =$ 251° 25·6′
$B = -$ 241° 28·8′

Mark: 251° 25·7′

Local time	Needle	M	D
h m			
5 22 p. m.	P_2	285° 38·6′	44° 9·8′ E
25	P_2	33·1	4·3
29	P_1	286 0·4	31·6
33	P_1	285 53·7	24·9
36	P_2	55·6	26·8
39	P_2	286 8·6	39·8
43	P_1	9·7	40·9
46	P_1	285 38·4	9·6
51	P_2	54·8	26·0
54	P_2	58·6	29·8
58	P_1	10·2	43 41·4
6 2	P_1	11·4	42·6
		Mean	44° 17·3′ E

Mark: 251° 25·5′

75. 1895. March 7.

Lat. N. 84° 1′
Long. E. 101° 53′

Mark: 251° 25·0′

Local time	Needle	M
h m		
5 9 p. m.	P_2	283° 18·1′
14	P_1	51·2
18	P_2	52·3
23	P_1	39·9
41	$P_1 . V_E$	40·9
59	P_1	37·9
6 4	P_2	53·6
9	P_1	33·7
12	P_2	54·6

Mark: 251° 25·5′

76. 1895. March 10.

Lat. N. 83° 59′
Long. E. 102° 12′

Mark: 251° 25·2′

Local time	Needle	M
h m		
3 34 p. m.	P_2	285° 36·6′
38	P_1	11·2
42	P_2	2·1
45	P_1	21·9
4 5	$P_1 . V_E$	284 49·6
43	$P_1 . VI_E$	52·4
5 3	P_1	285 9·9
7	P_2	27·6
11	P_1	17·9
15	P_2	21·6

Mark: 251° 26·0′

77. 1895. April 5.

Lat. N. 84° 17′
Long. E. 97° 23′

Mark: 251° 25·5′

Local time	Needle	M
h m		
4 14 p. m.	P_1	285° 36·4′
17	P_2	49·1
20	P_1	43·9
25	P_2	53·6
39	$P_2 . V_E$	21·3
5 9	$P_2 . VI_E$	10·7
23	P_2	284 36·8
26	P_1	9·2
30	P_2	20·1
33	P_1	10·9

Mark: 251° 24·7′

78. 1895. April 6.

Lat. N. 84° 18′
Long. E. 96° 47′

$C - S + A =$ 6° 33′
$m =$ 251° 24·8′
$B = -$ 244° 51·8′

Mark: 251° 25·0′

Local time h m	Needle	M	D
4 11 p. m.	P_1	285° 21·9′	40° 30·1′ E
14	P_2	46·6	54·8
19	P_1	10·7 [1])	18·9
23	P_2	13·1	21·3
28	P_1	284 58·7	6·9
32	P_2	285 19·8	28·0
39	P_1	22·7	30·9
43	P_2	51·3	59·5
48	P_1	35·9 [2])	44·1
54	P_2	286 24·8	41 33·0
58	P_1	14·2	22·4
5 3	P_1	4·4	12·6

Mark: 251° 24·5′

Mark: 251° 24·8′

7 31 p. m.	P_1	286° 6·4′	41° 14·6′
35	P_2	22·6	30·8
38	P_1	9·9	18·1
42	P_2	19·6	27·8
46	P_1	8·7	16·9
50	P_2	285 57·6	5·8
57	P_1	48·7	40 56·9
8 2	P_2	52·6	41 0·8
		Mean	40° 56·7′ E

Mark: 251° 24·8′

[1]) Somewhat disturbed. [2]) A few small hairs were discovered upon the needle close to the screws; they were immediately removed. The needle, however, oscillated freely, and did not give the impression of being impeded in its movements.

79. 1895. April 20.

Lat. N. 84° 13′
Long. E. 94° 30′

Mark: 249° 54·0′

Local time h m	Needle	M
5 17 p. m.	P_2	282° 8·3′
20	P_1	26·9
23	P_2	6·1
27	P_1	12·2
37	$P_1 . VI_E$	27·0
57	$P_1 . V_E$	281 59·8
6 6	P_1	282 10·4
10	P_2	24·3
12	P_1	26·4
15	P_2	15·1

Mark: 249° 54·2′

80. 1895. April 22.

Lat. N. 84° 13′
Long. E. 94° 36′

$C - S + A =$ 8° 24·5′
$m =$ 249° 46·8′
$B = -$ 241° 22·3′

Mark: 249° 47·5′

Local time h m	Needle	M	D
3 43 p. m.	P_1	281° 55·2′	40° 32·9′ E
46	P_2	59·1	36·8
49	P_1	33·9	11·6
53	P_2	55·6	33·3
4 1	P_1	26·9	4·6
5	P_2	29·6	7·3
10	P_1	22·6	0·3
13	P_2	46·1	23·8
17	P_1	37·9	15·6
20	P_2	52·1	29·8
		Mean	40° 19·6′ E

Mark: 249° 46·0′

81. 1895. May 9.

Lat. N. 84° 35′
Long. E. 90° 21′

Mark: 248° 5·7′

Local time	Needle	M
h m		
5 23 p. m.	P_1	284° 31·2′
26	P_2	9·8
29	P_1	4·4
32	P_2	19·1
45	$P_2 . V_E$	23·5
59	P_2	13·3
6 2	P_1	283 52·7
4	P_2	284 15·3
7	P_1	17·4

Mark: 248° 3·3′

82. 1895. May 11.

Lat. N. 84° 38′
Long. E. 89° 46′

$C - S + A =$ 3° 37·9′
$m =$ 247° 56·6′
$B = -$ 244° 18·7′

Mark: 247° 55·7′

Local time	Needle	M	D
h m			
4 38 p. m.	P_1	281° 35·9′	37° 17·2′ E
41	P_2	282 3·8	45·1
44	P_1	281 57·9	39·2
47	P_2	282 6·6	47·9
51	P_1	281 51·7	33·0
55	P_2	282 8·5	49·8
59	P_1	5·7	47·0
5 1	P_2	1·3	42·6
7	P_1	281 52·9	34·2
11	P_2	282 6·1	47·4
		Mean	37° 40·3′ E

Mark: 247° 57·5′

83. 1895. May 22.

Lat. N. 84° 40′
Long. E. 83° 51′

Mark: 245° 58·0′

Local time	Needle	M
h m		
4 46 p. m.	P_1	280° 35·4′
51	P_2	281 18·8
55	P_1	22·2
58	P_2	282 3·8
5 1	P_1	11·3
3	P_2	41·6
6	P_1	39·9
8	P_2	47·1
12	P_1	29·4
15	P_2	27·3
18	P_1	48·7
21	P_2	33·3
24	P_1	281 37·2
27	P_2	26·8

Mark: 245° 58·0′

84. 1895. May 24.

Lat. N. 84° 41′
Long. E. 82° 31′

$C - S + A =$ 359° 5·0′
$m =$ 248° 45·1′
$B =$ 110° 19·9′

Mark: 248° 45·5′

Local time	Needle	M	D
h m			
3 45 p. m.	P_1	283° 30·4′	33° 50·3′ E
48	P_2	42·6	34 2·5
51	P_1	34·2	33 54·1
54	P_2	58·6	34 18·5
4 9	$P_2 . V_E$	284 8·1	28·0
40	$P_2 . V_E$	283 56·7 [1]	16·6
55	P_2	39·3	33 59·2
5 0	P_1	20·4	40·3
3	P_2	284 1·6	34 21·5
6	P_1	283 39·7	33 59·6
9	P_1	29·4 [2]	49·3
12	P_2	284 5·6	34 25·5
15	P_1	283 42·2	2·1
20	P_2	56·3	16·2
		Mean	34° 6·0′ E

Mark: 248° 44·7′

[1] The revolver laid aside. [2] The revolver in its place again.

85. 1895. July 3.

Lat. N. 84° 42′
Long. E. 74° 20′

Mark: 10° 19·0′

Local time h m	Needle	M
3 23 p. m.	P_1	231° 5·1′
27	P_2	12·1
29	P_1	0·4
32	P_2	9·8
41	$P_2 . V_E$	20·0
59	$P_2 . V_e$	51·0
4 16	$P_2 . VI_e$	30.5
34	$P_2 . VI_E$	40·3
43	P_2	54·6
47	P_1	52·9
49	P_2	232 8·8
52	P_1	13·4

Mark: 11° 32·0′ [1])

86. 1895. July 5.

Lat. N. 84° 43′
Long. E. 75° 44′

$A - 180° - S = 43° 25·6′$

Mark: 50° 20·2′

Local time h m	Needle	M	D
4 43 p. m.	P_1	346° 54·7′	30° 20·3′ E
47	P_2	347 27·6	53·2
49	P_1	26·4	52·0
53	P_2	28·6	54·2
56	P_1	2·9	28·5
59	P_2	28·1	53·7
5 2	P_1	13·9	39·5
6	P_2	20·8	46·4
		Mean	30° 38·5′ E

Mark: 50° 21·0′

[1]) Ice in motion.

87. 1895. July 12.

Lat. N. 84° 41′
Long. E. 76° 0′

$A - 180° - S = 46° 49·6′$

Mark: 39° 36·0′

Local time h m	Needle	M	D
4 42 p. m.	P_1	342° 3·2′	28° 52·8′ E
45	P_2	26·3	29 15·9
51	P_1	5·2	28 54·8
54	P_2	341 58·8	48·4
57	P_1	44·4	34·0
5 0	P_2	20·6	10·2
		Mean	28° 46·0′ E

Mark: 39° 34·3′

88. 1895. July 13.

Lat. N. 84° 41′
Long. E. 76° 1′

$A - 180° - S = 55° 33·4′$

Mark: 20° 58·0′

Local time h m	Needle	M	D
4 45 p. m.	P_2	333° 48·3′	29° 21·7′ E
47	P_1	44·7	18·1
51	P_2	334° 1·6	35·0
54	P_1	10·7	44·1
5 5	$P_1 . V_E$	333 25·7	28 59·1
25	$P_1 . V_e$	332 42·5	15·9
35	P_1	333 49·4	29 22·8
38	P_2	334 1·8	35·2
42	P_1	333 57·4	30·8
46	P_2	334 18·1	51·5
		Mean	29° 21·4′ E

Mark: 21° 1·8′

89. 1895. July 26.

Lat. N. 84° 30′
Long. E. 73° 1′

Mark: 134° 17·2′

Local time	Needle	M
h m		
4 45 p. m.	P_1	283° 32·7′
49	P_2	43·6
52	P_1	29·7
55	P_2	42·3
5 4	$P_2 . V_e$	38·9
22	$P_2 . V_E$	40·8
40	$P_2 . VI_E$	33·4
58	$P_2 . VI_e$	9·8
6 6	P_2	14·6
10	P_1	282 56·7
12	P_2	283 0·1
15	P_1	282 54·2

Mark: 134° 17·0′

90. 1895. August 2.

Lat. N. 84° 32′
Long. E. 77° 40′

$A - 180° - S =$ 278° 26·7′

Mark: 112° 35·0′

Local time	Needle	M	D
h m			
5 14 p. m.	P_1	113° 7·7′	31° 34·4′ E
18	P_2	22·8	49·5
20	P_1	14·7	41·4
24	P_2	33·3	32 0·0
26	P_1	12·2	31 38·9
30	P_2	12·6	39·3
		Mean	31° 43·9′ E

Mark: 112° 36·5′

91. 1895. August 23.

Lat. N. 84° 11′
Long. E. 79° 1′

Mark: 258° 2·5′

Local time	Needle	M
h m		
4 12 p. m.	P_2	177° 11·6′
16	P_1	176 59·2
19	P_2	177 21·6
23	P_1	19·2
35	$P_1 . V_e$	178 36·2
5 0	$P_1 . V_E$	45·0
13	P_1	31·2
18	P_2	9·6
22	P_1	177 50·7
27	P_2	178 1·1

Mark: 257° 59′ [1])

92. 1895. September 6.

Lat. N. 84° 53′
Long. E. 78° 45′

$A - 180° - S =$ 313° 49·3′

Mark: 89° 17·5′

Local time	Needle	M	D
h m			
4 45 p. m.	P_1	77° 59·4′	31° 48·7′ E
49	P_2	78 15·1	32 4·4
51	P_1	14·7	4·0
54	P_2	9·1	31 58·4
$A - 180° - S =$ 313° 35·2′			
5 8 p. m.	$P_2 . V_E$	77° 56·7′	31° 31·9′
$A - 180° - S =$ 313° 21·1′			
5 22 p. m.	P_2	78° 17·8′	31° 38·9′
26	P_1	77 46·9 [2])	8·0
29	P_2	78 32·6	53·7
32	P_1	59·7	32 20·8
		Mean	31° 49·9′ E

Mark: 89° 27·7′

[1]) Dull weather. The ice in motion.
[2]) The ice packing.

93. 1895. September 7.

Lat. N. 84° 54′
Long. E. 78° 42′

Mark: 293° 39·0′

Local time	Needle	M
h m		
10 44 a. m.	P_1	77° 7·4′
48	P_2	19·3
54	P_1	17·9
56	P_2	19·8
11 6	$P_2 . V_E$	29·7
26	$P_2 . V_6$	23·0
36	P_2	21·3
41	P_1	2·9
44	P_2	14·1
48	P_1	76 54·9

Mark: 293° 39·5′

94. 1895. September 27. The ice-hut on the floe, 135 paces to starboard of the vessel, was taken into use on the 26th Sept. The instrument is placed on a ice-pillar. The revolver now lies to the N of the instrument, 3 metres from it, on the ice at the level of the foot of the pillar, with the butt-end pointing westwards. The height of the instrument above the floor is 1·4 metres.

Lat. N. 85° 8′
Long. E. 79° 28′

Mark: 99° 24·8′

Local time	Needle	M
h m		
11 5 a. m.	P_1	239° 47·4′
10	P_2	240 16·1
14	P_1	239 56·7
18	P_2	240 6·8
28	$P_2 . V_6$	239 55·9
50	$P_2 . V_E$	240 21·5
12 11 p. m.	$P_2 . VI_E$	7·1
22	P_2	239 57·1
26	P_1	47·9
29	P_2	59·8
32	P_1	59·4

Mark: 99° 16·8′ [1])

[1]) The ice in motion. The mark has been displaced on the other side of a channel in the ice, while the instrument has stood still.

95. 1895. September 28.

Lat. N. 85° 8′
Long. E. 79° 42′

$C - S + A =$ 254° 41·5′
$m =$ 100° 29·3′
$B =$ 154° 12·2′

Mark: 100° 29·3′

Local time	Needle	M	D
h m			
5 7 p. m.	P_1	239° 37·7′	33° 49·9′ E
13	P_2	24·3	36·5
17	P_1	45·9	58·1
21	P_2	34·3	46·5
24	P_1	13·4	25·6
27	P_2	29·6	41·8
32	P_1	38·7	50·9
35	P_2	31·3	43·5
39	P_1	11·4	23·6
42	P_2	27·8	40·0
		Mean	33° 41·6′ E

Mark: 100° 29·3′

96. 1895. October 3.

Lat. N. 85° 12′
Long. E. 78° 59′

Mark: 100° 30·0′

Local time	Needle	M
h m		
11 42 a. m.	P_1	240° 4·9′
45	P_2	239 50·6
48	P_1	240 11·8
51	P_2	239 50·8
12 2 p. m.	$P_2 . V_E$	35·2
23	$P_2 . V_6$	37·7
33	P_2	57·8
38	P_1	240 33·4
41	P_2	8·1
44	P_1	239 38·2
47	P_1	240 7·7

Mark: 100° 30·2′

97. 1895. October 4.

Lat. N. 85° 11′
Long. E. 78° 53′

Mark: 101° 49·5′

Local time	Needle	M
h m		
10 51 a. m.	P_1	240° 1·2′
52	P_2	239 51·3
59	P_1	51·9
11 3	P_2	12·8
14	$P_2.V_e$	25·5
36	$P_2.V_E$	54·4
47	P_2	240 7·3
51	P_1	239 58·9
58	P_2	237 41·6
Noon	P_2	239 6·1
12 3 p. m.	P_2	240 38·8
5	P_1	46·9
7	P_1	26·7
10	P_2	239 45·1

Mark: 101° 50·3′

98. 1895. October 14.

Lat. N. 85° 24′
Long. E. 78° 37′

$C - S + A =$ 262° 35·7′
$m =$ 101° 9·8′
$B =$ 161° 25·9′

Mark: 101° 9·8′

Local time	Needle	M	D
h m			
4 47 p. m.	P_2	230° 47·3′	32° 13·2′ E
54	P_1	231 29·4	55·3
58	P_2	37·6	33 3·5
5 3	P_1	10·4	32 36·3
7	P_2	15·8	41·7
11	P_1	4·7	30·6
16	P_2	230 38·8	4·7
20	P_1	43·4	9·3
23	P_2	52·1	18·0
28	P_1	59·9	25·8
33	P_2	56·1	22·0
36	P_1	231 0·2	26·1
		Mean	32° 28·9′ E

Mark: 101° 9·8′

99. 1895. October 17.

Lat. N. 85° 36′
Long. E. 78° 25′

Mark: 101° 9·8′

Local time	Needle	M
h m		
11 19 a. m.	P_1	231° 32·7′
22	P_2	18·8
25	P_1	230 48·2
30	P_2	231 6·1
41	$P_2.V_E$	24·7
Noon	$P_2.V_e$	20·0
12 19 p. m.	$P_2.VI_E$	232 16·6
30	P_2	231 5·1
36	P_1	232 8·7 [1])
39	P_1	43·8 [2])
42	P_2	10·1
45	P_2	19·8

Mark: 101° 10·5′

100. 1895. October 24.

Lat. N. 85° 46′
Long. E. 73° 40′

Mark: 101° 33·3′

Local time	Needle	M
h m		
10 38 a. m.	P_2	229° 39·8′
42	P_1	38·7
45	P_2	29·3
49	P_1	42·9
11 2	$P_1.V_E$	54·5
27	$P_1.V_e$	40·5
40	P_1	230 2·9
49	P_2	229 42·8
54	P_1	41·2
58	P_2	38·3

Mark: 101° 33·3′

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[1]) The needle suddenly moved from this position eastwards. [2]) After this reading, the needle moved westwards again.

101. 1895. October 25.

Lat. N. 85° 46′
Long. E. 72° 56′

$C - S + A = 261° 4·6′$
$m = 101° 42·3′$
$B = 159° 22·3′$

Mark: 101° 42·3′

Local time h m	Needle	M	D
3 48 p. m.	P_1	229° 44·2′	29° 6·5′ E
52	P_2	22·6	28 44·9
57	P_1	230 43·4	30 5·7
4 3	P_2	229 32·1	28 54·4
6	P_1	230 4·4	29 26·7
10	P_2	229 35·6	28 57·9
14	P_1	36·7	59·0
17	P_2	36·6	58·9
22	P_1	41·7	29 4·0
26	P_2	50·1	12·4
30	P_1	18·2	28 40·5
35	P_2	30·6	52·9
		Mean	29° 5·3′ E

Mark: 101° 42·3′

102. 1895. November 2. The ice has cracked between the observation-hut and the ship, and has shifted.

Lat. N. 85° 40′
Long. E. 69° 54′

Mark: 69° 14·5′

Local time h m	Needle	M
11 50 a. m.	P_1	233° 57·7′
53	P_2	49·6
56	P_1	41·4
Noon	P_2	42·1
12 10 p. m.	$P_2.V_e$	48·3
29	$P_2.V_E$	45·1
38	P_2	41·1
42	P_1	55·7
45	P_2	35·3
48	P_1	52·2

Mark: 69° 14·5′

103. 1895. November 9.

Lat. N. 85° 42′
Long. E. 64° 22′

$C - S + A = 204° 56·8′$
$m = 60° 42·3′$
$B = 144° 14·5′$

Mark: 60° 42·5′

Local time h m	Needle	M	D
4 34 p. m.	P_1	238° 3·9′	22° 18·4′ E
40	P_2	237 18·1	21 32·6
43	P_1	12·7	27·2
47	P_2	21·3	35·8
51	P_1	56·4	22 10·9
5 3	$P_1.V_E$	52·0	6·5
29	$P_1.V_e$	40·8	21 55·3
42	P_1	38·7	53·2
46	P_2	19·3	33·8
51	P_1	32·2	46·7
54	P_2	13·3	27·8
		Mean	21° 48·0′ E

Mark: 60° 42·0′

104. 1895. November 20.

Lat. N. 85° 51′
Long. E. 64° 20′

$C - S + A = 207° 40·4′$
$m = 63° 32·0′$
$B = 144° 8·4′$

Mark: 63° 32·3′

Local time h m	Needle	M	D
11 10 a. m.	P_1	238° 12·4′	22° 20·8′ E
15	P_2	237 44·3	21 52·7
19	P_1	41·2	49·6
24	P_2	49·6	58·0
34	$P_2.V_e$	51·7	22 0·1
54	$P_2.V_E$	46·5	21 54·9
12 4 p. m.	P_2	51·3	59·7
9	P_1	47·9	56·3
16	P_2	47·3	55·7
21	P_1	46·9	55·3
		Mean	21° 58·3′ E

Mark: 63° 31·7′

105. 1895. November 22.

Lat. N. 85° 47′
Long. E. 64° 11′

$C - S + A =$ 207° 12·7′
$m =$ 61° 5·4′
$B =$ 146° 7·3′

Mark: 61° 5·3′

Local time	Needle	M	D
h m			
3 58 p.m.	P_1	236° 15·2′	22° 22·5′ E
4 3	P_2	7·1	14·4
6	P_1	24·9	32·2
10	P_2	9·1	16·4
25	$P_2 . VI_E$	235 57·5	4·8
41	P_2	52·1	21 59·4
46	P_1	236 8·9	22 16·2
50	P_2	235 41·3	21 48·6
53	P_1	43·9	51·2
		Mean	22° 9·5′ E

Mark: 61° 5·5′

106. 1895. November 30.

Lat. N. 85° 28′
Long. E. 58° 41′

$C - S + A =$ 202° 37·2′
$m =$ 61° 29·8′
$B =$ 141° 7·4′

Mark: 61° 29·8′

Local time	Needle	M	D
h m			
3 54 p.m.	P_2	237° 35·6′	18° 43·0′ E
59	P_1	52·2	59·6
4 2	P_2	37·1	44·5
6	P_1	56·4	19 3·8
18	$P_1 . V_e$	54·5	1·9
41	$P_1 . V_E$	238 14·6	22·0
53	P_1	9·4	16·8
57	P_2	237 46·3	18 53·7
5 0	P_1	48·9	56·3
4	P_2	48·2	55·6
		Mean	18° 59·7′ E

Mark: 61° 29·8′

107. 1895. December 5.

Lat. N. 85° 29′
Long. E. 55° 52′

Mark: 61° 33·0′

Local time	Needle	M
h m		
3 26 p.m.	P_2	233° 54·8′
31	P_1	234 7·2
35	P_2	233 52·6
39	P_1	234 6·7
49	$P_1 . V_E$	233 56·4
4 15	$P_1 . V_e$	40·8
40	$P_1 . VI_E$	54·0
50	P_1	54·7
55	P_2	234 0·8
5 0	P_1	14·7
4	P_2	233 54·6

Mark: 61° 33·0′

108. 1895. December 7.

Lat. N. 85° 27′
Long. E. 54° 20′

$C - S + A =$ 205° 21·5′
$m =$ 61° 32·5′
$B =$ 143° 49·0′

Mark: 61° 33·0′

Local time	Needle	M	D
h m			
10 52 a.m.	P_2	232° 39·1′	16° 28·1′ E
57	P_1	41·9	30·9
11 0	P_2	231 59·6	15 48·6
4	P_1	232 10·4	59·4
9	P_2	231 34·1	23·1
13	P_1	46·7	35·7
17	P_2	44·8	33·8
21	P_1	54·4	43·4
26	P_2	51·1	40·1
30	P_1	232 4·2	53·2
34	P_2	5·3	54·3
39	P_1	20·4	16 9·4
		Mean	15° 53·3′ E

Mark: 61° 32·0′

109. 1895. December 12.

Lat. N. 85° 25′
Long. E. 50° 7′

Mark: 61° 32·0′

Local time	Needle	M
h m		
3 58 p. m.	P_1	227° 51·9′
4 3	P_2	21·1
8	P_1	30·7
12	P_2	18·6
26	$P_2 . V_E$	19·4
40	P_2	16·1
43	P_1	22·2
47	P_2	17·1
51	P_1	5·7

Mark: 61° 31·8′

110. 1896. January 4.

Lat. N. 85° 17′
Long. E. 44° 55′

$C - S + A =$ 199° 39·7′
$m =$ 57° 57·8′
$B =$ 141° 41·9′

Mark: 57° 58·0′

Local time	Needle	M	D
h m			
10 5 a. m.	P_1	226° 16·9′	7° 58·8 E
9	P_2	16·3	58·2
12	P_1	30·4	8 12·3
17	P_2	17·8	7 59·7
22	P_1	20·2	8 2·1
27	P_2	19·8	1·7
31	P_1	41·2	23·1
36	P_2	33·8	15·7

Mark: 57° 57·5′

Mark: 57° 58·0′

4 5 p. m.	P_2	226° 20·3′	8° 2·2′
10	P_1	31·2	13·1
13	P_2	25·6	7·5
17	P_1	16·7	7 58·6
29	$P_1 . V_E$	2·9	44·8
53	$P_1 . V_e$	23·0	8 4·9
5 5	P_1	37·2	19·1
10	P_2	31·3	13·2
14	P_1	50·2	32·1
17	P_2	38·3	20·2
		Mean	8° 8·2′ E

Mark: ?

111. 1896. January 10.

Lat. N. 84° 58′
Long. E. 41° 17′

$C - S + A =$ 199° 48·3′
$m =$ 57° 58·0′
$B =$ 141° 50·3′

Mark: 57° 58·0′

Local time	Needle	M	D
h m			
9 58 a. m.	P_2	223° 21·8′	5° 12·1′ E
10 3	P_1	22·7	13·0
7	P_2	35·8	26·1
10	P_1	27·2	17·5
15	P_2	16·8	7·1
19	P_1	8·9	4 59·2
23	P_2	222 54·8	45·1
27	P_1	223 16·7	5 7·0

Mark: 57° 58·0′

Mark: 57° 58·0′

3 38 p. m.	P_1	223° 7·2′	4° 57·5′
41	P_2	19·6	5 9·9
45	P_1	26·7	17·0
49	P_2	18·6	8·9
59	$P_2 . V_e$	10·5	0·8
4 30	$P_2 . V_E$	222 22·2	4 12·5
5 1	$P_2 . VI_E$	42·8	33·1
11	P_2	51·6	41·9
14	P_1	223 15·9	5 6·2
17	P_2	6·6	4 56·6
22	P_1	14·7	5 5·0
		Mean	5° 0·9′ E

Mark: 57° 58·0′

112. 1896. January 18.

Lat. N. 84° 56′
Long. E. 39° 47′

Mark: 57° 58·2′

Local time h m	Needle	M
11 37 a. m.	P_2	225° 26·1′
43	P_1	31·9
47	P_2	14·6
51	P_1	30·2
12 3 p. m.	$P_1 . V_E$	42·8
28	$P_1 . V_6$	226 0·1
40	P_1	6·9
44	P_2	2·6
48	P_1	15·7
52	P_2	17·3

Mark: 57° 58·2′

113. 1896. January 28.

Lat. N. 84° 41′
Long. E. 31° 41′

Mark: 58° 52·8′

Local time h m	Needle	M
11 4 a. m.	P_2	227° 55·3′
9	P_1	58·4
13	P_2	53·3
16	P_1	54·7
27	$P_1 . V_6$	50·4
52	$P_1 . V_E$	228 9·3
12 5 p. m.	P_1	10·4
9	P_2	227 46·1
12	P_1	49·9
17	P_2	45·1

Mark: 58° 52·8′

114. 1896. January 29.

Lat. N. 84° 43′
Long. E. 31° 43′

$C - S + A =$ 189° 51·7′
$m =$ 54° 35·6′
$B =$ 135° 16·1′

Mark: 54° 35·7′

Local time h m	Needle	M	D
2 54 p. m.	P_2	222° 12·6′	357° 28·7′ E
59	P_1	38·2	54·3
3 3	P_2	10·6	26·7
6	P_1	33·7	49·8
12	P_2	11·6	27·7
16	P_1	39·2	55·3
21	P_2	6·1	22·2
24	P_1	12·9	29·0
28	P_2	8·8	24·9
32	P_1	10·9	27·0
		Mean	357° 34·6′ E

Mark: 54° 35·5′

115. 1896. February 4.

Lat. N. 84° 43′
Long. E. 24° 59′

Mark: 54° 36·8′

Local time h m	Needle	M
11 41 a. m.	P_1	219° 13·4′
45	P_2	25·3
47	P_1	42·9
50	P_2	42·1
12 6 p. m.	$P_2 . VI_E$	25·1
22	P_2	31·6
25	P_1	56·2
28	P_2	38·6
31	P_1	46·2

Mark: 54° 36·8′

116. 1896. February 5.

Lat. N. 84° 39′
Long. E. 24° 38′

$C - S + A = 187° 22·7'$
$m = 54° 36·5'$
$B = 132° 46·2'$

Mark: 54° 36·7′

Local time h m	Needle	M	D
10 14 a. m.	P_1	219° 18·2′	352° 4·4′ E
18	P_2	18·8	5·0
22	P_1	21·7	7·9
26	P_2	23·3	9·5
37	$P_2.V_E$	18·9	5·1
59	$P_2.V_e$	18·2	4·4
11 10	P_2	15·6	1·8
15	P_1	12·4	351 58·6
20	P_2	218 51·6 [1]	37·8
25	P_1	50·7 [2]	36·9
30	P_2	219 1·6 [3]	47·8
33	P_1	28·3	352 14·5
		Mean	351° 59·5′ E

Mark: 54° 36·3′

117. 1896. February 13.

Lat. N. 84° 18′
Long. E. 22° 45′

$C - S + A = 183° 9·8'$
$m = 56° 11·6'$
$B = 126° 58·2'$

Mark: 56° 12·0′

Local time h m	Needle	M	D
10 27 a. m.	P_1	223° 48·2′	350° 46·4′ E
32	P_2	19·8	18·0
36	P_1	51·9	50·1
40	P_2	28·1	26·3
52	$P_2.V_e$	32·9	31·1
11 17	$P_2.V_E$	37·8	36·0
29	P_2	27·3	25·5
34	P_1	45·7	43·9
38	P_2	31·3	29·5
43	P_1	54·2	52·4
		Mean	350° 35·9′ E

Mark: 56° 11·2′

[1]) Disturbed. [2]) The needle much disturbed. It first moved towards the E, remained there a moment quietly, and then moved towards the W, became quiet again, whereupon the setting was made. [3]) Quiet.

118. 1896. February 25.

Lat. N. 84° 12′
Long. E. 24° 11′

$C - S + A = 173° 11·0'$
$m = 64° 57·4'$
$B = 108° 13·6'$

Mark: 64° 57·5′

Local time h m	Needle	M	D
10 54 a. m.	P_2	243° 37·1′	351° 50·7′ E
57	P_1	56·4	352 10·0
11 1	P_2	21·3	351 34·9
4	P_1	52·4	352 6·0
14	$P_1.VI_E$	43·5	351 57·1
37	$P_1.V_E$	35·1	48·7
12 1 p. m.	$P_1.V_e$	41·0	54·6
11	P_1	40·2	53·8
14	P_2	16·8	30·4
18	P_1	38·7	52·3
24	P_2	17·6	31·2

Mark: 64° 57·25′

Mark: 64° 57·5′

Local time h m	Needle	M	D
5 32 p. m.	P_2	243° 26·3′	351° 39·9′
36	P_1	36·9	50·5
39	P_2	24·3	37·9
42	P_1	30·2	43·8
45	P_2	5·8	19·4
48	P_1	28·4	42·0
		Mean	351° 46·1′ E

Mark: 64° 57·5′

No revolver.

119. 1896. March 6.

Lat. N. 84° 4′
Long. E. 24° 56′

Mark: ?

Local time	Needle	M
h m		
10 57 a. m.	P_1	249° 18·2′
11 1	P_2	248 43·1
5	P_1	249 11·2
10	P_2	248 44·3
23	$P_2 . V_6$	32·3
51	$P_2 . V_E$	7·9
12 4 p. m.	P_2	4·6
10	P_1	30·2
16	P_2	4·1
19	P_1	17·7

Mark: ?

The mark could not be seen for the falling snow.

120. 1896. March 7.

Lat. N. 84° 0′
Long. E. 24° 11′

$C - S + A = 164° 38·8′$
$m = 63° 41·3′$
$B = 100° 57·5′$

Mark: 63° 41·3′

Local time	Needle	M	D
h m			
4 48 p. m.	P_1	251° 21·9′	352° 19·4′ E
53	P_2	250 46·3	351 43·8
57	P_1	48·7	46·2
5 1	P_2	29·3	26·8
14	$P_2 . V_E$	7·9	5·4
28	P_2	17·3	14·8
32	P_1	40·9	38·4
36	P_2	249 57·3	350 54·8
40	P_1	250 40·2	351 37·7
		Mean	351° 31·9′ E

Mark: 63° 41·3′

121. 1896. March 19.

Lat. N. 84° 5′
Long. E. 24° 43′

Mark: 63° 39·5′

Local time	Needle	M
h m		
11 5 a. m.	P_2	260° 52·3′
9	P_1	34·9
14	P_2	52·6
17	P_1	49·4
27	$P_1 . VI_E$	45·6
56	$P_1 . V_E$	40·3
12 24 p. m.	$P_1 . V_6$	26·7
34	P_1	29·4
40	P_2	19·8
44	P_1	11·9
47	P_2	0·6

Mark: 63° 39·3′

122. 1896. April 9.

Lat. N. 84° 27′
Long. E. 18° 33′

Mark: 55° 16·8′

Local time	Needle	M
h m		
4 40 p. m.	P_2	253° 10·3′
43	P_1	2·4
46	P_2	252 57·8
50	P_1	51·9
5 1	$P_1 . V_6$	253 4·3
22	$P_1 . V_E$	11·9
36	P_1	9·9
40	P_2	22·1
43	P_1	12·4
46	P_2	8·3

Mark: 55° 16·8′

123. 1896. April 20.

Lat. N. 84° 1′
Long. E. 13° 58′

$C - S + A = 145° 24·7′$
$m = 57° 34·4′$
$B = 87° 50·3′$

Mark: 57° 34·5′

Local time	Needle	M	D
h m			
4 32 p. m.	P_2	255° 4·6′	342° 54·9′ E
43	P_1	2·4	52·7
46	P_2	3·3	53·6
50	P_1	6·4	56·7
53	P_2	7·3	57·6
57	P_1	10·9	343 1·2
5 0	P_2	8·6	342 58·9
4	P_1	4·4	54·7
		Mean	342° 56·3′ E

Mark: 57° 34·3′

124. 1896. April 21.

Lat. N. 84° 4′
Long. E. 13° 12′

Mark: 57° 37·8′

Local time	Needle	M
h m		
4 17 p. m.	P_1	255° 15·2′
21	P_2	3·1
24	P_1	1·2
28	P_2	2·6
38	$P_2.VI_E$	15·5
5 1	$P_2.V_E$	21·5
24	$P_2.V_e$	17·4
34	P_2	26·1
37	P_1	26·9
41	P_2	35·1
44	P_1	24·2

Mark: 57° 37·8′

The needle lively.

125. 1896. May 8.

Lat. N. 83° 56′
Long. E. 11° 4′

Mark: 55° 16·8′

Local time	Needle	M
h m		
11 4 a. m.	P_1	253° 4·4′
8	P_2	252 50·3
11	P_1	55·9
14	P_2	50·3
23	$P_2.V_e$	251 51·5
41	$P_2.V_E$	252 18·2
51	P_2	41·8
54	P_1	19·7
57	P_2	4·3
12 1 p. m.	P_1	8·9

Mark: 55° 19·5′ [1])

126. 1896. June 3.

Some movement in the ice. No revolver. The observations are made in the tent, 160 paces in front of the vessel's bow.

Lat. N. 83° 16′
Long. E. 12° 33′

Mark: 178° 52·3′

Local time	Needle	M
h m		
3 49 p. m.	P_1	277° 26·7′
4 3	P_2	6·6
6	P_1	34·2
9	P_2	48·6
18	$P_2.V_E$	55·2
36	$P_2.V_e$	18·7
45	P_2	14·6
49	P_1	12·9
52	P_2	31·6
56	P_1	276 56·2

Mark: 178° 54·0′

[1]) The channel between the observation-hut and the mark had opened somewhat.

127. 1896. June 18. No revolver.

Lat. N. 82° 56′
Long. E. 11° 35′

Mark: 125° 16·0′

Local time	Needle	*M*
h m		
11 5 a. m.	P_1	283° 41·9′
9	P_2	43·6
11	P_1	50·9
14	P_2	284 1·6
22	$P_2.V_6$	5·1
40	$P_2.V_E$	10·7
57	$P_2.VI_E$	7·5
12 5 p. m.	P_2	283 59·1
8	P_1	55·4
12	P_2	34·8
14	P_1	50·9

Mark: 125° 13·5′

128. 1896. June 19.

Lat. N. 82° 55′
Long. E. 11° 44′

$C - S + A = 206° 17·4′$
$m = 142° 59·0′$
$B = 63° 18·4′$

Mark: 142° 59·0′

Local time	Needle	*M*	*D*
h m			
5 4 p. m.	P_1	279° 59·2′	343° 17·6′ E
6	P_2	57·3	15·7
8	P_1	58·9	17·3
11	P_2	53·3	11·7
14	P_1	59·9	18·3
16	P_2	280 4·6	23·0
19	P_1	2·2	20·6
21	P_2	14·6	33·0
23	P_1	279 57·2	15·6
27	P_2	280 0·8	19·2
		Mean	343° 19·2′ E

Mark: 142° 59·0′

129. 1896. July 8.

Lat. N. 83° 3′
Long. E. 12° 56′

Mark: 33° 54·2′

Local time	Needle	*M*
h m		
4 19 p. m.	P_2	238° 10·1′
24	P_1	26·4
27	P_2	3·6
32	P_1	19·7
41	$P_1.VI_E$	15·6
56	$P_1.V_E$	237 39·7
5 10	$P_1.V_6$	27·3
20	P_1	19·7
25	P_2	236 59·6
28	P_1	237 14·9
32	P_2	236 55·6

Mark: 35° 53·2′

C. HORIZONTAL INTENSITY.

As already mentioned in the introduction, the magnetic apparatus E. A. Zschau No. 289 was arranged for the taking of both deflection observations at two different distances, and observations of the deflectors' time of vibration, whereby the absolute value of the horizontal intensity may be determined when the constants of the instrument are known.

If the following signs are employed:

H = absolute horizontal intensity

φ = angle of deflection

e = distance of the deflector

k = a constant depending upon the distribution of magnetism in the deflecting and deflected magnets

k' = induction coefficient

K = moment of inertia of the magnet

T = time of vibration, corrected for rate of chronometer, arc of vibration and torsion force of the suspending thread.

α = temperature coefficient

β = coefficient of dilatation for brass (0·000180)

β' = coefficient of dilatation for steel (0·000124)

t = temperature of magnet during the vibrations

t' = temperature of magnet during the deflections,

we have

$$H = \frac{C}{T\sqrt{\sin\varphi}}\left[1 + \beta' t - \tfrac{3}{4}\beta t' + \alpha\,(t - t')\right], \qquad (1)$$

where C is a constant quantity of the following form:

$$C = \pi \sqrt{\frac{2Kk}{e^3}} \left[1 - \tfrac{3}{7} k' (1 + \tfrac{4}{3} \sin \varphi) H\right]. \qquad (2)$$

As already mentioned, there are two magnets belonging to the apparatus, designated *V* and *VI*, respectively 99·0 mm. and 98·0 mm. in length.

The temperature coefficient α was determined for both of them in Hamburg on June 8th, 1893, by a long series of observations, after they had been placed, on June 3rd and 4th, in steam of 100° C., and kept there for 12 consecutive hours, in order to ensure them against loss of permanent magnetism afterwards.

The following values were found:

	α
For magnet *V*	0·000307
„ — *VI* . . .	0·000638 (?).

The moment of inertia of the magnets, *K*, was also determined on June 9th, 1893, from several series of vibration observations, alternately with and without the addition to the magnet of a ring of known weight and dimensions, with the following result, which, however, does not lay claim to any great accuracy:

	K
For magnet *V*	99·47
„ — *VI*	200·22

The induction coefficient cannot be directly determined with this instrument.

The total constant, *C*, in which both the moment of inertia and the induction coefficient are included, may, however, be inferred by means of equation (1), if combined vibration and deflection observations are taken with the instrument, in a place where the horizontal intensity is known, as the following equation is then obtained:

$$\log C = \log H + \log T + \tfrac{1}{2} \log \sin \varphi - \log [1 + \beta' t - \tfrac{3}{4} \beta t' + \alpha (t - t')] \qquad (3)$$

The observations for the calculation of the constant C were made in Hamburg before the departure of the expedition, and in Wilhelmshaven after its return.

As it was to be expected that there might often be occasions during the Fram Expedition, when there was no opportunity of observing simultaneous vibrations and deflections, Dr. NEUMAYER also considered it necessary to introduce a new constant, μ, which is proportional to the magnetic moment of the magnet in question, and by the aid of which the absolute horizontal intensity may be deduced from deflection observations alone, or from vibration observations alone, according to the following formulæ:

From deflection observations,

$$H = \frac{C\mu}{\sin\varphi}\left[1 - (3\beta + \alpha)\,t'\right] \tag{4}$$

From vibration observations,

$$H = \frac{C}{T^2\mu}\left[1 + (2\beta' + \alpha)\,t\right]. \tag{5}$$

The constant μ, of which the form is

$$\mu = \frac{\sqrt{\sin\varphi}}{T}\left[1 + \beta' t + \tfrac{3}{2}\beta t' + \alpha\left(\frac{t + t'}{2}\right)\right], \tag{6}$$

may of course be calculated, like the constant C, from the observations taken in Hamburg and Wilhelmshaven.

THE MAKING OF THE OBSERVATIONS.

OBSERVATIONS OF DEFLECTION.

The brass rod intended for the deflection-observations, was divided into two parts to facilitate transport, one half being affixed to each side of the alhidade of the horizontal circle. On each half of the rod, at definite distances from the centre of the horizontal circle, are placed two low uprights, between which a carriage may be inserted for the support of one of the magnets *V* and *VI* as deflector. The carriage may be screwed to the rod. Above the deflector is placed a box in which there is a thermometer. The arrangement of the rod only permits of deflections with the deflector placed E and W, not N and S.

Not only was the small needle used as deflected magnet, being specially intended for this, but also the double needle, when, as frequently happened, the mirror of the small needle gave a rather indistinct reflection.

The two distances at which the deflectors can be placed, are, as previously stated,

$$e = 29{\cdot}840 \text{ cm.}$$
$$E = 39{\cdot}638 \quad "$$

so that the proportion between e and E is as 1 : 1·33. By experiments in Hamburg during the construction of the instrument, the distances were chosen with a view to giving the deflection angles in the polar regions, where the horizontal intensity is very small, a suitable, not too great, value. According to the formula

$$\sin \varphi = \frac{H_0 \sin \varphi_0}{H},$$

where H_0 indicates the horizontal intensity in Hamburg, and φ_0 the angle of deflection found during the experiments there with the apparatus, Dr. Neumayer calculated the angle of deflection for Kristiania, Tromsö, and the polar regions, assuming for these localities a horizontal intensity of respectively 0·1616, 0·1228, and 0·0500 (C. G. S.), with the following result:

Place	H	φ			
		Magn. V		Magn. VI	
		e	E	e	E
		°	°	°	°
Hamburg. . . .	0·1800	10·3	4·3	16·75	7·0
Kristiania . . .	0·1616	11·4	4·35	18·7	7·8
Tromsö	0·1228	15·2	6·6	25·0	10·3
Polar Regions. .	0·0500	40·0	15·9	—	26·1

After this, it would always be possible in the regions which the Fram might traverse, to obtain efficient deflection-observations with magnet V at both distances, while magnet VI would in most cases probably only be capable of being employed at the greater distance E. It is also probable that it would be more advantageous on the whole for magnet V to use the greater distance. These hints were followed. During the expedition, there were, on the whole, 163 angles of deflection determined, 132 of them being with magnet V, and 31 with magnet VI. In the 132 cases in which magnet V has been used, φ was determined 79 times with the deflector at the distance E, and 53 times with the deflector at the distance e, both distances being of course employed simultaneously when opportunity offered. Out of the 31 determinations of the angle of deflection with magnet VI, the short distance e has been used in only 4 cases.

The deflection-observations were made in the usual manner, the deflector being placed successively in the well-known 4 positions. In each of these, the telescope was pointed towards the mirror of the deflected needle, whereupon the two verniers of the horizontal circle were read off, and also a reading was taken each time of the thermometer placed above the deflector.

If we call the two circle-readings (mean of the two verniers) with the N-end of the declination-needle deflected in an easterly direction, u_1 and u_2, and the readings with the N-end deflected in a westerly direction, u_3 and u_4, we obtain

$$\varphi = \varphi' + \delta ,$$

where

$$\varphi' = \tfrac{1}{2}\left[\frac{u_1 + u_2}{2} - \frac{u_3 + u_4}{2}\right],$$

while δ is the correction for angular inequality expressed in minutes.

If we put $u_1 - u_2 = \varDelta_1$, and $u_3 - u_4 = \varDelta_2$, and express $\varDelta_1$ and $\varDelta_2$ in degrees, then [1]

$$\delta = - A\,[\varDelta_1^2 + \varDelta_2^2] .$$

As we know, the factor A has the following form:

$$A = 0{\cdot}5236\ [\tfrac{1}{8} \tan \varphi + \tfrac{1}{6} \cot \varphi],$$

and according to this formula, I have drawn up a table for A for each single degree from $\varphi = 3°$ to $\varphi = 70°$, in order to simplify the calculation of δ.

The hour was unfortunately not noted for the separate settings of the needle during the actual deflections, but was noted at the setting of the free declination-needle before and after the deflections, and I have therefore tried by interpolation to fix the hour corresponding to the angle of deflection found. This interpolated hour is also assumed to be applicable to the reading of the needle's position in the magnetic meridian, calculated by the deflection-readings, this calculated reading being entered, as mentioned on page 17, in the series of directly observed declination-readings.

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[1] LAMONT. Handbuch des Erdmagnetismus, p. 31.

OBSERVATIONS OF VIBRATION.

The vibration-box belonging to the apparatus is furnished with suspension-tube and cocoon-thread, by which each of the two magnets, *V* and *VI*, may be suspended. The magnets have pointed ends, and the vibrations are observed with the naked eye. For the reading of the amplitudes, two different scales are placed at the bottom of the box, one a circle division, by the aid of which degrees and fractions of degrees may be read off directly, and the other a linear scale, of which the advantage is that the division-marks are farther apart. On this account, the latter scale was constantly employed. By a series of measurements taken in Hamburg, June 6th, 1893, one scale-division was found to equal 1·91 mm., and as the length of the magnets *V* and *VI* is respectively 99·0 mm. and 98·0 mm., the arc-value of one division on the linear scale is respectively 2·21° and 2·23°, mean 2·22°.

The way in which the vibration observations were made was that the time was noted to tenths of a second every third time the point of the magnet passed the middle division of the scale (zero) from the 1st passage to the 31st inclusive, and subsequently from the 101st to the 131st inclusive. Immediately before and after each series of vibrations, the magnitude of the amplitude to each side was read off on the scale to tenths of a division, with the hour belonging to it; while at the same time the temperature was read off on the thermometer placed with its bulb in the vibration-box. If the time of vibration directly deduced from each series of vibrations is called T', we obtain the actual time of vibration, T, from the formula

$$\log T = \log T' - \log \gamma \pm \log \varrho \,,$$

where γ is the correction for arc of vibration, and ϱ is the correction for rate of chronometer, the sign $+$ being used when the chronometer loses, the sign $-$ when it gains.

I have calculated γ by the formula

$$\gamma = 1 + \tfrac{1}{16}\left[2{\cdot}22^\circ\left(\frac{h_0 + h_1}{2}\right)\right]^2 \sin^2 1^\circ \,,$$

where h_0 and h_1 indicate the amplitude of the needle from the middle division in scale divisions, respectively for the beginning of the vibration observations, and after their termination. By the aid of this formula, I have drawn up a table of log γ with $\frac{h_0 + h_1}{2}$ expressed in scale divisions as argument. The table contains the value of log γ to 5 places of decimals, for every tenth of $\frac{h_0 + h_1}{2}$.

The correction for rate of chronometer is calculated according to the usual formula:

$$\varrho = 1 + \frac{s}{86400},$$

where s is the number of seconds gained or lost by the chronometer in 24 hours. Log ϱ has been placed in a table with s as argument.

The chronometer used as observation-chronometer on the 1st August, 1893, was the Kutter; afterwards, until the end of 1894, the Haagensen watch was used, being compared before and after the series of observations with the Hohwü chronometer. It lost daily between 9 and 15 seconds. In 1895 and 1896, the Frodsham chronometer was constantly used, being regulated according to sidereal time. Its daily acceleration in relation to mean solar time, which varied between 231·7 and 228·8 seconds, and its error on local time for the observation-days in question, have been given me by Professor GEELMUYDEN.

As the time for the value of the horizontal intensity corresponding to each separate calculated time of vibration, I have taken the mean of the hour noted at the needle's first and last passage over the middle division of the scale, reduced to local time.

I have been unable to introduce any correction for the torsion force of the suspending thread, as no observations for its determination were made.

After three series of vibration-observations with magnet *VI* on August 1st, 1893, at Khabarova, none were made until August 18th, 1894, when magnet *V* was used. After this the vibration time was determined regularly, most frequently for magnet *V*, now and then for magnet *VI*. There are altogether 82 series of vibrations for magnet *V*, and 19 for magnet *VI*. A few of the series, however, were made during such great disturbance, that the value of the time of vibration found must be considered very uncertain.

DETERMINATION OF THE CONSTANTS.

DIRECT DETERMINATIONS.

The constants employed in the calculation of the horizontal intensity, according to the formulæ given on page 64, are the temperature coefficient α, and the quantities C and μ.

These constants, as already mentioned, were determined by observations in Hamburg, between the 3rd and the 9th June, 1893, with the following results, given in Dr. NEUMAYER'S manuscript:

Magn.	Hamburg 1893	μ		C		α
		e	E	e	E	
L.V	June 5	0·11769	0·076812	0·27245	0·17735	0·000307
	— 6	0·11799	0·076668			
	— 9	0·11831	0·076921			
	Mean	0·11799	0·076800			
L.VI	June 5	0·14628	0·095074	0·34069	0·22169	0·000638 (?)
	— 6	0·14616	0·095178			
	— 9	0·14658	0·095456			
	Mean	0·14634	0·095234			

In order in the first place to get an idea as to how the constants C and μ had remained during the expedition, I first deduced their value from the complete series of observations taken after the return in Wilhelmshaven, in April, 1897, employing the value of the temperature coefficient α, found in Hamburg in 1893, as no later direct determination of it has been made.

The calculations gave the following result:

Magn.	Wilhelms-haven 1897	μ		C	
		e	E	e	E
L.V	April 18	0·11761	0·076503	0·27148	0·17658
	— 19	0·11753	0·076366	0·27157	0·17644
	Mean	0·11757	0·076435	0·27153	0·17651
L.VI	April 18	0·14227	0·092520	0·34006	0·22116
	— 19	0·14218	0·092520	0·34020	0·22139
	Mean	0·14223	0·092520	0·34013	0·22128

All these determinations of μ and C refer to cases in which the small needle has been used as deflected magnet, and may therefore be directly compared.

It will be seen from the two tables that in the case of magnet *V*, the values found for μ, which is proportional to the magnetic moment of the deflector, exhibit such slight differences, that the moment of this magnet may be assumed to have remained unchanged throughout the expedition. On the other hand, it appears as if the moment of magnet *VI* has undergone a weakening, which cannot be left altogether out of consideration. On September 30th, 1893, Capt. SCOTT-HANSEN makes the following remark in his magnetic journal: "Inadvertently allowed a steel knife to come near magnet *VI*". This may perhaps explain the above-mentioned weakening of the moment of the magnet, and in the absence of other particulars, there may be reason to suppose that as regards magnet *VI* also, μ has remained constant in each of the two periods marked by the above-mentioned contact, and that thus the value found in Hamburg in 1893 may be considered as applicable for the time before the 30th September, 1893, and the value found in Wilhelmshaven in 1897, for the time after the 30th September, 1893.

As both μ and C, as formulæ (6) and (2) show, are determined separately by a combination of the time of vibration and the angle of deflection, and the double needle was also used during the expedition as deflected magnet for the determination of the angle of deflection, the value of the two constants in question must be known in this case also. With this object, a series of deflection observations were taken in Wilhelmshaven, with the double needle both in position P_1 and in position P_2 as deflected magnet. If μ and C are calculated by these observations combined with the corresponding determinations of the magnets' time of vibration, the following values are obtained:

Magn.	Wilhelmshaven 1897	μ		C	
		e	*E*	*e*	*E*
$P_1.V$	April 17	0·11617	0·076082	0·26805	0·17554
$P_2.V$	— 18	0·11618	0·075932	0·26804	0·17518
Mean		0·11618	0·076007	0·26805	0·17536
$P_1.VI$	April 17	0·14052	0·091922	0·33552	0·21961
$P_2.VI$	— 18	0·14060	0·091916	0·33590	0·21959
Mean		0·14056	0·091919	0·33571	0·21960

This table shows that the values found for μ and C agree so well for the two positions of the double needle, P_1 and P_2, that it may be considered immaterial in which position the double needle is used as deflected magnet.

As mentioned in the introduction, determinations of constants were also attempted after the return, in Hamburg, in March, 1897; but as there are no simultaneous observations of absolute determinations, with any other instrument, of the value of the horizontal intensity, I have only been able to calculate μ, with the following result:

Magn.	Hamburg 1897	μ	
		e	E
P.V	March 2	0·11573	0·075845
P.VI	— 3	0·14007	0·091998
L.V	— 7	0·11753	0·076812

On the 7th March, only a series of deflections were taken, with deflector *V* and the small needle, and no vibration observations. I have therefore employed for the calculation of μ the time of vibration of magnet *V*, found on the 2nd March. In spite of the unfortunate circumstances under which these observations were made, the results, as it will be seen, agree fairly well with the values subsequently found in Wilhelmshaven.

EMPLOYMENT OF THE OBSERVATIONS FOR THE VERIFICATION OF THE CONSTANTS.

Although, as will be understood from the above, it may with tolerable certainty be taken for granted that the constants μ and C, at any rate as far as magnet *V* is concerned, have remained unchanged throughout the expedition, I have considered it worth while to attempt, as far as possible, to make use of the observations made during the expedition itself as a further check, the more so as it will also afford an opportunity for a more careful study of the temperature-coefficient α, whose determination in Hamburg, in 1893, was the result of observations made within comparatively narrow temperature limits. It is also expressly stated in Dr. Neumayer's manuscript, that there is reason to suppose that the temperature-coefficient has a different value in extreme temperatures such as those in which it is often necessary to take observations in the polar regions. He therefore recommends the making, if possible, of a direct determination of this coefficient upon the field of observation itself. There was no opportunity, however, of making such delicate investigations in the difficult natural conditions with which the expedition had to contend; and it is thus only a question of deducing indirectly from the series of observations a reasonable value for α, and this only for magnet V, which was the one most frequently employed.

With this object in view, I first took all the cases in which both the vibrations and the deflections had been observed with magnet V on the same day, and the double needle had been employed as deflected magnet. Assuming for the time being that the horizontal intensity on the above-mentioned days had been the same during both the deflections and the vibrations, I was able, for the determination of α, to draw up by formula (6), 39 equations in the form

$$\frac{t+t'}{2} \cdot \alpha = \frac{T}{\sqrt{\sin \varphi}} \cdot \mu - \left[1 + \beta' t - \tfrac{3}{2} \beta t'\right],$$

which fall into two groups, 15 with the deflector at the distance e, and 24 with the deflector at the distance E. As the constant value of μ, I employed the mean of the values found in Hamburg and Wilhelmshaven, in 1897. The mean value of α from the first group of equations was

$$\alpha = 0{\cdot}000431,$$

from the second

$$\alpha = 0{\cdot}000567,$$

and from the entire 39

$$\alpha = 0{\cdot}000514.$$

With this value for α, and the mean values for μ and C, found by the determinations in Hamburg and Wilhelmshaven in 1897, a temporary value for H was calculated by formulæ (4) and (5) (page 64) separately by vibrations and deflections in the above-mentioned 39 cases. It then appeared that in only 7 of these cases did the values for the horizontal intensity deduced from the vibration and deflection observations made on the same day, agree so far that there could be any question of using the observations for determinations of constants. These 7 days were:

in 1894, December 7th,
„ 1895, May 24th,

in 1895, October 17th,
December 12th,
„ 1896, January 28th,
March 19th,
June 18th.

If to these are added the observation-days after the return of the expedition — March 2nd, 1897, in Hamburg, and April 17th and 19th, 1897, in Wilhelmshaven — we have 10, what I will call normal, days on which determinations of the horizontal intensity have been made with the apparatus mounted in the same way, under comparatively quiet magnetic conditions, in temperatures varying from — 28° C. on the 28th January, 1896, to + 11°.6 C. on the 17th April, 1897.

THE FINAL VALUES OF THE TEMPERATURE-COEFFICIENT.

In order to study the temperature-coefficient more carefully, I calculated μ from the observations on the 10 normal days, by formula (6), both with the value $\alpha = 0{\cdot}000307$ (Hbg.) found in Hamburg in 1893, and with the mean value, $\alpha = 0{\cdot}000514$ (Ex), found in the above-described manner by the observations during the expedition. The result was as follows:

Date	μ					
	$P.V_e$			$P.V_E$		
	$\frac{t+t'}{2}$	$\alpha = 0{\cdot}000307$ (Hbg.)	$\alpha = 0{\cdot}000514$ (Ex.)	$\frac{t+t'}{2}$	$\alpha = 0{\cdot}000307$ (Hbg.)	$\alpha = 0{\cdot}000514$ (Ex.)
1894. Dec. 7				−27·4	0·076470	0·076033
1895. May 24				− 7·2	0·076045	0·075932
Oct. 10	−15·7	0·11637	0·11599	−15·7	0·076140	0·075892
Dec. 12				−22·6	0·076347	0·075987
1896. Jan. 28				−28·0	0·076463	0·076017
March 19	−13·8	0·11637	0·11604	−13·8	0·076170	0·075952
June 18	3·4	0·11587	0·11596			
1897. March 2	6·5	0·11573	0·11588	6·4	0·075843	0·075945
April 17	11·5	0·11617	0·11645	11·6	0·076082	0·076264
— 18	10·6	0·11618	0·11644	10·5	0·075932	0·076098

If the 4 series of values of μ in the table are plotted graphically as a function of $\frac{t+t'}{2}$, 4 fairly uniform curves are produced, which distinctly show that α cannot be constant, but, as we have already supposed, must depend upon the temperature. If we call this τ, we may put

$$\alpha = \alpha_1 + \alpha_2 \tau,$$

and equation (6) becomes

$$\mu = \frac{\sqrt{\sin \varphi}}{T} \left[1 + \beta' t - \tfrac{3}{2} \beta t' + \alpha_1 \frac{t + t'}{2} + \alpha_2 \left(\frac{t + t'}{2} \right)^2 \right], \qquad (7)$$

if t and t' have anything like the same value. This equation affords an opportunity for the determination of α_1 and α_2 by the method of least squares, as we obtain a series of equations in the form

$$\alpha_1 + A\alpha_2 = \frac{B}{A},$$

where

$$A = \frac{t + t'}{2}, \text{ and } B = \frac{T\mu}{\sqrt{\sin \varphi}} - \left[1 + \beta' t - \tfrac{3}{2} \beta t' \right].$$

After a careful study of the forthcoming observation-data, which determined me in excluding two of the above-mentioned normal days, namely June 18th, 1896, and March 2nd, 1897 (Hamburg) — it being likely that the observations on these days were more affected by disturbing forces than on the other normal days — I finally retained 12 corresponding values of A and B, employing the mean value of the constant μ used in the provisional calculation of α. By the aid of these 12 values of A and B, I have been able to draw up the following normal equations:

$$12\,\alpha_1 - 99{\cdot}9\,\alpha_2 = 0{\cdot}0043426$$
$$-\,99{\cdot}9\,\alpha_1 + 3462{\cdot}95\,\alpha_2 = -\,0{\cdot}045605,$$

which give

$$\alpha_1 = 0{\cdot}00033198$$
$$\alpha_2 = -\,0{\cdot}00000359,$$

and thus $\alpha = 0{\cdot}00033198 - 0{\cdot}00000359\,\tau$.

By this formula, which I consider to be the final one, I have calculated a table for α, for magnet *V*, with the temperature as argument, for every degree from $-40°$ to $+20°$ C.

I have been compelled to abandon a similar examination of the temperature-coefficient for magnet *VI*, that magnet having, as previously stated, been comparatively so seldom used, that the observations that we have do not give sufficiently serviceable material for investigation. For the cases in which magnet *VI* has been used, therefore, I have simply had to take the value found in Hamburg in 1893 for the temperature-coefficient:

$$\alpha = 0{\cdot}000638 \, .$$

THE FINAL VALUES OF THE CONSTANTS μ AND C.

The assumption that the magnetic moment of magnet *V*, and thus the factor μ also, have remained constant throughout the expedition, is made, as already mentioned, the basis of the final calculation of the temperature-coefficient of the magnet. As a check on the correctness of this assumption, I have again calculated μ with the final value of α for each of the 8 certain normal days with the following result:

Date	μ	
	$P.V_e$	$P.V_E$
1894. Dec. 7		0.076127
1895. May 24		0·075995
Oct. 17	0·11615	0·075996
Dec. 12		0·076094
1896. Jan. 28		0·076105
March 19	0·11619	0·076048
1897. April 17	0·11620	0·076100
— 18	0·11622	0·075952
Mean	0·11619	0·076052

The values found agree, as the table shows, very well with one another, and I have therefore assumed the mean of all the determinations as the final value of μ for the respective distances e and E.

No observations permitting of the determination of μ were made with the small declination-needle as deflected magnet during the expedition. For this mounting of the apparatus, I have therefore kept to the determinations in Hamburg in 1893, and in Wilhelmshaven in 1897. I have recalculated the latter, introducing the improved ultimate value of α and obtained:

		μ	
		e	E
1897. April 18	. . . .	0·11764	0·076523
„ 19	. . . .	0·11756	0·076385
	Mean	0·11760	0·076454
According to the table given on page 69, the mean found in Hamburg in 1893, is	. . .	0·11799	0·076800
	Mean	0·11780	0·076627

As regards the values of μ for magnet *VI,* I will refer the reader to what is said on this subject on page 70, merely adding that this magnet was not used for deflections with the double needle as deflected magnet before September 30th, 1893, and therefore the values of μ found for this mounting of the apparatus in Wilhelmshaven in 1897, have been exclusively used.

It was not possible to check the constant C during the expedition, a knowledge of the horizontal intensity determined by the aid of another instrument being required for such a check. I have therefore taken the mean of the values found in Hamburg in 1893 and in Wilhelmshaven in 1897, in the cases in which the small declination-needle has been used as deflected magnet, while we have only the determinations in Wilhelmshaven in 1897, in the cases in which the double needle has been used as deflected magnet.

The following table gives a summary of the final values of the constants μ and C, used in every case for the reduction of the observations:

Magn.	Period	μ		C	
		e	E	e	E
L.V	1893–1896	0·11780	0·076627	0·27199	0·17693
P.V	1893–1896	0·11619	0·076052	0·26805	0·17536
L.VI	before Sept. 30, 1893 after Sept. 30, 1893	0·14634 0·14224	0·095234 0·092220	0·34041 0·34041	0·22148 0·22148
P.VI	before Sept. 30, 1893 after Sept. 30, 1893	0·14056	0·091919	0·33571	0·21960

When the expressions for direct employment in the formulæ, log $C\mu$ and log $\frac{C}{\mu}$, are calculated by the values in the above table, it will be found that

$\log \frac{C}{\mu}$ has not exactly the same value when calculated by C and μ for distance e, as for distance E. The differences are, however, very small. Calling $\frac{C}{\mu}$, calculated for distance e, η_e, and for distance E, η_E, I have put:

$$\frac{C}{\mu} = \frac{\eta_e + \eta_E}{2}$$

With this mean value, and the values of μ found in the above table, I have then calculated $\log C\mu$ according to the formula

$$\log C\mu = \log \frac{\eta_e + \eta_E}{2} + 2 \log \mu .$$

THE OBSERVATIONS AND THEIR REDUCTION.

The following tables give, in chronological order, all the series of deflection and vibration observations made during the expedition, and the calculation, according to the formulæ on page 64, of the absolute value of the horizontal intensity from each separate series.

OBSERVATIONS OF DEFLECTION.

Under the date of each observation, the latitude and longitude of the place is given, the designation of the magnets used, and an indication of the distance e or E, at which the deflector was placed. These are followed by the readings on the horizontal circle, corresponding to the 4 positions of the deflector, each value of u_1, u_2, u_3 and u_4 being the mean of the readings on the two verniers. In several cases, 2, 3, or even 4 and 5 settings have been made, and readings taken, with the position of the deflector unaltered. A statement of this is made every time in the notes below the table. The small letters, a, b, c, d, placed before each value of u indicate the order in which the settings were made.

OBSERVATIONS OF DEFLECTION.

Date	1893. August 1.		1893. Aug. 8.	1893. October 10.			1893. Oct. 14.	1893. October 20.	
Lat. N. Long. E.	69° 41′ 60° 20′	Khabarova	69° 54′ 66° 43′	78° 19′ 136° 2′			78° 15′ 136° 1′	78° 19′ 136° 5′	
Deflected needle	*L*		*L*	P_1 [2]			P_2	*L*	
Deflector	VI_e	VI_E	VI_e	V_E	V_e	VI_E	V_e	V_e	V_E
u_1	a 163° 57·65′	a 148° 11·8′	c 243° 17·1′	a 280° 34·75′	c 304° 18·4′	d 289° 14·5′	a 357° 12·85′	c 95° 54·0′	c 71° 1·25′
u_2	d 163 3·9	b 148 22·7	d 244 10·45	b 280 49·85	d 303 0·0	c 289 0·65	b 357 31·5	d 94 47·1	d 70 52·5
u_3	b 112 0·5	c 127 0·45	b 191 8·75	c 250 5·15	a 227 11·8	a 240 37·45	c 279 21·5	a 13 42·8	a 38 54·85
u_4	c 111 38·8	d 127 4·35	a 190 48·25	d 250 2·25	b 226 44·85	b 240 23·6	d 279 31·75	b 13 31·0	b 38 58·95
Mean	137° 40·2′	137° 39·8′	217° 21·1′	265° 23·0′	265° 18·8′	264° 49·0′	318° 24·4′	54° 28·7′	54° 56·9′
φ'	25° 50·56′	10° 37·42′	26° 22·64′	15° 19·3′	38° 20·44′	24° 18·53′	38° 57·78′	40° 51·82′	16° 0·0′
δ	— 0·20	— 0·02	— 0·18	0·0	— 0·31	— 0·02	— 0·02	— 0·18	0·0
φ	25° 50·4′	10° 37·4′	26° 22·5′	15° 19·3′	38° 20·1′	24° 18·5′	38° 57·8′	40° 51·6′	16° 0·0′
t'	5·3°	5·3°	4·5°	−13·0°	−13·6°	−14·7°	−19·4°	−18·3°	−15·2°
cpl. log sin φ	0·36066	0·73435	0·35238	0·57800	0·20742	0·38548	0·02147	0·18428	0·55966
$\log[1-(3\beta+\alpha)t']$	9·99840	9·99840	9·99865	0·00244	0·00257	0·00439	0·00383	0·00358	0·00290
log C_μ	8·69731	8·32417	8·69731	8·12515	8·49327	8·30497	8·49327	8·50571	8·13217
log *H*	9·05637	9·05692	9·04834	8·70559	8·70326	8·69484	8·69857	8·69357	8·69473
Local time	$4^h 15^m$ p. m.	$4^h 35^m$ p. m.	$8^h 19^m$ p. m.	$12^h 21^m$ p. m.	$1^h 9^m$ p. m.	$2^h 3^m$ p. m.	$12^h 59^m$ p. m.	$12^h 29^m$ p. m.	$3^h 21^m$ p. m.
H	0·11386 [1]	0·11401 [1]	0·11177	0·05076	0·05050	0·04953	0·04995 [3]	0·04938 [3]	0·04951 [3]

[1]) After the deflection observations, it was discovered that an iron foot to which the thermometer was fixed had been placed between the legs of the stand. The position of the needle did not change, however, whether the thermometer-stand was taken away or left in its place. It was of course not used again. [2]) As it was difficult, on account of the light, to set the small declination needle, the double needle was used. [3]) See the notes to the declination observations of this date on page 21.

Date	1893. November 3.		1893. November 9.		1893. Nov. 18.	1893. November 25.		1894. Feb. 17.
Lat. N. Long. E.	78° 1′ 134° 57′		77° 54′ 137° 52′		78° 25′ 139° 16′	78° 37′ 139° 4′		80° 2′ 133° 49′
Deflected needle	L		P_2		L	L		P_2
Deflector	V_e	V_E	V_E	V_e	V_e	V_e	V_E	V_e
u_1	a 241° 30·05′	d 217° 50·5′	a 285° 35·5′	d 308° 19·0′	c 41° 51·15′	b 99° 46·5′	c 75° 27·7′	b 93° 58·55′
u_2	b 242 35·25	c 216 50·5	b 285 21·25	c 307 23·0	d 40 49·4	a 99 37·95	d 75 19·85	a 93 14·15
u_3	c 162 4·5	a 186 44·15	c 255 20·35	a 232 35·5	a 320 45·65	c 19 50·75	a 43 30·9	c 356 55·15
u_4	d 161 54·55	b 186 27·25	d 255 15·75	b 232 35·5	b 320 35·2	d 18 19·0	b 43 17·2	d 356 44·05
Mean	202° 1·1′	201° 58·1′	270° 23·2′	270° 13·3′	1° 0·4′	59° 23·6′	59° 23·9′	45° 13·0′
φ' δ	40° 1·56′ −0·19	15° 22·4′ −0·4	15° 5·16′ −0·02	37° 37·75′ −0·14	40° 19·93′ −0·17	40° 18·67′ −0·37	15° 59·86′ −0·02	48° 23·38′ −0·09
φ	40° 1·4′	15° 22·0′	15° 5·1′	37° 37·6′	40° 19·8′	40° 18·3′	15° 59·8′	48° 23·3′
t'	−33·3°	−33·1°	−20·9°	−21·0°	−29·3°	−26·1°	−26·5°	−42·6°
cpl. log sin φ log $[1-(3\beta+\alpha)t']$ log C_μ	0·19172 0·00726 8·50571	0·57676 0·00720 8·13217	0·58460 0·00416 8·12515	0·21430 0·00418 8·49327	0·18897 0·00621 8·50571	0·18919 0·00540 8·50571	0·55975 0·00550 8·13217	0·12630 0·00986 8·49327
log H	8·70469	8·71613	8·71391	8·71175	8·70089	8·70030	8·69742	8·62943
Local time	$12^h\ 9^m$ p. m.	$12^h\ 43^m$ p. m.	$12^h\ 14^m$ p. m.	$12^h\ 58^m$ p. m.	$12^h\ 56^m$ p. m.	$11^h\ 35^m$ a. m.	$12^h\ 9^m$ p. m.	$1^h\ 15^m$ p. m.
H	0·05066	0·05202	0·05175	0·05149	0·05022	0·05015	0·04982	0·04260

Date	1894. February 22.		1894. February 27.			1894. March 21.		1894. April 14.	
Lat. N.	80° 10′		80° 4′			79° 49′		80° 12′	
Long. E.	133° 49′		135° 27′			134° 58′		133° 43′	
Deflected needle	L		P_1			P_1		P_1	
Deflector	V_e	V_E	VI_E	V_E	V_e	V_e	V_E	VI_E	V_E
u_1	c 100° 42·55′	b 70° 4·35′	b 205° 59·25′	c 194° 12·5′	b 225° 0·5′	a 350° 21·25′	c 321° 23·0′	c 71° 21·25′	a 60° 48·7′
u_2	d 98 25·85	a 70 0·45	a 204 57·75	d 194 4·25	a 222 44·75	b 348 56·25	d 321 11·5	d 70 44·25	b 61 6·0
u_3	b 2 14·9	d 32 45·45	d 146 22·0	a 157 13·5	c 127 55·5	c 259 5·5	a 286 32·75	a 13 32·6	c 24 8·5
u_4	a 1 57·8	c 32 43·35	c 146 2·0	b 157 12·1	d 126 52·75	d 259 11·25	b 286 29·75	b 13 12·25	d 24 6·25
Mean	50° 50·3′	51° 23·4′	175° 50·25′	175° 40·6′	175° 38·4′	304° 23·56′	303° 54·25′	42° 11·6′	42° 32·4′
φ'	48° 43·92′	18° 39·0′	29° 38·25′	18° 27·79′	48° 14·25′	45° 15·19′	17° 23·0′	28° 51·16′	18° 25·0′
δ	−0·80	0·0	−0·22	0·0	−0·94	−0·31	0·0	−0·10	0·0
φ	48° 43·1′	18° 39·0′	29° 38·0′	18° 27·8′	48° 13·3′	45° 14·9′	17° 23·0′	28° 51·1′	18° 25·0′
t'	−17·9°	−17·9°	−13·5°	−13·7°	−13·9°	−31·8°	−32·0°	−17·0	−17·0°
cpl. log sin φ	0·12409	0·49514	0·30588	0·49735	0·12742	0·14864	0·52467	0·31647	0·50042
log [1−(3β+α)t′]	0·00349	0·00349	0·00403	0·00258	0·00263	0·00685	0·00690	0·00499	0·00329
log $C\mu$	8·50571	8·13217	8·30497	8·12515	8·49327	8·49327	8·12515	8·30497	8·12515
log H	8·63329	8·63080	8·61488	8·62508	8·62332	8·64876	8·65672	8·62643	8·62886
Local time	$12^h\ 37^m$ p. m.	$1^h\ 7^m$ p. m.	$12^h\ 54^m$ p. m.	$1^h\ 32^m$ p. m.	$2^h\ 9^m$ p. m.	$4^h\ 19^m$ p. m.	$5^h\ 20^m$ p. m.	$5^h\ 11^m$ p. m.	$5^h\ 45^m$ p. m.
H	0·04298	0·04274	0·04120 [1])	0·04218 [1])	0·04201 [1])	0·04454 [1])	0·04536 [1])	0·04231 [1])	0·04255 [1])

[1]) See the notes to the declination observations of this date.

Date	1894. April 27.			1894. May 5.		1894. May 10.		1894. May 22.		
Lat. N.	80° 36′		80° 36′	80° 49′		80° 54′		81° 24′		
Long. E.	131° 39′		131° 42′	130° 35′		130° 5′		124° 38′		
Deflected needle		P_2		L		L			L	
Deflector	VI_E	V_E	V_e	V_e	V_E	V_E	V_e	VI_E	V_E	V_e
u_1	a 80° 25·75′	c 68° 51·65′	a 100° 46·5′	c 102° 6·82′	a 69° 45·72′	a 69° 33·45′	c 104° 38·68′	a 95° 6·0′	c 83° 22·81′ [2]	a 118° 12·25′
u_2	b 80 42·0	d 69 9·25	b 102 47·05	d 100 1·3	b 70 1·0	b 69 44·5	d 102 35·82	b 95 17·25	d 83 19·05 [2]	b 119 11·33
u_3	c 19 35·9	a 29 40·88	c 357 3·2	a 0 1·18	c 32 1·82	c 29 33·85	a 355 7·6	c 30 58·5	a 42 6·63	c 5 54·62
u_4	d 19 14·9	b 29 50·82	d 356 31·9	b 0 12·58	d 32 1·18	d 29 10·7	b 354 53·75	d 31 24·2	b 42 35·25	d 7 25·63
Mean	49° 59·6′	49° 23·2′	49° 17·2′	50° 35·5′	50° 57·4′	49° 30·6′	49° 19·0′	63° 11·5′	62° 50·9′	62° 41·0′
φ'	30° 35·24′	19° 37·3′	52° 29·61′	50° 28·59′	18° 55·93′	20° 8·35′	54° 18·29′	32° 0·15′	20° 30·00′	56° 0·83′
δ	−0·04	0·0	−0·66	−0·65	−0·02	−0·05	−0·65	−0·04	−0·06	−0·51
φ	30° 34·2′	19° 37·3′	52° 29·0′	50° 27·9′	18° 55·9′	20° 8·3′	54° 17·6′	32° 0·1′	20° 29·9′	56° 0·3′
t'	−14·5°	−13·9°	−13·7°	−5·0°	−5·5°	−9·5°	−8·5°	−1·6°	−1·9°	−1·4°
cpl. log sin φ	0·29363	0·47391	0·10063	0·11281	0·48887	0·46308	0·09044	0·27577	0·45570	0·08140
log $[1-(3\beta+\alpha)t']$	0·00433	0·00263	0·00258	0·00088	0·00097	0·00173	0·00153	0·00048	0·00032	0·00024
log C_μ	8·30497	8·12515	8·49327	8·50571	8·13217	8·13217	8·50571	8·31151	8·13217	8·50571
log H	8·60293	8·60169	8·59648	8·61940	8·62201	8·59698	8·59768	8·58776	8·58819	8·58735
Local time	$12^h 33^m$ p.m.	$3^h 28^m$ p.m.	$4^h 5^m$ p.m.	$4^h 42^m$ p.m.	$5^h 9^m$ p.m.	$5^h 12^m$ p.m.	$6^h 17^m$ p.m.	$11^h 36^m$ a.m.	$12^h 10^m$ p.m.	$12^h 43^m$ p.m.
H	0·04001 [1]	0·03997 [1]	0·03949 [1]	0·04163	0·04188	0·03954	0·03960	0·03871	0·03874	0·03867

[1]) Needle on the whole disturbed.
[2]) The mean of 2 separate settings and readings.

Date	1894. May 31.			1894. June 7.			1894. June 12.	
Lat. N.	81° 32′			81° 28′			81° 43′	
Long. E.	122° 18′			122° 10′			122° 13′	
Deflected needle	L			L			L	
Deflector	VI_E	V_E	V_e	V_e	V_E	VI_E	V_E	V_E
u_1	a 105° 18·75′ 1)	c 92° 32·53′ 2)	a 125° 50·94′ 1)	a 123° 7·22′ 1)	c 89° 43·38′ 1)	c 100° 26·52′ 1)	a 91° 46·08′ 2)	c 94° 13·75′ 2)
u_2	b 105 36·23 1)	d 92 35·21 1)	b 127 22·94 1)	b 126 1·14 1)	d 89 40·33 2)	d 100 2·94 1)	b 92 13·75 2)	d 93 23·17 2)
u_3	c 42 19·15 2)	a 53 2·69 1) 3)	c 18 32·79 1)	c 15 45·91 1)	a 49 55·24 1)	a 39 3·71 1)	c 53 57·83 2)	a 53 22·17 2)
u_4	d 43 8·1 1)	b 52 58·46 2)	d 18 27·09 2) 4)	d 15 59·8 1)	b 49 53·06 1)	b 39 19·25 1)	d 53 7·75 2) 6)	b 54 30·24 2)
Mean	74° 10·6′	72° 47·2′	72° 33·4′	70° 13·5′	69° 48·0′	69° 43·1′	72° 46·4′	73° 54·8′
φ'	31° 16 93′	19° 46·65′	54° 3·50′	54° 20·66′	19° 53·9′	30° 31·63′	19° 13·56′	19° 48·63′
δ	−0·06	0·00	−0·35	−1·29	0·0	−0·04	−0·25	−0·43
φ	31° 16·9′	19° 46·6′	54° 3·1′	54° 19·4′	19° 53·9′	30° 31·6′	19° 13·3′	19° 48·2′
t'	−0·5°	−0·9°	−1·5°	0·3°	0·0°	0·8°	3·2°	2·4°
cpl. log sin φ	0·28463	0·47063	0·09176	0·09027	0·46808	0·29419	0·48251	0·47007
log $[1-(3\beta+\alpha)t']$	0·00015	0·00015	0·00025	9·99995	0·00000	9·99976	9·99948	9·99961
log $C\mu$	8·31151	8·13217	8·50571	8·50571	8·13217	8·31151	8·13217	8·13217
log H	8·59629	8·60295	8·59772	8·59593	8·60025	8·60546	8·61416	8·60185
Local time	$12^h\ 21^m$ p. m.	$4^h\ 30^m$ p. m.	$5^h\ 11^m$ p. m.	$11^h\ 54^m$ a. m.	$12^h\ 33^m$ p. m.	$4^h\ 51^m$ p. m.	$4^h\ 19^m$ p. m.	$5^h\ 42^m$ p. m.
H	0·03947	0·04008	0·03960	0·03944 5)	0·03983 5)	0·04031 5)	0·04113 7)	0·03998 7)

1) The mean of 2 separate settings and readings. 2) The mean of 3 separate settings and readings. 3) The mirror rising. 4) The needle trembled. 5) See the notes to the declination observations of this date. 6) The mirror danced up and down. 7) The needle much disturbed. See the notes to the declination observations of this date.

Date	1894. June 23.	1894. June 28.		1894. July 6.		1894. July 11.	
Lat. N.	81° 43′	81° 35′		81° 30′		81° 19′	
Long. E.	121° 24′	121° 37′		124° 33′		124° 38′	
Deflected needle	L	L		P_2		L	
Deflector	V_E	V_E	V_e	V_e	V_E	V_E	V_e
u_1	a 127° 1·17′ [1]	a 125° 25·25′	c 160° 12·87′ [3]	a 283° 20·75′ [3]	c 251° 23·9′ [3]	a 110° 12·25′	c 144° 20·55′ [6]
u_2	b 127 28·17 [1]	b 125 22·25	d 158 23·5	b 282 12·9 [3]	d 251 37·9 [3]	b 110 28·8	d 142 0·76 [7]
u_3	c 86 31·25 [1]	c 85 20·5	a 51 48·25	c 182 2·4 [3]	b 212 49·9 [3]	c 69 17·5	a 33 58·5
u_4	d 86 41·42 [1]	d 84 43·0	b 51 55·5	d 181 15·6 [3]	a 212 56·5 [3]	d 69 13·0	b 34 51·1 [6]
Mean	106° 55·5′	105° 12·75′	105° 35·0′	232° 12·9′	232° 12·05′	89° 47·9′	88° 47·7′
φ'	20° 19·17′	20° 11·0′	53° 43·16′	50° 33·90′	19° 18·85′	20° 32·64′	54° 23·09′
δ	−0·06	−0·10	−0·51	−0·28	−0·02	−0·02	−0·96
φ	20° 19·1′	20° 10·9′	53° 42·6′	50° 33·6′	19° 18·8′	20° 32·6′	54° 22·1′
t'	2·3°	1·7°	1·3°	1·2°	1·2°	3·1°	2·8°
cpl. log sin φ	0·45938	0·46218	0·09365	0·11222	0·48052	0·45480	0·09003
$\log[1-(3\beta+\alpha)t']$	9·99962	9·99972	9·99979	9·99980	9·99980	9·99950	9·99954
$\log C\mu$	8·13217	8·13217	8·50571	8·49327	8·12515	8·13217	8·50571
$\log H$	8·59117	8·59407	8·59915	8·60529	8·60547	8·58647	8·59528
Local time	$4^h\ 45^m$ p. m.	$5^h\ 19^m$ p. m.	$5^h\ 43^m$ p. m.	$4^h\ 28^m$ p. m.	$5^h\ 3^m$ p. m.	$4^h\ 36^m$ p. m.	$5^h\ 20^m$ p. m.
H	0·03901 [2]	0·03927	0·03973 [4]	0·04030	0·04031	0·03859	0·03938 [8]

[1]) The mean of 3 separate settings and readings. [2]) The needle much disturbed. See the notes to the declination observations of this date. [3]) The mean of 2 separate settings and readings. [4]) The needle disturbed; it danced up and down. [5]) The mean of 4 settings and readings varying between 33° 40′ and 36° 13′. [6]) The mean of 3 settings and readings varying between 143° 0′ and 146° 2′. [7]) The mean of 3 settings and readings varying between 141° 27′ and 142° 59′. [8]) The needle in continual motion.

Date	1894. July 14.	1894. July 25.		1894. August 4.		1894. August 18.	
Lat. N. Long. E.	81° 32′ 124° 58′	81° 20′ 125° 47′		81° 6′ 127° 25′		81° 5′ 128° 7′	
Deflected needle	P_1	P_1		L		P_1	
Deflector	V_E	V_E	VI_E	V_E	V_E	V_e	V_E
u_1	a 91° 15·75′ 1)	c 280° 14·13′ 4)	a 290° 46·12′ 4)	a 279° 49·88′ 5)	c 279° 12·25′ 2)	a 304° 8·63′ 4)	c 272° 46·0′ 4)
u_2	b 91 18·08 2)	d 279 49·25 4)	b 291 22·0 4)	b 280 13·69 1)	d 278 54·92 2)	b 306 27·5 4)	d 272 14·0 4)
u_3	c 131 2·83 2)	b 240 40·12 4)	c 229 11·0 4)	c 239 50·0 1)	b 239 6·92 2)	c 199 1·12 4)	a 232 16·75 4)
u_4	d 130 54·67 2)	a 240 30·88 4)	d 229 8·5 4)	d 239 29·69 1)	a 238 51·42 2)	d 199 22·5 4)	b 232 32·38 4)
Mean	111° 7·8′	260° 18·6′	260° 6·9′	259° 50·8′	259° 1·4′	252° 14·9′	252° 27·3′
φ' δ	19° 50·92′ −0·01	19° 43·09′ −0·05	30° 57·16′ −0·07	20° 10·97′ −0·07	20° 2·21′ −0·04	53° 3·13′ −0·73	20° 2·72′ −0·09
φ	19° 50·9′	19° 43·0′	30° 57·1′	20° 10·9′	20° 2·2′	53° 2·4′	20° 2·6′
t'	4·1°	2·2°	1·5°	9·9°	7·9°	1·0°	3·6°
cpl. log sin φ $\log[1-(3\beta+\alpha)t']$ log C_μ	0·46912 9·99934 8·12515	0·47189 9·99964 8·12515	0·28878 9·99955 8·30497	0·46218 9·99849 8·13217	0·46518 9·99877 8·13217	0·09742 9·99984 8·49327	0·46505 9·99942 8·12515
log H	8·59361	8·59668	8·59330	8·59284	8·59612	8·59053	8·58962
Local time	$5^h\ 17^m$ p. m.	$5^h\ 15^m$ p. m.	$5^h\ 50^m$ p. m.	$12^h\ 11^m$ p. m.	$2^h\ 57^m$ p. m.	$4^h\ 5^m$ p. m.	$4^h\ 33^m$ p. m.
H	0·03923 3)	0·03951	0·03920	0·03916 3)	0·03946	0·03895	0·03887

1) The mean of 4 settings and readings. 2) The mean of 3 settings and readings. 3) The needle somewhat disturbed. 4) The mean of 2 settings and readings. 5) The mean of 5 settings and readings varying between 278° 5′ and 280° 17′.

Date	1894. Sept. 5.	1894. September 21.		1894. October 20.		1894. Nov. 10.	1894. Nov. 16.
Lat. N.	81° 12′	81° 12′		81° 57′		82° 11′	82° 6′
Long. E.	123° 8′	123° 22′		115° 0′		110° 42′	110° 42′
Deflected needle	L	P_2		P_1		P_1	P_1
Deflector	V_E	V_E	V_e	V_e	V_E	V_E	V_E
u_1	c 47° 39·5′ [1]	a 102° 38·0′	c 143° 5·0′	a 147° 8·25′ [3]	c 115° 38·5′ [3]	a 194° 27·0′	c 171° 33·25′ [4]
u_2	d 47 22·42 [1]	b 102 57·5	d 141 35·5	b 149 21·75 [3]	d 115 27·5 [3]	b 194 42·75	d 171 31·88 [4]
u_3	b 8 3·75 [1]	c 61 43·5	a 26 52·0 [2]	d 45 9·5 [3]	a 76 41·75 [3]	c 156 48·75	a 133 54·0 [4]
u_4	a 8 3·25 [1]	d 61 32·0	b 26 35·0	c 44 47·0 [3]	b 76 43·5 [3]	d 156 48·25	b 133 49·38 [4]
Mean	27° 47·2′	82° 12·75′	84° 31·9′	96° 31·6′	96° 7·8′	175° 41·7′	152° 42·1′
φ'	19° 43·73′	20° 35·00′	57° 48·38′	51° 38·37′	19° 25·19′	18° 53·20′	18° 50·44′
δ	−0·02	−0·04	−0·37	−0·77	−0·01	0·00	0·00
φ	19° 43·7′	20° 35·0′	57° 48·0′	51° 37·6′	19° 25·2′	18° 53·2′	18° 50·4′
t'	−1·9°	−13·2°	−13·7°	−26·0°	−26·2	−24·7°	−21·6°
cpl. log sin φ	0·47164	0·45399	0·07253	0·10569	0·47822	0·48986	0·49089
$\log[1-(3\beta+\alpha)t']$	0·00032	0·00248	0·00258	0·00537	0·00543	0·00506	0·00432
log $C\mu$	8·13217	8·12515	8·49327	8·49327	8·12515	8·12515	8·12515
log H	8·60413	8·58162	8·56838	8·60433	8·60880	8·62007	8·62036
Local time	$4^h\ 51^m$ p. m.	$5^h\ 14^m$ p. m.	$5^h\ 42^m$ p. m.	$12^h\ 3^m$ p. m.	$12^h\ 24^m$ p. m.	$4^h\ 54^m$ p. m.	$5^h\ 4^m$ p. m.
H	0·04019	0·03816	0·03702	0·04021	0·04063	0·04169	0·04172

[1]) The mean of 3 settings and readings. The telescope laid aside, as the reflection of the wire was indistinct. [2]) The mean of 2 settings and readings. [3]) The telescope laid aside. [4]) The mean of 2 settings and readings.

Date	1894. Nov. 24.	1894. Nov. 29.	1894. Dec. 7.	1894. December 14.		1894. December 21.	
Lat. N.	81° 58′	82° 10′	82° 20′	82° 33′		82° 54′	
Long. E	111° 58′	110° 50′	108° 58′	107° 53′		104° 6′	
Deflected needle	P_1	P_1	P_1	P_1		P_1	
Deflector	V_E	V_E	V_E	V_E	V_E	V_E	VI_E
u_1	d 196° 35·0′	a 193° 36·25′ [2]	c 197° 10·13′ [2]	c 199° 40·75′	b 199° 5·5′	c 200° 22·0′	b 211° 21·0′
u_2	c 196 31·5	b 193 47·5 [2]	d 197 2·5 [2]	d 199 19·75	a 199 4·75	d 200 25·8	a 210 58·0
u_3	a 155 45·25	c 154 57·5 [2]	a 159 11·63 [2]	b 161 24·0	c 161 10·0	a 165 30·5	c 154 27·5
u_4	b 155 44·5	d 154 53·75 [2]	b 159 8·25 [2]	a 161 16·75	d 161 6·25	b 165 18·0	d 154 21·25
Mean	176° 9·1′	174° 18·75′	178° 8·1′	180° 25·3′	180° 6·6	182° 54·1′	182° 46·9′
φ'	20° 24·19′	19° 23·12′	18° 58·19′	19° 4·94′	18° 58·50′	17° 29·82′	28° 22·56′
δ	0·00	0·00	−0·01	−0·04	0·00	0·00	0·00
φ	20° 24·2′	19° 23·1′	18° 58·2′	19° 4·9′	18° 58·5′	17° 29·8′	28° 22·6′
t'	−19·7°	−25·7°	−26·0°	−24·9°	−24·3°	−27·7°	−27·0°
cpl. log sin φ	0·45764	0·47897	0·48802	0·48557	0·48791	0·52194	0·32306
log $[1-(3\beta+\alpha)t']$	0·00389	0·00530	0·00537	0·00513	0·00496	0·00573	0·00804
log C_μ	8·12515	8·12515	8·12515	8·12515	8·12515	8·12515	8·30497
log H	8·58668	8·60942	8·61854	8·61585	8·61802	8·65282	8·63607
Local time	$5^h 28^m$ p. m.	$4^h 42^m$ p. m.	$5^h 44^m$ p. m.	$4^h 55^m$ p. m.	$5^h 23^m$ p. m.	$4^h 6^m$ p. m.	$4^h 53^m$ p. m.
H	0·03861 [1]	0·04068	0·04155	0·04129	0·04150	0·04496 [1]	0·04326 [1]

[1]) See the notes to the declination observations of this date. [2]) The mean of 2 settings and readings.

Date	1895. Jan. 12.	1895. January 18.		1895. March 7.	1895. March 10.		1895. April 5.	
Lat. N.	83° 41′	83° 25′		84° 1′	83° 59′		84° 17′	
Long. E	102° 47′	102° 30′		101° 53′	102° 12′		97° 23′	
Deflected needle	P_2	P_1		P_1	P_1		P_2	
Deflector	V_E	V_E	VI_E	V_E	V_E	VI_E	VI_E	V_E
u_1	c 227° 28·25′	c 62° 46·25′	a 72° 20·25′	a 302° 19·25′	c 302° 59·0′ [1]	b 313° 51·75′ [1]	b 302° 19·0′	c 311° 36·0′
u_2	d 227 14·0	d 62 38·5	b 72 20·25	b 302 30·75	d 302 9·75 [1]	a 313 11·87 [1]	a 301 54·75	d 311 29·0
u_3	a 189 44·5	a 24 46·25	c 15 11·25	c 265 59·75	a 267 52·6 [1]	d 257 20·75 [1]	c 267 41·5	b 257 57·75
u_4	b 189 29·25	b 25 44·0	d 14 12·75	d 265 58·25	b 268 17·5 [1]	c 257 5·62 [1]	d 267 29·5	a 257 39·5
Mean	208° 29·0′	43° 58·8′	43° 31·1′	284° 11·0′	285° 19·7′	285° 22·5′	284° 51·2′	284° 40·6′
φ'	18° 52·13′	18° 43·60′	28° 49·13′	18° 13·00′	17° 14·68′	28° 9·30′	17° 15·70′	26° 51·95′
δ	−0·03	−0·26	−0·19	−0·01	−0·26	−0·10	−0·05	−0·02
φ	18° 52·1′	18° 43·3′	28° 48·9′	18° 13·0′	17° 14·4′	28° 9·2′	17° 15·7′	26° 51·9′
t'	−22·0°	−32·4°	−32·0°	−25·0°	−21·0°	−21·5°	−20·5°	−20·4°
cpl. log sin φ	0·49026	0·49354	0·31697	0·50500	0·52816	0·32621	0·52763	0·34496
$\log [1-(3\beta+\alpha)t']$	0·00442	0·00702	0·00951	0·00514	0·00418	0·00642	0·00407	0·00609
$\log C\mu$	8·12515	8·12515	8·30497	8·12515	8·12515	8·30497	8·12515	8·30497
$\log H$	8·61983	8·62571	8·63145	8·63529	8·65749	8·63760	8·65685	8·65602
Local time	$5^h 22^m$ p. m.	$4^h 35^m$ p. m.	$5^h 7^m$ p. m.	$5^h 41^m$ p. m.	$4^h 5^m$ p. m.	$4^h 43^m$ p. m.	$4^h 38^m$ p. m.	$5^h 8^m$ p. m.
H	0·04167	0·04224	0·04280	0·04318	0·04545	0·04341	0·04538	0·04529

[1]) The mean of 2 settings and readings.

Date	1895. April 20.		1895. May 9.	1895. May 24.		1895. July 3.			
Lat. N. Long. E.	84° 13′ 94° 30′		84° 35′ 90° 21′	84° 41′ 82° 31′		84° 42′ 74° 20′			
Deflected Needle	P_1		P_2	P_2		P_2			
Deflector	VI_E	V_E	V_E	V_E	V_E	V_E	V_6	VI_6	VI_E
u_1	c 309° 13·25′	a 299° 18·0′	a 300° 21·1′ ¹)	a 299° 14·9′ ¹)	c 299° 9·25′ ¹)	a 245° 21·5′	d 268° 39·0′	a 296° 43·75′	d 254° 8·5′
u_2	d 308 44·0	b 299 18·0	b 300 34·5 ¹)	b 299 26·1 ¹)	d 298 52·5 ¹)	b 245 32·75	c 267 43·5	b 294 25·25	c 253 54·0
u_3	b 257 26·0	c 265 58·5	c 267 19·6 ¹)	c 268 0·0 ¹)	a 267 53·0 ¹)	c 216 6·5	a 194 35·25	c 166 15·5	a 208 21·75
u_4	a 256 25·0	d 265 25·0	d 267 18·6 ¹)	d 267 51·1 ¹)	b 267 51·9 ¹)	d 216 18·75	b 194 25·75	d 166 37·25	b 208 16·5
Mean	282° 57·1′	282° 29·9′	283° 53·4′	283° 38·0′	283° 26·6′	230° 49·9′	231° 20·9′	231° 0·4′	231° 10·2′
φ' δ	26° 1·56′ −0·27	16° 48·12′ −0·10	16° 34·35′ −0·02	15° 42·48′ −0·02	15° 34·20′ −0·03	14° 37·26′ −0·03	36° 50·37′ −0·14	64° 34·06′ −0·98	22° 51·05′ −0·02
φ	26° 1·3′	16° 48·0′	16° 34·3′	15° 42·5′	15° 34·2′	14° 37·2′	36° 50·2′	64° 33·1′	22° 51·0′
t'	−20·0°	−20·2°	−10·1°	−7·0°	−6·9°	2·6°	2·0°	1·4°	0·8°
cpl. log sin φ log $[1-(3\beta+\alpha)t']$ log $C\mu$	0·35782 0·00597 8·30497	0·53905 0·00401 8·12515	0·54483 0·00184 8·12515	0·56744 0·00125 8·12515	0·57119 0·00123 8·12515	0·59814 9·99958 8·12515	0·22219 9·99967 8·49327	0·04432 9·99958 8·67389	0·41081 9·99976 8·30497
log H	8·66876	8·66821	8·67182	8·69384	8·69757	8·72287	8·71513	8·71779	8·71554
Local time	$5^h\ 37^m$ p. m.	$5^h\ 57^m$ p. m.	$5^h\ 45^m$ p. m.	$4^h\ 9^m$ p. m.	$4^h\ 40^m$ p. m.	$3^h\ 42^m$ p. m.	$3^h\ 59^m$ p. m.	$4^h\ 16^m$ p. m.	$4^h\ 33^m$ p. m.
H	0·04664	0·04658	0·04697	0·04941	0·04984 ²)	0·05283	0·05190	0·05221	0·05194

¹) The mean of 2 settings and readings. ²) The revolver laid aside.

Date	1895. July 13.		1895. July 26.				1895. August 23.	
Lat. N. Long. E.	84° 41′ 76° 1′		84° 30′ 73° 1′				84° 11 79° 1′	
Deflected needle	P_1		P_2				P_1	
Deflector	V_E	V_e	V_e	V_E	VI_E	VI_e	V_e	V_E
u_1	a 349° 1·75′	c 11° 18·5′	a 318° 54·75′	c 297° 50·5′	a 305° 40·75′	c 347° 27·5′	b 217° 6·75′	c 194° 17·65′
u_2	b 348 50·75	d 9 48·0	b 319 32·75	d 297 45·75	b 305 52·0	d 345 27·25	a 216 27·25	d 193 50·5
u_3	c 318 50·5	a 295 39·0	c 247 5·5	a 268 27·5	c 260 28·75	b 219 8·75	d 141 38·0	a 165 6·0
u_4	d 319 0·25	b 296 5·0	d 247 2·25	b 268 39·0	d 260 11·5	a 218 35·25	c 141 13·0	b 163 46·25 [1])
Mean	333° 55·8′	333° 12·6′	283° 8·8′	283° 10·7′	283° 3·3′	282° 39·7′	179° 6·3′	179° 15·1′
φ' δ	15° 0·44′ −0·02	37° 20·63′ −0·40	36° 4·94′ −0·07	14° 37·44′ −0·02	22° 43·13′ −0·03	63° 47·69′ −0·76	37° 40·75′ −0·10	14° 48·98′ −0·68
φ	15° 0·4′	37° 20·2′	36° 4·9′	14° 37·4′	22° 43·1′	63° 46·9′	37° 40·6′	14° 48·3′
t'	6·1°	6·0°	1·4°	1·1°	1·5°	1·6°	−4·4°	−4·4°
cpl. log sin φ log $[1-(3\beta+\alpha)t']$ log C_u	0·58681 9·99903 8·12515	0·21717 9·99905 8·49327	0·22993 9·99977 8·49327	0·59780 9·99982 8·12515	0·41319 9·99955 8·30497	0·04715 9·99952 8·67389	0·21381 0·00076 8·49327	0·59256 0·00076 8·12515
log H	8·71099	8·70949	8·72297	8·72277	8·71771	8·72056	8·70784	8·71847
Local time	$5^h 4^m$ p. m.	$5^h 25^m$ p. m.	$5^h 4^m$ p. m.	$5^h 22^m$ p. m.	$5^h 40^m$ p. m.	$5^h 58^m$ p. m.	$4^h 37^m$ p. m.	$5^h 0^m$ p. m.
H	0·05140	0·05123	0·05284	0·05282	0·05221	0·05255	0·05103	0·05230

[1]) A little earlier, the reading was 162°.

Date	1895. Sept. 6.	1895. September 7.		1895. September 27.			1895. October 3.	
Lat. N. Long. E.	84° 53′ 78° 45′	84° 54′ 78° 41′		85° 8′ 79° 28′			85° 12′ 78° 59′	
Deflected needle	P_2	P_2		P_2			P_2	
Deflector	V_E	V_E	V_e	V_e	V_E	VI_E	V_E	V_e
u_1	a 93° 3·25′	b 92° 29·5′	c 115° 34·0′	d 278° 40·5′	a 254° 46·5′	c 263° 26·75′	c 254° 39·25′	b 278° 13·5′
u_2	b 93 2·75	a 92 17·0	d 114 47·25	c 277 50·5	b 255 1·0	d 263 27·5	d 254 13·5	a 277 25·0
u_3	c 61 39·5	c 61 42·25	b 38 41·5	a 200 46·5	c 224 53·5	a 216 0·75	b 223 48·5	c 200 42·75
u_4	d 62 0·75	d 61 31·75	a 38 29·0	b 200 25·5	d 224 44·75	b 215 33·0	a 223 39·25	d 200 9·5
Mean	77° 26·6′	76° 59·6′	76° 52·9′	239° 25·8′	239° 51·4′	239° 37·0′	239° 5·1	239° 7·6′
φ' δ	15° 36·44′ −0·04	15° 23·13′ −0·03	38° 17·69′ −0·11	38° 49·75′ −0·13	15° 2·31′ −0·03	23° 50·13′ −0·05	15° 21·25′ −0·07	38° 41·56′ −0·16
φ	15° 36·4′	15° 23·1′	38° 17·6′	38° 49·6′	15° 2·3′	23° 50·1′	15° 21·2′	38° 41·4′
t'	1·0°	−5·5°	−5·5°	−13·7°	−13·8°	−14·0°	−13·0°	−12·4°
cpl. log sin φ log $[1-(3\beta+\alpha)t']$ log $C\mu$	0·57020 9·99984 8·12515	0·57625 0·00097 8·12515	0·20782 0·00097 8·49327	0·20275 0·00258 8·49327	0·58592 0·00260 8·12515	0·39351 0·00419 8·30497	0·57713 0·00244 8·12515	0·20405 0·00232 8·49327
log H	8·69519	8·70237	8·70206	8·69860	8·71367	8·70267	8·70472	8·69964
Local time	$5^h\ 8^m$ p. m.	$11^h\ 6^m$ a. m.	$11^h\ 26^m$ a. m.	$11^h\ 28^m$ a. m.	$11^h\ 50^m$ a. m.	$12^h\ 11^m$ p. m.	$12^h\ 2^m$ p. m.	$12^h\ 23^m$ p. m.
H	0·04957	0·05039	0·05036	0·04996 [1])	0·05172 [1])	0·05043 [1])	0·05067	0·05008

[1]) Movement in the ice.

Date	1895. October 4.		1895. October 17.			1895. October 24.		1895. November 2.	
Lat. N. Long. E.	85° 11′ 78° 53′		85° 36′ 78° 25′			85° 46′ 73° 40′		85° 40′ 69° 54′	
Deflected needle	P_2		P_3			P_1		P_1	
Deflector	V_e	V_E	V_E	V_e	VI_E	V_E	V_e	V_e	V_E
u_1	b 277° 51·75′	c 254° 36·25′	a 247° 24·75′	c 272° 22·75′	a 257° 19·75′	b 246° 39·5′	c 270° 43·0′	c 272° 31·25′	b 248° 52·0′
u_2	a 277 0·0	d 255 2·5	b 247 16·25	d 272 0·5	b 257 9·75	a 246 29·5	d 270 7·5	d 271 50·75	a 248 48·0
u_3	c 200 37·75	b 224 7·0	c 214 30·75	b 189 40·75	c 206 31·75	c 214 18·0	a 190 2·75	b 194 33·0	c 217 43·5
u_4	d 200 12·0	a 223 51·25	d 214 26·5	a 189 15·75	d 206 4·75	d 214 11·25	b 189 49·0	a 194 17·75	d 217 36·5
Mean	238° 55·4′	239° 24·3′	230° 54·6′	230° 49·9′	231° 46·5′	230° 24·6′	230° 10·6′	233° 18·2′	233° 15·0′
φ' δ	38° 30·50′ −0·15	15° 25·13′ −0·09	16° 25·94′ −0·02	41° 21·69′ −0·05	25° 28·25′ −0·05	16° 9·94′ −0·01	40° 14·69′ −0·06	38° 52·81′ −0·09	15° 35·00′ −0·01
φ	38° 30·4′	15° 25·0′	16° 25·9′	41° 21·6′	25° 28·2′	16° 9·9′	40° 14·6′	38° 52·7′	15° 35·0′
t'	−13·0°	−13·1°	−15·1°	−15·1°	−15·2°	−19·4°	−18·7°	−22·1°	−21·4°
cpl. log sin φ $\log[1-(3\beta+\alpha)t']$ log $C\mu$	0·20579 0·00244 8·49327	0·57539 0·00246 8·12515	0·54841 0·00288 8·12515	0·17994 0·00288 8·49327	0·36650 0·00454 8·30497	0·55532 0·00383 8·12515	0·18974 0·00366 8·49327	0·20227 0·00444 8·49327	0·57083 0·00428 8·12515
log H	8·70150	8·70300	8·67644	8·67609	8·67601	8·68430	8·68667	8·69998	8·70026
Local time	$11^h\ 14^m$ a. m.	$11^h\ 36^m$ a. m.	$11^h\ 41^m$ a. m.	Noon	$12^h\ 19^m$ p. m.	$11^h\ 2^m$ a. m.	$11^h\ 28^m$ a. m.	$12^h\ 10^m$ p. m.	$12^h\ 29^m$ p. m.
H	0·05029	0·05047	0·04747	0·04743	0·04743	0·04834	0·04860	0·05012	0·05015

Date	1895. November 9.		1895. November 20.		1895. Nov. 22.	1895. November 30.	
Lat. N.	85° 42′		85° 51′		85° 47′	85° 28′	
Long. E.	64° 22′		64° 20′		64° 11′	58° 41′	
Deflected needle	P_1		P_2		P_2	P_1	
Deflector	V_E	V_e	V_e	V_E	VI_E	V_e	V_E
u_1	a 253° 53·75′	d 277° 10·25′	b 274° 48·0′	c 252° 19·75′	c 258° 59·5′	c 275° 5·25′	b 253° 41·75′
u_2	b 253 44·0	c 275 30·75	a 274 22·5	d 252 14·75	d 258 46·0	d 274 47·75	a 253 26·25
u_3	d 223 3·75	b 200 4·75	c 200 15·5	b 222 20·25	b 212 7·25	b 201 58·25	c 224 1·0
u_4	c 222 46·75	a 199 58·0	d 200 0·5	a 222 11·0	a 211 57·0	a 201 47·0	d 223 49·75
Mean	238° 22·1′	238° 10·9′	237° 21·6′	237° 16·4′	235° 27·4′	238° 24·6′	238° 44·7′
φ'	15° 26·81′	38° 9·56′	37° 13·63′	15° 0·81′	23° 25·31′	36° 31·94′	14° 49·31′
δ	−0·03	−0·45	−0·04	−0·01	−0·02	−0·02	−0·04
φ	15° 26·8′	38° 9·1′	37° 13·6′	15° 0·8′	23° 25·3′	36° 31·9′	14° 49·3′
t'	−25·3°	−24·6°	−26·2°	−26·5°	−31·2°	−23·7°	−23·3°
cpl. log sin φ	0·57456	0·20919	0·21827	0·58661	0·40067	0·22529	0·59208
log $[1-(3\beta+\alpha)t']$	0·00521	0·00503	0·00543	0·00550	0·00928	0·00481	0·00474
log $C\mu$	8·12515	8·49327	8·49327	8·12515	8·30497	8·49327	8·12515
log H	8·70492	8·70749	8·71697	8·71726	8·71492	8·72337	8·72197
Local time	$5^h\ 3^m$ p. m.	$5^h\ 29^m$ p. m.	$11^h\ 34^m$ a. m.	$11^h\ 54^m$ a. m.	$4^h\ 25^m$ p. m.	$4^h\ 18^m$ p. m.	$4^h\ 41^m$ p. m.
H	0·05069	0·05099	0·05212	0·05215	0·05187	0·05289	0·05272

Date	1895. December 5.			1895. Dec. 12.	1896. January 4.		1896. January 10.		
Lat. N.	85° 29′			85° 25′	85° 17′		84° 58′		
Long. E.	55° 52′			50° 7′	44° 55′		41° 16′		
Deflected needle	P_1			P_2	P_1		P_2		
Deflector	V_E	V_e	VI_E	V_E	V_E	V_e	V_e	V_E	VI_E
u_1	c 248° 52·5′	b 270° 22·25′	c 257° 6·25′	a 240° 41·25′	b 241° 18·5′	c 262° 45·0′	b 254° 57·5′	c 234° 57·25′	b 243° 35·5′
u_2	d 248 46·0	a 269 26·75	d 256 42·75	b 240 49·0	a 240 43·75	d 261 51·5	a 254 34·0	d 234 54·25	a 242 49·25
u_3	b 220 4·0	d 198 32·5	b 212 6·75	c 212 59·75	c 212 14·75	a 191 32·0	c 190 45·75	a 209 1·75	c 201 20·5
u_4	a 220 3·5	c 198 22·25	a 211 40·75	d 212 47·25	d 211 54·75	b 191 23·75	d 190 24·25	b 208 35·25	d 201 5·5
Mean	234° 26·5′	234° 10·9′	234° 24·1′	226° 49·3′	226° 33·0′	226° 53·1′	222° 40·4′	221° 52·1′	222° 12·7′
φ'	14° 22·75′	35° 43·56′	22° 30·38′	13° 55·81′	14° 28·17′	35° 25·19′	32° 5·38′	13° 3·62′	20° 59·69′
δ	−0·01	−0·15	−0·08	−0·02	−0·15	−0·14	−0·05	−0·08	−0·17
φ	14° 22·7′	35° 43·4′	22° 30·3′	13° 55·8′	14° 28·0′	35° 25·1	32° 5·3′	13° 3·5′	20° 59·5′
t'	−28·8°	−28·2°	−28·6°	−22·4°	−32·3°	−32·5°	−37·1°	−36·8°	−37·0°
cpl. log sin φ	0·60498	0·23368	0·41707	0·61846	0·60238	0·23691	0·27472	0·64600	0·44583
log $[1-(3\beta+\alpha)t']$	0·00607	0·00594	0·00851	0·00452	0·00698	0·00704	0·00828	0·00820	0·01098
log $C\mu$	8·12515	8·49327	8·30497	8·12515	8·12515	8·49327	8·49327	8·12515	8·30497
log H	8·73620	8·73289	8·73055	8·74813	8·73451	8·73722	8·77627	8·77935	8·76178
Local time	3^h 49^m p. m.	4^h 15^m p. m.	4^h 40^m p. m.	4^h 26^m p. m.	4^h 29^m p. m.	4^h 53^m p. m.	3^h 59^m p. m.	4^h 30^m p. m.	5^h 1^m p. m.
H	0·05447	0·05406	0·05377	0·05599	0·05426	0·05460	0·05974	0·06017	0·05778

Date	1896. January 18.		1896. January 28.		1896. Feb. 4.	1896. February 5.		1896. February 13.	
Lat. N. Long. E.	84° 56′ 39° 47′		84° 41′ 31° 41′		84° 43′ 24° 59′	84° 39′ 24° 38′		84° 18′ 22° 45′	
Deflected needle	P_1		P_1		P_2	P_2		P_2	
Deflector	V_E	V_e	V_e	V_E	VI_E	V_E	V_e	V_e	V_E
u_1	b 239° 16·75′	c 258° 56·25′	b 259° 7·0′	c 241° 25·0′	b 238° 19·5′	b 231° 22·25′	c 249° 26·75′	c 251° 53·75′	b 235° 5·5′
u_2	a 239 9·25	d 258 28·0	a 258 13·5	d 241 12·0	a 238 15·5	a 231 12·0	d 249 6·0	d 251 40·0	a 235 2·0
u_3	c 213 14·5	b 194 19·5	d 198 5·25	b 216 1 25	c 199 39·25	c 206 24·0	c 188 25·75	b 194 20·5	c 211 16·75
u_4	d 213 11·0	a 194 17·0	c 197 56·25	a 215 59·25	d 199 25·75	d 206 17·0	a 188 13·75	a 194 16·75	d 211 6·5
Mean	226° 12·9′	226° 30·2′	228° 20·5′	228° 39·4′	218° 55·0′	218° 48·8′	218° 48·1′	223° 2·75′	223° 7·7′
φ' δ	13° 0·18′ −0·01	32° 11·94′ −0·04	30° 19·75′ −0·15	12° 39·13′ −0·02	19° 22·50′ −0·02	12° 28·34′ −0·02	30° 28·31′ −0·03	28° 44·13′ −0·01	11° 56·06′ −0·01
φ	13° 0·2′	32° 11·9′	30° 19·6′	12° 39·1′	19° 22·5′	12° 28·3′	30° 28·3′	28° 44·1′	11° 56·0′
t'	−33·2°	−32·9°	−27·7°	−27·9°	−27·2°	−30·0°	−30·0°	−34·6°	−34·5°
cpl. log sin φ log $[1-(3\beta+\alpha)\,t']$ log $C\mu$	0·64780 0·00723 8·12515	0·27339 0·00715 8·49327	0·29677 0·00581 8·49327	0·65951 0·00586 8·12515	0·47919 0·00809 8·30497	0·66563 0·00639 8·12515	0·29490 0·00639 8·49327	0·31808 0·00760 8·49327	0·68451 0·00758 8·12515
log H	8·78018	8·77381	8·79585	8·79052	8·79225	8·79717	8·79456	8·81895	8·81724
Local time	$12^h\,3^m$ p. m.	$12^h\,28^m$ p. m.	$11^h\,27^m$ a. m.	$11^h\,52^m$ a. m.	$12^h\,6^m$ p. m.	$10^h\,37^m$ a. m.	$10^h\,59^m$ a.m.	$10^h\,52^m$ a. m.	$11^h\,17^m$ a. m.
H	0·06028	0·05940	0·06250	0·06173	0·06198	0·06269	0·06231	0·06591	0·06565

Date	1896. February 25.			1896. March 6.		1896. March 7.	1896. March 19.		
Lat. N. Long. E.	84° 11′ 24° 13′			84° 4′ 24° 56′		84° 0′ 24° 9′	84° 5′ 24° 43′		
Deflected needle	P_1			P_2		P_2	P_1		
Deflector	VI_E	V_E	V_6	V_6	V_E	V_E	VI_E	V_E	V_6
u_1	b 262° 50·5′	c 256° 10·0′	b 273° 16·75′	c 278° 3·75′	b 259° 47·0′	a 261° 53·5′	b 280° 3·0′	c 273° 30·75′	b 290° 55·0′
u_2	a 262 32·75	d 255 57·0	a 272 31·75	d 277 19·0	a 259 43·0	b 261 50·5	a 279 46·75	d 273 7·0	a 289 55·5
u_3	c 225 48·0	b 232 9·75	d 215 33·0	b 218 31·5	c 235 36·25	c 237 24·75	c 242 38·5	a 249 3·25	d 231 31·25
u_4	d 225 43·0	a 232 4·0	c 215 22·75	a 218 14·5	d 235 24·75	d 237 22·25	d 242 26·5	b 249 0·5	c 231 25·5′
Mean	244° 13·6′	244° 5·2′	244° 11·1′	248° 2·2′	247° 37·8′	249° 37·8′	261° 15·7′	261° 10·4′	260° 56·8′
φ' δ	18° 28·06′ −0·03	11° 58·31′ −0·02	28° 43·19′ −0·12	29° 39·19′ −0·12	12° 7·25′ −0·02	12° 14·25′ −0·01	18° 41·19′ −0·03	12° 8·50′ −0·07	29° 28·44′ −0·19
φ	18° 28·0′	11° 58·3′	28° 43·1′	29° 39·1′	12° 7·2′	12° 14·2′	18° 41·2′	12° 8·4′	29° 28·2′
t'	−20·6°	−20·7°	−20·5°	−29·9°	−29·3°	−25·5°	−13·8°	−13·9°	−13·6°
cpl. log sin φ log $[1-(3\beta+\alpha)t']$ log $C\mu$	0·49928 0·00615 8·30497	0·68313 0·00411 8·12515	0·31831 0·00407 8·49327	0·30564 0·00637 8·49327	0·67786 0·00621 8·12515	0·67376 0·00526 8·12515	0·49432 0·00413 8·30497	0·67716 0·00263 8·12515	0·30806 0·00257 8·49327
log H	8·81040	8·81239	8·81565	8·80528	8·80922	8·80417	8·80342	8·80494	8·80390
Local time	$11^h 14^m$ a.m.	$11^h 37^m$ a.m.	$12^h 1^m$ p.m.	$11^h 23^m$ a.m.	$11^h 51^m$ a.m.	$5^h 14^m$ p.m.	$11^h 27^m$ a.m.	$11^h 56^m$ a.m.	$12^h 24^m$ p.m.
H	0·06463	0·06492	0·06541	0·06387	0·06445	0·06370	0·06359	0·06383	0·06367

Date	1896. April 9.		1896. April 21.			1896. May 8.	
Lat. N.	84° 27′		84° 4′			83° 56′	
Long. E.	18° 33′		13° 12′			11° 4′	
Deflected needle	P_1		P_2			P_2	
Deflector	V_e	V_E	VI_E	V_E	V_e	V_e	V_E
u_1	b 283° 9·25′	c 265° 58·0′	b 273° 29·25′	d 266° 56·0′	b 283° 44·25′	b 280° 46·75′	c 264° 2·0′
u_2	a 282 25·0	d 265 48·5	a 273 4·0	c 266 47·0	a 283 32·5	a 280 21·75	d 264 2·25
u_3	d 224 22·0	b 241 34·5	c 236 20·0	b 243 0·0	c 226 3·0	c 222 13·25	b 239 44·0
u_4	c 224 21·5	a 241 27·0	d 236 8·25	a 242 42·5	d 225 49·25	d 222 4·0	a 239 24·0
Mean	253° 34·4′	253° 42·0′	254° 45·4′	254° 51·4′	254° 47·25′	251° 21·4′	251° 48·1′
φ'	29° 12·69′	12° 11·25′	18° 31·25′	12° 0·13′	28° 51·13′	29° 12·81′	12° 14·06′
δ	−0·11	−0·02	−0·06	−0·05	−0·02	−0·04	−0·05
φ	29° 12·6′	12° 11·2′	18° 31·2′	12° 0·1′	28° 51·1′	29° 12·8′	12° 14·0′
t'	−11·8°	−11·9°	−16·2°	−16·2°	−16·1°	−15·0°	−14·9°
cpl. log sin φ	0·31157	0·67551	0·49807	0·68206	0·31647	0·31153	0·67388
log $[1-(3\beta+\alpha)t']$	0·00219	0·00223	0·00484	0·00311	0·00309	0·00286	0·00284
log $C\mu$	8·49327	8·12515	8·30497	8·12515	8·49327	8·49327	8·12515
log H	8·80703	8·80289	8·80788	8·81032	8·81283	8·80766	8·80187
Local time	$5^h\ 1^m$ p. m.	$5^h\ 22^m$ p. m.	$4^h\ 38^m$ p. m.	$5^h\ 1^m$ p. m.	$5^h\ 24^m$ p. m.	$11^h\ 23^m$ a. m.	$11^h\ 41^m$ a. m.
H	0·06413	0·06352	0·06425	0·06461	0·06499	0·06422	0·06337

Date	1896. June 3.		1896. June 18.			1896. July 8.		
Lat. N.	83° 16′		82° 56′			83° 3′		
Long. E	12° 33′		11° 35′			12° 56′		
Deflected needle	P_2		P_2			P_1		
Deflector	V_E	V_e	V_e	V_E	VI_E	VI_E	V_E	V_e
u_1	c 288° 41·25′	a 304° 12·75′	c 310° 42·0′	a 294° 43·75′	c 300° 40·75′	c 256° 50·5′	b 249° 33·5′	c 265° 39·0′
u_2	d 288 35·5	b 303 35·75	d 310 16·0	b 294 45·75	d 300 36·25	d 256 13·5	a 249 30·25	d 264 41·5
u_3	b 266 16·0	d 249 49·75	b 256 48·0	c 272 37·75	b 266 47·25	b 221 2·25	d 226 54·0	b 210 45·5
u_4	a 266 7·5	c 249 36·0	a 256 34·0	d 272 35·0	a 266 25·5	a 220 56·5	c 226 41·5	a 210 43·75
Mean	277° 25·1′	276° 48·6′	283° 35·0′	283° 40·6′	284° 37·4′	238° 45·7′	238° 9·8′	237° 57·4′
φ'	11° 13·31′	27° 5·69′	26° 54·00′	11° 4·19′	17° 1·06′	17° 16·31′	11° 22·06′	27° 12·81′
δ	−0·01	−0·09	−0·05	0·00	−0·04	−0·12	−0·02	−0·19
φ	11° 13·3′	27° 5·6′	26° 54·0′	11° 4·2′	17° 1·0′	17° 16·2′	11° 22·0′	27° 12·6′
t'	−2·4°	−2·3°	3·1°	3·6°	5·0	1·9°	2·0°	1·8°
cpl. log sin φ	0·71085	0·34157	0·34444	0·71668	0·53365	0·52743	0·70534	0·33985
$\log[1-(3\beta+\alpha)t']$	0·00041	0·00039	9·99950	9·99942	9·99850	9·99944	9·99967	9·99971
$\log C\mu$	8·12515	8·49327	8·49327	8·12515	8·30497	8·30497	8·12515	8·49327
$\log H$	8·83641	8·83523	8·83721	8·84125	8·83712	8·83184	8·83016	8·83283
Local time	$4^h\ 18^m$ p. m.	$4^h\ 36^m$ p. m.	$11^h\ 22^m$ a. m.	$11^h\ 40^m$ a. m.	$11^h\ 57^m$ a. m.	$4^h\ 41^m$ p. m.	$4^h\ 56^m$ p. m.	$5^h\ 10^m$ p. m.
H	0·06861 [1]	0·06843 [1]	0·06874 [2]	0·06938 [2]	0·06873 [2]	0·06790	0·06763	0·06805

[1]) Some movement in the ice. No revolver. [2]) No revolver.

OBSERVATIONS OF VIBRATION.

The manner, mentioned on page 67, in which the time of vibration for magnet *V* or *VI* was determined, gives, as will be understood, 11 separate determinations for each series of vibrations, of the time for 100 vibrations, all of which are given in the table. On rare occasions, the attempt to note the moment of an expected passage of the magnet over the middle line of the scale, has failed, and only 10, instead of 11, determinations of the time for 100 vibrations have been obtained. Once a series of observations of the time for 101 vibrations has been made, twice of the time for 130, and once of the time for 160 vibrations. Investigations as to the extent of the effect produced by the proximity of the revolver upon the values for the horizontal intensity deduced from the vibration observations, were made on the 20th April, 24th May, 4th and 26th July, and 20th August, 1895. On April 20th, the vibration box stood upon a stone slab frozen firmly into the ice. During two series of vibrations with magnet *V*, and two with magnet *VI*, the revolver lay east and west, 4 paces directly north of the magnet; while during one series of vibrations with magnet *V*, and two with magnet *VI*, it was laid aside. The values for the horizontal intensity, *H*, calculated from these 7 series of vibrations, are as follows:

1895	*H*			
	Magn. *V*		Magn. *VI*	
	a The revolver in its place	*b* The revolver laid aside	*a* The revolver in its place	*b* The revolver laid aside
April 20. $11^h\ 37^m$ a. m.	0·04695			
12 18 p. m.		0·04596		
12 39	0·04620			
3 23			0·04503	
3 46			0·04548	
4 10				0·04579
4 37				0·04585
Mean	0·04658	0·04596	0·04526	0·04582

According to this, we obtain the difference of the means:

		$a-b$
For magnet V	. . .	$+0{\cdot}00062$
„ „ VI	. . .	$-0{\cdot}00056$

From the 24th May to the 26th September, 1895, the vibration box was placed upon the ordinary stand of the apparatus, and the revolver, as usual, between the legs of the stand. The following determinations of H, for the purpose of ascertaining the influence of the revolver in this position, were made:

1895		H			
		Magn. V		Magn. VI	
		a The revolver in its place	b The revolver laid aside	a The revolver in its place	b The revolver laid aside
May 24.	$11^h\ 17^m$ a. m.	0·04958			
	11 48		0·04991		
	12 7 p. m.	0·05005			
	12 32		0·04984		
July 4.	4 22 p. m.			0·05227	
	4 44			0·05278	
	5 5				0·05284
	5 33	0·05274			
	5 52		0·05274		
— 26.	11 52 a. m.	0·05248			
	12 11 p. m.		0·05248		
Aug. 8.	4 7 p. m.	0·05140			
	4 28	0·05122			
	4 49		0·05153		
	5 10		0·05148		
Mean		0·05125	0·05133	0·05253	0·05284

According to this, we obtain:

		$a-b$
For magnet V	. . .	$-0{\cdot}00008$
„ „ VI	. . .	$-0{\cdot}00031$

When the ice hut was taken into use on the 26th September, 1895, the revolver, as stated in the introduction on page 9, was placed on the ice at a distance of 3 metres to the north of the stand of the instrument. From this time until October 3rd, the double declination needle was used for quieting the magnet during the vibration observations; and during the vibrations themselves, it was standing in a vertical position in the revolver's place. On the 4th and 17th October, 1895, several series of vibration observations were made with magnet *V*, to ascertain the influence of the declination needle, when placed in the above position.

1895	*H* The declination-magnet in the revolver's place		
	a With the north end upwards	*c* With the south end upwards	*b* The declination magnet laid aside
Oct. 4. $3^h\ 32^m$ p. m.	0·04846		
3 52		0·04915	
4 14			0·04901
4 38	0·04830		
5 0	0·04886		
5 22			0·04912
Mean	0·04854	0·04915	0·04906
Oct. 17. $4^h\ 27^m$ p. m.	0·04743		
4 58		0·04670	
5 25			0·04719
5 47			0·04763
Mean	0·04743	0·04670	0·04741

The differences of the means are:

	a—b	*c—b*
Oct. 4th	— 0·00052	+ 0·00009
„ 17th	+ 0·00002	— 0·00071

As will be seen from the results here given of the observations, no decided effect upon the vibration observations, either from the revolver or from the declination magnet in the above-mentioned positions, can be proved.

OBSERVATIONS OF VIBRATION.

Date	1893. August 1.			1894. August 18.	
Lat. N. Long. E.	69° 41′ 60° 20′ Khabarova			81° 5′ 128° 7′	
Clock Daily rate	Chron. Kutter -0.3^s			Haagensen -9^s	
Magnet	*VI*	*VI*	*VI*	*V*	*V*
Numb. of vibr.	100	100	100	100	100
	$7^m\,32{\cdot}0^s$	$7^m\,31{\cdot}5^s$	$7^m\,31{\cdot}6^s$	$12^m\,45{\cdot}2^s$	$12^m\,43{\cdot}2^s$
	32·2	31·7	31·6	44·4	43·4
	31·9	31·4	31·5	44·4	42·8
	32·0	31·4	31·5	44·2	43·4
	32·1	31·2	31·7	44·2	42·2
	32·0	31·6	31·4	44·6	42·2
	31·9	30·8	31.3	43.8	42·8
	32·2	30·9	31·6	44·0	42·0
	32·1	30·7	31·5	43·6	42·4
	32·0	31·0	31·7	43·4	42·0
	31·9		31·8	44·0	41·4
Mean	$7^m\,32{\cdot}03^s$	$7^m\,31{\cdot}22^s$	$7^m\,31{\cdot}56^s$	$12^m\,44{\cdot}16^s$	$12^m\,42{\cdot}53^s$
T'	$4{\cdot}5203^s$	$4{\cdot}5122^s$	$4{\cdot}5156^s$	$7{\cdot}6416^s$	$7{\cdot}6253^s$
$\frac{h_0 + h_1}{2}$	$5{\cdot}4^p$	$3{\cdot}9^p$	$4{\cdot}6^p$	$5{\cdot}95^p$	$3{\cdot}48^p$
t	4·5°	4·5°	4·5°	— 0·2°	— 0·1°
$\log T'$	0·65517	0·65439	0·65471	0·88319	0·88226
$\log \gamma$	— 0·00119	— 0·00061	— 0·00087	— 0·00144	— 0·00049
$\log \varrho$	0·00000	0·00000	0·00000	+ 0·00005	+ 0·00005
$\log T$	0·65398	0·65378	0·65384	0·88180	0·88182
cpl. $\log T^2$	8·69204	8·69244	8·69232	8·23640	8·23636
$\log [1 + (2\beta' + \alpha)t]$	0·00129	0·00129	0·00129	9·99997	9·99998
$\log \frac{C}{\mu}$	0·36659	0·36659	0·36659	0·36317	0·36317
$\log H$	9·05992	9·06032	9·06020	8·59954	8·59951
Local time	$8^h\,4^m$ p. m.	$8^h\,11^m$ p. m.	$8^h\,25^m$ p. m.	$6^h\,6^m$ p. m.	$7^h\,11^m$ p. m.
H	0·11479 [1])	0·11490 [1])	0·11487 [1])	0·03977	0·03977

[1]) Constantly disturbed by Samoyeds.

Date	1894. September 21.			1894. Oct. 20.	1894.
Lat. N. Long. E.	81° 12′ 123° 25′		81° 12′ 123° 23′	81° 58′ 114° 58′	82° 6′ 110° 39′
Clock Daily rate		Haagensen — 12 s		Haagensen — 12 s	Haagensen — 12 s
Magnet	V	V	V	V	V
Numb. of vibr.	100	100	100	100	100
	12 m 46·2 s	12 m 45·6 s	12 m 47·2 s	12 m 34·0 s	12 m 28·2 s
	46·2	45·6	47·5		27·3
	47·0	45·8	47·4	34·0	27·8
	46·0	46·2	46·8	33·2	27·6
	46·6	45·8	47·5	33·8	26·4
	46·2	46·2	47·2	33·4	27·6
	46·4	45·8	47·2	33·2	27·0
	46·8	45·8	47·0	33·6	26·5
	47·4	46·2	47·2	32·8	27·4
	46·4	46·0	47·0	33·6	26·0
	46·8	46·3	47·2	32·8	26·6
Mean	12 m 46·55 s	12 m 45·94 s	12 m 47·20 s	12 m 33·44 s	12 m 27·13 s
T'	7·6655 s	7·6594 s	7·6720 s	7·5344 s	7·4713 s
$\frac{h_0 + h_1}{2}$	5·73 p	6·73 p	4·35 p	6·63 p	6·85 p
t	— 13·35°	— 13·8°	— 13·75°	— 18·3°	— 28·2° [2]
log T'	0·88454	0·88419	0·88491	0·87705	0·87340
log γ	— 0·00133	— 0·00184	— 0·00078	— 0·00180	— 0·00191
log ϱ	+ 0·00006	+ 0·00006	+ 0·00006	+ 0·00006	+ 0·00006
log T	0·88327	0·88241	0·88419	0·87531	0·87155
cpl. log T^2	8·23346	8·23518	8·23162	8·24938	8·25690
log $[1 + (2\beta' + \alpha)t]$	9·99765	9·99756	9·99756	9·99662	9·99434
log $\frac{C}{\mu}$	0·36317	0·36317	0·36317	0·36317	0·36317
log H	8·59428	8·59591	8·59235	8·60917	8·61441
Local time	12h 46m p. m.	3h 6m p. m.	3h 30m p. m.	4h 20m p. m.	12h 34m p. m.
H	0·03929	0·03944	0·03912	0·04066 [1]	0·04115

[1]) Snow-storm. Difficult to make observations. [2]) As the divisions on the thermometer in the vibration-box do not go lower than — 21° C., another thermometer is used for lower temperatures, hung outside the apparatus along the suspension-tube.

November 16.	**1894. November 24.**			**1894. November 29.**		
82° 6′	81° 58′		81° 58′		82° 10′	
110° 39′	111° 59′		111° 58′		110° 54′	
Haagensen		Haagensen			Haagensen	
-12^s		-14^s			$-11{\cdot}5^s$	
V	*V*	*V*	*V*	*V*	*V*	*V*
100	100	160	100	100	100	100
$12^m\ 28{\cdot}8^s$	$12^m\ 31{\cdot}6^s$	$20^m\ 5{\cdot}6^s$	$12^m\ 42{\cdot}5^s$	$12^m\ 22{\cdot}2^s$	$12^m\ 14{\cdot}8^s$	$12^m\ 20{\cdot}1^s$
29·4	32·0	4·8	42·8	22·2	14·0	21·2
29·0	30·6	4·0	43·0	22·8	13·8	20·6
28·4	32·2	4·4	43·0	21·6	13·6	20·6
29·0	30·8	3·8	42·5	23·2	13·0	21·4
27·4	31·4	3·6	42·2	21·8	13·8	20·4
28·6	32·4	3·0	41·9	21·2	13·7	20·0
27·4	31·8	2·6	42·6	22·4	12·4	21·0
27·4	32·2	1·4	41·5	21·6	14·4	19·8
27·6	33·4	1·8	42·3	21·8	13·0	20·6
	31·0	1·2	41·6	23·6	13·8	19·4
$12^m\ 28{\cdot}30^s$	$12^m\ 31{\cdot}76^s$	$20^m\ 3{\cdot}29^s$	$12^m\ 42{\cdot}35^s$	$12^m\ 22{\cdot}22^s$	$12^m\ 13{\cdot}66^s$	$12^m\ 20{\cdot}46^s$
$7{\cdot}4830^s$	$7{\cdot}5176^s$	$7{\cdot}5206^s$	$7{\cdot}6235^s$	$7{\cdot}4222^s$	$7{\cdot}3366^s$	$7{\cdot}4046^s$
$6{\cdot}18^p$	$3{\cdot}5^p$	$5{\cdot}63^p$	$5{\cdot}9^p$	$5{\cdot}2^p$	$5{\cdot}57^p$	$6{\cdot}25^p$
$-28{\cdot}0^0$ [2])	$-21{\cdot}7^0$	$-21{\cdot}6^0$	$-21{\cdot}6^0$	$-28{\cdot}2^0$	$-29{\cdot}8^0$	$-29{\cdot}8^0$
0·87408	0·87608	0·87626	0·88213	0·87053	0·86550	0·86951
− 0·00156	− 0·00050	− 0·00129	− 0·00141	− 0·00111	− 0·00126	− 0·00160
+ 0·00006	+ 0·00007	+ 0·00007	+ 0·00007	+ 0·00006	+ 0·00006	+ 0·00006
0·87258	0·87565	0·87504	0·88079	0·86948	0·86430	0·86797
8·25484	8·24870	8·24992	8·23842	8·26104	8·27140	8·26406
9·99440	9·99588	9·99591	9·99591	9·99434	9·99395	9·99395
0·36317	0·36317	0·36317	0·36317	0·36317	0·36317	0·36317
8·61241	8·60775	8·60900	8·59750	8·61855	8·62852	8·62118
$12^h\ 56^m$ p. m.	$11^h\ 44^m$ a. m.	$12^h\ 38^m$ p. m.	$3^h\ 41^m$ p. m.	$11^h\ 37^m$ a. m.	$12^h\ 33^m$ p. m.	$12^h\ 54^m$ p. m.
0·04097	0·04053	0·04065	0·03958	0·04155	0·04251	0·04180

Date	1894. December 7.			1895. April 6.		
Lat. N.	82° 20′			84° 18′		
Long. E.	108° 58′			96° 52′		
Clock	Haagensen			Chron. Frodsham		
Daily rate	$-12{\cdot}5^s$			$+231{\cdot}7^s$		
Magnet	*V*	*V*	*V*	*V*	*V*	*V*
Numb. of vibr.	100	130	100	100	100	100
	$12^m\ 17{\cdot}6^s$	$16^m\ 3{\cdot}0^s$	$12^m\ 22{\cdot}8^s$	$11^m\ 54{\cdot}4^s$	$11^m\ 54{\cdot}3^s$	$11^m\ 54{\cdot}0^s$
	19·0	2·6	23·0	54·2	54·3	53·8
	17·4	2·0	23·6	54·3	54·1	53·6
	17·8	2·0	22·7	54·1	54·2	53·5
	18·2	1·0	23·0	54·3	53·8	53·5
	17·4	1·6	23·2	54·2	54·1	53·5
	17·6	1·2	22·2	54·0	54·0	53·1
	17·4	1·4	22·8	54·1	53·8	53·1
	16·8	0·8	21·5	54·0	54·0	52·8
	17·5	0·6	21·2	53·8	53·6	52·9
	17·2		22·2	53·7	53·8	53·7
Mean	$12^m\ 17{\cdot}63^s$	$16^m\ 1{\cdot}62^s$	$12^m\ 22{\cdot}56^s$	$11^m\ 54{\cdot}10^s$	$11^m\ 54{\cdot}00^s$	$11^m\ 53{\cdot}41^s$
T'	$7{\cdot}3763^s$	$7{\cdot}3955^s$	$7{\cdot}4256^s$	$7{\cdot}1410^s$	$7{\cdot}1400^s$	$7{\cdot}1341^s$
$\frac{h_0+h_1}{2}$	$6{\cdot}2^p$	$5{\cdot}65^p$	$6{\cdot}83^p$	$6{\cdot}58^p$	$5{\cdot}75^p$	$5{\cdot}58^p$
t	−29·0°	−28·9°	−28·7°	−25·5°	−25·6°	−25·6°
log T'	0·86784	0·86897	0·87073	0·85376	0·85370	0·85334
log γ	−0·00157	−0·00130	−0·00190	−0·00177	−0·00135	−0·00127
log ϱ	+0·00006	+0·00006	+0·00006	−0·00117	−0·00117	−0·00117
log T	0·86633	0·86773	0·86889	0·85082	0·85118	0·85090
cpl. log T^2	8·26733	8·26453	8·26221	8·29836	8·29764	8·29820
log $[1+(2\beta'+\alpha)\,t]$	9·99416	9·99418	9·99423	9·99500	9·99499	9·99499
log $\frac{C}{\mu}$	0·36317	0·36317	0·36317	0·36317	0·36317	0·36317
log H	8·62466	8·62188	8·61961	8·65653	8·65580	8·65636
Local time	$4^h\ 4^m$ p. m.	$4^h\ 25^m$ p. m.	$4^h\ 52^m$ p. m.	$2^h\ 26^m$ p. m.	$2^h\ 51^m$ p. m.	$3^h\ 13^m$ p. m.
H	0·04214	0·04187	0·04165	0·04535	0·04527	0·04533

1895. April 20.

84° 13′
94° 30′

Chron. Frodsham
+ 230·9 s

V	V	V	VI	VI	VI	VI
100	100	100	100	100	100	100
11 m 42·8 s	11 m 49·6 s	11 m 47·0 s	12 m 7·5 s	12 m 6·0 s	12 m 2·7 s	12 m 1·8 s
42·6	49·1	46·8	7·3	5·9		1·5
42·3	49·9	47·2	7·2	5·2	2·9	1·9
42·4	49·8	46·6	7·2	5·3	2·6	1·7
42·5	49·8	47·2	6·5	5·1	2·2	1·2
42·4	49·8	47·0	6·7	5·0	2·2	1·3
41·8	50·0	49·5	6·7	4·5	2·5	1·3
42·2	49·7	47·3	5·9	4·5	2·5	1·2
41·7	49·7	48·0	5·5	3·8	2·5	1·0
42·0	49·8	47·4	5·7	4·3	2·4	1·0
41·6	49·8	48·4	5·8	3·5	2·2	0·5
11 m 42·21 s	11 m 49·73 s	11 m 47·31 s	12 m 7·55 s	12 m 4·83 s	12 m 2·47 s	12 m 1·34 s
7·0221 s	7·0973 s	7·0731 s	7·2755 s	7·2483 s	7·2247 s	7·2134 s
4·63 p	5·85 p	5·13 p	5·08 p	6·3 p	6·43 p	5·63 p
— 15·0° [1]	— 19·9°	— 20·4°	— 20·1°	— 20·2°	— 20·3°	— 20·4°
0·84647	0·85109	0·84961	0·86186	0·86024	0·85882	0·85814
— 0·00088	— 0·00139	— 0·00108	— 0·00106	— 0·00162	— 0·00169	— 0·00129
— 0·00116	— 0·00116	— 0·00116	— 0·00116	— 0·00116	— 0·00116	— 0·00116
0·84443	0·84854	0·84737	0·85964	0·85746	0·85597	0·85569
8·31114	8·30292	8·30526	8·28072	8·28508	8·28806	8·28862
9·99731	9·99627	9·99618	9·99418	9·99415	9·99412	9·99409
0·36317	0·36317	0·36317	0·37859	0·37859	0·37859	0·37859
8·67162	8·66236	8·66461	8·65349	8·65782	8·66077	8·66130
11h 37m a. m.	12h 18m p. m.	12h 39m p. m.	3h 23m p. m.	3h 46m p. m.	4h 10m p. m.	4h 37m p. m.
0·04695 [2]	0·04596 [3]	0·04620 [2]	0·04503 [2]	0·04548 [2]	0·04579 [3] [4]	0·04585 [2] [5]

[1]) The thermometer belonging to the vibration-box was taken out, and another thermometer, on which the divisions went considerably lower was put into the box through a hole. [2]) The revolver lay east and west, 4 paces directly north of the magnet. [3]) The revolver laid aside. [4]) The magnet moving rather irregularly. This is perhaps due to movement in the ice? [5]) The magnet quieter.

Date	1895. May 9.			1895.	
Lat. N. Long. E.	84° 35′ 90° 21′			84° 41′ 82° 36′	
Clock Daily rate	Chron. Frodsham $+ 231{\cdot}2^s$			Chron. Frodsham $+ 230{\cdot}4^s$	
Magnet	*V*	*V*	*V*	*V*	*V*
Numb. of vibr.	100	100	100	100	100
	$11^m\ 54{\cdot}5^s$ 54·5 54·5 54·7 54·5 54·5 54·6 54·6 54·5 54·5 54·9	$11^m\ 55{\cdot}8^s$ 56·0 55·9 55·8 55·6 55·7 55·5 56·0 56·0 56·2 56·0	$11^m\ 55{\cdot}5^s$ 56·0 55·8 55·9 56·0 56·1 56·0 56·4 56·1 56·5 56·0	$11^m\ 25{\cdot}2^s$ 25·4 25·1 25·1 24·8 25·2 24·7 24·9 24·2 24·6 24·0	$11^m\ 22{\cdot}9^s$ 23·3 22·6 23·0 22·6 23·0 22·4 22·8 22·1 22·8 22·2
Mean	$11^m\ 54{\cdot}57^s$	$11^m\ 55{\cdot}86^s$	$11^m\ 56{\cdot}03^s$	$11^m\ 24{\cdot}84^s$	$11^m\ 22{\cdot}70^s$
T'	$7{\cdot}1457^s$	$7{\cdot}1586^s$	$7{\cdot}1603^s$	$6{\cdot}8484^s$	$6{\cdot}8270^s$
$\frac{h_0 + h_1}{2}$	$5{\cdot}73^p$	$5{\cdot}13^p$	$5{\cdot}18^p$	$5{\cdot}23^p$	$5{\cdot}3^p$
t	−10·0°	−9·4°	−9·3°	−7·3°	−7·2°
log T'	0·85404	0·85483	0·85493	0·83559	0·83423
log γ	−0·00133	−0·00108	−0·00110	−0·00112	−0·00115
log ϱ	−0·00117	−0·00117	−0·00117	−0·00116	−0·00116
log T	0·85154	0·85258	0·85266	0·83331	0·83192
cpl. log T^2	8·29692	8·29484	8·29468	8·33338	8·33616
log $[1 + (2\beta' + \alpha)t]$	9·99829	9·99840	9·99842	9·99878	9·99880
log $\frac{C}{\mu}$	0·36317	0·36317	0·36317	0·36317	0·36317
log H	8·65838	8·65641	8·65627	8·69533	8·69813
Local time	$3^h\ 18^m$ p. m.	$4^h\ 0^m$ p. m.	$4^h\ 32^m$ p. m.	$11^h\ 17^m$ a. m.	$11^h\ 48^m$ a. m.
H	0·04554 [1])	0·04533 [2])	0·04532 [2])	0·04958 [3])	0·04991 [4])

[1]) The revolver not there, but while noting the 101st to the 131st passage of the central division by the magnet, the observer had a pocket chronometer in his pocket at a distance of about half a metre from the north end of the magnet. [2]) No revolver. This series of vibrations is characterised in the journal as "very good". [3]) The revolver under the stand as usual. The vibration-box placed on the stand. The vibration-box has previously stood upon a stone slab, frozen firmly into the ice. [4]) The revolver laid aside.

May 24.		1895. July 4.				
84° 41′ 82° 36′		84° 43′ 74° 38′				
Chron. Frodsham + 230·4 s		Chron. Frodsham + 230·4 s				
V	*V*	*VI*	*VI*	*VI*	*V*	*V*
100	100	100	100	100	100	100
11 m 21·9 s	11 m 23·5 s	11 m 20·2 s	11 m 17·5 s	11 m 16·9 s	11 m 5·8 s	11 m 5·0 s
22·1	23·4	20·5	17·5	16·6	5·7	5·1
	23·3	20·1	17·3	16·8	5·4	4·9
21·7	23·5		17·4	16·7	5·5	4·9
21·8	23·1	20·2	17·3	16·5	5·4	5·0
21·4	23·0	20·4	16·9	16·8	5·2	5·2
21·1	23·2	20·1	17·4	16·7	5·3	5·3
21·2	23·1	20·1	17·2	16·7	5·0	
20·7	23·0	19·6	16·7	16·7	5·1	5·2
21·0	22·9	19·8	17·1	17·1	5·0	5·1
20·6	22·6	19·6	16·9	16·4	4·9	5·0
11 m 21·35 s	11 m 23·15 s	11 m 20·06 s	11 m 17·20 s	11 m 16·72 s	11 m 5·30 s	11 m 5·07 s
6·8135 s	6·8315 s	6·8006 s	6·7720 s	6·7672 s	6·6530 s	6·6507 s
4·78 p	5·35 p	4·38 p	5·28 p	5·08 p	5·33 p	4·88 p
−7·2°	−7·2°	3·0°	2·6°	2·5°	2·6°	2·8°
0·83337	0·83451	0·83255	0·83072	0·83041	0·82302	0·82287
−0·00094	−0·00117	−0·00078	−0·00114	−0·00106	−0·00116	−0·00097
−0·00116	−0·00116	−0·00116	−0·00116	−0·00116	−0·00116	−0·00116
0·83127	0·83218	0·83061	0·82842	0·82819	0·82070	0·82074
8·33746	8·33564	8·33878	8·34316	8·34362	8·35860	8·35852
9·99880	9·99880	0·00087	0·00075	0·00072	0·00039	0·00042
0·36317	0·36317	0·37859	0·37859	0·37859	0·36317	0·36317
8·69943	8·69761	8·71824	8·72250	8·72293	8·72216	8·72211
12 h 7 m p. m.	12 h 32 m p. m.	4 h 22 m p. m.	4 h 44 m p. m.	5 h 5 m p. m.	5 h 33 m p. m.	5 h 52 m p. m.
0·05005 [5])	0·04984 [4])	0·05227	0·05278	0·05284 [6])	0·05274 [6])	0·05274 [7])

[5]) The revolver in its place. [6]) During this series of vibrations the revolver was laid aside in one corner of the tent. [7]) The revolver under the stand again.

Date	1895. July 26.				1895.	
Lat. N. Long. E.	84° 30′ 72° 56′				84° 38′ 77° 7′	
Clock Daily rate	Chron. Frodsham + 230·3 s				Chron. Frodsham + 230·6 s	
Magnet	*V*	*V*	*VI*	*VI*	*V*	*V*
Numb. of vibr.	100	100	100	100	100	100
	11 m 7·6 s	11 m 6·8 s	11 m 16·7 s	11 m 15·6 s	11 m 14·5 s	11 m 15·9 s
	7·8	6·3	16·3	15·2	14·7	15·8
	7·2	6·7		14·9		15·5
	7·1	6·4	16·4	14·8	14·7	15·7
	7·0	6·2	15·7	14·6	14·5	15·5
	7·1	6·0	16·1	14·3	14·0	15·3
	7·0	6·1	16·0	14·1	14·5	15·2
	6·9	6·0	16·0	13·8	14·4	15·2
	6·9	6·3	15·8	13·8	14·2	15·1
	6·9		16·0	13·5	14·2	15·0
	6·9	6·3	16·1	13·2	14·2	14·8
Mean	11 m 7·13 s	11 m 6·31 s	11 m 16·11 s	11 m 14·35 s	11 m 14·39 s	11 m 15·36 s
T'	6·6713 s	6·6631 s	6·7611 s	6·7435 s	6·7439 s	6·7536 s
$\frac{h_0 + h_1}{2}$	5·28 p	4·25 p	4·73 p	4·53 p	5·38 p	5·23 p
t	4·5°	2·5°	2·0°	1·8°	6·3°	5·4°
log T'	0·82421	0·82368	0·83002	0·82888	0·82891	0·82954
log γ	−0·00114	−0·00074	−0·00092	−0·00084	−0·00118	−0·00112
log ϱ	−0·00116	−0·00116	−0·00116	−0·00116	−0·00116	−0·00116
log T	0·82191	0·82178	0·82794	0·82688	0·82657	0·82726
cpl. log T^2	8·35618	8·35644	8·34412	8·34624	8·34686	8·34548
log $[1 + (2\beta' + \alpha)t]$	0·00066	0·00037	0·00057	0·00051	0·00091	0·00079
log $\frac{C}{\mu}$	0·36317	0·36317	0·37859	0·37859	0·36317	0·36317
log H	8·72001	8·71998	8·72328	8·72534	8·71094	8·70944
Local time	$11^h 52^m$ a. m.	$12^h 11^m$ p. m.	$12^h 36^m$ p. m.	$1^h 2^m$ p. m.	$4^h 7^m$ p. m.	$4^h 28^m$ p. m.
H	0·05248 [1])	0·05248 [2])	0·05288 [2])	0·05313 [2])	0·05140 [1])	0·05122 [1])

[1]) The revolver in its place. [2]) The revolver laid aside.

August 8.		**1895. September 7.**		**1895. September 27.**			
84° 38′ 77° 7′		84° 54′ 78° 41′		85° 8′ 79° 30′			
Chron. Frodsham + 230·6^s		Chron. Frodsham + 230·8^s		Chron. Frodsham + 229·8^s			
V	*V*	*V*	*V*	*VI*	*VI*	*V*	*V*
100	100	100	101	100	100	100	100
11^m 14·0^s	11^m 14·8^s	11^m 16·5^s	11^m 22·3^s	11^m 35·8^s	11^m 37·5^s	11^m 24·0^s	11^m 24·6^s
13·7	14·6	16·8	22·4	35·7	37·5	23·9	24·3
13·9	14·2	16·9	22·0	35·8	37·2	23·9	24·2
13·7	14·4	16·6	22·0	35·5	37·2	23·6	
13·8	14·5	16·2	21·8	35·2	37·1	23·5	24·3
13·6	14·0	16·8	21·8	35·1	36·8	23·5	24·2
13·6	14·0	16·4	22·0	35·2	36·8	23·4	24·0
13·4	14·2	16·4	22·2	35·2	36·7	23·6	23·6
13·2	14·1	16·2	21·9	35·1	36·5	23·4	23·5
	13·9	16·4	21·8	35·0	36·4	23·5	23·5
13·2	14·0	16·0	21·9	34·8	36·3	23·2	23·6
11^m 13·61^s	11^m 14·25^s	11^m 16·47^s	11^m 22·01^s	11^m 35·31^s	11^m 36·91^s	11^m 23·59^s	11^m 23·98^s
6·7361^s	6·7425^s	6·7647^s	6·7526^s	6·9531^s	6·9691^s	6·8359^s	6·8398^s
5·73^p	6·1^p	5·15^p	5·45^p	7·15^p	7·53^p	5·35^p	6·3^p
4·9°	5·0°	−5·1°	−5·1°	−15·3°	−15·1°	−15·2°	−15·0°
0·82841	0·82882	0·83025	0·82947	0·84218	0·84318	0·83479	0·83505
−0·00133	−0·00152	−0·00109	−0·00121	−0·00209	−0·00231	−0·00117	−0·00162
−0·00116	−0·00116	−0·00116	−0·00116	−0·00116	−0·00116	−0·00116	−0·00116
0·82592	0·82614	0·82800	0·82710	0·83893	0·83971	0·83246	0·83227
8·34816	8·34772	8·34400	8·34580	8·32214	8·32058	8·33508	8·33546
0·00072	0·00073	9·99917	9·99917	9·99557	9·99564	9·99744	9·99748
0·36317	0·36317	0·36317	0·36317	0·37859	0·37859	0·36317	0·36317
8·71205	8·71162	8·70634	8·70814	8·69630	8·69481	8·69569	8·69611
4^h 49^m p. m.	5^h 10^m p. m.	3^h 21^m p. m.	3^h 40^m p. m.	5^h 13^m p. m.	5^h 34^m p. m.	6^h 54^m p. m.	7^h 15^m p. m.
0·05153 [2])	0·05148 [2])	0·05086	0·05107	0·04969	0·04952	0·04962	0·04967

Date	1895. October 3.				1895.	
Lat. N. Long. E.	85° 12′ 78° 59′				85° 10′ 78° 51′	
Clock Daily rate	Chron. Frodsham + 229·4 ^{s}				Chron. Frodsham + 229·7 ^{s}	
Magnet	*V*	*V*	*V*	*V*	*V*	*V*
Numb. of vibr.	100	100	100	100	100	100
	11 ^{m} 21·2 ^{s}	11 ^{m} 22·5 ^{s}	11 ^{m} 19·9 ^{s}	11 ^{m} 20·2 ^{s}	11 ^{m} 32·6 ^{s}	11 ^{m} 27·6 ^{s}
	21·3	22·6	19·8	19·9	32·7	27·9
	21·2	22·2	19·8	19·6	32·5	27·5
	21·1	22·1	19·4	19·7	32·4	27·4
	21·2	21·9	19·3	19·5	32·7	27·3
	20·9	22·0	19·2	19·3	32·5	27·3
	20·8	21·8	19·2	19·3	32·2	
		21·7	19·4	19·1	32·4	
	21·1	21·7	19·0		32·3	26·8
	20·9	21·7	19·2	19·2	32·2	26·7
	20·7	21·5	18·8	18·9	32·1	27·0
Mean	11 ^{m} 21·04 ^{s}	11 ^{m} 21·97 ^{s}	11 ^{m} 19·36 ^{s}	11 ^{m} 19·47 ^{s}	11 ^{m} 32·42 ^{s}	11 ^{m} 27·28 ^{s}
T'	6·8104 ^{s}	6·8197 ^{s}	6·7936 ^{s}	6·7947 ^{s}	6·9242 ^{s}	6·8728 ^{s}
$\frac{h_0 + h_1}{2}$	4·75 ^{p}	6·05 ^{p}	5·7 ^{p}	5·8 ^{p}	6·23 ^{p}	5·85 ^{p}
t	−13·7°	−13·7°	−13·7°	−13·7°	−14·4°	−14·0°
log T'	0·83317	0·83376	0·83210	0·83217	0·84037	0·83714
log γ	−0·00093	−0·00149	−0·00132	−0·00137	−0·00159	−0·00139
log ϱ	−0·00116	−0·00116	−0·00116	−0·00116	−0·00116	−0·00116
log T	0·83108	0·83111	0·82962	0·82964	0·83762	0·83459
cpl. log T^2	8·33784	8·33778	8·34076	8·34072	8·32476	8·33082
log $[1 + (2\beta' + \alpha)\, t]$	9·99758	9·99758	9·99758	9·99758	9·99743	9·99752
log $\frac{C}{\mu}$	0·36317	0·36317	0·36317	0·36317	0·36317	0·36317
log H	8·69859	8·69853	8·70151	8·70147	8·68536	8·69151
Local time	3 ^{h} 20 ^{m} p. m.	3 ^{h} 42 ^{m} p. m.	4 ^{h} 2 ^{m} p. m.	4 ^{h} 24 ^{m} p. m.	3 ^{h} 32 ^{m} p. m.	3 ^{h} 52 ^{m} p. m.
H	0·04996	0·04995	0·05029	0·05029 [1])	0·04846 [3])	0·04915 [4])

[1]) The observer had previously used one of the declination magnets for quieting the needle, and had it standing perpendicularly, north of the vibrating needle. It does not appear to have had any perceptible influence. After this, however, only a very small magnet was used for quieting, which had absolutely no influence. [2]) On this day no less than 9 series of vibrations were taken for the purpose of finding out what influence the declination magnet had when placed perpendicularly in the revolver's place after having been used for quieting. [3]) The declination magnet in the revolver's place with the north end upwards. [4]) The

October 4. [2])

85° 10′
78° 51′

Chron. Frodsham
+ 229·7 s

V	*V*	*V*	*V*	*V*	*V*	*V*
100	100	100	100	100	100	100
11 m 28·9 s	11 m 33·3 s	11 m 29·6 s	11 m ? s	11 m 37·1 s	11 m 50·5 s	12 m ? s
28·6	33·4	29·9	28·5	37·8	51·0	10·9
28·4	33·0	29·6	28·0	37·6		10·7
28·4	33·2	29·5	28·1	37·9	52·0	9·6
28·4	33·2	29·5	28·4	37·8	52·7	9·2
28·3	33·2	29·5	28·1		51·3	8·5
28·3	33·0	28·8	27·8		53·2	7·8
28·3		29·0	27·6		53·7	6·5
28·1	32·6	28·8			54·0	6·2
28·3	33·5	28·6	27·3		54·5	5·9
27·8	33·3	28·7	27·6		54·7	5·8
11 m 28·35 s	11 m 33·17 s	11 m 29·23 s	11 m 27·93 s	11 m 37·64 s	11 m 52·76 s	12 m 8·11 s
6·8835 s	6·9317 s	6·8923 s	6·8793 s	6·9764 s	7·1276 s	7·2811 s
5·85 p	5·6 p	5·63 p	6·23 p	6·0 p	5·08 p	5·43 p
−13·6°	−13·5°	−13·4°	−13·2°	−13·2°	−11·4°	−12·5°
0·83781	0·84084	0·83837	0·83755	0·84363	0·85295	0·86220
−0·00139	−0·00128	−0·00129	−0·00159	−0·00146	−0·00106	−0·00120
−0·00116	−0·00116	−0·00116	−0·00116	−0·00116	−0·00116	−0·00116
0·83526	0·83840	0·83592	0·83480	0·84101	0·85073	0·85984
8·32948	8·32320	8·32816	8·33040	8·31798	8·29854	8·28032
9·99759	9·99761	9·99764	9·99767	9·99767	9·99802	9·99780
0·36317	0·36317	0·36317	0·36317	0·36317	0·36317	0·36317
8·69024	8·68398	8·68897	8·69124	8·67882	8·65973	8·64129
$4^h\ 14^m$ p. m.	$4^h\ 38^m$ p. m.	$5^h\ 0^m$ p. m.	$5^h\ 22^m$ p. m.	$5^h\ 43^m$ p. m.	$7^h\ 1^m$ p. m.	$7^h\ 23^m$ p. m.
0·04901 [5])	0·04830 [3]) [6])	0·04886 [3])	0·04912 [5])	0·04773 [3])	0·04568 [3]) [7])	0·04378 [5]) [7])

declination magnet in the revolver's place with the south end upwards. [5]) The declination magnet laid aside. [6]) The magnet somewhat disturbed. [7]) The magnet much disturbed.

Date	1895. October 17.				1895.
Lat. N. Long. E.	85° 37' 78° 23'				85° 46' 73° 30'
Clock Daily rate	Chron. Frodsham + 229·7 s				Chron. Frodsham + 229·4 s
Magnet	V	V	V	V	V
Numb. of vibr.	100	100	100	100	100
	11 m 38·8 s	11 m ? s	11 m 41·0 s	11 m 37·9 s	11 m 32·8 s
	39·2	44·8	40·9	37·6	32·4
	38·6	44·5		37·7	32·5
	38·8	44·6	40·8	37·4	32·2
	38·4	44·4	40·9	37·7	32·5
	38·6	44·4	40·6	37·4	32·1
	37·9	44·3	40·5	37·5	32·1
	38·5	44·4	40·3	37·0	31·8
	38·0	43·8	40·3	37·2	32·2
	38·5	44·2	40·5	37·0	31·8
	37·8	43·6	40·0	37·0	32·3
Mean	11 m 38·46 s	11 m 44·30 s	11 m 40·58 s	11 m 37·40 s	11 m 32·25 s
T'	6·9846 s	7·0430 s	7·0058 s	6·9740 s	6·9225 s
$\frac{h_0 + h_1}{2}$	4·65 p	5·23 p	5·2 p	5·3 p	4·83 p
t	−16·2°	−16·2°	−16·2°	−16·2°	−13·9°
log T'	0·84414	0·84776	0·84546	0·84348	0·84026
log γ	−0·00089	−0·00112	−0·00111	−0·00115	−0·00096
log ϱ	−0·00116	−0·00116	−0·00116	−0·00116	−0·00116
log T	0·84209	0·84548	0·84319	0·84117	0·83814
cpl. log T^2	8·31582	8·30904	8·31362	8·31766	8·32372
log $[1 + (2\beta' + \alpha)t]$	9·99707	9·99707	9·99707	9·99707	9·99754
log $\frac{C}{\mu}$	0·36317	0·36317	0·36317	0·36317	0·36317
log H	8·67606	8·66928	8·67386	8·67790	8·68443
Local time	$4^h\ 27^m$ p. m.	$4^h\ 58^m$ p. m.	$5^h\ 25^m$ p. m.	$5^h\ 47^m$ p. m.	$4^h\ 8^m$ p. m.
H	0·04743 ¹)	0·04670 ²)	0·04719 ³)	0·04763 ³)	0·04835

¹) The declination magnet in the revolver's place with the north end upwards. ²) The declination magnet in the revolver's place with the south end upwards. ³) The declination magnet laid aside.

October 24.		1895. November 20.		
85° 46′ 73° 30′		85° 51′ 64° 18′		
Chron. Frodsham + 229·4 ^{s}		Chron. Frodsham + 228·8 ^{s}		
V	*V*	*V*	*V*	*V*
100	130	100	100	100
11 ^{m} 32·9 ^{s}	15 ^{m} 0·3 ^{s}	11 ^{m} 17·8 ^{s}	11 ^{m} 18·0 ^{s}	11 ^{m} 17·1 ^{s}
33·0	14 59·9	17·7	18·2	17·2
32·7	59·9	17·8	18·0	17·2
32·6	59·7	17·5	17·7	17·1
32·5	59·8	17·4	17·6	17·0
32·6	59·6	17·3	17·5	17·0
32·2	59·7	17·4	17·5	17·0
32·3	59·5	17 2	17·2	17·0
32·1	59·3	17·3	17·3	16·8
32·2	59·3	17·1	17·4	16·8
32·1	59·0	17·2	17·3	16·6
11 ^{m} 32·47 ^{s}	14 ^{m} 59·64 ^{s}	11 ^{m} 17·43 ^{s}	11 ^{m} 17·61 ^{s}	11 ^{m} 16·98 ^{s}
6·9247 ^{s}	6·9203 ^{s}	6·7743 ^{s}	6·7761 ^{s}	6·7698 ^{s}
5·68 ^{p}	5·3 ^{p}	6·3 ^{p}	5·38 ^{p}	5·35 ^{p}
— 17·2°	— 18·6°	— 28·8°	— 28·7°	— 28·6°
0·84040	0·84013	0·83087	0·83098	0·83058
— 0·00131	— 0·00115	— 0·00162	— 0·00118	— 0·00117
— 0·00116	— 0·00116	— 0·00115	— 0·00115	— 0·00115
0·83793	0·83782	0·82810	0·82865	0·82826
8·32414	8·32436	8·34380	8·34270	8·34348
9·99686	9·99656	9·99421	9·99423	9·99425
0·36317	0·36317	0·36317	0·36317	0·36317
8·68417	8·68409	8·70118	8·70010	8·70090
4^h 31^m p. m.	4^h 58^m p. m.	4^h 45^m p. m.	5^h 8^m p. m.	5^h 31^m p. m.
0·04832	0·04832	0·05026	0·05013	0·05022

Date	1895. December 12.				1896.	
Lat. N. Long. E.	85° 25' 50° 7'				84° 41' 31° 43'	
Clock Daily rate	Chron. Frodsham + 229·5 s				Chron. Frodsham + 229·6 s	
Magnet	V	V	V	V	V	V
Numb. of vibr.	100	100	100	100	100	100
	10 m 43·8 s	10 m 44·4 s	10 m 42·4 s	10 m 41·3 s	10 m 10·1 s	10 m 11·1 s
	43·9	44·1	42·3	41·3	9·9	
	43·6	44·1	42·1	41·4	9·9	10·9
	43·5	43·7	41·9	41·4	9·8	10·8
	43·8	43·5	42·1	40·9	9·6	10·8
	43·6	43·8	42·1	41·4	9·7	10·6
	43·6	43·7	41·8	41·3	9·7	10·7
	43·5	43·3	41·9	41·2	9·4	10·6
	43·5	43·5	41·8	40·9	9·6	10·3
	43·7	43·3	41·3	41·3	9·5	10·3
	43·4	43·4	41·7	41·1	9·7	10·4
Mean	10 m 43·63 s	10 m 43·71 s	10 m 41·95 s	10 m 41·23 s	10 m 9·72 s	10 m 10·65 s
T'	6·4363 s	6·4371 s	6·4195 s	6·4123 s	6·0972 s	6·1065 s
$\frac{h_0+h_1}{2}$	5·53 p	6·03 p	5·78 p	4·68 p	5·23 p	5·48 p
t	−22·5°	−23·5°	−23·0	−22·7°	−28·1°	−28·0°
log T'	0·80863	0·80869	0·80750	0·80701	0·78513	0·78579
log γ	−0·00124	−0·00148	−0·00136	−0·00090	−0·00112	−0·00122
log ϱ	−0·00116	−0·00116	−0·00116	−0·00116	−0·00116	−0·00116
log T	0·80623	0·80605	0·80498	0·80495	0·78285	0·78341
cpl. log T^2	8·38754	8·38790	8·39004	8·39010	8·43430	8·43318
$\log[1+(2\beta'+\alpha)t]$	9·99570	9·99546	9·99558	9·99565	9·99438	9·99440
$\log \frac{C}{\mu}$	0·36317	0·36317	0·36317	0·36317	0·36317	0·36317
log H	8·74641	8·74653	8·74879	8·74892	8·79185	8·79075
Local time	$5^h\ 27^m$ p. m.	$7^h\ 3^m$ p. m.	$7^h\ 22^m$ p. m.	$7^h\ 43^m$ p. m.	$4^h\ 18^m$ p. m.	$4^h\ 39^m$ p. m.
H	0·05577	0·05579	0·05608	0·05609	0·06192	0·06177

January 28.	1896. March 19.					
84° 41′ 31° 43′	84° 5′ 24° 40′					
Chron. Frodsham + 229·6 ^{s}	Chron. Frodsham + 231·4 ^{s}					
V	*V*	*V*	*V*	*VI*	*VI*	*VI*
100	100	100	100	100	100	100
10 ^{m} 10·3 ^{s}	10 ^{m} 2·5 ^{s}	10 ^{m} 3·7 ^{s}	10 ^{m} 4·7 ^{s}	10 ^{m} 14·5 ^{s}	10 ^{m} 15·9 ^{s}	10 ^{m} 16·0 ^{s}
10·1	2·6	3·5	4·6	14·7	15·9	16·2
9·9	2·0	3·2	4·5	14·3	15·6	16·1
10·1	2·8	3·6	4·8	14·5	15·9	16·1
9·9	2·1	3·6	4·5	14·3	15·6	16·0
10·1	2·7	3·6	4·0	14·5	16·4	15·9
9·9	2·0	3·5	4·2	14·3	15·5	
10·0	2·3	3·5	4·2	14·3	15·6	15·7
9·8	1·2	3·3	4·3	14·1	15·4	15·4
9·9	2·0	3·1	4·0	14·0	15·4	15·5
9·6	1·8	3·2	4·1	14·3	15·2	15·2
10 ^{m} 9·96 ^{s}	10 ^{m} 2·18 ^{s}	10 ^{m} 3·44 ^{s}	10 ^{m} 4·35 ^{s}	10 ^{m} 14·35 ^{s}	10 ^{m} 15·67 ^{s}	10 ^{m} 15·81 ^{s}
6·0996 ^{s}	6·0218 ^{s}	6·0344 ^{s}	6·0435 ^{s}	6·1435 ^{s}	6·1567 ^{s}	6·1581 ^{s}
5·43 ^{p}	4·3 ^{p}	5·58 ^{p}	5·58 ^{p}	5·53 ^{p}	6·13 ^{p}	6·95 ^{p}
−28·0°	−13·6°	−14·3°	−14·5°	−14·2°	−14·5°	−15·3°
0·78530	0·77973	0·78064	0·78128	0·78841	0·78935	0·78945
−0·00120	−0·00076	−0·00127	−0·00127	−0·00124	−0·00153	−0·00197
−0·00116	−0·00117	−0·00117	−0·00117	−0·00117	−0·00117	−0·00117
0·78294	0·77780	0·77820	0·77884	0·78600	0·78665	0·78631
8·43412	8·44440	8·44360	8·44232	8·42800	8·42670	8·42738
9·99440	9·99760	9·99746	9·99742	9·99590	9·99582	9·99559
0·36317	0·36317	0·36317	0·36317	0·37859	0·37859	0·37859
8·79169	8·80517	8·80423	8·80291	8·80249	8·80111	8·80156
5 ^{h} 3 ^{m} p. m.	4 ^{h} 0 ^{m} p. m.	4 ^{h} 22 ^{m} p. m.	4 ^{h} 42 ^{m} p. m.	5 ^{h} 21 ^{m} p. m.	5 ^{h} 40 ^{m} p. m.	6 ^{h} 49 ^{m} p. m.
0·06190	0·06385	0·06371	0·06352	0·06346	0·06326	0·06332

Date	**1896. May 8.**			
Lat. N. Long. E.	83° 56′ 11° 3′			
Clock Daily rate	Chron. Frodsham $+ 231{\cdot}0^s$			
Magnet	V	V	V	V
Numb. of vibr.	100	100	100	100
	$9^m\ 55{\cdot}4^s$	$9^m\ 55{\cdot}7^s$	$9^m\ 57{\cdot}4^s$	$9^m\ 58{\cdot}1^s$
	55·5	55·6	57·3	58·2
	55·2	55·5	57·2	57·9
	55·4	55·7	57·0	57·7
	55·4	55·6	57·1	57·8
		55·5	57·5	57·7
	55·6	55·2	57·3	57·7
	55·5	55·1	57·4	57·8
	55·6	54·5	56·9	57·4
	55·6	55·0	57·1	57·4
	55·5	55·2	57·1	57·4
Mean	$9^m\ 55{\cdot}47^s$	$9^m\ 55{\cdot}33^s$	$9^m\ 57{\cdot}21^s$	$9^m\ 57{\cdot}74^s$
T'	$5{\cdot}9547^s$	$5{\cdot}9533^s$	$5{\cdot}9721^s$	$5{\cdot}9774^s$
$\frac{h_0 + h_1}{2}$	$4{\cdot}03^p$	$5{\cdot}15^p$	$5{\cdot}8^p$	$5{\cdot}58^p$
t	$-9{\cdot}6^0$	$-12{\cdot}5^0$	$-13{\cdot}7^0$	$-14{\cdot}3^0$
log T'	0·77486	0·77476	0·77613	0·77651
log γ	−0·00066	−0·00109	−0·00137	−0·00127
log ϱ	−0·00117	−0·00117	−0·00117	−0·00117
log T	0·77303	0·77250	0·77359	0·77407
cpl. log T^2	8·45394	8·45500	8·45282	8·45186
log $[1 + (2\beta' + \alpha)t]$	9·99838	9·99782	9·99758	9·99746
log $\frac{C}{\mu}$	0·36317	0·36317	0·36317	0·36317
log H	8·81549	8·81599	8·81357	8·81249
Local time	$4^h\ 1^m$ p. m.	$4^h\ 23^m$ p. m.	$4^h\ 44^m$ p. m.	$5^h\ 5^m$ p. m.
H	0·06539	0·06546	0·06510	0·06494

1896. June 18.

82° 56′
11° 35′

Chron. Frodsham
+ 231·0 s

V	*V*	*V*	*VI*	*VI*
100	100	100	100	100
9 m 45·7 s	9 m 42·7 s	9 m 47·3 s	9 m 57·2 s	9 m 55·9 s
46·2	43·3	47·1	57·1	55·8
45·8		47·6	57·1	55·8
45·8	43·6	46·8	57·2	55·7
45·2	42·7	47·4	56·9	55·3
45·9	43·4	46·8	56·8	55·4
45·1	42·6	47·3	57·0	55·3
45·7	43·4	46·7	56·7	55·2
44·9	42·9	47·2	56·8	55·1
45·4	43·4	46·7	56·8	54·8
44·5	42·8	47·4	56·9	55·1
9 m 45·47 s	9 m 43·08 s	9 m 47·12 s	9 m 56·95 s	9 m 55·40 s
5·8547 s	5·8308 s	5·8712 s	5·9695 s	5·9540 s
5·95 p	4·85 p	5·48 p	3·53 p	4·78 p
3·9°	3·4°	3·7°	4·8°	4·4°
0·76751	0·76573	0·76873	0·77594	0·77481
−0·00143	−0·00097	−0·00122	−0·00051	−0·00094
−0·00117	−0·00117	−0·00117	−0·00117	−0·00117
0·76491	0·76359	0·76634	0·77426	0·77270
8·47018	8·47282	8·46732	8·45148	8·45460
0·00058	0·00050	0·00054	0·00138	0·00127
0·36317	0·36317	0·36317	0·37859	0·37859
8·83393	8·83649	8·83103	8·83145	8·83446
4 h 9 m p. m.	4 h 29 m p. m.	4 h 50 m p. m.	5 h 15 m p. m.	5 h 35 m p. m.
0·06822	0·06863	0·06777	0·06783	0·06831

SUMMARY OF THE RESULTS.

In the subjoined table will be found all the values of the horizontal intensity deduced either from deflection or vibration observations, and the mean value for every place of observation indicated by latitude and longitude. In the calculations of the means, I have given only half the weight to the determinations made with magnet *VI*, as, from what has been shown above, the values employed for the constants of this magnet cannot be assumed to be nearly so accurately determined as those of magnet *V*.

In calculating the means for the 4th October, 1895, I have not included the results of the last 3 series of vibrations, one of them being incomplete, and the other two taken during quite exceptionally violent magnetic disturbance.

HORIZONTAL INTENSITY.

Date			Local time	H deduced from			Lat. N.	Long. E.	H Mean	Remarks
				Deflections	Magn.	Vibrations				
1893.	Aug.	1	4^h 15^m p. m.	0·11386	VI_e					
			35	0·11401	VI_E					
			8 4		VI	0·11479	69° 41′	60° 20′	0·1145	
			11		VI	0·11490				
			25		VI	0·11487				
	Aug.	8	8 19 p. m.	0·11177	VI_e		69 54	66 43	0·1118	
	Oct.	10	12 21 p. m.	0·05076	V_E					
			1 9	0·05050	V_e		78 19	136 2	0·0504	
			2 3	0·04953	VI_E					
	Oct.	14	12 59 p. m.	0·04995	V_e		78 15	136 1	0·0500	
	Oct.	20	12 29 p. m.	0·04938	V_e		78 19	136 5	0·0494	
			3 21	0·04951	V_E					
	Nov.	3	12 9 p. m.	0·05066	V_e		78 1	134 57	0·0513	
			43	0·05202	V_E					
	Nov.	9	12 14 p. m.	0·05175	V_E		77 54	137 52	0·0516	
			58	0·05149	V_e					
	Nov.	18	12 56 p. m.	0·05022	V_e		78 25	139 16	0·0502	
	Nov.	25	11 35 a. m.	0·05015	V_e		78 37	139 4	0·0500	
			12 9 p. m.	0·04982	V_E					
1894.	Feb.	17	1 15 p. m.	0·04260	V_e		80 2	133 49	0·0426	
	Feb.	22	12 37 p. m.	0·04298	V_e		80 10	133 49	0·0429	
			1 7	0·04274	V_E					
	Feb.	27	12 54 p. m.	0·04120	VI_E					
			1 32	0·04218	V_E		80 4	135 27	0·0419	Disturbance
			2 9	0·04201	V_e					
	March	21	4 19 p. m.	0·04454	V_e		79 49	134 58	0·0450	Disturbance
			5 20	0·04536	V_E					
	April	14	5 11 p. m.	0·04231	VI_E		80 12	133 43	0·0425	
			45	0·04255	V_E					
	April	27	12 33 p. m.	0·04001	VI_E		80 36	131 39	0·0400	Disturbance
			3 28	0·03997	V_E		80 36	131 42	0·0397	Disturbance
			4 5	0·03949	V_e					

Date	Local time	*H* deduced from Deflections	Magn.	Vibrations	Lat. N.	Long. E.	*H* Mean	Remarks
1894. May 5	4^h 42^m p.m. 5 9	0·04163 0·04188	V_e V_E		80° 49′	130° 35′	0·0418	
May 10	5 12 p.m. 6 17	0·03954 0·03960	V_E V_e		80 54	130 5	0·0396	
May 22	11 36 a.m. 12 10 p.m. 43	0·03871 0·03874 0·03867	VI_E V_E V_e		81 24	124 38	0·0387	
May 31	12 21 p.m. 4 30 5 11	0·03947 0·04008 0·03960	VI_E V_E V_e		81 32	122 18	0·0398	Disturbance
June 7	11 54 a.m. 12 33 p.m. 4 51	0·03944 0·03983 0·04031	V_e V_E VI_E		81 28	122 10	0·0398	Disturbance
June 12	4 19 p.m. 5 42	0·04113 0·03998	V_E V_E		81 43	122 13	0·0406	Great disturbance
June 23	4 45 p.m.	0·03901	V_E		81 43	121 24	0·0390	Great disturbance
June 28	5 19 p.m. 43	0·03927 0·03973	V_E V_e		81 35	121 37	0·0395	Disturbance
July 6	4 28 p.m. 5 3	0·04030 0·04031	V_e V_E		81 30	124 39	0·0403	
July 11	4 36 p.m. 5 20	0·03859 0·03938	V_E V_e		81 19	124 38	0·0390	Disturbance
July 14	5 17 p.m.	0·03923	V_E		81 32	124 58	0·0392	Disturbance
July 25	5 15 p.m. 50	0·03951 0·03920	V_E VI_E		81 20	125 47	0·0394	
Aug. 4	12 11 p.m. 2 57	0·03916 0·03946	V_E V_E		81 6	127 25	0·0393	Disturbance
Aug. 18	4 5 p.m. 33 6 6 7 11	0·03895 0·03887	V_e V_E V V	 0·03977 0·03977	81 5	128 7	0·0393	
Sept. 5	4 51 p.m.	0·04019	V_E		81 12	123 8	0·0402	

Date		Local time	*H* deduced from			Lat. N.	Long. E.	*H* Mean	Remarks
			Deflections	Magn.	Vibrations				
1894.	Sept. 21	$12^h\ 46^m$ p. m.		V	0·03929	81° 12′	123° 25′	0·0393	
		3 6		V	0·03944				
		30		V	0·03912	81 12	123 22	0·0384	
		5 14	0·03816	V_E					
		42	0·03702	V_e					
	Oct. 20	12 3 p. m.	0·04021	V_e		81 57	115 0	0·0404	
		24	0·04063	V_E					
		4 20		V	0·04066	81 58	114 58	0·0407	
	Nov. 10	4 54 p. m.	0·04169	V_E		82 11	110 42	0·0417	
	Nov. 16	12 34 p. m.		V	0·04115	82 6	110 39	0·0411	
		56		V	0·04097				
		5 4	0·04172	V_E		82 6	110 42	0·0417	
	Nov. 24	11 44 a. m.		V	0·04053	81 58	111 59	0·0406	
		12 38 p. m.		V	0·04065				
		3 41		V	0·03958	81 58	111 58	0·0391	Great disturbance
		5 28	0·03861	V_E					
	Nov. 29	11 37 a. m.		V	0·04155				
		12 33 p. m.		V	0·04251	82 10	110 54	0·0420	
		54		V	0·04180				
		4 42	0·04068	V_E		82 10	110 50	0·0407	
	Dec. 7	4 4 p. m.		V	0·04214				
		25		V	0·04187				
		52		V	0·04165	82 20	108 58	0·0418	
		5 44	0·04155	V_E					
	Dec. 14	4 55 p. m.	0·04129	V_E		82 33	107 53	0·0414	
		5 23	0·04150	V_E					
	Dec. 21	4 6 p. m.	0·04496	V_E		82 54	104 6	0·0443	
		53	0·04326	VI_E					
1895.	Jan. 12	5 22 p. m.	0·04167	V_E		83 41	102 47	0·0417	
	Jan. 18	4 35 p. m.	0·04224	V_E		83 25	102 30	0·0424	
		5 7	0·04280	VI_E					
	March 7	5 41 p. m.	0·04318	V_E		84 1	101 53	0·0432	

Date	Local time	H deduced from Deflections	H deduced from Magn.	H deduced from Vibrations	Lat. N.	Long. E.	H Mean	Remarks
1895. March 10	4^h 5^m p.m.	0·04545	V_E		83° 59′	102° 12′	0·0448	
	43	0·04341	VI_E					
April 5	4 38 p.m.	0·04538	V_E		84 17	97 23	0·0454	
	5 8	0·04529	VI_E					
April 6	2 26 p.m.		V	0·04535				
	51		V	0·04527	84 18	96 52	0·0453	
	3 13		V	0·04533				
April 20	11 37 a.m.		V	0·04695				
	12 18 p.m.		V	0·04596				
	39		V	0·04620				
	3 23		VI	0·04503				
	46		VI	0·04548	84 13	94 30	0·0462	
	4 10		VI	0·04579				
	37		VI	0·04585				
	5 37	0·04664	VI_E					
	57	0·04658	V_E					
May 9	3 18 p.m.		V	0·04554				
	4 0		V	0·04533				
	32		V	0·04532	84 35	90 21	0·0458	
	5 45	0·04697	V_E					
May 24	11 17 a.m.		V	0·04958				
	48		V	0·04991				
	12 7 p.m.		V	0·05005	84 41	82 36	0·0498	
	32		V	0·04984				
	4 9	0·04941	V_E		84 41	82 31	0·0496	
	4 40	0·04984	V_E					
July 3	3 42 p.m.	0·05283	V_E					
	59	0·05190	V_e					
	4 16	0·05221	VI_e		84 42	74 20	0·0523	
	33	0·05194	VI_E					
July 4	4 22 p.m.		VI	0·05227				
	44		VI	0·05278				
	5 5		VI	0·05284	84 43	74 38	0·0527	
	33		V	0·05274				
	52		V	0·05274				

Date	Local time	*H* deduced from Deflections	Magn.	Vibrations	Lat. N.	Long. E.	*H* Mean	Remarks
1895. July 13	$5^h\ 4^m$ p.m.	0·05140	V_E		84° 41′	76° 1′	0·0513	
	25	0·05123	V_e					
July 26	11 52 a.m.		V	0·05248	84 30	72 56	0·0527	
	12 11 p.m.		V	0·05248				
	36		VI	0·05288				
	1 2		VI	0·05313				
	5 4	0·05284	V_e		84 30	73 1	0·0527	
	22	0·05282	V_E					
	40	0·05221	VI_E					
	58	0·05255	VI_e					
Aug. 8	4 7 p.m.		V	0·05140	84 38	77 7	0·0514	
	28		V	0·05122				
	49		V	0·05153				
	5 10		V	0·05148				
Aug. 23	4 37 p.m.	0·05103	V_e		84 11	79 1	0·0517	Disturbance
	5 0	0·05230	V_E					
Sept. 6	5 8 p.m.	0·04957	V_E		84 53	78 45	0·0496	
Sept. 7	11 6 a.m.	0·05039	V_E		84 54	78 41	0·0507	
	26	0·05036	V_e					
	3 21 p.m.		V	0·05086				
	40		V	0·05107				
Sept. 27	11 28 a.m.	0·04996	V_e		85 8	79 28	0·0508	Movement in the ice.
	50	0·05172	V_E					
	12 11 p.m.	0·05043	VI_E					
	5 13		VI	0·04969	85 8	79 30	0·0496	
	34		VI	0·04952				
	6 54		V	0·04962				
	7 15		V	0·04967				
Oct. 3	12 2 p.m.	0·05067	V_E		85 12	78 59	0·0502	
	23	0·05008	V_e					
	3 20		V	0·04996				
	42		V	0·04995				
	4 2		V	0·05029				
	24		V	0·05029				

Date	Local time	H deduced from			Lat. N.	Long. E.	H Mean	Remarks
		Deflections	Magn.	Vibrations				
1895. Oct. 4	11^h 14^m a. m.	0·05029	V_e		85° 11′	78° 53′	0·0504	
	36	0·05047	V_E					
	3 32 p. m.		V	0·04846				
	52		V	0·04915				
	4 14		V	0·04901	85 10	78 51	0·0488	Disturbance
	38		V	0·04830				
	5 0		V	0·04886				
	22		V	0·04912				
	43		V	[0·04773]				
	7 1		V	[0·04568]				
	23		V	[0·04378]				
Oct. 17	11 41 a. m.	0·04747	V_E					
	Noon	0·04743	V_e		85 36	78 25	0·0475	
	12 19 p. m.	0·04743	VI_E					
	4 27		V	0·04743				
	58		V	0·04670	85 37	78 23	0·0472	
	5 25		V	0·04719				
	47		V	0·04763				
Oct. 24	11 2 a. m.	0·04834	V_E		85 46	73 40	0·0485	
	28	0·04860	V_e					
	4 8 p. m.		V	0·04835				
	31		V	0·04832	85 46	73 30	0·0483	
	58		V	0·04832				
Nov. 2	12 10 p. m.	0·05012	V_e		85 40	69 54	0·0501	
	29	0·05015	V_E					
Nov. 9	5 3 p. m.	0·05069	V_E		85 42	64 22	0·0508	
	29	0·05099	V_e					
Nov. 20	11 34 a. m.	0·05212	V_e		85 51	64 20	0·0521	
	54	0·05215	V_E					
	4 45 p. m.		V	0·05026				
	5 8		V	0·05013	85 51	64 18	0·0502	
	31		V	0·05022				
Nov. 22	4 25 p. m.	0·05187	VI_E		85 47	64 11	0·0519	
Nov. 30	4 18 p. m.	0·05289	V_e		85 28	58 41	0·0528	
	41	0·05272	V_E					

Date			Local time	H deduced from			Lat. N.	Long. E.	H Mean	Remarks
				Deflections	Magn.	Vibrations				
1895.	Dec.	5	3^h 49^m p.m.	0·05447	V_E					
			4 15	0·05406	V_e		85° 29′	55° 52′	0·0542	
			40	0·05377	VI_E					
	Dec.	12	4 26 p.m.	0·05599	V_E					
			5 27		V	0·05577				
			7 3		V	0·05579	85 25	50 7	0·0559	
			22		V	0·05608				
			43		V	0·05609				
1896.	Jan.	4	4 29 p.m.	0·05426	V_E		85 17	44 55	0·0544	
			53	0·05460	V_e					
	Jan.	10	3 59 p.m.	0·05974	V_e					
			4 30	0·06017	V_E		84 58	41 16	0·0595	
			5 1	0·05778	VI_E					
	Jan.	18	12 3 p.m.	0·06028	V_E		84 56	39 47	0·0598	
			28	0·05940	V_e					
	Jan.	28	11 27 a.m.	0·06250	V_e		84 41	31 41	0·0621	
			52	0·06173	V_E					
			4 18 p.m.		V	0·06192				
			39		V	0·06177	84 41	31 43	0·0619	
			5 3		V	0·06190				
	Feb.	4	12 6 p.m.	0·06198	VI_E		84 43	24 59	0·0620	
	Feb.	5	10 37 a.m.	0·06269	V_E		84 39	24 38	0·0625	
			59	0·06231	V_e					
	Feb.	13	10 52 a.m.	0·06591	V_e		84 18	22 45	0·0658	
			11 17	0·06565	V_E					
	Feb.	25	11 14 a.m.	0·06463	VI_E					
			37	0·06492	V_E		84 11	24 13	0·0651	
			12 1 p.m.	0·06541	V_e					
	March	6	11 23 a.m.	0·06387	V_e		84 4	24 56	0·0642	
			51	0·06445	V_E					

Date	Local time	*H* deduced from			Lat. N.	Long. E.	*H* Mean	Remarks
		Deflections	Magn.	Vibrations				
1896. March 7	5^h 14^m p.m.	0·06370	V_E		84° 0′	24° 9′	0·0637	
March 19	11 27 a.m.	0·06359	VI_E					
	56	0·06383	V_E		84 5	24 43	0·0637	
	12 24 p.m.	0·06367	V_e					
	4 0		V	0·06385				
	22		V	0·06371				
	42		V	0·06352	84 5	24 40	0·0636	
	5 21		VI	0·06346				
	40		VI	0·06326				
	6 49		VI	0·06332				
April 9	5 1 p.m.	0·06413	V_e		84 27	18 33	0·0638	
	22	0·06352	V_E					
April 21	4 38 p.m.	0·06425	VI_E					
	5 1	0·06461	V_E		84 4	13 12	0·0647	
	24	0·06499	V_e					
May 8	11 23 a.m.	0·06422	V_e		83 56	11 4	0·0638	
	41	0·06337	V_E					
	4 1 p.m.		V	0·06539				
	23		V	0·06546	83 56	11 3	0·0652	
	44		V	0·06510				
	5 5		V	0·06494				
June 3	4 18 p.m.	0·06861	V_E		83 16	12 33	0·0685	Some movement in the ice
	36	0·06843	V_e					
June 18	11 22 a.m.	0·06874	V_e					
	40	0·06938	V_E					
	57	0·06873	VI_E					
	4 9 p.m.		V	0·06822	82 56	11 35	0·0685	
	29		V	0·06863				
	50		V	0·06777				
	5 15		VI	0·06783				
	35		VI	0·06831				
July 8	4 41 p.m.	0·06790	VI_E					
	56	0·06763	V_E		83 3	12 56	0·0679	
	5 10	0·06805	V_e					

D. INCLINATION.

When the Neumayer magnetometer is to be employed for the determination of inclination and total intensity, the magnet box, and the telescope, as indicated in the introduction, are removed, and upon the alhidade of the horizontal circle is fixed a vertical circle, intended for this purpose, and constructed like a Fox apparatus. For the purpose of deflecting the inclination-needle, two cylindrical magnets are to be screwed into the alhidade on the back of the circle as deflectors. There are two inclination-needles belonging to the instrument designated as B and B^{I}. Of these two, the needle B is stated in Dr. Neumayer's manuscript to be the most reliable, and it has therefore been used in the great majority of cases. There are in all 92 series of observations for the determination of the inclination, only 4 of these being with needle B^{I}. The observations were made in the usual manner, care being taken to observe the prescribed precautions, namely, constant rubbing with the ivory disc, turning the bracket by means of the screw-head at the back of the circle, cleaning the pivots with elder pith, and the cleaning of the needle itself and the pivot-holes.

The meridian reading was first determined on the horizontal circle by four settings in the magnetic prime vertical, both the north and the south end of the needle being brought into coincidence with the circle's vertical points, 90°, in both positions of the instrument designated as "Circle N" and "Circle S". In the next place, a series of inclination-readings were taken in the two positions of the instrument designated as "Circle E" and "Circle W". As the needles were always used in the same position, with the marked side of the needle outwards, and as naturally no inversion of the poles could be performed, since the needle was also to be employed for determinations of the intensity, the mean value of the inclination found by the method described above is only relative, and must be corrected for the index-error of the needle in question.

DETERMINATION OF THE INDEX-ERROR.

If the inclination observed with the apparatus is called I', the actual inclination I, and the index-error of the needle used $\varDelta$, we have

$$I = I' + \varDelta .$$

This index-error is due to two different sources, namely, first, the circumstance that the magnetic axis of the needle does not coincide with its geometrical axis, and secondly, that the needle's axis of rotation does not pass exactly through its centre of gravity.

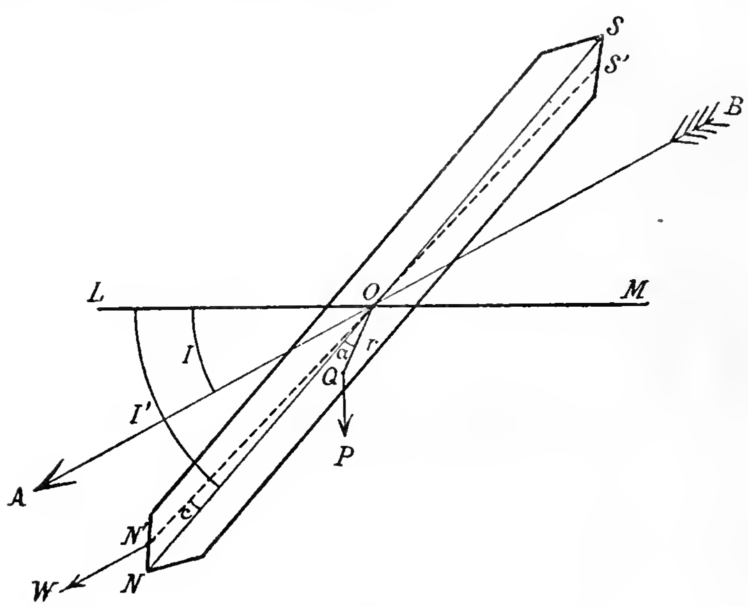

Fig. 3.

In fig. 3, NS indicates the needle's geometrical axis, $N'S'$ its magnetic axis, the angle between them being called c. Q is the needle's centre of gravity, and O the point of intersection of the axis of rotation with the vertical plane. The line connecting these two points, r, then makes with the geometrical axis of the needle, an angle NOQ, which we will call α, and which is reckoned as positive from the north end of the needle through the nadir from 0° to 360°. Let the weight of the needle be indicated by P. This, acting in the centre of gravity Q, will divert the needle from its position with its magnetic axis in the direction of the total intensity, indicated in the figure by the arrow $A\,B$. Calling the total intensity W, and the magnetic moment of the needle m, the following condition for equilibrium is obtained[1], the line LM indicating the horizon:

$$mW \sin (AON') = P.r.\cos (LOQ).$$

Now the angle of deflection

$$AON' = LON - c - LOA = I' - c - I = -c - \varDelta ,$$

and the angle $LOQ = I' + \alpha$. We then get

$$\sin (c + \varDelta) = -\frac{P.r}{m.W} \cos (I' + \alpha) ,$$

and when we put $\sin (c + \varDelta) = (c + \varDelta) \sin 1'$, and the constant quantity $-\frac{P.r}{m.\sin 1'}$ is signified by p,

$$\varDelta = -c + \frac{p}{W} \cos (I' + \alpha) . \qquad (1)$$

Thus the index-error consists of a constant and a variable term, and this equation contains 3 constants, c, p, and α, which can be determined when inclination-observations have been made with the needle in question in at least 3 different places, of which the inclination and total intensity are known.

Observations such as these, however, were only taken in Hamburg in 1893, and at Wilhelmshaven in 1897, in Hamburg with both needles, at Wilhelmshaven only with needle B. The result was as follows:

	W	I	Needle B		Needle B^{I}	
			I'	$\varDelta$	I'	$\varDelta$
Hamburg, June, 1893 . . .	0·47842	67° 42′	68° 2·7′	−20·7′	68° 5′	−23′
Wilhelmshaven, April 20, 1897	0·47630	67 47·5	68 0·8	−13·3		
Mean	0·4774	67° 44·8′	68° 1·8′	−17·0′		

[1] Liznar. Anleitung zur Messung und Berechnung der Elemente des Erdmagnetismus, Vienna, 1883, p. 44.

The material is thus insufficient for a direct calculation of the three constants, and I therefore hesitated at first in considering the entire index-error as approximately constant, with the mean value $-17'$ for needle B, and $-23'$ for needle B^{I}. This is a serious matter, however, when it is a question of observations in the polar regions where the inclination is not far from 90°, and the total intensity, or the horizontal intensity, has to be calculated by the formula

$$W = \frac{H}{\cos I}. \qquad (2)$$

It therefore occurred to me that it ought perhaps to be possible to make use of some of the observations made during the expedition with the Fox apparatus for the determination of the total intensity, as a check upon, or for the eventual improvement of, the value of the index-error, if we had simultaneous, reliable determinations of the horizontal intensity.

The apparatus was accompanied by the two already-mentioned cylindrical deflectors for the determination of the total intensity, as also by a set of accurately corrected weights. On only one occasion, however, was an attempt made to use these weights; and the observation-result obtained does not admit of criticism, as there is no material for the calculation of a table for equivalent weights. The employment of weights, moreover, is not very practical in the severe cold of the polar regions, on account of the repeated opening of the door of the apparatus. The deflectors, on the contrary, were regularly used for intensity determinations in connection with the inclination observations, generally, however, only one deflector, both deflectors together having been used only 5 times.

If we call the inclination-needle's angle of deflection produced by the employment of both deflectors simultaneously, ψ_2, and the total intensity W, we have the following condition for equilibrium:

$$W \sin \psi_2 = R_2 (1 + \zeta t), \qquad (3)$$

where R_2 is a constant quantity dependent upon the magnetic moment of both deflectors and the needle employed, ζ is the temperature-coefficient, and t the temperature observed during the deflection-observations. R_2 and ζ may then be determined by taking a series of observations of ψ_2 under the greatest possible differences of temperature, at one or more places where the total intensity is known. Deflection observations with the employment of both deflectors together were taken before leaving, in Hamburg, with both needles, and after the return, at Wilhelmshaven, with needle B, although in both places in a rather uniform temperature. The observations gave the following results:

	W	Needle B			Neeele B^{I}		
		$t°$ C.	ψ_2	$R_2(1+\zeta t)$	$t°$ C.	ψ_2	$R_2(1+\zeta t)$
Hamburg, 1893	0·47842	13·0	58° 31·25′	0·40492	13·0	57° 57·0′	0·40024
Wilhelmshaven, 1897	0·47630	18·3	57 15·0	0·40059			

The two values of R_2 $(1+\zeta t)$ for needle B indicate that the aggregate magnetic moment of the deflectors has become weaker in the course of the 4 years, if the decrease in the value of R_2 $(1+\zeta t)$ is not assumed to be due exclusively to the higher temperature noted during the experiment at Wilhelmshaven, which would give for ζ a value of $-0{\cdot}00258$.

The observations from the expedition, however, afford an opportunity for the calculation of an approximate value for ζ. As already mentioned, deflection observations with the employment of both deflectors were made 5 times, 4 times with needle B, and once with needle B^{I}. The results of the observations on the days on which needle B was used, are placed in the following table, which also contains the assumed value of the horizontal intensity, H, for the places of observation concerned, found by graphic interpolation by the aid of the direct determinations of H, made in adjacent places.

	t	ψ_2	H	I'
1893. Oct. 16	−17·0°	52° 40·4′	0·0497	85° 31·3′
Dec. 2	−23·7	52 46·2	0·0500	85 29·3
1894. Feb. 10	−31·6	53 1·2	0·0432	86 7·0
March 30	−24·0	51 44·1	0·0431	86 13·2

As shown by the table, the total intensity of the 16th October and the 2nd December, 1893, may be assumed to have been very nearly the same, as both H and I' — the uncorrected value of the inclination observed directly with the apparatus, simultaneously with the deflection observations — exhibit about the same value on both the days mentioned. The same assumption is also possible in the case of the last two observation-days, February 10th and March 30th, 1894. There are thus two groups of observation-data, from which ζ may be calculated, supposing that R_2 has remained constant during the period of a few weeks which each group embraces. We then obtain

$$\zeta = \frac{\sin \psi_2 - \sin \psi_2'}{t \sin \psi_2' - t' \sin \psi_2},$$

when ψ_2 and ψ_2', t and t' indicate the angle of deflection and the temperature observed respectively on the first and the second of the two days of the groups in question. The calculation gave the two following values for ζ:

	ζ
1893. Oct. 16 and Dec. 2	— 0·0001979
1894. Feb. 10 and March 30 . . .	— 0·002435
Mean	— 0·00132

Although this result cannot naturally lay claim to any great degree of accuracy, I have thought it possible, in the absence of anything better, to make use of it, and have therefore, with $\zeta = -0{\cdot}00132$, calculated R_2 by the observations in Hamburg in 1893, and in Wilhelmshaven in 1897, and have found,

	R_2
for June 9, 1893 . . .	0·41198
„ April 20, 1897 . . .	0·41054.

Starting with the supposition that R_2 has decreased proportionally with time, I have been able, by graphic interpolation, to deduce the following values for the above-mentioned 4 days, viz.

	R_2
in 1893, Oct. 16	0·4118
Dec. 2	0·4118
in 1894, Feb. 10	0·4117
March 30 . . .	0·4117.

By substituting these values in formula (3), we obtain the total intensity W, which, together with the corresponding values of the horizontal intensity specified on page 131, give the actual inclination I, according to formula (2).

The difference between this and the inclination I' observed with the apparatus, will then be the index-error of B. The result of the calculations is given in the following table.

Date			W	I	I'	$\varDelta$
1893.	Oct.	16	0·5295	84° 36·9′	85° 31·3′	−54·4′
	Dec.	2	0·5334	84 37·3	85 29·3	−52·0
1894.	Feb.	10	0·5369	85 23·1	86 7·0	−43·9
	March	30	0·5410	85 25·8	86 13·2	−47·4
Mean			0·5352	85° 0·8	85° 50·2′	−49·4

The mean value of the index-error found in this manner at an inclination of about 85°, differs so considerably from that found in Hamburg and Wilhelmshaven at an inclination of about 67°, that $\varDelta$ can hardly be regarded as constant. Now if we had also had a determination of $\varDelta$ at a place where the inclination is about 75°, we should, as already mentioned, have been able to determine all three constants, c, p, and α, in equation (1). As this is not the case, our only alternative is to put $c = 0$, if any regard at all is to be paid to the variableness of the index-error with inclination and total intensity. An assumption such as that the angle between the magnetic and the geometrical axes of the needle is infinitesimally small in proportion to the error in the inclination-determinations caused by the eccentricity of the centre of gravity, will also usually be perfectly justifiable, and upon this hypothesis equation (1) becomes

$$\varDelta = \frac{p}{W} \cos (I' + \alpha). \tag{4}$$

We then have the following corresponding data for the determination of the constants p and α:

	$\varDelta$	W	I'
$\dfrac{\text{Hamburg 1893} + \text{Wilhelmshaven 1897}}{2}$	−17·0′	0·4774	68° 1·8′
Fram Expedition 1893—94	−49·4′	0·5352	85° 50·2′

If we substitute these values in formula (4), to which is given the form

$$W\varDelta = x \cos I' - y \sin I',$$

where $x = p \cos \alpha$, and $y = p \sin \alpha$, we obtain

$$\alpha = 209^\circ\, 33'$$
$$p = \quad -61{\cdot}5'$$

In order now to be able to calculate by formula (4) the Δ corresponding to any inclination-determination, it will clearly be necessary to know the total intensity. It is true that during the expedition, observations with the Fox apparatus for the calculation of the total intensity were also generally made simultaneously with the inclination determinations; but since the result of these — as will presently be more fully explained — can hardly be regarded otherwise than as a failure, the horizontal intensity may be introduced into formula (4) instead of the total intensity — the former having been determined by separate observations independent of the Fox apparatus —, and we may put

$$W = \frac{H}{\cos (I' + \Delta)},$$

whereby we obtain

$$\Delta = \frac{p \cos (I' + \Delta)}{H} \cos (I' + \alpha),$$

an equation which may easily be solved with regard to Δ, when that quantity is assumed to be sufficiently small to allow of putting $\cos \Delta = 1$, and $\sin \Delta = \Delta \sin 1'$. The final formula for Δ then becomes

$$\Delta = \frac{p \, . \cos (I' + \alpha) \cos I'}{H + p \cos (I' + \alpha) \sin I' \sin 1'} \tag{5}$$

By the aid of this formula, I have calculated the following table, which gives Δ for needle B, in minutes, for every degree of I' from 83° to 87°, and for every 5th unit in the 3rd decimal place of the horizontal intensity from $H = 0{\cdot}035$ to $H = 0{\cdot}070$.

	Δ				
H	I'				
	83°	84°	85°	86°	87°
0·070	−45·5′	−40·9′	−35·6′	−29·7′	−23·2′
0·065	−49·4	−44·4	−38·7	−32·3	−25·2
0·060	−54·1	−48·6	−42·4	−35·4	−27·7
0·055	−59·7	−53·7	−46·8	−39·1	−30·6
0·050	−66·6	−59·9	−52·3	−43·8	−34·3
0·045	−75·3	−67·8	−59·3	−49·6	−38·9
0·040	−86·6	−78·1	−68·4	−57·3	−45·0
0·035	−102·0	−92·1	−80·8	−67·8	−53·3

I have finally represented graphically the values of $\varDelta$ contained in the table, as a function of I' and H, and have drawn curves through the points corresponding to the same value of $\varDelta$ for every 5th minute. I was hereby enabled to take out without difficulty the value of $\varDelta$ applicable to the case, in whole minutes, for every observation of I', when I had either directly or by interpolation found the value of H corresponding to the place of observation.

As already mentioned, deflection observations with the employment of both deflectors were only taken once with needle B^{I} during the expedition, namely on May 4th, 1894. Altogether this needle has only been used 4 times during the voyage, and no observations were made with it at Wilhelmshaven after the return. There is thus no material upon which to base even a roughly approximate determination of the temperature-coefficient ζ for this needle, but I have nevertheless thought it feasible to make use of the deflection observations of May 4th, 1894, for the calculation of the constants of the index-correction in the same manner as for needle B, taking for granted that also in the case of needle B^{I} the magnetic axis coincides with the geometrical axis. For the calculation of the total intensity, I have simply employed the value of $R_2\,(1+\zeta t)$ that was found in Hamburg in 1893, supposing a possible weakening of the magnetic moment of the magnets to be approximately compensated by the considerably lower temperature. This, during the observations in Hamburg, was 13° C., whereas on May 4th, 1894, it was —8° C.

Thus, if we put $R\,(1+\zeta t) = 0{\cdot}40024$, we obtain, with the angle of deflection observed $\psi_2 = 50°\,28'$, according to formula (3),

$$W = 0{\cdot}5186.$$

As the value for the horizontal intensity, I have employed the mean of the values found on April 27th and May 5th, 1894, and have put $H = 0{\cdot}041$. The true inclination, calculated by W and H, thus becomes $I = 85°\,28'$; and as the inclination observed with the Fox apparatus is $I' = 86°\,16'$, we obtain $\varDelta = -48'$. Thus we have for the determination of the constants p and α for needle B^{I},

	$\varDelta$	W	I'
Hamburg, June, 1893	—23′	0·4748	68° 5′
Fram Exp., May 4th, 1894 . . .	—48′	0·5186	86° 16′,

whence we obtain $\alpha = 215° 8'$
$p = -47{\cdot}8'$.

With these values substituted in formula (5) I have calculated Δ for the 4 cases in which the inclination has been determined with needle B^{I}. The calculation gave the following result:

Date	H	I'	Δ	I
1893. Aug. 8	0·1118	78° 56′	−35′	78° 21′
1894. May 4	0·0408	86 16	−48	85 28
May 23	0·0395	86 18	−50	85 28
June 1	0·0398	86 17	−50	85 27

The value of H for Aug. 8th, 1893, was determined directly by observation. I have determined the horizontal intensity for the remaining 3 days by graphic interpolation.

THE OBSERVATIONS.

No advantage was taken during the expedition of the opportunity afforded by the Fox apparatus of also determining the inclination indirectly by the aid of deflectors.

The following list contains in chronological order all the inclination observations taken, with a statement of the assumed value of the horizontal intensity for the place of observation, found by graphic interpolation from direct determinations of this element made at neighbouring places. As previously mentioned, no note was made of the time at the setting of the inclination-needle, and therefore no exact time can be given for the calculated mean value of the inclination. On a few occasions, however, a statement has been added in the observation-journal as to whether the inclination determination was made in the morning or the afternoon, this being indicated in the list with a. m. and p. m. respectively. When no time of day is stated, the given latitude and longitude apply to about midday, while a. m. is considered as about 10 a. m., and p. m. as about 4 p. m. The mean of the meridian readings is entered under the heading "Mer." and the readings of the north and south ends of the needle are indicated with N. and S. respectively.

OBSERVATIONS OF INCLINATION.

1893. August 1. Khabarova.

Lat. N. 69° 41′
Long. E. 60° 20′

Needle *B* $H = 0{\cdot}115$

Mer. 227° 44′

	Circle E.		Circle W.	
	N	S	N	S
	78° 30′	78° 32′	77° 50′	77° 58′
Mean	78° 31·0′		77° 54·0′	

$I' = 78° 13'$
$\Delta = -35$
$I = 77° 38'$

1893. August 8. On a grounded ice-floe to which the *Fram* was moored. Place of observation about 100 metres from the ship.

Lat. N. 69° 54′
Long. E. 66° 43′

Needle B^{I} $H = 0{\cdot}112$

Mer. [1])

	Circle E.		Circle W.	
	N	S	N	S
	78° 40′	78° 50′	79° 15′	79° 0′
Mean	78° 45·0′		79° 7·5′	

$I' = 78° 56'$ [2])
$\Delta = -35$
$I = 78° 21'$

[1]) The mean of the declination readings. [2]) Fresh breeze from ESE. Obliged to discontinue, as the waves broke upon the ice-floe, and we had to get ready to leave it with the vessel, in case the floe should break up.

1893. October 16. On the ice, 160 paces from the vessel.

Lat. N. 78° 17′
Long. E. 136° 9′

Needle *B* $H = 0{\cdot}050$

Mer. 241° 34′

	Circle E.		Circle W.	
	N	S	N	S
	85° 20′	85° 15′	85° 40′	85° 45′
	15	12	45	52
	18	15	48	55
	15	10	45	52
Mean	85° 15·0′		85° 47·7′	

$I' = 85° 31'$
$\Delta = -48$
$I = 84° 43'$

1893. October 21. On the ice, 160 paces from the vessel.

Lat. N. 78° 18′
Long. E. 135° 50′

Needle *B* $H = 0{\cdot}049$

Mer. 170° 28′

	Circle E.		Circle W.	
	N	S	N	S
	85° 40′	85° 25′	85° 22′	85° 30′
	38	27	32	32
	25	20	30	30
	35	22	28	40
	38	30	20	27
	25	12	20	25
	35	27	30	32
	35	20	30	32
Mean	85° 28·4′		85° 28·8′	

$I' = 85° 29'$
$\Delta = -50$
$I = 84° 39'$

1893. December 2.

Lat. N. 78° 43′
Long. E. 138° 30′

Needle *B* — $H = 0{\cdot}050$

Mer. 252° 26′

a. m.

	Circle W. N	Circle W. S	Circle E. N	Circle E. S
	85° 27′	85° 29′	85° 29′	85° 20′
	35	31	28	18
	50	40	25	20
	30	30	20	18
Mean	85° 34·0′		85° 22·3′	

I′ = 85° 28′
Δ = − 49
I = 84° 39′

p. m.

	Circle E. N	Circle E. S	Circle W. N	Circle W. S
	85° 25′	85° 20′	85° 40′	85° 38′
	18	20	50	48
	18	18	50	50
	18	18	35	40
	25	25	30	32
	28	20	32	35
Mean	85° 21·1′		85° 40·0′	

I′ = 85° 31′
Δ = − 48
I = 84° 43′

1894. January 26.

Lat. N. 79° 44′
Long. E. 153° 12′

Needle *B* — $H = 0{\cdot}045$

Mer. 243° 41′

	Circle E. N	Circle E. S	Circle W. N	Circle W. S
	86° 10′	86° 15′	86° 35′	86° 35′
	85 58	85 55	35	38
	86 15	86 20	30	33
	5	10	50	40
	5	0	45	38
	10	3	35	40
Mean	86° 7·2′		86° 37·8′	

I′ = 86° 23′
Δ = − 45
I = 85° 38′

1894. February 10.

Lat. N. 79° 56′
Long. E. 134° 51′

Needle *B* — $H = 0{\cdot}043$

Mer. 232° 18′

	Circle W. N	Circle W. S	Circle E. N	Circle E. S
	85° 50′	86° 2′	86° 0′	86° 0′
	58	12	8	12
	86 5	14	5	10
	5	10	8	0
	2	9	5	12
	15	25	5	15
Mean	86° 7·3′		86° 6·7′	

I′ = 86° 7′
Δ = − 51
I = 85° 16′

1894. March 17.

Lat. N. 79° 37′
Long. E. 135° 10′

Needle *B* — $H = 0{\cdot}045$

Mer. 212° 54′

	Circle E. N	Circle E. S	Circle W. N	Circle W. S
	85° 43′	85° 50′	86° 2′	86° 5′
	52	48	5	85 58
	55	45	2	86 0
	55	52	1	85 59
	55	48	0	86 5
	58	86 2	5	2
	58	0	0	1
	57	0	0	0
	50	85 58	0	0
	58	58	0	85 59
	57	55	85 58	59
	48	50	55	57
Mean	85° 53·8′		86° 0·5′	

I′ = 85° 57′
Δ = − 50
I = 85° 7′

1894. March 30, a. m. The revolver in its usual place.

Lat. N. 80° 8′
Long. E. 135° 0′

Needle B $H = 0{\cdot}043$
Mer. 215° 23′

Circle E. N	Circle E. S	Circle W. N	Circle W. S
86° 20′	86° 13′	86° 7′	86° 13′
14	10	14	20
17	11	10	17
20	13	6	18
10	1	18	31
8	4	13	20
10	6	14	18
2	2	15	16
20	15	15	17
13	5	13	18
Mean 86° 10·7′		86° 15·7′	

$I' = 86° 13'$
$\varDelta = -50$
$I = 85° 23'$

1894. April 19.

Lat. N. 80° 27′
Long. E. 131° 50′

Needle B $H = 0{\cdot}042$
Mer. 140° 14′ [1])

Circle E. N	Circle E. S	Circle W. N	Circle W. S
86° 13′	86° 2′	86° 15′	86° 12′
18	13	14	17
17	13	12	18
12	18	10	15
14	6	13	20
13	10	10	20
9	10	10	18
13	9	13	18
13	12	14	20
12	9	12	15
16	13	10	13
14	12	10	12
17	8	10	12
16	5	16	18
13	2	16	22
		13	18
Mean 86° 11·7′		86° 14·6′	

$I' = 86° 13'$
$\varDelta = -51$
$I = 85° 22'$

[1]) The needle somewhat disturbed.

1894. May 4, p. m.

Lat. N. 80° 51′
Long. E. 130° 56′

Needle B^{I} $H = 0{\cdot}041$
Mer. 140° 0′

Circle E. N	Circle E. S	Circle W. N	Circle W. S
86° 50′	87° 2′	86° 2′	85° 57′
40	86 50	85 45	86 0
35	45	86 1	0
35	42	1	85 51
31	38	0	54
30	48	85 59	50
42	55	59	50
31	50	86 0	52
31	45	0	57
29	37	0	47
27	35	85 59	46
20	26	58	42
19	30	59	41
		59	45
Mean 86° 37·8′		85° 54·8′	

$I' = 86° 16'$
$\varDelta = -48$
$I = 85° 28'$

1894. May 12.

Lat. N. 80° 52′
Long. E. 130° 10′

Needle *B* $H = 0{\cdot}040$
Mer. 138° 49′

	Circle E. N	Circle E. S	Circle W. N	Circle W. S
	86° 34′	86° 40′	86° 0′	85° 52′
	33	43	85 55	45
	45	36	50	38
	43	43	45	50
	33	48	52	45
	30	42	58	46
	26	36	86 0	48
	30	42	85 50	37
	31	45	44	44
	28	42	47	33
	19	33	45	31
	14	33	47	34
	13	27	57	43
	3	22	55	46
	6	17	86 0	45
	15	27	0	42
	5 [1])	16	85 57	47
	35	50	86 0	43
	32	35	85 59	52
	28	34	58	54
	25	35		
	29	30		
Mean	86° 30·3′		85° 48·8′	

$I' = 86°\,10'$
$\varDelta = -55$
$I = 85°\,15'$

1894. May 23.

Lat. N. 81° 27′
Long. E. 123° 55′

Needle B^{I} $H = 0{\cdot}0039$
Mer. 153° 26′

	Circle E. N	Circle E. S	Circle W. N	Circle W. S
	86° 28′	86° 36′	86° 8′	85° 56
	31	35	5	52
	35	46	8	57
	35	44	10	58
	29	38	13	59
	36	54	7	59
	36	52	3	48
	36	57	85 55	42
	30	40	54	38
	36	42	86 0	47
Mean	86° 38·8′		85° 58·0′	

$I' = 86°\,18'$
$\varDelta = -50$
$I = 85°\,28'$

[1]) Found here that the screw of the bracket had loosened; screwed it up again.

1894. June 1.

Lat. N. 81° 31′
Long. E. 122° 15′

Needle B — $H = 0{\cdot}040$

Mer. 160° 30′

Circle E. N	Circle E. S	Circle W. N	Circle W. S
86° 6	86° 3′	86° 29′	86° 21′
6	2	27	23
2	85 57	26	22
5	86 3	23	24
5	5	18	20
5	4	30	28
85 57	85 57	27	28
86 2	86 10	25	32
6	12	27	29
7	13	22	25
Mean 86° 4·4′		86° 25·3′	

$I' = 86° 15'$
$\Delta = -54$
$I = 85° 21'$

Needle B^{I} ¹)

Circle W. N	Circle W. S	Circle E. N	Circle E. S
85° 50′	85° 46′	86° 52′	87° 0′
57	52	48	5
52	48	44	86 56
58	50	43	55
49	46	45	55
57	48	38	54
48	42	40	48
46	35	50	58
42	25	52	59
32	18	44	50
35	20	46	51
Mean 85° 43·5′		86° 50·6′	

$I' = 86° 17'$
$\Delta = -50$
$I = 85° 27'$

¹) Had to turn the bracket towards the right in order to make the needle oscillate easily.

1894. June 8.

Lat. N. 81° 28′
Long. E. 122° 6′

Needle B — $H = 0{\cdot}040$

Mer. 158° 55′ ¹)

Circle E. N	Circle E. S	Circle W. N	Circle W. S
86° 10′	86° 4′	86° 4′	86° 10′
10	5	5	12
12	6	5	10
10	6	5	10
12	4	12	15
13	8	13	15
13	9	12	16
13	10	13	13
8	10	12	14
7	12	13	13
6	12	15	16
4	8	15	17
2	5	14	15
4	6	16	17
Mean 86° 8·2′		86° 12·4′	

$I' = 86° 10'$
$\Delta = -55$
$I = 85° 15'$

¹) Experimented with two buckles in the uppermost strap between the legs of the stand placing them successively on each side of the north end of the needle. No alteration observable in the position of the needle.

1894. June 14.

Lat. N. 81° 48′
Long. E. 122° 5′

Needle *B* — $H = 0{\cdot}040$

Mer. 161° 36′

Circle E. N	Circle E. S	Circle W. N	Circle W. S
86° 17′	86° 13′	86° 38′	86° 35′
18	12	33	33
20	14	32	34
20	15	33	32
28	23	32	34
25	18	33	35
19	14	31	34
18	13	30	33
16	11	30	37
15	9	31	38
10	6	34	38
5	3	30	38
5	1	33	42
5	1	33	46
8	7	32	44
12	12	31	44
12	12	38	41
10	12	25	31
14	16	29	37
15	17	22	30
		34	46
		30	42
Mean 86° 13·0′		86° 34·5′	

$I' = 86° 24'$
$\Delta = -53$
$I = 85° 31'$

1894. June 27.

Lat. N. 81° 36′
Long. E. 121° 12′

Needle *B* — $H = 0{\cdot}039$

Mer. 196° 43′

Circle E. N	Circle E. S	Circle W. N	Circle W. S
86° 0′	85° 55′	86° 12′	86° 15′
2	86 1	25	24
85 55	85 52	85 55	85 57
40	39	86 16	86 26
43	36	18	27
43	36	13	20
40	36	11	18
40	40	12	18
40	45	16 [1])	28
43	48	29	34
86 2	86 2	27	32
85 55	85 50	30	35
57	56	33 [2])	38
86 2	86 2	43	40
15	10	38	36 [3])
0	85 58	36	35
13	86 10	33	34
25	20	31	30
24	20	30	29
28	24	32	33
		33	31
Mean 85° 57·2′		86° 26·0′	

$I' = 86° 12'$
$\Delta = -57$
$I = 85° 15'$

[1]) Oscill. between 86° 6′ and 86° 18′
[2]) — — 86° 29′ „ 86° 45′
[3]) — — 86° 30′ „ 86° 45′

1894. June 28, a. m.

Lat. N. 81° 35′
Long. E. 121° 30′

Needle *B* $H = 0.039$

Mer. 195° 39′

Circle E. N	Circle E. S	Circle W. N	Circle W. S
86° 45′	86° 40′	86° 13′	86° 16′
33	26	14	19
42	32	9	16
30	20	25	33
35	31	3	8
28	18	38	43
3	2	45	48
24	14	43	52
12	2	48	48
10	8	46	48
1	0	44	47
85 59	0	41	46
86 2	0	43	47
3	1	44	46
4	3	43	41
6	5	43	42
3	2	43	43
5	8	44	43
1	6	45	44
0	5	44	45
Mean 86° 12·7′		86° 37·3′	

$I' = 86° 25'$
$\varDelta = -54$
$I = 85° 31'$ [1])

Circle W. N	Circle W. S	Circle E. N	Circle E. S
86° 10′	86° 14′	86° 12′	86° 12′
9	13	9	10
12	15	16	13
13	17	14	13
13	18	15	13
14	16	12	7
16	18	12	8
18	19	12	3
20	21	13	8
18	18	12	6
23	22		
Mean 86° 16·2′		86° 11·0′	

$I' = 86° 14'$
$\varDelta = -56$
$I = 85° 18'$

[1]) As the needle was oscillating so irregularly, the bracket was moved over so as to come to the left of the needle, whereupon the following observations were taken.

1894. July 10.

Lat. N. 81° 18′
Long. E. 124° 32′

Needle *B* $H = 0.039$

Mer. 185° 12′

Circle E. N	Circle E. S	Circle W. N	Circle W. S
86° 18′	86° 14′	86° 12′	86° 16′
16	12	10	15
15	12	10	17
14	12	13	17
15	12	14	18
17	17	12	18
17	16	14	16
16	14	15	18
17	14	16	18
12	13	17	19
13	13	18	19
16	14	17	18
17	16	15	17
18	17	15	17
13	11	16	18
12	8	18	20
12	7	18	19
12	8	22	24
13	10	20	20
		24	20
Mean 86° 13·8′		86° 17·0′	

$I' = 86° 15'$
$\varDelta = -56$
$I = 85° 19'$

Circle W. N	Circle W. S	Circle E. N	Circle E. S
86° 27′	86° 25′	86° 18′	86° 13′
27	25	16	12
20	22	15	14
13	20	12	13
12	17	12	13
Mean 86° 20·8′		86° 13·8′	

$I' = 86° 17'$
$\varDelta = -56$
$I = 85° 21'$ [1])

[1]) With the bracket near the needle.

1894. July 14, a. m.

Lat. N. 81° 32′
Long. E. 124° 59′

Needle *B* $H = 0{\cdot}039$

Mer. 200° 3′

	Circle E. N	Circle E. S	Circle W. N	Circle W. S
	86° 22′	86° 13′	86° 28′	86° 26′
	20	16	29	27
	18	16	27	25
	17	13	24	24
	17	15	25	24
	18	13	20	22
	17	13	22	22
	15	12	23	26
	16	13	20	21
	20	16	18	22
	18	17	17	19
	16	15	16	18
	17	17	15	18
	18	16	14	19
	15	16	14	17
	15	15	12	14
	18	16	10	14
	14	15	7	12
	15	14	8	14
	13	14	12	16
Mean	86° 15·8′		86° 19·0′	

$I' = 86° 17'$
$\varDelta = -55$
$I = 85° 22'$

Had laid pieces of board under the feet of the stand. The instrument has not hitherto been quite accurately levelled. It is only lately, however, since the setting up of the instrument began to be insecure, that it has two or three times happened that the bubble of the level has gone quite out to one side. Since then the screws have been adjusted all through the series of observations, so as to keep the bubble exactly in the middle.

1894. July 20.

Lat. N. 81° 30′
Long. E. 125° 5′

Needle *B* $H = 0{\cdot}039$

Mer. 172° 30′ [1])

	Circle E. N	Circle E. S	Circle W. N	Circle W. S
	86° 53′	86° 47′	87° 12′	87° 8′
	54	45	10	5
	48	44	6	1
	46	42	2	0
	43	40	0	0
	40	38	86 59	1
	38	35	87 1	86 58
	39	35	86 59	87 0
	34	33	58	0
	34	32	58	86 58
	33 [2])	30	57	58
	34	31	59	58
	31	27 [3])	57	56
	30	30	55	54
	28	27	54	56
	32	33 [4])	52	56
	32	32	54	56
	31	32	57	87 0
	33	33	59	2
	34	34	87 2	5
Mean	86° 36·2′ [5])		86° 59·6′	

$I' = 86° 48'$
$\varDelta = -49$
$I = 85° 59'$

Mer. 171° 10′

[1]) Needle restless. [2]) Oscillated a little between 86° 45′ and 86° 30′. [3]) Sudden dip of the north end. [4]) Jerk to 86° 45′. [5]) All through the settings "Circle E" the needle was lively, as also during the first two or three settings of "Circle W"; afterwards quiet.

Meridian setting uncertain. The ice possibly in vibratory motion. Once or twice during the observations heard a rumbling sound resembling distant thunder to the SSE, very unlike the ordinary sound of screwing. Heard also a little slight screwing in the east. A fresh meridian setting was taken after the observations were concluded.

1894. July 26, a. m.

Lat. N. 81° 17′
Long. E. 125° 57′

Needle *B* $H = 0{\cdot}039$

Mer. 169° 30′

	Circle E. N	Circle E. S	Circle W. N	Circle W. S
	86° 18′	86° 15′	86° 29′	86° 27′
	20	17	30	27
	18	15	26	23
	24	17	25	24
	18	17	22	21
	18	16	21	20
	20	18	23	21
	17	18	23	22
	19	18	24	23
	25	20	20	22
	21	21	17	20
	18	19	19	20
	20	19	19	21
	20	19	17	22
	18	21	15	19
	18 [1]	20	12	15
	20	19	13	16
	15	17	10	15
	12	13	7	11
	14	14	6	13
Mean	86° 18·1′		86° 19·5′	

$I' = 86° 19'$
$\Delta = -55$
$I = 85° 24'$ [2]

1894. July 26, p. m.

Lat. N. 81° 17′
Long. E. 125° 57′

Needle *B* $H = 0{\cdot}039$

Mer. 168° 24′

	Circle E. N	Circle E. S	Circle W. N	Circle W. S
	86° 18′	86° 15′	86° 12′	86° 18′
	19	16	13	17
	17	15	14	18
	18	17	14	19
	21	23	17	20
	20	22	19	21
	16	17	22	25
	16	18	27	27
	14	16	28	26
	13	15	33	33
Mean	86° 17·3′		86° 21·1′	

$I' = 86° 19'$
$\Delta = -55$
$I = 85° 24'$

Mer. 168° 8′

[1]) Oscillating between 86° 15′ and 86° 30′. [2]) During the observations, the double declination needle was lying in a box with requisites, at a distance of 15 paces about ENE of the instrument, with its south end pointing almost south.

1894. August 2, a. m.

Lat. N. 81° 4′
Long. E. 127° 0′

Needle *B* $H = 0{\cdot}039$
Mer. 226° 44′

Circle E. [1]) N	Circle E. [1]) S	Circle W. [2]) N	Circle W. [2]) S
86° 17′	86° 15′	86° 20′	86° 18′
17	16	19	17
18	14	21	18
18	15	19	16
18	15	18	16
18	16	19	15
19	17	21	16
18	15	19	17
17	14	21	16
17	13	19	17
Mean 86° 16·3′		86° 18·1′	

Circle E. [3]) N	Circle E. [3]) S
86° 17′	86° 13′
19	18
18	16
17	15
17	17
18	18
22	19
23	22
25	21
24	23
21	23
20	22
19	21
17	20
15	20
Mean 86° 19·3′	

Means

	Circle E.	Circle W.
1.	86° 16·3′	86° 18·1′
2.	86 19·3	
Mean	86° 17·8′	86° 18·1′

$I' = 86°\,18'$
$\varDelta = -55$
$I = 85°\,23'$

Investigation of the influence of inaccurate levelling upon the position of the needle.

1894. August 2, p. m.

Lat. N. 81° 4′
Long. E. 127° 0′

Needle *B* $H = 0{\cdot}039$
Mer. 227° 23′

Circle E. N	Circle E. S	Circle W. N	Circle W. S
86° 16′	86° 13′	86° 26′	86° 27′
16	12	26	25
18	16	25	23
15	13	25	22
18	15	22	21
17	15	20	20 [1])
18	17	17	18
18	19	17	18
20	20	15	16
19	21	16	17
17	19	15	18
20	22	14	19
16	20	12	16
17	19	11	16
13	15	5	11
17	18	8	12
12	15	6	12
12	13	5	11
8	12	3	10
5	13	5	11
Mean 86° 16·0′		86° 15·9′	

$I' = 86°\,16'$
$\varDelta = -55$
$I = 85°\,21'$

Mer. 228° 19′

[1]) The bubble of the level quite at the south end by the frame, the bracket remaining in the same position. [2]) The bubble of the level quite at the north end by the frame. The bracket not touched. [3]) Accurate levelling. The bracket moved over as usual.

[1]) Oscillating between 86° 28′ and 86° 15′.

1894. August 17, a. m.

Lat. N. 81° 6′
Long. E. 128° 4′

Needle *B* $H = 0{\cdot}039$
Mer. 159° 39′

Circle E. N	Circle E. S	Circle W. N	Circle W. S
86° 19′	86° 16′	86° 17′	86° 22′
17	12	17	21
17	15	17	22
18	15	15	19
17	14	15	20
17	14	18	21
19	18	20	22
23	19	25	23
22	22	25	28
26	22	22	25
20	20	23	25
20	22 [1])	25	26
24	23	25	24
23	22	28	27
18	19	27	27
19	20	32	29
18	18 [2])	30	28
22	19	29	29
17	18	32	31
15	17	33	34
12	17		
13	15		
Mean 86° 18·5′		86° 24·4′	

$I' = 86°\,21'$
$\varDelta = -55$
$I = 85°\,26'$

[1]) Oscill. between 86° 32′ and 86° 18′.
[2]) — — 86° 30′ and 86° 12′.

1894. August 17, p. m.

Lat. N. 81° 6′
Long. E. 128° 4′

Needle *B* $H = 0{\cdot}039$
Mer. 159° 1′

Circle E. N	Circle E. S	Circle W. N	Circle W. S
86° 10′	86° 6′	86° 25′	86° 27′
14	10	24	26
13	10	27	29
11	7	26	25
13	10	28	26
9	9	22	22
15	12	24	23
14	15	21	21
15	16	20	21
18	17	17	18
17	20	15	18
20	21	17	18
18	21	14	16
19	19	15	18
18	19	12	14
17	18	12	16
18	20	10	13
14	17	10	14
15	15	9	13
12	13	11	14
Mean 86° 14·8′		86° 18·9′	

$I' = 86°\,17'$
$\varDelta = -55$
$I = 85°\,22'$

1894. September 7.

Lat. N. 81° 9′
Long. E. 122° 40′

Needle *B* $H = 0{\cdot}039$
Mer. 168° 56′

	Circle E. N	Circle E. S	Circle W. N	Circle W. S
	86° 13′ 1)	86° 7′	86° 27′	86° 26′
	10	5	27	24
	8	9	30	24
	10 2)	6	30 7)	24
	5	0	28	25
	6	0	29	27
	2	85 59	26	22
	1	58	27	24
	0	86 0	27	26
	2	3	22	27 8)
	6	7	25	28
	4	6	25 9)	28
	5 3)	8	23	25
	5	5	25	26
	5 4)	5	20	23
	0	4 5)	15	20
	3	5	16	19
	4	7	12	15
	3	7	14	18
	8	10 6)	14	19
Mean	86° 4·8′		86° 23·3′	

$I' = 86° 14'$
$\varDelta = -56$
$I = 85° 18'$

Touched the needle with a small screw-driver while lubricating with vaseline. The contact, however, was very slight and brief.

1) Oscill. between 86° 8′ and 86° 16′
2) — — 86 8 " 86 18
3) — — 85 59 " 86 15
4) — — 85 59 " 86 12
5) — — 86 0 " 86 15
6) — — 86 6 " 86 15
7) — — 86 27 " 86 40
8) The needle a little disturbed.
9) Oscill. between 86° 13′ and 86° 28′

1894. September 20.

Lat. N. 81° 12′
Long. E. 123° 39′

Needle *B* $H = 0{\cdot}039$
a. m. Mer. 174° 6′

	Circle E. N	Circle E. S	Circle W. N	Circle W. S
	86° 26′	86° 20′	86° 47′	86° 45′
	28	22	48	48
	23	18	47	47
	23	18	44 7)	38
	14 1)	12	43	43
	13	7	42	40
	13	9	45	40
	15 2)	10	45	42
	8	10	43	45
	8	6 3)	38	40
	7 4)	10	42	38
	8	9	41	40
	4	3	42	43
	0	2	43	47
	1	2	44	47
	10	17	40	41
	13	18	37	41
	14 5)	17 6)	36	41
	14	18	36	40
	19	20	41	44
Mean	86° 12·7′		86° 42·4′	

$I' = 86° 28'$
$\varDelta = -53$
$I = 85° 35'$

1) Oscill. between 86° 6′ and 86° 20′
2) Disturbed.
3) Oscill. between 86° 0′ and 86° 15′
4) — — 86 3 " 86 18
5) — — 86 3 " 86 15; disturbed.
6) — — 86° 5′ and 86° 25′
7) — — 86 33 " 86 55

p. m. Mer. 174° 24′

	Circle E.		Circle W.	
	N	S	N	S
	86° 28′	86° 23′	87° 0′	87° 0′
	30	25	86 55	86 56
	26	24	45	47
	25	25	45	43 [6])
	28	26	42	45
	36 [1])	36	43	42
	33	37	45	48
	32 [2])	33	44	47
	31 [3])	40 [4])	41	43
	38 [5])	45	42	44
	40 [5])	42		
Mean	86° 32·0′		86° 46·8′	

I′ = 86° 39′
Δ = − 51
I = 85° 48′

1894. October 3.

Lat. N. 81° 5′
Long. E. 122° 3′

Needle *B* $H = 0·039$
Mer. 169° 34′

	Circle E.		Circle W.	
	N	S	N	S
	86° 9′	86° 5′	86° 30′	86° 35′
	8	6	29	32
	11	8	30	32
	16	12	28	31
	15	13	29	31
	13	12	30	30
	12	11	28	30
	9	12	31	28
	7	11	35	35
	5	10	38	38
Mean	86° 10·3′		86° 31·5′	

I′ = 86° 21′
Δ = − 55
I = 85° 26′

[1]) Oscill. between 86° 30′ „ 86° 42′
[2]) — — 86 30 „ 86 45; rather quickly.
[3]) — — 86° 28′ and 86° 47′
[4]) — — 86 29 „ 86 45
[5]) — — 86 27 „ 87 0
[6]) — — 86 30 „ 86 50

1894. October 11.

Lat. N. 81° 19′
Long. E. 119° 30′

Needle *B* $H = 0·040$
Mer. 173° 56′

	Circle E.		Circle W.	
	N	S	N	S
	86° 6′	86° 6′	86° 42′	86° 36′
	8	5	42	37
	2	0	33	33
	1	0	34	30
	7	5	30	31
	10	10	30	33
	13 [1])	12 [1])	28	30
	12	10	29	28
	6	8	28	28
	10	12	29	30
Mean	86° 7·2′		86° 32·0′	

	Circle E.	
	N	S
	86° 12′	86° 7′
	8	2
	3	2
	0	85 56
	0	59
	4	86 6
	5	5
	5	8
	3 [2])	4 [2])
	5 [2])	5
Mean	86° 4·0′	

Means

	Circle E.	Circle W.
1.	86° 7·2′	86° 32·0′
2.	86 4·0	
Mean	86° 5·6′	86° 32·0′

I′ = 86° 19′
Δ = − 53
I = 85° 26′

1894. October. 19.

Lat. N. 81° 52′
Long. E. 115° 15′

Needle *B* $H = 0·041$
Mer. 184° 9′

	Circle E.		Circle W.	
	N	S	N	S
	86° 0′	85° 57′	86° 32′	86° 35′
	1	59	30	32
	1	56	26	29
	3	86 0	30	30
	0	85 58	27	29
	1	86 1	29	32
	1	1	27	29
	2 [3])	2	30	30
	4	3	32	33
	5	3	33	36
Mean	86° 0·9′		86° 30·6′	

I′ = 86° 16′
Δ = − 52
I = 85° 24′

[1]) Somewhat disturbed. [2]) Disturbed.
[3]) Oscill. between 86° 0′ and 86° 10′.

1894. October 27.

Lat. N. 82° 4'
Long. N. 114° 35'

Needle *B* — $H = 0.041$

Mer. 104° 19'

Circle E. N	Circle E. S	Circle W. N	Circle W. S
86° 0'	85° 58'	86° 34'	86° 31'
85 58	59	30	28
57	57	29	26
59	86 0	30	27
86 2	3	30	33
1	3	30	29
0 [1])	0 [2])	35	37
0 [3])	85 59	26	25
85 58 [4])	54 [4])	23	24
86 0	86 0	22	23
Mean 85° 59·4'		86° 28·6'	

I' = 86° 14'
Δ = − 53
I = 85° 21'

1894. November 9, p. m.

Lat. N. 82° 10'
Long. E. 110° 50'

Needle *B* — $H = 0.042$

Mer. 265° 5'

Circle E. N	Circle E. S	Circle W. N	Circle W. S
86° 12'	86° 12'	86° 14'	86° 17'
19	13	6	7
13	10	3	7
7	3	3	8
13	12	3	6
15	14	5	7
17	13	9	12
14	12	8	8
12	10	3	5
12	12	3	4
Mean 86° 12·3'		86° 6·9'	

I' = 86° 10'
Δ = − 52
I = 85° 18'

Used a copper lamp during the observations, which, however, had some iron in the burner. The lamp stood upon a foot to the east of the instrument and 1 metre distant from it. Presumably no influence.

[1]) Oscill. between 85° 55' and 86° 15'
[2]) — — 85 57 „ 86 20
[3]) — — 85 45 „ 86 15
[4]) Disturbed.

1894. November 15.

Lat. N. 82° 7'
Long. E. 110° 30'

Needle *B* — $H = 0.041$

Mer. 262° 2'

Circle E. N	Circle E. S	Circle W. N	Circle W. S
85° 57'	85° 55'	86° 33'	86° 32'
52	50	31	30
50	49	21	20
56	55	19	18
58	57	15	13
86 1	86 2	25	24
85 58	0	27	27
86 2	1	20	22
85 58	0	20	22
58	85 57	19	23
Mean 85° 56·8'		86° 23·0'	

I' = 86° 10'
Δ = − 53
I = 85° 17'

1894. November 23, p. m.

Lat. N. 81° 59'
Long. E. 112° 2'

Needle *B* — $H = 0.041$

Mer. 87° 45'

Circle E. N	Circle E. S	Circle W. N	Circle W. S
86° 10'	86° 7'	86° 38'	86° 37'
5	3	30	30
3	4	27	29
0	1	29	27
2	7 [1])	29	29
12	16	30	31
2	6	28	31
12	13	27	31
10	15	30	30
11	13	31	33
10	11 [2])		
Mean 86° 7·9'		86° 30·3'	

I' = 86° 19'
Δ = − 52
I = 85° 27'

[1]) Oscillated out to 86° 24'.
[2]) Oscillated between 86° 4' and 86° 17'.

1894. November 28.

Lat. N. 82° 9′
Long. E. 111° 13′

Needle *B* $H = 0{\cdot}042$
Mer. 263° 32′

	Circle E. N	Circle E. S	Circle W. N	Circle W. S
	86° 3′	86° 3′	86° 35′	86° 38′
	1	1	26	28
	2	3	23	23
	0	85 59	22	20
	3	86 5	23	23
	3	4	25	27
	0	1	26	30
	0	5	27	26
	3	5	28	27
	4	4	29	28
Mean	86° 2·5′		86° 26·7′	

$I' = 86° 15'$
$\varDelta = -51$
$I = 85° 24'$

1894. December 5.

Lat. N. 82° 17′
Long. E. 109° 30′

Needle *B* $H = 0{\cdot}042$

	Circle E. N	Circle E. S	Circle W. N	Circle W. S
	86° 4′	86° 3′	86° 37′	86° 35′
	0	85 57	29	28
	85 59	55	24	23
	56	51	25	27
	55	52	26	28
	86 0	86 0	29	31
	1	0	23	26
	0	0	23	26
	3	4	23	25
	4	0	26	27
Mean	85° 59·2′		86° 27·1′	

$I' = 86° 13'$
$\varDelta = -52$
$I = 85° 21'$

1894. December 14, a. m.

Lat. N. 82° 33′
Long. E. 107° 53′

Needle *B* $H = 0{\cdot}041$
Mer. 89° 26′

	Circle E. N	Circle E. S	Circle W. N	Circle W. S
	85° 49′	85° 51′	86° 13′	86° 11′
	54	57	9	8
	55	56	10	7
	56	55	6	3
	53	54	4	4
	54	55	3	3
	58	58	2	3
	55	58	2	3
	57	86 0	3	4
	56	0	2	3
	58	0	4	5
	86 1	0	4	6
	85 58	85 59	7	8
	59	86 3	5	6
	86 0	2	5	5
	85 59	4	1	3
	86 1	3	85 59	2
	0	2	59	3
	85 57	0	86 0	2
	53	85 59	0	2
Mean	85° 57·7′		86° 4·2′	

$I' = 86° 1'$
$\varDelta = -55'$
$I = 85° 6'$

1894. December 20.

Lat. N. 82° 52′
Long. E. 104° 30′

Needle B — $H = 0{\cdot}044$

Mer. 92° 22′

	Circle E. N	Circle E. S	Circle W. N	Circle W. S
	85° 54′	85° 56′	86° 15′	86° 17′
	52	57	12	14
	44	45	11	15
	43	47	12	12
	40	44	10	13
	36	36	12	14
	33	35	10	10
	36	38	11	12
	40	41	11	12
	40	42	17	15
Mean	85° 43·0′		86° 12·8′	

$I' = 85° 58'$
$\varDelta = -52$
$I = 85° 6'$

During the observations, the double declination needle was inadvertently left upon the table by the lamp. Distance between the stand and the magnet, 1·3 m. The latter lay with its north end pointing almost due north, in a horizontal plane about 0·3 m. below the centre of the inclination needle. A fresh inclination-determination was therefore made on Dec. 22nd.

1894. December 22.

Lat. N. 83° 0′
Long. E. 103° 40′

Needle B — $H = 0{\cdot}044$

Mer. 92° 11′

	Circle E. N	Circle E. S	Circle W. N	Circle W. S
	85° 49′	85° 53′	86° 10′	86° 11′
	48	48	8	7
	48	47	1	0
	49	50	0	1
	58	55	85 58	0
	56	57	57	85 58
	58	58	58	86 1
	52	55	56	0
	50	55	57	0
	48	51	56	85 58
Mean	85° 52·3′		86° 0·9′	

$I' = 85° 57'$
$\varDelta = -52$
$I = 85° 5'$

1895. January 12.

Lat. N. 83° 41′
Long. E. 102° 47′

Needle B — $H = 0{\cdot}042$

Mer. 118° 17′

	Circle E. N	Circle E. S	Circle W. N	Circle W. S
	85° 47′	85° 43′	86° 0′	86° 2′
	46	43	1	1
	48	48	85 57	85 58
	51	48	58	58
	57	56	57	86 0
	57	58	59	0
	58	57	56	85 59
	55	59	55	56
	51	55	54	58
	45	50	50	54
Mean	85° 51·6′		85° 57·7′	

$I' = 85° 55'$
$\varDelta = -55$
$I = 85° 0'$

1895. January 19.

Lat. N. 83° 26′
Long. E. 102° 0′

Needle B — $H = 0{\cdot}042$

Mer. 131° 35′

	Circle E. N	Circle E. S	Circle W. N	Circle W. S
	85° 42′	85° 38′	86° 30′	86° 27′
	40	36	26	24
	41	36	20	18
	33	37	22	19
	36	40	23	19
	40	45	20	21
	42	45	20	24
	40	42	19	19
	38	40	19	20
	40	42	20	23
Mean	85° 39·6′		86° 21·7′	

$I' = 86° 1'$
$\varDelta = -54$
$I = 85° 7'$

1895. March 5.

Lat. N. 84° 4′
Long. E. 101° 27′

Needle *B* $H = 0.044$
Mer. 194° 41′

Circle E. N	Circle E. S	Circle W. N	Circle W. S
85° 55′	85° 50′	86° 12′	86° 15′
57	52	14	17
57	54	12	13
86 3	86 0	10	12
8	4	8	11
3	0	7	12
0	85 59	6	8
1	86 0	1	5
0	85 59	0	1
85 59	58	85 58	0
Mean 85° 59·0′		86° 8·1′	

$I' = 86°\ 4'$
$\Delta = -50$
$I = 85°\ 14'$

1895. March 21.

Lat. N. 84° 9′
Long. E. 100° 28′

Needle *B* $H = 0.045$
Mer. 194° 17′

Circle E. N	Circle E. S	Circle W. N	Circle W. S
85° 40′	85° 37′	85° 48′	85° 53′
43	38	48	52
47	41	50	54
45	40	54	57
48	45	54	56
47	46	57	86 0
48	48	58	2
47	44	86 7	6
40	41	5	4
38	41	5	4
Mean 85° 43·2′		85° 57·7′	

$I' = 85°\ 50'$
$\Delta = -51'$
$I = 84°\ 59'$

1895. April 3.

Lat. N. 84° 14′
Long. E. 98° 35′

Needle *B* $H = 0.045$
Mer. 195° 2′

Circle E. N	Circle E. S	Circle W. N	Circle W. S
85° 37′	85° 35′	86° 20′	86° 20′
35	33	16	18
34	31	3	5
33	30	6	8
33	29	7	7
35	37	8	10
37	37	10	11
45	45	6	6
44	42	10	12
44	42	14	16
Mean 85° 36·9′		86° 10·7′	

$I' = 85°\ 54'$
$\Delta = -51$
$I = 85°\ 3'$

1895. April 19.

Lat. N. 84° 14′
Long. E. 94° 36′

Needle *B* $H = 0.046$
Mer. 192° 54′

Circle E. N	Circle E. S	Circle W. N	Circle W. S
85° 31′	85° 30′	86° 10′	86° 8′
35	32	8	6
32	33	85 57	0
31	30	57	85 59
29	27	58	86 0
35	34	86 2	3
33	33	0	3
37	37	0	2
38 [1])	38 [1])	85 59	0
33 [1])	30 [1])	0	3
Mean 85° 32·9′		86° 1·8′	

$I' = 85°\ 47'$
$\Delta = -50$
$I = 84°\ 57'$

[1]) Somewhat disturbed.

1895. May 8.

Lat. N. 84° 33′
Long. E. 90° 40′

Needle *B* $H = 0.046$

Mer. 192° 35′

	Circle E. N	Circle E. S	Circle W. N	Circle W. S
	85° 28′	85° 24′	85° 40′	85° 40′
	30	25	43	45
	31	30	41	43
	32	29	35	36
	35	33	37	40
	39	35	32	36
	41	37	33	36
	38	37	30	33
	33	31	30	33
	30	28	29	32
Mean	85° 32·3′		85° 36·2′	

$I' = 85° 34'$
$\Delta = -53$
$I = 84° 41'$

1895. May 22.

Lat. N. 84° 40′
Long. E. 83° 51′

Needle *B* $H = 0.049$

Mer. 189° 1′

	Circle E. N	Circle E. S	Circle W. N	Circle W. S
	85° 24′	85° 18′	85° 50′	85° 50′
	25	20	54	50
	22	18	45	44
	20	16	46	44
	18	18	40	42
	19	19	38	42
	22	20	41	43
	27	25	40	45
	27 [1])	24	43	48
	25	25	48	53
Mean	85° 21·6′		85° 45·3′	

$I' = 85° 33'$
$\Delta = -49$
$I = 84° 44'$

[1]) Oscill. between 85° 15′ and 85° 40′

1895. July 2. In the tent on the port bow.

Lat. N. 84° 40′
Long. E. 74° 19′

Needle *B* $H = 0.052$

Mer. 141° 49′

	Circle E. N	Circle E. S	Circle W. N	Circle W. S
	84° 56′	84° 50′	85° 7′	85° 10′
	55	53	6	5
	55	53	5	7
	58	56	5	7
	59	55	6	10
	59	59	0	84 57
	57	57	84 58	57
	54	57	85 2	85 4
	50	53	84 58	2
	50	53	59	4
Mean	84° 55·0′		85° 3·5′	

$I' = 84° 59'$
$\Delta = -50$
$I = 84° 9'$

1895. July 11.

Lat. N. 84° 42′
Long. E. 75° 55′

Needle *B* $H = 0.052$

Mer. 255° 39′

	Circle E. N	Circle E. S	Circle W. N	Circle W. S
	85° 3′	85° 5′	85° 46′	85° 50′
	2	0	38	40
	84 58	84 55	33	33
	56	55	32	35
	55	58	32	35
	57	85 0	31	32
	55	84 58	35	36
	85 0	85 0	40	40
	0 [1])	0 [1])	41	42
	0	2	45	46
Mean	84° 59·0′		85° 38·1′	

$I' = 85° 19'$
$\Delta = -48$
$I = 84° 31'$

[1]) Disturbed.

1895. July 25.

Lat. N. 84° 31′
Long. E. 72° 20′

Needle *B* — $H = 0{\cdot}053$
Mer. 192° 30′

Circle E. N	Circle E. S	Circle W. N	Circle W. S
84° 58′	84° 55′	85° 25′	85° 30′
58	55	20	22
55	56	14	17
53	50	14	17
48	50	10	14
54	55	14	15
52	56	16	14
54	59	17	15
53	53	20	22
58	59	24	28
Mean 84° 54·5′		85° 18·4′	

$I' = 85° \; 6'$
$\Delta = -48$
$I = 84° \, 18'$ [1]

Circle W. N	Circle W. S	Circle E. N	Circle E. S
85° 28′	85° 34′	84° 58′	85° 0′
23	27	57	84 58
16	18	59	85 0
15	18	55	84 58
11	15	55	57
15	15	50	50
15	15	52	51
18	19	54	53
19	24	55	53
25	30	55	50
Mean 85° 20·0		84° 55·0′	

$I' = 85° \; 8'$
$\Delta = -48$
$I = 84° \, 20'$ [2]

[1]) The revolver in its place.
[2]) The revolver laid aside.

1895. August 7.

Lat. N. 84° 38′
Long. E. 77° 20′

Needle *B* — $H = 0{\cdot}051$
Mer. 212° 50′

Circle E. N	Circle E. S	Circle W. N	Circle W. S
85° 4′	85° 5′	85° 30′	85° 35′
6	6	25	29
4	3	20	23
0	84 59	20	21
5	85 6	17	18
4	5	16	18
3	3	17	17
5 [1])	3 [1])	22	23
11 [1])	8 [1])	25	28
7	10	31	32
Mean 85° 4·8′		85° 23·4′	

$I' = 85° \, 14'$
$\Delta = -50$
$I = 84° \, 24'$ [2]

Circle E. N	Circle E. S	Circle W. N	Circle W. S
85° 5′	85° 2′	85° 30′	85° 30′
4	3	20	20
0	84 58	18	18
0	57	17	18
2	85 4	18	20
4	5	16	20
4	4	19	22
7	7	19	22
10	10	25	31
9	10	30	35
Mean 85° 4·3′		85° 22·4′	

$I' = 85° \, 13'$
$\Delta = -50$
$I = 84° \, 23'$ [3]

[1]) Disturbed.
[2]) The revolver in its place.
[3]) The revolver laid aside.

1895. August 13.

Lat. N. 84° 31′
Long. E. 76° 19′

Needle *B* — $H = 0{\cdot}051$

Mer. 219° 37′

Circle E. N	Circle E. S	Circle W. N	Circle W. S
85° 0′	84° 54′	85° 33′	85° 35′
1	85 0	25	27
84 57	84 57	18	20
85 0	58	18	19
0	58	12	14
0	85 0	15	18
84 59	0	17	19
57	0	20	20
59	1	20	25
85 3	3	30	28
Mean 84° 59·3′		85° 21·6′	

$I' = 85° 10′$
$\Delta = -50$
$I = 84° 20′$

1895. August 23, a. m.

Lat. N. 84° 11′
Long. E. 79° 4′

Needle *B* — $H = 0{\cdot}052$

Mer. 88° 46′

Circle E. N	Circle E. S	Circle W. N	Circle W. S
85° 12′	85° 7′	85° 38′	85° 38′
15	12	37	36
13	8	32	30
5	5	27	27
13	15	26	28
20	18	23	25
17	18	27	29
18 [1])	18	30	30
17	17	33	36
15	15	37	43
Mean 85° 13·9′		85° 31·6′	

$I' = 85° 23′$
$\Delta = -47$
$I = 84° 36′$

[1]) Disturbed. Oscill. between 85° 5′ and 85° 25′.

1895. September 5, p. m.

Lat. N. 84° 52′
Long. E. 78° 34′

Needle *B* — $H = 0{\cdot}050$

Mer. 168° 59′

Circle E. N	Circle E. S	Circle W. N	Circle W. S
85° 13′	85° 10′	85° 25′	85° 25′
15	12	25	24
15	12	25	22
15	14	22	20
17	15	21	20
15	16	18	20
15	14	19	19
13	12	15	17
8	10	16	20
12	13	15	18
Mean 85° 13·3′		85° 20·3′	

$I' = 85° 17′$
$\Delta = -50$
$I = 84° 27′$

Discovered, after the conclusion of the observations, that the fixing-screws on the base of the instrument were loose. A fresh inclination-determination was therefore made the following morning.

1895. September 6, a. m.

Lat. N. 84° 53′
Long. E. 78° 42′

Needle *B* — $H = 0{\cdot}050$

Mer. 167° 40′

Circle E. N	Circle E. S	Circle W. N	Circle W. S
85° 13′	85° 10′	85° 30′	85° 37′
19	13	33	35
17	12	26	27
10	10	29	30
15	16	20	25
24	25	20	19
20	23	23	23
30	28	28	30
30	30	31	35
25	25	30	37
Mean 85° 19·8′ [1])		85° 28·4′	

$I' = 85° 24′$
$\Delta = -49$
$I = 84° 35′$

[1]) The needle somewhat disturbed; the readings were taken when the needle was most quiet.

1895. September 6, p. m.

Lat. N. 84° 53′
Long. E. 78° 45′

Needle *B* $H = 0{\cdot}050$
Mer. 168° 13′

	Circle E.		Circle W.	
	N	S	N	S
	85° 11′	85° 5′	85° 25′	85° 30′
	11	7	20	23
	11	11	21	23
	8	6	17	18
	11	10	19	20
	15	12	18	20
	13	13	23	20
	18	17	18	20
	18	18	25	32
	17	14	32	34
Mean	85° 12·3′		85° 22·9′	

$I' = 85° 18'$
$\varDelta = -50$
$I = 84° 28'$

1895. September 26.

Lat. N. 85° 7′
Long. E. 79° 17′

Needle *B* $H = 0{\cdot}050$
Mer. 148° 56′

	Circle E.		Circle W.	
	N	S	N	S
	85° 18′	85° 15′	85° 40′	85° 38′
	17	12	33	30
	16	13	29	29
	14	12	29	28
	15	13	27	27
	14	14	23	24
	14	15	23	25
	26	25	24	29
	20	18	25	27
	18	18	32	35
Mean	85° 16·4′		85° 28·9′	

$I' = 85° 23'$
$\varDelta = -49$
$I = 84° 34'$

1895. October 2, p. m.

Lat. N. 85° 11′
Long. E. 79° 9′

Needle *B* $H = 0{\cdot}050$
Mer. 148° 30′

	Circle E.		Circle W.	
	N	S	N	S
	85° 17′	85° 15′	85° 43′	85° 48′
	16	13	36	42
	18	14	35	37
	19	15	30	29
	18	15	29	32
	23	17	34	40
	18	20	36	36
	25	27	35	40
	25 [1])	24 [1])	48	47
	24 [1])	20	46	48
	19	23	48	47
	18	20	47	48
	24	25	40	41
	18	17	35	35
	17	18	36	33
	15	16	27	30
	20	17	35	38
	18	16	40	41
	13	12	42	42
	13	10	43	45
Mean	85° 18·3′		85° 39·1′	

$I' = 85° 29'$
$\varDelta = -48$
$I = 84° 41'$

[1]) Disturbed.

1895. October 15, p. m.

Lat. N. 85° 28′
Long. E. 78° 33′

Needle *B* $H = 0{\cdot}048$

Mer. 139° 54′

	Circle W. N	Circle W. S	Circle E. N	Circle E. S
	85° 48′	85° 50′	85° 26′	85° 20′
	43	45	27	22
	43	43	27	25
	40	38	30	27
	40	40	32	31
	40	37	34	31
	38	40	30	32
	42	43	43 [1]	42 [1]
	54 [1]	50 [1]	41	38
	48	48	38	40
	52	48	34	40
	50	49	40	41
	42	43	30	30
	41	40	30	27
	42	42	24	22
	43	42	27	22
	37	38	30	28
	38	41	27	23
	41	43	20	20
	45	47		
Mean	85° 43·4′		85° 30·3′	

$I' = 85° 37'$
$\varDelta = -50$
$I = 84° 47'$

[1]) Disturbed.

1895. October 16, p. m.

Lat. N. 85° 32′
Long. E. 78° 28′

Needle *B* $H = 0{\cdot}048$

Mer. 142° 13′

	Circle W. N	Circle W. S	Circle E. N	Circle E. S
	85° 50′	85° 54′	85° 27′	85° 23′
	54	86 0	30	24
	48	85 51	27	25
	47	49	30	26
	43	46	32	28
	44	43	31	30
	44	46	36	33
	47	49	36	35
	52	86 0 [1]	37	33
	86 3	6	35	35
Mean	85° 50·8′		85° 30·7′	

$I' = 85° 41'$
$\varDelta = -49$
$I = 84° 52'$

[1]) Disturbed. Oscill. out to 86° 15′

1895. October 22, p. m.

Lat. N. 85° 46′
Long. E. 75° 40′

Needle *B* $H = 0{\cdot}048$
Mer. 138° 21′

	Circle E. N	Circle E. S	Circle W. N	Circle W. S
	85° 15′	85° 12′	85° 15′	85° 18′
	14	12	15	13
	16	13	17	20
	22	19	19	19
	25	28	18	22
	30	30	22	23
	28	27	18	17
	31	31	23	20
	24	25	30	28
	19	17	28	25
	18	18	28	24
	24	27	28	22
	25	28	24	22
	28	27	24	18
	30	27	23	23
	25	24	22	24
	20	19	18	20
	17	15	19	20
	18	13	15	18
	16	14	15	18
Mean	85° 21·8′		85° 20·9′	

$I' = 85° 21′$
$\Delta = -52$
$I = 84° 29′$

1895. November 2, p. m.

Lat. N. 85° 40′
Long. E. 69° 50′

Needle *B* $H = 0{\cdot}050$
Mer. 143° 4′

	Circle W. N	Circle W. S	Circle E. N	Circle E. S
	85° 32′	85° 37′	85° 22′	85° 25′
	32	35	24	29
	30	32	29	27
	30	32	23	23
	32	29	20	20
	30	29	18	18
	28	24	17	17
	42	36	15	17
	43	40	15	15
	48	45	16	13
Mean	85° 34·3′		85° 20·2′	

$I' = 85° 27′$
$\Delta = -49$
$I = 84° 38′$

1895. November 9, a. m.

Lat. N. 85° 42′
Long. E. 64° 25′

Needle *B* $H = 0{\cdot}051$
Mer. 147° 40′

	Circle E. N	Circle E. S	Circle W. N	Circle W. S
	84° 55′	84° 49′	85° 45′ [1]	85° 40′
	50	48	37	33
	53	50	30	30
	58	55	35	31
	85 0	85 0	28	31
	84 57	84 55	28	28
	85 0	85 0	27	29
	84 57	84 58	31	30
	58	55	30	33
	55	58	37	38
Mean	84° 55·6′		85° 32·6′	

$I' = 85° 14′$
$\Delta = -50$
$I = 84° 24′$

[1]) Disturbed.

1895. November 19, p. m.

Lat. N. 85° 52′
Long. E. 64° 47′

Needle B — $H = 0{\cdot}051$
Mer. 147° 17′

	Circle E. N	Circle E. S	Circle W. N	Circle W. S
	84° 58′	84° 55′	85° 17′	85° 15′
	55	54	20	19
	59	56	13	10
	85 0	59	12 [1])	16 [1])
	4 [1])	85 2 [1])	10	11
	5	3	3	0
	0	1	6	6
	0	3	5	5
	0	3	0	0
	84 58	84 59	2	6
Mean	84° 59·7′		85° 8·8′	

$I' = 85°\ 4'$
$\Delta = -50$
$I = 84°\ 14'$

1895. November 30, a. m.

Lat. N. 85° 28′
Long. E. 58° 41′

Needle B — $H = 0{\cdot}053$
Mer. 147° 23′

	Circle E. N	Circle E. S	Circle W. N	Circle W. S
	84° 54′	84° 54′	85° 33′	85° 38′
	59	57	28 [1])	33
	85 1	58	18	17
	84 58	58	12	15
	85 0	85 2	13	16
	3	5	5	10
	3	6	13	17
	3	3	7	14
	84 58	0	13	17
	85 0	2	20	20
Mean	85° 0·2′		85° 18·0′	

$I' = 85°\ 9'$
$\Delta = -48$
$I = 84°\ 21'$

The bracket turned 180° out from its former position.

[1]) Disturbed.

1895. December 4.

Lat. N. 85° 29′
Long. E. 56° 46′

Needle B — $H = 0{\cdot}054$
Mer. 144° 23′

	Circle W. N	Circle W. S	Circle E. N	Circle E. S
	85° 14′	85° 16′	84° 57′	85° 0′
	12	12	85 0	84 58
	17	15	0	85 4
	10	8	84 57	84 59
	6	6	59	56
	15	13	85 0	57
	23	18	84 53	55
	30	31	49	46
	33	27 [1])	46	42
	32	28	45	43
Mean	85° 18·3′		84° 54·0′	

$I' = 85°\ 6'$
$\Delta = -47$
$I = 84°\ 19'$

The bracket turned 180° out from the position it had on Nov. 30th.

1895. December 13.

Lat. N. 85° 25′
Long. E. 49° 32′

Needle B — $H = 0{\cdot}056$
Mer. 136° 46′

	Circle E. N	Circle E. S	Circle W. N	Circle W. S
	84° 45′	84° 40′	85° 5′	85° 5′
	45	44	0	3
	45	44	84 56	84 57
	40	40	58	85 2
	42	38	57	0
	40	43	85 0	0
	43	42	0	2
	48	48	84 59	0
	45	45	85 15	12
	45	45	12	10
Mean	84° 43·4′		85° 2·6′	

$I' = 84°\ 53'$
$\Delta = -47$
$I = 84°\ 6'$

[1]) Disturbed.

1896. January 3.

Lat. N. 85° 17′
Long. E. 45° 10′

Needle *B* $H = 0{\cdot}054$
Mer. 136° 6′

	Circle W.		Circle E.	
	N	S	N	S
	84° 38′	84° 43′	84° 17′	84° 20′
	36	38	24	27
	40	41	27	28
	42	40	30	32
	42	42	33	35
	48	45	30	30
	50 [1])	50 [1])	30	26
	53	48	28	23
	57	50	24	19
	54	48	22	19
Mean	84° 45·3′		84° 26·2′	

$I' = 84°36'$
$\Delta = -50$
$I = 83°46'$

1896. January 11, a. m.

Lat. N. 84° 56′
Long. E. 41° 10′

Needle *B* $H = 0{\cdot}060$
Mer. 138° 54′

	Circle W.		Circle E.	
	N	S	N	S
	84° 18′	84° 20′	83° 50′	83° 48′
	18	16	57	52
	13	15	84 2	57
	24	20	3	84 2
	24	20	8	5
	19	18	10	3
	23 [1])	20 [1])	0	6
	23	24	1	8
	30	30	0	2
	27	27	83 58	0
Mean	84° 21·5′		84° 0·6′	

$I' = 84°11'$
$\Delta = -47$
$I = 83°24'$

[1]) Disturbed.

1896. January 17.

Lat. N. 84° 53′
Long. E. 40° 13′

Needle *B* $H = 0{\cdot}060$
Mer. 135° 31′

	Circle E.		Circle W.	
	N	S	N	S
	84° 16′	84° 13′	84° 38′	84° 35′
	15	13	33	34
	12	12	43	40
	26	20	43	45
	27	27	42	40
	30	33	43	40
	32	35	42	38
	32	30	45	47
	28	28	57	57
	30	36	58	58
Mean	84° 24·8′		84° 43·9′	

$I' = 84°34'$
$\Delta = -45$
$I = 83°49'$

1896. January 27, p. m.

Lat. N. 84° 40′
Long. E. 31° 36′

Needle *B* $H = 0{\cdot}062$
Mer. 136° 40′

	Circle E.		Circle W.	
	N	S	N	S
	83° 53′	83° 50′	84° 23′	84° 18′
	50	54	17	18
	50	53	15	17
	58	84 0	14	14
	84 2	0	13	12
	2	5	16	16
	2	0	8	8
	0	3	8	10
	83 58	1	5	5
	58	2	4	8
Mean	83° 58·1′		84° 12·5′	

$I' = 84°\ 5'$
$\Delta = -47$
$I = 83°18'$

1896. February 3, p. m.

Lat. N. 84° 47′
Long. E. 25° 18′

Needle *B* $H = 0{\cdot}062$

Mer. 129° 21′

	Circle E. N	Circle E. S	Circle W. N	Circle W. S
	83° 50′	83° 47′	84° 15′	84° 13′
	55	50	20	17
	55	55	15	14
	57	59	16	12
	84 4 [1])	84 3 [1])	13	10
	5	6	8	8
	0	0	5	3
	83 50	83 55	2	2
	48	52	83 59	0
	50	54	84 0	2
Mean	83° 55·8′		84° 8·7′	

$I' = 84° 2'$
$\varDelta = -47$
$I = 83° 15'$

1896. February 11, p. m.

Lat. N. 84° 30′
Long. E. 24° 45′

Needle *B* $H = 0{\cdot}064$

Mer. 132° 46′

	Circle E. N	Circle E. S	Circle W. N	Circle W. S
	83° 42′	83° 40′	84° 15′	84° 10′
	40	35	15	12
	42	40	14	10
	45	40	15	12
	45	48	13	10
	45	43	3	3
	45	45	4	0
	45	45	83 58	83 58
	42	42	58	84 0
	44	47	55	83 58
Mean	83° 43·0′		84° 6·2′	

$I' = 83° 55'$
$\varDelta = -46$
$I = 83° 9'$

[1]) Disturbed.

1896. February 12, a. m.

Lat. N. 84° 25′
Long. E. 23° 56′

Needle *B* $H = 0{\cdot}065$

Mer. 133° 17′

	Circle W. N	Circle W. S	Circle E. N	Circle E. S
	83° 46′	83° 45′	83° 30′	83° 35′
	45	48	32	33
	48	50	36	38
	52	55	32	32
	56	84 0	35	37
	84 5	5	33	30
	7	7	35	33
	8	6	33	30
	12	7	31	30
	10	5	30	27
Mean	83° 58·9′		83° 32·6′	

$I' = 83° 46'$
$\varDelta = -46$
$I = 83° 0'$

1896. February 24, p. m.

Lat. N. 84° 7′
Long. E. 24° 28′

Needle *B* — $H = 0{\cdot}065$
Mer. 151° 55′

Circle W. N	Circle W. S	Circle E. N	Circle E. S
84° 10′	84° 12′	83° 47′	83° 47′
10	10	55	55
2	2	84 0	58
8	10	0	84 0
10	6	0	83 59
10	8	1	84 2
10	5	83 59	0
12	6	84 5	8
18	17	83 59	1
16	12	58	3
16	13	59	1
13	12	57	3
5	2	84 1	2
3	2	83 59	4
1	2	84 0	0
1	0	83 59	83 57
83 58	1	57	55
84 1	2	59	57
0	0	57	57
5	5	58	57
Mean 84° 6·9′		83° 58·9′	

$I' = 84°\ 3'$
$\varDelta = -45$
$I = 83°\ 18'$

The bracket frozen fast.

1896. March 5, p. m.

Lat. N. 84° 6′
Long. E. 25° 27′

Needle *B* — $H = 0{\cdot}064$
Mer. 157° 54′

Circle E. N	Circle E. S	Circle W. N	Circle W. S
83° 35′	83° 36′	83° 50′	83° 55′
35	35	50	53
45	47	50	56
45	47	56	53
50	52	52	53
52	55	57	57
57	57	84 0	84 0
50	54	3	3
44	48	5	3
42	45	7	5
Mean 83° 46·6′		83° 57·4′	

$I' = 83°\ 52'$
$\varDelta = -46$
$I = 83°\ 6'$

1896. March 18, a. m.

Lat. N. 84° 5′
Long. E. 24° 56′

Needle *B* — $H = 0{\cdot}064$
Mer. 169° 56′

Circle E. N	Circle E. S	Circle W.[1] N	Circle W.[1] S
83° 59′	84° 0′	84° 20′	84° 18
84 0	0	18	15
1	0	0	2
83 59	83 58	83 58	83 57
58	84 1	57	57
58	3	59	59
57	0	84 2	84 2
57	0	1	2
53	83 54	5	7
57	59	13	17
Mean 83° 58·7′		84° 5·5′	

$I' = 84°\ 2'$
$\varDelta = -45$
$I = 83°\ 17'$

[1]) The needle disturbed during the first 2 or 3 settings.

1896. April 9, a. m.

Lat. N. 84° 27′
Long. E. 18° 48′

Needle *B* $H = 0{\cdot}064$
Mer. 163° 13′

	Circle E. N	Circle E. S	Circle W. N	Circle W. S
	83° 48′	83° 48′	84° 18′	84° 18′
	50	50	15	13
	53	55	5	2
	56	55	2	83 59
	50	50	0	84 0
	48	48	83 54	83 54
	46	50	84 0	2
	45	50	1	3
	47	48	10	15
	47	48	13	15
Mean	83° 49·6′		84° 6·0′	

$I' = 83° 58'$
$\varDelta = -45$
$I = 83° 13'$

1896. April 21, a. m.

Lat. N. 84° 3′
Long. E. 13° 25′

Needle *B* $H = 0{\cdot}065$
Mer. 164° 54′.

	Circle E. N	Circle E. S	Circle W. N	Circle W. S
	83° 48′	83° 47′	84° 17′	84° 17′
	47	45	12	10
	47	45	2	0
	45	46	83 56	83 50
	43	45	53	50
	47	48	53	50
	44	47	55	57
	43	43	58	57
	40	42	58	84 0
	42	44	52	0
Mean	83° 44·9′		83° 59·4′	

$I' = 83° 52'$
$\varDelta = -45$
$I = 83° 7'$

1896. May 7, p. m.

Lat. N. 84° 0′
Long. E. 11° 6′

Needle *B* $H = 0{\cdot}065$
Mer. 162° 8′

	Circle W. N	Circle W. S	Circle E. N	Circle E. S
	84° 16′	84° 15′	83° 55′	84° 2′
	3	5	53	83 55
	83 55	83 55	53	50
	84 6	84 10	45	48
	83 59	0	42	45
	84 8	4	46	50
	8 [1])	10	48 [2])	48
	10	4	47 [2])	47
	8	25 [2])	47	53 [4])
	15 [3])	20	55	84 2
Mean	84° 7·8′		83° 50·6′	

$I' = 83° 59'$
$\varDelta = -45$
$I = 83° 14'$

1896. June 4, p. m. No revolver.

Lat. N. 83° 14′
Long. E. 13° 3′

Needle *B* $H = 0{\cdot}068$
Mer. 176° 32′

	Circle W. N	Circle W. S	Circle E. N	Circle E. S
	83° 40′	83° 43′	83° 30′	83° 27′
	32	33	32	28
	30	30	34	36
	33	34	35	33
	24	27	30	30
	27	30	30	32
	30	33	30	33
	37	38	33	36
	43	45	32	36
	43	44	32	37
Mean	83° 34·8′		83° 32·3′	

$I' = 83° 34'$
$\varDelta = -45$
$I = 82° 49'$

[1]) Oscill. between 83° 50′ and 84° 30′. [2]) Disturbed. [3]) Much disturbed. Oscill. between 84° 5′ and 84° 40′. [4]) Disturbed. Oscill. between 83° 45′ and 84° 25′.

1896. June 17, p. m.

Lat. N. 82° 57′
Long. E. 11° 38′

Needle *B* $H = 0{\cdot}068$

Mer. 193° 20′

	Circle E. N	Circle E. S	Circle W. N	Circle W. S
	83° 32′	83° 32′	83° 45′	83° 45′
	31	33	42	42
	32	31	37	36
	30	29	33	36
	30	30	30	31
	33	33	30	30
	33	36	35	38
	35	36	36	42
	36	40	45	48
	38	43	50	52
Mean	83° 33·7′		83° 39·2′	

$I' = 83° 36'$
$\Delta = -44$
$I = 82° 52'$

1896. July 7, p. m.

Lat. N. 83° 1′
Long. E. 12° 52′

Needle *B* $H = 0{\cdot}068$

Mer. 146° 31′

	Circle E. N	Circle E. S	Circle W. N	Circle W. S
	83° 30′	83° 30′	83° 48′	83° 48′
	35	33	44	46
	34	28	38	40
	30	30	36	36
	28	27	32	32
	30	35	30	30
	32	33	36	37
	32	33	35	40
	35	38	42	48
	40	42	45	48
Mean	83° 32·8′		83° 39·6′	

$I' = 83° 36'$
$\Delta = -44$
$I = 82° 52'$

E. TOTAL INTENSITY.

As we have already mentioned, deflection observations were frequently made in connection with the inclination determinations, for the determination of the total intensity. The alhidade on the back of the vertical circle with one or both deflectors screwed in, was set with its zero exactly at the division of the limb that indicated the mean of the inclination readings obtained immediately before, with the same position of the instrument, "Circle E" or "Circle W". A series of readings of both ends of the needle were then taken, first with the needle deflected within one quadrant, and next a corresponding series with the needle deflected past the vertical. The thermometer belonging to the Fox apparatus proved several times to be out of order, and in these cases another thermometer was introduced into the box of the inclination-needle.

Only in five cases were both the deflectors used together; on all other occasions only the one deflector marked N was employed.

In analogy with the formula given on page 130, we obtain, as an expression for the total intensity W,

$$W = \frac{R_1 (1 + \zeta_1 t)}{\sin \psi_1}, \qquad (1)$$

where R_1, ζ_1 and ψ_1 are substituted for R_2, ζ, and ψ_2, and indicate the corresponding quantities applicable in the case of only the one deflector being employed. No determination of the constants R_1 and ζ_1 were made either before the voyage, in Hamburg, or after the return, at Wilhelmshaven.

It is true that in Hamburg, after the return, on March 6th, 1897, a series of observations were also made by Captain SCOTT-HANSEN with needle B deflected by means of only the one deflector N, the result yielded being

$$\psi_1 = 31^\circ\,43{\cdot}5'$$

at a temperature of 6·6° C. Assuming, for the place of observation in Hamburg on that day, an inclination of 67° 21′ and a horizontal intensity of 0·1812, we obtain

$$R_1\,(1 + \zeta_1\,t) = 0{\cdot}2474\,.$$

I have already pointed out, however, that the constant-determinations made in Hamburg after the return, cannot be considered thoroughly reliable, owing to the proximity of the electric tramway. Considering also the uncertainty prevailing with regard to the changes that the magnetic moment of the magnets may have undergone during the voyage, it seems to me hardly fair to make this one uncertain constant-determination the basis for a calculation of the absolute value of the total intensity, the more so as the determinations of the angle of deflection ψ, with the one deflector, were made in temperatures varying between $+\,6^1/_2{}^\circ$ and $-\,36^1/_2{}^\circ$, while no notice can be taken of this fact, there being no material forthcoming for the determination of the temperature-coefficient.

It might perhaps be thought that out of the values of the angle of deflection ψ_1 found when drifting with the ice, a few data might be picked out, to which there were corresponding values of the horizontal intensity and inclination sufficiently well determined to justify an attempt at an approximate calculation of R_1 and ζ_1, according to formula (1), by the method of least squares, when the formula will become

$$\frac{1}{R_1} - t\,\frac{\cos I}{H \sin \psi_1}\,\zeta_1 = \frac{\cos I}{H \sin \psi_1}\,.$$

But to this it must be remarked that the observation-material that would then be employed, would have to be selected within sufficiently narrow time-limits for R_1 to be supposed to have remained constant, which, in its turn, would occasion the risk of there being too little variation in the temperature in which the observations were made.

I have nevertheless made some experiments in this direction, but unfortunately without success. I am therefore convinced that it is best to make direct use of the determinations of horizontal intensity and inclination made during the expedition for the calculation of the total intensity, and leave the deflection observations made with the Fox apparatus as a check on the intensity determinations, altogether out of consideration. I have, however, as demonstrated above, found employment for the deflection-observations with both deflectors, in the determination of the index-error of the inclination-needle.

In the following list, however, I have entered all the deflection observations, partly for possible future utilisation, and partly, too, to show what might have been done in this direction with the instrument, if the necessary determinations of the constants had been forthcoming.

The temperature given in the list is the mean of all the temperatures taken during both the simultaneous inclination determinations, and the deflection observations, corrected for the error of the thermometer used. In the column containing the readings of the needle's position, when it was deflected "directly" (within one quadrant), and when "past the vertical", the figures given are the mean of the readings of the north and south ends of the needle. The angle of deflection ψ is calculated in the following manner. If we call the mean of all readings with the needle deflected directly a, and the mean of all readings with the needle deflected past the vertical b, we have

$$\psi = 90° - \frac{a + b}{2}.$$

OBSERVATIONS OF DEFLECTION.

Date	Lat. N.	Long. E.	Needle	Numb. of Deflectors	*t*	Circle E Needle deflected Directly	Circle E Needle deflected Past the vert.	Circle W Needle deflected Directly	Circle W Needle deflected Past the vert.	ψ
1893.										
Aug. 1.	69° 41′	60° 20′	*B*	1	4·4°	50° 29′	72° 44′	49° 42′	73° 51′	28° 18·5′
Oct. 16.	78 17	136 9	*B*	2	−17·0	32 56	41 57·5	32 49	41 36·5	52° 40·4′
						51·5	42 0·5	45	41	
Dec. 2, p. m.	78 43	138 30	*B*	2	−23·7	32 39	41 57·5	32 43·5	41 38	52° 46·2′
						35	57·5	45	35	
1894.										
Feb. 10.	79 56	134 51	*B*	2	−31·6	33 0	41 1	32 54	41 0	
						32 57·5	1	58	0	
						33 2	3·5	33 0·5	40 56	53° 1·2′
									47·5	
March 30, a. m.	80 8	135 0	*B*	2	−24·0	34 30	42 2·5	34 17·5	42 9·5	
						27	2	21	14	
						30	5·5	18·5	8·5	
						30	6·5	18	6·5	51° 44·1′
						29·5	6	24	5	
						30	11	24·5	7·5	
						27·5	6·5	20·5	5·5	
May 4, p. m.	80 51	130 56	*B*^I^	2	− 8·0	35 59·5	42 50	35 19	43 36·5	
						36 1	54	16·5	38	
						4	57	22	45·5	50° 28·4′
						10·5	55	29·5	45·5	
						7·5	43 0·5	38	42·5	
May 23.	81 27	123 55	*B*^I^	1	− 2·1	58 28·5	65 5	58 5·5	65 58·5	
						7·5	64 58·5	0	44	
						21	65 2·5	57 43	43	
						15·5	64 59·5	41.5	54	
						18·5	65 4	37	66 14·5	
						23	7	36·5	22	28° 10·7′
						23	15	35·5	10·5	
						25	20	36	65 51·5	
						31·5	25·5	40	45	
						43·5	35·5	43·5	44	
						44·5			52·5	

Date	Lat. N.	Long. E.	Needle	Numb. of Deflectors	t	Circle E, Needle deflected, Directly	Circle E, Needle deflected, Past the vert.	Circle W, Needle deflected, Directly	Circle W, Needle deflected, Past the vert.	ψ
1894.										
June 8.	81° 28′	122° 6′	*B*	1	5·2°	58° 14·5′	65° 34·5′	57° 46′	66° 7′	
						16·5	37	47	9	
						17·5	47	50·5	17·5	
						20	52	59	18	
						24·5	56·5	58 3·5	18·5	27° 53·2′
						23·5	66 1	6·5	21·5	
						19	3·5	13	16	
						16	0·5	15	11	
						15·5	65 58·5	15	11	
						11	66 2	9·5	5·5	
July 26, p. m.	81 17	125 57	*B*	1	3·0	58 26	65 24	58 2	65 56·5	
						31	29	2·5	59·5	
						33·5	34·5	10	66 1·5	
						33	45	17	13	
						36·5	48·5	18	13·5	27° 49·5′
						35·5	52	26·5	13·5	
						32·5	55	29	11	
						31	55	30	8·5	
						30	53	29	5·5	
						28·5	51·5	28	0	
Aug. 2, p. m.	81 4	127 0	*B*	1	4·0	58 25·5	65 27·5	57 56·5	65 57·5	
						29	30·5	56·5	66 2	
						31·5	40	59	13	
						36·5	45	58 6·5	13	
						37	51·5	16	14	27° 48·6′
						39·5	56	25	15·5	
						34	59	26·5	16·5	
						34	59	28	15	
						29	57	28	11	
						26·5	57·5	24	7·5	
Aug. 17, a. m.	81 6	128 4	*B*	1	5·2	58 26·5	65 23	58 1·5	65 56	
						32	28·5	4	66 1	
						36	35	11	4	
						39·5	45	15	11·5	
						45	53·5	20·5	11·5	
						43·5	58·5	27	12	27° 48·0′
						43	59·5	31·5	10	
						34·5	57·5	33·5	2	
						40	56·5	30	65 59·5	
						34	54·5	27	55·5	
						28				

Date	Lat. N.	Long. E.	Needle	Numb. of Deflectors	t	Circle E, Needle deflected, Directly	Circle E, Needle deflected, Past the vert.	Circle W, Needle deflected, Directly	Circle W, Needle deflected, Past the vert.	ψ
1894.										
Aug. 17, p. m.	81° 6′	128° 4′	*B*	1	4·5°	58° 24·5′	65° 43′	58° 0′	66° 0′	
						31·5	33·5	0	2·5	
						38·5	39	2	3·5	
						38·5	54·5	8	9·5	
						38	66 0	12	14·5	
						38·5	2	14	14·5	27° 47·0′
						36·5	4	22·5	16·5	
						35·5	0	24	17·5	
						29	0·5	25	11·5	
						29	0	26	7·5	
								24	6	
								22·5		
Sept. 20, p. m.	81 12	123 39	*B*	1	− 8·4	58 22	65 26·5	58 1	65 36·5	
						24·5	29	4	38	
						25·5	28·5	7	40·5	
						28	32	13·5	43·5	
						29	32·5	17·5	44	
						30·5	36	23	45·5	28° 1·5′
						28·5	36·5	25	44	
						26·5	35	24·5	38	
						20·5	33·5	25	36	
						18	35	23	32·5	
Oct. 19.	81 52	115 15	*B*	1	−16·9	57 58·5	65 57·5	58 11	65 46	
						59·5	58·5	11	49	
						58 3	66 1	13	51·5	
						3	2·5	11	53	
						7	7	6·5	55	
						7·5	10	5	57	27° 58·6′
						7·5	12	3·5	54	
						4·5	11·5	1·5	47·5	
						1·5	9·5	57 59	45·5	
						57 58·5	10·5	58·5	46·5	
Nov. 9, p. m.	82 10	110 50	*B*	1	−25·5	57 55	65 27	57 26	65 58·5	
						58	28·5	27	66 0	
						58 2	34	29	1	
						4·5	35·5	32·5	1·5	
						4	35·5	32	4	
						2	41	37	5	28° 12·3′
						0·5	43·5	37	4	
						0·5	44·5	36	1	
						57 59·5	37·5	34·5	65 59	
						59	38·5	35	57·5	

Date	Lat. N.	Long. E.	Needle	Numb. of Deflectors	t	Circle E		Circle W		ψ
						Needle deflected		Needle deflected		
						Directly	Past the vert.	Directly	Past the vert.	
1894.										
Nov. 23, p. m.	81° 59′	112° 2′	*B*	1	−25·7°	57° 55′	65° 38′	57° 44·5′	65° 43·5′	
						57·5	41	46·5	42·5	
						58	42	51·5	43·5	
						58 0	43·5	53	46·5	
						1	48	55	48	
						0·5	51·5	58 0	48	28° 9·2′
						1·5	53	0·5	44	
						57 57	54·5	0	41	
						55·5	51·5	0·5	36·5	
						54	50	57 59·5	34	
Nov. 28.	82 9	111 13	*B*	1	−26·7	57 44	65 32	57 31·5	65 40	
						40·5	35	34	42·5	
						42	37	39	43·5	
						45	39	43	42	
						49·5	44	43·5	43	
						49·5	47·5	44·5	45·5	28° 17·3′
						46·5	48·5	49	41·5	
						42	51·5	51	40·5	
						36	50·5	50·5	36	
						34	50	48	35·5	
Dec. 20.	82 52	104 30	*B*	1	−23·9	57 22·5	65 50	57 29·5	65 52·5	
						25·5	51	31·5	53·5	
						27·5	55·5	32	54	
						27·5	56	31	54·5	
						29·5	59	29	54·5	
						30·5	66 1	26	54	28° 19·6′
						28·5	2	24	52·5	
						28	1	21·5	49·5	
						25	0	16·5	46·5	
						24	65 59·5	14·5	46	
Dec. 22.	83 0	103 40	*B*	1	−25·5	57 34·5	65 25·5	57 11·5	65 49	
						36	31	10	52	
						36·5	32·5	14	51	
						41	40	21·5	54·5	
						44·5	46·5	30·5	56·5	
						46	46	33·5	54·5	28° 20·6′
						42·5	51	35·5	53·5	
						39·5	48·5	37	48·5	
						37	47	34·5	44	
						35	46·5	33	44·5	

Date	Lat. N.	Long. E.	Needle	Numb. of Deflectors	t	Circle E Needle deflected Directly	Circle E Needle deflected Past the vert.	Circle W Needle deflected Directly	Circle W Needle deflected Past the vert.	ψ
1895.										
Jan. 19.	83° 26′	102° 0′	*B*	1	−26·8°	57° 5·5′	65° 33·5′	57° 13·5′	65° 29·5′	
						7	36	16·5	31	
						9·5	38·5	19	31	
						10	44	23·5	32	
						13·5	48	26	31·5	28° 32·2′
						13	56	28	33	
						12	58	30	31	
						7·5	57·5	27·5	27·5	
						4	66 0	28	27·5	
						2·5	65 58	27	26·5	
March 21.	84 9	100 28	*B*	1	−23·4	57 21·5	66 0	57 18·5	65 52	
						26	0	20	56	
						25·5	1	19	55·5	
						29	2·5	18·5	58·5	
						32	65 59·5	16	59·5	28° 22·4′
						34·5	58	13	66 0·5	
						34·5	49	13·5	65 59·5	
						35	44·5	4	54·5	
						29	42	3·5	51·5	
						25	31	1·5	49·5	
April 3.	84 14	98 35	*B*	1	−21·3	57 5·5	65 52	57 2	65 49	
						8	53·5	5	50	
						11	59	6·5	53·5	
						11·5	66 0	11	53·5	
						15·5	2·5	12	55	28° 26·6′
						14·5	5·5	14·5	56	
						12·5	8·5	16·5	53	
						7·5	7	15·5	46	
						5	9	12·5	46	
						3·5	7·5	12·5	46	
April 19.	84 14	94 36	*B*	1	−20·4	57 0·5	65 55·5	56 49·5	65 58·5	
						0	56	52	57·5	
						56 59	66 0	57·5	59	
						59·5	2	58·5	66 1	
						57 2	6·5	57 2	1·5	
						3	11·5	5·5	1·5	28° 28·7′
						2·5	11	7·5	65 59·5	
						0	10·5	5	58·5	
						56 59	11·5	1·5	56	
						57·5	10·5	2	58	

Date	Lat. N.	Long. E.	Needle	Numb. of Deflectors	t	Circle E Needle deflected Directly		Circle W Needle deflected Directly		ψ
						Directly	Past the vert.	Directly	Past the vert.	
1895.										
May 22.	84° 40′	83° 51′	*B*	1	−5·3°	56° 53′	66° 10′	56° 35·5	66° 15′	
						56	14·5	36·5	16·5	
						58·5	15·5	42	17·5	
						59·5	20	45	19·5	
						57 1·5	27	48	20·5	28° 23·5′
						0	30	51·5	24·5	
						56 57	31·5	54·5	23·5	
						55	30	53	19	
						51·5	30	50·5	17·5	
						47	31·5	52	17·5	
July 2.	84 40	74 19	*B*	1	6·5	56 34	66 17	56 12·5	66 46·5	
						36·5	27·5	13	48	
						38·5	37	8·5	52	
						46·5	48	30	59	
						46	53·5	33·5	67 1	28° 16·3′
						48·5	57·5	36·5	1·5	
						45·5	67 0	42	0	
						44·5	66 59·5	41·5	2	
						41	59	40	66 55	
						35·5	58	38·5	52	
July 11.	84 42	75 55	*B*	1	6·4	56 32	66 42	56 27·5	66 26	
						34	44	30	28·5	
						34·5	46	33·5	27·5	
						36	44·5	36·5	26·5	
						35·5	41·5	39	28	28° 26·1′
						35·5	37·5	41	29	
						36	35	42·5	28·5	
						33·5	29·5	42·5	24	
						31·5	28·5	42	23·5	
						31·5	27·5	41	24	
Aug. 13	84 31	76 19	*B*	1	0·9	56 25	66 50	56 27	66 38·5	
						29	52	27·5	39	
						29	50	28	41	
						30	48	27·5	45·5	
						32	49·5	25	45	28° 25·8′
						30·5	44·5	23	45·5	
						30·5	42·5	18	44·5	
						29	37	16	41·5	
						28	35·5	13	40·5	
						26·5	34	13·5	34	

Date	Lat. N.	Long. E.	Needle	Numb. of Deflectors	t	Circle E Needle deflected Directly	Circle E Needle deflected Past the vert.	Circle W Needle deflected Directly	Circle W Needle deflected Past the vert.	ψ
1895.										
Sept. 5, p. m.	84° 52′	78° 34′	*B*	1	– 2·4°	56° 44′	66° 1·5′	56° 29′	66° 17′	
						49	8·5	24·5	15	
						46·5	16·5	33·5	21	
						53	20·5	34	25	
						55	25·5	43	26·5	
						53·5	29	46·5	28	28° 26·3′
						54	30·5	45·5	23·5	
						52	30	47·5	23·5	
						52	28·5	47·5	22	
						50	29	44	22	
Sept. 6, a. m.	84 53	78 42	*B*	1	– 0·3	56 46′	66 34·5	56 31·5	66 39′	
						49	33	34·5	36·5	
						49	32·5	35	37·5	
						53	37	36	39	
						50	35	34	38·5	
						53·5	26·5	30	40	28° 25·2′
						48	23	27	35·5	
						47	14·5	21·5	32	
						45	14	18	30·5	
						41·5	13·5	18·5	31·5	
Oct. 16, p. m.	85 32	78 28	*B*	1	–17·3	56 46·5	65 55·5	56 27·5	65 57	
						48·5	59·5	35	59	
						49	66 7·5	36·5	66 0·5	
						54·5	11	45	2·5	
						56	13	44	2·5	
						59·5	12·5	47	8	28° 34·4′
						50	12·5	45	2·5	
						51·5	14·5	45	65 59·5	
						45·5	15	47·5	59	
						45·5	14	46	55	
Nov. 9, a. m.	85 42	64 25	*B*	1	–23·6	56 11	66 1·5	55 59	66 9	
						15	12·5	56 1	15·5	
						16·5	19	8·5	16	
						24	30	13	17·5	
						26	27·5	16	20	
						30	35	18·5	19·5	28° 41·0′
						28	34·5	21	16	
						25·5	33	22·5	15	
						19·5	31·5	22	13·5	
						13·5	32	18	12	

Date	Lat. N.	Long. E.	Needle	Numb. of Deflectors	t	Circle E Needle deflected Directly	Circle E Needle deflected Past the vert.	Circle W Needle deflected Directly	Circle W Needle deflected Past the vert.	ψ
1895.										
Nov. 19, p. m.	85° 52′	64° 47′	*B*	1	−25·2°	56° 17′	66° 1·5′	55° 59′	66° 23′	
						20	8·5	56 4	26·5	
						24·5	13·5	6	30·5	
						29	19·5	18	39·5	
						30·5	30	21·5	42·5	
						33	31·5	22	42	28° 34·8′
						31	33·5	27	39	
						29·5	29·5	29	33·5	
						26·5	33	26·5	31·5	
						19	34	25·5	26·5	
Nov. 30, a. m.	85 28	58 41	*B*	1	−23·2	55 56·5	66 11	55 38′	66 23·5	
						59	15	45·5	23	
						56 0	16	49	21·5	
						1·5	24	58·5	25	
						4·5	21·5	55·5	25·5	
						5·5	30·5	59	24	28° 49·6′
						5·5	29	56 1·5	23·5	
						1	30	0·5	16·5	
						55 59·5	29·5	0	19·5	
						58·5	31·5	0·5	16	
Dec. 4.	85 29	56 46	*B*	1	−29·4	55 46	66 10	55 36	66 14	
						51·5	13·5	38·5	15·5	
						53·5	16·5	45·5	16·5	
						59	23·5	48·5	20·5	
						59·5	24·5	51	20·5	
						59	30	53	20	28° 54·1′
						56·5	28·5	57	15·5	
						56·5	29	56·5	14	
						55	31	56	11·5	
						52	30	53·5	8·5	
Dec. 13.	85 25	49 32	*B*	1	−21·0	55 36	66 49	55 41	66 31	
						42·5	49	44·5	31·5	
						45·5	49	46	39·5	
						48·5	52	45·5	45·5	
						48·5	49·5	45	44·5	
						50	43·5	41	42	28° 49·7′
						46	41	36·5	36	
						42	33	30	32	
						42·5	31	30	31	
						38·5	27·5	24·5	28·5	

Date	Lat. N.	Long. E.	Needle	Numb. of Deflectors	*t*	Circle E, Needle deflected, Directly	Circle E, Needle deflected, Past the vert.	Circle W, Needle deflected, Directly	Circle W, Needle deflected, Past the vert.	ψ
1896.										
Jan. 11, a. m.	84° 56′	41° 10′	*B*	1	−36·7°	54° 55·5′	66° 54′	55° 4′	66° 51·5	
						57	67 0	8	57·5	
						55 0	66 55	10·5	67 0	
						0	58·5	5·5	1	
						2·5	67 9	4	6	
						4	10	1·5	2	29° 0·2′
						54 59	9	54 58	66 57·5	
						54·5	4·5	47·5	52	
						54·5	6	46·5	53	
						50	6·5	58·5		
Jan. 17, a. m.	84 53	40 13	*B*	1	−33·7	55 2·5	66 57·5	55 4·5	66 44·5	
						10	59	6·5	48·5	
						12	67 1	6·5	50	
						12	2	6	54·5	
						14·5	66 59	5	59	
						11·5	53	1	55	29° 2·7′
						11	49	54 59	52	
						2·5	45	58	47·5	
						54 59	42·5	48	44	
						59	36	46	40	
Jan. 27, p. m.	84 40	31 36	*B*	1	−29·8	54 47	66 42	54 37·5	66 59·5	
						49	47	35·5	67 6	
						56	55	36	10	
						57	67 1	47	12·5	
						55 0·5	12·5	56·5	16·5	
						2	16	55 0·5	15	29° 0·8′
						0	15·5	1·5	12	
						54 55·5	14	0	6	
						45	11	54 57·5	66 59	
						45·5	11	56·5	67 0·5	
Feb. 3, p. m.	84 47	25 18	*B*	1	−25·0	54 49	66 42·5	54 32·5	67 3	
						51·5	51	38	5	
						58	67 0·5	44·5	1[illegible] 5	
						55 0	11	52·5	1[illegible]	
						3	20	55 0·5	25	
						6·5	25	2·5	23	28° 55·5′
						2	26	3·5	20	
						54 59	22·5	1	16	
						58	21	1·5	11·5	
						52·5	19	0	4	

Date	Lat. N.	Long. E.	Needle	Numb. of Deflectors	t	Circle E		Circle W		ψ
						Needle deflected		Needle deflected		
						Directly	Past the vert.	Directly	Past the vert.	
1896.										
Feb. 12, a. m.	84° 25′	23° 56′	*B*	1	−33·1°	54° 16′	66° 59′	54° 16′	67° 13·5′	
						19	67 1	17·5	16·5	
						26	13·5	25·5	18·5	
						31	21·5	30	21·5	
						33·5	31	39	25	29° 3·6′
						32·5	33·5	43·5	20	
						30	38·5	44·5	21	
						30	40·5	44·5	16	
						29	39·5	45	15	
						25	39	43	12·5	
March 5, p. m.	84 6	25 27	*B*	1	−28·0	54 46·5	67 46′	55 1·5	67 28·5	
						49	48	2	31	
						52·5	50	4	36	
						56·5	46	4	42·5	
						55 2	45	3	45	28° 43·1′
						2	44	0·5	45	
						0·5	41	54 53	39	
						0·5	33	43	37·5	
						54 57·5	30	38·5	32	
						55·5	18	37·5	30·5	
March 18, a. m.	84 5	24 56	*B*	1	−13·0	54 59	67 20·5	54 33·5	67 32	
						55 0	23·5	34·5	31·5	
						2	29·5	43·5	35	
						4	35	50	45	
						11	36	57	47·5	28° 42·3′
						11·5	36·5	59·5	50	
						10	37	55 0	48·5	
						6·5	38·5	0	43·5	
						0·5	42	54 59	40	
						54 59	41	58	36	
April 9, a. m.	84 27	18 48	*B*	1	−17·4	54 50	67 29·5	54 37·5	67 31·5	
						56	32	38	29·5	
						57·5	33	43·5	31·5	
						57·5	38·5	47	34	
						55 2	39·5	51·5	41·5	28° 43·1′
						3	43·5	56	42	
						2	47	55 0	42·5	
						0·5	49	2	41	
						54 58	47·5	4·5	36·5	
						58·5	48	2·5	32	

Date	Lat. N.	Long. E.	Needle	Numb. of Deflectors	t	Circle E Needle deflected Directly	Circle E Needle deflected Past the vert.	Circle W Needle deflected Directly	Circle W Needle deflected Past the vert.	ψ
1896.										
April 21, a. m.	84° 3′	13° 25′	*B*	1	−17·4°	54° 41′	67° 39′	54° 31′	67° 28′	
						44·5	44	37	29·5	
						45	46·5	40·5	29·5	
						43·5	49	42	32·5	
						49	52·5	46·5	40·5	28° 44·4′
						49	52·5	50	43·5	
						50·5	57	53·5	44	
						48	59·5	56·5	44	
						47·5	68 2·5	58	40	
						45·5	2	56·5	33·5	
May 7, p. m.	84 0	11 6	*B*	1	−15·3	54 36·5	67 34	54 31·5	67 30·5	
						41·5	37	34	29	
						41·5	43·5	38	37	
						45·5	48	41·5	36	
						45	48·5	42·5	36·5	
						46	53·5	47	35·5	2 47·4′
						44·5	55·5	47·5	37·5	
						42·5	58·5	48·5	40	
						44	59·5	49	35	
						41	58	52	31·5	
June 4, p. m.	83 14	13 3	*B*	1	3·2	54 32·5	67 55	54 27	68 11·5	
						34	57	26·5	13·5	
						35·5	68 1	25	11·5	
						37	3	19	12·5	
						40	8	17	15	28° 41·8′
						39	10	14	15·5	
						40·5	13·5	11	15	
						37·5	14·5	6·5	15	
						34·5	12·5	7·5	11	
						33	13	8	12·5	
June 17, p. m.	82 57	11 38	*B*	1	5·8	54 30·5	67 52	54 5·5	68 13·5	
						31·5	53·5	10	13	
						32·5	58·5	15	13·5	
						34·5	68 1	19	12·5	
						35·5	6·5	21	15·5	28° 42·7′
						35	4·5	23·5	14	
						36·5	12·5	24·5	14	
						34	11·5	27·5	13·5	
						29·5	10·5	24·5	12	
						29·5	9	21·5	8·5	

Date	Lat. N.	Long. E.	Needle	Numb. of Deflectors	t	Circle E Needle deflected Directly	Circle E Needle deflected Past the vert.	Circle W Needle deflected Directly	Circle W Needle deflected Past the vert.	ψ
1896.										
July 7, p. m.	83° 1′	12° 52′	*B*	1	4·6°	54° 34′	67° 58·5′	53° 57·5′	68° 2·5′	
						31	68 0	54 14	11	
						33·5	6·5	16·5	15	
						33	10	17·5	15	
						34·5	12	24·5	18	
						36	12	29	16	28° 40·0′
						36·5	15	32	18·5	
						36·5	16	31·5	13·5	
						29·5	15	35·5	11·5	
						28·5	12·5	34	9	
								31·5		

F. GENERAL RESULTS.

In a treatise "Ueber die Darstellung der Ergebnisse erdmagnetischer Beobachtungen im Anschluss an die Theorie"[1]), as also on several previous occasions, Professor Dr. Ad. Schmidt of Gotha has strongly advocated the desirability, in the publication of terrestrial-magnetic investigations from various quarters of the globe, of giving not only the directly observed values of the three magnetic elements, but also the difference between them and the theoretically calculated values for the points of observation in question, as in this way the material for a more and more wide-spread improvement of the theory of terrestrial magnetism would be collected.

Dr. Ad. Schmidt has paid the Norwegian Polar Expedition the marked attention of offering to perform the arduous labour of calculating theoretically the value of the magnetic elements for all the points at which magnetic observations were made during the expedition, an offer which I have of course accepted with very great gratitude. I am therefore enabled, in the following list of all the results of the observations in chronological order, to append the deviation of every single result from the corresponding theoretically calculated value. These differences (observed value *minus* calculated value), indicated in the table as $O—C$, are not, however, really strictly correct, as they contain the influence of the secular variation of the magnetic elements for a period of about 10 years, the values calculated theoretically by Dr. Ad. Schmidt having reference to 1885·0, while the observations of the

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[1]) Annalen der Hydrographie und Maritimen Meteorologie. Jahrg. XXVI, Berlin 1898, p. 21.

Norwegian Polar Expedition were made during the period from 1893·6, to 1896·5. Finally, it should also be remarked that in the calculation of the results of the observations, no regard has been paid to the more or less considerable magnetic disturbances that may have prevailed during the actual making of the observations.

Each separate point of observation (station) is designated with a number, the numbers running continuously from 1 to 225.

Station No.	Date			Lat. N.	Long. E.	D		H		I	
						Obs.	O−C	Obs.	O−C	Obs.	O−C
1	1893.	Aug.	1	69° 41′	60° 20′	..	..	0·1145	−0·0046	77° 38′	+15′
2		–	8	69 54	66 43	20° 28′	+1° 22′	0·1118	−0·0025	78 21	+18
3		Oct.	10	78 19	136 2	..	..	0·0504	−0·0121	..	..
4		–	14	78 15	136 1	..	..	0·0500	−0·0128	..	..
5		–	16	78 17	136 9	..	..	..	..	84 43	+49
6		–	18	78 19	136 15	14 6	−4 54	..	..	..	..
7		–	20	78 19	136 5	..	..	0·0494	−0·0131	..	..
8		–	21	78 18	135 50	..	..	..	..	84 39	+44
9		–	30	78 13·5	135 28	14 19	−4 24	..	..	..	..
10		Nov.	3	78 1	134 57	..	..	0·0513	−0·0122	..	..
11		–	9	77 54	137 52	..	..	0·0516	−0·0130	..	..
12		–	17	78 25	139 16	14 4	−5 15	..	..	..	..
12		–	18	78 25	139 16	..	..	0·0502	−0·0126	..	..
13		–	21	78 24	139 18	14 18	−4 58	..	..	..	..
14		–	25	78 37	139 4	..	..	0·0500	−0·0119	..	..
15		Dec.	2	78 43	138 30	..	..	..	..	84 41	+39
16		–	12	79 7	137 40	17 55	−4 2	..	..	..	..
17	1894.	Jan.	23	79 42	135 32	23 39	−0 37	..	..	..	..
18		–	26	79 44	135 12	..	..	..	..	85 38	+73
19		Feb.	10	79 56	134 51	..	..	..	..	85 16	+47
20		–	14	80 0	133 59	22 34	−2 57	..	..	..	..
21		–	17	80 2	133 49	..	..	0·0426	−0·0138	..	..
22		–	22	80 10	133 49	24 31	−1 42	0·0429	−0·0131	..	..
23		–	27	80 4	135 27	..	..	0·0419	−0·0144	..	..
24		March	6	79 51	135 0	23 16	−1 37	..	..	..	..
25		–	17	79 37	135 10	..	..	..	..	85 7	+44
26		–	21	79 48	135 0	23 18	−1 23	..	..	..	..
27		–	”	79 49	134 58	22 55	−1 50	0·0450	−0·0121	..	..
28		–	23	80 1	134 41	22 44	−2 52	..	..	..	..
29		–	30	80 8	135 0	..	..	..	..	85 23	+51
30		–	31	80 6	135 0	23 34	−2 22	..	..	..	..
31		April	14	80 12	133 43	..	..	0·0425	−0·0134	..	..
32		–	16	80 18	133 5	25 42	−1 5	..	..	..	..
33		–	19	80 27	131 50	..	..	..	..	85 22	+45
34		–	21	80 28	131 8	25 49	−1 40	..	..	..	..
35		–	26	80 35	131 29	26 47	−1 12	..	..	..	..
36		–	27	80 36	131 39	..	..	0·0400	−0·0147	..	..
37		–	”	80 36	131 42	..	..	0·0397	−0·0150	..	..
38		May	4	80 51	130 56	..	..	..	..	85 28	+45
39		–	5	80 49	130 35	28 53	−0 4	0·0418	−0·0124	..	..

Station No.	Date	Lat. N.	Long. E.	*D*		*H*		*I*	
				Obs.	*O—C*	Obs.	*O—C*	Obs.	*O—C*
40	1894. May 10	80° 54′	130° 5′	..	..	0·0396	—0·0144	..	..
41	— 11	80 52	130 6	29° 18′	+0° 7′	..	..	..	..
42	— 12	80 52	130 10	..	..	..	..	85° 15′	+32′
43	— 22	81 24	124 38	..	..	0·0387	—0·0148	..	..
44	— 23	81 27	123 55	..	..	..	..	85 28	+42
45	— 26	81 31	123 2	35 6	+3 28	..	..	..	..
46	— "	81 31	122 59	34 32	+2 54	..	..	..	..
47	— 31	81 32	122 18	..	..	0·0398	—0·0138	..	..
48	June 1	81 31	122 15	..	..	..	..	85 24	+39
49	— 4	81 31	122 8	36 33	+4 56	..	..	..	..
50	— 7	81 28	122 10	35 25	+3 59	0·0398	—0·0139	..	..
51	— 8	81 28	122 6	..	..	..	..	85 15	+31
52	— 12	81 43	122 13	..	..	0·0406	—0·0127	..	..
53	— 13	81 46	122 14	35 39	+3 7	..	..	..	..
54	— 14	81 48	122 5	..	..	..	..	85 31	+44
55	— 23	81 44	121 28	36 52	+4 30	..	..	..	..
56	— "	81 43	121 24	37 6	+4 49	0·0390	—0·0144	..	..
57	— 27	81 36	121 12	..	..	..	..	85 15	+31
58	— 28	81 35	121 30	..	..	..	..	85 25	+41
59	— "	81 35	121 37	..	..	0·0395	—0·0141	..	..
60	July 6	81 30	124 39	34 17	+2 39	0·0403	—0·0130	..	..
61	— 10	81 18	124 32	..	..	..	..	85 20	+35
62	— 11	81 19	124 38	32 19	+1 23	0·0390	—0·0146	..	..
63	— 14	81 32	124 59	..	..	..	..	85 22	+34
64	— "	81 32	124 58	34 9	+2 23	0·0392	—0·0140	..	..
65	— 20	81 30	125 5	..	..	..	..	85 59	+72
66	— 25	81 20	125 47	..	..	0·0394	—0·0141	..	..
67	— 26	81 17	125 57	..	..	..	..	85 24	+38
68	— 28	81 10	125 57	30 56	+0 34	..	..	..	..
69	Aug. 2	81 4	127 0	..	..	..	..	85 22	+38
70	— 3	81 5	127 19	29 46	—0 16	..	..	..	..
71	— 4	81 6	127 25	..	..	0·0393	—0·0145	..	..
72	— 15	81 7	127 52	30 2	—0 8	..	..	..	..
73	— 17	81 6	128 4	..	..	..	..	85 24	+39
74	— 18	81 5	128 7	..	..	0·0393	—0·0145	..	..
75	Sept. 4	81 14	123 26	32 9	+1 34	..	..	..	..
76	— 5	81 12	123 8	..	..	0·0402	—0·0139	..	..
77	— 7	81 9	122 40	..	..	..	..	85 18	+37
78	— 20	81 12	123 39	..	..	..	..	85 41	+58
79	— 21	81 12	123 25	..	..	0·0393	—0·0148	..	..

Station No.	Date	Lat. N.	Long. E.	D		H		I	
				Obs.	O−C	Obs.	O−C	Obs.	O−C
80	1894. Sept. 21	81° 12′	123° 22′	..	..	0·0384	−0·0157	..	..
81	— 24	81 20	122 35	34° 27′	+3° 31′	..	..	..	..
82	— 28	81 13	122 2	35 4	+4 32	..	..	..	..
83	Oct. 3	81 5	122 3	..	..	..	..	85° 26′	+46′
84	— 11	81 19	119 30	..	..	..	..	85 26	+47
85	— 19	81 52	115 15	..	..	..	..	85 24	+46
86	— 20	81 57	115 0	..	..	0·0404	−0·0140	..	..
87	— „	81 58	114 58	..	..	0·0407	−0·0137	..	..
88	— 27	82 4	114 35	38 59	+6 4	..	..	85 21	+42
89	Nov. 9	82 10	110 50	..	..	..	..	85 18	+45
90	— 10	82 11	110 42	39 8	+6 22	0·0417	−0·0136	..	..
91	— 15	82 7	110 30	..	..	..	..	85 17	+45
92	— 16	82 6	110 39	..	..	0·0411	−0·0143	..	..
93	— „	82 6	110 42	..	..	0·0417	−0·0137	..	..
94	— 22	82 1	112 15	40 30	+7 57	..	..	..	..
95	— „	82 0	112 5	38 44	+6 15	..	..	..	..
96	— 23	81 59	112 2	..	..	..	..	85 27	+53
97	— 24	81 58	111 59	..	..	0·0406	−0·0146	..	..
98	— „	81 58	111 58	..	..	0·0391	−0·0161	..	..
99	— 27	82 9	111 27	39 18	+6 30	..	..	..	..
100	— 28	82 9	111 13	..	..	..	..	85 24	+50
101	— 29	82 10	110 54	..	..	0·0420	−0·0132	..	..
102	— „	82 10	110 50	..	..	0·0407	−0·0145	..	..
103	Dec. 5	82 17	109 30	..	..	..	..	85 21	+49
104	— 6	82 20	109 12	40 38	+7 45	..	..	..	..
105	— 7	82 20	108 58	..	..	0·0418	−0·0138	..	..
106	— 14	82 33	107 53	..	..	0·0414	−0·0142	85 6	+35
107	— 15	82 34	107 38	41 32	+8 24	..	..	..	..
108	— 19	82 51	104 45	40 58	+7 54	..	..	..	..
109	— 20	82 52	104 30	..	..	..	..	85 6	+40
110	— 21	82 54	104 6	..	..	0·0443	−0·0120	..	..
111	— 22	83 0	103 40	..	..	..	..	85 5	+39
112	1895. Jan. 12	83 41	102 47	..	..	0·0417	−0·0140	85 0	+31
113	— 17	83 23	103 2	42 24	+8 53	..	..	..	..
114	— 18	83 25	102 30	..	..	0·0424	−0·0137	..	..
115	— 19	83 26	102 0	..	..	..	..	85 7	+41
116	March 5	84 4	101 27	..	..	..	..	85 14	+45
117	— 6	84 3	101 45	44 17	+10 8	..	..	..	..
118	— 7	84 1	101 53	..	..	0·0432	−0·0124	..	..
119	— 10	83 59	102 12	..	..	0·0448	−0·0107	..	..

Station No.	Date	Lat. N.	Long. E.	D		H		I	
				Obs.	$O-C$	Obs.	$O-C$	Obs.	$O-C$
120	1895. March 21	84° 9′	100° 28′	..	..	..	..	84° 59′	+ 31′
121	April 3	84 14	98 35	..	..	..	..	85 3	+ 38
122	— 5	84 17	97 23	..	..	0·0454	−0·0112	..	..
123	— 6	84 18	96 52	..	..	0·0453	−0·0114	..	..
124	— „	84 18	96 47	40° 57′	+ 8° 32′	..	..	..	..
125	— 19	84 14	94 36	..	..	..	..	84 57	+ 40
126	— 20	84 13	94 30	..	..	0·0462	−0·0114	..	..
127	— 22	84 13	94 36	40 20	+ 8 58	..	..	..	..
128	May 8	84 33	90 40	..	..	..	..	84 41	+ 29
129	— 9	84 35	90 21	..	..	0·0458	−0·0125	..	..
130	— 11	84 38	89 46	37 40	+ 8 21	..	..	..	..
131	— 22	84 40	83 51	..	..	..	..	84 44	+ 44
132	— 24	84 41	82 36	..	..	0·0498	−0·0106	.	..
133	— „	84 41	82 31	34 6	+ 8 41	0·0496	−0·0108	..	..
134	July 2	84 40	74 19	..	..	..	..	84 9	+ 27
135	— 3	84 42	74 20	..	..	0·0523	−0·0105	..	..
136	— 4	84 43	74 38	..	..	0·0527	−0·0100	.	..
137	— 5	84 43	75 44	30 39	+ 9 11	..	..	..	..
138	— 11	84 42	75 55	..	..	..	..	84 31	+ 46
139	— 12	84 41	76 0	28 46	+ 7 7	..	..	..	..
140	— 13	84 41	76 1	29 21	+ 7 42	0·0513	−0·0111	..	..
141	— 25	84 31	72 20	..	..	..	..	84 19	+ 44
142	— 26	84 30	72 56	..	..	0·0527	−0·0111	..	..
143	— 26	84 30	73 1	..	..	0·0527	−0·0110	..	..
144	Aug. 2	84 32	77 40	31 44	+ 9 1	..	..	..	..
145	— 7	84 38	77 20	..	..	..	..	84 24	+ 37
146	— 8	84 38	77 7	..	..	0·0514	−0·0108	..	..
147	— 13	84 31	76 19	..	..	..	..	84 20	+ 37
148	— 23	84 11	79 4	..	..	..	..	84 36	+ 52
149	— „	84 11	79 1	..	..	0·0517	−0·0109	..	..
150	Sept. 5	84 52	78 34	..	..	..	..	84 27	+ 34
151	— 6	84 53	78 42	..	..	..	..	84 35	+ 42
152	— „	84 53	78 45	31 50	+ 8 38	0·0496	−0·0115	84 28	+ 35
153	— 7	84 54	78 41	..	..	0·0507	−0·0104	..	..
154	— 26	85 7	79 17	..	..	..	..	84 34	+ 36
155	— 27	85 8	79 28	..	..	0·0508	−0·0095	..	..
156	— „	85 8	79 30	..	..	0·0496	−0·0107	..	..
157	— 28	85 8	79 42	33 42	+ 10 1	..	..	..	..
158	Oct. 2	85 11	79 9	..	..	..	..	84 41	+ 42
159	— 3	85 12	78 59	..	..	0·0502	−0·0101	..	..

Station No.	Date			Lat. N.	Long. E.	D		H		I	
						Obs.	O−C	Obs.	O−C	Obs.	O−C
160	1895.	Oct.	4	85° 11′	78° 53′	..	..	0·0504	−0·0100	..	..
161		—	„	85 10	78 51	..	..	0·0488	−0·0116	..	..
162		—	14	85 24	78 37	32° 29′	+ 9° 35′	..	..	..	..
163		—	15	85 28	78 33	..	..	..	..	84° 47′	+ 45′
164		—	16	85 32	78 28	..	..	..	..	84 52	+ 50
165		—	17	85 36	78 25	..	..	0·0475	−0·0121	..	..
166		—	„	85 37	78 23	..	..	0·0472	−0·0123	..	..
167		—	22	85 46	75 40	..	..	..	..	84 29	+ 28
168		—	24	85 46	73 40	..	..	0·0485	−0·0118	..	..
169		—	„	85 46	73 30	..	..	0·0483	−0·0121	..	..
170		—	25	85 46	72 56	29 5	+ 10 9	..	..	..	..
171		Nov.	2	85 40	69 54	..	..	0·0501	−0·0113	..	..
172		—	„	85 40	69 50	..	..	..	..	84 38	+ 47
173		—	9	85 42	64 25	..	..	..	..	84 24	+ 40
174		—	„	85 42	64 22	21 48	+ 8 43	0·0508	−0·0118	..	..
175		—	19	85 52	64 47	..	..	..	..	84 14	+ 27
176		—	20	85 51	64 20	21 58	+ 9 7	0·0521	−0·0100	..	..
177		—	„	85 51	64 18	..	..	0·0502	−0·0119	..	..
178		—	22	85 47	64 11	22 10	+ 9 21	0·0519	−0·0105	..	..
179		—	30	85 28	58 41	19 0	+ 9 43	0·0528	−0·0117	84 21	+ 50
180		Dec.	4	85 29	56 46	..	..	..	..	84 19	+ 50
181		—	5	85 29	55 52	..	..	0·0542	−0·0108	..	..
182		—	7	85 27	54 20	15 53	+ 9 47	..	..	..	..
183		—	12	85 25	50 7	..	..	0·0559	−0·0104	..	..
184		—	13	85 25	49 32	..	..	..	..	84 6	+ 48
185	1896.	Jan.	3	85 17	45 10	..	..	..	..	83 46	+ 36
186		—	4	85 17	44 55	8 8	+ 8 59	0·0544	−0·0133	..	..
187		—	10	84 58	41 17	5 1	+ 8 8	..	..	..	..
188		—	„	84 58	41 16	..	..	0·0595	−0·0100	..	..
189		—	11	84 56	41 10	..	..	..	..	83 24	+ 27
190		—	17	84 53	40 13	..	..	..	..	83 49	+ 54
191		—	18	84 56	39 47	..	..	0·0598	−0·0101	..	..
192		—	27	84 40	31 36	..	..	..	..	83 18	+ 37
193		—	28	84 41	31 41	..	..	0·0621	−0·0098	..	..
194		—	„	84 41	31 43	..	..	0·0619	−0·0100	..	..
195		—	29	84 43	31 43	−2 25	+ 8 2	..	..	..	..
196		Feb.	3	84 47	25 18	..	..	..	..	83 15	+ 34
197		—	4	84 43	24 59	..	..	0·0620	−0·0103	..	..
198		—	5	84 39	24 38	−8 0	+ 8 20	0·0625	−0·0101	..	..
199		—	11	84 30	24 45	..	..	..	..	83 9	+ 36

Station No.	Date	Lat. N.	Long. E.	D		H		I	
				Obs.	*O−C*	Obs.	*O−C*	Obs.	*O−C*
200	1896. Feb. 12	84° 25′	23° 56′	..	..	..	..	83° 0′	+30′
201	— 13	84 18	22 45	−9° 24′	+7° 51′	0·0658	−0·0084	..	..
202	— 24	84 7	24 28	..	..	..	..	83 18	+57
203	— 25	84 11	24 13	..	..	0·0651	−0·0096	..	..
204	— „	84 12	24 11	−8 14	+7 35	..	..	..	..
205	March 5	84 6	25 27	..	..	..	..	83 6	+45
206	— 6	84 4	24 56	..	..	0·0642	−0·0109	..	..
207	— 7	84 0	24 11	−8 28	+6 58	0·0637	−0·0118	..	..
208	— 18	84 5	24 56	..	..	..	..	83 17	+56
209	— 19	84 5	24 43	..	..	0·0637	−0·0114	..	..
210	— „	84 5	24 39	..	..	0·0636	−0·0115	..	..
211	April 9	84 27	18 48	..	..	..	..	83 13	+43
212	— „	84 27	18 33	..	..	0·0638	−0·0099	..	..
213	— 20	84 1	13 58	−17 4	+7 25	..	..	..	..
214	— 21	84 3	13 25	..	..	..	..	83 7	+49
215	— „	84 4	13 12	..	..	0·0647	−0·0107	..	..
216	May 7	84 0	11 6	..	..	..	..	83 14	+57
217	— 8	83 56	11 4	..	..	0·0638	−0·0121	..	..
218	— „	83 56	11 3	..	..	0·0652	−0·0107	..	..
219	June 3	83 16	12 33	..	..	0·0685	−0·0104	..	..
220	— 4	83 14	13 3	..	..	..	..	82 49	+55
221	— 17	82 57	11 38	..	..	..	..	82 52	+66
222	— 18	82 56	11 35	..	..	0·0685	−0·0118	..	..
223	— 19	82 55	11 44	−16 41	+7 51	..	..	..	..
224	July 7	83 1	12 52	..	..	.	..	82 52	+65
225	— 8	83 3	12 56	..	..	0·0679	−0·0119	..	..

ARRANGEMENT OF THE RESULTS IN GROUPS.

As a determination of all three elements was made at only three stations, namely, Nos. 2, 152, and 179, it becomes necessary, if the total magnetic force, or its three orthogonal components, X, Y, Z, are to be calculated, to gather the stations into groups, and calculate the mean of the observation-results belonging to each group. This mode of procedure may be considered quite justifiable when we remember that the position of the *Fram* often changed only very slightly during long periods, and that the drift of the ice often carried the vessel back again to points in the neighbourhood of which observations had already been taken. By a calculation such as this of the mean values, we also obtain the advantage of being able to reduce to some extent the influence upon the results, of the magnetic disturbances that may be present. The area for each separate group, however, must of course not be made too large, as there would then be a risk of the variation of the magnetic elements with latitude and longitude not standing out with sufficient distinctness. As an experiment, I have taken as the greatest extent for a group, half a degree in latitude, and a number of degrees of longitude to correspond, which makes an area of about 3100 sq. kilometres. The number of degrees of longitude corresponding to a change of half a degree of latitude is

2·4°	in	78°	of latitude
2·6	„	79	—
2·8	„	80	—
3·2	„	81	—
3·6	„	82	—
4·1	„	83	—
4·7	„	84	—
5·7	„	85	—
7·2	„	86	—

From the observation-results falling within each of the groups thus defined, I have calculated a mean declination, horizontal intensity, and inclination, with corresponding mean geographic coördinates, and thence again a mean value for the total intensity, W, and its three components, X, Y, and *Z*, which may then approximately be assumed to be applicable to the latitude and longitude obtained as the average of the mean geographic coördinates calculated for the declination, horizontal intensity, and inclination of the group. The results thus deduced are given in the following concluding table, which also contains an enumeration of the stations that are employed in the making-up of each separate group of the 33, the groups being numbered with Roman numerals.

Stations 1 and 2 do not fit into any group. No. 2 is therefore entered separately; but it has been impossible to include No. 1, as there was no opportunity of making any determination of declination at this station. Station 15 has been employed in two groups, III and IV.

Group	Station No.	Lat. N.	Long. E.	D	H	I	W	X	Y	Z
	2	69° 54′	66° 43′	20° 28′	0·1118	78° 21′	0·5535	0·1047	0·0391	0·5422
I	3–7	78° 19′ 78 18 78 17 78° 18′	136° 15′ 136 3 136 9 136° 9′	14° 6′	0·0499	84° 43′	0·5419	0·0484	0·0122	0·5396
II	8–11	78° 14′ 77 58 78 18 78° 10′	135° 28′ 136 24 135 50 135° 54′	14° 19′	0·0514	84° 39′	0·5513	0·0498	0·0127	0·5489
III	12, 13, 15	78° 25′ 78 24 78 43 78° 31′	139° 17′ 139 16 138 30 139° 1′	14° 11′	0·0502	84° 41′	0·5418	0·0487	0·0123	0·5394
IV	14–16	79° 7′ 78 37 78 43 78° 49′	137° 40′ 139 4 138 30 138° 28′	17° 55′	0·0500	84° 41′	0·5396	0·0476	0·0154	0·5373
V	17—30	79° 56′ 80 1 79 51 79° 56′	134° 45′ 134 31 135 3 134° 46′	23° 19′	0·0431	85° 21′	0·5317	0·0396	0·0171	0·5299
VI	31—37	80° 27′ 80 28 80 27 80° 27′	131° 54′ 132 21 131 50 132° 2′	26° 6′	0·0407	85° 22′	0·5038	0·0365	0·0179	0·5022

Group	Station No.	Lat. N.	Long. E.	*D*	*H*	*I*	*W*	*X*	*Y*	*Z*
VII	38–42	80° 51′	130° 21′	29° 6′						
		80 51	130 20		0·0407					
		80 51	130 33			85° 22′				
		80° 51′	130° 25′				0·5038	0·0356	0·0198	0·5022
VIII	43–46, 60–68	81° 26′	124° 22′	33° 33′						
		81 25	124 56		0·0393					
		81 25	124 54			85° 31′				
		81° 25′	124° 43′				0·5027	0·0328	0·0217	0·5012
IX	47–59	81° 38′	121° 53′	36° 19′						
		81 36	121 56		0·0397					
		81 36	121 50			85° 22′				
		81° 37′	121° 53′				0·4915	0·0320	0·0235	0·4899
X	69–74	81° 6′	127° 36′	29° 54′						
		81 6	127 46		0·0393					
		81 5	127 32			85° 23′				
		81° 6′	127° 38′				0·4883	0·0341	0·0196	0·4867
XI	75–84	81° 16′	122° 41′	33° 53′						
		81 12	123 18		0·0393					
		81 11	121 58			85° 28′				
		81° 13′	122° 39′				0·4972	0·0326	0·0219	0·4957
XII	85–88, 94–98	82° 2′	112° 58′	39° 24′						
		81 58	113 29		0·0402					
		81 58	113 57			85° 24′				
		81° 59′	113° 28′				0·5013	0·0311	0·0255	0·4996
XIII	89–93, 99–105	82° 13′	110° 27′	39° 41′						
		82 11	110 28		0·0415					
		82 11	110 31			85° 20′				
		82° 12′	110° 29′				0·5101	0·0319	0·0265	0·5084

Group	Station No.	Lat. N.	Long. E.	*D*	*H*	*I*	*W*	*X*	*Y*	*Z*
XIV	106–111	82° 43′ 82 44 82 48	106° 12′ 106 0 105 21	41° 15′	0·0429	85° 6′				
		82° 45′	105° 51′				0·5023	0·0323	0·0283	0·5004
XV	112–115	83° 23′ 83 33 83 34	103° 2′ 102 39 102 24	42° 24′	0·0421	85° 4′				
		83° 30′	102° 42′				0·4896	0·0311	0·0284	0·4877
XVI	116–120	84° 3′ 84 0 84 7	101° 45′ 102 3 100 58	44° 17′	0·0440	85° 7′				
		84° 3′	101° 35′				0·5169	0·0315	0·0307	0·5150
XVII	121–127	84° 16′ 84 16 84 14	95° 42′ 96 15 96 36	40° 39′	0·0456	85° 0′				
		84° 15′	96° 11′				0·5232	0·0346	0·0297	0·5212
XVIII	128–130	84° 38′ 84 35 84 33	89° 46′ 90 21 90 40	37° 40′	0·0458	84° 41′				
		84° 35′	90° 16′				0·4943	0·0363	0·0280	0·4922
XIX	131–133	84° 41′ 84 41 84 40	82° 31′ 82 34 83 51	34° 6′	0·0497	84° 44′				
		84° 41′	82° 59′				0·5415	0·0412	0·0279	0·5392
XX	134–143	84° 42′ 84 37 84 38	75° 55′ 74 11 74 11	29° 35′	0·0523	84° 20′				
		84° 39′	74° 46′				0·5297	0·0455	0·0258	0·5271

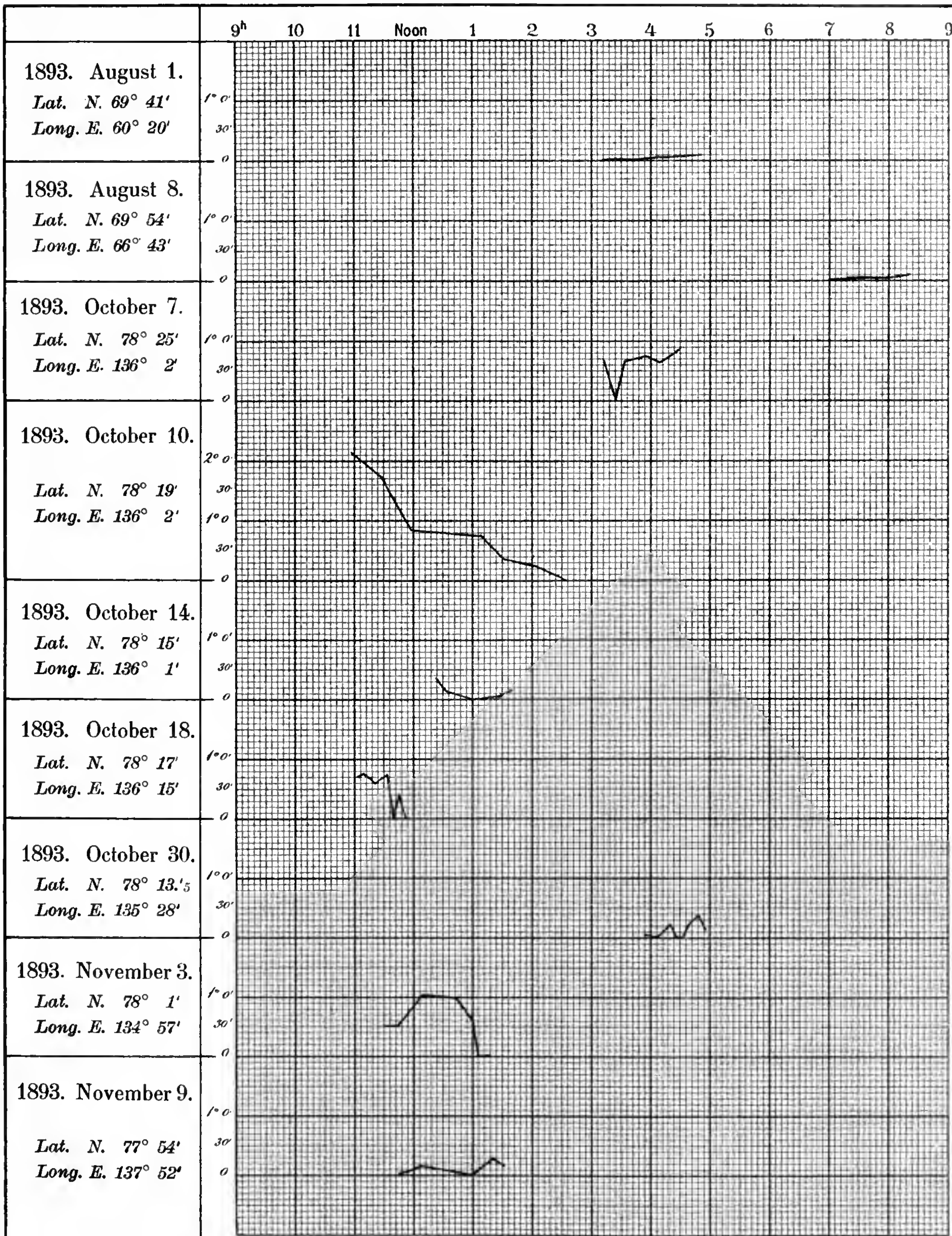
Group	Station No.	Lat. N.	Long. E.	D	H	I	W	X	Y	Z
XXI	144—149	84° 32′ 84 25 84 27 84° 28′	77° 40′ 78 4 77 34 77° 46′	31° 44′	0·0516	84° 27′	0·5335	0·0439	0·0271	0·5310
XXII	150—161	85° 1′ 85 5 84 59 85° 2′	79° 14′ 79 1 78 53 79° 3′	32° 46′	0·0500	84° 33′	0·5264	0·0420	0·0271	0·5241
XXIII	162—170	85° 35′ 85 41 85 35 85° 37′	75° 47′ 76 0 77 34 76° 27′	30° 47′	0·0479	84° 43′	0·5202	0·0412	0·0245	0·5180
XXIV	171—178	85° 47′ 85 46 85 45 85° 46′	64° 18′ 65 25 66 21 65° 21′	21° 59′	0·0510	84° 25′	0·5242	0·0473	0·0191	0·5217
XXV	179—182	85° 28′ 85 28 85 28 85° 28′	56° 31′ 57 17 57 43 57° 10′	17° 27′	0·0535	84° 20′	0·5418	0·0510	0·0160	0·5392
XXVI	183—186	85° 17′ 85 21 85 21 85° 20′	44° 55′ 47 31 47 21 46° 36′	8° 8′	0·0552	83° 56′	0·5223	0·0546	0·0078	0·5194
XXVII	187—191	84° 58′ 84 57 84 55 84° 57′	41° 17′ 40 32 40 42 40° 50′	5° 1′	0·0597	83° 37′	0·5370	0·0595	0·0052	0·5336

Group	Station No.	Lat. N.	Long. E.	*D*	*H*	*I*	*W*	*X*	*Y*	*Z*
XXVIII	192—195	84° 43′ 84 41 84 40 84° 41′	31° 43′ 31 42 31 36 31° 40′	−2° 25′	0·0620	83° 18′	0·5314	0·0619	−0·0026	0·5278
XXIX	196—199	84° 39′ 84 41 84 39 84° 40′	24° 38′ 24 49 25 2 24° 50′	−8° 0′	0·0623	83° 12′	0·5262	0·0617	−0·0087	0·5225
XXX	200, 201, 211, 212	84° 18′ 84 23 84 26 84° 22′	22° 45′ 20 39 21 22 21° 35′	−9° 24′	0·0648	83° 7′	0·5407	0·0639	−0·0106	0·5368
XXXI	202—210	84° 6′ 84 5 84 6 84° 6′	24° 11′ 24 32 24 57 24° 33′	−8° 21′	0·0641	83° 14′	0·5440	0·0634	−0·0093	0·5402
XXXII	213—218	84° 1′ 83 59 84 2 84° 1′	13° 58′ 11 46 12 16 12° 40′	−17° 4′	0·0646	83° 11′	0·5443	0·0618	−0·0190	0·5404
XXXIII	219—225	82° 55′ 83 5 83 4 83° 1′	11° 44′ 12 21 12 31 12° 12′	−16° 41′	0·0683	82° 51′	0·5487	0·0654	−0·0196	0·5445

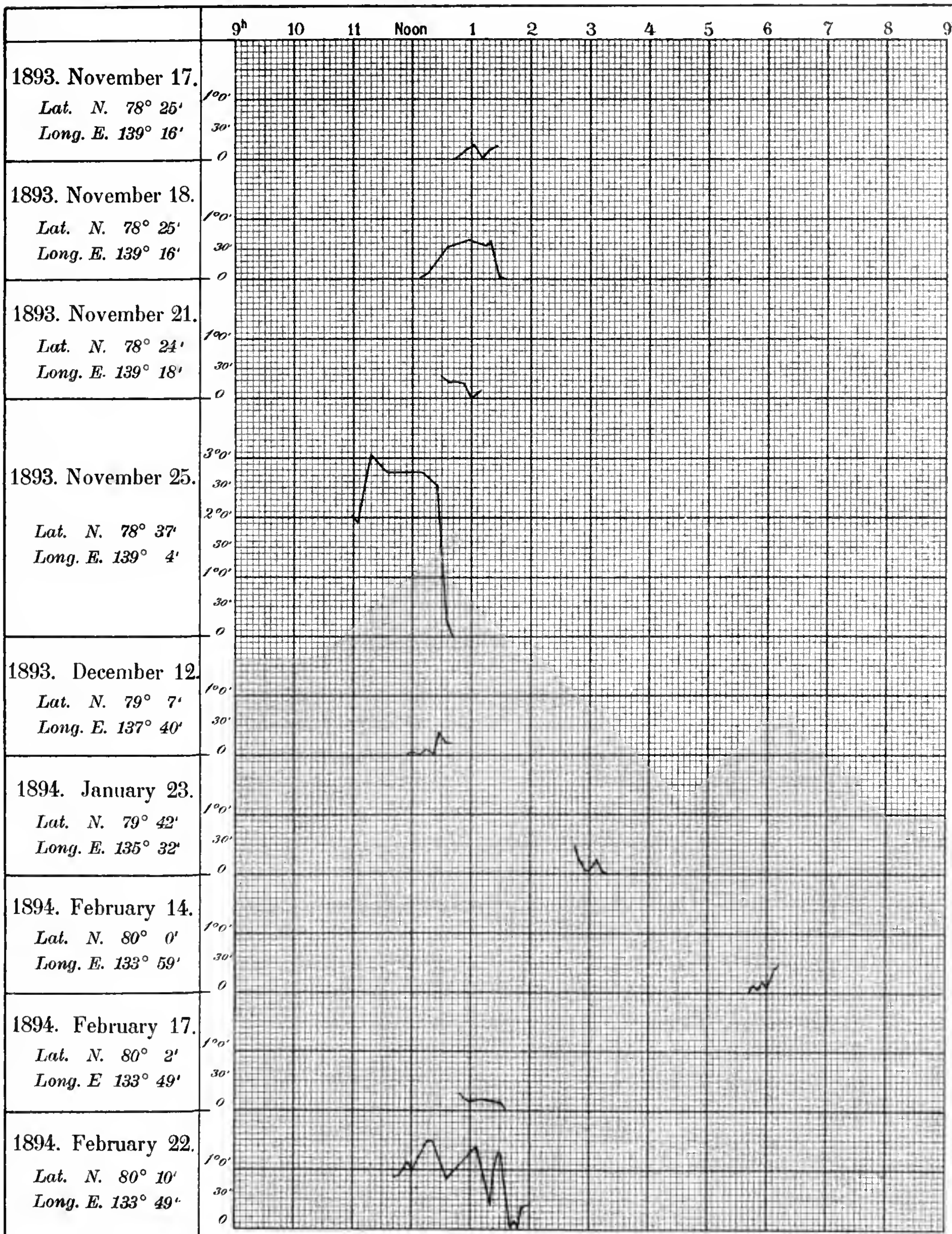
The principle here followed for the grouping of the observations is, as I have already said, arbitrarily chosen, and I have therefore not considered it necessary to deduce and put down the difference between the mean values belonging to each group, and the corresponding theoretically calculated values, as I have thought it possible that others might find a better mode of grouping than the one here adopted. Moreover, for the sake of conciseness, I have given all single observation-results the same weight in the formation of the mean values, without regard to the circumstances under which they were produced. Thus, side by side with all the detailed data previously given in the present paper, the foregoing table on pages 183—188 will become the natural basis for the employment of the magnetic observations of Dr. NANSEN's Norwegian Polar Expedition, in a closer inquiry into the general theory of terrestrial magnetism.

CHRISTIANIA. *December, 1900.*

AKSEL S. STEEN.



L. Fehr's lith. Officin, Chr a



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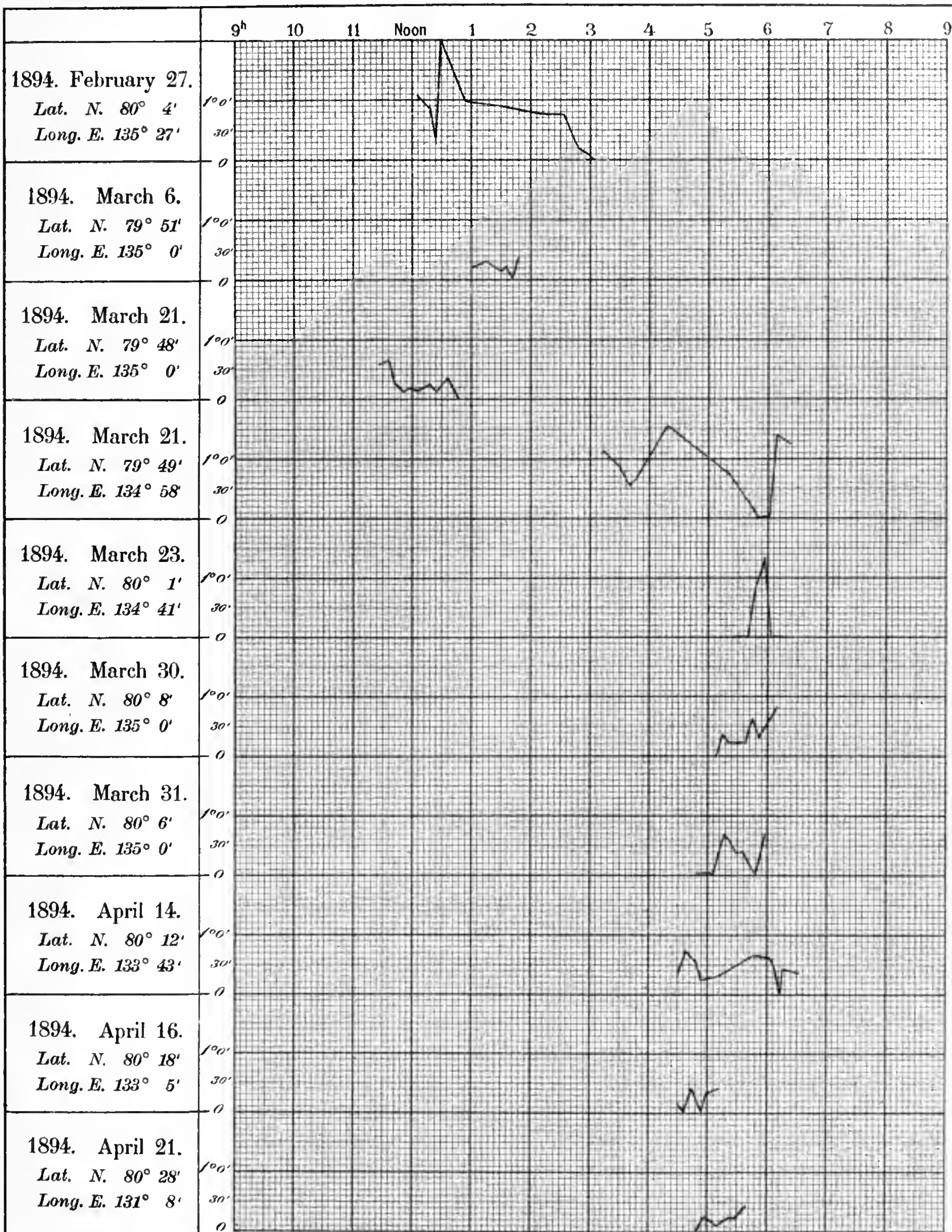

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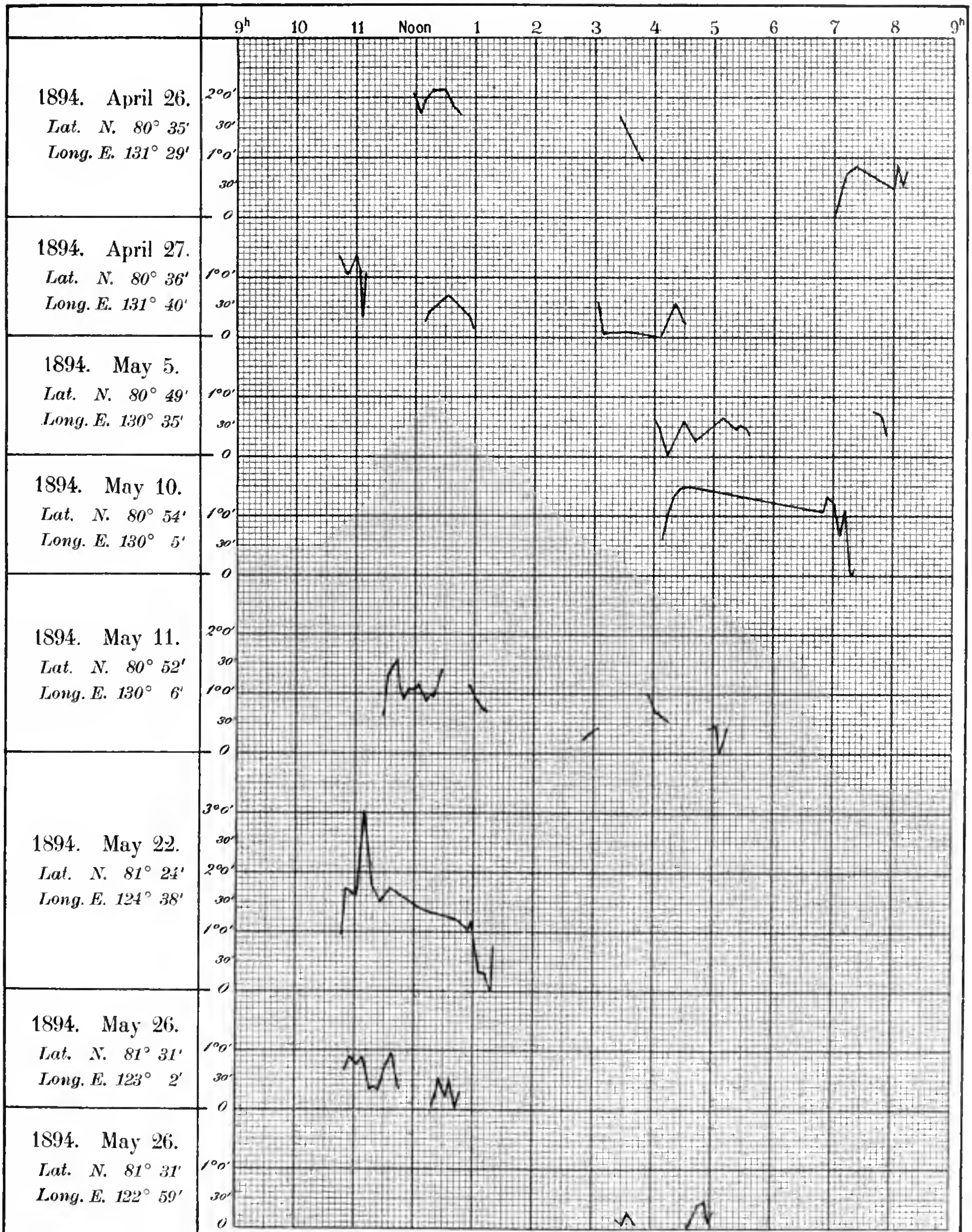


L. Fehr's lith. Officin Chr'a

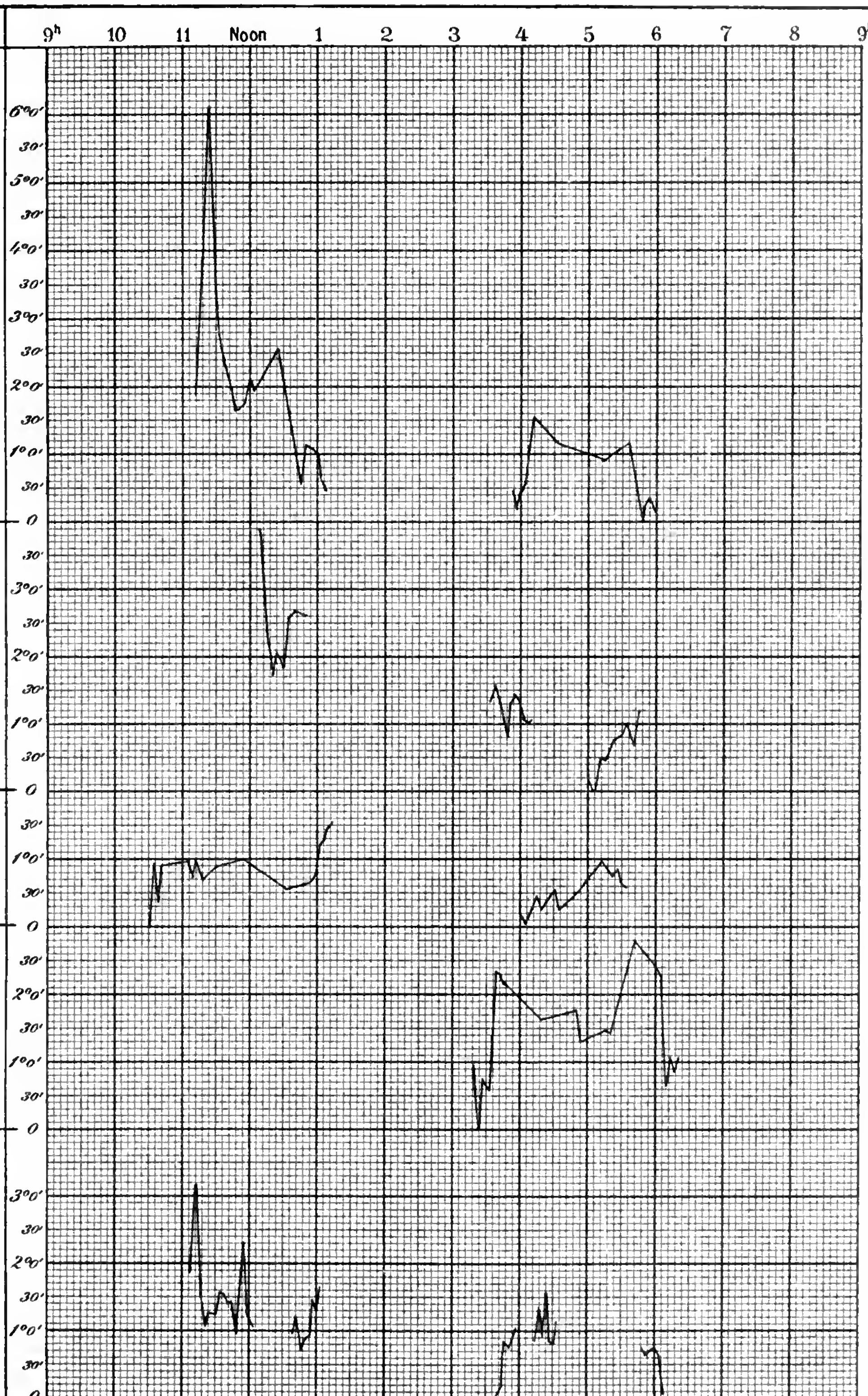
1894. May 31.
Lat. N. 81° 32'
Long. E. 122° 18'

1894. June 4.
Lat. N. 81° 31'
Long. E. 122° 8'

1894. June 7.
Lat. N. 81° 28'
Long. E. 122° 10'

1894. June 12.
Lat. N. 81° 43'
Long. E. 122° 13'

1894. June 13.
Lat. N. 81° 46'
Long. E. 122° 14'



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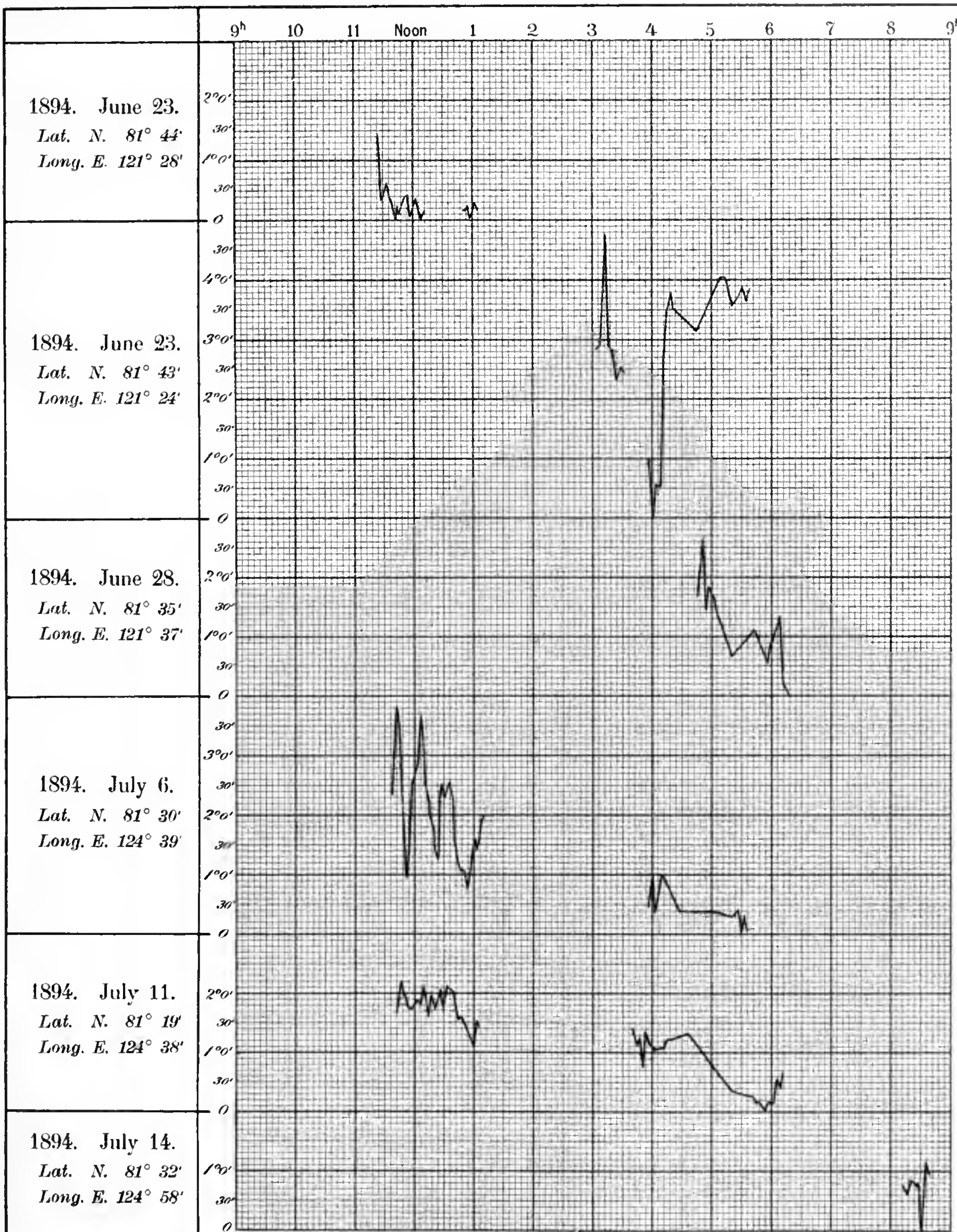

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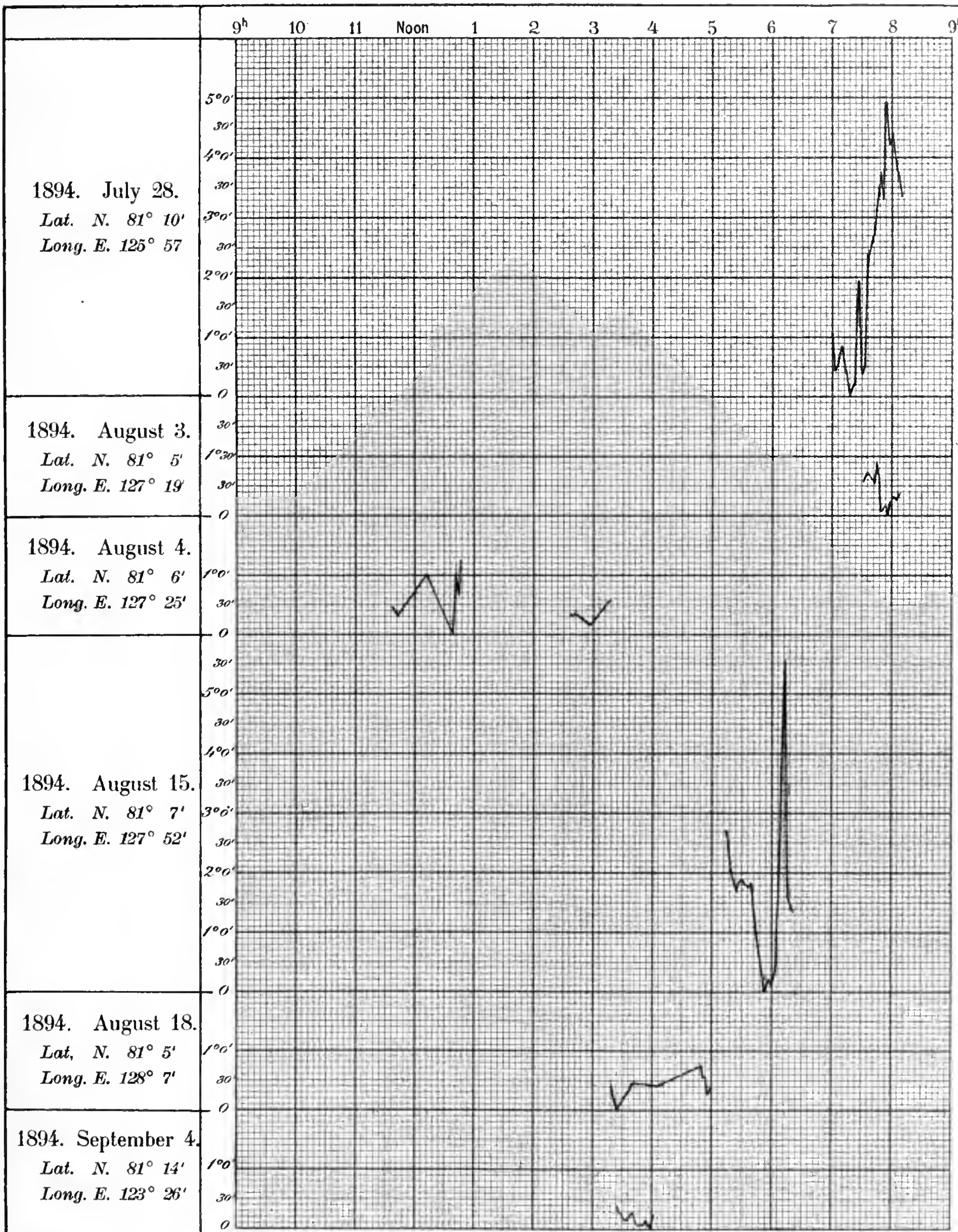

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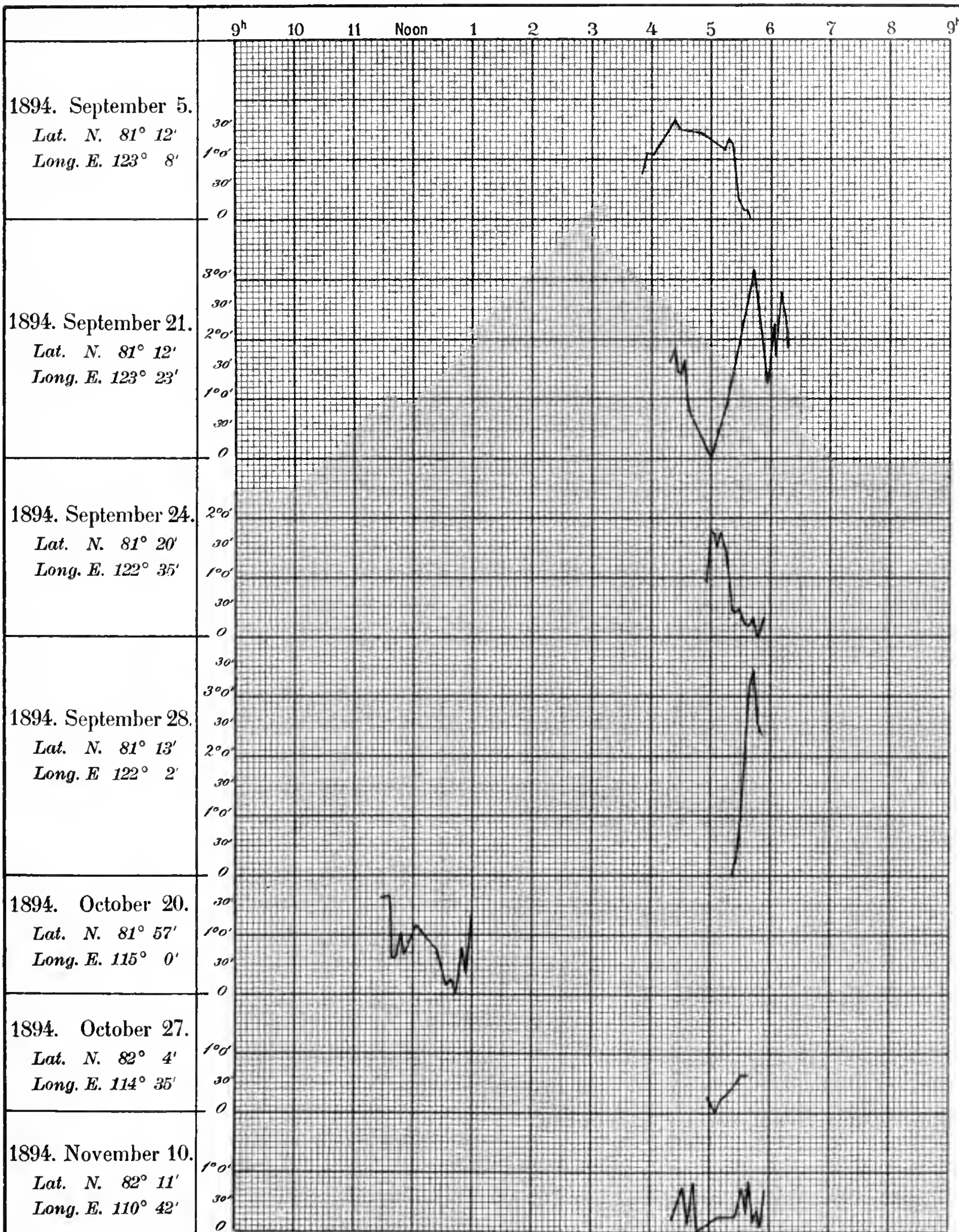
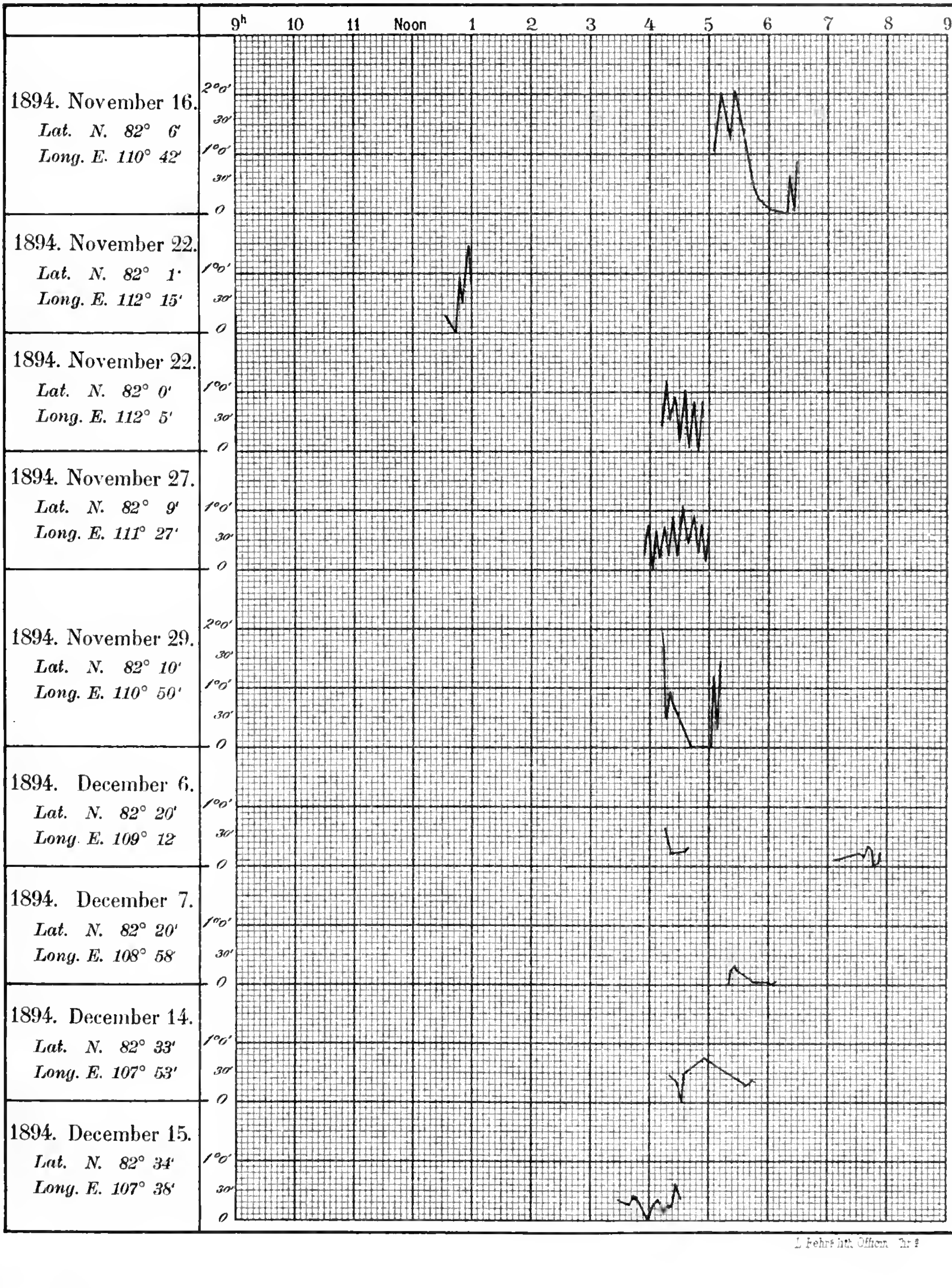


L. Fehr's lith. Officin. Chr.a



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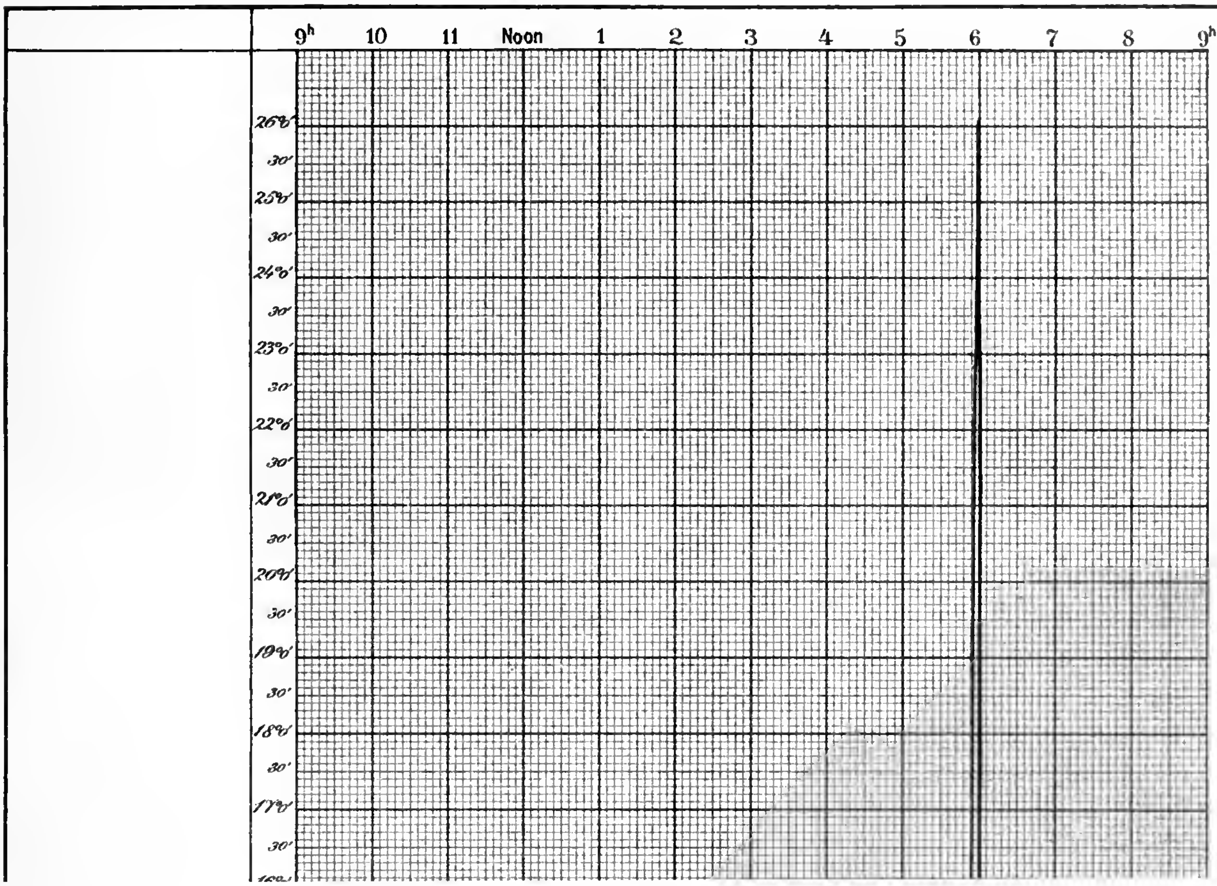
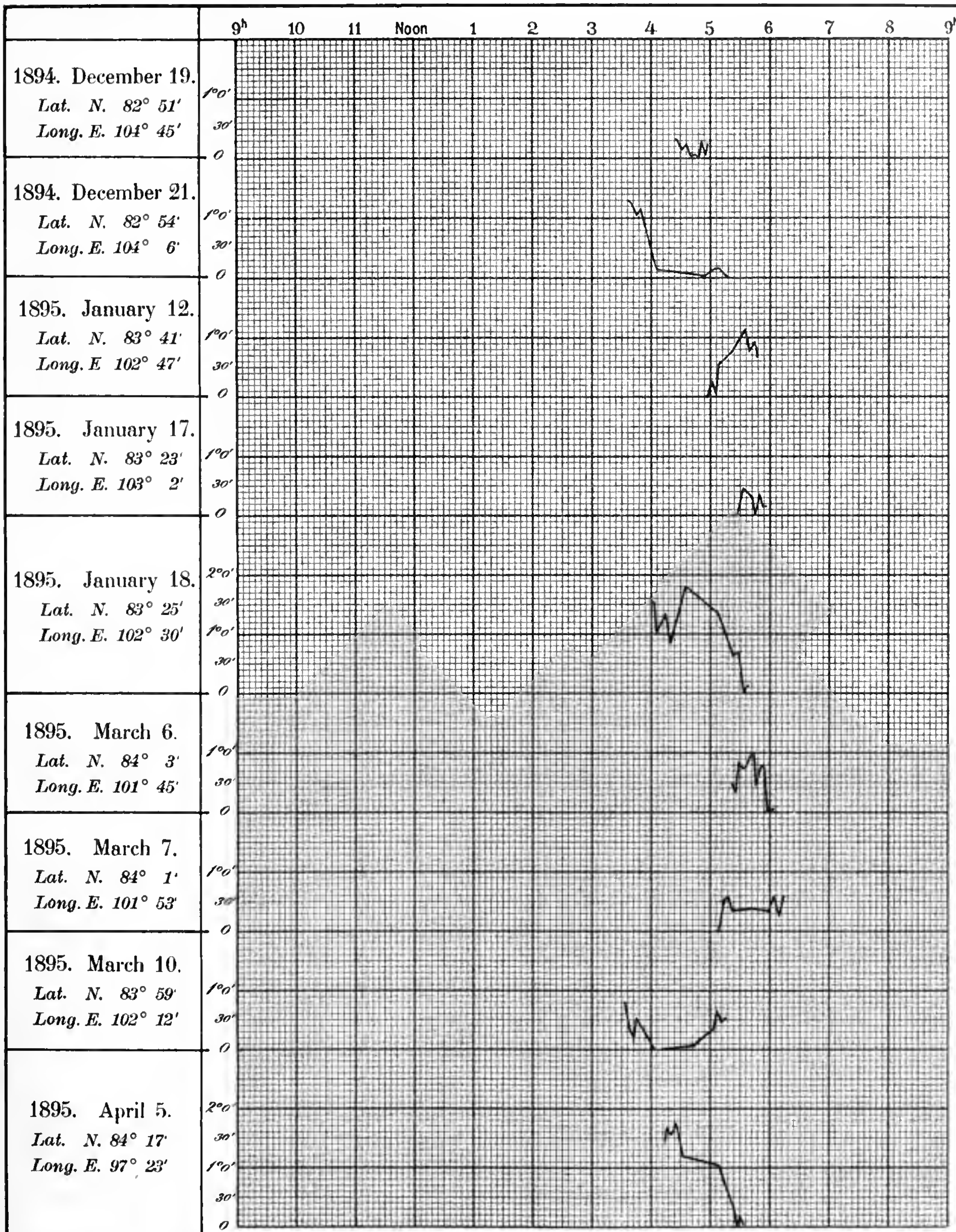
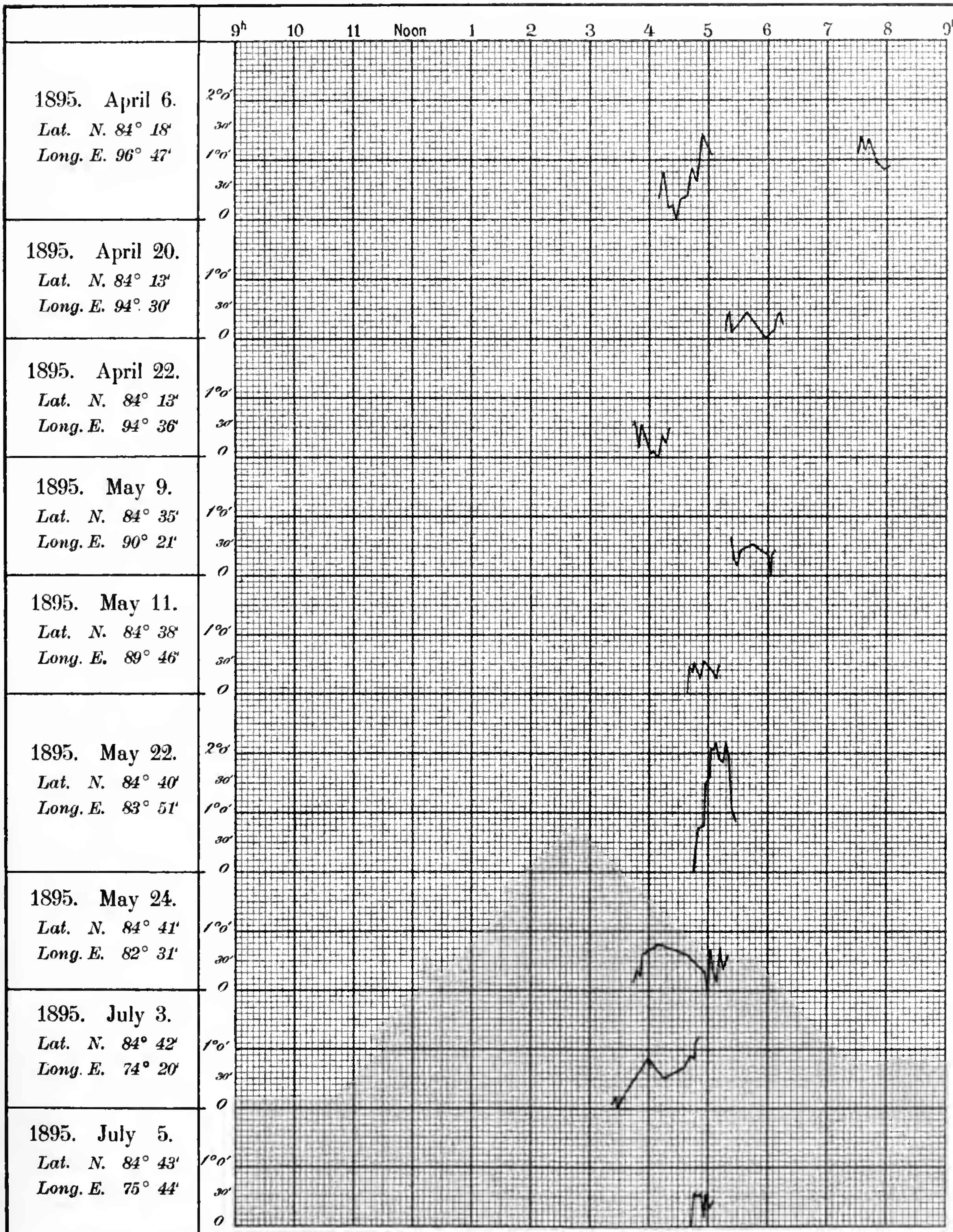

9h
10
11
Noon
1
2
3
4
5
6
7
8
9h
26°0'
30'
25°0'
30'
24°0'
30'
23°0'
30'
22°0'
30'
21°0'
30'
20°0'
30'
19°0'
30'
18°0'
30'
17°0'
30'



L. Fehr's lith. Officin, Chr^a



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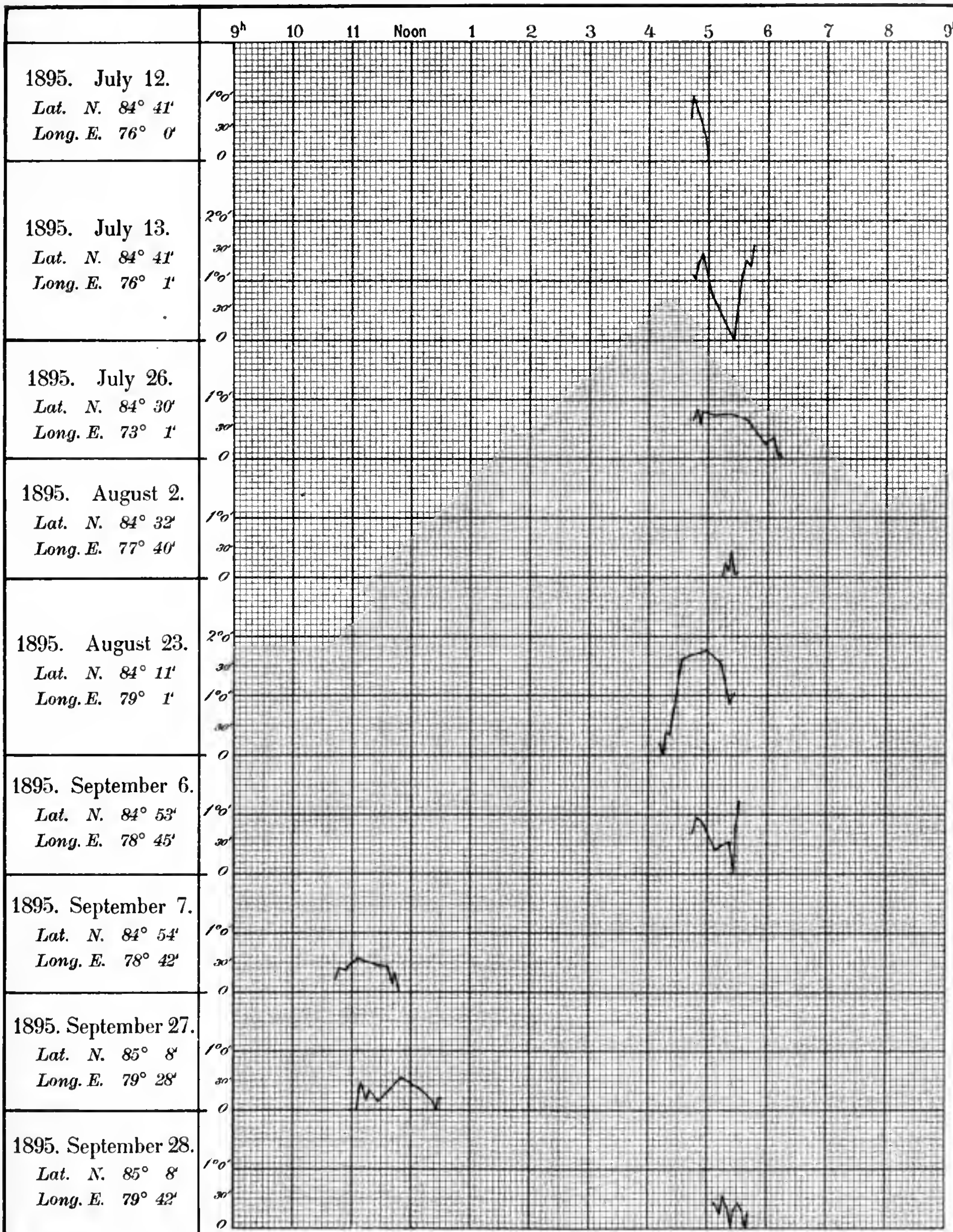

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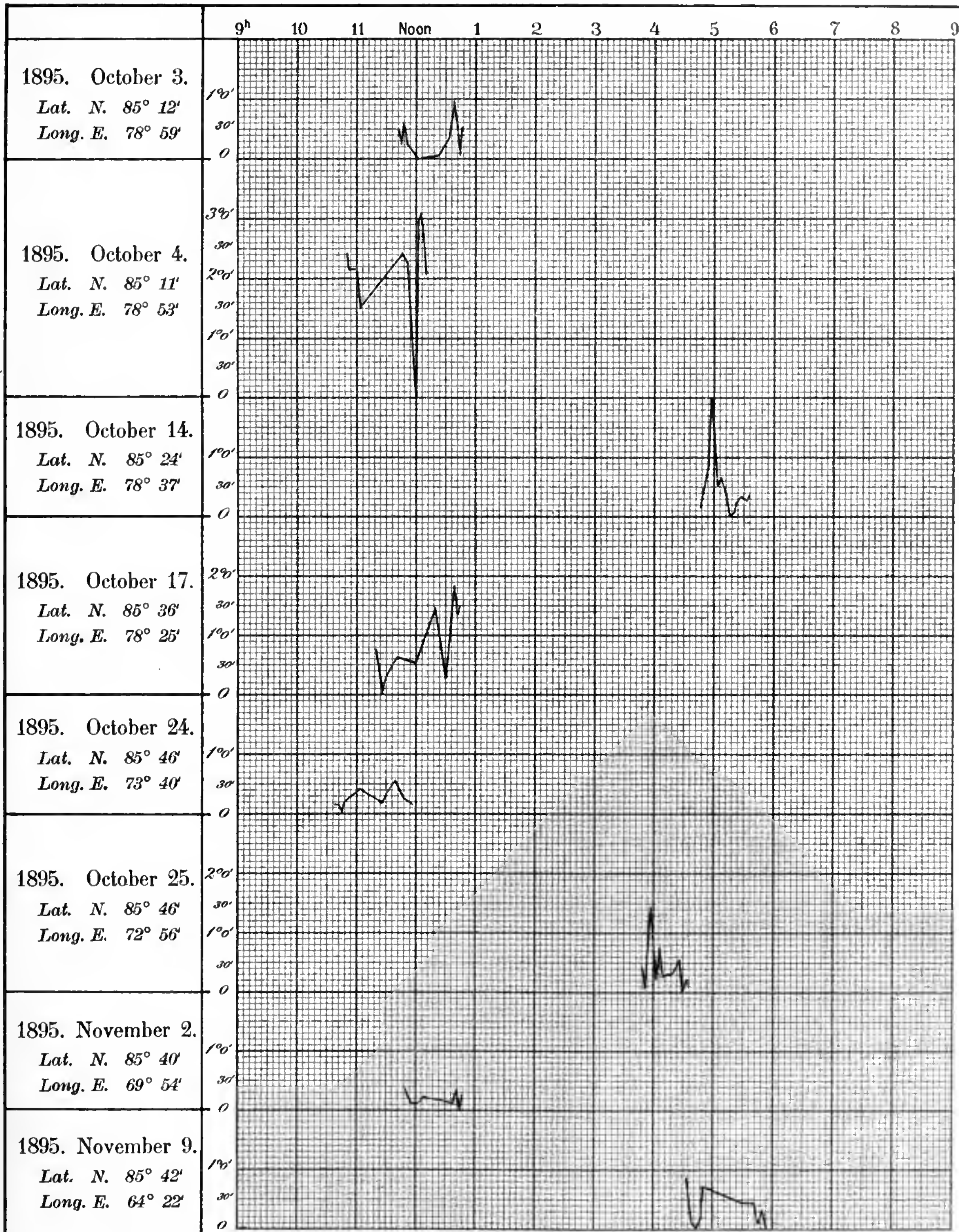
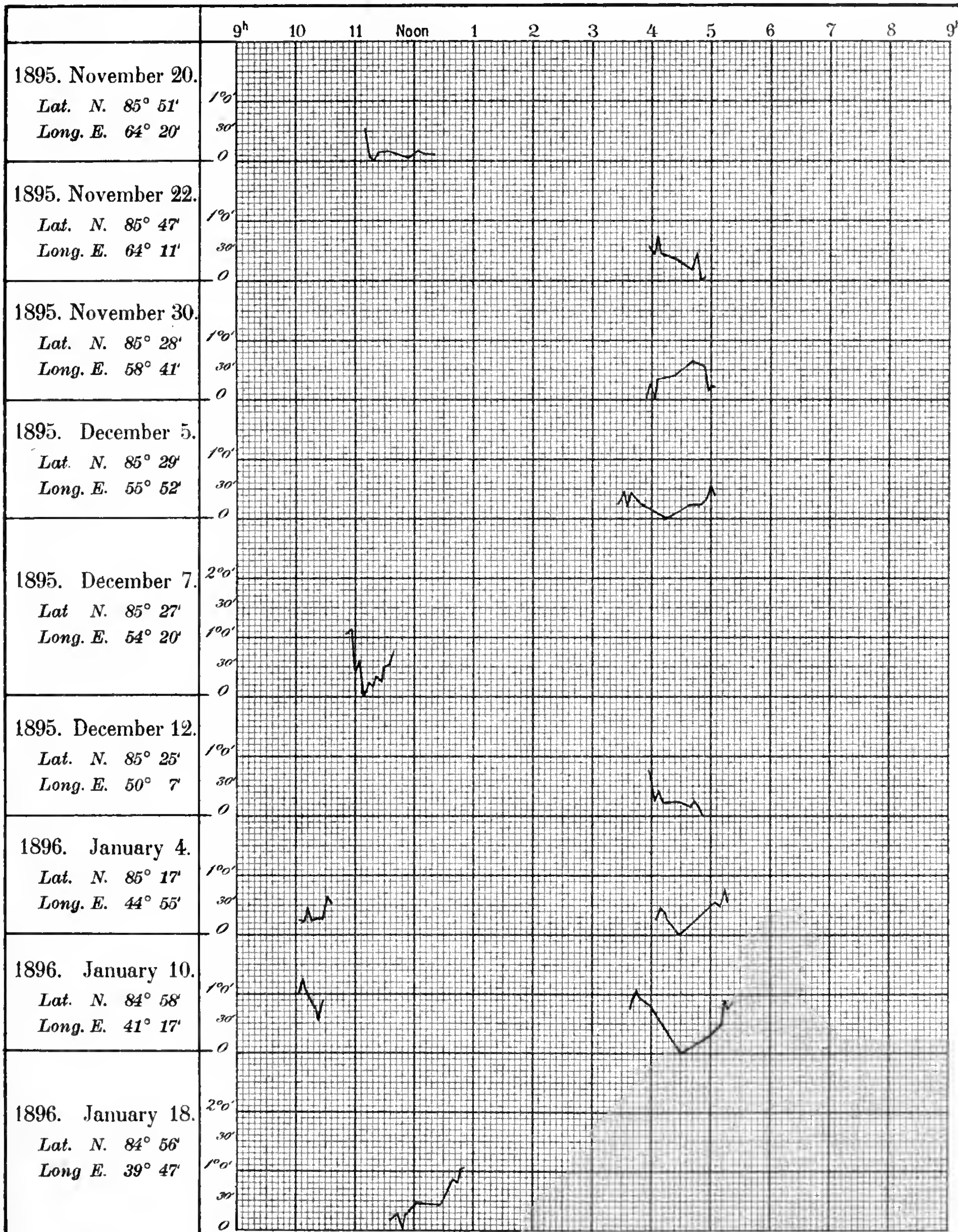


L. Fehr's lith Officin. Chr a



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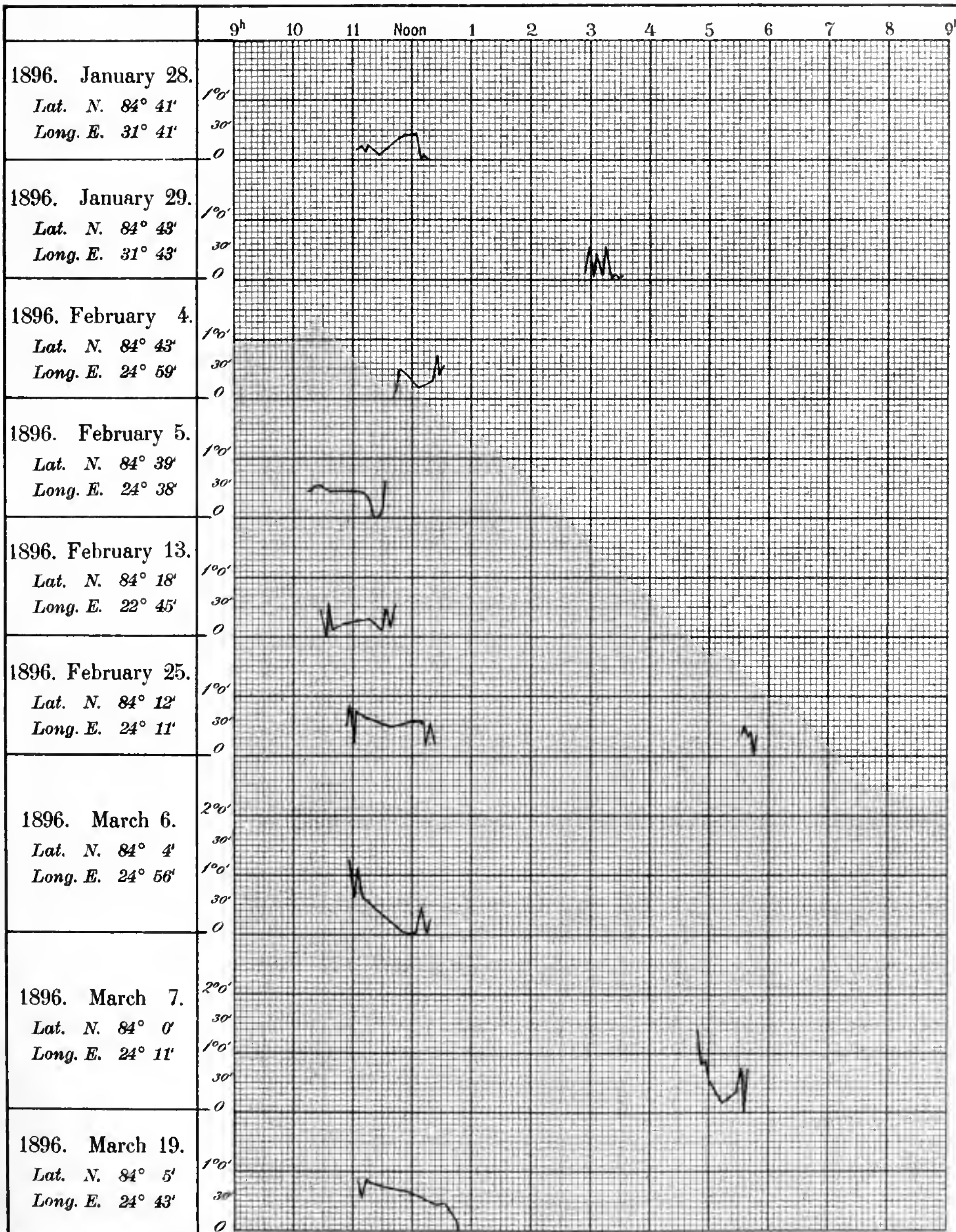
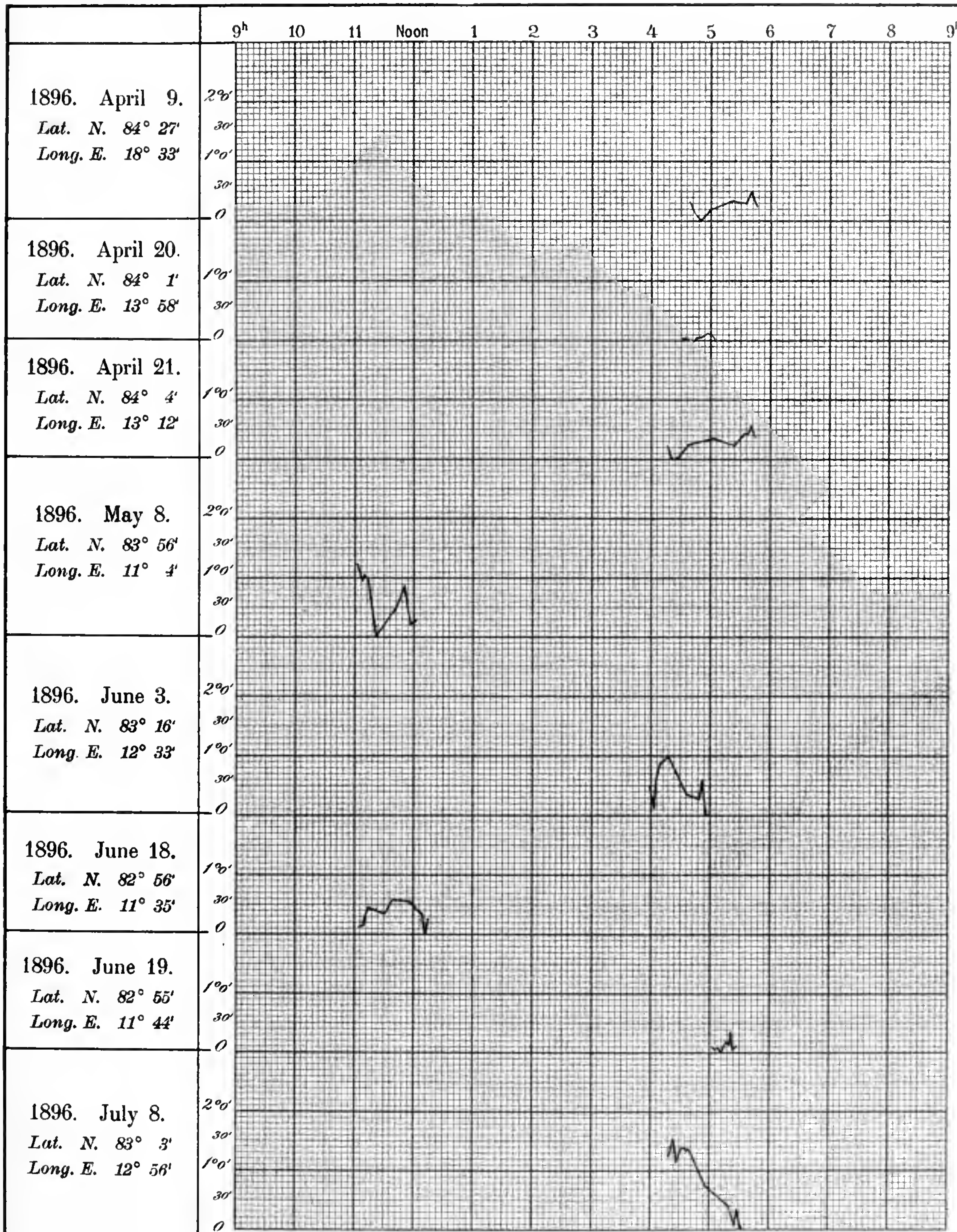


L. Fehrs lith. Officin. Chr.


9h 10 11 Noon 1 2 3 4 5 6 7 8 9h
1896. April 9.
Lat. N. 84° 27'
Long. E. 18° 33'
1896. April 20.
Lat. N. 84° 1'
Long. E. 13° 58'
1896. April 21.
Lat. N. 84° 4'
Long. E. 13° 12'
1896. May 8.
Lat. N. 83° 56'
Long. E. 11° 4'
1896. June 3.
Lat. N. 83° 16'
Long. E. 12° 33'
1896. June 18.
Lat. N. 82° 56'
Long. E. 11° 35'
1896. June 19.
Lat. N. 82° 55'
Long. E. 11° 44'
1896. July 8.
Lat. N. 83° 3'
Long. E. 12° 56'
2°0'
30'
1°0'
30'
0

VIII.

RESULTS OF THE PENDULUM OBSERVATIONS

AND

SOME REMARKS ON THE CONSTITUTION OF THE EARTH'S CRUST

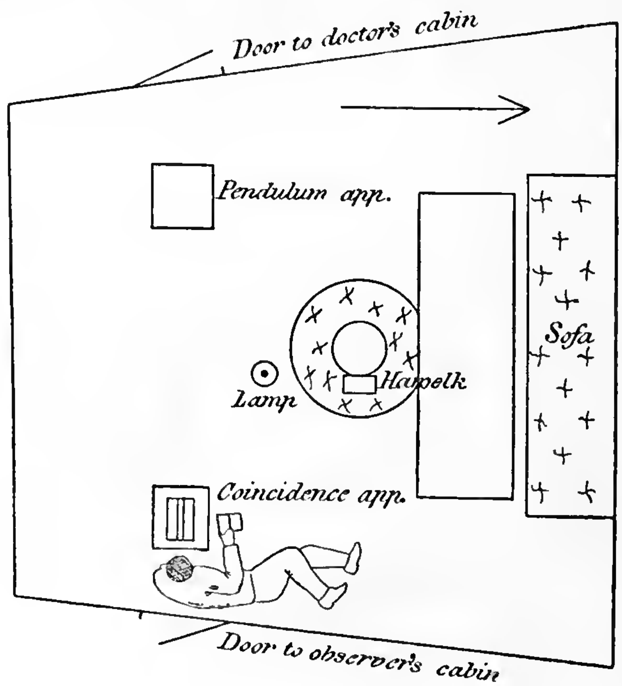
BY

O. E. SCHIØTZ.

Among the investigations that the Polar Expedition had placed upon its programme, were those for the determination of the variations in the force of gravity in different places in the high latitudes which it hoped to reach. As, on a journey of this description, there could be no question of anything but relative determinations, it was decided, at my suggestion, to employ the pendulum apparatus constructed by Colonel von Sterneck, and consisting of invariable half-seconds pendulums, of which the period of oscillation is determined by the aid of a coincidence apparatus. An apparatus of this kind, with two pendulums, was therefore procured for the expedition. Von Sterneck was kind enough to determine its constants before it was despatched from Vienna, so that it was possible to refer the observations at each place to the actual determination of the acceleration of gravity in Vienna, made by Von Oppolzer. As soon as I received the apparatus, I determined the period of oscillation of the pendulums in the Observatory in Christiania. After the return of the expedition, I subjected the pendulums to fresh examination, which showed that they had undergone only an exceedingly slight change during the journey.

In these observations, a half-seconds pendulum clock, Hawelk No. 5, was employed to work the coincidence apparatus. Before and after each observation, which generally lasted 3/4 of an hour, this was compared with a mean-time chronometer. In 1892, a chronometer Hohwü 639, belonging to the Observatory, and afterwards taken on the Fram expedition, was used; in 1893 and 1897, a chronometer Michelet 20. The chronometer was compared with the Kessels normal sidereal clock of the Observatory, before beginning the observations, and after their conclusion.

During the expedition, the observations were made by Lieut. Scott-Hansen. Only one determination was made on shore, namely at Khabarova, at the mouth of the Kara Sea, all other observations being carried out while drifting with the ice. With the exception of the summer of 1895, when on the 8th, 10th and 11th June, the pendulum apparatus was set up on the ice near the vessel, all the observations were taken on board in the winter. The pendulum apparatus was set up on the iron cross belonging to it, with nothing between it and the solid floor of the saloon, near one long wall; while the coincidence apparatus was placed opposite to it, near the opposite wall, with an underlayer of folios. During the experiments, the observer had to



lie upon the floor parallel with the wall, and observe the greatest caution all the time in his movements; but the floor was so steady, that the level on the pendulum apparatus moved only very slightly when any one went close up to the apparatus. The observations were taken in the middle of the night, when no one but the observer was up, so that the apparatus was not exposed to any chance of disturbance. All the apparatuses were invariably set up very nearly on the same spots. Their situation will be seen from the accompanying sketch.

In all the observations except the first, the half-seconds pendulum clock, HAWELK No. 3, which worked the coincidence apparatus, was compared with the mean-time chronometer, HOHWÜ, either directly or indirectly by means of the sidereal chronometer, FRODSHAM. In the first observation, at Khabarova, the mean-time chronometer KUTTER was used instead of the HOHWÜ. The Hawelk was compared with the chronometer every time before and after the observations.

Professor GEELMUYDEN, who has worked out the time observations taken during the expedition, has stated that the rate of HOHWÜ may be calculated according to the formula

$$\text{Daily acceleration} = \overset{s.}{0}{\cdot}446 - \overset{s.}{0}{\cdot}080\, t,$$

where t is the temperature.

From this we obtain the following values for the rate of HOHWÜ on the days on which observations were made:

		$t°$	Rate
			s.
1893	July 30	12	– 0·49
1894	January 16	6	– 0·01
»	March 16	5	+ 0·07
1895	June 8	15	– 0·73
»	» 10	15	– 0·73
»	» 11	13	– 0·57
»	November 14	9	– 0·25
»	» 23	11	– 0·41
1896	January 16	10	– 0·33
»	April 29	12	– 0·49
»	» 30	12	– 0·49

Professor Geelmuyden remarks that the above temperatures are taken from registered curves for the time of observation; but as the thermograph stood somewhat higher than the chronometer, and the comparison between it and the thermometer on the chronometer-shelf was made only once a day, the temperature cannot be given more accurately than to the nearest whole degree. He considers, however, that the actual rate cannot have varied more than $\pm\, 0^s.1$ from the above.

As regards the chronometer, Kutter, used on July 30, 1893, I have received the following comparisons between it and the chronometer, Hohwü.

		Hohwü	Kutter—Hohwü	$t°$	Rate of Hohwü	Rate of Kutter
					In interval	In interval
		h. m.	*m. s.*		*s.*	*s.*
1893	July 29	0 32 p. m.	— 47 38·80	14·1	— 0·64	— 0·03
»	» 30	11 41 a. m.	— 47 38·19	11·7	— 0·59	— 0·12
»	» 31	5 46 p. m.	— 47 37·72			

There were two thermometers belonging to the pendulum apparatus of the expedition, marked 23 and 24. Thermometer 23 was used in all the observations carried out during the time of drifting, except the one observation on the ice on June 8th, 1895, when another thermometer, SÖDERBERG No. 114, was employed, because the temperature was too low for the pendulum thermometers.

The correction for Söderberg No. 114 was zero between — 7° and + 5°.

Colonel von Sterneck has supplied the following reduction-formula for the pendulum thermometers.

Thermometer 23 $t°$ C. = 1·988 (reading — 2·66)
— 24 $t°$ C. = 1·903 (reading — 2·16)

After the return of the expedition, thermometer 23 was accidentally broken while I was comparing it with a thermometer Tonnelot 4519, of which the correction was determined by the "Bureau International des Poids et Mesures" at Breteuil. Both thermometers, as well as a pendulum thermometer 20, belonging to the Norwegian "Gradmaalings Kommission", were hanging side by side in a vessel full of water. I had fortunately taken the following readings before the accident occurred.

July 29th, 1897.

	Tonnelot 4519	Pendulum therm. 20	Pendulum therm. 23
	15°.86 15°.90	11·915	10·73
	16°.015	11·99	10·80
Mean	15°.947	11·953	10·765

According to Colonel von Sterneck, the reduction-formula for thermometer 20 is:

$$t° \text{ C.} = 1{\cdot}863 \text{ (reading} - 3{\cdot}41).$$

The above observations thus give the following values for the temperature, (the reduction for Tonnelot to the hydrogen-thermometer being — 0°.095 at this temperature):

according to	Tonnelot 4519	Pendulum therm. 20	Pendulum therm. 23
	15°.852 C.	15°.916 C.	16°.113 C.

Thus, with Von Sterneck's formulæ, both the pendulum thermometers give somewhat too high a temperature, indicating that the zero has risen.

I have examined thermometer 20 repeatedly. The year after I received the pendulum apparatus, in the summer and winter of 1893, some comparisons were made in the air with a thermometer Baudin 8967, of which the corrections to the hydrogen-thermometer were determined by the aid of a thermometer Tonnelot 4506, which had been examined at the "Bureau International des Poids et Mesures". I have since made several series of comparisons, some with Baudin 8967, some with Tonnelot 4519, with the two thermometers hung up side by side in water. It appears that thermometer 20 has not changed more than a couple of hundredths of a degree since the summer of 1893, and that the zero has risen about 0°.09. My temperature comparisons give the following formula:

$$t° \text{ C.} = 1{\cdot}863 \text{ (reading} - 3{\cdot}46).$$

It is the same with the other thermometer, 17, belonging to the pendulum apparatus for the "Gradmaalings Kommission". Its zero has risen 0°.12 C. I assume therefore, that it may be taken for granted that the rise of the zero in the case of thermometer 23 had already taken place before the observations made during the expedition were begun on July 30th, 1893. According to the above observation, I have assumed a rise of 0°.25 in the following calculations, and in so doing will remark that a more exact agreement between the indications of the pendulum thermometers than within a few hundredths of a degree cannot be expected, as one division on them answers to 0°.2, and the thermometers are not calibrated. The second thermometer of the expedition, 24, shows a zero-rise of 0°.375.

The following are the observations made, in Vienna, in Christiania, and during the expedition. For the calculation of the time of coincidence, c, we have, by the method of least squares,

$$c = \frac{1}{pn}\sum_{1}^{p}(b_q - a_q) + \frac{1}{p\,[n^2 + \frac{1}{3}(p^2-1)]}\times$$

$$\times\left[\sum_{1}^{r}(p-2q+1)\,[(b_{p-q+1}-b_q)+(a_{p-q+1}-a_q)]-\frac{p^2-1}{3n}\sum_{1}^{p}(b_q-a_q)\right],$$

where $r = \frac{p}{2}$ for p even, and $= \frac{p-1}{2}$ for p odd. The sign p indicates the number of observations in each of the two series that are taken, and n the number of coincidences between the times, a_q and b_q, of two corresponding observations in the two series. The second term on the right will generally be exceedingly small in proportion to the first, if n is not too small; this term can therefore be left out of consideration, and notice is only taken of it in two or three observations made in Christiania (added as "Corr." in the last column of the following tables). On one or two occasions during the expedition, three series of observations were taken, the following formula, in which the correction terms are left out of consideration, being employed for their calculation:

$$p\,[m^2 + n^2 + (m-n)^2 + \tfrac{3}{4}\,(p^2-1)]\,c =$$

$$= n\sum_{1}^{p}(b_q - a_q) + (m-n)\sum_{1}^{p}(c_q - b_q) + \left(m + \tfrac{3}{4}\frac{p^2-1}{m}\right)\sum_{1}^{p}(c_q - a_q).$$

a_q, b_q, c_q, are corresponding observations in the 3 series; n is the number of coincidences between the first and the second series, m between the first and the third. If $m = 2n$, the formula is reduced to

$$c = \frac{1}{pm}\sum_{1}^{p}(c_q - a_q),$$

so that the second series will be of no importance.

The constants necessary for the reduction of the observed periods of oscillation, have been determined, as already mentioned, by Colonel von Sterneck. Expressed in units of the 7th decimal place of the period of oscillation (in mean time), the correction for the temperature, τ, is 44·23 for every degree Celsius, and the correction for the resistance of the atmosphere, δ, 5·53 for every per cent of the relative density, the density of the atmosphere at zero, and a pressure of 76 cm. being taken as unity. If the rate of the watch is given for 24 hrs., the correction, u, is 58·6 units in the 7th decimal place for every second. The correction for the amplitude, α, is

$$\alpha = \tfrac{1}{64} \frac{9\,a^2}{l^2} S,$$

where a is the observed amplitude, and l the distance in millimetres between the coincidence apparatus and the pendulum mirror, while S is the period of the pendulum. Each division on the scale is equal to 3 mm.

For the thermometers before the journey, we have, according to the above,

Thermometer 20 $t°$ C. = 1·863 (reading — 3·41) (in 1892)
— 23 $t°$ C. = 1·988 (reading — 2·66)
— 24 $t°$ C. = 1·903 (reading — 2·16);

during and after the expedition,

Thermometer 20 $t°$ C. = 1·863 (reading — 3·41) — 0°.09 (in 1893 and subsequently)
— 23 $t°$ C. = 1·988 (reading — 2·66) — 0°.25
— 24 $t°$ C. = 1·903 (reading — 2·16) — 0°.375.

Pendulum	No. of Coincidence	Time of Coincidence	No. of Coincidence	Time of Coincidence	Observed Duration of Coincidences	Calculation of Period

Vienna (Türkenschanze) Observer, Colonel von Sterneck.

Distance l = 3180 mm., thermometer 23, barometer No. 22.

May 27, 1892, forenoon.

	Before	After	Mean
Bar.	745·2 14°.4 = 744·4	745·3 14°.5 = 744·5	744·5
$t°$	9·18	9·20	9·19 = 12°.98
a	7·1 – 7·1	5·6 – 5·4	6·3

		h m s		h m s	m s	
33	1	10 13 11·5	51	10 46 30·5	50 c = 33 19·0	c = 39ˢ.973
	2	13 50·3	52	47 9·0	18·7	$2c-1$ = 78·946
	3	14 31·5	53	47 50·3	18·8	$\log c$ = 1·6017667
	4	15 10·3	54	48 29·2	18·9	$\log(2c-1)$ = 1·8973301
	5	15 51·3	55	49 10·3	19·0	$\log S$ = 9·7044366
	6	16 30·3	56	49 49·0	18·7	S = 0·5063334
	7	17 11·8	57	50 30·2	18·4	α = — 2⁸
	8	17 50·1	58	51 8·3	18·2	τ = — 574²
	9	18 31·5	59	51 50·2	18·7	δ = — 517¹
	10	19 10·2	60	52 28·3	18·1	u = — 266
	11	19 51·3			50 c = 33 18·65	S_{33} = 0·5061974

May 27, 1892, forenoon.

	Before	After	Mean
Bar.	744·8 14°.4 = 744·0	744·8 14°.4 = 744·0	744·0
$t°$	9·28	9·24	9·26 = 13°.12
a	7·2 – 7·0	5·4 – 5·4	6·25

		h m s		h m s	m s	
33	1	11 28 29·8	51	12 1 48·4	50 c = 33 18·6	c = 39ˢ.972
	2	29 11·0	52	2 30·0	19·0	$2c-1$ = 78·944
	3	29 50·0	53	3 8·2	18·2	$\log c$ = 1·6017559
	4	30 31·0	54	3 49·9	18·9	$\log(2c-1)$ = 1·8973191
	5	31 9·8	55	4 28·2	18·4	$\log S$ = 9·7044368
	6	31 51·0	56	5 9·9	18·9	S = 0·5063336
	7	32 29·9	57	5 48·2	18·3	α = — 2⁷
	8	33 10·8	58	6 29·8	19·0	τ = — 580³
	9	33 49·8	59	7 8·1	18·3	δ = — 516⁵
	10	34 31·4	60	7 49·8	18·4	u = — 266
	11	35 9·8			50 c = 33 18·60	S_{33} = 0·5061970

May 27, 1892, afternoon.

	Before	After	Mean
Bar.	744·8 14°.0 = 744·0	743·8 14°.2 = 743·0	743·5
$t°$	9·22	9·27	9·25 = 13°.10
a	7·4 — 7·5	5·3 — 6·0	6·55

Pendulum	No. of Coincidence	Time of Coincidence	No. of Coincidence	Time of Coincidence	Observed Duration of Coincidences	Calculation of Period
		h m s		h m s	m s	$c = 38^s.5114$
34	1	2 37 32·0	51	3 9 37·3	50 c = 32 5·3	$2c - 1 = 76·0228$
	2	38 9·2	52	10 14·8	5·6	
	3	38 48·6	53	10 54·5	5·9	$\log c = 1·5855893$
	4	39 26·6	54	11 32·3	5·7	$\log(2c-1) = 1·8809439$
	5	40 6·0	55	12 11·8	5·8	$\log S = 9·7046454$
	6	40 43·9	56	12 49·2	5·3	$S = 0·5065769$
	7	41 22·8	57	13 28·5	5·7	$\alpha = -\ 3^0$
	8	42 1·0	58	14 6·3	5·3	$\tau = -\ 579^4$
	9	42 40·0	59	14 45·5	5·5	$\delta = -\ 516^0$
	10	43 17·9	60	15 23·5	5·6	$u = -\ 266$
	11	43 57·0			50 c = 32 5·57	$S_{34} = 0·5064405$

May 27, 1892, afternoon.

	Before	After	Mean
Bar.	743·5 14°.4 = 742·7	743·8 14°.5 = 743·0	742·9
$t°$	9·37	9·33	9·35 = 13°.30
a	7·7 — 7·7	6·0 — 6·0	6·85

Pendulum	No. of Coincidence	Time of Coincidence	No. of Coincidence	Time of Coincidence	Observed Duration of Coincidences	Calculation of Period
		h m s		h m s	m s	$c = 38^s.4924$
34	1	4 11 20·2	51	4 43 25·5	50 c = 32 5·3	$2c - 1 = 75·9848$
	2	11 58·0	52	44 2·7	4·7	
	3	12 37·5	53	44 42·5	5·0	$\log c = 1·5853750$
	4	13 14·9	54	45 19·0	4·1	$\log(2c-1) = 1·8807268$
	5	13 54·5	55	45 58·8	4·3	$\log S = 9·7046482$
	6	14 32·0	56	46 36·3	4·3	$S = 0·5065802$
	7	15 11·5	57	47 16·3	4·8	$\alpha = -\ 3^3$
	8	15 49·0	58	47 53·7	4·7	$\tau = -\ 588^2$
	9	16 28·6	59	48 33·2	4·6	$\delta = -\ 515^4$
	10	17 6·0	60	49 10·4	4·4	$u = -\ 266$
	11	17 45·8			50 c = 32 4·62	$S_{34} = 0·5064429$

May 28, 1892, forenoon.

	Before	After	Mean
Bar.	744.2 14°.2 = 743·4	743·8 14°.5 = 743·0	743·2
$t°$	9·30	9·38	9·34 = 13°.28
a	7·0 — 7·5	5·0 — 5·8	6·33

Pendulum	No. of Coincidence	Time of Coincidence	No. of Coincidence	Time of Coincidence	Observed Duration of Coincidences	Calculation of Period
		h m s		h m s	m s	c = 39^s.9654
33	1	8 45 51·5	51	9 19 9·9	50 c = 33 18·4	2 c—1 = 78·9308
	2	46 31·2	52	19 49·5	18·3	
	3	47 11·5	53	20 29·5	18·0	log c = 1·6016842
	4	47 51·2	54	21 9·0	17·8	log (2 c—1) = 1·8972465
	5	48 31·2	55	21 49·5	18·3	log S = 9·7044377
	6	49 10·9	56	22 29·0	18·1	S = 0·5063347
	7	49 51·0	57	23 9·0	18·0	α = — 2^{8}
	8	50 30·3	58	23 49·0	18·7	τ = — 587^{3}
	9	51 11·0	59	24 29·5	18·5	δ = — 515^{4}
	10	51 50·3	60	25 8·9	18·6	u = — 274
	11	52 30·7			50 c = 33 18·27	S_{33} = 0·5061967

May 28, 1892, forenoon.

	Before	After	Mean
Bar.	744·2 14°·9 = 743·4	743·8 15°.0 = 743·0	743·2
$t°$	9·47	9·49	9·48 = 13°.56
a	7·5 — 7·4	6·0 — 6·0	6·73

Pendulum	No. of Coincidence	Time of Coincidence	No. of Coincidence	Time of Coincidence	Observed Duration of Coincidences	Calculation of Period
		h m s		h m s	m s	c = 38^s.4992
34	1	10 27 28·0	51	10 59 32·4	50 c = 32 4·4	2 c—1 = 75·9984
	2	28 5·3	52	11 0 10·0	4·7	
	3	28 45·0	53	0 49·8	4·8	log c = 1·5854517
	4	29 21·2	54	1 26·3	5·1	log (2 c—1) = 1·8808045
	5	30 2·0	55	2 6·8	4·8	log S = 9·7046472
	6	30 39·0	56	2 44·0	5·0	S = 0·5065791
	7	31 18·3	57	3 24·0	5·7	α = — 3^{2}
	8	31 56·2	58	4 0·9	4·7	τ = — 599^{6}
	9	32 35·5	59	4 40·9	5·4	δ = — 514^{8}
	10	33 13·0	60	5 18·0	5·0	u = — 274
	11	33 52·6			50 c = 32 4·96	S_{34} = 0·5064399

Pendulum	No. of Coincidence	Time of Coincidence	No. of Coincidence	Time of Coincidence	Observed Duration of Coincidences	Calculation of Period

Christiania (the Observatory). Observer, Professor SCHIØTZ.

Distance l = 1691 mm., thermometer 20, barometer Adie 1504.

July 21, 1892.

Comparison of Clocks.

Pendulum	Hohwü	Error of Pendulum	
h m s	h m s	s	
5 11 32	9 12 26	July 21, 3^h a. m. 54·94	log 1^s Hohwü = $-35 . 10^{-7}$
10 44 46	2 44 45·5	» 22, —»— 55·25	

Hohwü	Hawelk	Hohwü	Hawelk	
h m s	h m s	h m s	h m s	
12 40 39·5	9 55 20	2 37 28	11 51 23	log Hohwü = 2·8456044
41 57	56 37	38 45·5	52 40	log Hawelk = 2·8427756
43 15·5	57 55	40 3	53 57	0·0028288
				log 1^s Hohwü = — 35
12 41 57·33	9 56 37·33	2 38 45·5	11 52 40	log 1^s Hawelk = 0·0028253

Bar. $12^h\ 24^m$ 758 19°.1 = 755·7, $2^h\ 49^m$ 757·5 19°.3 = 755·2

Pendulum	No. of Coincidence	Time of Coincidence	No. of Coincidence	Time of Coincidence	Observed Duration of Coincidences	Calculation of Period
33	t	13·32		13·36		Bar. = 755·5
	a	4·8 — 4·8		3·6 — 3·8		t = 13·35 = 18°.52
		h m s		h m s	m s	a = 3·93
	1	10 6 36·5	21	10 36 53·6	20 c = 30 17·1	c = 90s.8435
	2	8 8·2	22	38 25·4	17·2	2 c—1 = 180·687
	3	9 38·0	23	39 55·3	17·3	
	4	11 10·2	24	41 27·5	17·3	log c = 1·9582939
	5	12 40·0	25	42 57·1	17·1	log (2 c—1) = 2·2569259
	6	14 11·7	26	44 28·5	16·8	9·7013670
	7	15 40·8	27	45 58·2	17·4	log 1^s Haw. = 28253
	8	17 13·5	28	47 30·1	16·6	log S = 9·7041923
	9	18 43·2	29	48 59·4	16·2	
	10	20 15·5	30	50 31·2	15·7	S = 0·5060487
						a = — 3^8
					20 c = 30 16·87	τ = — 819^1
	a	3·95 — 4·05		3·2 — 3·2		δ = — 514^4
	t	13·35		13·37		S_{88} = 0·5059150

Pendulum	No. of Coincidence	Time of Coincidence	No. of Coincidence	Time of Coincidence	Observed Duration of Coincidences	Calculation of Period
33	*t*	13·38		13·41		Bar. = 755·3
	a	4·2 — 4·2		3·3 — 3·4		*t* = 13·40 = 18°.61
		h m s		*h m s*	*m s*	*a* = 3·6
	1	10 58 41·4	21	11 28 55·7	20 *c* = 30 14·3	*c* = 90*s*.6923
	2	0 10·7	22	30 25·2	14·5	Cor. = — 60
	3	1 42·8	23	31 57·0	14·2	*c* = 90*s*.6863
	4	3 12·3	24	33 26·3	14·0	2 *c*—1 = 180·3726
	5	4 44·2	25	34 58·2	14·0	
	6	6 13·5	26	36 27·4	13·9	log *c* = 1·9575416
	7	7 45·3	27	37 59·4	14·1	log (2 *c*—1) = 2·2561705
	8	9 15·1	28	39 28·5	13·4	9·7013711
	9	10 47·0	29	41 0·4	13·4	log 1*s* Haw. = 28253
	10	12 16·3	30	42 29·5	13·2	log *S* = 9·7041964
	11	13 48·2	31	44 1·5	13·3	
					20 *c* = 30 13·845	*S* = 0·5060535
	a	3·8 — 3·9		2·95 — 3·05		α = — 3²
	t	13·40		13·41		τ = — 823²
						δ = — 514¹
						S_{33} = 0·5059194

July 22, 1892.

Comparison of Clocks.

Pendulum	Hohwü	Error of Pendulum	
h m s	*h m s*	*s*	
5 55 44	9 52 35	July 22, 3*h* a. m. 55·25	log 1*s* Hohwü = —30 . 10⁻⁷
10 42 56	2 39 0	» 23, —»— 55·58	

Hawelk	Hohwü	Hawelk	Hohwü	
h m s	*h m s*	*h m s*	*h m s*	
12 16 58·5	1 16 33	1 31 27·5	2 31 25	log 1*s* Hawelk = 0·0022263
18 32·5	18 7·5	33 1·5	32 59·5	
12 17 45·5	1 17 20·25	1 32 14·5	2 32 12·25	

Bar. 12*h* 11*m* 758·5 18°.9 = 756·2, 2*h* 24*m* 758·0 19°.2 = 755·7

Pendulum	No. of Coincidence	Time of Coincidence	No. of Coincidence	Time of Coincidence	Observed Duration of Coincidences	Calculation of Period
34	t	13·5		13·515		Bar. = 755·8
	a	4·2 — 4·3		3·4 — 3·5		t = 13·51 = 18°.82
		h m s		h m s	m s	a = 3·68
	1	12 29 19·5	31	1 3 17·2	30 c = 33 57·7	
	2	30 26·1	32	4 24·7	58·6	c = 67^s.9198
	3	31 35·5	33	5 33·2	57·7	2 c—1 = 134·8396
	4	32 41·8	34	6 40·0	58·2	
	5	33 51·5	35	7 48·6	57·1	log c = 1·8319964
	6	34 58·7	36	8 56·0	57·3	log (2 c—1) = 2·1298174
	7	36 6·8	37	10 4·6	57·8	9·7021790
	8	37 13·5	38	11 12·0	58·5	log 1^s Haw. = 22263
	9	38 22·7	39	12 19·8	57·1	log S = 9·7044053
	10	39 30·2	40	13 27·8	57·6	
	11	40 38·7	41	14 35·6	56·9	S = 0·5062970
	12	41 46·0	42	15 43·7	57·7	α = — 3^5
	13	42 54·3	43	16 51·5	57·2	τ = — 832^5
	14	44 1·7	44	17 58·6	56·9	δ = — 514^0
	15	45 9·8	45	19 7·4	57·6	S_{34} = 0·5061620
					30 c = 33 57·593	
	a	3·95 — 4·0		3·05 — 3·05		
	t	13·51		13·52		

July 25, 1892.

Comparison of Clocks.

Pendulum	Hohwü	Error of Pendulum	
h m s	h m s	s	
6 23 55	10 8 54·5	July 25, 3^h a. m. 56·40	log 1^s Hohwü = — 41 . 10^{-7}
10 13 14	1 57 36·0	» 26, —»— 56·80	

Hawelk	Hohwü	Hawelk	Hohwü	Hawelk	Hohwü
h m s	h m s	h m s	h m s	h m s	h m s
10 38 22·5	11 59 46	11 28 56·5	12 50 35·5	12 30 58·5	1 52 56·5
40 0·5	12 1 24·5	30 35·5	52 15	32 36·5	54 35
10 39 11·5	12 0 35·25	11 29 46	12 51 25·25	12 31 47·5	1 53 45·75

log 1^s Hawelk = 0·0022086, log 1^s Hawelk = 0·0022076

Bar. 11^h 58^m 766·1 19°.3 = 763·8, 2^h 4^m 765·3 19°.6 = 762·9

Pendulum	No. of Coincidence	Time of Coincidence	No. of Coincidence	Time of Coincidence	Observed Duration of Coincidences	Calculation of Period
34	t	13·70		13·71		Bar. = 763·5
	a	1·5 — 1·6		1·2 — 1 2		t = 13·71 = 19°.19
		h m s		h m s	m s	a = 1·31
	1	10 47 18·5	21	11 9 50·7	20 c = 22 32·2	
	2	48 24·7	22	10 56·4	31·7	c = 67^s.5645
	3	49 33·7	23	12 5·9	32·2	Cor. = + 132
	4	50 40·7	24	13 12·0	31·3	c = 67^s.5777
	5	51 50·5	25	14 21·5	31·0	2 c—1 = 134·1554
	6	52 56·8	26	15 27·9	31·1	
	7	54 4·9	27	16 36·8	31·9	log c = 1·8298034
	8	55 11·5	28	17 42·7	31·2	log (2 c—1) = 2·1276081
	9	56 20·6	29	18 51·6	31·0	9·7021953
	10	57 27·3	30	19 57·7	30·4	log 1^s Haw. = 22086
	11	58 36·5	31	21 6·7	30·2	log S = 9·7044039
					20 c = 22 31·291	
	a	1·3 — 1·3		1·2 — 1·2		S = 0·5062953
	t	13·71		13·72		α = — 0^4
						τ = — 848^7
						δ = — 518^7
						S_{34} = 0·5061585

Pendulum	No. of Coincidence	Time of Coincidence	No. of Coincidence	Time of Coincidence	Observed Duration of Coincidences	Calculation of Period
34	t	13·77		13·79		Bar. = 763·2
	a	3·05 — 3·1		2·5 — 2·5		t = 13·78 = 19°.32
		h m s		h m s	m s	a = 2·67
	1	11 43 19·6	31	12 17 1·0	30 c = 33 41·4	
	2	44 26·3	32	18 8·6	42·3	c = 67^s.399
	3	45 35·0	33	19 16·8	41·8	2 c—1 = 133·798
	4	46 41·5	34	20 23·2	41·7	
	5	47 49·8	35	21 »	»	log c = 1·8286535
	6	48 55·4	36	22 38·0	42·6	log (2 c—1) = 2·1264496
	7	50 4·3	37	23 46·5	42·2	9·7022039
	8	51 11·0	38	24 53·0	42·0	log 1^s Haw. = 22076
	9	52 19·4	39	26 1·2	41·8	log S = 9·7044115
	10	53 25·9	40	27 7·5	41·6	
	11	54 33·9	41	28 16·2	42·3	S = 0·5063042
					30 c = 33 41·97	α = — 1^8
	a	2·9 — 2·95		2·2 — 2·2		τ = — 854^7
	t	13·77		13·795		δ = — 518^2
						S_{34} = 0·5061667

Christiania. The Observatory.

June 11th, 1893.

Comparison of Clocks.

		s	
Michelet 10^h a. m.	Error	40·48	log 1^s Michelet = -59.10^{-7}
» 10^h p. m.	»	41·07	

Hawelk	Michelet	Hawelk	Michelet	Hawelk	Michelet
h m s	*h m s*	*h m s*	*h m s*	*h m s*	*h m s*
1 19 23·0	10 44 18·5	2 46 30·5	12 11 58·5	4 17 26·5	1 43 28·5
29 39·5	45 35·5	47 51	13 19·5	18 48	44 50·5
1 20 1·25	10 44 57	2 47 10·75	12 12 39	4 18 7·25	1 44 9·5

log 1^s Hawelk = 0·0026847 log 1^s Hawelk = 0·0026918

Pendulum	No. of Coincidence	Time of Coincidence	No. of Coincidence	Time of Coincidence	Observed Duration of Coincidences	Calculation of Period
33	Bar.	764·9 18°.1				Bar. = 762·5
	t	12·92		12·975		*t* = 12·97 = 17°.72
	a	3·9 — 4·1		2·8 — 3·1		*a* = 3·3
		h m s		*h m s*	*m s*	
	1	1 28 39·1	31	2 11 31·6	30 *c* = 42 52·5	*c* = 85*s*.759
	2	30 5·5	32	12 57·8	52·3	2 *c* − 1 = 170·518
	3	31 30·2	33	14 22·5	52·3	
	4	32 56·3	34	15 49·0	52·7	log *c* = 1·9332797
	5	34 21·8	35	17 14·0	52·2	log (2 *c*—1) = 2·2317702
	6	35 »	36	18 40·8	»	9·7015095
	7	37 13·5	37	20 5·9	52·4	log 1^s Haw. = 26847
	8	38 39·8	38	21 33·1	53·3	log *S* = 9·7041942
	9	40 5·4	39	22 57·9	52·5	
	10	41 31·0	40	24 25·0	54·0	*S* = 0·5060509
	11	42 57·0	41	25 50·5	53·5	*a* = — 2^9
					30 *c* = 42 52·77	τ = — 783^3
	a	3·4 — 3·8		2·5 — 2·8		δ = — 520^5
	t	12·92		13·05		
	Bar.			764·75 18°.7		S_{33} = 0·5059202

Pendulum	No. of Coincidence	Time of Coincidence	No. of Coincidence	Time of Coincidence	Observed Duration of Coincidences	Calculation of Period
34	Bar.	764·5 18°.5				Bar. = 762·0
	t	13·06		13·09		t = 13·09 = 17°.93
	a	3·0 — 3·2		2·2 — 2·5		a = 2·60
		h m s		h m s	m s	
	1	3 19 28·5	31	3 59 12·0	30 c = 39 43·5	c = 79^s.4748
	2	20 48·2	32	0 31·8	43·6	$2c-1$ = 157·9496
	3	22 7·4	33	1 50·9	43·5	log c = 1·9002294
	4	23 26·5	34	3 10·6	44·1	log $(2c-1)$ = 2·1985185
	5	24 46·0	35	4 30·2	44·2	9·7017109
	6	26 5·5	36	5 50·1	44·6	log 1^s Haw. = 26918
	7	27 25·0	37	7 9·3	44·3	log S = 9·7044027
	8	28 44·5	38	8 28·9	44·4	
	9	30 4·0	39	9 48·5	44·5	S = 0·5062940
	10	31 23·5	40	11 8·2	44·7	α = — 1^{8}
	11	32 42·5	41	12 27·8	45.3	τ = — 793^{1}
					30 c = 39 44·245	δ = — 519^{8}
	a	2·7 — 2·9		2·0 — 2·2		
	t	13·08		13·11		S_{34} = 0·5061625
	Bar.			764·1 18°.4		

Comparison of Clocks.

Hawelk	Michelet	Hawelk	Michelet	Hawelk	Michelet
h m s	h m s	h m s	h m s	h m s	h m s
7 59 41	5 27 43·5	9 40 24·5	7 9 1·5	10 48 54	8 17 54·5
1 6·5	29 9·5	41 54	10 31·5	50 19·5	19 20·5
8 0 23·75	5 28 26·5	9 41 9·25	7 9 46·5	10 49 36·75	8 18 37·5

log 1^s Hawelk = 0·0024655 log 1^s Hawelk = 0·0024717

Pendulum	No. of Coincidence	Time of Coincidence	No. of Coincidence	Time of Coincidence	Observed Duration of Coincidences	Calculation of Period
34	Bar.	763·4 18°.7				Bar. = 761·1
	t	13·385		13·35		t = 13·36 = 18°.44
	a	6·9 — 7·1		5·4 — 5·7		a = 5·97
		h m s		h m s	m s	
	1	8 16 16·5	31	8 53 26·0	30 c = 36 39·5	c = 73^s.3367
	2	17 59·3	32	54 40·5	41·2	$2c-1$ = 145·6734
	3	19 12·3	33	55 53·0	40·7	log c = 1·8653213
	4	20 25·6	34	57 6·5	40·9	log $(2c-1)$ = 2·1633802
	5	21 39·3	35	58 19·5	40·2	9·7019411
	6	22 52·7	36	59 32·6	39·9	log 1^s Haw. = 24655
	7	24 6·2	37	0 46·0	39·8	log S = 9·7044066
	8	25 19·6	38	1 59·6	40·0	
	9	26 32·9	39	3 12·3	39·4	S = 0·5062985
	10	27 46·5	40	4 26·3	39·8	α = — 9^{4}
	11	28 59·6	41	5 39·3	39·7	τ = — 815^{9}
	a	6·2 — 6·5		4·9 — 5·1	30 c = 36 40·1	δ = — 518^{3}
	t	13·36		13·35		S_{34} = 0·5061641
	Bar.			763·5 18°.75		

Pendulum	No. of Coincidence	Time of Coincidence	No. of Coincidence	Time of Coincidence	Observed Duration of Coincidences	Calculation of Period
33	Bar.	763·55 18°.7				Bar. = 761·2
	t	13·61		13·65		t = 13·63 = 18°.95
	a	4·9 — 5·0		3·7 — 3·9		a = 4·1
		h m s		h m s	m s	c = 79^s.1709
	1	9 48 45·7	31	10 28 19·2	30 c = 39 33·5	2 c − 1 = 157·3418
	2	50 4·3	32	29 38·2	33·9	
	3	51 23·1	33	30 57·8	34·7	log c = 1·8985656
	4	52 41·9	34	32 16·5	34·6	log (2 c − 1) = 2·1968441
	5	54 0·1	35	33 35·5	35·4	9·7017215
	6	55 19·8	36	34 53·8	34·0	log 1^s Haw. = 24717
	7	56 38·5	37	36 14·7	36·2	log S = 9·7041932
	8	57 57·5	38	37 33·3	35·8	
	9	59 16·7	39	38 52·8	36·1	S = 0·5060498
	10	0 35·8	40	40 11·5	35·7	α = − 4^4
	11	1 54·7	41	41 31·2	36·5	τ = − 837^7
					30 c = 39 35·127	δ = − 517^5
	a	4·3 — 4·5		3·2 — 3·3		S_{33} = 0·5059138
	t	13·65		13·59		
	Bar.			763·5 17°.8		

Christiania. *The Pendulum-house (in the garden of the Observatory).*

Distance l = 1930 mm., thermometer 20, barometer, an aneroid, Cary 623, of which the correction was daily determined by the aid of a hypsometer, Tonnelot 11364, with divisions of fiftieths of a degree.

May 30th, 1897.

Comparison of Clocks.

Pendulum	Michelet	Pendulum	Michelet
h m s	h m s	h m s	h m s
22 22 48	6 11 28·5	3 47 52	11 35 39·5
25 50	14 30	50 57	38 44
22 24 19	6 12 59·25	3 49 24·5	11 37 11·75

Error of Pendulum	s
May 30, Midnight	— 44·75
» 31, —»—	— 44·78

log 1^s Michelet = -56.10^{-7}

Hawelk	Michelet	Hawelk	Michelet	Hawelk	Michelet
h m s	h m s	h m s	h m s	h m s	h m s
4 18 51·5	6 45 25·5	5 30 55	7 57 49·5	6 28 58·5	8 56 9·5
20 34	47 8·5	32 40	59 35	30 40·5	57 52
4 19 42·75	6 46 17	5 31 47·5	7 58 42·25	6 29 49·5	8 57 0·75

log 1^s Hawelk = 0·0020482 log 1^s Hawelk = 0·0020475

Pendulum	No. of Coincidence	Time of Coincidence	No. of Coincidence	Time of Coincidence	Observed Duration of Coincidences	Calculation of Period
		Hawelk	Michelet		Hawelk	Michelet
		h m s	h m s		h m s	h m s
		7 44 36·5	10 12 9		8 49 35	11 17 26
		46 19	10 13 52·5		51 19	19 10·5
		7 45 28	10 13 0·75		8 50 27	11 18 18·25
		log 1^s Hawelk = 0·0020469			log 1^s Hawelk = 0·0020502	
33	Bar.	763·0 = 763·6				Bar. = 763·7
	t	11·34		11·41		t = 11·39 = 14°.76
	a	4·0 — 4·0		3·1 — 3·1		a = 3·45
		h m s		h m s	m s	
	1	4 26 5·9	31	5 0 31·0	30 c = 34 25·1	c = $68^s.8552$
	2	27 14·5	32	1 39·4	24·9	2 c—1 = 136·7104
	3	28 23·7	33	2 »	»	log c = 1·8379368
	4	29 31·5	34	3 56·8	25·3	log(2 c—1) = 2·1358016
	5	30 41·0	35	5 6·6	25·6	9·7021352
	6	31 49·4	36	6 14·6	25·2	log 1^sHaw. = 20482
	7	32 58·4	37	7 24·1	25·7	log S = 9·7041834
	8	34 6·7	38	8 32·5	25·8	
	9	35 15·7	39	9 42·4	26·7	S = 0·5060384
	10	36 24·0	40	10 50·6	26·6	α = — 2^3
					30 c = 34 25·656	τ = — 653^1
	a	3·8 — 3·8		2·9 — 2·9		δ = — 526^7
	t	11·37		11·42		S_{33} = 0·5059202
34	Bar.	763·2 = 763·8				Bar. = 764·0
	t	11·49		11·49		t = 11·49 = 14°.96
	a	4·1 — 4·1		3·3 — 3·3		a = 3·6
		h m s		h m s	m s	
	1	5 35 50·5	31	6 8 8·7	30 c = 32 18·2	c = $64^s.62$
	2	36 56·0	32	9 14·5	18·5	2 c—1 = 128·24
	3	37 59·6	33	10 18·3	18·7	log c = 1·8103670
	4	39 5·0	34	11 23·9	18·9	log (2 c—1) = 2·1080235
	5	40 8·6	35	12 27·5	18·9	9·7013435
	6	41 14 1	36	13 33·0	18·9	log 1^sHaw. = 20475
	7	42 17·7	37	14 36·4	18·7	log S = 9·7043910
	8	43 23·4	38	15 42·0	18·6	
	9	44 27·2	39	16 45·8	18·6	S = 0·5062802
	10	45 33·0	40	17 51·0	18·0	α = — 2^5
					30 c = 32 18·60	τ = — 661^8
	a	3·9 — 3 9		3·1 — 3·1		δ = — 526^6
	t	11·49		11·49		S_{34} = 0·5061611

Pendulum	No. of Coincidence	Time of Coincidence	No. of Coincidence	Time of Coincidence	Observed Duration of Coincidences.	Calculation of Period
34	Bar.	763·7 = 764·3				Bar. = 764·3
	t	11·51		11·58		$t = 11·57 = 15°.11$
	a	6·4 — 6·4		5·2 — 5·2		$a = 5·63$
		h m s		*h m s*	*m s*	$c = 64^s.646$
	1	6 42 45·7	31	7 15 4·4	30 *c* = 32 18·7	$2c-1 = 128·292$
	2	43 51·0	32	16 9·9	18·9	
	3	44 54·8	33	17 14·0	19·2	$\log c = 1·8105417$
	4	46 0·0	34	18 19·2	19·2	$\log (2c-1) = 2·1081996$
	5	47 4·0	35	19 23·4	19·4	9·7023421
	6	48 8·9	36	20 28·6	19·7	$\log 1^s$ Haw. = 20469
	7	49 13·0	37	21 32·5	19·5	
	8	50 18·2	38	22 37·9	19·7	$\log S = 9·7043890$
	9	51 22·5	39	23 42·1	19·6	
	10	52 27·4	40	24 47·3	19·9	$S = 0·5062779$
						$\alpha = -\ 6^0$
					30 *c* = 32 19·38	$\tau = -\ 668^5$
	a	6·0 — 6·0		4·9 — 4·9		$\delta = -\ 526^5$
	t	11·52		11·61		$S_{34} = 0·5061578$

33	Bar.	763·9 = 764·4				Bar. = 764·5
	t	11·71		11·74		$t = 11·73 = 15°.41$
	a	4.8 — 4·8		3·7 — 3·7		$a = 4·05$
		h m s		*h m s*	*m s*	$c = 68^s.9537$
	1	7 51 46·6	31	8 26 15·9	30 *c* = 34 29·3	$2c-1 = 136·9074$
	2	52 55·4	32	27 23·7	28·3	
	3	54 5.0	33	28 33·4	28·4	$\log c = 1·8385576$
	4	55 13·1	34	29 41·8	28·7	$\log (2c-1) = 2·1364269$
	5	56 22·9	35	30 51·6	28·7	9·7021307
	6	57 30·7	36	31 59·5	28·8	$\log 1^s$ Haw. = 20502
	7	58 40·8	37	33 9·2	28·4	
	8	59 48·5	38	34 17·0	28·5	$\log S = 9·7041809$
	9	0 58·4	39	35 27·0	28·6	$S = 0·5060354$
	10	2 6·4	40	36 34·8	28·4	$\alpha = -\ 3^2$
					30 *c* = 34 28·61	$\tau = -\ 681^5$
	a	4.3 — 4.3		3·4 — 3·4		$\delta = -\ 526^1$
	t	11·71		11·76		$S_{33} = 0·5059143$
	Bar.			764·1 = 764·6		

Pendulum	No. of Coincidence	Time of Coincidence	No. of Coincidence	Time of Coincidence	Observed Duration of Coincidences	Calculation of Period

June 13th, 1897.

Comparison of Clocks.

Pendulum	Michelet	Pendulum	Michelet	Error of Pendulum
h m s	h m s	h m s	h m s	s
0 10 47	7 4 22·5	5 16 58	12 9 43·5	June 13th, 3^h a. m. — 44·81
13 50	7 25·0	19 57	12 42	» 14th, —»— — 44·93
0 12 18·5	7 5 53·75	5 18 27·5	12 11 12·75	

log 1^s Michelet $= -31 . 10^{-7}$

Hawelk	Michelet	Hawelk	Michelet	Hawelk	Michelet
h m s	h m s	h m s	h m s	h m s	h m s
4 31 38	7 33 29	5 38 41	8 40 51·5	6 48 58·5	9 51 29·5
33 21	35 12·5	40 25	42 36	50 45	53 16·5
4 32 29·5	7 34 20·75	5 39 33	8 41 43·75	6 49 51·75	9 52 23

log 1^s Hawelk = 0·0020966 log 1^s Hawelk = 0·0021022

Hawelk	Michelet	Hawelk	Michelet
h m s	h m s	h m s	h m s
7 54 42	10 57 32	8 58 51	12 1 59·5
56 26·5	59 17	60 37·5	3 46·5
7 55 34·25	10 58 24·5	8 59 44·25	12 2 53

log 1^s Hawelk = 0·0020849 log 1^s Hawelk = 0·0020788

Pendulum	No. of Coincidence	Time of Coincidence	No. of Coincidence	Time of Coincidence	Observed Duration of Coincidences	Calculation of Period
34	Bar.	766·9				Bar. = 766·9
	t	11·983		12·093		$t = 12·06 = 16°.02$
	a	6·4 — 6·4		5·2 — 5·2		$a =$ 5·63
		h m s		h m s	m s	$c = 65^s.4861$
	1	4 41 28·4	31	5 14 14·5	30 c = 32 46·1	$2c—1 = 129·9722$
	2	42 34·4	32	15 20·0	45·6	
	3	43 39·7	33	16 24·6	44·9	log c = 1·8161492
	4	44 46·2	34	17 30·5	44·3	log (2 c—1) = 2·1138504
	5	45 50·4	35	18 35·4	45·0	9·7022988
	6	46 56·6	36	19 41·5	44·9	log 1^s Haw. = 20966
	7	48 1·7	37	20 46·4	44·7	log S = 9·7043954
	8	49 7·6	38	21 52·0	44·4	
	9	50 12·8	39	22 56·8	44·0	S = 0.5062854
	10	51 19·1	40	24 2·6	43·5	$\alpha = -$ 6^0
	11	52 24·3	41	25 7·3	43·0	$\tau = -$ 709^0
					30 c = 32 44·582	$\delta = -$ 527^2
	a	6·0 — 6·0		4·9 — 4·9		$S_{34} = 0·5061613$
	t	12·007		12·16		

Pendulum	No. of Coincidence	Time of Coincidence	No. of Coincidence	Time of Coincidence	Observed Duration of Coincidences	Calculation of Period
33	Bar.	767·0				Bar. = 766·8
	t	12·35		12·45		t = 12·42 = 16°.70
	a	5·2 — 5·2		4·1 — 4·1		a = 4·45
		h m s		h m s	m s	
	1	5 45 38·4	31	6 20 38·8	30 c = 34 60·4	c = 69^s.9663
	2	46 49·1	32	21 49·5	60·4	2 c—1 = 133·9326
	3	47 58·8	33	22 58·3	59·5	log c = 1·8448889
	4	49 8·9	34	24 8·5	59·6	(log 2 c—1) = 2·1428041
	5	50 18·4	35	25 17·4	59·0	9·7020848
	6	21 29·5	36	26 28·0	58·5	log 1^s Haw. = 21022
	7	52 39·4	37	27 37·5	58·1	log S = 9·7041870
	8	53 49·6	38	28 48·0	58·4	
	9	54 58·8	39	29 57·1	58·3	S = 0·5060426
	10	56 9·5	40	31 7·2	57·7	α = — 3^{8}
	11	57 19·2			30 c = 34 58·99	τ = — 738^{5}
						δ = — 524^{9}
	a	4·8 — 4·8		3·7 — 3·7		S_{33} = 0·5059159
	t	12·38		12·51		

Pendulum	No. of Coincidence	Time of Coincidence	No. of Coincidence	Time of Coincidence	Observed Duration of Coincidences	Calculation of Period
33	Bar.	766·7				Bar. = 766·5
	t	12·725		12·865		t = 12·82 = 17°.43
	a	5·3 — 5·3		4·2 — 4·2		a = 4·57
		h m s		h m s	m s	
	1	6 55 36·8	31	7 30 20·3	30 c = 34 43·5	c = 69^s.462
	2	56 47·1	32	31 30·6	43·5	2 c—1 = 137·924
	3	57 56·0	33	32 39·4	43·4	log c = 1·8417473
	4	59 6·1	34	33 50·0	43·9	log (2 c—1) = 2·1396398
	5	60 14·5	35	34 58·6	44·1	9·7021075
	6	1 24·9	36	36 8·9	44·0	log 1^s Haw. = 20849
	7	2 33·4	37	37 17·4	44·0	log S = 9·7041924
	8	3 44·0	38	38 28·0	44·0	
	9	4 52·5	39	39 36·5	44·0	S = 0·5060488
	10	6 2·8	40	40 47·0	44·2	α = — 4^{0}
	11	7 11·4			30 c = 34 43·86	τ = — 770^{9}
						δ = — 523^{5}
	a	4·9 — 4·9		3·9 — 3·9		S_{33} = 0·5059190
	t	12·745		12·93		

Pendulum	No. of Coincidence	Time of Coincidence	No. of Coincidence	Time of Coincidence	Observed Duration of Coincidences	Calculation of Period
34	Bar.	766·3				Bar. = 766·2
	t	13·15		13·345		t = 13·28 = 18°.30
	a	4·2 — 4·2		3·4 — 3·4		a = 3·7
		h m s		h m s	m s	c = $64^s.9753$
	1	8 5 57·3	33	8 40 37·0	32 c = 34 39·7	$2c$—1 = 128·9506
	2	7 2·2	34	41 41·0	38·8	
	3	8 8·0	35	42 47·0	39·0	log c = 1·8127483
	4	9 12·4	36	43 51·4	39·0	log ($2c$—1) = 2·1104233
	5	10 17·9	37	44 57·3	39·4	9·7023250
	6	11 22·0	38	46 1·6	39·6	log 1^s Haw. = 20788
	7	12 27·9	39	47 7·0	39·1	log S = 9·7044038
	8	13 32·4	40	48 11·2	38·8	
	9	14 37·6	41	49 17·1	39·5	S = 0·5062952
	10	15 42·2	42	50 21·4	39·2	α = — 2^7
	11	16 47·5			32 c = 34 39·21	τ = — 809^1
	a	4·0 — 4·0		3·2 — 3·2		δ = — 522^0
	t	13·20		13·418		S_{34} = 0·5061618
	Bar.			766·1		

Observer, Lieutenant Scott-Hansen.

Khabarova.

July 30th, 1893; afternoon.

The place of observation was situated about 500 metres WNW by compass of the Russian church, whose latitude was determined by Nordenskiöld to be 69° 38′ 50″ N., and longitude 60° 19′ 49″ E. of Greenwich.

The apparatus was set up on a crag of slate on the shore to the north of Sibiriakoff's warehouse. The pendulum clock was hung up on a packing-case of which one end was sunk into the tundra, and partly filled with shingle. The lower edge of the glass case that was put over the pendulum apparatus was lined with asbestos packing, and during the observations, water was placed round the foot, and Lieut. Scott-Hansen further laid his cloak over it. The wind was south-westerly, and the sky half overcast. There was no opportunity of determining the rate of the chronometer by time observations. The barometer-readings were taken by an aneroid Perkins-Rayment 1298, which was compared before and after with a mercurial barometer, Adie 764. Scott-Hansen is uncertain whether thermometer 23 or 24 was used for the observations. The difference between the two thermometers in the same reading is, as we have seen on page 9,

$$23 - 24 = \text{reading} \times 0°.085 - 1°.053;$$

so that the temperature corresponding to a given reading, may differ between 0°.40 and 0°.67, according to which of the two thermometers was used. I have supposed that thermometer 23 was used in this case as subsequently. The observations, however, are not very trustworthy, on account of the rapid rise in temperature that took place.

Pendulum	No. of Coincidence	Time of Coincidence	No. of Coincidence	Time of Coincidence	Observed Duration of Coincidences	Calculation of Period

Comparison of Clocks.

Hawelk	Kutter	Hawelk	Kutter
h m s	*h m s*	*h m s*	*h m s*
3 7 5	9 57 52	8 54 18	3 47 2
8 36·5	59 24	55 45·5	48 30
10 5	60 53	57 11	49 46
3 8 35·5	9 59 23	8 55 44·83	3 48 29·33

The rate of Kutter at the time of observation may be assumed (see p. 6) to be $-0^s.06$ in 24^h

From this we obtain log 1^s Hawelk = 0·0024329

				$\varDelta$
July 30; afternoon:	Barometer, Perkins-Rayment 1298,	778·5		— 16·7
—»—	— Adie 764,	762·8	8°.0 = 761·8	
July 31; morning:	Barometer, Perkins-Rayment 1298,	782·7		— 17·6
—»—	— Adie 764,	766·3	9°.4 = 765·1	

Distance l = 2065 mm.

33	Bar.	779·4		780·3		Bar. 779·7 = 762·8
	t	4·46		4·52		$t = 4{\cdot}51 = 3°.43$
	a	5·5 — 5·4		3·9 — 4·0		$a = 4{\cdot}31$
		h m s		*h m s*	*m s*	
	1	3 16 43·3	31	3 58 40	30 c = 41 56·7	c = 83^s.9306
	2	18 3·5	32	0 1·3	57·8	2 c — 1 = 166·8612
	3	19 31·8	33	1 30·0	58·2	
	4	20 51·5	34	2 50·0	58·5	log c = 1·9239203
	5	22 18·0	35	4 17·5	59·5	log (2 c — 1) = 2·2223553
	6	23 36·0	36	5 37·0	61·0	9·7015650
	7	25 6·5	37	7 2·5	56·0	log 1^s Haw. = 24329
	8	26 28·0	38	8 26·0	58·0	log S = 9·7039979
	9	27 55·3	39	9 53·0	57·7	
	10	29 14·8	40	11 13·0	58·2	S = 0·5058222
	11	30 43·0	41	12 38·5	55·5	α = — 3^1
					30 c = 41 57·918	τ = — 151^8
	Bar.			780·0		δ = — 547^6
	t	4·50		4·57		S_{33} = 0·5057519
	a	4·5 — 4·3		3·4 — 3·5		

Pendulum	No. of Coincidence	Time of Coincidence	No. of Coincidence	Time of Coincidence	Observed Duration of Coincidences	Calculation of Period
33	Bar.	780·35		780·4		Bar. 780·35 = 763·2
	t	4·66		5·07		t = 4·94 = 4°.27
	a	6·3 — 6·4		4·5 — 4·1		a = 5·07
		h m s		h m s	m s	
	1	4 34 59	41	5 30 50	40 c = 55 51·0	c = 83ˢ.7488
	2	36 22	42	32 13·2	51·2	2 c—1 = 166·4976
	3	37 46	43	33 37·0 ?	»	
	4	39 9	44	35 1·5	52·5	log c = 1·9229786
	5	40 34·5	45	36 (20) ?	»	log (2 c—1) = 2·2214080
	6	41 57·0	46	37 46·7	49·7	9·7015706
	7	43 21·0	47	39 22·5 ?	»	log 1ˢ Haw. = 24329
	8	44 44·0	48	40 35·8	51·8	log S = 9·7040035
	9	46 9·6	49	41 57·3	47·7	
	10	47 33·8	50	43 22·7	48·9	S = 0·5058287
	11	48 58·0	51	44 44·8	46·8	α = — 4^3
					40 c = 55 49·95	τ = — 188^9
	Bar.	780·3		780·35		δ = — 546^3
	t	4·76		5·25		S_{33} = 0·5057547
	a	5·8 — 5·8		4·1 — 3·6		

The observations marked with a note of interrogation are entered as unreliable, and are therefore not used in the computations.

Pendulum	No. of Coincidence	Time of Coincidence	No. of Coincidence	Time of Coincidence	Observed Duration of Coincidences	Calculation of Period
34	Bar.	780·6		780·8		Bar. 780·8 = 763·6
	t	5·63		6·80		t = 6·35 = 7°.09
	a	8·0 — 5·4		5·3 - 3·4		a = 5·25
		h m s		h m s	m s	
	1	6 23 37·4	51	7 28 6·0	50 c = » »	c = 77ˢ.489
	2	25 4·0	52	29 27·5	»	2 c—1 = 153·978
	3	26 13·0	53	30 53·0	»	
	4	27 38·8	54	32 19·0	»	log c = 1·8892401
	5	28 47·2	55	33 28·0	»	log (2 c—1) = 2·1874587
	6	30 13·7	56	34 48·5	64 34·8	9·7017814
	7	31 22·0	57	35 57·0	35·0	log 1ˢ Haw. = 24329
	8	32 49·5	58	37 23·0	33·5	log S = 9·7042143
	9	33 57·8	59	38 32·0	34·2	
	10	35 25·0	60	39 58·7	33·7	S = 0·5060743
	11	36 32·5	61	41 8·0	35·5	α = — 4^6
					50 c = 64 34·45	τ = — 313^6
	Bar.	780·7		781 1		δ = — 541^2
	t	5·99		6·99		S_{34} = 0·5059884
	a	7·2 — 4·9		4·8 — 3·0		

The first 5 observations in the second series must be inaccurate, as there is far too great a difference between them and the succeeding observations. They are therefore not taken into consideration.

Pendulum	No. of Coincidence	Time of Coincidence	No. of Coincidence	Time of Coincidence	Observed Duration of Coincidences	Calculation of Period
34	Bar.	781·2		781·5		Bar. 781·4 = 764·0
	t	7·0		8·04		t = 7·67 = 9°.70
	a	6·3 — 6·2		4·9 — 4·9		a = 5·27
		h m s		*h m s*	*m s*	
	1	7 58 39·7	31	8 37 25·0	30 c = 38 45·3	c = 77ˢ.5057
	2	59 56·0	32	38 41·8	45·8	2 c—1 = 154·0114
	3	1 15·0	33	40 3·0	48·0	
	4	2 32·5	34	41 17·0	44·5	log c = 1·8893336
	5	3 48·9	35	42 32·5	43·6	log (2 c − 1) = 2·1875528
	6	5 7·0	36	43 49·5	42·5	9·7017808
	7	6 25·0	37	45 10·0	45·0	log 1ˢ Haw. = 24329
	8	7 41·0	38	46 26·5	45·5	log S = 9·7042137
	9	8 59·0	39	47 42·0	43·0	
	10	10 16·5	40	49 5·0	48·5	S = 0·5060736
					30 c = 38 45·17	α = — 4⁶
	Bar.	781·2		781·6		τ = — 429⁰
	t	7·75		7·87		δ = — 536⁴
	a	5·7 — 5·7		4·2 — 4·3		S_{34} = 0·5059766

Saloon of the Fram.

January 16, 1894.

The observations were made between midnight on the 15th January, and 5 o'clock the following morning, according to the ship's time.

Comparison of Clocks.

Hawelk	Hohwü	Hawelk	Hohwü	Hawelk	Hohwü
h m s	*h m s*	*h m s*	*h m s*	*h m s*	*h m s*
10 19 20	3 32 29	1 33 50	6 47 59	3 1 18	8 15 54
22 36	35 46	37 4	51 14	4 35	19 12
25 56	39 7	40 20	54 31	7 50	22 28
10 22 37·33	3 35 47·33	1 37 4·67	6 51 14·67	3 4 34·33	8 19 11·33

Rate of Hohwü in 24^h = — 0ˢ·01

log 1ˢ Hawelk = 0·0022278 log 1ˢ Hawelk = 0·0022281

Distance l = 2075 mm., thermometer 23, barometer Adie 763

Pendulum	No. of Coincidence	Time of Coincidence	No of Coincidence	Time of Coincidence	No. of Coincidence	Time of Coincidence	Observed Duration of Coincidences	Calculation of Period
33	Bar.	769·5 15°.0						Bar. = 768·1
	t	7·75		7·69		7·56		t = 7·63 = 9°.63
	a	4·0 — 3·9		3·1 — 3·0		2·4 — 2·1		a = 2·95
		h m s		h m s		h m s		
	1	11 39 42·4	21	0 6 9·7	41	0 32 38 ?	m s	$c = 79^s.3705$
	2	41 0·0	22	7 26·2	42	33 53·6	40 c = 52 53·6	$2c-1$ = 157·741
	3	42 20·9	23	8 48·1	43	35 17·4	56·5	
	4	43 39·4	24	10 5·0	44	36 32·0	52·6	log c = 1·8996592
	5	45 0·5	25	11 25·6 ?	45	37 56·0	55·5	log $(2c-1)$ = 2·1979446
	6	46 17·5	26	12 43·2	46	39 11·0	53·5	9·7017146
	7	47 39·0	27	14 6·1	47	40 35·0	56·0	log 1^s Haw. = 22278
	8	48 56·4	28	15 23·0	48	41 50·0	53·6	log S = 9·7039424
	9	50 17·8	29	16 44·2	49	43 13·1	55·3	
	10	51 35·0	30	»	50	44 29·0	54·0	S = 0·5057576
	11	52 56·4	31	19 24·0	51	45 54·0	57·6	$\alpha = -\ 1^4$
							40 c = 52 54·82	$\tau = -\ 425^9$
	Bar.					770·0 13°.9		$\delta = -\ 539^5$
	t					7·50		
	a					1·9 — 2·0		S_{33} = 0·5056609

Pendulum	No. of Coincidence	Time of Coincidence	No of Coincidence	Time of Coincidence	No. of Coincidence	Time of Coincidence	Observed Duration of Coincidences	Calculation of Period
33	Bar.	770·1 13°.4						Bar. = 768·6
	t	7·20		7·10				t = 7·13 = 8°.64
	a	6·3 — 6·0		4·2 — 4·0				a = 4·88
		h m s		h m s				
	1	2 0 28·7	31	» » »			m s	$c = 79^s.516$
	2	1 49·1	32	2 41 34·6			30 c = 39 45·5	$2c-1$ = 158·032
	3	3 7·8	33	42 52·8			45·0	
	4	4 28·1	34	44 13·4			45·3	log c = 1·9004545
	5	5 46·8	35	45 32·0			45·2	log $(2c-1)$ = 2·1987450
	6	7 7·0	36	46 53·1			46·1	9·7017095
	7	8 25·7	37	48 11·0			45·3	log 1^s Haw. = 22281
	8	9 45·9	38	49 31·9			46·0	log S = 9·7039376
	9	11 4·8	39	50 50·1			45·3	
	10	12 25·1	40	52 11·0			45·9	S = 0·5057520
	11	13 43·8	41	53 29·0			45·2	$\alpha = -\ 3^9$
							30 c = 39 45·48	$\tau = -\ 382^2$
	Bar.			770·15 13°.0				$\delta = -\ 541^6$
	t	7·17		7·06				
	a	5·5 — 5·2		4·0 — 3·8				S_{33} = 0·5056592

Saloon of the Fram.

Night of the 15th March, 1894.

Comparison of Clocks.

Hawelk	Hohwü	Hawelk	Hohwü
h m s	*h m s*	*h m s*	*h m s*
9 11 3	6 52 18·5	11 51 56	9 32 45
14 3	55 18	54 41	35 29·5
17 2	58 16·5	57 40	38 28
9 14 2·67	6 55 17·67	11 54 45·67	9 35 34·17

Hohwü's rate in 24^h $+ 0^s{\cdot}07$

$\log 1^s$ Hawelk = −0·0011955

Distance l = 2215 mm.

Pendulum	No. of Coincidence	Time of Coincidence	No. of Coincidence	Time of Coincidence	Observed Duration of Coincidences	Calculation of Period
33	Bar.	756·7 12°.4				Bar. = 755·2
	t	7·06		6·94		t = 6·97 = 8°.32
	a	4·7 — 4·8		4·0 — 4·0		a = 4·23
		h m s		*h m s*	*m s*	
	1	9 27 26·5	31	9 45 14·4	$30c$ = 17 47·9	$c = 35^s.5994$
	2	28 2·2	32	45 50·3	48·1	$2c-1$ = 70·1988
	3	28 37·5	33	46 25·5	48·0	
	4	29 13·4	84	47 1·0	47·6	$\log c$ = 1·5514427
	5	29 48·7	35	47 36·9	48·2	$\log(2c-1)$ = 2·8463297
	6	30 24·4	36	48 12·3	47·9	9·7051130
	7	30 59·6	37	48 48·2	48·6	$\log 1^s$ Haw. = — 11955
	8	31 35·6	38	49 23·4	47·8	$\log S$ = 9·7039175
	9	32 11·3	39	49 59·1	47·8	
	10	32 47·2	40	50 34·8	47·6	S = 0·5057286
	11	33 22·1	41	51 10·4	48·3	$\alpha = -\ 2^6$
					$30c$ = 17 47·982	$\tau = -\ 367^9$
	Bar.			756·4 12°.0		$\delta = -\ 532^6$
	t	7·01		6·87		S_{83} = 0·5056383
	a	4·4 — 4·3		3·9 — 3·8		

Pendulum	No. of Coincidence	Time of Coincidence	No. of Coincidence	Time of Coincidence	Observed Duration of Coincidences	Calculation of Period
33	Bar.					Bar. = 755·1
	t	6·79		6·61		t = 6·66 = 7°.70
	a	2·2 — 2·1		1·8 — 1·8		a = 1·9
		h m s		h m s	m s	
	1	10 3 33·6	31	10 21 21·6	30 c = 17 48·0	c = 35s.6085
	2	4 8·9	32	21 57·9	49·0	2 c—1 = 70·217
	3	4 45·0	33	22 32·3	47·3	
	4	5 19·9	34	23 9·4	49·5	log c = 1·5515537
	5	5 56·4	35	23 43·9	47·5	log (2 c—1) = 2·8464423
	6	6 31·4	36	24 20·3	48·9	9·7051114
	7	7 7·5	37	24 55·2	47·7	log 1s Haw. = — 11955
	8	7 42·9	38	25 31·8	48·9	log S = 9·7039159
	9	8 18·5	39	26 6·1	47·6	
	10	8 53·6	40	26 42·6	49·0	S = 0·5057267
	11	9 30·0	41	27 17·4	47·4	α = — 0^5
					30 c = 17 48·255	τ = — 340^6
	Bar.			756·35 11°.5		δ = — 533^8
	t	6·70		6·54		S_{33} = 0·5056392
	a	1·9 — 2·0		1·7 — 1·7		

Pendulum	No. of Coincidence	Time of Coincidence	No. of Coincidence	Time of Coincidence	Observed Duration of Coincidences	Calculation of Period
33	Bar.	756·2 11°.2				Bar. = 754·8
	t	6·02		6·10		t = 6·03 = 6°.45
	a	3·0 — 2·9		2·5 — 2·4		a = 2·57
		h m s		h m s	m s	
	1	10 57 29·3	51	11 27 9·9	50 c = 29 40·6	c = 35s.6153
	2	58 4·2	52	27 45·1	40·9	2 c—1 = 70·2306
	3	58 40·4	53	28 21·2	40·8	
	4	59 15·4	54	28 55·9	40·5	log c = 1·5516366
	5	59 51·2	55	29 32·3	41·1	log (2 c—1) = 2·8465264
	6	0 26·7	56	30 6·7	40·0	9·7051102
	7	1 2·9	57	30 43·4	40·5	log 1s Haw. = — 11955
	8	1 37·8	58	31 18·5	40·7	log S = 9·7039147
	9	2 14·0	59	31 54·6	40·6	
	10	2 49·0	60	32 30·7	41·7	S = 0·5057253
	11	3 25·0	61	33 6·0	41·0	α = — 1^0
					50 c = 29 40·764	τ = — 285^2
	Bar.			755·7 10°.9		δ = — 536^3
	t	5·95		6·05		S_{33} = 0·5056430
	a	2·8 — 2·8		2·0 — 2·0		

On the Ice Near the Ship.

The oscillations were performed in the snow-hut in which the magnetic observations had been carried out. The iron cross for the pendulum apparatus was placed on the ice itself, to which it froze so firmly, that the bubble of the level did not move as much as one division. The pendulum oscillated from about NW to SE, the direction being determined by the compass on board and the bearings of the stand. The angle made by the plane of oscillation with the diametral plane of the vessel measured $39^\circ \pm 2^\circ$. The position was the same on the three days, the 8th, 10th and 11th June. The pendulum clock Hawelk was compared with the chronometer Frodsham.

June 8, 1895; afternoon.

Comparison of Clocks.

Hawelk	Frodsham	Hawelk	Frodsham
h m s	*h m s*	*h m s*	*h m s*
11 41 43	8 41 46	0 49 12	9 49 20·5
47 47	47 50·5	55 46	55 55
11 44 45	8 44 48·25	0 52 29	9 52 37·75

	Frodsham	Hohwü
	h m s	*h m s*
June 8, p. m.	8 1 51·5	3 43 23
» 9, a. m.	8 32 48·5	4 12 20

Hohwü's rate in $24^h = -0\overset{s}{\cdot}73$

log 1^s Hawelk $= -0{\cdot}0005671$ log 1^s Frodsham $= -0{\cdot}0011545$

Mean Time on Board	Barometer Adie 763 in Saloon	
h m	°	
9 » p. m.	16.4	758·0 = 756·1
9 30	16·0	58·0 = 56·1
10 »	16·0	57·8 = 55·9
10 30	16·05	57·7 = 55·8

Distance $l = 2338$ mm. Thermometer Söderberg 114.

Pendulum	No. of Coincidence	Time of Coincidence	No. of Coincidence	Time of Coincidence	Observed Duration of Coincidences	Calculation of Period
34	t	$-5°.20$		$-5°.15$		Bar. = 756·0
	a	7·3 — 7·3		6·2 — 6·1		$t = -5°.16$
		h m s		h m s	m s	$a = 6·55$
	1	0 8 47·7	41	0 34 34·8	$40c =$ 25 47·1	
	2	9 26·1	42	35 12·9	46·8	$c = 38^s.6633$
	3	10 5·0	43	»	»	$2c-1 = 76·3266$
	4	10 43·5	44	36 30·3	46·8	$\log c = 1·5872989$
	5	11 21·6	45	37 9·1	47·5	$\log (2c-1) = 2·8826759$
	6	12 0·9	46	»	»	9·7046230
	7	12 40·0	47	38 25·9	45·9	$\log 1^s$ Haw. = − 5671
	8	13 18·4	48	39 4·4	46·0	$\log S = 9·7040559$
	9	13 57·3	49	39 43·6	46·3	
	10	14 35·7	50	40 22·0	46·3	$S = 0·5058898$
	11	15 14·6	51	41 0·7	46·1	$\alpha = -\ 5^6$
					$40c =$ 25 46·533	$\tau = +\ 228^2$
	t	$-5°.15$		$-5°.15$		$\delta = -\ 560^7$
	a	6·9 — 6·9		5·9 — 5·8		$S_{34} = 0·5058560$

On the Ice Near the Ship.

June 10, 1895.

Comparison of Clocks.

Hohwü	Frodsham
h m s	h m s
9 43 36	2 8 49
7 24 35	11 51 21·5

Hohwü's rate in 24^h
$-0^s.73$

$\log 1^s$ Frodsham = −0·0011597

Hawelk	Frodsham	Hawelk	Frodsham	Hawelk	Frodsham
h m s	h m s	h m s	h m s	h m s	h m s
6 22 9	3 29 21·5	8 7 16	5 14 44·5	0 14 2	9 22 7·5
25 28	32 41	10 31	18 0	17 22	25 28
6 23 48·5	3 31 1·25	8 8 53·5	5 16 22·25	0 15 42	9 23 47·75

$\log 1^s$ Hawelk = −0·0000590 $\log 1^s$ Hawelk = −0·0000760

Mean Time on Board		Barometer Adie 763 in Saloon
h m	°	
4 »	16·0	756·5 = 754·7
8 »	15·6	56·7 = 55.0
10 13	15·7	56·9 = 55·2

Distance l = 2338 mm., thermometer 23.

Pendulum	No. of Coincidence	Time of Coincidence	No. of Coincidence	Time of Coincidence	Observed Duration of Coincidences	Calculation of Period
34	*t*	1·73		1·58		Bar. = 754·8
	a	6·1 — 6·0		5·0 — 5·0		*t* = 1·62 = — 2°.31
		h m s		*h m s*	*m s*	*a* = 5·4
	1	6 48 6·0	41	7 16 24·5	40 *c* = 28 18·5	
	2	48 48·3	42	» »	»	*c* = 42*s*.4691
	3	49 30·9	43	17 49·5	18·6	2 *c*—1 = 83·9382
	4	50 13·2	44	18 31·5	18·3	log *c* = 1·6280730
	5	50 55·6	45	19 14·6	19·0	log (2 *c*—1) = 2·9239596
	6	51 37·9	46	19 56·7	18·8	9·7041134
	7	52 20·5	47	20 39·4	18·9	log 1*s* Haw. = — 590
	8	53 2·7	48	21 21·6	18·9	log *S* = 9·7040544
	9	53 45·5	49	»	»	
	10	54 27·6	50	22 46·7	19·1	*S* = 0·5058880
					40 *c* = 28 18·763	α = — 3^8
	t	1·63		1·55		τ = + 102^3
	a	5·8 — 5·7		4·9 — 4·7		δ = — 553^5
						S_{84} = 0·5058425

34	*t*	1·55		1·51		Bar. = 754·9
	a	6·3 — 6·0		5·5 — 5·2		*t* = 1·52 = — 2°.52
		h m s		*h m s*	*m s*	*a* = 5·61
	1	7 31 17·3	31	7 52 30·7	30 *c* = 21 13·4	
	2	32 0·4	32	53 14·6	14·2	*c* = 42*s*.466
	3	32 42·2	33	53 55·8	13·6	2 *c*—1 = 83·932
	4	33 25·4	34	54 39·6	14·2	
	5	34 7·1	35	55 20·7	13·6	log *c* = 1·6280414
	6	34 50·3	36	56 4·4	14·1	log (2 *c*—1) = 2·9239276
	7	35 31·9	37	56 45·7	13·8	9·7041138
	8	36 15·1	38	57 29·6	14·5	log 1*S* Haw. = — 590
	9	36 56·6	39	58 10·5	13·9	log *S* = 9·7040548
	10	37 39·9	40	58 54·4	14·5	
	11	38 21·5	41	»	»	*S* = 0·5058885
					30 *c* = 21 13·98	α = — 4^0
	t	1·54		1·48		τ = + 111^3
	a	6·0 — 5·8		5·2 — 4·9		δ = — 554^0
						S_{84} = 0·5058438

Distance l = 2342 mm.

Pendulum	No. of Coincidence	Time of Coincidence	No. of Coincidence	Time of Coincidence	Observed Duration of Coincidences	Calculation of Period
33	t	1·74		1·77		Bar. = 755·0
	a	7·0 — 7·0		6·0 — 6·1		t = 1·76 = — 2°.05
		h m s		h m s	m s	a = 6·36
	1	10 49 31·6	31	11 11 29·6	$30c$ = 21 58·0	
	2	50 15·2	32	12 13·2	58·0	c = $43^s.9463$
	3	50 59·6	33	12 57·7	58·1	$2c-1$ = 86·8926
	4	51 43·2	34	»	»	
	5	52 27·6	35	14 25·8	58·2	log c = 1·6429223
	6	53 11·2	36	15 9·2	58·0	log ($2c-1$) = 2·9389828
	7	53 55·4	37	15 54·0	58·6	9·7039395
	8	54 38·9	38	16 37·2	58·3	log 1^s Haw. = — 760
	9	55 23·1	39	17 22·0	58·9	log S = 9·7038635
	10	56 6·6	40	18 5·3	58·7	
	11	56 51·0	41	18 50·1	59·1	S = 0·5056657
					$30c$ = 21 58·39	α = — 5^{2}
	t	1·76		1·76		δ = + 90^{5}
	a	6·7 — 6·6		5·8 — 5·7		τ = — 553^{0}
						S_{88} = 0·5056189

Pendulum	No. of Coincidence	Time of Coincidence	No. of Coincidence	Time of Coincidence	Observed Duration of Coincidences	Calculation of Period
33	t	1·82		1·80		Bar. = 755·1
	a	6·4 — 6·5		5·5 — 5·8		t = 1·80 = — 1°.95
		h m s		h m s	m s	a = 5·84
	1	11 35 39·0	31	11 57 42·7	$30c$ = 22 3·7	
	2	36 22·6	32	58 26·0	3·4	c = $44^s.1276$
	3	37 7·2	33	59 11·1	3·9	$2c-1$ = 87·2552
	4	37 50·7	34	59 54·1	3·4	
	5	38 35·6	35	60 39·4	3·8	log c = 1·6447103
	6	39 19·0	36	1 22·6	3·6	log ($2c-1$) = 2·9407913
	7	40 3·7	37	2 7·6	3·9	9·7039190
	8	40 47·1	38	2 50·9	3·8	log 1^s Haw. = — 760
	9	41 32·0	39	3 36·1	4·1	log S = 9·7038430
	10	42 15·0	40	4 19·0	4·0	
	11	43 0·0	41	5 4·5	4·5	S = 0·5056419
					$30c$ = 22 3·827	α = — 4^{4}
	t	1·81		1·78		τ = + 86^{5}
	a	6·0 — 6·2		5·3 — 5·0		δ = — 552^{9}
						S_{88} = 0·5055948

Pendulum	No. of Coincidence	Time of Coincidence	No. of Coincidence	Time of Coincidence	Observed Duration of Coincidences	Calculation of Period

On the Ice Near the Ship.

June 11, 1895.

Comparison of Clocks.

	Frodsham	Hohwü	Hohwü's Rate in 24^h
	h m s	*h m s*	$-0^s.57$
June 11, a. m.	8 40 27	4 12 16	
—»— p. m.	10 45 7·5	6 14 41	log 1^s Frodsham = —0·0011598

Hawelk	Frodsham	Hawelk	Frodsham [1]	
h m s	*h m s*	*h m s*	*h m s*	
5 15 12	2 25 52	0 18 16	9 30 0	
18 19	28 59·5	21 35	33 19·5	log 1^s Hawelk = — 0·0000665
21 39	32 20	24 52	36 37	
5 18 23·33	2 29 3·83	0 21 34·33	9 33 18·83	

Mean Time on Board		Barometer Adie 763 in Saloon	Mean Time on Board		Barometer Adie 763 in Saloon
h m	°		*h m*	°	
3 30	21·2	759·65 = 757·2	8 »	21.0	759·9 = 757·5
4 »	20·2	59·6 = 57·3	8 30	20·9	60·0 = 57·6
4 30	18·4	59·4 = 57·3	9 »	20·8	59·9 = 57·5
5 »	17·0	59·15 = 57·2	9 30	20·3	59·9 = 57·6

Distance l = 2338 mm.

34	t	2·06		2·04		Bar. = 757·2
	a	5·0 — 5·0		4·4 — 4·3		t = 2·05 = —1°.47
		h m s		*h m s*	*m s*	a = 4·60
	1	5 33 31·9	31	5 54 45·0 ?	$30c$ = 21 »	
	2	34 14·6	32	55 29·0	14·4	$c = 42^s.483$
	3	34 56·9	33	56 10·9	14·0	$2c-1$ = 83·966
	4	35 39·4	34	56 54·3	14·9	
	5	36 21·9	35	57 36·0	14·1	log c = 1·6282152
	6	37 4·4	36	58 19·2	14·8	log $(2c-1)$ = 2·9241035
	7	37 46·6	37	59 1·0	14·4	9·7041117
	8	38 29·6	38	59 44·3	14·7	log 1^s Haw. = — 665
	9	39 11·8	39	0 26·0	14·2	log S = 9·7040452
	10	39 54·3	40	1 9·2	14·9	
	11	40 36·4	41	»	»	S = 0·5058773
					$30c$ = 21 14·489	$\alpha = -\ 2^7$
	t	2·07		2·01		$\tau = +\ 65^2$
	a	4·8 — 4·8		4·0 — 4·1		$\delta = -\ 553^5$
						S_{34} = 0·5058282

[1] During the first comparison between Frodsham and Hawelk, some rumbling was heard in the ice.

Pendulum	No. of Coincidence	Time of Coincidence	No. of Coincidence	Time of Coincidence	Observed Duration of Coincidences	Calculation of Period
34	t	2·01		2·02		Bar. = 757·3
	a	6·3 — 6·4		5·7 — 5·6		t = 2·02 = − 1°.53
		h m s		h m s	m s	a = 5·83
	1	6 12 12·1	31	6 33 28·8	30 c = 21 16·7	
	2	12 55·3	32	34 11·9	16·6	c = 42^s.5530
	3	13 37·1	33	34 53·9	16·8	2 c—1 = 84·1060
	4	14 20·1	34	35 36·7	16·6	
	5	15 2·3	35	36 18·9	16·6	log c = 1·6289302
	6	15 45·3	36	37 1·9	16·6	log (2 c—1) = 1·9248270
	7	16 27·4	37	37 43·9	16·5	9·7041032
	8	17 10·4	38	38 27·1	16·7	log 1^s Haw. = − 665
	9	17 52·5	39	39 8·9	16·4	log S = 9·7040367
	10	18 35·6	40	39 52·2	16·6	
	11	19 17·6	41	40 34·0	16·4	S = 0·5058674
					30 c = 21 16·591	α = − 4^4
	t	2·04		2·00		τ = + 67^5
	a	6·1 — 6·0		5·3 — 5·1		δ = − 553^7
						S_{34} = 0·5058183

34	t	2·01		2·01				
	a	4·7 — 4·7		4·2 — 4·1				
		h m s		h m s		h m s	m s	m s
	1	6 52 13·8	31	7 13 28·6	41	7 20 33·1	40 c = 28 19·3	30 c = 21 14·8
	2	52 56·0	32	14 10·7	42	21 15·4	19·4	14·7
	3	53 38·9	33	14 53·5	43	21 58·1	19·2	14·6
	4	54 21·1	34	»	44	22 40·4	19·3	»
	5	55 4·0	35	16 18·4	45	23 22·9	18·9	14·4
	6	55 46·3	36	17 0·8	46	24 5·4	19·1	14·5
	7	56 29·0	37	17 43·3	47	24 48·2	19·2	14·3
	8	57 11·4	38	18 25·7	48	25 30·3	18·9	14·3
	9	57 53·8	39	19 8·2	49	26 13·0	19·2	14·4
	10	58 36·1	40	19 50·4	50	26 55·3	19·2	14·3
	11	59 19·0	41	»	51	27 38·3	19·3	»
							40 c = 28 19·182	30 c = 21 14·478
	t	2·03				2·00		
	a	4·4 — 4·4				3·7 — 3·7		

Bar. = 757·3
t = 2·01 = − 1°.54
a = 4·2
c = 42^s.4801
2 c—1 = 83·9602

log c = 1·6281855
log (2 c—1) = 1·9240734
9·7041121
log 1^s Haw. = − 665
log S = 9·7040456

S = 0·5058778
α = − 2^3
τ = + 68^0
δ = − 553^7
S_{34} = 0·5058290

Distance l = 2342 mm.

Pendulum	No. of Coincidence	Time of Coincidence	No. of Coincidence	Time of Coincidence	Observed Duration of Coincidences	Calculation of Period
33	*t*	2·02		2·07		Bar. = 757·5
	a	6·8 — 6·9		5·8 — 5·9		*t* = 2·06 = — 1°.44
		h m s		*h m s*	*m s*	*a* = 6·03
	1	10 16 47·8	41	10 46 17·8	40 *c* = 29 30·0	
	2	17 32·1	42	47 2·3	30·2	$c = 44^{s}.2636$
	3	18 16·0	43	47 46·4	30·4	2 *c*—1 = 87·5272
	4	19 0·4	44	48 31·0	30·6	
	5	19 44·6	45	49 15·0	30·4	log *c* = 1·6460467
	6	20 28·8	46	49 59·6	30·8	log (2 *c*—1) = 1·9421430
	7	21 12·9	47	50 43·6	30·7	9·7039037
	8	21 57·2	48	51 28·0	30·8	log 1^{s} Haw. = — 665
	9	22 41·6	49	52 11·9	30·3	log *S* = 9·7038372
	10	23 25·7	50	52 56·6	30·9	
	11	24 9·7	51	53 40·6	30·9	*S* = 0·5056351
					40 *c* = 29 30·545	α = — 4^{7}
	t	2·07		2·08		τ = + 63^{9}
	a	6·3 — 6·4		5·0 — 5·2		δ = — 553^{5}
						S_{33} = 0·5055857

Pendulum	No. of Coincidence	Time of Coincidence	No. of Coincidence	Time of Coincidence	Observed Duration of Coincidences	Calculation of Period
33	*t*	2·10		2·13		Bar. = 757·6
	a	5·0 — 5·0		4·3 — 4·3		*t* = 2·12 = — 1°.32
		h m s		*h m s*	*m s*	*a* = 4·47
	1	11 2 10·4	31	11 24 18·0	30 *c* = 22 7·6	
	2	2 54·6	32	25 2·0	7·4	$c = 44^{s}.263$
	3	3 38·8	33	25 46·4	7·6	2 *c*—1 = 83·526
	4	4 22·8	34	26 30·6	7·8	
	5	5 7·2	35	27 14·9	7·7	log *c* = 1·6460408
	6	5 51·1	36	27 59·2	8·1	log (2 *c*—1) = 1·9421371
	7	6 35·8	37	28 43·6	7·8	9·7039037
	8	7 19·6	38	29 27·8	8·2	log 1^{s} Haw. = — 665
	9	8 4·0	39	30 12·1	8·1	log *S* = 9·7038372
	10	8 48·0	40	30 56·6	8·6	
					30 *c* = 22 7·89	*S* = 0·5056351
	t	2·12		2·14		α = — 2^{6}
	a	4·6 — 4·6		4·0 — 4·0		τ = + 58^{4}
						δ = — 553^{5}
						S_{33} = 0·5055853

Pendulum	No. of Coincidence	Time of Coincidence	No. of Coincidence	Time of Coincidence	Observed Duration of Coincidences	Calculation of Period
33	t	2·15		2·15		Bar. = 757·5
	a	5·3 — 5·4		4·6 — 4·6		t = 2·15 = — 1°.27
		h m s		h m s	m s	a = 4·8
	1	11 41 41·8	31	0 3 51·9	30 c = 22 10·1	
	2	42 26·0	32	4 35·6	9·6	c = $44^s.3278$
	3	43 10·6	33	5 20·0	9·4	$2c-1$ = 87·6556
	4	43 54·6	34	6 4·4	9·8	
	5	44 39·1	35	6 49·0	9·9	log c = 1·6466761
	6	45 23·1	36	7 33·3	10·2	log $(2c-1)$ = 1·9427797
	7	46 7·7				9·7038964
	8	46 52·0				log 1^s Haw. = — 665
	9	47 36·3		The light burnt out.		log S = 9·7038299
	10	48 20·5				
	11	49 5·0				S = 0·5056266
						α = — 3^0
					30 c = 22 9·833	τ = + 56^4
	t	2·15		2·13		δ = — 553^3
	a	5·0 — 5·0		4·3 — 4·3		S_{33} = 0·5055766

The Saloon of the Fram.

Night of November 13, 1895.

Comparison of Clocks.

Hawelk	Hohwü	Hawelk	Hohwü	
h m s	h m s	h m s	h m s	Hohwü's Rate in 24^h
6 0 23	10 22 20·5	10 30 44	2 51 53	— $0^s.25$
2 19	24 16	32 42	53 30·5	
6 1 21	10 23 18·25	10 31 43	2 52 31·75	

log 1^s Hawelk = — 0·0018364

Distance l = 1987 mm., thermometer 23, barometer Adie 763.

Pendulum	No. of Coincidence	Time of Coincidence	No. of Coincidence	Time of Coincidence	Observed Duration of Coincidences	Calculation of Period
33	Bar.	758·1 16°.9				Bar. = 756·1
	t	8·95		8 70		*t* = 8·80 = 11°.96
	a	6·0 — 6·3		5·0 — 4·8		*a* = 5·37
		h m s		*h m s*	*m s*	
	1	6 18 51·6	61	6 51 11·7	60 *c* = 32 20·1	*c* = 32*s*.3291
	2	19 23·7	62	51 43·5	19·8	2 *c*—1 = 63·6582
	3	19 56·3	63	52 16·2	19·9	
	4	20 28·5	64	52 48·3	19·8	log *c* = 1·5095936
	5	21 1·0	65	53 21·0	20·0	log (2 *c*—1) = 1·8038544
	6	21 33·1	66	53 52·7	19·6	9·7057392
	7	22 5·7	67	54 25·4	19·7	log 1*s* Haw. = — 18364
	8	22 37·7	68	54 57·2	19·5	log *S* = 9·7039028
	9	23 10·2	69	55 30·0	19·8	
	10	23 42·4	70	56 2·0	19·6	*S* = 0·5057115
	11	24 15·1	71	56 34·5	19·4	α = — 5^{2}
					60 *c* = 32 19·745	τ = — 529^{0}
	t	8·90		8·66		δ = — 526^{5}
	a	6·0 — 5·8		4·7 — 4·4		S_{83} = 0·5056054
	Bar.			758·0 16°.5		

Pendulum	No. of Coincidence	Time of Coincidence	No. of Coincidence	Time of Coincidence	Observed Duration of Coincidences	Calculation of Period
33	Bar.					Bar. = 755·7
	t	8·40		8·36		*t* = 8·38 = 11°.13
	a	8·0 — 8·3		6·2 — 6·4		*a* = 7·03
		h m s		*h m s*	*m s*	
	1	7 12 11·4	61	7 44 34·0	60 *c* = 32 22·6	*c* = 32*s*.3763
	2	12 44·0	62	45 6·8	22·8	2 *c*—1 = 63·7526
	3	13 16·1	63	45 38·6	22·5	
	4	13 48·7	64	46 11·3	22·6	log *c* = 1·5102272
	5	14 21·0	65	46 43·4	22·4	log (2 *c*—1) = 1·8044979
	6	14 53·5	66	47 16·0	22·5	9·7057293
	7	15 25·3	67	47 48·2	22·9	log 1*s* Haw. = — 18364
	8	»	68	48 20·9	»	log *S* = 9·7038929
	9	»	69	48 53·0	»	
	10	17 2·9	70	49 25·4	22·5	*S* = 0·5056999
	11	17 35·2	71	49 57·6	22·4	α = — 8^{9}
					60 *c* = 32 22·578	τ = — 491^{9}
	t	8·44		8·32		δ = — 527^{9}
	a	7·9 — 7·6		5·8 — 6·0		S_{83} = 0·5055970
	Bar.			757·25 16°.0		

Pendulum	No. of Coincidence	Time of Coincidence	No. of Coincidence	Time of Coincidence	Observed Duration of Coincidences	Calculation of Period
33	t	8·14		8·17		Bar. = 755·5
	a	8·7 — 9·0		6·8 — 6·5		t = 7·16 = 10°.69
		h m s		h m s	m s	a = 7·5
	1	8 28 38·0	61	9 1 1·0	60 c = 32 23·0	
	2	29 10·0	62	1 33·0	23·9	c = 32^s.3765
	3	29 42·9	63	2 5·8	22·9	$2c-1$ = 63·7530
	4	30 14·9	64	2 37·7	22·8	
	5	30 47·8	65	3 10·2	22·4	log c = 1·5102299
	6	31 19·6	66	3 42·1	22·5	log $(2c-1)$ = 1·8045006
	7	31 52·3	67	4 14·8	22·5	9·7057293
	8	32 24·4	68	4 46·7	22·3	log 1^s Haw. = — 18364
	9	32 57·1	69	5 19·4	22·3	log S = 9·7038929
	10	33 29·1	70	5 51·4	22·3	
	11	34 1·9	71	6 24·4	22·5	S = 0·5056999
					60 c = 32 22·591	α = — 10^1
	t	8·17		8 16		τ = — 472^5
	a	8·4 — 8·1		6·1 — 6·4		δ = — 528^5
						S_{33} = 0·5055988

Pendulum	No. of Coincidence	Time of Coincidence	No. of Coincidence	Time of Coincidence	Observed Duration of Coincidences	Calculation of Period
33	t	8·08		7·95		Bar. = 755·6
	a	6·0 — 6·3		4·8 — 4·5		t = 8·00 = 10°.36
		h m s		h m s	m s	a = 5·23
	1	9 28 6·3	61	10 0 28·0	60 c = 32 21·7	
	2	»	62	1 0·5	»	c = 32^s.3493
	3	29 11·1	63	1 32·6	21·5	$2c-1$ = 63·6986
	4	29 43·9	64	2 5·3	21·4	
	5	30 15·9	65	2 37·0	21·1	log c = 1·5098649
	6	30 48·9	66	3 10·0	21·1	log $(2c-1)$ = 1·8041299
	7	31 20·8	67	3 41·5	20·7	9·7057350
	8	31 53·6	68	4 14·3	20·7	log 1^s Haw. = — 18364
	9	32 25·6	69	4 46·0	20·4	log S = 9·7038986
	10	32 58·2	70	5 19·0	20·8	
	11	33 30·4	71	5 50·6	20·2	S = 0·5057066
					60 c = 32 20·96	α = — 4^9
	t	8·06		7·90		τ = — 458^3
	a	5·9 — 5·6		4·9 — 4·2		δ = — 529^1
						S_{33} = 0·5056074[1]

Hawelk 10^h 17^m 15°.0 Bar. 757·3 = 755·6

[1] In the middle of this observation, two men turned out and walked softly across the floor, causing a movement in the level as they passed near the apparatus. To this observation, therefore, only half the weight can be given as compared with the other 3.

Pendulum	No. of Coincidence	Time of Coincidence	No. of Coincidence	Time of Coincidence	Observed Duration of Coincidences	Calculation of Period

The Saloon of the Fram.

Night of November 22, 1895.

Comparison of Clocks.

Hawelk	Hohwü	Hawelk	Hohwü	
h m s	*h m s*	*h m s*	*h m s*	Hohwü's rate in 24^h
7 42 59	9 6 5	11 40 54	1 3 1	$-0^s.41$
45 8	8 13·5	42 55	5 1·4	
7 44 3·5	9 7 9·25	11 41 54·5	1 4 1·25	

log 1^s Hawelk = —0·0017971

Distance l = 2268 mm., thermometer 23, barometer Adie 763.

34	Bar.	771·15 16°.2				Bar. = 769·2
	t	7·96		7·75		t = 7·84 = 10°.05
	a	5·1 — 5·1		4·0 — 3·9		a = 4·43
		h m s		*h m s*	*m s*	
	1	8 10 54·6	61	8 42 29·6 ?	60 c = 31 ?	$c = 31^s.5707$
	2	11 26·6	62	43 0·8	34·2	$2c-1$ = 62·1414
	3	11 58·1	63	43 32·2	34·1	
	4	12 29·8	64	44 4·2	34·4	log c = 1·4992842
	5	13 1·0	65	44 35·4	34·4	log $(2c-1)$ = 1·7933810
	6	13 32·8	66	45 7·4	34·6	log S = 9·7059032
	7	14 4·4	67	45 38·6	34·2	log 1^s Haw. = — 17971
	8	14 36·2	68	46 10·7	34·5	log S = 9·7041061
	9	15 7·7	69	46 41·6	33·9	
	10	15 39·5	70	47 13·6	34·1	S = 0·5059483
	11	16 10·8	71	47 44·8	34·0	α = — 2^7
					60 c = 31 34·24	τ = — 444^7
	t	7·96		7·70		δ = — 539^3
	a	4·9 — 4·9		3·7 — 3·8		S_{34} = 0·5057496

Pendulum	No. of Coincidence	Time of Coincidence	No. of Coincidence	Time of Coincidence	Observed Duration of Coincidences	Calculation of Period
34	t	7·47		7·25		Bar. = 769·2
	a	7·1 — 7·0		5·4 — 5·3		t = 7·34 = 9°.15
		h m s		h m s	m s	a = 6·03
	1	9 16 55·8	61	9 48 29·5	60 c = 31 33·7	
	2	17 27·1	62	49 0·2	33·1	c = 31^s.555
	3	17 58·8	63	49 32·6	33·8	2 c—1 = 62·11
	4	18 30·2	64	50 3·4	33·2	
	5	19 2·0	65	50 35·6	33·6	log c = 1·4990682
	6	19 33·3	66	51 6·5	33·2	log (2 c—1) = 1·7931615
	7	20 5·1	67	51 38·6	33·5	9·7059067
	8	20 36·6	68	52 9·6	33·0	log 1^s Haw. = — 17971
	9	21 8·5	69	52 41·6	33·1	log S = 9·7041096
	10	21 39·9	70	53 12·8	32·9	
	11	22 11·7	71	53 44·9	33·2	S = 0·5059523
					60 c = 31 33·3	α = — 5^1
	t	7·41		7·21		τ = — 400^4
	a	6·7 — 6·6		5·1 — 5·0		δ = — 541^0
						S_{34} = 0·5058577

Pendulum	No. of Coincidence	Time of Coincidence	No. of Coincidence	Time of Coincidence	Observed Duration of Coincidences	Calculation of Period
34	t	7·06		6·91		Bar. = 769·2
	a	6·9 — 6·8		5·3 — 5·2		t = 6·96 = 8°.29
		h m s		h m s	m s	a = 5·83
	1	10 19 38·2	61	10 51 13·4	60 c = 31 35·2	
	2	20 10·0	62	51 45·3	35·3	c = 31^s.5897
	3	20 41·4	63	52 16·4	35·0	2 c—1 = 62·1794
	4	21 13·0	64	52 48·5	35·5	
	5	21 44·7	65	53 19·7	35·0	log c = 1·4995455
	6	22 16·6	66	53 51·9	35·3	log (2 c—1) = 1·7936465
	7	22 48·0	67	54 23·0	35·0	9·7058990
	8	23 18·8	68	54 55·0	36·2	log 1^s Haw. = — 17971
	9	23 50·9	69	55 26·3	35·4	log S = 9·7041019
	10	24 22·6	70	55 58·5	35·9	
	11	24 54·1	71	56 29·5	35·4	S = 0·5059434
					60 c = 31 35·382	α = — 4^7
	t	7·02		6·83		τ = — 366^6
	a	6·4 — 6·3		3·8 — 4·9		δ = — 542^6
	Bar.			770·9 15°.0		S_{34} = 0·5058520

The Saloon of the Fram.

Night of January 15, 1896.

Comparison of Clocks.

Hawelk	Hohwü	Hawelk	Hohwü	
h m s	*h m s*	*h m s*	*h m s*	
11 22 49	10 41 51	2 30 0	1 48 15	Hohwü's rate in 24^h
24 39	43 40·5	31 55	50 9·5	$-0^s.33$
11 23 44	10 42 45·75	2 30 57·5	1 49 12·25	

log 1^s Hawelk = — 0·0018192

Distance l = 1932 mm., thermometer 23, barometer Adie 763.

	h m		
Hawelk	11 45	15°.3	Bar. 762·1 = 760·4
—	2 45	14°.9	— 763·3 = 761·6

Pendulum	No. of Coincidence	Time of Coincidence	No. of Coincidence	Time of Coincidence	No. of Coincidence	Time of Coincidence	Observed Duration of Coincidences	Calculation of Period
33	t	7·60		7·70		7·75		Bar. = 760·5
	a	5·2 — 5·1		4·5 — 4·5		3·8 — 4·0		$t = 7·70 = 9°.78$
		h m s		*h m s*		*h m s*	*m s*	$a = 4·36$
	1	11 49 2·9	31	0 5 16·4	61	0 21 31·3	$60c$ = 32 28·4	
	2	»	32	5 48·0	62	22 2·9	»	$c = 32^s.4732$
	3	50 7·9	33	6 21·2 ?	63	22 36·4	28·5	$2c—1 = 63·9464$
	4	50 40·0	34	6 53·0	64	23 8·0	28·0	
	5	51 12·9	35	7 26·0	65	23 41·6	28·7	$\log c = 1·5115251$
	6	51 44·6	36	7 58·0	66	24 13·0	28·4	$\log (2c—1) = 1·8058161$
	7	52 17·7	37	8 30·9	67	24 46·0	28·3	9·7057090
	8	52 49·5	38	9 2·9	68	25 18·0	28·5	log 1^s Haw. = — 18192
	9	53 22·6	39	9 36·1	69	25 51·2	28·6	$\log S = 9·7038898$
	10	53 54·5	40	10 7·9	70	26 22·7	28·2	
	11	54 27·7	41	10 41·0	71	26 56·0	28·3	$S = 0·5056963$
							$60c$ = 32 28·39	$\alpha = — 3^7$
	t	7·66		7·72		7·80		$\tau = — 432^3$
	a	4·9 — 4·8		4·2 — 4·0		3·8 — 3·5		$\delta = — 533^4$
								$S_{33} = 0·5055994$

Pendulum	No. of Coincidence	Time of Coincidence	No. of Coincidence	Time of Coincidence	Observed Duration of Coincidences	Calculation of Period
33	*t*	7·81		7·85		Bar. = 761·0
	a	5·0 — 5·0		3·9 — 3·7		$t = 7·84 = 10°.04$
		h m s		*h m s*	*m s*	$a = 4·3$
	1	0 56 26·9	61	1 28 55·6	60 *c* = 32 28·7	
	2	57 0·0	62	29 29·6	29·6	$c = 32^s.485$
	3	57 32·0	63	»	»	$2c-1 = 63·970$
	4	58 5·0	64	30 34·7	29·7	
	5	58 36·9	65	31 5·6	28·7	$\log c = 1·5116829$
	6	59 10·0	66	31 39·6	29·6	$\log(2c-1) = 1·8059764$
	7	59 41·9	67	32 10·6	28·7	9·7057065
	8	0 14·9	68	32 44·5	29·6	$\log 1^s$ Haw. = — 18192
	9	0 47·0	69	33 15·5	28·5	$\log S = 9·7038873$
	10	1 20·0	70	33 49·0	29·0	
	11	1 51·7	71	34 20·6	28·9	$S = 0·5056934$
					60 *c* = 32 29·1	$\alpha = -\ 3^5$
	t	7·83		7·85		$\tau = -\ 444^0$
	a	4·7 — 4·8		3·4 — 3·8		$\delta = -\ 534^0$
						$S_{33} = 0·5055952$

Pendulum	No. of Coincidence	Time of Coincidence	No. of Coincidence	Time of Coincidence	Observed Duration of Coincidences	Calculation of Period
33	*t*	7·85		7·84		Bar. = 761·3
	a	5·0 — 5·0		3·7 — 3·8		$t = 7·85 = 10°.06$
		h m s		*h m s*	*m s*	$a = 4·25$
	1	1 48 48·4	61	2 21 17·0	60 *c* = 32 28·6	
	2	49 20·7	62	21 49·6	28·9	$c = 32^s.4842$
	3	49 53·4	63	22 22·0	28·6	$2c-1 = 63·9684$
	4	50 25·6	64	22 54·5	28·9	
	5	50 58·1	65	23 27·1	29·0	$\log c = 1·5116722$
	6	51 30·4	66	23 59·6	29·2	$\log(2c-1) = 1·8059655$
	7	52 3·0	67	24 32·0	29·0	9·7057067
	8	52 35·1	68	25 4·6	29·5	$\log 1^s$ Haw. = — 18192
	9	53 8·0	69	25 37·1	29·1	$\log S = 9·7038875$
	10	53 40·1	70	26 9·5	29·4	
	11	54 12·6	71	26 42·0	29·4	$S = 0·5056936$
					60 *c* = 32 29·055	$\alpha = -\ 3^5$
	t	7·85		7·84		$\tau = -\ 444^9$
	a	4·7 — 4·6		3·6 — 3·6		$\delta = -\ 534^3$
						$S_{33} = 0·5055953$

Pendulum	No. of Coincidence	Time of Coincidence	No. of Coincidence	Time of Coincidence	Observed Duration of Coincidences	Calculation of Period

The Saloon of the Fram.

Night of April 28, 1896.

Comparison of Clocks.

Hawelk	Hohwü	Hawelk	Hohwü
h m s	h m s	h m s	h m s
3 26 23	1 35 53	7 46 11	6 44 20
38 19	37 48·5	48 9	46 17·5
2 37 21	1 36 50·75	7 47 10	6 45 18·75

Hohwü's rate in 24^h
$-0^s.49$

log 1^s Hawelk = — 0018940

Distance l = 2130 mm., thermometer 23, barometer Adie 763.

	h m		
Hawelk	2 45	16°.1	Bar. 761·8 = 759·9
—	4 47	16°.9	» 62·5 = 60·5
Hohwü	7 40	16°.7	» 63·5 = 61·5

Pendulum	No. of Coincidence	Time of Coincidence	No. of Coincidence	Time of Coincidence	Observed Duration of Coincidences	Calculation of Period
34	t	8·70		8·77		Bar. = 760·0
	a	5·4 — 5·4		4·4 — 4·5		t = 8·75 = 11°.86
		h m s		h m s		a = 4·74
	1	2 55 16·9	41	3 16 »	m s	
	2	55 47·6	42	16 32·2	40 c = 20 44·6	c = $31^s.0988$
	3	56 19·1	43	17 2·9	43·8	$2c-1$ = 61·1976
	4	56 50·2	44	17 34·5	44·3	
	5	57 21·6	45	18 4·9	43·3	log c = 1·4927436
	6	57 52·4	46	18 36·6	44·2	log $(2c-1)$ = 1·7867344
	7	58 23·6	47	19 7·0	43·4	9·7060092
	8	58 54·4	48	19 38·9	44·5	log 1^s Haw. = — 18940
	9	59 25·8	49	20 9·3	43·5	log S = 9·7041152
	10	59 56·4	50	20 40·8	44·4	
	11	0 27·9	51	21 11·4	43·5	S = 0·5059588
					40 c = 20 43·95	α = — 3^5
	t	8·74		8·79		τ = — 524^4
	a	5·0 — 5·0		4·0 — 4·2		δ = — 529^5
						S_{34} = 0·5058531

Pendulum	No. of Coincidence	Time of Coincidence	No. of Coincidence	Time of Coincidence	Observed Duration of Coincidences	Calculation of Period
34	t	8·81		8·84		Bar. = 760·3
	a	5·6 — 5·6		4·8 — 4·8		t = 8·83 = 12°.02
		h m s		h m s	m s	a = 5·03
	1	3 42 34·9	41	4 3 18·7	40 c = 20 43·8	
	2	43 6·0	42	3 49·6	43·6	c = 31s.0934
	3	43 36·9	43	4 20·6	43·7	2 c—1 = 61·1868
	4	44 8·1	44	4 51·8	43·7	
	5	44 39·1	45	5 23·0	43·9	log c = 1·4926682
	6	45 10·4	46	5 54·0	43·6	log (2 c—1) = 1·7866578
	7	45 41·3	47	6 25·0	43·7	9·7060104
	8	46 12·5	48	6 56·2	43·7	log 1s Haw. = — 18940
	9	46 43·4	49	7 27·3	43·9	log S = 9·7041164
	10	47 14·6	50	7 58·3	43·7	
	11	47 45·6	51	8 29·4	43·8	S = 0·5059602
					40 c = 20 43·736	α = — 4^{0}
	t	8·83		8·84		τ = — 531^{4}
	a	5·2 — 5·2		4·5 — 4·5		δ = — 529^{4}
						S_{34} = 0·5058537

Pendulum	No. of Coincidence	Time of Coincidence	No. of Coincidence	Time of Coincidence	Observed Duration of Coincidences	Calculation of Period
34	t			8·86		Bar. = 760·6
	a			5·0 — 4·9		t = 8·86 = 12°.08
		h m s		h m s	m s	a = 5·25
	1	5 3 13·0	41	5 23 54·3	40 c = 20 41·3	
	2	3 44·0	42	24 25·6	41·6	c = 31s.0361
	3	4 14·9	43	24 56·2	41·3	2 c—1 = 61·0722
	4	4 46·3	44	25 27·9	41·6	
	5	5 17·1	45	25 58·4	41·3	log c = 1·4918671
	6	5 48·4	46	26 30·0	41·6	log (2 c—1) = 1·7858435
	7	6 19·2	47	27 0·5	41·3	9·7060236
	8	6 50·4	48	27 32·0	41·6	log 1s Haw. = — 18940
	9	7 21·3	49	28 2·7	41·4	log S = 9·7041296
	10	7 52·8	50	28 24·3	41·5	
	11	8 23·6	51	29 5·0	41·4	S = 0·5059756
					40 c = 20 41·445	α = — 4^{3}
	t	8·86		8·85		τ = — 533^{8}
	a	5·5 — 5·6		4·8 — 4·7		δ = — 529^{6}
						S_{34} = 0·5058688

Pendulum	No. of Coincidence	Time of Coincidence	No. of Coincidence	Time of Coincidence	Observed Duration of Coincidences	Calculation of Period

Remounted. Distance l = 2110 mm.

33	t	8·77		8·79		Bar. = 760·9
	a	9·5 — 9·5		7·3 — 7·8		t = 8·78 = 11°.92
		h m s		h m s	m s	a = 8·2
	1	6 13 53·0	41	6 » »	40 c = 21 »	
	2	14 26·0	42	35 46·7	20·7	c = 32^s.0175
	3	14 57·6	43	36 18·0	20·4	2 c—1 = 63·035
	4	15 29·9	44	36 50·3	20·4	
	5	16 1·3	45	37 22·3	21·0	log c = 1·5053874
	6	16 34·0	46	37 54·2	20·2	log (2 c—1) = 1·7995818
	7	17 5·3	47	38 26·5	21·2	9·7058056
	8	17 38·0	48	38 58·4 [1]	20·4	log 1^s Haw. = — 18940
	9	18 9·3	49	39 30·3 [1]	21·0	log S = 9·7039116
	10	18 42·0	50	40 2·6 [1]	20·6	
	11	19 13·4	51	40 34·5 [1]	21·1	S = 0·5057217
					40 c = 21 20·70	α = — 10^8
	t	8·79		8·78		τ = — 527^3
	a	8·5 — 8·9		6·9 — 7·3		δ = — 530^0
						S_{33} = 0·5056149

33	t	8·78		8·74		Bar. = 761·1
	a	6·6 — 6·6		5·4 — 5·5		t = 8·75 = 11°.86
		h m s		h m s	m s	a = 5·83
	1	7 5 38·0	41	7 26 59·0	40 c = 21 21·0	
	2	6 10·0	42	27 30·9	20·9	c = 32^s.0241
	3	6 42·1	43	28 3·1	21·0	2 c—1 = 63·0482
	4	7 14·1	44	28 34·9	20·8	
	5	7 46·3	45	29 7·2	20·9	log c = 1·5054770
	6	8 18·1	46	29 39·0 (38·9)	20·9	log (2 c—1) = 1·7996727
	7	8 50·2	47	30 11·2	21·0	9·7058043
	8	9 22·1	48	30 43·0	20·9	log 1^s Haw. = — 18940
	9	9 54·4	49	31 15·3	20·9	log S = 9·7039103
	10	10 26·0	50	31 47·2	21·2	
	11	10 58·3	51	32 19·4	21·1	S = 0·5057202
					40 c = 21 20·964	α = — 5^4
	t	8·76		8·73		τ = — 524^6
	a	6·2 — 6·1		5·2 — 5·0		δ = — 530^3
						S_{33} = 0·5056142

[1] These 4 observations are entered as bad, but as they give the same result as the others, they are included in the calculation.

The Saloon of the Fram.

Night of April 29, 1896.

Comparison of Clocks.

Hawelk	Hohwü	Hawelk	Hohwü
h m s	*h m s*	*h m s*	*h m s*
1 36 14	0 35 48	7 10 33	6 8 41
38 19	37 52·5	12 30	10 37·5
40 23	39 56	14 27	12 34
1 38 18·33	0 37 52·17	7 12 30	6 10 37·5

Hohwü's rate in 24^h
$-0^s.49$

log 1^s Hawelk = —0·0018641

	h m			Barometer Adie 763
Hohwü	0 12 Midnight	°		766·0
Hawelk	4 8	16·9	768·8 =	766·8
—	4 43	16·4	68·9 =	66·9
—	6 42	16·8	69·6 =	67·6

Distance l = 2160 mm., thermometer 23.

Pendulum	No. of Coincidence	Time of Coincidence	No. of Coincidence	Time of Coincidence	Observed Duration of Coincidences	Calculation of Period
33	t	8·90		9·00		Bar. = 766·2
	a	6·0 — 6·0		4·8 — 5·0		t = 8·96 = 12°.27
		h m s		*h m s*	*m s*	a = 5·23
	1	1 59 13·9	41	2 20 40·5	40 c = 21 26·6	
	2	59 46·5	42	21 13·6	27·1	c = $32^s.1768$
	3	0 18·1	43	21 45·0	26·9	$2c-1$ = 63·3536
	4	0 50·6	44	22 18·0	27·4	log c = 1·5075429
	5	1 22·4	45	22 49·4	27·0	log $(2c-1)$ = 1·8017713
	6	1 55·0	46	23 22·3	27·3	9·7057716
	7	2 26·8	47	23 53·9	27·1	log 1^s Haw. = — 18641
	8	2 59·6	48	24 26·8	27·2	
	9	3 31·1	29	24 58·2	27·1	log S = 9·7039075
	10	4 4·0	50	25 31·1	27·1	
	11	4 35·6	51	26 2·6	27·0	S = 0·5057170
					40 c = 21 27·073	α = — 4^{1}
	t	8·95		8·99		τ = — 542^{7}
	a	5·5 — 5·7		4·8 — 4·4		δ = — 533^{1}
						S_{88} = 0·5056090

Pendulum	No. of Coincidence	Time of Coincidence	No. of Coincidence	Time of Coincidence	Observed Duration of Coincidences	Calculation of Period
33	t	8·70		8·84		Bar. = 766·6
	a	6·4 — 6·4		5·2 — 5·2		t = 8·80 = 11°.95
		h m s		h m s	m s	a = 5·6
	1	3 1 19·6	41	3 22 47·6	40 c = 21 28·0	c = 32^s.2027
	2	1 51·8	42	23 19·7	27·9	2c—1 = 63·4054
	3	2 24·1	43	23 51·9	27·8	
	4	2 56·2	44	24 24·2	28·0	log c = 1·5078923
	5	3 28·3	45	24 56·4	28·1	log (2c—1) = 1·8021263
	6	4 0·5	46	25 28·5	28·0	9·7057660
	7	4 32·6	47	26 0·6	28·0	log 1^s Haw. = — 18641
	8	5 4·6	48	26 33·0	28·4	log S = 9·7039019
	9	5 36·9	49	27 5·1	28·2	
	10	6 9·0	50	27 37·5	28·5	S = 0·5057105
	11	6 41·1	51	28 9·4	28·3	α = — 4^{8}
					40 c = 21 28·109	τ = — 528^{3}
	t	8·80		8·84		δ = — 533^{9}
	a	5·9 — 5·9		4·9 — 4·9		S_{33} = 0·5056038

Pendulum	No. of Coincidence	Time of Coincidence	No. of Coincidence	Time of Coincidence	Observed Duration of Coincidences	Calculation of Period
33	t	8·84		8·81		Bar. = 766·7
	a	4·9 — 4·9		4·1 — 4·0		t = 8·83 = 12°.01
		h m s		h m s	m s	a = 4·3
	1	3 38 50·7	41	4 0 15·7	40 c = 21 25·0	c = 32^s.1366
	2	39 22·4	42	0 48·0	25·6	2c—1 = 63·2732
	3	39 54·9	43	1 20·0	25·1	
	4	40 26·7	44	1 52·3	25·6	log c = 1·5069999
	5	40 59·0	45	2 24·4	25·4	log (2c—1) = 1·8012198
	6	41 30·9	46	2 56·6	25·7	9·7057801
	7	42 3·1	47	3 28·6	25·5	log 1^s Haw. = — 18641
	8	42 35·1	48	4 0·9	25·8	log S = 9·7039160
	9	43 7·6	49	4 33·0	25·4	
	10	43 39·4	50	5 5·0	25·6	S = 0·5057269
	11	44 11·9	51	5 37·3	25·4	α = — 2^{8}
					40 c = 21 25·464	τ = — 531^{1}
	t	8·84		8·81		δ = — 534^{1}
	a	4·5 — 4·5		3·8 — 3·9		S_{33} = 0·5056201

Pendulum	No. of Coincidence	Time of Coincidence	No. of Coincidence	Time of Coincidence	Observed Duration of Coincidences	Calculation of Period
33	*t*	8·79		8·74		Bar. = 766·8
	a	5·7 — 5·8		4·7 — 4·8		t = 8·76 = 11°.88
		h m s		*h m s*	*m s*	a = 5·07
	1	4 13 18·0	41	4 34 45·0	40 c = 21 27·0	c = 32^s.1684
	2	13 49·9	42	35 16·9	27·0	2 c—1 = 63·3368
	3	14 22·3	43	35 49·2	26·9	
	4	14 54·6	44	36 21·1	26·5	log c = 1·5074295
	5	15 26·6	45	36 53·4	26·8	log (2 c—1) = 1·8016561
	6	15 58·6	46	37 25·5	26·9	9·7057734
	7	16 31·0	47	37 57·7	26·7	log 1^s Haw. = — 18641
	8	17 3·1	48	38 29·8	26·7	log S = 9·7039093
	9	17 35·4	49	39 2·0	26·6	
	10	18 7·6	50	39 34·1	26·5	S = 0·5057191
	11	18 39·7	51	40 6·2	26·5	α = — 3^{9}
					40 c = 21 26·736	τ = — 525^{1}
	t	8·78		8·72		δ = — 534^{3}
	a	5·3 — 5·4		4·4 — 4·5		S_{33} = 0·5056128

Distance l = 2145 mm.

Pendulum	No. of Coincidence	Time of Coincidence	No. of Coincidence	Time of Coincidence	Observed Duration of Coincidences	Calculation of Period
34	*t*	8·54		8·62		Bar. = 767·1
	a	5·8 — 5·7		4·8 — 4·9		t = 8·59 = 11°.55
		h m s		*h m s*	*m s*	a = 5·1
	1	5 8 25·5	41	5 29 13·5	40 c = 20 48·0	c = 31^s.1997
	2	8 56·6	42	29 44·7	48·1	2 c—1 = 61·3994
	3	9 28·0	43	30 »	»	
	4	9 59·2	44	30 47·1	47·9	log c = 1·4941504
	5	10 30·3	45	31 18·3	48·0	log(2 c—1) = 1·7881641
	6	11 1·6	46	31 49·4	47·8	9·7059863
	7	11 32·7	47	32 20·8	48·1	log 1^sHaw. = — 18641
	8	12 3·7	48	32 51·9	48·2	log S = 9·7041222
	9	12 35·2	49	33 23·0	47·8	
	10	13 6·2	50	33 54·2	48·0	S = 0·5059670
	11	13 37·4	51	34 25·4	48·0	α = — 4^{0}
					40 c = 20 47·99	τ = — 510^{6}
	t	8·58		8·63		δ = — 535^{1}
	a	5·2 — 5·3		4·5 — 4·6		S_{34} = 0·5058620

Pendulum	No. of Coincidence	Time of Coincidence	No. of Coincidence	Time of Coincidence	Observed Duration of Coincidences.	Calculation of Period
34	t	8·63		8·63		Bar. = 767·3
	a	7·9 — 7·8		6·5 — 6·5		t = 8·62 = 11°.60
		h m s		h m s	m s	a = 6·93
	1	5 40 56·2	41	6 1 43·6	40 c = 20 47·4	c = $31^{s}.1916$
	2	41 27·4	42	2 14·8	47·4	$2c-1$ = 61·3832
	3	41 58·4	43	2 46·0	47·6	
	4	42 29·6	44	3 17·3	47·7	log c = 1·4940376
	5	43 0·7	45	3 48·5	47·8	log $(2c-1)$ = 1·7880495
	6	43 31·9	46	4 19·5	47·6	9·7059881
	7	44 3·0	47	4 50·8	47·8	log 1^{s} Haw. = — 18641
	8	44 34·4	48	5 22·0	47·6	log S = 9·7041240
	9	45 5·4	49	5 53·2	47·8	
	10	45 36·6	50	6 24·4	47·8	S = 0·5059691
	11	46 7·8	51	6 55·6	47·8	α = — 7^{4}
					40 c = 20 47·664	τ = — 513^{1}
	t	8·62		8·60		δ = — 535^{1}
	a	7·3 — 7·2		6·1 — 6·1		S_{34} = 0·5058635

Pendulum	No. of Coincidence	Time of Coincidence	No. of Coincidence	Time of Coincidence	Observed Duration of Coincidences.	Calculation of Period
34	t	8·59		8·63		Bar. = 767·5
	a	7·0 — 7·0		6·0 — 6·0		t = 8·62 = 11°.59
		h m s		h m s	m s	a = 6·3
	1	6 13 4·6	41	6 33 54·0	40 c = 20 49·4	c = $31^{s}.2307$
	2	13 35·8	42	34 25·2	49·4	$2c-1$ = 61·4614
	3	14 7·0	43	34 56·2	49·2	
	4	14 38·3	44	35 27·5	49·2	log c = 1·4945817
	5	15 9·5	45	35 58·6	49·1	log $(2c-1)$ = 1·7886024
	6	15 40·8	46	36 30·0	49·2	9·7059793
	7	16 12·1	47	37 1·2	49·1	log 1^{s} Haw. = — 18641
	8	16 43·2	48	37 32·4	49·2	log S = 9·7041152
	9	17 14·4	49	38 3·5	49·1	
	10	17 45·6	50	38 35·0	49·4	S = 0·5059588
	11	18 16·8	51	39 6·0	49·2	α = — 6^{1}
					40 c = 20 49·227	τ = — 512^{6}
	t	8·61		8·63		δ = — 535^{3}
	a	6·5 — 6·5		5·7 — 5·7		S_{34} = 0·5058534

According to the above, the following periods of oscillation for the pendulums have been found for the various places:

	Pendulum 33	Pendulum 34
	Vienna, 1892	
	0·5061974	0·5064405
	1970	4429
	1967	4399
Mean	0·5061970	0·5064411
	Christiania, 1892	
	0·5059150	0·5061620
	9194	1585
		1667
Mean	0·5059172	0·5061624 [1]
	Christiania, 1893	
	0·5059202	0·5061625
	9138	1641
Mean	0·5059170	0·5061633 [1]

	Pendulum 33	Pendulum 34
	Christiania, 1897	
	0·5059202	0·5061611
	9143	1578
	9159	1613
	9190	1618
Mean	0·5059174	0·5061605
	Khabarova, 1893	
	0·5057519	0·5059884
	7547 (½)	9760 [2]
Mean	0·5057528	0·5059884
	January 16, 1894	
	0·5056609	
	6592	
Mean	0·5056601	

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[1] O. E. Schiøtz, „*Resultate der im Sommer 1893 in dem nordlichsten Theile Norwegens ausgeführten Pendelbeobachtungen*", etc. (Kristiania, J. Dybwad, 1894), p. 7. these periods of oscillation are given as,

In 1892, 0·5059169 and 0·5061591;
» 1893, 9164 » 1618.

The difference chiefly arises from my having chanced, in the previous calculation, to use a slightly incorrect reduction-formula for the thermometer 20 that was used, and from not having taken into consideration the fact that from 1892 to 1893, the zero had risen 0°.1. With regard to pendulum 34, moreover, an error had found its way, in 1892, into the time determination, which had previously been overlooked.

[2] During the experiments with pendulum 34, the temperature of the air rose with remarkable rapidity. The correction for the temperature is therefore presumably too great, as the pendulum has not kept pace with the rise in the temperature. Both the values found for the period of oscillation appear small in proportion to that of pendulum 33, especially as regards the second value, which I have therefore thought it best to leave out of consideration.

	Pendulum 33	Pendulum 34
	March 16, 1894	
	0·5056383	
	6392	
	6430	
Mean	0·5056402	
	June 8, 1895	
		0·5058560
	June 10, 1895	
	0 5056139 [1]	0·5058425
	5948	8438
Mean	0·5055948	0·5058432
	June 11, 1895	
	0·5055857	0·5058282
	5853	8183
	5766 (½)	8290
Mean	0·5055837	0·5058252
	November 14, 1895	
	0·5056054	
	5970	
	5988	
	6074 (½)	
Mean	0·5056014	

	Pendulum 33	Pendulum 34
	November 23, 1895	
		0·5058496
		8577
		8520
Mean		0·5058531
	January 16, 1896	
	0·5055994	
	5952	
	5953	
Mean	0·5955966	
	April 29, 1896	
	0·5056149	0·5058531
	6142	8537
		8688
Mean	0·5056146	0·5058585
	April 30, 1896	
	0·5056090	0·5058620
	6038	8635
	6201	8534
	6128	
Mean	0·5056114	0·5058596

The observations to which (½) is appended have been accorded half the weight given to the others.

[1] This value is far too high in comparison with the other determinations made on the same day. I have therefore left it out of consideration.

The observations taken thus give the following mean value for the periods of the pendulums:

Station	Date	Pendulum 33	Pendulum 34	Mean
Vienna, Türkenschanze.	May 27, 28, 1892	0·5061970	0·5064411	0·5063191
Christiania, Observatory	July 21 – 25, 1892	0·5059172	0·5061624	0·5060398
Christiania, Observatory	June 11, 1893	0·5059170	0·5061633	0·5060402
Christiania, Pendulum-house	May 30, June 13, 1897	0·5059174	0·5061605	0·5060389
Khabarova	July 30, 1893	0·5057528	0·5059884	0·5058721
79° 15′.2 N. Lat. 137° 28′ E. Long.	January 16, 1894	0·5056601		
79° 38′.5 » » 135° 10′ » »	March 16, 1894	0·5056402		
84° 34′.1 » » 84° 25′.3 » »	June 8, 1895		0·5058560	
84° 42′.4 » » 83° 14′ » »	June 10, 1895	0·5055948	0·5058432	0·5057190
84° 44′.7 » » 83° 0′.5 » »	June 11, 1895	0·5055837	0·5058252	0·5057045
85° 55′.3 » » 66° 48′ » »	November 14, 1895	0·5056014		
85° 47′.7 » » 64° 1′ » »	November 23, 1895		0·5058531	
84° 51′.9 » » 40° 43′.6 » »	January 16, 1896	0·5055966		
84° 14′.7 » » 12° 21′.6 » »	April 29, 1896	0·5056146	0·5058585	0·5057365
84° 12′.4 » » 12° 14′.7 » »	April 30, 1896	0·5056114	0·5058596	0·5057355

If we take the difference between the periods of the two pendulums, we obtain:

From the observations in Vienna, 1892, $S_{34} - S_{33} = 2441 \times 10^{-7}$
—»— » Christiania, 1892, » » » $= 2452$ »
—»— » — 1893, » » » $= 2463$ »
—»— » — 1897, » » » $= 2431$ » ,
or as a mean » » » $= 2447$ »

The following are the results of the observations made during the expedition:

The observations of June 10, 1895, $S_{34} - S_{33} = 2484 \times 10^{-7}$
—»— » » 11, 1895, » » » $= 2415$ »
—»— » April 29, 1896, » » » $= 2439$ »
—»— » » 30, 1896, » » » $= 2482$ » ,

these values agreeing satisfactorily with the above-determined mean values. If the two observations made with separate pendulums on the 14th and 23rd November, are reduced to the same latitude, they will give a difference of 2513×10^{-7}, a value which is not too far removed from the above mean.

At Khabarova, where the observations as a whole were not so successful, the period for pendulum 34, as has been already mentioned, was found too small, on account of the rapid rise in the temperature during the experiments. Even with the highest value, which is the only one retained above, the difference in question is only 2356×10^{-7}. For this reason, I have thought it best to give the period of oscillation for pendulum 34, half the weight of that for pendulum 33. If we suppose, moreover, that the difference between the periods of oscillation is 2447×10^{-7}, we find the mean period of oscillation of the two pendulums to be 0·5058721, the value given in the table.

What distinguishes the above observations of the Fram expedition from others that have hitherto been made, is that they have been made upon the open sea, over depths of water of more than 2000 metres. They were rendered possible by the fact that the vessel was frozen into the sea-ice, and drifted with it. The great pressure, however, to which the ship was exposed, even in the middle of winter, shows that this mass of ice cannot be regarded at all times as one coherent layer, drifting along with one motion for the whole. The various parts of the ice-covering may be moving at variance with one another, and this movement may be carried so far as to cause the ice-covering to burst at such places where the compression or distention becomes too great. If this be the case, it is to be feared that even if the ice is apparently motionless, there may be imperceptible movements and tremblings in the covering that may affect the oscillations of the pendulum. The influence that the motion of the ice may have upon the pendulum's period of oscillation ought therefore to be more carefully investigated. It is easy to show that a simple motion of translation, even if not uniform, but uniformly accelerated or retarded, will produce no change in the period of oscillation; the motion need not, I presume, be imagined to be more complicated than this in the comparatively short time that each observation lasts, if it is possible at all to consider the motion of the ice to be regular. The case would be different with the irregular movements and tremors of the ice. As I have attempted to demonstrate in a previous work[1], these tremors of the

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[1] O. E. Schiøtz, *Resultate der im Sommer 1893 in dem nördlichsten Theile Norwegens ausgeführten Pendelbeobachtungen nebst einer Untersuchung über den Einfluss von Bodenerschütterungen auf die Schwingungszeit* (Kristiania, J. Dybwad 1894.) p. 15 et seq.

substratum will always cause a diminution in the pendulum's period of oscillation. It is there stated that I have observed this actually to be the case in experiments carried out in the Christiania Observatory[1]; and I have also since had an opportunity of making a similar observation in Trondhjem. From these it is clear that the experiments made on the Fram when she was drifting with the ice, can never give too low values for the acceleration; it would be more reasonable to expect the values to be too high, if the ice-covering was in irregular, trembling motion during the observations.

In order to obtain some idea of the motion of the ice, I have made an examination as to the condition of the wind on the days of observation, and immediately before them, as the motion will depend chiefly upon the wind. I find the following statements:

January,	1894,	slight wind on the 15th and 16th.
March,	1894,	calm on the 15th, but rather windy on the 16th, continuing so during the night.
June,	1895,	rather strong wind on the 7th and the morning of the 8th, the rest of the latter day being calm; strong ESE wind on the 9th; blowing fresh on the 10th, but less on the 11th.
November,	1895,	no wind from the 14th to the 24th; had been a breeze on the 11th.
January,	1896,	calm all the month, no screwing and little wind.
April,	1896,	little wind from the 26th to the 30th, no screwing.

It will been seen from this that the masses of ice ought to have been in the greatest state of disturbance in June, 1895. If we examine the drift, we find that the ship has drifted as much as 19·9 km. in the two civil days from the 8th to the 10th June, and that the distance drifted diminishes to 4·8 km. in the following 24 hours (10th and 11th June). If we now consider the above given values for the periods of oscillation, we find that the lowest values are found just on the 10th and 11th June, 1895, although the latitude is more than 1° lower than that reached on the 14th and 23rd November, 1895. That this cannot be due to a greater local value of gravity is apparent from the fact that the mean period of oscillation observed on the 11th

[1] l. c. p. 8.

June is as much as 145 units in the seventh decimal-place less than that found on the 10th, although the two points of observation lay no more than about 5 km. apart, above a depth of over 3000 metres. If we especially examine the period for pendulum 34, with which experiments on the 8th, 10th and 11th June were made, we find that the period decreases regularly from the 8th — when, as we shall subsequently see, it was about normal — to the 11th. We must suppose that after the violent wind of the 9th June, internal tremblings have commenced in the ice-masses, and have increased in strength on the 10th and 11th, as the force of the wind diminished, and the rate of the drift became slower. I think we may conclude that this has really been the case, from the fact that Lieut. Scott-Hansen, on the 11th, expressly mentions that he heard rumblings in the ice during the first comparison of clocks, previous to the commencement of the pendulum observations. These observations are thus easily explained by the influence — already pointed out by me — of imperceptible tremblings upon a pendulum's period of oscillation.

As the observations show, the pendulums have only altered in a very slight degree during the expedition. The mean period of oscillation before the departure of the expedition was 0·5060400 in the Observatory, and after its return, 0·5060389 in the new pendulum-house in the Observatory Garden. The difference only amounts to 11 units in the last decimal-place, and 4 or 5 of these may be attributed to the difference in elevation — 5·6 m. — between the two points of observation[1], thus leaving a difference of only 7 units due to an alteration of the pendulums during the expedition. This alteration is so small that the pendulums may safely be considered as unchanged during the expedition, with a mean period of oscillation in the Observatory equal to 0·5060397, corresponding to the mean of the period of oscillation in the same place before and after the journey.

If we start with the value found by VON OPPOLZER for the acceleration of gravity in Vienna (Türkenschanze), viz.

$$g = 9{\cdot}80866 \text{ m.},$$

[1] When the new pendulum-house was taken into use, an attempt was made to determine directly the difference between the periods at the two places. No certain difference was obtained.

we obtain for the Observatory in Christiania,

by the observations in 1892, $g = 9{\cdot}81949$ m.

" " — " 1893, $g = 9{\cdot}81948$ m.

With the pendulum apparatus belonging to the Norwegian "Gradmaalings Kommission", I have found at the same place,

in 1892, $g = 9{\cdot}81949$ m.

" 1893, $g = 9{\cdot}81952$ m.

These, when regard is paid to the weight of the various values, give as mean for the acceleration in the Christiania Observatory[1],

$$g = 9{\cdot}81949 \text{ m.}$$

For the calculation of the experiments in which only one pendulum has been employed, I have taken $S_{33} = 0{\cdot}5059175$ as the value for the period of oscillation of pendulum 33 in the Observatory, assuming $S_{33} = 0.5059174 + 4 \times 10^{-7}$ to be the period of oscillation at the same place in 1897. The period of oscillation of pendulum 34 will then be $S_{34} = 0{\cdot}5061619$.

The following table gives the result of the calculation. In the column headed 'Calculated Acceleration', are given the values found by the aid of Helmert's formula.

$$\gamma_0 = 9{\cdot}780\ (1 + 0.005310 \sin^2 \varphi) \text{ m.}$$

It will be seen that the gravity was found a little too great at the only land-station that was investigated; but the numerical value obtained must, for reasons already given, be considered as only approximate. As regards the other values found for the acceleration, they do not indicate that the gravity over the ocean is greater than on land, when the observations of the 10th and 11th June, 1895, are left out of consideration, it having been shown above that they must give too high values. One observation — that of the 16th January, 1894 — gives somewhat too low a value, and one — that of the 16th January, 1896 — too high a value by not quite so much; otherwise the observed values accord very well with the calculated values. If we now con-

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[1] In *"Resultate der im Sommer 1893"*, etc., p. 8, the following values are given respectively for g, instead of those mentioned above:

$g = 9{\cdot}81957$ m. and $g = 9{\cdot}81953$ " } determined with the Fram expedition apparatus;

$g = 9{\cdot}81950$ m. and $g = 9{\cdot}81954$ " } determined with the apparatus of the Norwegian "Gradmaalings Kommission."

The reason of this difference has already been given in the note on page 53.

Station	Height above Sea-level	N. Lat.	E. Long.	g Observed Acceleration	γ_0 Calculated Acceleration	$g-\gamma_0$ Difference	Remarks
		° ′	° ′	m.	m.	m.	
Christiania Observatory . .	27·7 m.	59 54·7	10 43·5	9·81949	9·81888	+ 0·00061	
Khabarova.	?	69 39	60 20	2599	2565	+ 34	
January 16, 1894 . . .	On board	79 15·2	137 28	2949	3013	— 64	Only pendulum 33
March 16, 1894 . . .	—	79 38·5	135 10	3026	3025	+ 01	— — 33
June 8, 1895 . . .	On the ice	84 34·1	84 25·3	3136	3147	— 11	— — 34
— 10, 1895 . . .	—	84 42·4	83 14	3195	3149	+ 46	Both pendulums
— 11, 1895 . . .	—	84 44·7	83 0·5	3251	3150	+ 101	— —
November 14, 1895 . . .	On board	85 55·3	66 48	3177	3167	+ 10	Only pendulum 33
— 23, 1895 . . .	—	85 47·7	64 1	3148	3165	— 17	— — 34
January 16, 1896 . . .	—	84 51·9	40 43·6	3196	3152	+ 44	— — 33
April 29, 1896 . . .	—	84 14·7	12 21·6	3127	3141	— 14	Both pendulums
— 30, 1896 . . .	—	84 12·4	12 14·7	3131	3140	— 9	— —

sider that the irregular movements which could be imparted to the ship, through her drifting with the ice, would cause an increase in the observed value for the acceleration at each separate place, we may conclude from the above results, that the force of gravity over the polar basin cannot be greater than the normal. On account of the close agreement between the observed and the calculated values, it seems to me reasonable to assume that the force of gravity over the polar basin is normal. The circumstance that on January 16th, 1894, the acceleration was found too small, will be more fully discussed later on.

At the two stations on the 14th and 23rd November, separate pendulums were fortunately employed; and as the stations are only about 26 km. distant from one another, and very nearly in the same latitude, we may consider a combination of these two observations to be equal to a complete observation with both pendulums at the same station. As the latitude is not far off 86°, the period of the oscillation may be reduced so as to apply to that latitude. The reduction-formula that may be employed is

$$\Delta S = \tfrac{1}{2} S (\varphi_0 - \varphi) \frac{b \sin 2\varphi_0 \sin 1'}{1 + b \sin^2 \varphi_0},$$

where φ_0 and φ are the latitude at the two places, and b the constant in the formula

$$g = k(1 + b \sin^2 \varphi).$$

As the gravity may be considered normal, we may take for b the value in Helmert's formula, and put $b = 0{\cdot}00531$.

By this means we find that the correction to a latitude of 86°

for the period of pendulum 33, Nov. 14, $= -3 \times 10^{-7}$
" " — " — 34, Nov. 23, $= -7 \times 10^{-7}$;

and the period in a latitude of 86° thus becomes,

for pendulum 33, $S_{33} = 0{\cdot}5056011$
" — 34, $S_{34} = 0{\cdot}5058524$
} Mean, 0·5057268.

If the observations of the 29th and 30th April, 1896, are reduced in a similar way to one latitude, namely 84°, the reduction

for April 29th, $= +12 \times 10^{-7}$
" " 30th, $= +10 \times 10^{-7}$

The mean period of oscillation for the two pendulums in a latitude of 84° should thus be,

according to the observations of April 29, 0·5057377 } Mean 0·5057371
— „ „ — „ „ 30, 0·5057365 }

If the acceleration is calculated from this, we obtain

N. Lat.	E. Long.	Acceleration		Difference
		g observed	γ_0 calculated	
84°	12° 18′	9·83124	9·83136	— 0·00012
86°	65° 25′	3165	3168	— 3

The above values for the acceleration in 84° and 86° latitude may be regarded as the main result of the pendulum observations of the Fram expedition, and these values are to be regarded as normal. From these observations, by combination, the value for the acceleration in a latitude of 85° may be deduced; for if we put

$g = k\,(1 + b \sin^2 \varphi)$, we obtain $g_1 - g_2 = k\,b \sin(\varphi_1 - \varphi_2) \sin(\varphi_1 + \varphi_2)$,

and hence

$$g_{86} - g_{84} = k\,b \sin 2° \sin 10°, \text{ and } g_{85} - g_{84} = k\,b \sin 1° \sin 11°.$$

By eliminating $k\,b$, these give

$$g_{85°} = 9·83147 \text{ m.},$$

a value which thus contains the combined results of the observations of the expedition.

As I have already shown, my observations with the apparatus of the Norwegian "Gradmaalings Kommission" at the coast-stations in northern and southern Norway lead to the result that

in 70° 15′ N. Lat., we have $g = 9·82640$ m.
„ 59° 15′ N. Lat., „ „ $g = 9·81878$ m.,

if we start with Von Oppolzer's value in Vienna[1].

As these values refer to coast-stations, they are presumably somewhat higher than the normal values for the same latitudes. We will assume that they are a mm. too great, and combine them with the above value found

[1] Cf. O. E. Schiøtz "*Resultate der im Sommer 1894 in dem südlichsten Theile Norwegens ausgeführten Pendelbeobachtungen*" (Kristiania, J. Dybwad, 1895), p. 13, where these values are given respectively as $g = 9·826413$ m. and 9·818810 m. The difference is accounted for in the reasons given in the note on page 53.

for the acceleration in 85° N. Lat. We then find that these 3 values, each of which represents the combined results of observations at several stations, satisfy the following equation:

$$g = 9{\cdot}78011\ (1 + 0{\cdot}005292 \sin^2 \varphi)\ \text{m.},$$

together with $\alpha = 0{\cdot}45$ mm.

This value for α is probably somewhat high, but it does not differ too much from the value deduced by HELMERT from 37 coast-stations, namely,

$$\alpha = 0{\cdot}30 \pm 0{\cdot}05\ \text{mm.}$$ [1]

The above formula, on the other hand, differs only very slightly from Helmert's well-known formula,

$$g = 9{\cdot}780\ (1 + 0{\cdot}005310 \sin^2 \varphi)\ \text{m.},$$

which has been employed above for calculating the acceleration at the various places. The difference between them, expressed in millimetres, is only

$$(0{\cdot}11 - 0{\cdot}177 \sin^2 \varphi)\ \text{mm.}$$

As will be seen from the foregoing, Nansen's expedition has furnished the first answer to the question as to what are the facts with regard to the force of gravity over great ocean depths. The observations show that the gravity may be regarded as normal over the polar basin; and as it is not probable that this is a peculiarity of the Polar Sea, we are led to the assumption that the force of gravity is normal all over the great oceans. The increased attraction observed on oceanic islands must therefore only be due the local attraction of the heaped-up masses at the bottom of the ocean, that form the islands.

We will attempt to draw from the result arrived at above, some conclusions respecting the constitution of the earth's crust. We were led to assume that the gravity over the sea has the same value as on the continents in the same latitudes, at the level of the sea, if at a sufficient distance from the coast. In the first place, therefore, we will only consider those parts of the continents which form extensive lowlands, where the reduction to sea-level will play no important part. At the same depth below the earth's surface, the average density beneath the continents must differ from the density beneath the oceans; but the farther down we go, the less will this difference be, so that after a certain depth it may be assumed that the density is the same, on an average, all over the earth.

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[1] F. R. HELMERT, *Die Schwerkraft im Hochgebirge*, Berlin, 1890. p. 49.

In the following pages, we will consider the earth to be spherical, and pay no regard to its rotation. Thus on a spherical surface concentric with the earth's surface, at a sufficient depth, the density must be regarded as constant; and as the density, starting from this surface, may be considered on the whole to change in one and the same manner inwards towards the centre, the acceleration at the depth in question must have the same value over the whole earth, at any rate beneath that portion of the earth's surface, which we are here considering. Let the radius of this spherical surface be R_1, and that of the earth's surface R_0.

According to the potential theory, the flux of force from a closed surface is equal to 4π times the sum of the active masses in the same. This can be immediately employed upon the gravity, only taking the inward flux instead of the outward flux through the surface, as the force between two ponderable masses is in the opposite direction to the force between two similar electric or magnetic masses. We will consider a portion of the shell outside the spherical surface with radius R_1, which is cut off by a conical surface with its vertex at the centre of the earth, and subtending a solid angle $d\omega$. We may consider the force of gravity along the sides of the cone, at any rate at a sufficient distance from the boundary between land and sea, as running parallel to those sides. The flux of force through the boundary of this part of the cone will thus be limited to the two end surfaces, one of which is in the open surface of the earth, the other on the spherical surface farther in. If the acceleration at the earth's surface equals g_0, and below at the spherical surface with radius R_1, g_1, the flux of force, K, will be

$$K = \frac{g_0}{f} R_0^2 \, d\omega - \frac{g_1}{f} R_1^2 \, d\omega ,$$

where f is the gravitation constant. Thus this expression gives the entire mass that is found in the part considered, multiplied by 4π. It follows from this, since g_0 according to the above, has the same value over the oceans as in the lowlands of the continents, that over each surface unit of the inner spherical surface with radius R_1, beneath such portions of the earth's surface, there must be the same quantity of mass, whether it is beneath land or sea. If this be so, we can, in the following pages, when we leave out of consideration those parts of the earth's crust that contain the boundary between land and sea, regard the depths of the ocean as constant, equal to h_2, and assume that the density, ϱ, in the firm earth's crust beneath, changes on an average in one and the same manner downwards. We may assume that the case is similar with regard to the density, ϱ_1, beneath the portions of continent considered. ϱ and ϱ_1 are functions of the distance from the earth's surface, and according to the above, the average value along a vertical must be greater for ϱ than for ϱ_1 in the outer spherical shell, of which we will call the thickness h_1, when we have $h_1 = R_0 - R_1$. If we now compare a portion of the earth's crust belonging to the continental lowlands with a piece belonging to the ocean, the result of the equation for the flux of force is that

$$4\pi \int_0^{h_1 - h_2} R^2\, d\omega\, (\varrho_1 - \varrho)\, dh + 4\pi \int_{h_1 - h_2}^{h_1} R^2\, d\omega\, (\varrho_1 - 1)\, dh = 0,$$

which means that the difference between the mass of the two pieces above equal elements of the inner spherical surface equals zero.

Here $R = R_1 + h = R_0 - h_1 + h$; substituting this and expanding, we obtain, after division by $4\pi R_0^2\, d\omega$,

$$\int_0^{h_1-h_2} (\varrho_1 - \varrho)\, dh + \int_{h_1-h_2}^{h_1} (\varrho_1 - 1)\, dh + \frac{2}{R_0}\Big[\int_0^{h_1-h_2} (\varrho_1 - \varrho)(h - h_1)\, dh + \int_{h_1-h_2}^{h_1} (\varrho_1 - 1)(h - h_1)\, dh\Big] +$$
$$+ \frac{1}{R_0^2}\Big[\int_0^{h_1-h_2} (\varrho_1 - \varrho)(h - h_1)^2\, dh + \int_{h_1-h_2}^{h_1} (\varrho_1 - 1)(h - h_1)^2\, dh\Big] = 0. \qquad \text{I.}$$

The radius of the earth must here be regarded as great, not only in proportion to the depth of the sea, h_2, which we may take on an average as 3.5 km., but also in proportion to the thicknes of the shell, h_1. The fourth term in the above equation must therefore be exceedingly small, and even the third term can only have a small value, as the two integrals in it have opposite signs. The first two terms can consequently only have a value that scarcely differs from 0; moreover it is easy to show that their sum must be less than 0. If we inquire into the pressure that the separate parts of the earth's crust each exert upon the interior nucleus on account of the attraction of the latter, we shall find that, taking M_1 as the mass of the interior nucleus, it will amount for every surface element, $R_1^2\, d\omega$, beneath the continents, to

$$\int_0^{h_1} f \frac{M_1}{R^2} R^2 \, d\omega \, \varrho_1 \, dh = f M_1 \, d\omega \int_0^{h_1} \varrho_1 \, dh = f \frac{M_1}{R_1^2} R_1^2 \, d\omega \int_0^{h_1} \varrho_1 \, dh =$$

$$= g_1 R_1^2 \, d\omega \int_0^{h_1} \varrho_1 \, dh,$$

and under the oceans to

$$g_1 R_1^2 \, d\omega \left(\int_0^{h_1 - h_2} \varrho \, dh + \int_{h_1 - h_2}^{h_1} dh \right).$$

These two pressures are not equally great, and their difference $\varDelta$,

$$\varDelta = g_1 R_1^2 \, d\omega \left[\int_0^{h_1 - h_2} (\varrho_1 - \varrho) \, dh + \int_{h_1 - h_2}^{h_1} (\varrho_1 - 1) \, dh \right], \qquad \text{II.}$$

must, as we shall immediately see, be negative. In order to produce the distribution of matter in the earth's crust, that is found beneath the portions of continent under consideration, from the distribution of matter that exists beneath the oceans, masses must be removed from the deeper strata, and added above, where the sea is found; and in this way the attraction exerted by the interior nucleus upon the masses, and consequently their pressure upon it, are diminished. The sum of the two integrals in II, must thus, as already mentioned, be negative.

It is easy to find an approximate value for this sum, and thus for the difference in pressure, $\varDelta$, even if nothing more is known as to how the density changes down a vertical line from the surface. If we call the sum of the integrals δ, we may put

$$\delta = \int_0^{h_1 - h_2} (\varrho_1 - \varrho) \, dh + \int_{h_1 - h_2}^{h_1} (\varrho_1 - 1) \, dh = \varrho' (h_1 - h_2) + (\varrho_1' - 1) \, h_2, \qquad \text{III.}$$

where ϱ' indicates the difference between the mean values of the densities ϱ_1 and ϱ in the crust reaching from $h = 0$ to $h = h_1 - h_2$, and ϱ_1' is the average density in the uppermost stratum of continent of thickness h_2. According to equation I., we now have, neglecting quantities of the second order,

$$\delta + \frac{2}{R_0} \left[\int_0^{h_1 - h_2} (\varrho_1 - \varrho)(h - h_1) \, dh + \int_{h_1 - h_2}^{h_1} (\varrho_1 - 1)(h - h_1) \, dh \right] = 0. \qquad \text{IV.}$$

If the integration in this equation is effected in the same way, we obtain:

$$\delta - \varrho'' (h_1 - h_2) \frac{h_1 + h_2}{R_0} - (\varrho_1' - 1) h_2 \frac{h_2}{R_0} = 0,$$

where ϱ'' is the difference between two densities, which may be considered as a kind of mean value of ϱ_1 and ϱ, between $h = 0$ and $h = h_1 - h_2$, differing from ϱ', although the difference cannot be great, as in any case $\varrho_1 - \varrho$ is only very small. ϱ_1' may be straightway put down as equal to ϱ_1' in equation III. According to this equation,

$$(\varrho_1' - 1) h_2 = \delta - \varrho' (h_1 - h_2),$$

which, substituted in the previous equation, gives

$$\delta [1 - \frac{h_2}{R_0}] = (h_1 - h_2) [\varrho'' \frac{h_1 + h_2}{R_0} - \varrho' \frac{h_2}{R_0}].$$

As already mentioned, there can only be a slight difference between ϱ'' and ϱ'. The numerical value of ϱ'' is probably less than that of ϱ', as the difference in density is least, and the densities themselves greatest, in the lowest strata, where the factor $(h - h_1)$ in the first integral IV. has its greatest value. Recollecting that δ, ϱ'' and ϱ' are negative, we may write, if we substitute ϱ' for ϱ''

$$- \delta (1 - \frac{h_2}{R_0}) \leqq - (h_1 - h_2) \varrho' \frac{h_1}{R_0}.$$

If now equation III. is employed for the elimination of $\varrho' (h_1 - h_2)$, we finally obtain

$$- \delta (1 - \frac{h_1 + h_2}{R_0}) \leqq (\varrho_1' - 1) h_2 \frac{h_1}{R_0},$$

or

$$- \delta \leqq (\varrho_1' - 1) h_2 \frac{h_1}{R_0} (1 + \frac{h_1 + h_2}{R_0}). \qquad \text{V.}$$

If, as previously stated, we assume that h_2 equals 3·5 km., and that the average density in the uppermost 3·5 km. of the continents is 2·7, then, with a sufficient degree of accuracy,

$$- \delta \leqq 6 \frac{h_1}{R_0} \text{ km. of density one.} \qquad \text{V b.}$$

Even if the exterior spherical shell has a thickness corresponding to 0·02 of the earth's radius, or $h_1 =$ circ. 126 km.,

$$- \delta \leqq 120 \text{ m. of density one.}$$

We thus find that the difference Δ between the pressures exerted by the external shell upon the internal nucleus beneath the oceans and beneath the continents, cannot be greater under the conditions we have considered, than the pressure that a volume of water of a depth of 120 m., or a slab of rock of 48 m., with specific gravity 2·5, will exert upon their substratum.

A slab of rock such as this, by its attraction, will only alter the acceleration at one point on its surface by 0·05 mm. If it be considered that the various points on the lowlands where the force of gravity has been determined, are not on the sea-level, but at a greater or less, though slight, height above it, making it necessary to reduce the observations to sea-level, it will be seen that the observations in the lowlands could be as well satisfied by assuming that equally large areas of the surface of the internal nucleus are exposed on the average to an equal pressure from the external shell, as by supposing that the quantities of mass above it are on an average equally large.

In the calculation of the flux of force above, we have started with the supposition that the lines of force follow the normals of the limiting spherical surface. Strictly speaking we cannot generally assume this to be the case, on account of the uneven distribution of the masses in the external shell. As experience shows, the deviation of the vertical line in the lowlands is slight on the whole, and this deviation will not therefore produce any change in the general result at which we have arrived.

Before proceeding further, however, we will consider what conclusion may be drawn, with regard to the acceleration, from the fact that the lines of force are deflected from their normal straight course, supposing that this is not due to any special accumulation or deficiency of masses in the depths. We will imagine a tube of force passing through the boundary of a surface-element, $R_1^2\, d\omega$, upon the surface of the inner nucleus. Owing to local irregularities in the distribution of matter, the walls of the tube, during its passage through the earth's crust, will not follow the normals through the boundary of the element, and the tube will cut off from the free surface of the earth a surface-element, $R_0^2\, d\omega'$, which will generally differ somewhat from the normal, $R_0^2\, d\omega$, which would have been cut off if the lines of force had had a normal, straight course. $d\omega$ and $d\omega'$ are, as above, the solid angle under which the elements are seen from the centre.

The equation for the flux of force now gives

$$\frac{g}{f} R_0^2 \, d\omega' - \frac{g_1}{f} R_1^2 \, d\omega = 4\pi \int_0^{h_1} \varrho \, R^2 \, d\omega \, dh,$$

where $d\omega$ under the integral sign, is to be considered as a function of h. If we call the normal acceleration upon the earth's surface g_0, the mass of the earth M, and its average density σ_0, then

$$g_0 = f \frac{M}{R_0^2} = \frac{4}{3} \pi f \sigma_0 R_0;$$

putting this in the above equation, we obtain

$$g \, d\omega' - g_1 \frac{R_1^2}{R_0^2} d\omega = 3 g_0 \int_0^{h_1} \frac{\varrho}{\sigma_0} \frac{R^2}{R_0^2} d\omega \frac{dh}{R_0} \qquad \text{VI.}$$

As the thickness of the earth's crust must always be considered a small quantity in proportion to the earth's radius, R_0, it will be seen that the integral on the right will have to be regarded as a quantity of the third order, if the quantities on the left are of the second. If therefore the density, ϱ, does not undergo finite changes, an alteration in the course of the lines of force in the interior of the earth's crust will have no perceptible influence upon the magnitude of the acceleration, g, as the change undergone by the integral will have to be regarded as a quantity of the fourth order. If, however, the surface-element, $R_0^2 \, d\omega'$, cut off by the tube of force, differs from the normal, the acceleration will prove to be changed — augmented, as equation VI shows, where the element cut off is less than normal, and diminished where the element is greater than normal. It will generally be difficult to express an opinion as to the manner in which the transverse section of a tube of force will change in its course through the earth's crust to the external surface; but I think it will be clear from the above that we cannot straightway conclude that there is an accumulation of mass deep down below a place, because the acceleration there appears to be somewhat too great, or a deficiency of mass if it is rather too small. If the tube of force meets the surface of the earth near the coast-line of a continent, we may infer, as we shall also see subsequently, that its transverse section at the free surface is smaller than normal if the tube of force intersects that surface in the continent, but greater than normal if it is beyond the coast-line, out on the ocean; and this is on the very assumption that there is an equal amount of matter under surface-elements of equal size, in both places.

If, however, the density undergoes finite changes from one place to another, the change in the integral on the right side of equation VI may be of the same order as the integral itself, and the acceleration may then show an increase, even if the element, $R_0^2\, d\omega'$, cut off by the tube of force, is greater than normal, and a decrease if it is smaller than normal.

We have, in the above, only considered the lowlands on the continents. Experience seems to show with regard to the mountain regions and the elevated plateaus, that this accumulation of matter above the level of the sea is compensated on the whole by deficiency of matter in the depths. If this be so, there should also, on an average, be the same quantity of matter above every unit element of the surface of the inner nucleus beneath these portions of the continents as beneath the remainder of the earth's surface.[1] It has been to some extent supposed that this compensation depends upon an equilibrium of pressure of all parts of the earth's crust upon the inner nucleus. It is easy to show that in this case too, the two suppositions are almost equally good. If the mean elevation of the plateaus is h', and if their density is assumed to be ϱ_1 as in the upper part of the continents, we have only to add $\varrho_1' h'$ to the right side of equation (III), and the integral $\frac{2}{R_0}\int_0^{h'} \varrho_1\, h\, dh$ to the left side of equation (IV). Equation (V) will then become

$$-\delta\left(1 - \frac{h_1 + h_2}{R_0}\right) \leqq (\varrho_1' - 1)\, h_2 \frac{h_1}{R_0} + \varrho_1' h' \frac{h_1 + h_2 + h'}{R_0}$$

$$-\delta \leqq [(\varrho_1' - 1)\, h_2 + \varrho_1' h'] \frac{h_1}{R_0}.$$

Thus the term $\varrho_1' h' \frac{h_1}{R_0}$ has been added here. If we assume the same quantity of matter over every element of the surface of the inner nucleus, then, in order to obtain an equilibrium of pressure upon the latter as regards the continents, we must add, at sea-level, a layer of rock of a thickness

[1] F. R. Helmert. *Höhere Geodäsie* Bd. II, p. 365.

$$\frac{(\varrho_1' - 1) h_2 + \varrho_1' h'}{\varrho_1'} \frac{h_1}{R_0} = \text{circ. } (48 + 20\, h') \text{ m.},$$

if, as previously, we assume that $h_1 = 0{\cdot}02\, R_0$, and $h_2 = 3{\cdot}5$ km.; for every additional 1000 m. in the height of the plateau, the thickness of the added mass must consequently be increased by 20 m.

In the following pages we shall assume, for the sake of simplicity, that there is on an average the same quantity of matter over every surface unit of the inner nucleus. If we then imagine all the deficiencies of matter in the depths compensated by filling up from the corresponding accumulations above sea-level, the surface of all continents would in the main coincide with the spherical surface through sea-level.

I have above taken the thickness of the earth's crust to be 0·02 of the earth's radius. How far down we must go before we reach a depth where we may assume that the density is constant all over the earth, will depend upon the manner in which the density on an average alters downwards from the surface of the continents and from the bottom of the oceans. By the inequality in the moon's motion, dependent on the ellipticity of the earth, we may now infer how the density on the whole ought to change inwards towards the interior of the earth. Helmert gives the following formula:[1]

$$\Theta = 11{\cdot}3 \left[1 - 1{\cdot}04 \left(\frac{a}{a_0}\right)^2 + 0{\cdot}275 \left(\frac{a}{a_0}\right)^4\right],$$

where Θ is the density, a_0 the equatorial radius of the earth, and a the equatorial radius of the equipotential surface through the point under consideration. When $a = a_0$, *i. e.* at the surface of the earth, the density becomes 2·66. If s denotes the density at the surface of the inner nucleus, and the same symbols are employed as before, we obtain for the density, ϱ_1, h km. above this surface, since $a = R_0 - h_1 + h$, and $a_0 = R_0$,

$$\varrho = s - 0{\cdot}00177\, h.$$

This gives a very trifling change of density in the external strata of the earth. In the earth's crust, however, which has been subject to a more rapid cooling and less pressure than the interior of the earth, we may possibly

1 F. R. Helmert. *Höhere Geodäsie.* Bd. II, p. 487.

assume a somewhat more rapid decrease than the above equation gives. In any case, I assume that it follows from this equation that the difference between the densities in the firm crust beneath the continents and beneath the oceans can be only slight, so that the earth's crust must have a comparatively considerable thickness, if equation (I) is to be satisfied.

It appears to me that with regard to the density nearest the surface at the bottom of the ocean, there is no reason for supposing that it is perceptibly different from that at the surface of the continents. The oceans in all probability have not always been so deep as they are now; the depth has increased little by little, as the earth's outer shell has shrunk more and more together with the cooling down and contraction of the inner nucleus. If we look back in time, we must therefore suppose the oceans shallower and shallower the further back we go, taking for granted that on the whole they have always occupied the same places on the earth's surface. When the firm earth's crust was formed, there is no reason therefore to suppose it otherwise where the continents happened to lie than in the other places where the oceans subsequently came to be. It is true that the surface of the continents, after the latter had risen out of the sea, was exposed to continual denudation; but as the eroded masses were once more deposited upon areas belonging to the continents, this denudation has principally brought about a re-adjustment of the masses at the surface of the continents, and presumably cannot, to any perceptible extent, have produced any alteration in the average density at the surface, if, as previously mentioned, we imagine the continents to have been reduced to the level of the sea by the employment of the accumulated masses to compensate for deficiency of mass below. By thus sinking deeper and deeper during the shrinkage, those parts of the firm earth's crust upon which the ocean would rest were brought into contact with denser masses than those parts of which the continents were formed. On this account, I imagine, the density beneath the oceans came to increase more rapidly with the depth, than beneath the continents.

If this is the case, it seems to me reasonable to suppose that those parts of the earth's crust containing the boundaries of the continents, and which we have hitherto not considered, do not differ in any essential degree in their constitution from the other parts, but that in their case also we may suppose that on an average there is the same quantity of matter above every unit element of the surface of the inner nucleus as in the rest of the earth's crust, or, what is almost the same thing, that these parts are also, on an average, in an equilibrium of pressure upon the inner nucleus. If this supposition is correct, we must be able to infer from it the peculiarity that appears to characterise the coast-stations, namely, that the gravity increases a little with an approach towards the coast-margin of the continents. It has been stated above that for 37 coast-stations on various continents, HELMERT found the difference between the observed and the normal acceleration to be

$$0{\cdot}00030 \pm 0{\cdot}00005 \text{ m.}$$

According to PUTNAM, the coast-stations in North America along the Atlantic exhibit positive, or very small negative, differences, while the stations in the interior show much larger negative differences.[1]

The relative determinations made by the Austrian Navy during the years 1892—1898, also always give positive differences at the coast-stations examined, these being situated on various continents — Australia, Asia, Africa and South America — along the Indian, Atlantic and Pacific Oceans.[2]

The incline of submarine parts of the continents towards the ocean depths outside differs in different places. It is generally somewhat less nearest land (about 1 in 250 for a distance of 50 km.), and increases farther out to about 1 in 100. The incline is steeper, however, at several places, e. g. along the west coast of North and South America, where it amounts to 1 in 40.[3]

If, as before, ϱ stands for the density in the firm mass under the oceans, and ϱ_1 for that under the continents, we may imagine the crust of the earth to be formed of a sea, of depth h_2, extending over the whole earth, and resting upon a shell of thickness $(h_1 - h_2)$ and a density ϱ, when we add, as regards the continents, a mass of which the sum total is zero, but distributed in such a manner that above there will be a covering of thickness h_2 and density

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[1] *United States Coast and Geodetic Survey,* Appendix No. 1. Report for 1894, p. 28. *Relative determinations of gravity with half-seconds pendulums, and other pendulum investigations.* G. R. PUTNAM. Washington, 1895.

[2] *Relative Schwerebestimmungen durch Pendelbeobachtungen.* Ausgeführt durch die k. und k. Kriegs-Marine in den Jahren 1892—1894. Herausgegeben vom k. und k. Reichs-Kriegs-Ministerium, Marine-Section. Vienna, 1895.

Relative Schwerebestimmungen durch Pendelbeobachtungen, Heft II. Veröffentlichungen des hydrografischen Amtes der k. und k. Kriegs-Marine in Pola. Pola 1898.

[3] F. R. HELMERT. *Höhere Geodäsie* Bd. II, p. 345.

$(\varrho_1 - 1)$, and under it a base of thickness $(h_1 - h_2)$ and density $(\varrho_1 - \varrho)$, which on the whole is negative. Along the coast margin, we must imagine this covering with density $(\varrho_1 - 1)$, decreasing in thickness outwards towards the bottom of the ocean, following the slope of the continents down to the depths the covering here too, resting upon a substratum of thickness $(h_1 - h_2)$, whose density, however, is not constant at the same depth, but decreases in an outward direction as the thickness of the covering diminishes, and becomes 0 where the covering ceases. We thus suppose that the sum of the added masses above every element of the surface of the inner nucleus, everywhere equals 0.

If we now consider a point on the surface of a continent, we shall find that the attraction exerted upon it will depend not only upon the masses that determine the attraction out on the ocean, but also upon the above-mentioned added masses. If the point is sufficiently far from the coast, these will very nearly neutralise one another's effect, as their sum is zero. If the point approaches the coast, the effect arising from the fact that the added masses do not form a continuous shell all round the earth, will become more and more apparent; and as the positive masses lie nearer to the point acted upon than the negative, the result will be, as we shall see, a slight increase of attraction towards the coast-margin. In order to have a clearer view of this, we will first calculate the effect of a conical section of a spherical shell with constant density ϱ at a point situated at the pole of the zone; the vertex of the cone must be imagined in the centre of the sphere. If the external and internal radii of the shell are R_0 and R_2, and half the aperture of the cone θ, the attraction will be F_θ

$$F_\theta = \frac{2}{3}\pi\varrho f \frac{R_0^3 - R_2^3}{R_0^2} + \frac{2}{3}\frac{\pi\varrho f}{R_0^2}\Big[2R_0^3\,(2 + \cos\theta - 3\sin^2\theta)\sin\frac{\theta}{2} -$$

$$- (R_0^2 + R_2^2 + R_0 R_2 \cos\theta - 3 R_0^2 \sin^2\theta)\sqrt{R_0^2 + R_2^2 - 2R_0 R_2\cos\theta}\Big] + \qquad \text{VII.}$$

$$+ 2\pi\varrho f .\, R_0 \sin^2\theta\cos\theta \,\text{log. nat.} \frac{2R_0\,(1 - \sin\frac{\theta}{2})\sin\frac{\theta}{2}}{\sqrt{R_0^2 + R_2^2 - 2R_0R_2\cos\theta} - (R_2 - R_0\cos\theta)},$$

where f, as before, indicates the constant of gravity.

The first term is independent of the aperture, and represents half the attraction of the entire shell at the point under consideration. The two other terms, on the other hand, vary with θ; for a certain value of the latter, their sum equals 0. For smaller values their sum is negative, and its numerical value becomes greater and greater the nearer θ approaches 0, in which case the numerical value becomes equal to the first term. For greater values of θ, the sum becomes positive, and increases continually with θ, until for $\theta = \pi$ it becomes equal to the first term. An idea of the value of θ for which the sum of the two terms equals 0 may be obtained by the aid of the following proposition, which is easily proved. If a point P is situated outside a spherical shell with constant density and its centre at O, a spherical surface with the line OP as its diameter will divide the shell into two parts, which will each exert an equal influence upon P, and thus an influence equal to half that of the entire shell. Thus the thinner the shell, the smaller will be the angular radius, θ, of the conical section, which will exert an influence equal to half that of the entire shell upon a point in the centre of the limiting zone.

By the aid of the above expression, we will try to determine the influence of a similar conical section of the above-mentioned continental added masses upon a point on the earth's surface in the centre of the limiting zone. We will, as before, assume the thickness of the earth's crust to be $h_1 = 0{\cdot}02\ R_0$, and the depth of the sea, $h_2 = 3{\cdot}5$ km. $= \frac{1}{1800} R_0$.[1] For the sake of simplicity we will assume the densities, $(\varrho_1 - 1)$ and $(\varrho_1 - \varrho)$, to be constant in both layers. This will make no perceptible change, as the numerical value of $(\varrho_1 - \varrho)$, according to what we have said above with regard to the constitution of the ocean-bed, is probably smallest not only deepest down in the base, but also above just below the covering. The following diagram represents graphically the result of the calculation. The angular radius of the zone is the abscissa, and the ordinate gives the alteration in the acceleration of gravity dependent upon the section. Each division indicates 0·02 mm. It will be seen that even for an angular radius of 20°, which will correspond to a radius of about 2200 km., the interior negative masses will not altogether succeed in neutralising the attraction of the external positive shell. The aggregate effect of the section, however, is only about 0·07 mm.

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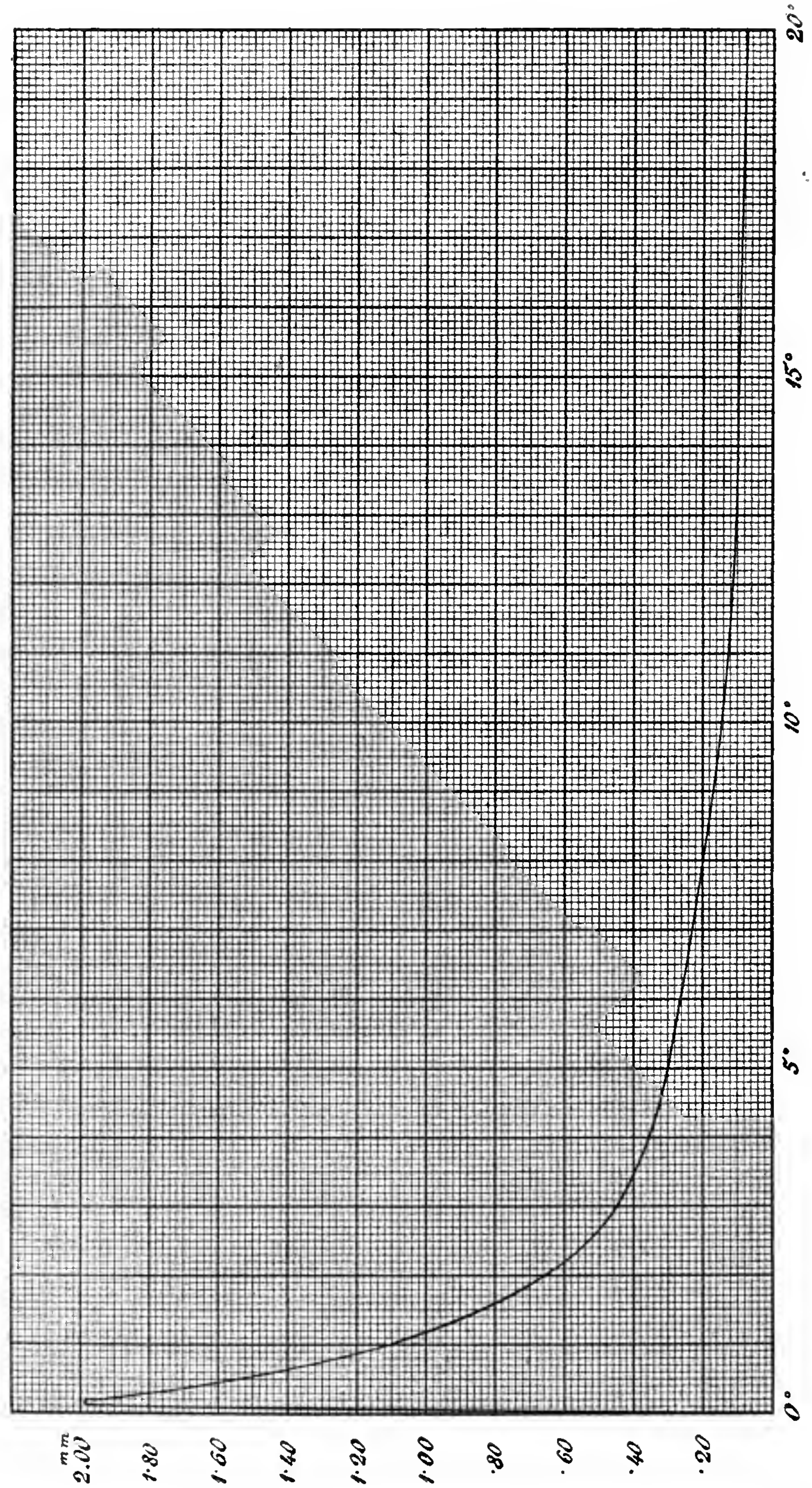
[1] The numerical values here chosen are of no importance for the following investigation, only supposing that the thickness of the crust is considerable in relation to the depth of the ocean, and very small in comparision to the earth's radius.


20°
15°
10°
5°
0°
mm
2.00
1·80
1·60
1·40
1·20
1·00
·80
·60
·40
·20

When the angle is reduced, the influence of the section becomes greater, and with small values of θ, the influence increases very rapidly when θ diminishes. For $\theta = 3°$, which will give a radius of 330 km. for the limiting zone, the increase in the acceleration will be 0·44 mm., and for $\theta = 0°.25$ as much as 1·85 mm. The influence will still increase a little, if θ decreases yet more; but a decrease soon commences, and the influence then sinks with extreme rapidity towards zero, when θ approaches that value.

By the aid of this curve, we can now easily obtain an idea of the influence of the added masses here treated of, disregarding for the present those that correspond to the incline of the continents towards the ocean depths. We will consider a circular continent, say as large as South America, with a radius equal to about 0·37 R_0, or an angular radius of rather more than 20°.[1] In the centre of the continent, or about 2200 km. from the coast, the added masses, as we have seen, will produce an increase in the acceleration of about 0·07 mm. When we approach the coast, the influence will at first increase exceedingly slowly; at a point about 1000 km. from the nearest coast, the increase in the acceleration will be only about 0·085 mm.

If we divide the continent by a great circle through the point under consideration parallel to the nearest portion of the coast-line, the influence of the greater part will diminish quite slowly when the point approaches the coast-line, and will produce an increase in the acceleration of about 0·03 mm. As the angular radius of the continent is less than 90°, the effect, however, of this part will again increase a little, when the point comes very close to the coast-margin, so that the acceleration in the coast-margin itself will have an increase of about 0·06 mm. The influence of the other part, on the other hand, will increase as the distance from the coast-line diminishes. In order to make a more exact calculation of this influence, we may imagine the part divided up into wedge-shaped sectors radiating from the point under consideration, and so small that the angular radius of the sector may be regarded as constant. The result given by this calculation is that at a distance of 3°, or about 330 km., from the coast, the influence will be about 0.17 mm., so that the added masses for the whole continent at this point will produce an increase in the acceleration of about 0·20 mm., or only 0·13 mm. more than in the middle of the continent; at a distance of 0°.5, or about 55 km., from the coast, the influence will be

[1] F. R. Helmert *Höhere Geodäsie.* Bd. II, p. 313.

much greater, and the increase in the acceleration will amount on the whole to about 0·65 mm. or 0·58 mm. more than in the middle of the continent. The influence will continue to increase until a distance of about 20 km. from the coast-line is reached. If, as mentioned above, we disregard the slope of the continents towards the ocean depths, and imagine them abruptly cut off, the influence of the added masses will diminish rapidly towards zero with a still nearer approach to the coast-line. On the very boundary between land and sea therefore, the acceleration in this case, as indicated above, will be about normal.

If we go out upon the sea, it is easy to see that the acceleration must show a decrease as the distance from the coast-line increases, so that at the same distance from the margin out there, the acceleration will prove to be about as much diminished as it was increased upon the continent. For if we imagine the land spread over the whole earth, the influence of the added masses on every external point will be zero. If, therefore, we add to the given masses the added masses of a continent such as this, extending over the whole earth, the influence on external points will not be altered. If we now assume that the density of the added masses of this continent is equal and opposite to the density of the added masses in the given continent, it is evident that the influence of our continent upon external points is equal to the influence of a continent occupying the place of the ocean, but with added masses whose density is equal and opposite to the density in the added masses 'of the continent. Out on the sea, we can consequently consider ourselves as being near the margin of this negative continent, and therefore the influence upon the acceleration will be the reverse of the influence on the actual continent, and about as great, if the radius of the circumscribing coast-line is not too short.

The continents, however, do not terminate abruptly. The added masses on the slope and in the base beneath it will somewhat modify the change of the acceleration. When the slope nearest land is very gentle, as is generally the case, it will have very much the same effect as a continuation of the continent itself, and therefore in the above deduction we must reckon the coast margin from the place where the rapid incline towards the ocean depths commences. The added masses on this incline will act as a check upon the above-mentioned decrease in the value of the acceleration when the land-point under consideration advances quite up to the coast-margin, so that instead of becoming normal again along the coast-margin, the acceleration will show somewhat of an increase. The increase will depend upon the steepness of the incline, there being thus a maximum for a certain slope, the increase becoming less both for steeper and gentler inclines.

It is easy to see that the effect resulting from these added masses upon a point on the coast-margin itself will be an attraction. If we imagine a sphere with the surface passing through the centre of the earth, and the earth's radius as diameter, this, as already mentioned, will cut off from the added masses a portion whose influence upon that point on the surface through which this sphere passes, will be the half of the influence of an entire spherical shell with thickness and density like those of the added masses. If a sphere such as this is made to pass through a point in the coast-margin, it will cut the spherical surface going through the ocean-bed in a small circle with a radius of about 200 km. If the slope of the continent is 1 in 60 — which is not unusual (see page 73) — the base of the continent will lie at a distance of about 210 km. from the coast-line, assuming the depth of the ocean to be 3·5 km. It will then be seen that the incline encloses almost completely that part of the sphere which falls within the outermost shell of the earth, which has a thickness of 3·5 km. The added masses on the incline will consequently, at one point in the coast-line, exert an influence about equal to a fourth part of that of a spherical shell having a thickness of 3·5 km., and the same density as that of the added masses, and will thus effect an increase of about 1·2 mm. in the acceleration. The subjacent negative added masses will not nearly be able to compensate this influence, as they only contain a portion of the masses that the spherical surface in question would cut off from a spherical shell of the same thickness $(h_1 - h_2)$ as theirs. A more minute determination of the effect of these added masses upon a point on the surface requires a somewhat complicated calculation, as the integrations can only be approximately performed. I have obtained at one point in the coast-line the following expression for the attraction, assuming that the slope is constant.

For the positive masses on the slope itself:

$$F_0 = f\varrho R_0 \alpha_2 \sqrt{\frac{\sin\psi_1}{\sin\psi_0}}\Big[(2-\beta_1\cot\psi_1)\operatorname{arctg}\frac{\beta_1}{\alpha_2} +$$

$$+\Big(\frac{5}{2}\frac{\alpha_2^2}{\beta_1}+\frac{1}{2}(\beta_1^2-\alpha_2)\cot\psi_1\Big)\log.\text{nat.}\,\alpha_2 +$$

$$+\Big(2\frac{\beta_1}{\alpha_2}-\frac{5}{2}\frac{\beta_1^2+\alpha_2^2}{\beta_1}-\frac{1}{2}\frac{\beta_1^2-\alpha_2^2}{\alpha_2}\cot.\,\psi_1\Big)\log.\ \text{nat.}\,\sqrt{\beta_1^2+\alpha_2^2} -$$

$$-\Big(2\frac{\beta_1}{\alpha_2}-\frac{5}{2}\beta_1-\frac{1}{2}\frac{\beta_1^2}{\alpha_2}\cot\psi_1\Big)\log.\ \text{nat.}\,\beta_1\Big];$$

for the negative masses beneath:

$$F_n = f\varrho R_0 \alpha_2 \sqrt{\frac{\sin\psi_1}{\sin\psi_0}}\Big[\beta_1 - \frac{\alpha_1+\alpha_2}{3}\cot\psi_1 - \frac{\alpha_2(2-\beta_1\cot\psi_1)}{\alpha_1-\alpha_2}\operatorname{arctg}\frac{\beta_1}{\alpha_2} +$$

$$+\frac{\alpha_1\left(2+\alpha_1-\left(\beta_1-\frac{\alpha_1^2}{3\beta_1}\right)\cot\psi_1\right)}{\alpha_1-\alpha_2}\operatorname{arctg}\frac{\beta_1}{\alpha_1} -$$

$$-\frac{\alpha_2^2}{\alpha_1-\alpha_2}\,\frac{1-\beta_1\cot\psi_1}{\beta_1}\log.\text{nat.}\,\alpha_2 + \frac{\alpha_1^2}{\alpha_1-\alpha_2}\,\frac{1-\beta_1\cot\psi_1+\frac{\alpha_1}{2}}{\beta_1}\log.\text{nat.}\,\alpha_1 -$$

$$-\frac{(\beta_1^2-\alpha_2^2)(1+\frac{\alpha_1}{2})-\beta_1(\frac{\beta_1^2}{3}-\alpha_2^2)\cot\psi_1}{\beta_1(\alpha_1-\alpha_2)}\log.\text{nat.}\,\sqrt{\beta_1^2+\alpha_2^2} +$$

$$+\frac{(\beta_1^2-\alpha_1^2)(1+\frac{\alpha_1}{2})-\beta_1(\frac{\beta_1^2}{3}-\alpha_1^2)\cot\psi_1}{\beta_1(\alpha_1-\alpha_2)}\log.\text{nat.}\,\sqrt{\beta_1^2+\alpha_1^2}\Big].$$

Here $\varrho = \varrho_1 - 1$, where ϱ_1 is the density in the upper part of the solid earth's crust, ψ_0 the angular radius of the circular coast-line, $\psi_1 = \psi_0 + \beta_1$ the angular radius of the line parallel to the latter along the base of the slope at the bottom of the sea, $\alpha_2 = \frac{h_2}{R_0}$, and $\alpha_1 = \frac{h_1}{R_0}$.

If we assume the slope to be as steep as that on the west coast of North and South America, namely 1 in 40, the result is found to be

$$F_0 - F_n = f(\varrho_1 - 1)\,R_0\,\alpha_2\sqrt{\frac{\sin(\psi_0+\beta_1)}{\sin\psi_0}}\,1{\cdot}163,$$

where $\beta_1 = 1^\circ\,16'.4$; if we make $\psi_0 = 20^\circ$, as in the case of South

America, and $\varrho_1 = 2{\cdot}66$, we obtain for the increase in the acceleration which this force will produce,

$$0{\cdot}46 \text{ mm.}$$

The effect will probably be somewhat greater if the incline is supposed to be rather less; for very gentle inclines, the effect will, as previously mentioned, again decrease.

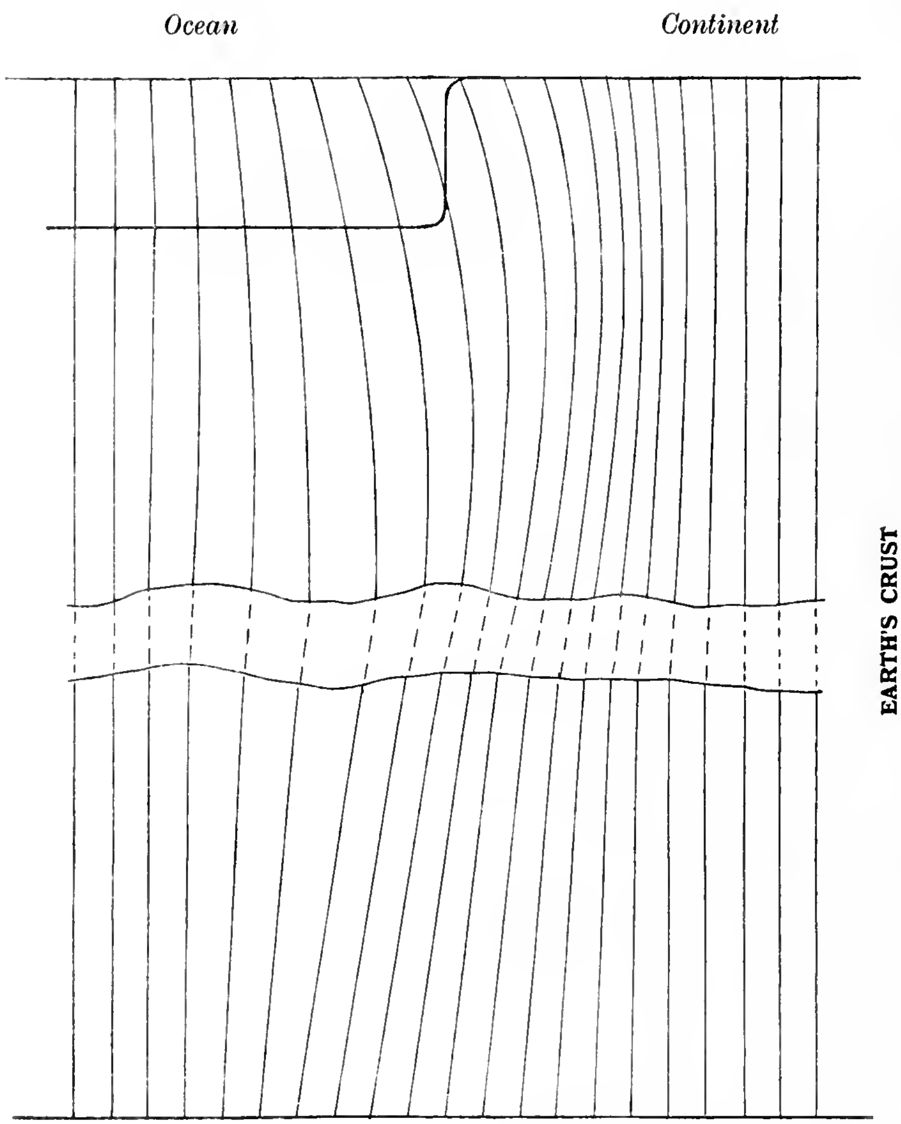
For points farther in on the continent, the increase in the acceleration, on account of the slope, will take place rather more slowly as we approach the coast-line, than if the continent were cut off abruptly, as the slope will act very much as an extension of the continent seawards. In other respects, the course of the phenomenon will be on the whole as we have shown it above. We thus se ethat upon the above-mentioned supposition concerning the composition of the earth's crust, it is easy to explain the fact that gravity generally increases somewhat on an approach to the coast-margin. Our deduction, however, leads moreover to a result with which we have hitherto been unacquainted. If we imagined ourselves going out to sea from the coast-margin, we found, in the case of the continent falling abruptly off towards the bottom of the ocean, that the acceleration out at sea will prove to be about as much diminished as it was increased at the same distance landwards. If we take into consideration the more or less steep incline of the continents towards the ocean depths, it must still appear, as we go out farther from the coast, that the acceleration first decreases and falls below the normal, and then once more rises and approaches it farther out from land. The change upon land and out at sea, however, will no longer take place almost symmetrically in relation to the coast-line, as the slope of the negative land-masses by which, in the case of the sea, we can replace the continent in question, is in an opposite direction to that of the latter, since both land-masses together are to form a continuous shell all over the earth.

The Fram expedition has been the first to give information as to what are the circumstances with regard to gravity out on the ocean. We have seen that the gravity is normal over the Polar Basin. As already mentioned, the irregular, trembling motion in which the ice-masses might possibly have been during the observations, would only cause a shortening of the period of the pendulum employed, so that we may assume that the values found for the acceleration have not come out too small. In spite of this, however, one observation, made on the 16th January, 1894, gives a noticeably too small value for the acceleration, the difference amounting to as much as 64 units in the 5th decimal place. I assume therefore, that we may certainly take for granted that the acceleration at this place of observation is somewhat smaller than normal. It is true that only one pendulum was used; but the two observations taken accord very well. The Fram was then already out in the Polar Basin, as a little farther south, on the 21st December, 1893, the bottom had not been reached at 2100 metres. But the vessel was not far from the coast-margin of the continent, for on November 28th, 1893, in 78° 39'.7 N. Lat. and 138° 49' E. Long., and on November 30th, 1893, in 78° 41'.9 N. Lat. and 138° 37' E. Long., the bottom was reached at respectively 143 and 170 metres, while it was not reached at 250 m. on December 3rd, 1893, in 78° 47'.3 N. Lat. and 138° 8' E. Long. As the place of observation on January 16th, 1894, was in latitude 79° 15'.2 N. and longitude 137° 28' E., it will be seen that it was not farther from the coast of the Asiatic continent than about 60 km., the line where the rapid incline towards the ocean depths commences being considered as the coast-line. The incline here appears to be particularly steep, as the depth shows an increase of at least 2000 m. in a distance of 60 km. The incline would thus be 1 in 30 or thereabouts. The smaller value for the acceleration observed at the above-mentioned place seems therefore to accord well with the result at which we arrived above. It must be remarked that the acceleration was found normal on the following 16th March, 1894, in latitude 79° 38'.5 N. and longitude 135° 10' E. This place of observation, however, is fully 60 km. from the former one, and in such a direction that its distance from the coast-margin is about double. The difference, therefore, according to our explanation, should here be much less than at the first place. At all events, the acceleration in this case was found greater than it should have been according to the distance of the place from the coast-margin; but this cannot be brought forward as any incontestable objection to the correctness of the above result, since we cannot, as already stated, draw any certain conclusion from the fact that the acceleration has been found too great. I believe, therefore, that we may take it for granted that the observations in question are not at variance with the theory expounded above, but that this theory is directly supported by the observation of the 16th January, 1894.

We may convince ourselves of the correctness of the result arrived at above, by examining the course of the lines of force through the earth's crust. If the masses in the earth's crust had been so distributed that the density at equal distances from the surface had been constant, the lines of force would simply have run straight in along the radii to the places in question. This, however, is not the case, even under the simplified conditions under which we are here considering the matter. The density at a certain depth is not the same beneath the continents as beneath the oceans. The lines of force, in consequence of this, will be deflected from their straight course during their passage inwards towards the inner nucleus. This deflection will take place, as we may easily convince ourselves, when the lines pass through a space in which the masses are unevenly distributed in directions at right angles to them, and in such a manner that they will turn aside from those places where the density of mass is least, towards those where it is greatest. Instead of following the lines of force on their inward course from the surface of the earth through the earth's crust to the inner nucleus, it will be preferable to follow them in the opposite direction, as we may assume that the lines of force that reach the surface of the nucleus, are evenly distributed over it. We must recollect, however, in thus following the lines of force backwards in the opposite direction to their course, that their deflection will also be in the opposite direction to that mentioned above, so that the lines we are following will turn away from the places where the density is greatest towards those where it is least.

We will now assume the surface of the inner nucleus to be divided into a number of equal surface-elements, and that through each element there runs a line of force. If the masses had been evenly distributed throughout the earth's crust, these lines, as already mentioned, would have been produced through it as right lines, so that equal surfaces of the outer surface would be intersected by an equal number of lines of force all over the earth. The masses, however, as we know, are unevenly distributed, and on an average the density at greater depths than that of the bottom of the ocean is somewhat less beneath the continents than beneath the oceans. The consequence of this is that the lines of force rising from the surface of the inner nucleus along the border of the base of the continents, must converge under the latter, so that the space under the continents will be more and more filled with lines of

LINES OF FORCE



force the higher they rise, while on the other hand, the lines of force in the space beyond, under the ocean, will be thinned out (see fig.). This holds good until the level of the ocean bottom is reached, when the density becomes greatest on the side of the continents, and the difference of density is considerably greater than below. As a consequence of this, the lines of force are obliged to turn back towards the oceans again, und that more rapidly than they had turned in under the continent. On account of the inconsiderable depth of the oceans as compared with the thickness of the earth's crust, however, this turning back is not so complete as to cause a regular distribution of the lines of force over the outer surface of the earth. The lines of force will therefore be crowded rather more closely together on the continents, along their boundary or towards the coast-line; while immediately outside this, on the ocean, they will lie farther from one another than the normal distance. An endeavour to illustrate these conditions is made in the accompanying figure.

If we now consider a tube of force issuing from the outer surface, and terminating in one of the surface-elements into which we have imagined the surface of the inner nucleus to be divided, it is evident, since the lines of force, according to the above, lie somewhat closer together than normally just within the coast-line of a continent, that this tube of force will cut off from the free surface an element somewhat smaller than it would have been had the lines of force been normally distributed over the free surface, and the acceleration been normal in consequence. The reverse will be the case if the tube of force intersects the free surface somewhat beyond the coast-line out on the ocean. According to our explanation on page 69, the direct consequence of this will be that the acceleration must be rather greater than normal on the continents in the neighbourhood of the coast-line, and somewhat less than normal out on the ocean a little beyond the shore, as we have demonstrated above.

We have assumed above that on an average there are equally large masses over equal elements of the surface of the inner nucleus. If we imagine that there is an equilibrium of pressure upon this from the outer crust, the result arrived at above will not be altered in any degree worth mentioning. In order to satisfy this new condition, we need only, as regards the continents, add at sea-level a stratum of rock about 50 m. thick, to the masses we have considered above.

As regards the oceanic islands, the increased attraction on them is easily explained, whether we imagine the masses of which they are formed to represent actual surplus mass, or assume — which seems the more reasonable —

that in this case also, the masses are to a greater or less extent compensated by deficiencies of mass in the depths below. On account of the small extent of the islands, the acceleration must nevertheless show a considerably greater increase here than along the continental coast-margin.

CHRISTIANIA. *July 1900.*

O. E. SCHIØTZ.

SUPPLEMENT.

On page 58, mention was omitted of the fact, that the period of the pendulum may be somewhat altered by an imparted oscillation of the support. As this was of course not forgotten in treating of the observations, the following considerations may be inserted here.

We will first consider the observations that were made out on the ice between the 8th and the 11th June, 1895. As mentioned on page 32, the iron cross on which the pendulum apparatus was placed, was in immediate contact with the ice. This was effected by scraping away the snow from the floor of the snow hut in which the observations were made, until homogeneous, solid ice was reached, when the iron cross was laid upon it. The cross became firmly attached to the ice, and was so steady that the position of the level of the pendulum apparatus remained almost unchanged from day to day during the time that the observations were being made. Lieut. Scott-Hansen also notes it as his impression that this setting up of the instrument was the steadiest during the whole expedition. As the pendulum apparatus stood immediately upon the floor of the hut, Scott-Hansen had here, too, to carry out his observations in a recumbent position. The ice at that time being depressed by the surrounding snow-drifts, water continually penetrated into the hut, and kept the floor wet, so that it was necessary now and then to remove the water by throwing dry snow into it, and then shovelling away the slush. It afterwards appeared that the floor of the snow-hut was rather below the level of the sea; for immediately after the observations were terminated, the ice cracked right across it, and the water rose to such a height, that if the apparatus had been in position, the bob of the pendulum would have been a few centimetres below the surface of the water.

I assume from the foregoing, that as far as these observations are concerned, there is no fear of any simultaneous movement other than those imparted to the pendulum-stand itself, and these will increase the pendulum's period of oscillation in the same manner wherever the apparatus is set up. These observations may therefore safely be compared with those made in the observatory in Christiania, where the pendulum apparatus was set up on the iron cross in a window-recess in the thick brick wall.

This I also assume must be the case with the observations taken in the saloon of the Fram. In the first place, it may be remarked that the ship at that time was frozen into the ice, and may thus be considered as forming a part of the ice-covering. In the saloon, the apparatus, as the drawing on page 4 shows, was set up in such a manner that the pendulum swung across the ship, and consequently at right angles to the planks of the floor, but parallel with the beams beneath them. As may be seen from the plates accompanying Colin Archer's description of the Fram [1], there is a beam beneath the floor between the doors of the doctor's and Scott-Hansen's cabins. According to the above-mentioned drawing on page 4, the apparatus has stood above this beam during the observations. In order to give the ship the necessary strength to resist the pressure of the ice from the side, there were fitted under every beam in both decks, strong diagonal stays, placed nearly at right angles to the side of the ship, and securely fastened to the side and to the beam with wooden knees. The subjoined drawing from Archer's description [2], shows the relative position of the parts in a section through the ship a little in front of the saloon.

The width of the saloon between the two cabins mentioned above, according to Archer's drawing, is 3·4 metres. The distance between the pendulum apparatus and the coincidence apparatus differed a little in the different observations, varying from 1932 to 2268 mm. The centre of the pendulum apparatus was therefore between 60 and 70 cm. from the nearest wall, which connected the upper and middle decks, and separated the cabins from the saloon. If we take into consideration this fact, and also that the pendulum apparatus was in direct contact with the floor, and immediately over one of the beams,

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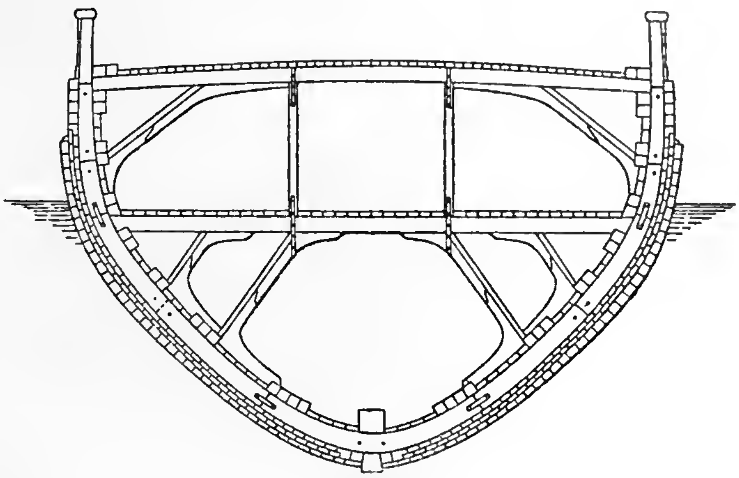
[1] *The Norwegian North Polar Expedition 1893—1896, Scientific Results, edited by F. Nansen.* Vol. I. I, Colin Archer, *The Fram;* Pl. II, figs. 1 & 2.

[2] l. c., Pl. II, fig. 4.

so that the plane of oscillation was parallel with the longitudinal direction of the beam, and further, the solid construction of the ship, I take it that the simultaneous movement of the substratum may be assumed to have been



trifling, and mainly confined to oscillations of the pendulum apparatus itself. It is true that Scott-Hansen remarks that the level moved when he approached the apparatus from various sides, but only very slightly; and he also states that *from the coincidence apparatus*, he could approach sufficiently near to observe the level, and see that it did not move at his approach.[1]

It seems to me that the correctness of the above assumption is corroborated by the observation made on the ice on June 8th, 1895, for this, as the table on page 60 shows, leads to a result exactly similar to that of the observations made in the saloon, if we except those of January 16th, 1894 and 1896. It is true that on the day in question (June 8th, 1895) only one observation was made with the one pendulum 34; but nevertheless it seems unlikely that the accordance should be due to chance. It may also be mentioned that among the observations made on the 10th June following, out on the ice, there is one with pendulum 33[2], that gives far too large a period

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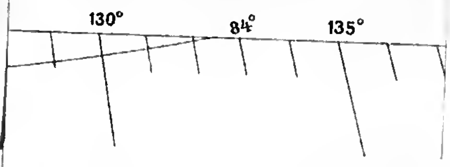
[1] On page 41 an error has slipped in, where, instead of "two men . . walked . . across the floor, causing a movement in the level as they passed near the apparatus", it should read " . . *across the floor. Scott-Hansen states that movement is perceptible in the level when he crosses the floor in the neighbourhood of the apparatus*".

[2] On page 54, the period is wrongly given as 0·5056139. It should be 0·5056189, as calculated on page 35.

— more than 200 units in the 7th decimal place — as compared with the others determined on that day. The observation in question was the first made in the evening when the observations were resumed after an interval of about 3 hours. The disagreement may therefore possibly be explained by assuming that the imperceptible trembling movements in the ice-covering had gradually subsided during the time of repose, but that the motion recommenced when this observation was completed, and continued with increasing violence through the night and day following. If this explanation is correct, this observation with pendulum 33 should about correspond with the observation made on June 8th with pendulum 34, as the results also seem to indicate; for if these two observations are combined, they give as the value for the acceleration, 9·83131, while the second observation alone gives 9·83136 (see p. 60).

In accordance with the above, I have, in the preceding calculations, started with the assumption that no appreciable error will be committed by leaving out of consideration possible simultaneous movement in the substratum of the pendulum apparatus.



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