DEPARTMENT OF TERRESTRIAL MAGNETISM
J. A. Fleming, Director

Scientific Results of Cruise VII of the CARNEGIE during 1928-1929
under Command of Captain J. P. Ault

METEOROLOGY–II

Upper-Wind Observations and Results Obtained on Cruise VII of the CARNEGIE

ANDREW THOMSON

CARNEGIE INSTITUTION OF WASHINGTON PUBLICATION 547
WASHINGTON, D. C.
1943

This book first issued March 31, 1943

PREFACE

Of the 110,000 nautical miles planned for the seventh cruise of the nonmagnetic ship Carnegie of the Carnegie Institution of Washington, nearly one-half had been completed on her arrival at Apia, November 28, 1929. The extensive program of observation in terrestrial magnetism, terrestrial electricity, chemical oceanography, physical oceanography, marine biology, and marine meteorology was being carried out in virtually every detail. Practical techniques and instrumental appliances for oceanographic work on a sailing vessel had been most successfully developed by Captain J. P. Ault, master and chief of the scientific personnel, and his colleagues. The high standards established under the energetic and resourceful leadership of Dr. Louis A. Bauer and his co-workers were maintained, and the achievements which had marked the previous work of the Carnegie extended.

But this cruise was tragically the last of the seven great adventures represented by the world cruises of the vessel. Early in the afternoon of November 29, 1929, while she was in the harbor at Apia completing the storage of 2000 gallons of gasoline, there was an explosion as a result of which Captain Ault and cabin boy Anthony Kolar lost their lives, five officers and seamen were injured, and the vessel with all her equipment was destroyed.

In 376 days at sea nearly 45,000 nautical miles had been covered (see map p. iv). In addition to the extenive magnetic and atmospheric-electric observations, a great number of fdata and marine collections had been obtained in the field of chemistry, physics, and biology, including bottom samples and depth determinations. These observations were made at 162 stations, at an average distance apart of 300 nautical miles. The distribution of these stations is shown in the map, which delineates also the course followed by the vessel from Washington, May 1, 1928, to Apia, November 28, 1929. At each station, salinities and temperatures were obtained at depths of 0, 5, 25, 50, 75, 100, 200, 300, 400, 500, 700, 1000, 1500, etc., meters, down to the bottom or to a maximum of 6000 meters, and complete physical and chemical determinations were made. Biological samples to the number of 1014 were obtained both by net and by pump, usually at 0, 50, and 100 meters. Numerous physical and chemical data were obtained at the surface. Sonic depths were determined at 1500 points and bottom samples were obtained at 87 points. Since, in accordance with the established policy of the Department of Terrestrial Magnetism, all observational data and materials were forwarded regularly to Washington from each port of call, the records of only one observation were lost with the ship, namely, a depth determination on the short leg between Pago and Pago and Apia.

The compilations of, and reports on, the scientific results obtained during this last cruise of the Carnegie are being published under the classifications Physical Oceanography, Chemical Oceanography, Meteorology, and Biology, in a series numbered, under each subject, I, II, and III, etc.

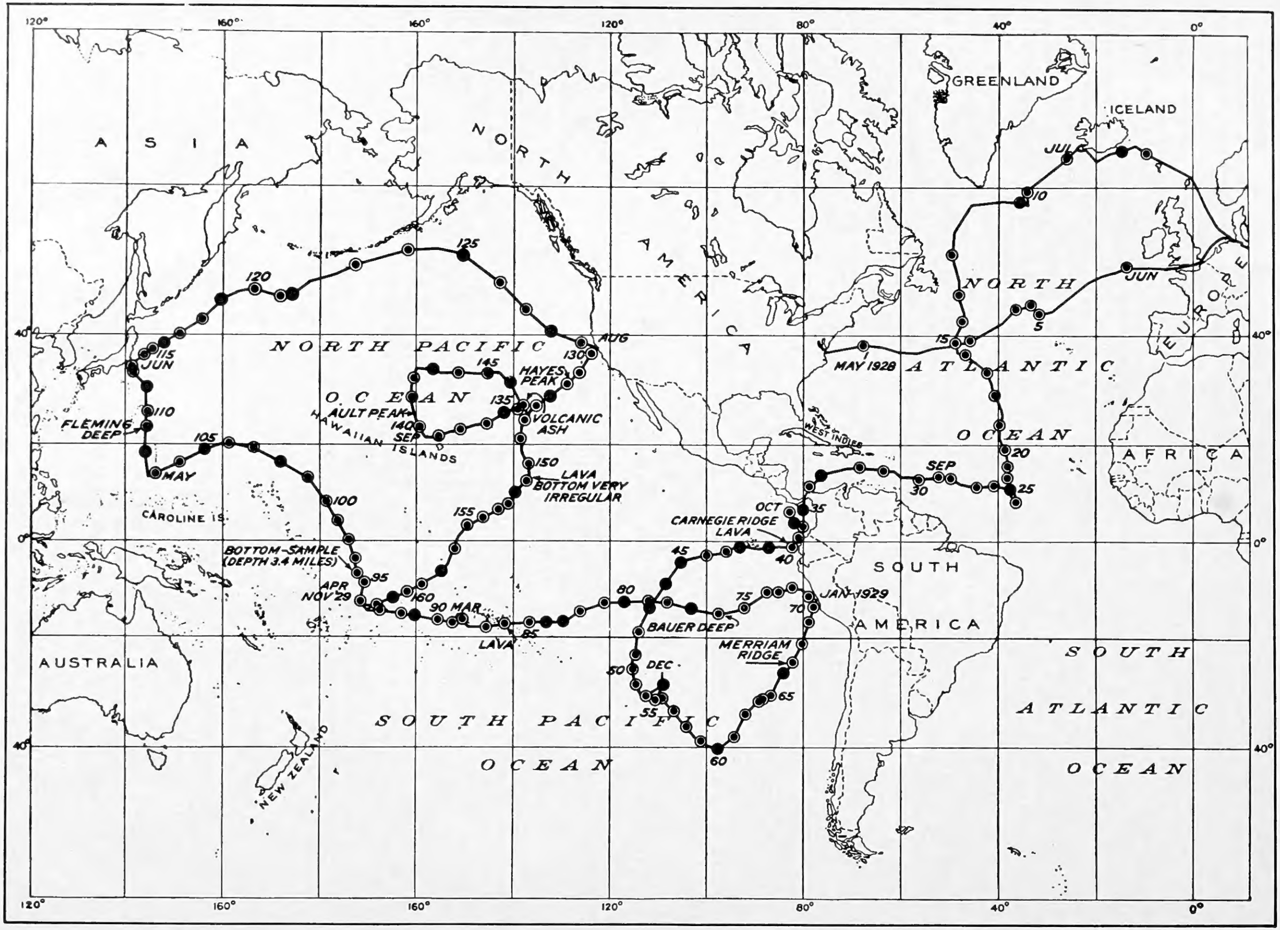
A general account of the expedition has been prepared and published by J. Harland Paul, ship's surgeon and observer, under the title The last cruise of the Carnegie, and contains a brief chapter on the previous cruises of the Carnegie, a description of the vessel and her equipment, and a full narrative of the cruise (Baltimore, Williams and Wilkins Company, 1932; xiii + 331 pages with 198 illustrations).

The preparations for, and the realization of, the program would have been impossible without the generous cooperation, expert advice, and contributions of special equipment and books received on all sides from interested organizations and investigators both in America and in Europe. Among these, the Carnegie Institution of Washington is indebted to the following: the United States Navy Department, including particularly its Hydrographic Office and Naval Research Laboratory; the Signal Corps and the Air Corps of the War Department; the National Museum, the Bureau of Fisheries, the Weather Bureau, the Coast Guard, and the Coast and Geodetic Survey; the Scripps Institution of Oceanography of the University of California; the Museum of Comparative Zoōlogy of Harvard University; the School of Geography of Clark University; the American Radio Relay League; the Geophysical Institute, Bergen, Norway; the Marine Biological Association of the United Kingdom, Plymouth, England; the German Atlantic Expedition of the Meteor, Institut für Meereskunde, Berlin, Germany; the British Admiralty, London, England; the Carlsberg Laboratorim, Bureau International pour l'Exploration de la Mer, and Laboratoire Hydrographique, Copenhagen, Denmark; and many others. Dr. H. U. Sverdrup, now Director of the Scripps Institution of Oceanography of the University of California, at La Jolla, California, who was then a Research Associate of the Carnegie Institution of Washington at the Geophysical Institute at Bergen, Norway, was consulting oceanographer and physicist.

In summarizing an enterprise such as the magnetic, electric, and oceanographic surveys of the Carnegie and of her predecessor the Galilee, which covered a quarter of a century, and which required cooperative effort and unselfish interest on the part of many skilled scientists, it is impossible to allocate full and appropriate credit. Captain W. J. Peters laid the broad foundation of the work during the early cruises of both vessels, and Captain J. P. Ault, who had had the good fortune to serve under him, continued and developed that which Captain Peters had so well begun. The original plan of the work was envisioned by L. A. Bauer, the first Director of the Department of Terrestrial Magnetism, Carnegie Institution of Washington; the development of suitable methods and apparatus was the result of the painstaking efforts of his co-workers at Washington. Truly, as was stated by Captain Ault in an address during the commemorative exercises held on board the Carnegie in San Francisco, August 26, 1929, "The story of individual endeavor and enterprise, of invention and accomplishment, cannot be told."

After the Carnegie entered the Pacific Ocean on her last voyage, there was initiated a pilot-balloon program which continued throughout her cruise on the North and South Pacific oceans. From October 27, 1928 until November 11, 1929 observations were made daily while at sea if weather conditions made it appear probable that a flight could be followed to an altitude of a kilometer or more. Altogether 171 observations were made over the Pacific Ocean, mostly in the tropical zone. Of this total 112 flights were followed to 2 km, 76 to 4 km, 28 to 6 km, and one balloon was observed to 12.5 km.

The great majority of the observations were made in the belt of the northeast and of the southeast trades. The winds in these regions are extraordinarily constant both in direction and velocity. The results of a few flights in



OCEANOGRAPHIC STATIONS, CRUISE VII OF THE CARNEGIE, 1928-29

(At the 35 stations marked ● true sea-water samples were also obtained for salinity calibrations) an area in the trade-wind belt may be expected to give a close approximation of the average upper-wind conditions prevailing at that season. Thus 171 flights, although not sufficient for the purposes of the study of upper winds over a continental region, may be sufficient to extend considerably our knowledge of the trade-wind circulation over the Pacific.

Although the surface-wind observations for the Pacific Ocean had been collected for many years, almost nothing had been learned of the upper winds over the same region. The Carnegie observations discussed in this memoir represent a considerable contribution to meteorology which will find use both in the theoretical study of the circulation of the atmosphere and in planning air routes across the Pacific.

The present volume is the fifth in the series of "Scientific results of cruise VII of the Carnegie during 1928-1929 under command of Captain J. P. Ault." It is the second of the Meteorological Reports. The first of these, "Meteorological results of cruise VII of the Carnegie, 1928-1929" by Woodrow C. Jacobs and Katherine B. Clarke (1943), contains the data resulting from the observations and records of atmospheric pressure, air temperature, sea-surface temperature, humidity, evaporation, and miscellaneous meteorological phenomena.

Mr. Thomson's discussion provides a fairly complete account of the technique employed in making pilot-balloon observations on shipboard. Besides giving the results of the flights themselves, the weather conditions prevailing at the time of the flights are described in detail. The observations are quite fully represented in charts and tables so that it is hoped the data can be utilized for many different purposes by investigators with a minimum of additional work.

J. A. Fleming
Director, Department of Terrestrial Magnetism

CONTENTS

UPPER-WIND OBSERVATIONS AND RESULTS OBTAINED ON CRUISE VII OF THE CARNEGIE

INTRODUCTION

Early in 1928 the Department of Terrestrial Magnetism of the Carnegie Institution of Washington decided to make pilot-balloon observations as opportunity permitted on cruise VII of the Carnegie. The immediate consideration which led to the initiation of an upper-wind program was that the Carnegie's proposed sailing route lay across rarely visited parts of the oceans, where no upper-air data had been obtained. The value of such upper-wind observations in the navigation of flying craft over the ocean, as well as in the elucidation of problems of the atmospheric circulation over the earth's surface, was obviously great.

Since the study of upper-air currents lay outside the geophysical program of the Department, government organizations engaged in aerological investigations were consulted with regard to equipment and procedure. The Bureau of Aeronautics, United States Navy Department; the Meteorological Service of the Signal Corps and the Air Corps of the United States War Department; and the Aerological Division of the United States Weather Bureau cooperated generously. Each of these organizations was liberal with advice, and the use of the best aerological equipment at its command.

The Carnegie received a shipboard theodolite at Panama, Canal Zone, and on October 27, 1928 observed the first flight in the Gulf of Panama. Throughout the cruise in the Pacific the officers took advantage each day of any opportunity of skies comparatively free from clouds to make a flight. The only part of the cruise without observations was from July 3 to 21, 1929, in the northern Pacific about latitude 50° north, when fog, low clouds, and almost uninterrupted foul weather would have prevented the observer following the balloons for more than two minutes. Only 5 of the 171 flights in the Pacific were made in higher latitudes than 40° north. The remaining 166 flights were made as follows: equator to 20° north, 23 flights; 20° north to 40° north, 47 flights; equator to 20° south, 79 flights; and from 20° to 40° south, 17 flights. Of 110 flights within the tropics, 29 were made north and 81 south of the equator. Thus, the majority of the observations were inside the trade-wind regions, where a comparatively small number of observations reveals the typical air movements characteristic of the locality more clearly than an equal number of observations made in temperate or polar regions.

The balloons were observed to the following heights: 171 balloons at the surface, 153 at 1 km, 112 at 2 km, 90 at 3 km, 76 at 4 km, 58 at 5 km, 38 at 6 km, 23 at 7 km, 14 at 8 km, 10 at 9 km, 5 at 10 km, 3 at 11 km, 2 at 12 km, and 1 at 12.5 km. The observers followed one-half the flights to 3.5 km, and in the highest flight, no. 77, on the afternoon of March 18, 1929 an extreme height computed to be 12.8 km was attained.

EQUIPMENT USED IN UPPER-WIND OBSERVATIONS ON THE CARNEGIE

The usual pilot-balloon apparatus and observational procedure have been greatly modified for use on board battleships and large ocean liners, where, almost exclusively, such observations have been made. The small size of the Carnegie (her displacement tonnage being only 568 tons), and her lively ship motion, rendered it imperative to obtain good equipment, and also to attempt expedients which would not be necessary on larger vessels.

Shipboard Theodolite

During 1927 and 1928 the Bureau of Aeronautics of the United States Navy Department, developed and had manufactured (by Keuffel and Esser, Brooklyn, N. Y.) shipboard theodolites, which included numerous modifications from earlier types. The first of these theodolites available, Aero 1928 U.S.N. No. 15, was loaned to the Carnegie in October 1928. Subsequently the Bureau of Aeronautics replaced this theodolite with an improved model, which was employed in all flights after leaving San Francisco on September 4, 1929.

Both shipboard theodolites embraced a principle similar to the sextant, differentiating them sharply from the land pilot-balloon theodolite. The observer kept the balloon in view in the vertical plane by rotating a small reflecting prism around a horizontal axis, the angle of prism rotation measuring the balloon's elevation above the horizon line in an exactly analogous manner to measuring the altitude of a star with a marine sextant. When the balloon and the horizon line were brought into coincidence, the correct angle of elevation was read off the scale. No further adjustment of the setting was necessary from instant to instant to correct for pitch and roll of the ship, as both horizon and balloon shifted together in the field of view.

The optical arrangement is shown in figure 1 (p. 47) and the theodolite in figure 2 (p. 47). The magnification of the optical system is eight power and the field covers 6°.

When the horizon line was indistinct, either because of atmospheric obscurity or night, the observer could employ an artificial horizon formed by an ingenious small bubble device. On the cruise from Panama to San Francisco, however, flights were restricted to fair weather, during which the observer found the natural horizon much easier for the eye than the artificial. In using the natural horizon the balloon was seen between two parts of a horizontal line, whereas the bubble gave a reference only on one side.

The red and yellow color filters on numerous flights increased the visibility of the pearly surface of the balloon against a background of blue or whitish-blue sky. The routine use of a filter was found desirable for cutting down the scattered light from both the sky and the surface of the sea. A shade glass, designed to reduce horizon glare, helped on a few occasions to make the horizon line more distinct. The eye blinder, furnished as a cover for the eye not in use, reduced eye fatigue, and together with the eyepiece, supported the observer's head at the proper position.

The optical system was supported over an azimuth circle, which was itself carried by a base plate capable of being turned in azimuth. The azimuth circle had a slow-motion micrometer adjustment reading to one-tenth degree, but for rapid movement when picking up a balloon, this might be disengaged, and the whole head rotated.

Because the base plate was adjustable, the observer was able to set the azimuth of the upper circle to read 0 on north, and thus eliminate one step in the subsequent reduction of the observations.

The index prism, carried on a movable arc, was graduated to even degrees, and could be read to tenths by means of a micrometer drum.

For the purpose of making observations the theodolite, mounted in gimbals, was set up on a heavy tripod on the raised quarter-deck of the Carnegie. The legs of the tripod were chained to each other and set in rubber feet in order to grip firmly the deck. The theodolite had attached to it, below the gimbals, a large counterweight which could be made to exercise additional restoring force by attaching springs. Actually the observer found it most efficient to steady the theodolite by allowing the counterweight to slide over, or to be lightly held in his hand.

The most important alteration in the new theodolite No. 54005, which replaced Aero 1928 U.S.N. No. 15 used from October 23, 1928 to August 1929, consisted in orienting the optical system so that the observer looked downward at an angle of about 45°, instead of horizontally, into the eyepiece. The eyepiece was placed so that the observer could remain in a comfortable position without the strain of continuously keeping his eye lightly pressed against the moving eyepiece. Hitherto much difficulty had been experienced in keeping the eye uninterruptedly on the balloon, since in the rolling and pitching of the ship the eye could not quickly be brought into an easy observing position.

The azimuth circle in theodolite No. 54005 could be rotated about its spindle axis and clamped in any position, but the graduated base plate was not included in the new design. The operator could not, without considerable trial and error, set up theodolite No. 54005 with the azimuth circle reading 0°0 on north. The elimination of the graduated base plate considerably reduced the manufacturing cost of the theodolite, with the single disadvantage of requiring the computer to apply a constant small correction to the observed azimuth angles.

Hydrogen

Hydrogen for inflating balloons was carried on board in iron cylinders having a capacity of 200 cubic feet. The United States Navy supplied four cylinders at Panama, and subsequently replaced them, when emptied, by fully charged cylinders at the naval bases at Pago Pago, Honolulu, and San Francisco.

The balloons regularly used measured about 65 cm in diameter when fully inflated, so that the hydrogen in a cylinder measuring 200 cubic feet would, if no gas were lost, have filled forty balloons. Actually, considerable hydrogen was required in blowing out the long connecting tubes, and smaller quantities were lost by valves and connections, so that only fifteen balloons were filled from each cylinder.

The hydrogen cylinders were stored in the afterhold, and the hydrogen passed through about 30 feet of 1/2-inch rubber hose to the magnetic control room, where the balloon-filling apparatus was set up. One assistant stationed in the hold controlled the gas supply, and the whole filling operation was completed within about a minute after the connecting hose was flushed out with hydrogen. The inflation balance was supplied by the United States Navy and is of the type regularly used by this service.

The balloons were inflated to ascend with an approximate vertical velocity of 180 m per minute. To determine the free lift the formula employed is

$$V = 72\,(\ell^3/L^2)^{0.208}$$

where V = ascensional rate in meters per minute, ℓ = free lift in grams, L = free lift plus weight of balloon in grams. The following table, computed from the above formula, gives the free lifts used.

Balloon weight gram	Free lift grams
20	112.7
21	114.0
22	115.3
23	116.5
24	117.8
25	119.0
26	120.2
27	121.4
28	122.6
29	123.8
30	125.0
31	126.2
32	127.3
33	128.5
34	129.6

In accordance with the practice of the United States Weather Bureau, the rate of ascent for the first minute was increased 20 per cent, the second and third minutes by 10 per cent, and the fourth and fifth by 5 per cent.

Balloons

Balloons supplied were either black or in their natural color, tan. Observers followed black balloons to a maximum distance of 3000 m, whereas the tan balloons were in some instances followed to a distance of 25,000 m.

From Panama to San Francisco, 6-inch balloons weighing from 24 to 32 grams were used. Later on six flights were made with 9-inch balloons weighing 60 to 75 grams. Many more would have been made with the 9-inch size had it not been for the impossibility of carrying the inflated balloon through the doorways leading from the filling room to the quarter-deck. The only place such large size balloons could be inflated and weighed was in the after companionway, where it was tedious and difficult owing to drafts and the impossibility of installing permanent equipment for proper inflation.

During the cruise from Panama to Callao the experiment was tried of tying two balloons together to obtain a large object in the field of the theodolite. The observers believed that the distance to which the balloon could be followed was considerably increased. Owing to the fear, however, that the ascensional rate of the two balloons tied together would not be the same as for each balloon separately, this practice was given up after a few flights.

Only a very few balloons burst during inflation, and no inconvenience was experienced with oddly shaped balloons, nor was special care taken to inflate slowly. The balloons showed no sign of deterioration in the tropics, even after they were on board five months. The balloons were stored in sealed tins in the instrument room, where the temperature was approximately 30° C.

Balloon-Sextant

Since the observer had to steady the counterweight with his hand, he had, at times of rapid motion of the balloon, to make a choice between working the azimuth or elevation micrometer. The procedure developed was to keep the right hand adjusting the azimuth micrometer head. An additional observer watched the balloon through a sextant so that if the balloon were lost to the theodolite, the sextant gave its height, and the direction of the sextant pointing gave the approximate bearing of the balloon.

Captain Ault's report of March 14, 1929 describes the following expedient: "In view of the length of time required to hold up a sextant, and of the weight of the new balloon-sextant, it became necessary to devise some method for supporting the instrument. One of the deck chairs was provided with arms and two upright pieces supporting an overhead bar. A fine spring was suspended from this bar, and the sextant is now used hanging from this spring. The entire weight is supported at the height of the observer's eye and the freedom of motion is in no wise restricted. The chair can be moved to the most advantageous position on deck for observing the balloon; the ease of operation involves no strain on the observer's arms and it serves its purpose with a high degree of efficiency."

When the balloon changed more than 1 or 2 points in azimuth, the chair had to be shifted around so that the observer would be able to look directly at the balloon. The practical difficulties of following the balloon while shifting the chair were considerable, and these, and the hope of getting azimuths directly with the sextant, led to the design of a sextant chair (fig. 3, p. 48) on a rotating platform. This chair was rigidly attached to a small circular base about 80 cm in diameter, which rotated about a central pin, and was supported by rollers near the outer edge. The chair and rotating bases were carried on a small portable platform. The sextant was suspended by a coil spring from a crossarm carried above the observer's head from the back of the chair. A pointer attached to the supporting platform showed the azimuth of the chair on a scale of degrees marked on the rotating disc. When set up on the ship's deck the platform was arranged so that the chair reading was 0° when the observer looked in a direction parallel to the mid-line of the ship. The azimuth of the balloon was read directly from the scale as an assistant moved the chair around to face directly the balloon. Owing to the improvement in the new theodolite received at San Francisco, the sextant chair was not required so often after leaving this port, but in the earlier part of the cruise this expedient was of material assistance.

REDUCTION OF OBSERVATIONS

The wind velocity and direction corresponding to the balloon's height at various minutes after release from the ship, were computed by graphical methods on a plotting board. The procedure was along lines similar to those adopted for pilot-balloon observations at a fixed station on land. The plotting board permits the computer to see and to correct, not only errors in reading angles, but also those from the lurching and rolling of the ship.

The plotting board used was of United States Navy design with a circular celluloid sheet of 87 cm diameter, graduated in even degrees around the edge, and rotating about a central pin. A set of parallel vertical lines 1 cm apart was drawn on the rigid base beneath, but clearly visible through the movable celluloid sheet. The vertical line passing through the center of the board was subdivided for two scales--one for use with short flights when the distance from center to edge of board represented 8000 m, and the other for longer flights when the same distance represented 20,000 m.

The ship's track was laid off by turning the celluloid sheet so that the circle reading denoting the angle of the ship's heading lay over the azimuth arrow at the bottom of the board and pointed off the ship's position from minute to minute along the appropriate distance scale.

It was always assumed that the Carnegie maintained constant speed throughout the time of observation, the speed being determined from log readings at the beginning and end of the observation. When the ship changed her course during a flight, the celluloid sheet was rotated to the new heading at the moment of change. The ship's subsequent positions from minute to minute were indicated along the vertical line following on from the former course.

The horizontal projection (d) of a line from the ship to the balloon is

$$d = h \cot e$$

where h = height of balloon and e = angle of elevation.

For plotting the balloon's position at any particular minute, the celluloid sheet was turned until the angle at its edge read the same as the true azimuth of the balloon's position. From the ship's position for this minute and at the distance (d), a point was located on the vertical line toward the plotter. The horizontal projection of the balloon's course from minute to minute was thus laid down on the celluloid sheet.

As in ordinary pilot-balloon observations, the direction and velocity at any minute was obtained from the positions of the balloon a minute before and a minute after, making the usual assumption that this equalled the wind velocity for the air stratum in which the balloon was moving.

Table 1. Example of effect of steering error on computed wind velocities and directions

Minute	Steering error	True wind		Effect produced by steering error	
		Direction	Velocity	Direction	Velocity
	°	°	m/sec	°	m/sec
10	-1.1	....	....	.....	......
11	-0.8	233	5.5	+ 3	+0.4
12	0.0	226	5.4	0	+0.3
13	-0.2	211	6.3	+ 2	+0.3
14	+1.3	210	5.7	- 4	0.0
15	-1.8	220	4.3	- 3	-0.4
16	-0.1	224	4.8	+ 3	+0.4
17	0.0	233	4.2	+ 3	+0.1
18	+0.4	245	2.8	+25	+0.6
19	+3.4	240	2.9	- 2	-0.4
20	......	236	4.9	+ 6	-0.9
21	+0.4	....	....	.....	......
22	......	220	8.6	0	0.0
23	+1.5	....	....	.....	......

Errors in the computed position of the balloon in its horizontal projection arise largely from two sources: (1) at the time of observation either the balloon may not be centered in the eyepiece, or (2) the ship may have been off her projected course.

In the shipboard theodolite an error in centering the balloon in the field of view is relatively more serious than in the regular land instrument because of its larger field of view. This larger field is required to allow the balloon to be located easily. Since the field of the theodolite covers 6°, the error arising from the balloon being 0.1 of the radius off the center would be equivalent to an azimuth error of 0°.3. The error in the horizontal projection, due to an incorrect azimuth, decreases with the cosine of the angle of elevation, and increases directly with the distance away of the balloon. With a balloon at a distance of 10 km and at an angle of elevation of 45°, an error of 0.1 radius in centering in the eyepiece leads to an error of 36 m in the horizontal projection of the balloon's position.

The magnitude of the errors in the computed upper-wind velocity and direction arising from the steersman being unable to keep the ship exactly on her course may be obtained from a short series of readings made on December 30, 1928 in latitude 34°.0 south, longitude 91°.4 west. For fourteen minutes an additional observer read the ship's compass at the same instant as the observer at the shipboard theodolite read the balloon's elevation and azimuth. The data in table 1 show that considerable errors are introduced into the computed wind directions and velocities by comparatively small errors in steering. The wind was blowing Beaufort force 4 and the Carnegie according to the report was under "regular sailing conditions."

The largest steering error is 3°.4 on the nineteenth minute, which produces an error of 25° in the wind direction in the eighteenth and 0.9 m per second in the wind velocity on the twentieth minute. The large errors do not occur in the values for the nineteenth minute, since these depend on the readings for the eighteenth and twentieth minutes. It may be pointed out that errors of this magnitude in wind direction occur almost entirely with light winds.

WIND FORCE (Beaufort Scale)

0	calm
1	light airs
2	light breeze
3	gentle breeze
4	moderate breeze
5	fresh breeze
6	strong breeze
7	high wind (moderate gale)
8	gale (fresh gale)
9	strong gale
10	whole gale
11	storm
12	hurricane

The ship was assumed to have constant velocity, which is probably correct within the limits of observation.

A good helmsman may, in moderate winds, permit the ship to run a quarter-point off course. During the pilot-balloon flights special precautions were taken by the helmsman to keep the ship on her course. During a few periods of calm and adverse winds the Carnegie was hove to during a flight. It was then impossible to keep the ship's heading steady during the observations. Because of the varying azimuth, one observer stationed at the ship's compass read the magnetic direction on hearing the recorder's signal to read the theodolite. The compass reading was then corrected for declination and the true azimuth obtained. This procedure was found tedious in practice, so that only a few flights were made under these conditions.

Rolling and pitching of the ship are generally revealed by irregularities in the plotted positions of the balloon from minute to minute. When there was a continuous change in the balloon's elevation for three or four minutes, however, the resulting values of wind shift were considered in every case to be genuine. The Carnegie's periods of roll and of pitch were less than ten seconds. Especially in times of light wind, if the balloon was some distance from the ship, the balloon's plotted positions were at times irregular, although taken over a period of ten minutes the direction of wind motion appeared definite enough. These minute-to-minute irregularities may, of course, be owing to turbulence, but it seemed more likely they were of observational origin. From this point of view, changes in azimuth readings, which led to violent wind shifts but continued only for a stratum of 250 m or less, were disregarded and the movement over five minutes rather than one or two minutes considered.

Considerable judgment was used in accepting the data for the last minutes of a flight if they fell rapidly out of line with preceding data. Frequently it would appear that the ship had been swinging and when it righted itself the azimuth angle quickly changed its direction, so that the observer failed to locate the balloon again on the new course.

PROCEEDURE

Efforts were made to obtain a pilot-balloon flight on every day it seemed probable that the observer could follow the balloon for at least ten minutes. It required about thirty minutes for unstowing the theodolite, setting up the inflation balance, inflating the balloon, and making minor preparations for a flight. On a number of occasions during the period of preparation, weather and sky conditions changed materially, so that the balloons were lost at low altitudes in quickly formed low clouds.

The Carnegie could not be maneuvered so as to remain at one point during the period of a flight. The general procedure was to set the ship's heading so as to keep a steady course. If, while on this course, the balloon went behind the ship's sails or rigging, a new course was chosen, which it was considered would bring the balloon in sight for a considerable time. In calm weather, or when the winds were so light that the helmsman could not keep the ship on a course, it was the practice to start the small auxiliary engine, which gave the Carnegie a speed of five or six knots and allowed a good course to be sailed.

METEOROLOGICAL CONDITIONS DURING PILOT-BALLOON FLIGHTS

The meteorological log of the Carnegie with entries of weather conditions, constituted an invaluable record for interpreting the upper-wind data. Unfortunately, the meteorological log was destroyed with the Carnegie in Apia harbor. Captain Ault had made an abstract of the ship's log for each leg of the cruise, however, which he forwarded immediately after the Carnegie reached a port of call. Meteorological observations were made regularly at Greenwich mean noon, and observers noted certain weather conditions during atmospheric-electric determinations. From all these sources a fairly comprehensive account of the prevailing weather has been compiled for periods when pilot-balloon flights were made.

CLOUDS

Cirrus	Ci
Cirro-Stratus	Ci-St
Cirro-Cumulus	Ci-Cu
Alto-Stratus	A-St
Alto-Cumulus	A-Cu
Fracto-Cumulus	Fr-Cu
Strato-Cumulus	St-Cu
Nimbus	Nb
Cumulus	Cu
Cumulo-Nimbus	Cu-Nb
Stratus	St

Flights 1 to 4, October 27 to 31, 1928

The first four flights were made in the Gulf of Panama from October 27 to 31, 1928. Owing to low cumulus or nimbus clouds on three occasions, and once largely to the observer's inexperience none of the balloons were followed higher than 1 km. The surface winds of Beaufort force 3 or 4 varied from west to southwest. On three out of four flights the west-southwest surface winds turned to a more northerly direction, the mean velocity apparently increasing from 5.4 m per second at the surface of the ocean to 7.4 m per second at levels of 0.25 and 0.50 km. The observed west-southwest surface winds agree with those shown on the United States Pilot Chart of the South Pacific Ocean for the September-November quarter, and represent an inflow of colder air from above the waters at abnormally low temperature off the South American coast [1]. This area, forming the eastern extremity of the doldrums of the Pacific, lies protected behind the mountains of Panama and Colombia, which interrupt the regular east-west circulation of the atmosphere. At lower levels there are doubtless strong upward vertical currents which cause the cumulus clouds observed. The weather during the week these flights were made was characterized by frequent rain squalls and variable winds with thunder and lightning reported on October 27 and 28. All these are indications of the strong convection going on in this area.

Flights 5 to 8, November 9 to 17, 1928

Owing to continuous overcast and cloudy weather from November 1 to 9, no flights were made. The Carnegie in these eight days sailed only 626 miles. The equator was crossed on November 6 with southwest breezes generally occurring. Flights 5 to 8 were made as the Carnegie sailed westward, just south of the equator, from 85°.2 to 105°.4 west. The surface winds blew from south or southeast, the typical trade-wind condition existing at all seasons in this area. According to the United States South Pacific Pilot Chart the winds blow 85 per cent of the time from south or southeast on an eight-point wind rose. Despite its great constancy at sea level, the southerly current was very shallow, being displaced by northerly winds in every flight below 2.5 km. Table 2 shows the complexity of the winds from 1 to 4 km above the ocean.

Table 2. Wind directions in flights 5 to 8, showing complexity of winds immediately above southeast trades

Flight	Date	Wind direction				
		Surface	1 km	2 km	3 km	4 km
	1928					
5	Nov. 9	S	S	NW	N	NNW
6	11	S	NW	S	E	SSW
7	15	SE	ENE	NE	E	SE
8	17	SSE	SSE	ESE	ESE	ESE

Flight 6 was made about 40 km from one of the Galapagos Islands, so that the numerous changes in wind direction observed in this flight may have been because of effects set up by this island group.

Flights 9 to 16, November 19 to 25, 1928

These flights were made as the Carnegie sailed southward across an area where southeast trades generally prevail. The Carnegie experienced fair weather with southeast or east-southeast breezes and trade wind; there were cumulus clouds chiefly around the horizon. The surface winds turned from east-southeast to east below 1 km, and in the single flight above 2 km this rotation continued to northeast at 3.5 km, which was the greatest height reached.

Flights 17 to 29, November 26 to December 26, 1928

The Carnegie ran out of the southeast trade winds about latitude 20° south. From this parallel of latitude southward to 40°.4 south the winds were variable, but mostly from the east. From November 26 to December 6, when the Carnegie reached Easter Island, the winds were light; drizzling rain fell on the evening of November 29, and rain squalls occurred on November 27 and 30, and December 4 and 5. The Carnegie sailed from Easter Island on December 12, 1928, going in a general direction southward and on December 26 reached the extreme southernmost point of the cruise--40°.4 south, 97°.4 west. The barometer reading, 773.7 mm, taken here near the South Pacific high-pressure center, was the highest recorded during the cruise. Light to moderate breezes prevailed, and the skies were comparatively clear, except for a ring of clouds around the horizon. On December 22 in latitude 36°.9 south, 104°.1 west, fog continued all day and generally hazy conditions were observed for the following week. Rain squalls occurred on December 13, 14, 15, and 19.

The surface winds from latitudes 20° to 25° south were easterly and from there to 31° south, from northeast. In all cases the winds at increasing heights to 3 km above the sea turned counterclockwise to a more northerly direction. The three flights observed up to 6 km show a general change back to southeast at this level, whereas flight 21 on December 21 shows southeast winds up to 11 km. In all cases the winds were very light, having a mean velocity based on all three flights from 3 to 6 km of only 3.6 m per second, which is also the mean value of the scant data to 11 km.

Flights 27, 28, and 29 made on December 18, 20, and 26, although covering a period of eight days and made at points 1700 km apart, showed much similarity of air motion at all levels. The northeast surface winds became northwest at 1 km and remained from this direction to a height of 9.5 km, with an extreme observed velocity of 11 m per second.

Flights 30 to 34, December 30, 1928 to January 8, 1929

These flights were made as the Carnegie sailed northward across the center of the South Pacific high-pressure area during the southern midsummer. Except on January 7, when drizzle and rain occurred in the afternoon, the weather was pleasant, with light breezes or airs generally from southeast and cumulus clouds chiefly around the horizon.

At the instants of releasing the pilot balloons, the surface winds were once each calm, southeast, northwest, west, and south-southeast, showing the variable nature of the surface winds. At increasing height above the surface the winds turned through south to a definite southwest drift, which increased in velocity with height. The stratum from 1 to 2.5 km has the most pronounced drift from the south, with velocities of 5 to 6 m per second. The westerly winds above this height have higher velocities, one of the highest wind velocities observed during the cruise being 19 m per second from west-southwest at a height of 7.5 km in flight 34 (latitude 24°.8 south, 82°.1 west). The outstanding feature of these data is the uniformity over a wide extent of southwest winds at levels above 2 km.

Flights 35 to 39, January 12 to February 6, 1929

Flights 35 and 36 were made near the South American coast en route to Callao in an interval of almost uninterrupted overcast skies. After remaining in Callao harbor from January 14 to February 5, where flight 37 was made, the Carnegie sailed for Papeete, Tahiti. Flight 38 was made on the following day, February 6, in pleasant weather with gentle southeast breezes. All flights except no. 35 showed northwest winds above 1 km, in opposition to the strong surface southeast trades. In flight 35 southeast winds were found to 4.5 km, probably owing to a low pressure developing off the coast of Chile.

Flights 40 to 49, February 7 to 16, 1929

This group of observations was made as the Carnegie sailed westward from Callao to Tahiti in the first 20° of longitude west of South America. Southerly to southeast breezes and airs persisted throughout, with considerable clouds round the horizon, but no rain fell. Flights 40 to 42, made at 14h 12m, 15h 54m, and 17h 48m on February 7, showed the same upper winds as found in the flights made nearer the coast. The southerly surface winds turned to northwest at heights of 2.5 km. In both flights 43 and 44, taken on February 9 and 11, a thin northwest stratum was found, but flight 43 had above this west-southwest winds to 6 km, and flight 44 had west winds. It would thus appear that the west-southwest and westerly winds reach to considerable heights above the southeast trades as one moves out toward the Central Pacific from the Peruvian coast.

Flights 45 to 47, made on the afternoons of February 12, 13, and 14, all showed a remarkably solid current from 4 to 5.5 km moving from northeast, but above 8 km the flights on February 12 and 14 showed northwest winds, with velocities on February 12 averaging 16 m per second at these levels. Flight 48 showed this abrupt change to northwest at 4.3 km, but the observers reported that at this elevation the balloon was lost through haze or distance, probably caused by a slight amount of fog at the surface of discontinuity.

Flights 50 to 59, February 17 to 25, 1929

These flights were made toward the close of the southern summer, about 14° south of the equator, midway between the Tuamotu Archipelago and the Peruvian coast. The weather continued fine and without rain, except for a brief drizzle at 5 a.m. on February 17. The cloudiness ranged from 1 to 8, with a daily mean of 4, recorded in every entry as chiefly on the horizon.

Whereas the surface winds along this parallel from 80° to 100° west longitude had been southerly, the surface winds from 100° to 110° west shifted to southeast, and from 110° to 120° west, farther to east or even slightly north of east. The southeast winds reached a maximum height of 4 km on February 17, but the change in constancy from 0.95 at 1.5 km for a resultant direction of 116° (east-southeast) to a constancy of 0.55 at a height of 2.5 km, and 0.25 at 3 km, indicates that the average height of the southeast winds in the central tropical South Pacific between 10° to 15° south lies between 2 and 3 km. Although the computed resultant is northeast at 3 km, the winds in almost every case turned through south to southwest and northwest.

The highest observation at 7 km showed west-northwest winds at this level. The four balloons reaching 6.5 km had directions 285°, 210°, 268°, and 286°. All these flights exhibit great uniformity over an east-west distance of 2000 km, especially as the value of 210 is rather questionable because the choppy sea made observations difficult.

Flights 60 to 68, February 26 to March 7, 1929

These flights were made for the greater part about latitude 17° south in the eastern outskirts of the Tuamotu Archipelago. This very thinly scattered group of coral islands of the Pacific rarely has an elevation of 50 m above the surface, yet it may exert considerable effect on the air currents in this region of the Pacific. Tatakoto Island was sighted at 5:30 a.m. on March 7, and Amanu Island on March 8 at 5:00 a.m. Gentle easterly to southeast breezes and airs blew steadily for ten days except for March 5 and 6 when the winds moved around to east-northeast and northeast, bringing on a rain squall at 1:30 a.m., March 6, followed by a 36-hour period of calm. Drizzling rain and a rain squall occurred between 1:00 and 3:00 a.m. on February 27, but otherwise the weather continued extremely pleasant with the usual clear blue tropical sky, and the horizon fringed about with cumulus clouds for heights between one and four tenths of the whole sky.

The winds show great uniformity of motion, especially up to a height of 1.5 km, the direction turning slowly from east-southeast almost to northeast at a height of 1.5 km, and then turning back to east at a height of 2.5 and 3 km. From 3.5 to 4.5 km there is great variability of direction, but above this the winds turn very definitely to northwest.

On March 5 a very high flight reaching 10 km was made, which showed solid but light southwest winds from 3.5 to 8 km. The northeast stratum, which for the previous week lay from 0.25 to 0.75 km above the east-southeast stratum, actually broke down through the trades and came to the surface on March 6. This interruption of the trades was responsible for the rain squalls on March 6. The southwest winds persisted at levels from 4 km from March 4 to 12. The change from northeast to southwest winds, as shown diagrammatically in figure 34 (which shows resulting data for flights 61 to 70), is very abrupt, but in the majority of cases the winds in the transition layer are southeast rather than southwest.

Flights 69 to 83, March 10 to April 23, 1929

These flights were made while the Carnegie was passing through the Society and Samoan island groups between 18° and 10° south, slightly west of the central line of the South Pacific Ocean. Of this time, March 13 to 20 was spent at anchor at Papeete, and April 1 to 10 at Pago Pago and Apia. Rain squalls occurred from March 10 to 22, 24 to 28, 30, and 31, that is, on all except two of fourteen days at sea prior to reaching Pago Pago harbor. Lightning was observed on March 10 and 25.

Surface winds between Tahiti and Samoa were variable, but in flights 82 and 83, made after leaving Apia, southeast trades were blowing up to 1 and 4 km, respectively.

Flights 84 to 91, April 24 to 30, 1929

These eight flights were made between 8° south and 0°.5 north latitude as the Carnegie sailed almost due north from Samoa in longitude 171° to 174° west. Although a few rain squalls occurred on April 24 and 25, the weather was good, with relatively few clouds and light variable airs.

The upper winds were also light, but very uniform in direction from almost due east up to 2.5 km. Above this there was a turning to southeast with extremely light velocities above 4 km, the mean for the three flights available from 4.5 to 5.5 km being only 1.6 m per second.

This is the equatorial area, where the most prominent feature is the easterly drift of air.

Flights 92 to 95, May 4 to 9, 1929

Short wind squalls with rain occurred every day during this period, with skies generally half overcast. The northeast trades blew fresh to strong during the whole time, setting up choppy or moderate seas. Both factors combined to make observing difficulties so great that the highest flight reached was only 4.5 km, and the other three could not be followed above 1.5 km. These few flights showed generally a slight turning from northeast to east from the surface up to 4 km.

Flights 96 to 103, May 13 to 27, 1929

This group of eight flights was made in the general vicinity of the Marianas, the Carnegie having been moored in Port Apra, Guam, from May 20 to 25. From May 13 to 20 the Carnegie sailed west-southwest, making long day's runs in the favorable moderate to fresh southeast breezes prevailing. Lightning was observed in the early morning of July 15 at about 18° north, 205°.3

west, with a rain squall at 10 a.m. and heavy rain the following morning. During the three days' passage northward, from Guam to 20° north, the winds were moderate to gentle from east-northeast to east, with little cloud and generally fair weather. There were two brief periods of drizzling rain in the early mornings of May 26 and 27.

Flights 104 to 110, May 28 to June 5, 1929

This group of seven flights was made while the Carnegie was sailing northward from Guam to Yokohama, between the meridians 215° and 220° west. For the last three days of May moderate to gentle breezes and airs between east and south prevailed, occasionally broken by short periods of calm. The sky on all days of these flights was comparatively free from clouds although there was considerable haze, and on two days, May 29 and 31, there was dew during the evening. During June 1 to 7, in increasing northerly latitudes, the cloudiness increased with much haze. The surface winds varied in force, but were generally southerly to westerly. The Manila Observatory reported by radio on the night of June 1 the positions of a typhoon on two previous days. These reports indicated that the typhoon would intercept the Carnegie's track in a few hours.

Captain Ault gave the following report on the passage of the typhoon: "The Barometer had dropped 4 mm during the preceding eight hours, and it seemed wise to head east by south and place the vessel in a safer position to avoid the path of the storm. After we had been running eastward for two hours, the barometer began to rise and the wind moderated, so we hove the vessel to and waited for wind and sea to moderate further. After another wait for two hours, course was again set toward the northwest, the vessel riding on the tail of the typhoon. The wind continued to shift to the right, showing that the storm had passed on to the eastward."[2]

On June 6, not far from Tokyo Bay at the entrance to Yokohama, the Carnegie passed very close to another typhoon center.

Flights 111 to 118, June 25 to July 3, 1929

These eight flights were made off the coast of Japan as the Carnegie sailed northeast from Yokohama on a great circle course to San Francisco. After July 3, when the Carnegie was in 40°.4 north and 209°.0 west, bad weather with almost continuous fog and mist set in, so that no further pilot-balloon observations were made for the following nineteen days during the cruise of 5200 km across the northern Pacific. As a description of the typical weather prevailing, except that the winds were easterly rather than westerly, the entry in the log for July 8 is given: "Overcast throughout with mist, fog, or drizzling rain; moderate to gentle south and west breezes; moderate sea." The weather during the first week's voyage northeast from Yokohama was generally overcast, with light breezes and airs from between south and east. Hazy conditions were frequently observed even at distances of 700 km from land.

All these flights were made on the southwest outskirts of the Aleutian low-pressure center. Although the surface winds were fairly uniform, being at the times of all flights, except one, from the quadrant between south and east, the winds from 0.5 km upward were extremely variable from day to day, their frequent variation, characteristic of these latitudes, owing to the progression of centers of high and low pressure across the North Pacific.

Flights 119 to 122, July 21 to 26, 1929

These four flights were made far from the North American coast as the Carnegie sailed on a southeast course to San Francisco. The weather over the period was generally overcast, and rain was recorded every day except July 21. Winds from July 21 to 25 continued from west to south, but then changed to a strong northerly breeze on July 26. The barometer, which was rather low (760.6 mm) on July 21, continued to rise steadily from day to day until it reached 768.5 on July 26. This general pressure rise was because of approaching the semipermanent high-pressure center off the coast of California.

Flights 123 to 130, September 8 to 14, 1929

The Carnegie left San Francisco on September 3 equipped with a new pilot-balloon theodolite and new supplies of balloons and hydrogen. Owing to overcast skies, the first flight was not made until September 8, but flights continued daily after this until September 14 when the Carnegie crossed the 140th meridian. The weather was generally fine, with rather cloudy skies but without rain for six days, except for a shower at 6:30 a.m. on September 14. From September 6 to 9, northwest breezes and airs blew fairly steadily, except for intervals of gentle northeast breezes which, however, continued without interruption through September 10 and 11. From September 12 to 14 the winds were continuously from the southeast quadrant. The barometer fluctuated considerably from day to day in a general level of high pressures.

On September 8 and 10 the pilot balloon was lost in cloud at 1 km, and on the 9th at 2.5 km, all winds up to these levels having been from northeast. On September 11, above a thick stratum of northeast winds, southeast winds were found at a level of 3 km. On September 12 and 13 the surface winds were southeast and continued so to a height of 1 km, above which they were variable to 3.5 km. At this height moderately strong southwest winds were observed, which on the following day were found to blow from the surface to 4.5 km.

Flights 131 to 139, September 16 to 24, 1929

This group of ten flights was made as the Carnegie moved west-southwest from the 140th meridian to Honolulu. After the southeast winds of September 15, 16, and 17, due to the passage of a depression, moderate breezes usually between northeast and north blew until September 22, when in proximity to the Hawaiian Islands gentle east-southeast to easterly breezes were encountered. With the favorable following northeast wind the Carnegie had good daily runs in her west-southwest course, making 177 miles on September 19, and averaging 135 miles from September 17 to 22. Skies were partly cloudy to overcast in morning and evening, but clear about midday, except for the usual cumulus clouds around the horizon. These flights show, from the surface up to 4 km, a general northeast to east drift, occasionally getting around as far as east-southeast.

Flights 140 to 144, October 3 to 7, 1929

The Carnegie left Honolulu on October 2, sailing a course a little west of north until reaching latitude 34° north on October 8. Flights 140 to 144 were made on October 3, 4, 5, and 6. The weather was generally fine, although a few drops of rain fell during the afternoons of October 3, 4, and 5. The sky was about half overcast for the whole period, slightly more cloud being encountered in the more northerly latitudes. The surface winds blew very steadily from between east and east-northeast, with a force varying between fresh and moderate breeze, enabling the Carnegie to make almost 170 miles a day.

Flights 145 to 150, October 7 to 13, 1929

These flights were made along the 34° parallel of latitude to the northward of the Hawaiian Islands as the Carnegie sailed eastward in the northern part of a great loop of her cruise to Pago Pago, Samoa. The weather was broken and squally with either showers, drizzle, or moderate rain every day except October 10. The sky was mostly overcast, and the surface winds very variable. At higher levels the winds blew very steadily from west-southwest with velocities from 4 to 10 m per second. On October 10, although the surface wind was only a light northwest air of Beaufort force 1, above 1.5 km the west-southwest winds were notably strong, blowing from 7 to 10 in force.

Flights 151 to 153, October 17 to 19, 1929

These three flights on October 17, 18, and 19, form a group centered about latitude 26° north--which is 1100 km--about four days' run from the nearest preceding and succeeding flights. Balloons were not released October 14, 15, and 16 because of squally and threatening weather with rain showers and overcast or mostly overcast sky. On October 17 and 18, however, the sky was mostly clear, and calms or light breezes from a southerly direction persisted. On October 19 there were frequent rain squalls, but in a brief clearing at 1 p.m. a flight was made, the sky being almost wholly overcast during the rest of the day. The flight on October 17 showed westerly winds from the surface to 8 km. In flight 152 on the following day, westerly winds did not set in up to a height of 5.5 km, but persisted to 8.5 km, whereas on the third day the winds above the surface blew from southeast to a height of 2.5 km, where the balloon was lost.

Flights 154 to 156, October 23 to 26, 1929

These flights were made as the Carnegie sailed southward along approximately the 138th west meridian in the northern limits of the northeast trades. On October 23 and until the afternoon of October 24 the surface winds blew from between east and north. In the afternoon these winds dropped to calm, broken by brief spells of light and variable breezes from the southwest quadrant. These overcast skies and frequent spells of rain continued on October 24 and 25, preventing any balloon observations. On October 26, with a smooth sea and light northwest breezes and airs, the balloon was followed to 3 km, and on the following day, with calms and easterly airs, to 7 km.

Flight 154 showed strongly developed northeast trades from the surface to 1 km, with southwest winds-probably antitrades--from 3 to 4.5 km. Although at the surface northwest breezes continued throughout October 26, flight 155 shows this northwest stratum is very thin, being overrun by the northeast trades. Above the trades from 1.5 to 2.5 km a transition layer moving from southwest was observed on both October 23 and 26. On October 27 light northeast winds reached 2.5 km, above which level the winds were more an easterly drift to 5.5 km, when a definite south wind was observed to a height of 6.5 km. On the morning of October 28 the Carnegie experienced southeast winds, showing that the northeast trades were slowly carving a tunnel for themselves under the warm southerly current.

Flights 157 and 158, October 28 and 29, 1929

These flights, taken 8° north of the equator, showed the northeast trades well developed reaching to 5.5 km. It is remarkable that the northeast trades did not come down to the level of the ocean; the surface winds, however, were light and variable, blowing between southeast and northeast with Beaufort force 1 to 3. The sky continued for two days half overcast, with showers developing in the afternoon of October 28 at 14h 42m and 18h 54m.

Flights 159 to 166, November 4 to 11, 1929

These eight flights, lying between 140° and 160° west longitude, were made while the Carnegie was going southward from 3° north to 9.°4 south latitude. These flights were made a little more than six months after the group 84 to 91 on April 24 to 30, both at a time of the year usually unsettled by the change from the wet to the dry season. No rain occurred during this period, however, although the skies were reported as "partly cloudy" or "partly overcast" on all except November 7 and 8, when they were reported as "mostly clear."

The surface winds showed a curious transposition of the trades. On November 4 and 5, while the Carnegie was north of the equator, southeast breezes to light airs were experienced, whereas south of the equator the winds were northeast, varying from moderate to gentle breezes. The surface southeast trades were found from the pilot balloons on November 4 and 5 to be a very shallow stratum, reaching only 1 km on November 4 and 1.7 km on November 5. Above these southeast winds there is a uniform movement from northeast, and the observations as far as they go show northeast winds to 4 km. Flight 159, made 3° north of the equator, showed northeast trades with the relatively high velocity up to 10 m per second at a height of 3.5 km. When the other two flights reached above 3 km in latitudes 7° and 8° south, the winds were very light and decreased sharply from the velocities at 2 and 2.5 km. This velocity decrease doubtless is owing to the thinning out of the northeast trade air mass as it projects itself southward over the equator. The presence of northeast winds so far south of the equator at this season is not unusual, as a few unpublished observations from Nassau Island have indicated.

Flights 167 to 171, November 14 to 17, 1929

These flights were made northeast of the Samoan Islands between latitudes 10° and 14° south. Light breezes from north to east were continuous from November 11 to 15, when southeast and south airs were recorded in the afternoon, and though interrupted by long periods of calm, were observed until November 17. On this date, after slowly going through southwest, west, and and west by north, the winds settled down from northwest. The weather continued beautifully clear and without rain, so that the balloons were followed to considerable heights. The winds altogether were extremely variable owing to the conflict between northeast and southeast trades. Thus, at a height of 0.25 and 0.50 km on November 11, 15, and 16, winds were northeast, whereas on November 14 and 17 southwest winds occurred at these levels. In general the northeast trades dominated the situation southward to latitude 13° south up to a level of 4 km, but on November 15 and 16 southeast winds occurred above the northeast current from 3.5 to 8 km.

GENERAL CIRCULATION OF WINDS OVER THE TROPICAL REGIONS OF THE PACIFIC

The pilot-balloon observations made over considerable areas are advantageously discussed together to obtain a picture of the general circulation of the atmosphere. The upper winds in individual flights reflect not only the permanent or seasonal conditions, but also the passage of ephemeral centers of high or low pressure. These passing conditions of weather have been dealt with in the previous section and only the permanent state of atmospheric movement will be discussed here. Fortunately, most of the Carnegie flights were made within the tropics where the regularity of weather conditions is unbroken except for the passage of cyclones. Little generalization can be made from the flights in temperate latitudes until further data which will include temperature and humidity have been obtained. The only aerological observations over the South Pacific that have been published are those taken by Dr. Harry Meyer in 1909-11 and analyzed by P. Perlewitz [3].

Shallowness of Southeast Trade Winds Off the Peruvian Coast

The southeast trade winds in the eastern South Pacific from the equator to at least 15° south become a very shallow layer as they near the coast of the South American continent. Within 200 km of the Peruvian coast the northwest wind develops definitely at levels of about 1 km. In the few mountain stations in Peru, where wind observations are recorded, the surface winds as shown in table 3 blow mainly from between north and west [4].

Table 3. Frequency of winds from northwest quadrant at Peruvian stations

Station	Latitude S	Longitude W	Elevation	Annual frequency			
				W	NW	N	Total
	°	°	m	per cent	per cent	per cent	per cent
St. Ana	12.5	72.8	1040	24	5	27	56
Arequipa	16.4	71.6	2451	13	45	18	76

The wind shift from southeast to northwest is extremely abrupt, so that the top of the southeast trades lies only 200 to 500 m below the stratum of northwest winds. The shift is regularly from southeast through south and west.

A series of cloud observations by R. deC Ward made at Arequipa, Peru in October-November showed without exception 194 cirrus observations from the northwest quadrant. Cirrus clouds occur in equatorial latitudes between 10 and 15 km high, and, since both balloon and cloud are in agreement in showing northwest winds at these heights, the northwest current, at least during the months September to December, forms a deep current, which is constant in direction from a height of 10 km or lower up to the stratosphere. In the Carnegie observations made between latitudes 85° and 90° west the mean height of the wind shift from the southeasterly direction to northerly occurs at about a height of 1 km. Just south of the equator the discontinuity surface between trades and antitrades slopes up more abruptly nearer the continent, and occurred at 1.8 km in flight 5, which was made 500 km off the coast. In flight 6 at 1000 km from the coast there was no wind shift up to 6.2 km, whereas flight 7, farther to the west, showed southeast winds to 5 km. The upper limit of the easterly drift over great areas of the central South Pacific lies between 3.5 and 6 km, but the southeast trades on many flights do not reach 1.5 km.

The origin of these northwest winds within 20° of the South American coast arises from the flow of northeast trades across the equator, where their direction is changed by the force of the earth's rotation. In the eastern Atlantic off the coast of Africa the trades are similarly shallow, and are also found at greater heights as one goes west to the central and western Atlantic [5]. The northeast trades are made up in large measure of a great current of air which has crossed Central America at low points in the mountain range. This outflow represents the emptying of polar air, which, in its previous history, traversed the central United States and finally here combines in the great equatorial circulation.

Upper Winds Over South American High-Pressure Area

The upper winds in the great area extending from longitude 100° east to the coast of Chile would appear from the few flights available to be from the southwest. Along the Chilean coast at Iquique, Caldera, Valparaiso, and other sea-level stations, the prevailing wind blows from the southwest. In flights 30 to 34, made between longitudes 100° and 120° west, the southwest stratum was observed in all except flight 32. The thickness of the southeast trade wind layer above which southwest winds blew was 1.2, 0.7, and 3.9 km on three flights. Northerly winds persisted to 5.7 km in flight 32, probably owing to a small low-pressure center which developed nearer the South American coast, the barometer falling from 767.3 to 765.4 mm in a change of 250 km in the ship's position.

During January and February, while the Carnegie was in the South Pacific, the center of the great whirl of winds around the South Pacific high-pressure area was just south of Easter Island. The observed wind velocities above 3 km were very light over this area, and the directions generally from east or north in flights made north of latitude 30° south, whereas south of this latitude winds were generally westerly. The two high flights revealed light southeast winds from 8 up to 11 and 12 km. This South American high-pressure area with cloudless sky is like the "Azores high," a region of strong downward currents, but with very light horizontal movements to the highest levels of the troposphere.

Trades and Antitrades Between Longitudes 100° and 140° West in Latitudes 15° to 20° South

Not only the balloon flights, but also the Greenwich noon observations made from latitudes 15° to 20° south, show that the surface winds constitute an easterly current of extraordinary uniformity in direction from longitudes 100° to 140° west. The eastern half of this section is entirely free from oceanic islands, and in the western half only the low coral islands of the Tuamotu Archipelago raise themselves a few meters above the surface of the ocean. Their effect, however, on the great atmospheric circulation is probably out of all proportion to their size.

From longitudes 100° to 120° west the surface winds have a southerly component and a force of 3 to 5 Beaufort force (4 m to 12 m per second), whereas from longitudes 120° to 140° west the winds are more nearly due east or with a northerly component and a slightly reduced velocity, varying usually between the limits of 2 and 4 Beaufort force (2 m to 7 m per second). The southerly components generally disappeared from 1 to 2 km above the surface, so that the winds developed into a great easterly drift with its greatest velocity at the bottom. From longitudes 120° to 135° west, above this easterly drift, setting in at a mean level of about 3 km, is a west-northwest wind. The shift from east to west-northwest winds is not abrupt, but above a layer of stagnant or lightly moving air. The exact height at which the northwest current makes its appearance seems to be variable from 2 to 6 km. The velocity of the northwest current in the stratum from a height of 6 to 7 km is of the order of 6 to 10 m per second.

The flights showed that the northwest current probably reached 8 km, but an upper limit was not indicated. The southeast trade winds exhibited the remarkably high constancy of 0.95 or more to a height of 1.5 km.

Trades and Antitrades in the Central Area of the South Pacific Ocean

From longitudes 133° to 140° west the data indicate that above the southeast trades an inflow of air from south-southwest sets in at levels from 2.6 to 3.3 km and continues from a southerly direction to considerable heights. One flight reached a height of 5.5 km and another 10 km in the southerly current.

Although further observations may not confirm the existence of a southwest current above the trades at a point so far to the east in the Pacific as the meridian of 133° west, it may be noted that at Apia Observatory, Samoa, 30° farther west, a long series of observations has shown that at a height of 12 km a very strong southwest current exists throughout the year, but its lower level varies with the season. From January to June, the same season in which the Carnegie observations in this area were made, the upper winds at Apia begin to show a definite southerly component at heights between 4 and 6 km. After turning through southeast, the winds pass into the southwest quadrant between 7 and 11 km. In the distance to Samoa unfortunately few flights reached this height, but in flight 71 south-southwest winds were found from 3 km until the balloon was lost at 4.5 km. In flight 77, above a very thick calm stratum, south winds developed at 6.6 km and continued to 12.5 km, whereas flight 80, made near Samoa, had south-southwest winds above 6 km.

In passing through the Society Islands in the belt between latitudes 20° and 12° south and from longitude 140° west to Apia, Samoa, the surface and lower-level winds, though mostly between east and north, were frequently from the northwest quadrant. The typical southeast trades were rarely observed. This northerly component of the atmosphere at the lower levels has been confirmed both by the Apia upper-air observations and by the Carnegie observations made on her second visit to Samoa in November 1929.

Winds in the Equatorial Region of the Pacific Ocean

Two series of flights were made in the equatorial region of the Pacific, the first in April-May along the meridian of 175° west and the second in October-November in longitudes 145° to 155° west. Along both these cross sections easterly winds were found to prevail at the surface, being for 5° on either side of the equator more commonly east-northeast than from a southerly direction. The east-northeast surface layer near the equator varied from 400 to 800 m in thickness, and had a mean velocity at 500 m of between 5 to 12 m per second, thus setting up a vigorous circulation in a region where doldrums might be expected.

Above the easterly winds to the south of the equator and more especially from latitudes 7° to 15° south, southerly winds were found, which turned to southwest at heights from 3 to 8.5 km. In the region from longitude 190° to 210° west and latitudes 15° to 20° north the winds were from east and east-southeast up to levels of 6 km, although in flights 96 and 97, extending beyond this height, there was a shift to east-northeast above 6 km. In the few isolated observations made about 1000 km northeast of the Marshall Islands east-northeast winds blew from the surface up to the greatest heights. These winds are controlled by the great high-pressure center north of the Hawaiian Islands, which is increasing the area under its influence during May to June. E. A. Beals has found at Guam for the greater part of the year east-northeast winds from the surface to the limit of observation [6]. These are set up by the enormous insolation over Australia. This east-northeast drift has great uniformity of velocity with a mean velocity at 0.50 km above the surface of about 8 m per second, and decreasing gradually to 5 m per second at levels of 6 to 8 km. The observations were made not far from a line of divergence, the air to the north moving northward, as was frequently found in the next group of Carnegie flights, whereas to the south the winds move southeast.

Along meridian 216° west from 25° north to Yokohama (35° north), the prevailing winds were from south or west at the surface, turning to a uniform southwest drift at 4 km and continuing from this direction to 5.5 km, the highest point reached. The westerly winds were associated with a cyclone which had its center northward of the Carnegie position.

Pacific Ocean off Japan

In the extreme northeastern part of the Pacific Ocean, in latitudes 36° to 40° north, the surface winds were variable. The winds at 3 km and upward were found to blow from directions equally varied, but generally opposite to the surface direction. The wind shifts were frequently abrupt and occurred at various heights. In the northern summer when these flights were made, this area is dominated exclusively by the central Pacific high-pressure area, the Aleutian low having disappeared at this season. The resultant southwest surface wind shows this underlying effect, but the passage of local centers of high and low pressure renders the individual observations of comparatively small value.

Trades and Antitrades East of the Latitudes of the Hawaiian Islands

There was fortunately a considerable number of observations of the surface and upper winds overlying the area between San Francisco and Honolulu. In the easterly part of this voyage to Honolulu the surface winds observed were northerly, with a tendency to veer around to east at 1.5 km and even to southeast in some flights.

Along the northern limit of the northeast trades the surface winds were variable and marked by the passage of a small center of high pressure. Over the area lying from longitude 120° to 160° west, and from the Tropic of Cancer northward to latitude 30° north, the winds at the surface and lower levels blew steadily from east and northeast. The single high flight in latitude 25° north, showed that northeast winds turned to southeast at 5 km, south at 6 km, and blew strongly from southwest from 8 to 9 km. In the study of upper winds at Honolulu, E. A. Beals [6, pp. 222-226] found that the frequency of east and east-northeast winds decreases rapidly above 2 km, and that the southwest drift first makes itself pronounced at 6 km. The southwest winds doubtless come down to lower and lower levels at increasing latitudes north of Honolulu until they reach the surface throughout the year at about latitude 35° north [1, p. 468]. The Carnegie encountered these strong westerly surface winds in latitude 34° north during October, and a few days earlier in latitudes 31°.6 and 33°.0 north at heights of 3 and 1.5 km respectively. South of latitude 20° north the few flights showed generally strong northeast trades overrun by an easterly drift. Above the easterly drift the winds at varying heights turned through south to southwest. In latitude 15°.9 north, south winds occurred at 2 km, whereas in latitude 9°.9 north they occurred only above 6 km.

HEIGHT OF CLOUDS OVER THE PACIFIC OCEAN

Table 4. Estimated height of cloud above surface of ocean as determined from disappearance of pilot balloons into cloud mass

Cloud form	Latitude zone	Occasions when cloud forms were observed at various heights (in meters) over Pacific Ocean												
		410-surface	800-411	1170-801	1530-1171	1890-1531	2250-1891	2610-2251	2970-2611	3330-2971	3690-3331	4590-3691	5490-4591	6210-5491
cu	0°-20° S	..	1	3	4	4	4	2	1	2	2	5	2	..
cu	0°-20° N	1	2	2	3	3	3	2	1	4	..	1	3	..
cu	20°-41° S	..	2	..	..	..	1	1	..	1	..	..	..	..
cu	20°-48° N	..	2	4	5	1	3	1	1	1	1	..	..	..
cu	Sum	1	7	9	12	8	11	6	3	8	3	6	5	..
st	20°-48° N	..	1	..	2	..	..	1	..	..	..	..	..	..

All flights in which the observer stated that the balloon was lost sight of on account of clouds, either entirely or for a time, were analyzed to determine, as far as the data permitted, the height of clouds over the ocean. The observer noted in his record balloons "entering cloud" and those passing "behind cloud." Thus, when a tan balloon passed in front of a cloud--especially one with a white background, such as a cumulus cloud--it was difficult to recognize, and increased the other difficulties which are inherent to observing on ship.

The flights were made when conditions were favorable for observing, and naturally the sky had little cloud in the anticipated direction of the balloon's flight. Frequently, however, clouds were present in other quarters of the sky. Cumulus clouds were almost exclusively recorded, and mostly of the fair-weather type (cumulus-humilis). It would appear that strato-cumulus clouds were included under the term cumulus. From latitude 20° north to 20° south in the equatorial region cumulus clouds predominated, frequently in broad strata from 1.2 to 2.2 km and from 3.7 to 5.5 km. In the North and South Pacific outside this tropical belt the most common occurrence of clouds was from 0.8 to 1.5 km.

Observation of cirrus clouds during balloon flights was rare. In flight 59 (latitude 13°0 south, longitude 119°8 west) the balloon was lost in cirrus clouds at 7.6 km, and in flight 66 (latitude 17°1 south, longitude 135°5 west) at 10.9 km.

Stratus-cloud heights were measured on several occasions in the northern Pacific at heights varying from 0.4 to 2.6 km.

TRADE WINDS

Variation in Velocity with Height

In flights 40 to 49, made where the trades are well developed off the South American coast, the maximum mean wind velocity, 7 m per second, occurred at the second minute of the flight, and the most rapidly moving stratum occurred between a height of 200 and 400 m above the surface. Farther west, midway between the Tuamotu Archipelago and South America, where the trades are most strongly developed in the South Pacific, the mean maximum velocity of 10.3 m per second occurred at the fourth minute, and the whole stratum from 400 to 1200 m had a mean velocity of 10 m per second. Above this stratum the wind velocity decreased rapidly to 3 m per second at the level of 3 km, at which the smallest wind velocities occurred over the eastern trade-wind region traversed by the Carnegie during the southern summer. Farther west in the Pacific the Carnegie observations indicate that the height of air stratum of minimum velocity is somewhat higher, namely, 4 km (fig. 45b). This agrees with the upper-wind velocities determined only on days comparatively free from clouds at Apia in longitude 171°8 west, which indicate a broad minimum from 1.5 to 4 km with the lowest value of 3.9 m per second at 3.5 km.

Stratification of Trade Winds

The winds over the Atlantic Ocean have been recognized by almost all observers to have a stratiform character. At certain levels, good for all latitudes, changes in the structure of the air strata over the ocean are clearly marked in temperature records, but they can also be seen in changes in wind direction and less clearly in wind velocity. These wind shifts are not those associated with cyclones, anticyclones, and large scale pressure distributions, but arise from turbulence and friction in air strata.

Since the horizontal projection of the balloon's position was determined only for each minute, close approximation of the height of a discontinuity cannot be given. The criterion used in determining the discontinuity level was a wind shift, especially when accompanied by a change in velocity. An inspection of the plotted points (tab. 5) representing the balloon's position on a horizontal projection (figs. 6-27) shows that they lie usually on a succession of straight lines representing various distinct strata of air. In some flights the personal factor enters considerably in determining the minutes where the strata may be considered to begin or end. The writer and another person studied each flight to avoid or at least to reduce the personal element.

Table 5. Heights where wind shifts occur, indicating change in air stratum

Flights	Minute and corresponding height in meters								
	2	3	4	5	6	7	8	9	10
	415	610	800	990	1170	1350	1530	1710	1890
1- 39	4	1	6	2	2	..	2	1	..
40- 61	..	..	7	..	4	..	3	..	6
62- 83	1	1	9	2	1	1	6	1	..
92-110	2	5	8	..	..	1	3	1	..
123-171	10	3	14	1	8	1	3	1	2
Total	17	10	44	5	15	3	17	4	8

LITERATURE CITED

1. Hann, J. v. Lehrbuch der Meteorologie, 4th ed., p. 151 (1926).
2. Ault, Captain J. P. Jour. Terr. Mag., vol. 34, pp. 254-255 (1929).
3. Perlewitz, P. Ann. Hydrogr., vol. 40, p. 454 (1912).
4. Knoche, K. Klimakunde von Sudamerika, p. 279 (1930).
5. Sverdrup, H. U. Der Nordatlantische Passat, Veröff. Geophys. Inst. Univ. Leipzig, vol. 2, Heft 1, p. 51 (1917).
6. Beals, E. A. Mon. Weath. Rev., vol. 55, pp. 224-226 (1927).

TABLES 6 - 8

(For tables 1 - 5 see pages 4, 5, 10, 12, and 13)

CLOUD FORMS AND ABBREVIATIONS USED

Cirrus	Ci	Strato-Cumulus	St-Cu
Cirro-Stratus	Ci-St	Nimbus	Nb
Cirro-Cumulus	Ci-Cu	Cumulus	Cu
Alto-Stratus	A-St	Cumulo-Nimbus	Cu-Nb
Alto-Cumulus	A-Cu	Stratus	St
Fracto-Cumulus	Fr-Cu		

Table 6. Analysis of Carnegie flights 50 to 83

Element and unit	Height in kilometers															
	Surface	0.25	0.50	0.75	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5
Flights 50 to 59, latitudes 10° to 20° south, longitudes 100° to 120° west[a]																
East component, m/sec	+5.6	+8.6	+9.2	+9.7	+10.0	+8.5	+5.0	+2.3	+0.4	-0.4	-1.1	-1.6	-1.4	-2.4	-3.8	......
North component, m/sec	-2.5	-1.7	-1.5	-0.9	- 1.0	-1.9	-2.4	-1.7	+0.9	+1.2	+0.6	+1.0	0.0	-0.6	-1.0	......
Resultant velocity, m/sec	6.1	8.8	9.3	9.7	10.0	8.7	5.6	2.9	1.0	1.3	1.2	1.9	1.4	2.5	3.9	......
Resultant direction, °	114	101	99	95	96	103	116	126	24	342	299	302	270	256	255	......
Mean velocity, m/sec	6.4	9.3	9.8	10.1	10.3	9.2	6.8	5.3	4.0	3.4	3.8	3.2	2.1	3.3	5.0	......
Wind constancy	.95	.95	.95	.96	.97	.95	.82	.55	.25	.38	.32	.59	.67	.76	.78	......
Flights 60 to 68, latitudes 13° to 18° south, longitudes 120° to 140° west																
East component, m/sec	+4.3	+5.8	+6.2	+6.0	+5.4	+4.6	+5.1	+3.8	+3.5	+0.5	-1.0	-1.1	-4.8	-5.5	-6.0	-6.3
North component, m/sec	-0.8	+0.4	-1.2	+0.5	+1.3	+2.2	+0.9	-0.4	+0.3	+0.7	+1.0	+0.8	+1.6	+0.9	+2.5	+1.3
Resultant velocity, m/sec	4.4	5.8	6.3	6.0	5.6	5.1	5.2	3.8	3.5	0.9	1.4	1.4	5.1	5.6	6.5	6.4
Resultant direction, °	101	86	101	85	76	64	80	96	85	36	315	306	298	279	293	282
Mean velocity, m/sec	4.4	5.9	6.4	6.2	5.8	5.2	5.6	5.0	5.6	5.1	4.5	5.2	6.6	7.0	7.8	7.2
Wind constancy	1.00	.98	.98	.97	.96	.99	.93	.76	.62	.18	.31	.27	.77	.80	.83	.89
Flights 69 to 83, latitudes 18° to 10° south, longitudes 140° to 172° west, central South Pacific[b]																
East component, m/sec	+1.8	+2.1	+1.8	+1.7	+1.7	+1.5	+1.4	+1.5	+1.6	+1.5	+0.9	+0.2	-0.1	+0.4	+0.2	-1.1
North component, m/sec	+0.1	+1.5	+1.6	+1.9	+2.5	+2.0	+1.8	+1.3	+0.7	+0.5	-0.2	–0.4	+0.8	+1.1	-0.5	+1.0
Resultant velocity, m/sec	1.8	2.6	2.4	2.6	3.0	2.5	2.3	2.0	1.8	1.6	0.9	0.4	0.8	1.2	0.5	1.5
Resultant direction, °	87	54	48	42	34	37	38	49	66	72	103	153	353	20	158	312
Mean velocity, m/sec	3.7	5.1	5.0	5.0	4.9	4.4	4.3	3.3	3.2	2.9	2.3	2.7	3.4	3.0	2.6	2.9
Wind constancy	.49	.52	.48	.52	.61	.57	.54	.61	.56	.55	.38	.15	.24	.40	.19	.52

[a] Outstanding features are the great constancy of southeast winds to a height of 1.5 km, and the development of westerly winds above 4 km; wind constancy = [(resultant velocity) / (mean wind velocity)].

[b] Both velocity and constancy of winds are less than in eastern South Pacific.

Table 7—Upper-wind-components determined from pilot-balloon

No.	Date	Local apparent time	Position		Wind component					
			Latitude	Long. west of Gr.		Surface	0.25	0.50	0.75	1.0
	1928	hour	°	°		° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec
1	Oct 27	16.4	5.4 N	80.0	Total	270 4.0	312 5.9	330 6.6	359 6.6	18 7.2
					E	- 4.0	- 4.4	- 3.3	- 0.1	+ 2.2
					N	0.0	+ 4.0	+ 5.7	+ 6.6	+ 6.8
2	Oct 29	14.5	4.0 N	80.0	Total	236 4.0	251 5.3	[251 4.5]		
					E	- 3.3	- 5.0	- 4.2		
					N	- 2.2	- 1.7	- 1.5		
3	Oct 29	14.7	4.0 N	80.0	Total	236 4.0	255 7.1	259 6.4		
					E	- 3.3	- 6.9	- 6.3		
					N	- 2.2	- 1.8	- 1.2		
4	Oct 31	17.3	5.0 N	82.2	Total	236 9.4	234 11.3	236 12.8		
					E	- 7.8	- 9.1	-10.6		
					N	- 5.3	- 6.6	- 7.2		
5	Nov 9	14.6	1.4 S	85.2	Total	180 4.0	185 1.6	183 1.6	183 2.1	183 2.3
					E	0.0	- 0.1	- 0.1	- 0.1	- 0.1
					N	- 4.0	- 1.6	- 1.6	- 2.1	- 2.3
6	Nov 11	13.3	1.8 S	89.3	Total	180 4.0	173 4.1	176 4.0	283 2.9	310 4.2
					E	0.0	+ 0.5	+ 0.3	- 2.8	- 3.2
					N	- 4.0	- 4.0	- 4.0	+ 0.6	+ 2.7
7	Nov 15	14.1	2.6 S	96.0	Total	135 5.4	137 7.8	138 7.5	123 5.7	74 7.6
					E	+ 3.8	+ 5.3	+ 5.0	+ 4.8	+ 7.3
					N	- 3.8	- 5.7	- 5.6	- 3.1	+ 2.1
8	Nov 17	13.4	3.3 S	100.1	Total	158 6.7	154 9.0	153 9.6	151 9.1	156 7.3
					E	+ 2.6	+ 4.0	+ 4.4	+ 4.4	+ 3.0
					N	- 6.2	- 8.1	- 8.6	- 8.0	- 6.7
9	Nov 19	14.4	4.8 S	105.4	Total	124 6.7	129 6.8	129 7.7	130 9.1	117 8.7
					E	+ 5.6	+ 5.3	+ 6.0	+ 7.0	+ 7.8
					N	- 3.7	- 4.3	- 4.8	- 5.8	- 4.0
10	Nov 20	15.5	7.3 S	107.1	Total	112 6.7	110 7.6	113 8.8	120 10.0	129 9.8
					E	+ 6.2	+ 7.1	+ 8.1	+ 8.7	+ 7.6
					N	- 2.6	- 2.6	- 3.4	- 5.0	- 6.2
11	Nov 22	15.3	12.3 S	110.6	Total	112 9.4	117 9.0	114 9.8	119 9.8	122 9.8
					E	+ 8.7	+ 8.0	+ 9.0	+ 8.6	+ 8.3
					N	- 3.6	- 4.1	- 4.0	- 4.8	- 5.2
12	Nov 22	15.7	12.3 S	110.6	Total	112 9.4	114 8.6	111 7.7	113 8.6	98 9.0
					E	+ 8.7	+ 7.9	+ 7.2	+ 7.9	+ 8.9
					N	- 3.6	- 3.5	- 2.8	- 3.4	- 1.2
13	Nov 23	15.6	14.5 S	112.1	Total	112 6.7	112 8.0	108 8.0	99 7.9	91 8.3
					E	+ 6.2	+ 7.4	+ 7.6	+ 7.8	+ 8.3
					N	- 2.5	- 3.0	- 2.5	- 1.2	- 0.1
14	Nov 24	14.2	17.0 S	113.2	Total	101 6.7	86 8.7	89 9.1	86 9.7	78 10.1
					E	+ 6.6	+ 8.7	+ 9.1	+ 9.7	+ 9.9
					N	- 1.3	+ 0.6	+ 0.2	+ 0.7	+ 2.1
15	Nov 25	14.4	19.5 S	114.1	Total	90 6.7	100 10.0	100 10.3	106 10.1	107 8.5
					E	+ 6.7	+ 9.8	+10.1	+ 9.7	+ 8.1
					N	0.0	- 1.7	- 1.8	- 2.8	- 2.5
16	Nov 25	14.6	19.5 S	114.1	Total	90 6.7	107 11.5	98 10.3	91 9.0	92 9.0
					E	+ 6.7	+11.0	+10.2	+ 9.0	+ 9.0
					N	0.0	- 3.4	- 1.4	- 0.2	- 0.3
17	Nov 26	16.4	22.1 S	114.4	Total	90 4.0	99 5.8	94 5.6	88 5.8	84 8.0
					E	+ 4.0	+ 5.7	+ 5.6	+ 5.8	+ 8.0
					N	0.0	- 0.9	- 0.4	+ 0.2	+ 0.8
18	Nov 27	13.4	23.4 S	114.8	Total	79 4.0	100 6.3	98 7.1	105 7.2	116 7.0
					E	+ 3.9	+ 6.2	+ 7.0	+ 7.0	+ 6.3
					N	+ 0.8	- 1.1	- 1.0	- 1.9	- 3.1
19	Nov 29	16.6	25.1 S	115.5	Total	101 4.0	109 8.3	117 8.5	88 7.3	78 6.9
					E	+ 3.9	+ 7.8	+10.4	+ 7.3	+ 6.8
					N	- 0.8	- 2.7	- 5.3	+ 0.2	+ 1.4
20	Nov 30	14.5	28.3 S	115.1	Total	45 4.0	56 10.2	52 8.8	59 7.3	62 5.4
					E	+ 2.8	+ 8.5	+ 6.9	+ 6.3	+ 4.8
					N	+ 2.8	+ 5.7	+ 5.4	+ 3.8	+ 2.5

No.	Date	Local apparent time	Position		Wind component					
			Latitude	Long. west of Gr.		6.0	6.5	7.0	7.5	8.0
	1928	hour	°	°		° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec
18	Nov 27	13.4	23.4 S	114.8	Total	165 3.5				
					E	+ 0.9				
					N	- 3.4				
20	Nov 30	14.5	28.3 S	115.1	Total	94 3.1	94 2.8	91 3.4	86 4.3	
					E	+ 3.1	+ 2.8	+ 3.4	+ 4.3	
					N	- 0.2	- 0.2	- 0.1	+ 0.3	

flights made on the Carnegie, Pacific Ocean, 1928-1929

Heights in kilometers								
1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5
°or m/sec	°or m/sec	°or m/sec	°or m/sec	°or m/sec	°or m/sec	°or m/sec	°or m/sec	°or m/sec
220 3.3 - 2.1 - 2.5	307 3.5 - 2.8 + 2.1	340 4.8 - 1.6 + 4.5	360 4.6 0.0 + 4.6	322 3.8 - 2.3 + 3.0	335 5.0 - 2.1 + 4.5	332 5.5 - 2.6 + 4.9	333 5.5 - 2.5 + 4.9	
220 5.2 - 3.3 - 4.0	188 7.8 - 1.1 - 7.7	132 3.0 + 2.2 - 2.0	79 4.0 + 3.9 + 0.8	320 7.9 - 5.1 + 6.0	206 2.4 - 1.0 - 2.2	173 3.7 + 0.4 - 3.7	149 5.5 + 2.8 - 4.7	96 6.5 + 6.5 - 0.7
31 6.9 + 3.6 + 5.9	55 3.4 + 2.8 + 2.0	97 3.6 + 3.6 - 4.4	101 10.7 +10.5 - 2.0	88 8.0 + 8.0 + 0.3	128 6.9 + 5.4 - 4.2	67 6.6 + 6.1 + 2.6	135 2.9 + 2.0 - 2.0	79 6.0 + 5.9 + 1.1
55 3.3 + 2.7 + 1.9	103 4.3 + 4.2 - 1.0	104 10.8 +10.5 - 2.6	119 8.3 + 7.3 - 4.0	154 4.2 + 1.8 - 3.8	117 7.5 + 6.7 - 3.4			
51 3.0 + 2.3 + 1.9	18 4.1 + 1.3 + 3.9	4 6.2 + 0.4 + 6.2	356 5.2 - 0.4 + 5.2	142 3.3 + 2.0 - 2.6	109 6.9 + 6.5 - 2.2	138 5.3 + 3.6 - 3.9	111 6.1 + 5.7 - 2.2	69 12.7 +11.9 + 4.6
82 9.0 + 8.9 + 1.2	86 9.5 + 9.5 + 0.7							
92 9.0 + 9.0 - 0.3	101 7.7 + 7.6 - 1.5	107 8.1 + 7.8 - 2.4	79 4.2 + 4.1 + 0.8	56 2.5 + 2.1 + 1.4				
84 5.9 + 5.9 + 0.6	90 8.7 + 8.7 0.0							
91 8.7 + 8.7 - 0.2	120 6.3 + 5.5 - 0.3	80 14.2 +14.0 + 2.5						
116 5.4 + 4.8 - 2.4	116 8.0 + 7.2 - 3.5	104 6.0 + 5.8 - 1.4	104 3.0 + 2.9 - 0.7	104 3.5 + 3.4 - 0.8	165 3.5 + 0.9 - 3.4	165 3.5 + 0.9 - 3.4	165 3.5 + 0.9 - 3.4	165 3.5 + 0.9 - 3.4
82 3.0 + 3.0 + 0.4	81 2.8 + 2.8 + 0.4	55 5.8 + 4.8 + 3.3	77 5.6 + 5.5 + 1.3	58 7.2 + 6.1 + 3.8	44 6.9 + 4.8 + 5.0	83 7.3 + 7.2 + 0.9	88 4.8 + 4.8 + 0.2	88 4.8 + 4.8 + 0.2

Heights in kilometers								
8.5	9.0	9.5	10.0	10.5	11.0	11.5	12.0	12.5
°or m/sec	°or m/sec	°or m/sec	°or m/sec	°or m/sec	°or m/sec	°or m/sec	°or m/sec	°or m/sec

Table 7.—Upper-wind components determined from pilot-balloon

No.	Date	Local apparent time	Position: Latitude	Position: Long. west of Gr.	Wind component	Surface	0.25	0.50	0.75	1.0
	1928	hour	°	°		° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec
21	Dec 1	13.4	29.4 S	114.7	Total	45 4.0	21 3.9	46 3.8	53 2.9	52 2.5
					E	+ 2.8	+ 1.4	+ 2.7	+ 2.3	+ 2.0
					N	+ 2.8	+ 3.6	+ 2.6	+ 1.8	+ 1.5
22	Dec 2	13.2	30.7 S	114.2	Total	45 4.0	35 4.8	34 5.8	34 5.9	40 7.4
					E	+ 2.8	+ 2.8	+ 3.2	+ 3.3	+ 4.8
					N	+ 2.8	+ 3.9	+ 4.8	+ 4.9	+ 5.7
23	Dec 4	16.7	31.0 S	109.5	Total	270 9.4	292 10.7	289 11.7	289 11.3	287 10.4
					E	- 9.4	- 9.9	-11.1	-10.7	-10.0
					N	0.0	+ 4.0	+ 3.8	+ 3.7	+ 3.0
24	Dec 5	14.2	28.6 S	108.7	Total	292 6.7	274 10.8	265 11.4	254 11.1	
					E	- 6.2	-10.8	-11.4	-10.7	
					N	+ 2.5	+ 0.8	- 1.0	- 3.1	
25	Dec 13	14.1	28.4 S	109.2	Total	90 6.7	83 6.3	81 5.6	66 4.8	74 4.6
					E	+ 6.7	+ 6.3	+ 5.6	+ 4.4	+ 4.4
					N	0.0	+ 0.8	+ 0.9	+ 2.0	+ 1.3
26	Dec 17	14.9	31.7 S	109.2	Total	135 6.7		125 5.6	115 4.6	110 2.0
					E	+ 4.7		+ 4.6	+ 4.2	+ 1.9
					N	- 4.7		- 3.2	- 1.9	- 0.7
27	Dec 18	13.5	32.0 S	108.8	Total	22 6.7	2 6.1	3 7.0	355 5.6	309 2.2
					E	+ 2.5	+ 0.2	+ 0.4	- 0.5	- 1.7
					N	+ 6.2	+ 6.1	+ 7.0	+ 5.6	+ 1.4
28	Dec 20	16.6	34.3 S	106.5	Total	45 4.0	61 5.8	48 4.1	5 4.1	353 3.7
					E	+ 2.8	+ 5.1	+ 3.0	+ 0.4	- 0.4
					N	+ 2.8	+ 2.8	+ 2.7	+ 4.1	+ 3.7
29	Dec 26	13.4	40.4 S	97.5	Total	11 0.9	346 4.1	335 5.1	328 5.0	324 4.0
					E	+ 0.2	- 1.0	- 2.2	- 2.6	- 2.4
					N	+ 0.9	+ 4.0	+ 4.6	+ 4.2	+ 3.2
30	Dec 30	16.7	34.0 S	91.4	Total	124 6.7		131 6.7	138 5.3	
					E	+ 5.6		+ 5.1	+ 3.6	
					N	- 3.8		- 4.4	- 3.9	
	1929									
31	Jan 1	14.3	32.2 S	89.0	Total	-- 0.0		193 0.2	192 0.2	200 0.5
					E	0.0		0.0	0.0	- 0.2
					N	0.0		- 0.2	- 0.2	- 0.5
32	Jan 4	10.7	31.8 S	87.3	Total	315 2.2	280 5.0	276 5.8	279 4.9	296 2.4
					E	- 1.6	- 4.9	- 5.8	- 4.8	- 2.2
					N	+ 1.6	+ 0.9	+ 0.6	+ 0.8	+ 1.0
33	Jan 5	11.0	31.1 S	86.6	Total	270 4.0	253 6.5	234 7.0	223 6.1	214 5.4
					E	- 4.0	- 6.2	- 5.7	- 4.2	- 3.0
					N	0.0	- 1.9	- 4.1	- 4.5	- 4.5
34	Jan 8	16.6	24.8 S	82.1	Total	146 6.7	151 6.5	152 6.7	158 6.0	164 5.1
					E	+ 3.8	+ 3.2	+ 3.2	+ 2.2	+ 1.4
					N	- 5.6	- 5.7	- 5.9	- 5.6	- 4.9
35	Jan 12	13.9	16.5 S	78.6	Total	146 6.7	142 8.4	138 8.0	128 7.8	150 8.1
					E	+ 3.8	+ 5.2	+ 5.4	+ 6.2	+ 4.0
					N	- 5.6	- 6.6	- 6.0	- 4.8	- 7.0
36	Jan 13	10.6	14.2 S	78.0	Total	135 6.7	120 8.6	120 8.0	122 4.1	306 1.1
					E	+ 4.7	+ 7.4	+ 6.9	+ 3.5	- 0.9
					N	- 4.7	- 4.3	- 4.0	- 2.2	+ 0.6
37	Feb 5	12.2	12.1 S	77.2	Total	360 1.5	35 2.8	35 3.0	35 3.9	
					E	0.0	+ 1.6	+ 1.7	+ 2.2	
					N	+ 1.5	+ 2.3	+ 2.5	+ 3.2	
38	Feb 6	8.9	12.0 S	78.6	Total	169 6.7	157 7.0	147 7.2	121 6.5	
					E	+ 1.3	+ 2.7	+ 3.9	+ 5.6	
					N	- 6.6	- 6.4	- 6.0	- 3.4	

No.	Date	Local apparent time	Position: Latitude	Position: Long. west of Gr.	Wind component	6.0	6.5	7.0	7.5	8.0
	1928	hour	°	°		° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec
21	Dec 1	13.4	29.4 S	114.7	Total	162 1.6	158 1.5	158 1.5	134 2.6	142 2.6
					E	+ 0.5	+ 0.6	+ 0.6	+ 1.9	+ 1.6
					N	- 1.5	- 1.4	- 1.4	- 1.8	- 2.0
26	Dec 17	14.9	31.7 S	109.2	Total	211 2.2	207 2.0	200 1.8	204 1.5	212 2.0
					E	- 1.1	- 0.9	- 0.6	- 0.6	- 1.1
					N	- 1.9	- 1.8	- 1.7	- 1.4	- 1.7
29	Dec 26	13.4	40.4 S	97.5	Total	279 2.6	306 2.2	331 3.2	304 3.5	315 7.7
					E	- 2.6	- 1.8	- 1.6	- 2.9	- 5.4
					N	+ 0.4	+ 1.3	+ 2.8	+ 2.0	+ 5.4
	1929									
34	Jan 8	16.6	24.8 S	82.1	Total	246 11.9	266 8.9	264 7.0	252 19.0	
					E	-10.9	- 8.9	- 7.0	-18.1	
					N	- 4.8	- 0.6	- 0.7	- 5.9	

flights made on the Carnegie, Pacific Ocean, 1928-1929—Continued

Heights in kilometers								
1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5
° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec
52 2.5	54 3.6	53 4.9	101 2.0	66 2.9	57 3.3	54 1.5	168 3.2	104 1.6
+ 2.0	+ 2.9	+ 3.5	+ 2.0	+ 2.6	+ 2.8	+ 1.2	+ 0.7	+ 1.6
+ 1.5	+ 2.1	+ 2.6	- 0.4	+ 1.2	+ 1.8	+ 0.9	- 3.1	- 0.4
54 2.3	15 4.8	359 5.6						
+ 1.9	+ 1.2	- 0.1						
+ 1.4	+ 4.6	+ 5.6						
265 11.4								
-11.4								
- 1.0								
82 3.3	101 4.6	108 4.8	135 2.8	217 2.2	288 2.4	285 2.5		
+ 3.3	+ 4.5	+ 4.6	+ 2.0	- 1.3	- 2.3	- 2.4		
+ 0.5	- 0.9	- 1.5	- 2.0	- 1.8	+ 0.7	+ 0.6		
		240 5.5	252 5.5	258 3.3	218 2.7	215 1.1	211 1.6	211 2.0
		- 4.8	- 5.2	- 3.2	- 1.7	- 0.6	- 0.8	- 1.0
		- 2.8	- 1.7	- 0.7	- 2.1	- 0.9	- 1.4	- 1.7
265 7.0	298 9.8	300 9.3	302 10.6	306 10.1	302 11.0			
- 7.0	- 8.6	- 8.0	- 9.0	- 8.2	- 9.3			
- 0.6	+ 4.6	+ 4.6	+ 5.6	+ 5.9	+ 5.8			
321 2.0	327 2.2	320 3.1	313 3.6	338 6.2	318 7.4	317 4.1	328 2.9	292 3.0
- 1.3	- 1.2	- 2.0	- 2.6	- 2.3	- 5.0	- 2.8	- 1.5	- 2.8
+ 1.6	+ 1.8	+ 2.4	+ 2.5	+ 5.8	+ 5.5	+ 3.0	+ 2.5	+ 1.1
	240 5.0	213 6.0	226 4.3	229 4.3	225 6.0	225 8.0	222 3.5	220 5.5
	- 4.3	- 3.3	- 3.1	- 3.2	- 4.2	- 5.7	- 2.3	- 3.5
	- 2.5	- 5.0	- 3.0	- 2.8	- 4.2	- 5.7	- 2.6	- 4.2
251 0.5	115 3.0	115 4.0	118 5.0	134 8.7	196 4.4			
- 0.5	+ 2.7	+ 3.6	+ 4.4	+ 6.3	- 1.2			
- 0.2	- 1.3	- 1.7	- 2.4	- 6.0	- 4.2			
311 4.1	340 6.0	308 4.2	41 1.7	115 2.1	256 1.5	315 6.0	310 10.0	
- 3.1	- 2.0	- 3.3	+ 1.1	+ 1.9	- 1.5	- 4.2	- 7.7	
+ 2.7	+ 5.6	+ 2.6	+ 1.3	- 0.9	- 0.4	+ 4.2	+ 6.4	
186 6.8	181 9.8	185 8.4	204 5.9	216 5.5				
- 0.7	- 0.2	- 0.7	- 2.4	- 3.2				
- 6.8	- 9.8	- 8.4	- 5.4	- 4.4				
191 5.7	219 5.2	186 5.0	182 6.2	180 6.2	182 11.3	192 8.2	225 6.8	231 6.1
- 1.1	- 3.3	- 0.5	- 0.2	0.0	- 0.4	- 1.7	- 4.8	- 4.7
- 5.6	- 4.0	- 5.0	- 6.2	- 6.2	-11.3	- 8.0	- 4.8	- 3.8
147 5.8	97 2.3	69 2.6	115 4.2	116 6.0	127 8.5	154 9.2		
+ 3.2	+ 2.3	+ 2.4	+ 3.8	+ 5.4	+ 6.8	+ 4.0		
- 4.9	- 0.3	+ 0.9	- 1.8	- 2.6	- 5.1	- 8.3		
314 5.8	336 15.7	342 15.7						
- 4.2	- 6.4	- 4.8						
+ 4.0	+14.3	+14.9						

Heights in kilometers								
8.5	9.0	9.5	10.0	10.5	11.0	11.5	12.0	12.5
° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec
224 3.3	202 2.9	136 4.6	162 5.0	158 5.1	155 4.0			
- 2.3	- 1.1	+ 3.2	+ 1.6	+ 1.9	+ 1.7			
- 2.4	- 2.7	- 3.3	- 4.8	- 4.7	- 3.6			
187 0.8	189 1.4	204 2.0	164 2.0	196 3.0	174 1.4	174 1.0	174 1.0	
- 0.1	- 0.2	- 0.8	+ 0.6	- 0.8	+ 0.2	+ 0.1	+ 0.1	
- 0.8	- 1.4	- 1.8	- 1.9	- 2.9	- 1.4	- 1.0	- 1.0	
323 5.0	317 6.1	314 4.9						
- 3.0	- 4.2	- 3.5						
+ 4.0	+ 4.5	+ 3.4						

Table 7.—Upper-wind components determined from pilot-balloon

No.	Date	Local apparent time	Position: Latitude	Position: Long. west of Gr.	Wind component	Surface	0.25	0.50	0.75	1.0
	1929	hour	°	°		° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec
39	Feb 7	8.3	10.4 S	79.8	Total	158 4.0	144 7.4	154 6.4	156 4.6	190 1.5
					E	+ 1.5	+ 4.4	+ 2.8	+ 1.9	- 0.3
					N	- 3.7	- 6.0	- 5.8	- 4.2	- 1.5
40	Feb 8	14.2	10.0 S	82.4	Total	191 6.7	188 9.0	195 8.4		
					E	- 1.3	- 1.2	- 2.2		
					N	- 6.6	- 8.9	- 8.1		
41	Feb 8	15.9	10.0 S	82.5	Total	197 6.7	176 6.0	178 5.2	183 3.6	185 3.3
					E	- 2.0	+ 0.4	+ 0.2	- 0.2	- 0.3
					N	- 6.4	- 6.0	- 5.2	- 3.6	- 3.3
42	Feb 8	17.8	10.0 S	82.7	Total	208 6.7	186 5.3	178 5.7	185 4.9	196 5.0
					E	- 3.2	- 0.6	+ 0.2	- 0.4	- 1.4
					N	- 5.9	- 5.3	- 5.7	- 4.9	- 4.8
43	Feb 9	13.5	10.5 S	84.3	Total	158 2.2	150 3.0	167 2.9	177 1.7	286 0.4
					E	+ 0.8	+ 1.5	+ 0.6	+ 0.1	- 0.4
					N	- 2.0	- 2.6	- 2.8	- 1.7	+ 0.1
44	Feb 11	17.1	10.7 S	86.2	Total	190 2.2	158 4.8	159 3.3	209 1.8	274 1.5
					E	- 0.4	+ 1.8	+ 1.2	- 0.9	- 1.5
					N	- 2.2	- 4.5	- 3.1	- 1.6	+ 0.1
45	Feb 12	14.5	11.2 S	87.7	Total	180 6.7	154 6.1	151 5.9	141 5.5	149 5.7
					E	0.0	+ 2.7	+ 2.9	+ 3.5	+ 2.9
					N	- 6.7	- 5.5	- 5.2	- 4.3	- 4.9
46	Feb 13	13.2	12.6 S	89.9	Total	180 9.4	154 8.3	130 7.6	109 6.6	92 6.8
					E	0.0	+ 3.6	+ 5.8	+ 6.2	+ 6.8
					N	- 9.4	- 7.5	- 4.9	- 2.2	- 0.2
47	Feb 14	15.1	14.6 S	92.6	Total	174 6.7	144 7.3	141 7.1	147 5.7	148 5.2
					E	+ 0.7	+ 4.3	+ 4.5	+ 3.1	+ 2.8
					N	- 6.7	- 5.9	- 5.5	- 4.8	- 4.4
48	Feb 15	15.6	15.7 S	95.3	Total	158 6.7	130 9.0	124 10.1	123 10.7	112 11.0
					E	+ 2.5	+ 6.9	+ 8.4	+ 9.0	+10.2
					N	- 6.2	- 5.8	- 5.6	- 5.8	- 4.1
49	Feb 16	16.5	15.2 S	98.2	Total	135 6.7	113 10.9	107 11.9	103 13.1	99 13.1
					E	+ 4.7	+10.0	+11.4	+12.8	+12.9
					N	- 4.7	- 4.3	- 3.5	- 3.0	- 2.0
50	Feb 17	14.1	14.7 S	101.1	Total	135 6.7	117 12.2	112 13.1	104 12.9	100 13.0
					E	+ 4.7	+10.9	+12.2	+12.5	+12.8
					N	- 4.7	- 5.5	- 4.9	- 3.1	- 2.3
51	Feb 17	14.6	14.7 S	101.2	Total	135 9.4	[117 10.9]	[114 11.1]	102 10.5	94 10.3
					E	+ 6.6	+ 9.7	+10.1	+10.3	+10.3
					N	- 6.6	- 5.0	- 4.5	- 2.2	- 0.7
52	Feb 18	13.3	14.3 S	103.5	Total	124 6.7	110 7.7	104 9.0	103 11.1	104 11.8
					E	+ 5.6	+ 7.2	+ 8.7	+10.8	+11.4
					N	- 3.8	- 2.6	- 2.2	- 2.5	- 2.8
53	Feb 19	17.9	13.5 S	106.4	Total	123 6.7	130 9.0	130 10.0	121 10.4	111 11.7
					E	+ 5.6	+ 6.9	+ 7.7	+ 8.9	+10.9
					N	- 3.7	- 5.8	- 6.4	- 5.4	- 4.2
54	Feb 20	16.4	12.9 S	108.5	Total	112 4.0	105 8.0	105 8.6	106 8.0	106 7.3
					E	+ 3.7	+ 7.7	+ 8.3	+ 7.7	+ 7.0
					N	- 1.5	- 2.1	- 2.2	- 2.2	- 2.0

No.	Date	Local apparent time	Position: Latitude	Position: Long. west of Gr.	Wind component	6.0	6.5	7.0	7.5	8.0
	1929	hour	°	°		° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec
43	Feb 9	13.5	10.5 S	84.3	Total	191 16.4				
					E	- 3.1				
					N	-16.1				
45	Feb 12	14.5	11.2 S	87.7	Total	80 5.4	103 9.0			290 9.0
					E	+ 5.3	+ 8.8			- 8.5
					N	+ 0.9	- 2.0			+ 3.1
46	Feb 13	13.2	12.6 S	89.9	Total	91 9.2	105 3.2	123 5.3	127 6.8	128 6.1
					E	+ 9.2	+ 3.1	+ 4.4	+ 5.4	+ 4.8
					N	- 0.2	- 0.8	- 2.9	- 4.1	- 3.8
47	Feb 14	15.1	14.6 S	92.6	Total	54 6.5	67 4.8	70 4.3	41 3.7	350 6.0
					E	+ 5.3	+ 4.4	+ 4.0	+ 2.4	- 1.0
					N	+ 3.8	+ 1.9	+ 1.5	+ 2.8	+ 5.9
51	Feb 17	14.6	14.7 S	101.2	Total	294 9.4	285 11.3			
					E	- 8.6	-10.9			
					N	+ 3.8	+ 2.9			
53	Feb 19	17.9	13.5 S	106.4	Total	210 7.0	210 7.0			
					E	- 3.5	- 3.5			
					N	- 6.1	- 6.1			

flights made on the Carnegie, Pacific Ocean, 1928-1929—Continued

Heights in kilometers								
1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5
° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec
299 4.8	311 3.1	[279 0.5]	[279 0.5]	[358 0.5]	337 3.0	294 6.0	275 4.0	
- 4.2	- 2.3	- 0.5	- 0.5	0.0	- 1.2	- 5.5	- 4.0	
+ 2.3	+ 2.0	+ 0.1	+ 0.1	+ 0.5	+ 2.8	+ 2.4	+ 0.4	
192 4.4	263 2.5	290 2.0						
- 0.9	- 2.5	- 1.9						
- 4.3	- 0.3	+ 0.7						
214 5.6	[252 3.1]	[287 2.4]	[283 2.0]	[275 3.6]				
- 3.1	- 3.0	- 2.3	- 2.0	- 3.6				
- 4.6	- 1.0	+ 0.7	+ 0.4	+ 0.3				
322 4.9	302 8.1	312 7.1	266 7.4	254 10.0	271 6.3	256 8.4	220 7.5	216 5.0
- 3.0	- 6.9	- 5.3	- 7.4	- 9.6	- 6.3	- 8.2	- 4.8	- 2.9
+ 3.9	+ 4.3	+ 4.8	- 0.5	- 2.8	+ 0.1	- 2.0	- 5.8	- 4.0
321 3.0	269 4.0	254 7.3	254 7.5	[245 7.5]				
- 1.9	- 4.0	- 7.0	- 7.2	- 6.8				
+ 2.3	- 0.1	- 2.0	- 2.1	- 3.2				
215 3.2	272 5.9	221 5.4	25 1.5	15 7.2	32 9.4	24 10.2	40 11.4	50 11.4
- 1.8	- 5.9	- 3.5	+ 0.6	+ 1.9	+ 5.0	+ 4.2	+ 7.3	+ 8.7
- 2.6	+ 0.2	- 4.1	+ 1.4	+ 7.0	+ 8.0	+ 9.3	+ 8.7	+ 7.3
122 6.3	64 5.6	61 3.3	97 1.9	59 3.6	61 4.5	59 10.9	64 11.0	58 7.8
+ 5.3	+ 5.0	+ 2.9	+ 1.9	+ 3.1	+ 3.9	+ 9.3	+ 9.9	+ 6.6
- 3.3	+ 2.4	+ 1.6	- 0.2	+ 1.8	+ 2.2	+ 5.6	+ 4.8	+ 4.1
136 5.1	128 6.1	135 4.9	116 3.5	95 1.0	70 2.3	51 9.6	79 3.5	80 0.6
+ 3.5	+ 4.8	+ 3.5	+ 3.2	+ 1.0	+ 2.2	+ 7.5	+ 3.4	+ 0.6
- 3.7	- 3.8	- 3.5	- 1.5	- 0.1	+ 0.8	+ 6.0	+ 0.7	+ 0.1
101 9.5	111 6.7	134 5.1	152 5.7	180 4.2	222 2.6			
+ 9.3	+ 6.2	+ 3.7	+ 2.7	0.0	- 1.7			
- 1.8	- 2.4	- 3.5	- 5.0	- 4.2	- 1.9			
91 10.3	92 8.2	97 7.9						
+10.3	+ 8.2	+ 7.8						
- 0.2	- 0.3	- 1.0						
85 8.9	97 7.4	112 6.1	50 3.0	15 1.0	323 2.8	[305 4.0]	[295 3.9]	[290 6.5]
+ 8.9	+ 7.3	+ 5.7	+ 2.3	+ 0.3	- 1.7	- 3.3	- 3.5	- 6.1
+ 0.8	- 0.9	- 2.3	+ 1.9	+ 1.0	+ 2.2	+ 2.3	+ 1.6	+ 2.2
121 8.4	157 6.0	173 3.7	177 3.1	188 4.0	197 5.2	231 3.1		
+ 7.2	+ 2.3	+ 0.4	+ 0.2	- 0.6	- 1.5	- 2.4		
- 4.3	- 5.5	- 3.7	- 3.1	- 4.0	- 5.0	- 2.0		
126 12.4	128 8.6	180 6.6	148 2.0	140 2.0	165 2.0	209 2.0	203 2.0	[204 3.5]
+10.0	+ 6.8	0.0	+ 1.1	+ 1.3	+ 0.5	- 1.0	- 0.8	- 1.4
- 7.3	- 5.3	- 6.6	- 1.7	- 1.5	- 1.9	- 1.8	- 1.8	- 3.2

Heights in kilometers								
8.5	9.0	9.5	10.0	10.5	11.0	11.5	12.0	12.5
° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec
304 14.5	329 16.8	348 18.7						
-12.0	- 8.6	- 3.9						
+ 8.1	+14.4	+18.3						
172 7.0								
+ 1.0								
- 6.9								
290 5.7	280 4.0							
- 5.4	- 3.9							
+ 2.0	+ 0.7							

Table 7—Upper-wind components determined from pilot-balloon

No.	Date	Local apparent time	Position: Latitude	Position: Long. west of Gr.	Wind component	Surface	0.25	0.50	0.75	1.0
	1929	hour	°	°		° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec
55	Feb 21	15.0	12.6 S	110.4	Total	101 6.7	98 9.3	96 9.7	94 10.3	98 10.7
					E	+ 6.6	+ 9.2	+ 9.7	+10.3	+10.6
					N	- 1.3	- 1.3	- 1.0	- 0.7	- 1.5
56	Feb 22	13.9	12.6 S	112.6	Total	101 6.7	85 9.2	84 9.8	84 9.9	86 11.2
					E	+ 6.6	+ 9.2	+ 9.8	+ 9.8	+11.2
					N	- 1.3	+ 0.8	+ 1.0	+ 1.0	+ 0.8
57	Feb 23	14.4	12.5 S	115.5	Total	102 6.7	99 11.2	95 11.0	90 11.0	95 10.9
					E	+ 6.6	+11.1	+11.0	+11.0	+10.9
					N	- 1.4	- 1.8	- 1.0	0.0	- 1.0
58	Feb 24	13.7	12.7 S	117.7	Total	79 4.0	61 7.6	65 7.9	62 7.9	65 7.2
					E	+ 3.9	+ 6.6	+ 7.2	+ 7.0	+ 6.5
					N	+ 0.8	+ 3.7	+ 3.3	+ 3.7	+ 3.0
59	Feb 25	16.8	13.0 S	119.8	Total	101 6.7	71 7.7	71 7.9	74 9.0	88 8.8
					E	+ 6.6	+ 7.3	+ 7.5	+ 8.6	+ 8.8
					N	- 1.3	+ 2.5	+ 2.6	+ 2.5	+ 0.3
60	Feb 26	14.8	13.1 S	121.6	Total	101 6.7	93 8.4	90 9.0	90 9.0	[90 8.7]
					E	+ 6.6	+ 8.4	+ 9.0	+ 9.0	+ 8.7
					N	- 1.3	- 0.4	0.0	0.0	0.0
61	Feb 27	10.3	13.3 S	124.0	Total	101 9.4	87 10.7	91 10.8	89 8.2	82 7.3
					E	+ 9.2	+10.7	+10.8	+ 8.2	+ 7.2
					N	- 1.8	+ 0.6	- 0.2	+ 0.1	+ 1.0
62	Mar 1	10.4	16.4 S	128.0	Total	101 4.0	72 6.6	74 7.8	70 9.4	71 9.0
					E	+ 3.9	+ 6.3	+ 7.5	+ 8.8	+ 8.5
					N	- 0.8	+ 2.0	+ 2.2	+ 3.2	+ 2.9
63	Mar 2	13.3	17.0 S	129.9	Total	90 6.7	86 7.8	94 8.2	93 8.2	81 6.2
					E	+ 6.7	+ 7.8	+ 8.2	+ 8.2	+ 6.1
					N	0.0	+ 0.5	- 0.6	- 0.4	+ 1.0
64	Mar 3	10.8	17.1 S	131.6	Total	101 4.0	98 5.0	99 5.7	93 6.2	81 5.9
					E	+ 3.9	+ 5.0	+ 5.6	+ 6.2	+ 5.8
					N	- 0.8	- 0.7	- 0.9	- 0.3	+ 0.9
65	Mar 4	13.4	17.2 S	133.4	Total	101 4.0	93 5.9	92 6.3	82 6.1	66 6.2
					E	+ 3.9	+ 5.9	+ 6.3	+ 6.0	+ 5.7
					N	- 0.8	- 0.3	- 0.2	+ 0.8	+ 2.5
66	Mar 5	13.2	17.1 S	135.5	Total	124 4.0	79 5.7	88 6.2	87 5.8	62 5.0
					E	+ 3.3	+ 5.6	+ 6.2	+ 5.8	+ 4.4
					N	- 2.2	+ 1.1	+ 0.2	+ 0.3	+ 2.4
67	Mar 6	14.8	17.2 S	136.9	Total	56 0.9	19 1.0	5 1.0	353 1.2	4 1.5
					E	+ 0.8	+ 0.3	+ 0.1	- 0.2	+ 0.1
					N	+ 0.5	+ 1.0	+ 1.0	+ 1.2	+ 1.5
68	Mar 7	14.0	17.4 S	139.1	Total	56 0.0	107 2.1	101 2.2	102 2.1	101 2.4
					E	0.0	+ 2.0	+ 2.2	+ 2.0	+ 2.4
					N	0.0	- 0.6	- 0.4	- 0.4	- 0.5
69	Mar 10	13.8	18.0 S	144.2	Total	34 1.6	51 3.8	51 3.9	54 4.2	54 3.7
					E	+ 0.9	+ 3.0	+ 3.0	+ 3.4	+ 3.0
					N	+ 1.3	+ 2.4	+ 2.4	+ 2.5	+ 2.2
70	Mar 11	17.5	18.2 S	146.3	Total	326 2.2	336 4.8	329 5.2	312 5.0	310 5.2
					E	- 1.2	- 2.0	- 2.7	- 3.7	- 4.0
					N	+ 1.8	+ 4.4	+ 4.5	+ 3.4	+ 3.3

No.	Date	Local apparent time	Position: Latitude	Position: Long. west of Gr.	Wind component	6.0	6.5	7.0	7.5	8.0
	1929	hour	°	°		° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec
55	Feb 21	15.0	12.6 S	110.4	Total	224 2.7	[268 3.8]			
					E	- 1.9	- 3.8			
					N	- 1.9	- 0.1			
59	Feb 25	16.8	13.0 S	119.8	Total	281 1.0	286 7.6	291 9.9		
					E	- 1.0	- 7.3	- 9.2		
					N	+ 0.2	+ 2.1	+ 3.6		
62	Mar 1	10.4	16.4 S	128.0	Total	344 6.3				
					E	- 1.7				
					N	+ 6.1				
63	Mar 2	13.3	17.0 S	129.9	Total	302 11.3	298 9.8			
					E	- 9.6	- 8.6			
					N	+ 6.0	+ 4.6			
64	Mar 3	10.8	17.1 S	131.6	Total	277 8.8	291 6.5	313 4.5	357 5.0	317 4.0
					E	- 8.7	- 6.1	- 3.3	- 0.3	- 2.7
					N	+ 1.1	+ 2.3	+ 3.1	+ 5.0	+ 2.9
66	Mar 5	13.2	17.1 S	135.5	Total	232 5.0	234 5.3	249 3.0	207 0.8	[190 1.0]
					E	- 3.9	- 4.3	- 2.8	- 0.4	- 0.2
					N	- 3.1	- 3.1	- 1.1	- 0.7	- 1.0

flights made on the Carnegie, Pacific Ocean, 1928-1929—Continued

Heights in kilometers								
1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5
° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec
114 10.6	225 3.4	290 5.2	305 7.0	326 8.3	333 8.0	341 6.1	257 1.8	[219 2.5]
+ 9.7	- 2.4	- 4.9	- 5.7	- 4.6	- 3.6	- 2.0	- 1.8	- 1.6
- 4.3	- 2.4	+ 1.8	+ 4.0	+ 6.9	+ 7.1	+ 5.8	- 0.4	- 1.9
114 8.4	121 6.6	358 1.0	328 2.8	12 4.0				
+ 7.7	+ 5.7	0.0	- 1.5	+ 0.8				
- 3.4	- 3.4	+ 1.0	+ 2.4	+ 3.9				
101 10.1								
+ 9.9								
- 1.9								
81 5.0								
+ 4.9								
+ 0.8								
67 8.5	79 7.1	99 6.9	75 6.4	[30 0.9]	[45 0.9]	[45 0.9]	40 0.7	328 0.6
+ 7.8	+ 7.0	+ 6.8	+ 6.2	+ 0.4	+ 0.6	+ 0.6	+ 0.4	- 0.3
+ 3.3	+ 1.4	- 1.1	+ 1.7	+ 0.8	+ 0.6	+ 0.6	+ 0.5	+ 0.5
69 6.7	58 9.5	77 7.9	55 9.1	55 6.0	55 5.9	55 8.2		
+ 6.2	+ 8.1	+ 7.7	+ 7.4	+ 4.9	+ 4.8	+ 6.7		
+ 2.4	+ 5.0	+ 1.8	+ 5.2	+ 3.4	+ 3.4	+ 4.7		
73 7.6	71 7.0	56 6.8	22 9.4	7 9.1	344 7.6	345 6.5	338 8.8	327 8.9
+ 7.3	+ 6.6	+ 5.6	+ 3.5	+ 1.1	- 2.1	- 1.7	- 3.3	- 4.8
+ 2.2	+ 2.3	+ 3.8	+ 8.7	+ 9.0	+ 7.3	+ 6.3	+ 8.2	+ 7.5
64 5.8	69 5.7	76 6.5	93 3.7	12 3.4	340 1.0	319 1.0	315 7.0	295 7.3
+ 5.2	+ 5.3	+ 6.3	+ 3.7	+ 0.7	- 0.3	- 0.7	- 5.0	- 6.6
+ 2.5	+ 2.0	+ 1.6	- 0.2	+ 3.3	+ 0.9	+ 0.8	+ 5.0	+ 3.1
72 7.6	101 6.7	110 6.4	105 4.2	27 2.8	332 2.1	298 4.2	266 6.6	273 9.4
+ 7.2	+ 6.6	+ 6.0	+ 4.1	+ 1.3	- 1.0	- 3.7	- 6.6	- 9.4
+ 2.4	- 1.3	- 2.2	- 1.1	+ 2.5	+ 1.8	+ 2.0	- 0.5	+ 0.5
51 6.9	75 6.4	107 4.4	162 5.5	183 8.0				
+ 5.4	+ 6.2	+ 1.3	+ 1.7	- 0.4				
+ 4.3	+ 1.7	- 4.2	- 5.2	- 8.0				
69 4.1	84 4.0	85 1.6	122 2.3	211 1.7	232 5.6	218 8.5	249 8.9	231 7.4
+ 3.8	+ 4.0	+ 1.6	+ 2.0	- 0.9	- 4.4	- 5.2	- 8.3	- 5.8
+ 1.5	+ 0.4	+ 0.1	- 1.2	- 1.5	- 3.4	- 6.7	- 3.2	- 4.7
22 1.2	160 2.0	207 2.5						
+ 0.4	+ 0.7	- 1.1						
+ 1.1	- 1.9	- 2.2						
45 2.0	107 3.1	126 3.9	156 4.7	224 4.8	214 4.8	221 2.7	210 1.6	210 2.2
+ 1.4	+ 3.0	+ 3.2	+ 1.9	- 3.3	- 2.7	- 1.8	- 0.8	- 1.1
+ 1.4	- 0.9	- 2.3	- 4.3	- 3.4	- 4.0	- 2.0	- 1.4	- 1.9
50 1.8								
+ 1.4								
+ 1.2								

Heights in kilometers								
8.5	9.0	9.5	10.0	10.5	11.0	11.5	12.0	12.5
° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec
3 4.2	11 2.9	[103 4.0]						
+ 0.2	+ 0.6	+ 3.9						
+ 4.2	+ 2.8	- 0.9						
180 5.8	159 5.5	150 9.5	172 6.2					
0.0	+ 2.0	+ 4.8	+ 0.9					
- 5.8	- 5.1	- 8.2	- 6.5					

Table 7—Upper-wind components determined from pilot-balloon

No.	Date	Local apparent time	Position: Latitude	Position: Long. west of Gr.	Wind component	Surface	0.25	0.50	0.75	1.0
	1929	hour	°	°		° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec
71	Mar 12	16.1	17.8 S	148.4	Total	326 4.0	10 5.0	14 5.9	9 5.3	27 5.6
					E	- 2.2	+ 0.9	+ 1.4	+ 0.8	+ 2.5
					N	+ 3.3	+ 4.9	+ 5.7	+ 5.2	+ 5.0
72	Mar 22	13.3	17.6 S	151.8	Total	[315 2.2]	314 7.3	303 8.6	305 10.6	313 11.2
					E	- 1.5	- 5.2	- 7.3	- 8.7	- 8.2
					N	+ 1.5	+ 5.1	+ 4.6	+ 6.1	+ 7.6
73	Mar 23	13.4	17.1 S	152.8	Total	56 0.9	346 2.8	337 2.3	335 1.7	334 3.2
					E	+ 0.8	- 0.7	- 0.9	- 0.7	- 1.4
					N	+ 0.5	+ 2.7	+ 2.1	+ 1.5	+ 2.9
74	Mar 24	10.4	16.9 S	153.6	Total	112 4.0	132 6.1	116 4.4	98 5.0	78 6.7
					E	+ 3.7	+ 4.5	+ 4.0	+ 5.0	+ 6.6
					N	- 1.5	- 4.1	- 1.9	- 0.7	+ 1.4
75	Mar 25	13.8	16.5 S	156.2	Total	90 6.7	94 8.6	93 9.5	92 8.8	71 9.0
					E	+ 6.7	+ 8.6	+ 9.5	+ 8.8	+ 8.5
					N	0.0	- 0.6	- 0.5	- 0.3	+ 2.9
76	Mar 27	11.7	15.7 S	160.6	Total	56 6.7	55 8.2	57 8.3	52 9.1	47 8.9
					E	+ 5.6	+ 6.7	+ 7.0	+ 7.2	+ 6.5
					N	+ 3.8	+ 4.7	+ 4.5	+ 5.6	+ 6.1
77	Mar 28	13.3	15.5 S	162.1	Total	56 2.2	15 3.0	29 3.0	34 3.3	34 3.0
					E	+ 1.8	+ 0.8	+ 1.4	+ 1.8	+ 1.7
					N	+ 1.2	+ 2.9	+ 2.6	+ 2.7	+ 2.5
78	Mar 29	13.3	15.2 S	163.5	Total	-- 0.0	[130 0.6]	[130 0.6]	[130 0.6]	[130 0.6]
					E	0.0	+ 0.5	+ 0.5	+ 0.5	+ 0.5
					N	0.0	- 0.4	- 0.4	- 0.4	- 0.4
79	Mar 30	15.6	14.7 S	166.1	Total	191 2.2	86 1.6	20 2.4	10 2.6	11 2.0
					E	- 0.4	+ 1.6	+ 0.8	+ 0.4	+ 0.4
					N	- 2.2	+ 0.1	+ 2.3	+ 2.6	+ 2.0
80	Mar 31	13.2	14.7 S	168.0	Total	110 4.0	357 4.9	1 4.2	359 3.6	353 3.2
					E	+ 3.8	- 0.3	+ 0.1	- 0.1	- 0.4
					N	- 1.4	+ 4.9	+ 4.2	+ 3.6	+ 3.2
81	Apr 1	15.1	14.4 S	170.3	Total	326 4.0	23 4.5	14 3.2	7 2.9	358 2.2
					E	- 2.2	+ 1.8	+ 0.8	+ 0.4	- 0.1
					N	+ 3.3	+ 4.1	+ 3.1	+ 2.9	+ 2.2
82	Apr 22	13.8	12.6 S	171.6	Total	112 6.7	109 5.7	105 4.6	94 4.5	90 4.5
					E	+ 6.2	+ 5.4	+ 4.4	+ 4.5	+ 4.5
					N	- 2.5	- 1.9	- 1.2	- 0.3	0.0
83	Apr 23	13.6	11.2 S	171.5	Total	158 6.7	138 9.2	143 9.2	136 7.8	119 5.9
					E	+ 2.5	+ 6.2	+ 5.5	+ 5.4	+ 5.2
					N	- 6.2	- 6.8	- 7.4	- 5.6	- 2.9
84	Apr 24	16.7	8.4 S	171.2	Total	68 2.2	63 4.7	66 4.3	77 6.1	89 6.2
					E	+ 2.0	+ 4.2	+ 3.9	+ 5.9	+ 6.2
					N	+ 0.8	+ 2.1	+ 1.8	+ 1.4	+ 0.1
85	Apr 25	14.3	7.5 S	171.9	Total	-- 0.0	143 2.2	142 1.7	119 1.3	110 1.7
					E	0.0	+ 1.3	+ 1.0	+ 1.1	+ 1.6
					N	0.0	- 1.8	- 1.3	- 0.6	- 0.6
86	Apr 25	16.2	7.3 S	171.9	Total	56 1.5	120 1.8	111 2.0	86 2.1	81 1.7
					E	+ 1.2	+ 1.6	+ 1.9	+ 2.1	+ 1.7
					N	+ 0.8	- 0.9	- 0.7	+ 0.2	+ 0.3

No.	Date	Local apparent time	Position: Latitude	Position: Long. west of Gr.	Wind-component	6.0	6.5	7.0	7.5	8.0
	1929	hour	°	°		° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec
74	Mar 24	10.4	16.9 S	153.6	Total	42 3.0	17 4.0	9 8.8	359 10.0	359 10.0
					E	+ 2.0	+ 1.2	+ 1.4	- 0.2	- 0.2
					N	+ 2.2	+ 3.8	+ 8.7	+10.0	+10.0
77	Mar 28	13.3	15.5 S	162.1	Total	325 0.5	222 1.6	207 3.2	121 5.7	165 5.2
					E	- 0.3	- 1.1	- 1.4	+ 4.9	+ 1.4
					N	+ 0.4	- 1.2	- 2.8	- 2.9	- 5.0
78	Mar 29	13.3	15.2 S	163.5	Total	152 4.4				
					E	+ 2.1				
					N	- 3.9				
79	Mar 30	15.6	14.7 S	166.1	Total	194 2.4	244 3.0	290 5.8		
					E	- 0.6	- 2.7	- 5.4		
					N	- 2.3	- 1.3	+ 2.0		
80	Mar 31	13.2	14.7 S	168.0	Total	296 2.6	324 3.1			
					E	- 2.3	- 1.8			
					N	+ 1.1	+ 2.5			
86	Apr 25	16.2	7.3 S	171.9	Total	159 5.8	167 5.7	177 10.1	218 10.0	
					E	+ 2.1	+ 1.3	+ 0.5	- 6.2	
					N	- 5.4	- 5.6	-10.1	- 7.9	

flights made on the Carnegie, Pacific Ocean, 1928-1929—Continued

Heights in kilometers								
1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5
° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec
352 2.8	35 2.2	46 2.0	201 1.0	193 2.1	190 5.1	192 6.1		
- 0.4	+ 1.3	+ 1.4	- 0.4	- 0.5	- 0.9	- 1.3		
+ 2.8	+ 1.8	+ 1.4	- 0.9	- 2.0	- 5.0	- 6.0		
318 10.1	316 11.1	314 7.0	298 6.0					
- 6.8	- 7.7	- 5.0	- 5.3					
+ 7.5	+ 8.0	+ 4.9	+ 2.8					
352 5.1	355 4.6	5 3.4	28 3.1	348 3.7	333 1.4	329 2.5	327 4.7	335 5.0
- 0.7	- 0.4	+ 0.3	+ 1.5	- 0.8	- 0.6	- 1.3	- 2.6	- 2.1
+ 5.0	+ 4.6	+ 3.4	+ 2.7	+ 3.6	+ 1.2	+ 2.1	+ 3.9	+ 4.5
51 5.4	50 6.6	34 5.8	56 5.7	74 5.0	81 4.4	48 4.1	60 3.6	60 2.8
+ 4.2	+ 5.1	+ 3.2	+ 4.7	+ 4.8	+ 4.4	+ 3.0	+ 3.1	+ 2.4
+ 3.4	+ 4.2	+ 4.8	+ 3.2	+ 1.4	+ 0.7	+ 2.7	+ 1.8	+ 1.4
89 7.1	98 6.7							
+ 7.1	+ 6.6							
+ 0.1	- 0.9							
57 7.5	60 7.0	97 5.8	87 5.0					
+ 6.3	+ 6.1	+ 5.8	+ 5.0					
+ 4.1	+ 3.5	- 0.7	+ 0.3					
56 2.7	123 1.8	130 1.8	130 1.8	304 1.5	315 1.5	315 1.5	315 1.5	325 0.5
+ 2.2	+ 1.5	+ 1.4	+ 1.4	- 1.2	- 1.1	- 1.1	- 1.1	- 0.3
+ 1.5	- 1.0	- 1.2	- 1.2	+ 0.8	+ 1.1	+ 1.1	+ 1.1	+ 0.4
[206 0.8]	[187 0.8]	154 1.1	107 1.9	118 2.0	109 2.0	131 2.9	141 4.2	148 4.8
- 0.4	- 0.1	+ 0.5	+ 1.8	+ 1.8	+ 1.9	+ 2.2	+ 2.6	+ 2.5
- 0.7	- 0.8	- 1.0	- 0.6	- 0.9	- 0.6	- 1.9	- 3.3	- 4.1
20 2.6	35 2.0	61 2.5	80 3.0	70 4.0	85 1.4	189 1.5	193 1.9	186 1.0
+ 0.9	+ 1.2	+ 2.2	+ 3.0	+ 3.8	+ 1.4	- 0.2	- 0.4	- 0.1
+ 2.4	+ 1.6	+ 1.2	+ 0.5	+ 1.4	+ 0.1	- 1.5	- 1.8	- 1.0
25 3.8	21 2.8	55 1.3	35 1.7	35 1.3	55 1.5	55 1.5	220 2.0	341 1.6
+ 1.6	+ 1.0	+ 1.1	+ 1.0	+ 0.8	+ 1.2	+ 1.2	- 1.3	- 0.5
+ 3.4	+ 2.6	+ 0.8	+ 1.4	+ 1.1	+ 0.9	+ 0.9	- 1.5	+ 1.5
15 2.5	357 2.0	40 1.4						
+ 0.6	- 0.1	+ 0.9						
+ 2.4	+ 2.0	+ 1.1						
90 3.6								
+ 3.6								
0.0								
164 5.5	150 4.0	94 4.6	120 3.2	111 3.9	116 1.0	226 1.5	351 5.9	12 5.0
+ 1.5	+ 2.0	+ 4.6	+ 2.8	+ 3.6	+ 0.9	- 1.1	- 0.9	+ 1.0
- 5.3	- 3.5	- 0.3	- 1.6	- 1.4	- 0.4	- 1.0	+ 5.8	+ 4.9
99 7.6	98 8.2	102 8.7	110 7.1	140 8.0				
+ 7.5	+ 8.1	+ 8.5	+ 6.7	+ 5.1				
- 1.2	- 1.1	- 1.8	- 2.4	- 6.1				
81 1.8	73 4.0	73 4.0	73 4.0	73 4.0	83 3.1	85 1.1	120 1.9	159 1.0
+ 1.8	+ 3.8	+ 3.8	+ 3.8	+ 3.8	+ 3.1	+ 1.1	+ 1.6	+ 0.4
+ 0.3	+ 1.2	+ 1.2	+ 1.2	+ 1.2	+ 0.4	+ 0.1	- 1.0	- 0.9

Heights in kilometers								
8.5	9.0	9.5	10.0	10.5	11.0	11.5	12.0	12.5
° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec
174 5.9	[60 2.9]	[358 2.4]	[153 3.2]	124 8.4	135 6.0	111 10.6	133 12.9	113 11.3
+ 0.6	+ 2.5	- 0.1	+ 1.4	+ 7.0	+ 4.2	+ 9.9	+ 9.4	+10.4
- 5.9	+ 1.4	+ 2.4	- 2.8	- 4.7	- 4.2	- 3.8	- 8.8	- 4.4

Table 7—Upper-wind-components determined from pilot-balloon

No.	Date	Local apparent time	Position: Latitude	Position: Long. west of Gr.	Wind component	Surface	0.25	0.50	0.75	1.0
	1929	hour	°	°		° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec
87	Apr 26	16.8	6.4 S	172.4	Total	34 0.9	292 2.0	291 2.3	283 2.0	102 0.3
					E	+ 0.5	- 1.8	- 2.2	- 2.0	+ 0.3
					N	+ 0.8	+ 0.8	+ 0.8	+ 0.4	- 0.1
88	Apr 27	10.8	5.2 S	172.4	Total	360 0.9	97 0.6	70 1.7	56 3.1	57 2.5
					E	0.0	+ 0.6	+ 1.6	+ 2.6	+ 2.1
					N	+ 0.9	- 0.1	+ 0.6	+ 1.7	+ 1.4
89	Apr 28	16.7	3.4 S	172.8	Total	68 4.0	62 5.2	75 5.9	88 5.5	104 6.3
					E	+ 3.7	+ 4.6	+ 5.7	+ 5.5	+ 6.1
					N	+ 1.5	+ 2.4	+ 1.5	+ 0.2	- 1.5
90	Apr 29	10.8	1.8 S	173.5	Total	90 6.7	87 7.5	89 8.2	91 9.9	90 11.7
					E	+ 6.7	+ 7.5	+ 8.2	+ 9.9	+11.7
					N	0.0	+ 0.4	+ 0.1	- 0.2	0.0
91	Apr 30	13.3	0.5 N	174.1	Total	90 9.4	96 7.5	92 11.4	91 15.0	96 14.7
					E	+ 9.4	+ 7.5	+11.4	+15.0	+14.6
					N	0.0	- 0.8	- 0.4	- 0.3	- 1.5
92	May 4	16.9	8.5 N	179.3	Total	34 9.4	49 9.8	52 7.7	61 8.8	72 8.8
					E	+ 5.3	+ 7.4	+ 6.1	+ 7.7	+ 8.4
					N	+ 7.8	+ 6.4	+ 4.7	+ 4.3	+ 2.7
93	May 5	13.8	9.5 N	179.8	Total	79 10.8	72 12.3	75 13.4	73 13.7	
					E	+10.6	+11.7	+12.9	+13.1	
					N	+ 2.1	+ 3.8	+ 3.5	+ 4.0	
94	May 7	13.6	13.6 N	182.8	Total	79 9.4	59 13.7	61 13.2	67 13.3	80 15.8
					E	+ 9.2	+11.7	+11.5	+12.2	+15.6
					N	+ 1.8	+ 7.1	+ 6.4	+ 5.2	+ 2.7
95	May 9	13.6	16.6 N	188.4	Total	79 9.4	80 10.2	87 11.9	88 11.4	86 10.8
					E	+ 9.2	+10.0	+11.9	+11.4	+10.8
					N	+ 1.8	+ 1.8	+ 0.6	+ 0.4	+ 0.8
96	May 13	10.9	20.2 N	198.8	Total	68 6.7	59 7.7	67 7.9	73 7.2	79 6.8
					E	+ 6.2	+ 6.6	+ 7.3	+ 6.9	+ 6.7
					N	+ 2.5	+ 4.0	+ 3.1	+ 2.1	+ 1.3
97	May 14	13.7	19.4 N	201.8	Total	112 9.4	100 10.0	97 9.9	101 9.1	103 8.0
					E	+ 8.7	+ 9.8	+ 9.8	+ 8.9	+ 7.8
					N	- 3.5	- 1.7	- 1.2	- 1.7	- 1.8
98	May 15	13.2	18.6 N	204.1	Total	124 6.7	105 8.5	103 8.7	107 9.7	108 9.8
					E	+ 5.6	+ 8.2	+ 8.5	+ 9.3	+ 9.3
					N	- 3.8	- 2.2	- 2.0	- 2.8	- 3.0
99	May 16	11.2	17.5 N	206.5	Total	112 6.7	102 7.3	106 8.2	114 8.7	110 9.0
					E	+ 6.2	+ 7.1	+ 7.9	+ 8.0	+ 8.5
					N	- 2.5	- 1.5	- 2.3	- 3.5	- 3.1
100	May 17	13.2	16.1 N	209.3	Total	112 9.4	96 9.2	103 10.6	103 10.6	103 10.6
					E	+ 8.7	+ 9.2	+10.3	+10.3	+10.3
					N	- 3.5	- 1.0	- 2.4	- 2.4	- 2.4
101	May 19	15.4	13.9 N	214.4	Total	79 4.0	84 6.8	84 7.0	86 6.5	81 5.9
					E	+ 3.9	+ 6.8	+ 7.0	+ 6.5	+ 5.8
					N	+ 0.8	+ 0.7	+ 0.7	+ 0.4	+ 0.9
102	May 26	13.4	16.2 N	215.9	Total	79 6.7	93 6.1	100 8.4	104 9.0	104 7.7
					E	+ 6.6	+ 6.1	+ 8.3	+ 8.7	+ 7.5
					N	+ 1.3	- 0.3	- 1.5	- 2.2	- 1.9
103	May 27	13.6	18.7 N	216.0	Total	79 6.7	85 8.8	87 8.5	93 8.4	98 8.8
					E	+ 6.6	+ 8.8	+ 8.5	+ 8.4	+ 8.7
					N	+ 1.3	+ 0.8	+ 0.4	- 0.4	- 1.2
104	May 28	15.4	21.8 N	215.8	Total	101 4.0	121 5.3	126 5.6	124 5.8	131 7.2
					E	+ 3.9	+ 4.5	+ 4.5	+ 4.8	+ 5.4
					N	- 0.8	- 2.7	- 3.3	- 3.2	- 4.7

No.	Date	Local apparent time	Position: Latitude	Position: Long. west of Gr.	Wind component	6.0	6.5	7.0	7.5	8.0
	1929	hour	°	°		° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec
89	Apr 28	16.7	3.4 S	172.8	Total	121 5.9	122 14.9	127 12.0	130 11.1	
					E	+ 5.1	+12.6	+ 9.6	+ 8.5	
					N	- 3.0	- 7.9	- 7.2	- 7.1	
96	May 13	10.9	20.2 N	198.8	Total	143 3.9	97 4.4	68 4.3	47 4.4	
					E	+ 2.4	+ 4.4	+ 4.0	+ 3.2	
					N	- 3.1	- 0.5	+ 1.6	+ 3.0	
97	May 14	13.7	19.4 N	201.8	Total	95 5.6	86 4.7	79 4.7		
					E	+ 5.6	+ 4.7	+ 4.6		
					N	- 0.5	+ 0.3	+ 0.9		
104	May 28	15.4	21.8 N	215.8	Total	147 3.0	147 3.0	147 3.0	147 3.0	
					E	+ 1.6	+ 1.6	+ 1.6	+ 1.6	
					N	- 2.5	- 2.5	- 2.5	- 2.5	

flights made on the Carnegie, Pacific Ocean, 1928-1929—Continued

Heights in kilometers								
1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5
° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec
50 1.2	50 0.6	50 0.6	158 1.1	141 3.4	182 2.0	166 1.6	150 1.6	150 1.6
+ 0.9	+ 0.5	+ 0.5	+ 0.4	+ 2.1	- 0.1	+ 0.4	+ 0.8	+ 0.8
+ 0.8	+ 0.4	+ 0.4	- 1.0	- 2.6	- 2.0	- 1.6	- 1.4	- 1.4
67 4.5	59 4.6	94 1.8						
+ 4.1	+ 3.9	+ 1.8						
+ 1.8	+ 2.4	- 0.1						
95 4.6	82 5.2	90 4.6	175 3.7	206 3.5	219 1.3	170 2.7	221 1.0	66 1.8
+ 4.6	+ 5.2	+ 4.6	+ 0.3	- 1.5	- 0.8	+ 0.5	- 0.7	+ 1.6
- 0.4	+ 0.7	0.0	- 3.7	- 3.2	- 1.0	- 2.7	- 0.8	+ 0.7
89 11.8	82 9.8							
+11.8	+ 9.7							
+ 0.2	+ 1.4							
110 14.7								
+13.8								
- 5.0								
78 6.0	80 6.0	78 6.5	66 7.9	75 5.0	90 5.0	90 4.0		
+ 5.9	+ 5.9	+ 6.4	+ 7.2	+ 4.8	+ 5.0	+ 4.0		
+ 1.2	+ 1.0	+ 1.4	+ 3.2	+ 1.3	0.0	0.0		
74 13.8								
+13.3								
+ 3.8								
95 12.9								
+12.8								
- 1.1								
111 6.4	120 6.8	130 6.4	136 6.9	129 7.0	150 8.0	152 8.3	152 8.3	152 8.4
+ 6.0	+ 5.9	+ 4.9	+ 4.8	+ 5.4	+ 4.0	+ 3.9	+ 3.9	+ 3.9
- 2.3	- 3.4	- 4.1	- 5.0	- 4.4	- 6.9	- 7.3	- 7.3	- 7.4
106 7.5	102 5.0	125 5.0	112 8.0	112 8.0	128 8.5	110 7.3	109 7.0	116 8.4
+ 7.2	+ 4.9	+ 4.1	+ 7.4	+ 7.4	+ 6.7	+ 6.9	+ 6.6	+ 7.6
- 2.1	- 1.0	- 2.9	- 3.0	- 3.0	- 5.2	- 2.5	- 2.3	- 3.7
107 9.1	107 9.1	112 8.0	117 9.2	131 8.0	130 5.0	130 5.0	130 5.0	130 5.0
+ 8.7	+ 8.7	+ 7.4	+ 8.2	+ 6.0	+ 3.8	+ 3.8	+ 3.8	+ 3.8
- 2.7	- 2.7	- 3.0	- 4.2	- 5.2	- 3.2	- 3.2	- 3.2	- 3.2
105 8.2	126 9.7	123 11.4	129 8.0	137 5.0	137 5.0	137 5.0	137 5.0	137 5.0
+ 7.9	+ 7.8	+ 9.6	+ 6.2	+ 3.4	+ 3.4	+ 3.4	+ 3.4	+ 3.4
- 2.1	- 5.7	- 6.2	- 5.0	- 3.7	- 3.7	- 3.7	- 3.7	- 3.7
88 8.7	88 8.7	101 5.6	84 6.5	84 6.5	84 6.5	85 8.2		
+ 8.7	+ 8.7	+ 5.5	+ 6.5	+ 6.5	+ 6.5	+ 8.2		
+ 0.3	+ 0.3	- 1.1	+ 0.7	+ 0.7	+ 0.7	+ 0.7		
106 5.2	113 6.4	105 6.2						
+ 5.0	+ 5.9	+ 6.0						
- 1.4	- 2.5	- 1.6						
117 7.3	116 5.1	117 6.6	122 7.8					
+ 6.5	+ 4.6	+ 5.9	+ 6.6					
- 3.3	- 2.2	- 3.0	- 4.1					
100 7.7	100 7.7	100 7.7	100 7.7	100 7.7	100 7.7	100 7.7	100 7.7	
+ 7.6	+ 7.6	+ 7.6	+ 7.6	+ 7.6	+ 7.6	+ 7.6	+ 7.6	
- 1.3	- 1.3	- 1.3	- 1.3	- 1.3	- 1.3	- 1.3	- 1.3	
128 7.0	146 8.8	104 7.6	106 7.0	99 8.3	107 5.7	105 2.2	108 2.2	147 3.0
+ 5.5	+ 4.9	+ 7.4	+ 6.7	+ 8.2	+ 5.4	+ 2.1	+ 2.1	+ 1.6
- 4.3	- 7.3	- 1.8	- 1.9	- 1.3	- 1.7	- 0.6	- 0.7	- 2.5

Heights in kilometers								
8.5	9.0	9.5	10.0	10.5	11.0	11.5	12.0	12.5
° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec

Table 7—Upper-wind components determined from pilot-balloon

No.	Date	Local apparent time	Position: Latitude	Position: Long. west of Gr.	Wind component	Surface	0.25	0.50	0.75	1.0
	1929	hour	°	°		° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec
105	May 29	13.2	23.5 N	215.9	Total	135 6.7	148 7.7	154 8.5	160 8.6	147 6.8
					E	+ 4.7	+ 4.1	+ 3.7	+ 2.9	+ 3.7
					N	- 4.7	- 6.5	- 7.6	- 8.1	- 5.7
106	May 30	11.0	25.2 N	215.9	Total	158 4.0	175 8.3	185 8.1	191 6.2	202 7.3
					E	+ 1.5	+ 0.7	- 0.7	- 1.2	- 2.7
					N	- 3.7	- 8.3	- 8.1	- 6.1	- 6.8
107	Jun 1	10.8	28.4 N	216.0	Total	169 6.7	178 13.0	185 14.2	183 12.9	187 12.9
					E	+ 1.3	+ 0.4	- 1.2	- 0.7	- 1.6
					N	- 6.6	-13.0	-14.2	-12.9	-12.8
108	Jun 3	13.3	31.1 N	215.8	Total	259 6.7	270 8.5	275 8.8	269 8.1	267 8.5
					E	- 6.6	+ 8.5	- 8.8	- 8.1	- 8.5
					N	- 1.3	0.0	+ 0.8	- 0.1	- 0.4
109	Jun 3	13.6	31.2 N	215.8	Total	259 6.7	275 8.4	275 8.6	267 8.2	278 7.8
					E	- 6.6	- 8.4	- 8.6	- 8.2	- 7.7
					N	- 1.3	+ 0.7	+ 0.8	- 0.4	+ 1.1
110	Jun 5	15.9	34.3 N	219.1	Total	225 6.7	227 6.4	238 5.8	216 6.4	
					E	- 4.7	- 4.7	- 4.3	- 3.8	
					N	- 4.7	- 4.4	- 3.9	- 5.2	
111	Jun 25	16.5	34.9 N	218.8	Total	90 4.0	71 6.6	70 6.0	71 3.8	49 3.7
					E	+ 4.0	+ 6.2	+ 5.6	+ 3.6	+ 2.8
					N	0.0	+ 2.2	+ 2.0	+ 1.2	+ 2.4
112	Jun 26	14.2	36.1 N	217.7	Total	135 6.0	183 6.3	204 5.7	223 4.9	230 4.7
					E	+ 4.2	- 0.3	- 2.3	- 3.3	- 3.6
					N	- 4.2	- 6.3	- 5.2	- 3.6	- 3.0
113	Jun 27	14.7	36.7 N	216.2	Total	202 2.2	245 4.8	255 4.8	252 4.0	236 3.0
					E	- 0.8	- 4.4	- 4.6	- 3.8	- 2.5
					N	- 2.0	- 2.0	- 1.2	- 1.2	- 1.7
114	Jun 29	13.6	37.9 N	214.5	Total	[101 4.0]	94 4.9	69 4.4	16 4.0	353 3.0
					E	+ 3.9	+ 4.9	+ 4.1	+ 1.1	- 0.4
					N	- 0.8	- 0.3	+ 1.6	+ 3.8	+ 3.0
115	Jun 30	13.7	38.2 N	212.9	Total	135 2.2	164 5.8	198 4.2	223 4.0	233 3.9
					E	+ 1.6	+ 1.6	- 1.3	- 2.7	- 3.1
					N	- 1.6	- 5.6	- 4.0	- 2.9	- 2.4
116	Jul 1	13.3	38.8 N	212.2	Total	124 2.2	116 5.8	94 2.9	60 2.5	52 3.4
					E	+ 1.2	+ 5.2	+ 2.9	+ 2.2	+ 2.7
					N	- 1.8	- 2.5	- 0.2	+ 1.2	+ 2.1
117	Jul 2	14.0	39.9 N	210.4	Total	146 4.0	177 4.2	206 2.9	221 2.9	209 3.4
					E	+ 2.2	+ 0.2	- 1.3	- 1.9	- 1.6
					N	- 3.3	- 4.2	- 2.6	- 2.2	- 3.0
118	Jul 3	14.0	40.4 N	208.7	Total	[135 4.0]	187 3.8	198 3.4		
					E	+ 2.8	- 0.5	- 1.0		
					N	- 2.8	- 3.8	- 3.2		
119	Jul 21	14.0	47.8 N	142.4	Total	281 12.1	309 13.9	302 14.3	302 12.6	316 12.5
					E	-11.9	-10.8	-12.1	-10.7	- 8.7
					N	+ 2.3	+ 8.8	+ 7.6	+ 6.7	+ 9.0
120	Jul 21	14.3	47.8 N	142.4	Total	281 12.1	306 12.9	308 14.2	311 13.5	315 13.0
					E	-11.9	-10.4	-11.2	-10.2	- 9.2
					N	+ 2.3	+ 7.6	+ 8.7	+ 8.9	+ 9.2
121	Jul 23	13.3	44.2 N	137.5	Total	248 6.7	279 10.3	283 9.6	282 8.2	273 7.2
					E	- 6.2	-10.2	- 9.4	- 8.0	- 7.2
					N	- 2.5	+ 1.6	+ 2.2	+ 1.7	+ 0.4
122	Jul 26	13.5	39.5 N	129.3	Total	34 9.4	6 9.5	4 9.6	4 9.1	3 7.5
					E	+ 5.3	+ 1.0	+ 0.7	+ 0.6	+ 0.4
					N	+ 7.8	+ 9.4	+ 9.6	+ 9.1	+ 7.5
123	Sep 8	15.9	31.4 N	129.2	Total	331 4.0	1 6.0	8 6.0	10 5.6	12 5.3
					E	- 1.9	+ 0.1	+ 0.8	+ 1.0	+ 1.1
					N	+ 3.5	+ 6.0	+ 5.9	+ 5.5	+ 5.2
124	Sep 9	11.1	30.4 N	130.8	Total	330 4.0	24 6.1	20 6.1	15 6.8	3 5.6
					E	- 2.0	+ 2.5	+ 2.1	+ 1.8	+ 0.3
					N	+ 3.5	+ 5.6	+ 5.7	+ 6.6	+ 5.6

No.	Date	Local apparent time	Position: Latitude	Position: Long. west of Gr.	Wind component	6.0	6.5	7.0	7.5	8.0
	1929	hour	°	°		° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec
114	Jun 29	13.6	37.9 N	214.5	Total	279 4.1	313 4.5			
					E	- 4.0	- 3.3			
					N	+ 0.6	+ 3.1			
117	Jul 2	14.0	39.9 N	210.4	Total	348 10.0				
					E	- 2.1				
					N	+ 9.8				

flights made on the Carnegie, Pacific Ocean, 1928-1929—Continued

Heights in kilometers								
1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5
° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec
159 6.8 + 2.4 - 6.4	164 6.8 + 1.9 - 6.5	156 5.9 + 2.4 - 5.4	156 4.8 + 2.0 - 4.4	194 6.2 - 1.5 - 6.0	241 5.9 - 5.2 - 2.9	243 3.9 - 3.5 - 1.8	264 3.7 - 3.7 - 0.4	
196 7.1 - 2.0 - 6.8	213 9.8 - 5.3 - 8.2	211 7.4 - 3.8 - 6.3	223 8.9 - 6.1 - 6.5	223 8.0 - 5.5 - 5.8	223 6.5 - 4.4 - 4.8	223 6.5 - 4.4 - 4.8	223 6.5 - 4.4 - 4.8	223 6.5 - 4.4 - 4.8
191 13.4 - 2.6 -13.2	214 13.8 - 7.7 -11.4	215 12.0 - 6.9 - 9.8	215 12.0 - 6.9 - 9.8					
50 3.7 + 2.8 + 2.4	20 4.0 + 1.4 + 3.8	340 5.0 - 1.7 + 4.7	343 6.0 - 1.8 + 5.7	343 6.0 - 1.8 + 5.7				
259 4.3 - 4.2 - 0.8								
309 1.5 - 1.2 + 0.9	69 1.3 + 1.2 + 0.5	92 1.5 + 1.5 0.0	48 1.7 + 1.3 + 1.1	40 1.1 + 0.7 + 0.8	291 1.0 - 0.9 + 0.4	247 4.0 - 3.7 - 1.6	241 4.0 - 3.5 - 1.9	271 5.4 - 5.4 + 0.1
211 4.2 - 2.2 - 3.6	204 5.9 - 2.4 - 5.4	160 5.0 + 1.7 - 4.7	116 3.7 + 3.3 - 1.6	64 2.8 + 2.5 + 1.2	69 3.9 + 3.6 + 1.4	49 4.3 + 3.2 + 2.8	19 5.5 + 1.8 + 5.2	37 5.0 + 3.0 + 4.0
101 3.4 + 3.3 - 0.6	90 3.9 + 3.9 0.0	71 5.8 + 5.5 + 1.9	41 5.6 + 3.7 + 4.2					
186 3.9 - 0.4 - 3.9	160 2.2 + 0.8 - 2.1	132 2.7 + 2.0 - 1.8	19 3.1 + 1.0 + 2.9	10 5.1 + 0.9 + 5.0	11 5.0 + 1.0 + 4.9	351 6.9 - 1.1 + 6.8	346 11.8 - 2.8 +11.4	344 11.4 - 3.1 +11.0
306 13.0 -10.5 + 7.6								
276 9.6 - 9.6 + 1.0	277 12.3 -12.2 + 1.5							

Heights in kilometers								
8.5	9.0	9.5	10.0	10.5	11.0	11.5	12.0	12.5
° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec

Table 7—Upper-wind components determined from pilot-balloon

No.	Date	Local apparent time	Position: Latitude	Position: Long. west of Gr.	Wind component	Surface	0.25	0.50	0.75	1.0
	1929	hour	°	°		° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec
125	Sep 9	11.4	30.4 N	130.9	Total	330 4.0	18 6.9	25 6.3	22 6.5	16 5.6
					E	- 2.0	+ 2.1	+ 2.7	+ 2.4	+ 1.5
					N	+ 3.5	+ 6.6	+ 5.7	+ 6.0	+ 5.4
126	Sep 10	16.0	29.1 N	132.9	Total	38 4.0	31 4.8	29 5.8	23 7.5	
					E	+ 2.5	+ 2.5	+ 2.8	+ 2.9	
					N	+ 3.2	+ 4.1	+ 5.1	+ 6.9	
127	Sep 11	15.4	28.1 N	134.5	Total	59 2.2	54 4.8	58 4.2	45 3.9	36 3.9
					E	+ 1.9	+ 3.9	+ 3.6	+ 2.8	+ 2.3
					N	+ 1.1	+ 2.8	+ 2.2	+ 2.8	+ 3.2
128	Sep 12	13.2	27.7 N	135.6	Total	172 2.2	179 3.0	175 3.0	171 2.8	159 2.4
					E	+ 0.3	0.0	+ 0.3	+ 0.4	+ 0.9
					N	- 2.2	- 3.0	- 3.0	- 2.8	- 2.2
129	Sep 13	10.8	27.0 N	137.7	Total	126 2.2	127 3.5	124 3.5	128 2.8	134 1.7
					E	+ 1.8	+ 2.8	+ 2.9	+ 2.2	+ 1.2
					N	- 1.3	- 2.1	- 2.0	- 1.7	- 1.2
130	Sep 14	14.8	26.7 N	139.2	Total	-- 0.0	243 1.8	225 2.0	238 2.2	232 1.6
					E	0.0	- 1.6	- 1.4	- 1.9	- 1.3
					N	0.0	- 0.8	- 1.4	- 1.2	- 1.0
131	Sep 16	14.0	26.2 N	142.2	Total	126 4.0	137 4.6	136 3.9	125 2.6	127 2.3
					E	+ 3.2	+ 3.1	+ 2.7	+ 2.1	+ 1.8
					N	- 2.4	- 3.4	- 2.8	- 1.5	- 1.4
132	Sep 16	14.4	26.2 N	142.2	Total	126 4.0	132 4.7	141 4.8		
					E	+ 3.2	+ 3.5	+ 3.0		
					N	- 2.4	- 3.1	- 3.7		
133	Sep 16	15.0	26.2 N	142.2	Total	126 4.0	142 3.5	137 3.0	149 2.4	149 2.1
					E	+ 3.2	+ 2.2	+ 2.0	+ 1.2	+ 1.1
					N	- 2.4	- 2.8	- 2.2	- 2.1	- 1.8
134	Sep 17	13.7	25.0 N	143.8	Total	92 4.0	48 5.8	45 5.7	47 6.0	46 6.1
					E	+ 4.0	+ 4.3	+ 4.0	+ 4.4	+ 4.4
					N	- 0.1	+ 3.9	+ 4.0	+ 4.1	+ 4.2
135	Sep 17	14.7	25.0 N	143.8	Total	92 4.0	59 5.4	60 5.9	62 6.7	54 7.8
					E	+ 4.0	+ 4.6	+ 5.1	+ 5.9	+ 6.3
					N	- 0.1	+ 2.8	+ 3.0	+ 3.2	+ 4.6
136	Sep 18	13.9	24.0 N	145.8	Total	68 6.7	72 9.7	72 9.9	76 9.6	89 9.6
					E	+ 6.2	+ 9.2	+ 9.4	+ 9.3	+ 9.6
					N	+ 2.5	+ 3.0	+ 3.1	+ 2.3	+ 0.2
137	Sep 20	15.7	22.8 N	151.8	Total	91 6.7	92 7.8	93 8.0	97 7.3	96 7.2
					E	+ 6.7	+ 7.8	+ 8.0	+ 7.2	+ 7.2
					N	- 0.1	- 0.3	- 0.4	- 0.9	- 0.8
138	Sep 21	14.0	22.3 N	153.8	Total	79 2.2	86 7.9	83 7.3	94 5.6	100 4.8
					E	+ 2.2	+ 7.9	+ 7.2	+ 5.6	+ 4.7
					N	+ 0.4	+ 0.6	+ 0.9	- 0.4	- 0.8
139	Sep 22	17.7	21.6 N	156.1	Total	101 4.0	96 6.8	101 7.0	109 6.5	106 6.0
					E	+ 3.9	+ 6.8	+ 6.9	+ 6.2	+ 5.8
					N	- 0.8	- 0.7	- 1.3	- 2.1	- 1.6
140	Oct 3	15.3	23.9 N	159.7	Total	101 9.4	108 7.5	109 7.8	105 7.5	105 7.4
					E	+ 9.2	+ 7.1	+ 7.4	+ 7.2	+ 7.2
					N	- 1.8	- 2.3	- 2.5	- 1.9	- 1.9
141	Oct 4	15.5	26.8 N	160.6	Total	80 9.4	77 7.5	82 8.1	74 8.9	66 9.7
					E	+ 9.3	+ 7.3	+ 8.0	+ 8.6	+ 8.9
					N	+ 1.6	+ 1.7	+ 1.1	+ 2.4	+ 4.0
142	Oct 5	15.3	29.5 N	161.3	Total	80 6.7	74 10.2	79 9.7	86 10.3	86 9.2
					E	+ 6.6	+ 9.8	+ 9.5	+10.3	+ 9.2
					N	+ 1.2	+ 2.8	+ 1.8	+ 0.7	+ 0.6
143	Oct 6	11.1	31.6 N	161.0	Total	103 4.0	114 7.6	115 6.8	131 6.8	139 5.8
					E	+ 3.9	+ 6.9	+ 6.2	+ 5.1	+ 3.8
					N	- 0.9	- 3.1	- 2.9	- 4.5	- 4.4
144	Oct 7	16.1	33.0 N	160.6	Total	69 2.2	352 4.4	351 3.5	359 2.1	279 1.1
					E	+ 2.0	- 0.6	- 0.6	0.0	- 1.1
					N	+ 0.8	+ 4.4	+ 3.5	+ 2.1	+ 0.2

No.	Date	Local apparent time	Position: Latitude	Position: Long. west of Gr.	Wind component	6.0	6.5	7.0	7.5	8.0
	1929	hour	°	°		° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec
135	Sep 17	14.7	25.0 N	143.8	Total	179 3.0	189 3.0	222 4.8	250 5.0	231 9.6
					E	0.0	- 0.5	- 3.2	- 4.7	- 7.5
					N	- 3.0	- 3.0	- 3.6	- 1.7	- 6.0
143	Oct 6	11.1	31.6 N	161.0	Total	151 3.0	150 2.7	158 1.8	158 1.8	
					E	+ 1.4	+ 1.4	+ 0.7	+ 0.7	
					N	- 2.6	- 2.3	- 1.7	- 1.7	

flights made on the Carnegie, Pacific Ocean, 1928-1929—Continued

Heights in kilometers								
1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5
°or m/sec	°or m/sec	°or m/sec	°or m/sec	°or m/sec	°or m/sec	°or m/sec	°or m/sec	°or m/sec
58 6.6	64 6.6	78 4.1						
+ 5.6	+ 5.9	+ 4.0						
+ 3.5	+ 2.9	+ 0.8						
12 5.0			154 3.2	153 3.2	150 3.8	135 5.9	139 5.0	
+ 1.0			+ 1.4	+ 1.4	+ 1.9	+ 4.2	+ 3.3	
+ 4.9			- 2.9	- 2.8	- 3.3	- 4.2	- 3.8	
26 2.2	352 2.3	266 4.2	172 5.6	205 11.4	195 9.0			
+ 1.0	- 0.3	- 4.2	+ 0.8	- 4.8	- 2.3			
+ 2.0	+ 2.3	- 0.3	- 5.6	-10.3	- 8.7			
166 2.3	93 1.3	27 2.6	283 8.0	273 2.7	233 6.9			
+ 0.6	+ 1.3	+ 1.2	- 7.8	- 2.7	- 5.5			
- 2.2	- 0.1	+ 2.3	+ 1.8	+ 0.1	- 4.2			
220 1.8	223 2.2	237 4.2	246 6.4	257 7.9	258 6.9	263 11.6		
- 1.2	- 1.5	- 3.5	- 5.8	- 7.7	- 6.8	-11.5		
- 1.4	- 1.6	- 2.3	- 2.6	- 1.8	- 1.4	- 1.4		
48 4.3	27 6.3							
+ 3.2	+ 2.9							
+ 2.9	+ 5.6							
31 7.5								
+ 3.9								
+ 6.4								
56 7.0	49 9.5	61 7.8	63 5.8	87 6.7	35 6.2	43 5.6	122 3.0	170 3.0
+ 5.8	+ 7.2	+ 6.8	+ 5.2	+ 6.7	+ 3.6	+ 3.8	+ 2.5	+ 0.5
+ 3.9	+ 6.2	+ 3.8	+ 2.6	+ 0.4	+ 5.1	+ 4.1	- 1.6	- 3.0
98 8.5	71 10.7	87 11.1	54 9.5					
+ 8.4	+10.1	+11.1	+ 7.7					
- 1.2	+ 3.5	+ 0.6	+ 5.6					
66 5.9	86 7.7	106 9.7	82 7.5	82 7.5	82 7.5			
+ 5.4	+ 7.7	+ 9.3	+ 7.4	+ 7.4	+ 7.4			
+ 2.4	+ 0.5	- 2.7	+ 1.0	+ 1.0	+ 1.0			
115 5.4	97 5.8	88 7.6	102 6.7					
+ 4.9	+ 5.8	+ 7.6	+ 6.6					
- 2.3	- 0.7	+ 0.3	- 1.4					
72 11.6								
+11.0								
+ 3.6								
99 8.2								
+ 8.1								
- 1.3								
154 5.1	158 5.0	166 2.6	224 0.5	284 1.9	292 1.6	286 4.1	284 8.6	247 5.1
+ 2.2	+ 1.9	+ 0.6	- 0.4	- 1.8	- 1.5	- 3.9	- 8.3	- 4.7
- 4.6	- 4.6	- 2.5	- 0.5	+ 0.5	+ 0.6	+ 1.1	+ 2.1	- 2.0
221 2.6	230 3.9	257 5.1	277 6.0	268 9.1	258 9.5	244 5.5	264 8.2	
- 1.7	- 3.0	- 5.0	- 6.0	- 9.1	- 9.3	- 4.9	- 8.2	
- 2.0	- 2.5	- 1.2	+ 0.7	- 0.3	- 2.0	- 2.4	- 0.9	

Heights in kilometers								
8.5	9.0	9.5	10.0	10.5	11.0	11.5	12.0	12.5
°or m/sec	°or m/sec	°or m/sec	°or m/sec	°or m/sec	°or m/sec	°or m/sec	°or m/sec	°or m/sec
239 10.0	235 9.6	238 10.9	256 15.0	261 17.2				
- 8.6	- 7.9	- 9.2	-14.6	-17.0				
- 5.2	- 5.5	- 5.8	- 3.6	- 2.7				

Table 7—Upper-wind components determined from pilot-balloon

No.	Date	Local apparent time	Position: Latitude	Position: Long. west of Gr.	Wind component	Surface	0.25	0.50	0.75	1.0
	1929	hour	°	°		° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec
145	Oct 9	13.9	34.0 N	156.5	Total	262 9.4	271 12.3	275 13.6	280 13.6	
					E	- 9.3	-12.3	-13.6	-13.4	
					N	- 1.3	+ 0.2	+ 1.2	+ 2.4	
146	Oct 9	14.4	34.0 N	156.5	Total	262 9.4	273 11.6	273 13.1	277 13.8	285 14.7
					E	- 9.3	-11.6	-13.1	-13.7	-14.2
					N	- 1.3	+ 0.6	+ 0.7	+ 1.7	+ 3.8
147	Oct 10	11.1	33.6 N	154.5	Total	330 0.9	300 2.5	282 2.3	270 2.7	263 4.3
					E	- 0.4	- 2.2	- 2.2	+ 2.7	- 4.3
					N	+ 0.8	+ 1.2	+ 0.5	0.0	- 0.5
148	Oct 11	13.5	33.6 N	151.4	Total	229 9.4	235 14.0			
					E	- 7.1	-11.5			
					N	- 6.2	- 8.0			
149	Oct 11	13.8	33.6 N	151.4	Total	229 9.4	235 15.8			
					E	- 7.1	-12.9			
					N	- 6.2	- 9.1			
150	Oct 13	13.5	33.4 N	145.3	Total	330 2.2	323 4.5	305 3.5	298 3.7	280 4.4
					E	- 1.1	- 2.7	- 2.9	- 3.3	- 4.3
					N	+ 1.9	+ 3.6	+ 2.0	+ 1.7	+ 0.8
151	Oct 17	11.3	27.4 N	138.2	Total	[191 2.2]	254 3.0	232 2.8	247 2.4	323 2.3
					E	- 0.4	- 2.9	- 2.2	- 2.2	- 1.4
					N	- 2.2	- 0.8	- 1.7	- 0.9	+ 1.8
152	Oct 18	13.4	26.0 N	137.2	Total	138 2.2	124 4.2	118 4.4	121 4.4	102 5.3
					E	+ 1.5	+ 3.5	+ 3.9	+ 3.8	+ 5.2
					N	- 1.6	- 2.4	- 2.1	- 2.3	- 1.1
153	Oct 19	13.3	24.9 N	137.7	Total	79 2.2	77 4.7	105 3.6	123 2.7	148 3.1
					E	+ 2.2	+ 4.6	+ 3.5	+ 2.3	+ 1.6
					N	+ 0.4	+ 1.1	- 0.9	- 1.5	- 2.6
.154	Oct 23	14.6	15.9 N	136.9	Total	67 6.7	73 10.0	74 11.0	75 7.7	74 6.7
					E	+ 6.2	+ 9.6	+10.6	+ 7.4	+ 6.4
					N	+ 2.6	+ 2.9	+ 3.0	+ 2.0	+ 1.8
155	Oct 26	11.1	11.4 N	138.6	Total	324 2.2	64 4.8	61 5.0	70 5.6	80 5.7
					E	- 1.3	+ 4.3	+ 4.4	+ 5.3	+ 5.6
					N	+ 1.8	+ 2.1	+ 2.4	+ 1.9	+ 1.0
156	Oct 27	14.9	9.9 N	139.9	Total	[90 2.2]	32 1.9	35 0.9	38 0.5	39 0.5
					E	+ 2.2	+ 1.0	+ 0.5	+ 0.3	+ 0.3
					N	0.0	+ 1.6	+ 0.7	+ 0.4	+ 0.4
157	Oct 28	14.9	8.5 N	140.8	Total	76 2.2	61 3.9	55 4.0	58 4.0	58 4.9
					E	+ 2.1	+ 3.4	+ 3.3	+ 3.4	+ 4.2
					N	+ 0.5	+ 1.9	+ 2.3	+ 2.1	+ 2.6
158	Oct 29	14.4	7.6 N	141.5	Total	87 4.0	87 5.8	77 6.5	72 6.9	67 7.2
					E	+ 4.0	+ 5.8	+ 6.3	+ 6.6	+ 6.6
					N	+ 0.2	+ 0.3	+ 1.5	+ 2.1	+ 2.8
159	Nov 4	13.7	3.0 N	149.9	Total	143 4.0	138 6.2	130 6.5	103 7.8	84 8.5
					E	+ 2.4	+ 4.2	+ 5.0	+ 7.6	+ 8.4
					N	- 3.2	- 4.6	- 4.2	- 1.8	+ 0.9
160	Nov 5	13.5	0.6 N	151.6	Total	120 9.4	96 9.3	106 10.5	100 13.6	101 12.0
					E	+ 8.1	+ 9.2	+10.1	+13.4	+11.8
					N	- 4.7	- 1.0	- 2.9	- 2.4	- 2.3
161	Nov 6	13.9	2.1 S	152.4	Total	87 9.4	73 9.4	76 9.1	72 10.0	66 10.8
					E	+ 9.4	+ 9.0	+ 8.8	+ 9.5	+ 9.9
					N	+ 0.5	+ 2.8	+ 2.2	+ 3.1	+ 4.4
162	Nov 6	14.4	2.2 S	152.4	Total	87 9.4	70 9.2	73 9.9		
					E	+ 9.4	+ 8.6	+ 9.5		
					N	+ 0.5	+ 3.2	+ 2.9		

No.	Date	Local apparent time	Position: Latitude	Position: Long. west of Gr.	Wind component	6.0	6.5	7.0	7.5	8.0
	1929	hour	°	°		° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec
147	Oct 10	11.1	33.6 N	154.5	Total	244 4.2	244 4.2			
					E	- 3.8	- 3.8			
					N	- 1.8	- 1.8			
151	Oct 17	11.3	27.4 N	138.2	Total	245 6.1	314 9.1	283 6.2	317 7.7	320 6.0
					E	- 5.5	- 6.6	- 6.0	- 5.2	- 3.9
					N	- 2.6	+ 6.3	+ 1.4	+ 5.6	+ 4.6
152	Oct 18	13.4	26.0 N	137.2	Total	257 2.7	253 2.2	267 3.4	265 2.4	290 3.1
					E	- 2.6	- 2.1	- 3.4	- 2.4	- 2.9
					N	- 0.6	- 0.6	- 0.2	- 0.2	+ 1.1
156	Oct 27	14.9	9.9 N	139.9	Total	176 6.0	180 6.0			
					E	+ 0.4	0.0			
					N	- 6.0	- 6.0			

flights made on the Carnegie, Pacific Ocean, 1928-1929—Continued

Heights in kilometers								
1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5
° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec
263 9.6 - 9.5 - 1.2	258 10.1 - 9.9 - 2.1	250 10.8 -10.2 - 3.7	283 9.5 - 9.3 + 2.1	244 7.0 - 6.3 - 3.1	244 7.0 - 6.3 - 3.1	244 7.0 - 6.3 - 3.1	244 7.0 - 6.3 - 3.1	244 4.2 - 3.8 - 1.8
271 8.6 - 8.6 + 0.2								
332 4.8 - 2.2 + 4.2	322 8.0 - 4.9 + 6.3	298 6.2 - 5.5 + 2.9	255 5.3 - 5.1 - 1.4	342 3.8 - 1.2 + 3.6	311 3.7 - 2.8 + 2.4	311 5.1 - 3.8 + 3.4	301 4.4 - 3.8 + 2.3	306 6.9 - 5.6 + 4.1
85 5.9 + 5.9 + 0.5	90 6.7 + 6.7 0.0	115 5.6 + 5.1 - 2.4	148 1.4 + 0.7 - 1.2	160 1.6 + 0.6 - 1.5	128 3.4 + 2.7 - 2.1	113 2.5 + 2.3 - 1.0	109 2.3 + 2.2 - 0.8	217 3.2 - 1.9 - 2.6
135 7.1 + 5.0 - 5.0	151 6.1 + 3.0 - 5.3	145 7.1 + 4.1 - 5.8						
136 2.5 + 1.7 - 1.8	178 5.0 + 0.2 - 5.0	221 3.5 - 2.3 - 2.6	301 3.2 - 2.7 + 1.6	301 4.8 - 4.1 + 2.5	314 4.8 - 3.4 + 3.3	302 3.8 - 3.2 + 2.0	206 3.7 - 1.6 - 3.3	
213 2.4 - 1.3 - 2.0	255 2.0 - 1.9 - 0.5	293 4.5 - 4.1 + 1.8	275 5.0 - 5.0 + 0.4					
39 1.8 + 1.1 + 1.4	54 2.7 + 2.2 + 1.6	66 3.1 + 2.8 + 1.3	86 4.9 + 4.9 + 0.3	127 5.6 + 4.5 - 3.4	93 4.0 + 4.0 - 0.2	80 3.5 + 3.4 + 0.6	102 2.5 + 2.4 - 0.5	171 2.9 + 0.4 - 2.9
67 5.6 + 5.2 + 2.2	67 5.6 + 5.2 + 2.2	71 5.9 + 5.6 + 1.9						
72 6.3 + 6.0 + 2.0	67 6.5 + 6.0 + 2.5	90 6.2 + 6.2 0.0	91 6.9 + 6.9 - 0.1	83 7.7 + 7.6 + 0.9	86 7.5 + 7.5 + 0.5	89 9.8 + 9.8 + 0.2	70 7.7 + 7.2 + 2.6	70 7.7 + 7.2 + 2.6
84 5.3 + 5.3 + 0.6	84 5.7 + 5.7 + 0.6	87 6.7 + 6.7 + 0.4	87 6.6 + 6.6 + 0.4	75 9.8 + 9.5 + 2.5				
93 9.3 + 9.3 - 0.5								

Heights in kilometers								
8.5	9.0	9.5	10.0	10.5	11.0	11.5	12.0	12.5
° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec
275 3.3 - 3.3 + 0.3	164 3.3 + 0.9 - 3.2	166 4.9 + 1.2 - 4.8						

Table 7—Upper-wind components determined from pilot-balloon

No.	Date	Local apparent time	Position: Latitude	Position: Long. west of Gr.	Wind component	Surface	0.25	0.50	0.75	1.0
	1929	hour	°	°		° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec
163	Nov 7	13.7	5.0 S	153.6	Total	53 6.7	47 9.3	44 9.7	44 10.3	47 9.3
					E	+ 5.4	+ 6.8	+ 6.7	+ 7.2	+ 6.8
					N	+ 4.0	+ 6.3	+ 7.0	+ 7.4	+ 6.3
164	Nov 8	13.3	6.7 S	155.2	Total	65 6.7	67 10.1	71 9.7	68 8.4	76 6.6
					E	+ 6.1	+ 9.3	+ 9.2	+ 7.8	+ 6.4
					N	+ 2.8	+ 4.0	+ 3.2	+ 3.2	+ 1.6
165	Nov 9	15.7	8.3 S	157.2	Total	32 6.7	50 9.5	51 9.1	56 8.3	66 7.1
					E	+ 3.6	+ 7.3	+ 7.1	+ 6.9	+ 6.5
					N	+ 5.7	+ 6.1	+ 5.7	+ 4.6	+ 2.9
166	Nov 11	15.3	9.4 S	159.2	Total	[45 4.0]	65 4.8	66 5.5	70 5.4	
					E	+ 2.8	+ 4.4	+ 5.0	+ 5.1	
					N	+ 2.8	+ 2.0	+ 2.2	+ 1.8	
167	Nov 14	14.5	11.6 S	163.1	Total	212 0.9	221 1.1	257 1.3	309 1.2	318 1.8
					E	- 0.5	- 0.7	- 1.3	- 0.9	- 1.2
					N	- 0.8	- 0.8	- 0.3	+ 0.8	+ 1.3
168	Nov 15	14.0	12.1 S	165.1	Total	55 0.9	58 2.8	39 3.1	27 3.9	38 4.4
					E	+ 0.7	+ 2.4	+ 2.0	+ 1.8	+ 2.7
					N	+ 0.5	+ 1.5	+ 2.4	+ 3.5	+ 3.5
169	Nov 16	14.8	13.0 S	167.3	Total	-- 0.0	54 2.0	53 2.1	44 1.8	35 2.0
					E	0.0	+ 1.6	+ 1.7	+ 1.2	+ 1.2
					N	0.0	+ 1.2	+ 1.3	+ 1.3	+ 1.6
170	Nov 17	13.8	13.7 S	168.6	Total	-- 0.0	224 1.0	240 1.1	285 1.6	293 2.9
					E	0.0	- 0.7	- 1.0	- 1.6	- 2.7
					N	0.0	- 0.7	- 0.6	+ 0.4	+ 1.1
171	Nov 17	14.3	13.7 S	168.6	Total	-- 0.0	245 2.6	241 2.5	263 2.0	295 2.6
					E	0.0	- 2.4	- 2.2	- 2.0	- 2.4
					N	0.0	- 1.1	- 1.2	- 0.2	+ 1.1

No.	Date	Local apparent time	Position: Latitude	Position: Long. west of Gr.	Wind-component	6.0	6.5	7.0	7.5	8.0
	1929	hour	°	°		° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec
167	Nov 14	14.5	11.6 S	163.1	Total	341 3.5				
					E	- 1.1				
					N	+ 3.3				
169	Nov 16	14.8	13.0 S	167.3	Total	120 4.5	133 6.7	149 7.0	159 2.9	124 3.7
					E	+ 3.9	+ 4.9	+ 3.6	+ 1.0	+ 3.1
					N	- 2.2	- 4.6	- 6.0	- 2.7	- 2.1

Note: Wind direction measured from north through east; thus "Total 135 2.2, component from the east being of velocity 1.5 meters per second and flights made on the Carnegie, Pacific Ocean, 1928-1929—Concluded

Heights in kilometers								
1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5
° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec
46 8.2 + 5.9 + 5.7	46 11.1 + 8.0 + 7.7							
99 5.6 + 5.5 - 0.9	71 2.3 + 2.2 + 0.8	17 3.9 + 1.1 + 3.7	13 1.6 + 0.4 + 1.6	350 1.9 - 0.3 + 1.9	66 1.7 + 1.6 + 0.7			
89 4.4 + 4.4 + 0.1	80 4.4 + 4.3 + 0.8	54 7.6 + 6.2 + 4.5	23 2.8 + 1.1 + 2.6	69 1.8 + 1.7 + 0.6				
325 0.8 - 0.5 + 0.7	325 0.5 - 0.3 + 0.4	14 1.7 + 0.4 + 1.6	18 3.1 + 1.0 + 3.0	13 3.2 + 0.7 + 3.1	18 2.9 + 0.9 + 2.8	354 2.5 - 0.3 + 2.5	337 2.4 - 0.9 + 2.2	299 3.3 - 2.9 + 1.6
44 3.0 + 2.1 + 2.2	62 2.4 + 2.1 + 1.1	80 1.8 + 1.8 + 0.3	90 0.8 + 0.8 0.0	99 1.3 + 1.3 - 0.2	170 1.3 + 0.2 - 1.3			
36 1.4 + 0.8 + 1.1	64 1.9 + 1.7 + 0.8	77 3.5 + 3.4 + 0.8	109 3.8 + 3.6 - 1.2	137 4.0 + 2.7 - 2.9	165 2.8 + 0.7 - 2.7	132 3.6 + 2.7 - 2.4	149 4.4 + 2.3 - 3.8	116 2.5 + 2.2 - 1.1
301 3.8 - 3.3 + 2.0	295 2.0 - 1.8 + 0.8	8 1.9 + 0.3 + 1.9	304 3.0 - 2.5 + 1.7	229 4.3 - 3.2 - 2.8				

Heights in kilometers								
8.5	9.0	9.5	10.0	10.5	11.0	11.5	12.0	12.5
° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec	° or m/sec
159 2.3 + 0.8 - 2.2								

E +1.5, N -1.5" means SE wind of velocity 2.2 meters per second, the
the component from the south being of velocity 1.5 meters per second.

Table 8—Data regarding pilot-balloon flights

No.	Date	Local apparent time	Position: Latitude	Position: Long. west of Gr.	Pressure	Temperature: Dry	Temperature: Wet	Humidity: Rel.	Humidity: Abs.	Visibility	Sun	Surface wind: True dir.	Surface wind: Force Beaufort
	1928	h m	° '	° '	mm	°C	°C	o/o	mm				
1	Oct 27	16 23	5 24 N	79 59	755.7	24.6	24.2	97	22.4	Good	Obscured	W	3
2	29	14 31	3 59 N	79 57	754.1	28.8	25.4	76	22.6	Good	Obscured	SWxW	3
3	29	14 44	3 59 N	79 57	754.1	28.8	25.4	76	22.6	Good	Bright	SWxW	3
4	31	17 16	5 02 N	82 12	750.8	26.3	24.2	84	21.6	Good	Obscured	SWxW	5
5	Nov 9	14 38	1 21 S	85 11	759.7	19.8	17.1	77	13.3	Good	Bright	S	3
6	11	13 19	1 51 S	89 16	761.1	20.9	17.6	73	13.4	Good	Bright	S	3
7	15	14 05	2 36 S	95 57	758.7	20.2	18.5	85	15.1	Very good	Bright	SE	3-4
8	17	13 25	3 17 S	100 05	759.2	21.9	19.2	78	15.3	Very good	Bright	SSE	4
9	19	14 26	4 50 S	105 21	751.7	22.8	19.8	76	15.8	Very good	Bright	SExE	4
10	20	15 30	7 20 S	107 08	758.9	22.7	20.5	82	17.0	Fair,hazy	Bright	ESE	4
11	22	15 20	12 19 S	110 34	760.2	23.2	20.7	79	17.1	Good,sl.hazy	Bright	ESE	5
12	22	15 41	12 19 S	110 34	760.2	23.2	20.7	79	17.1	Good,sl.hazy	Bright	ESE	5
13	23	15 34	14 32 S	112 05	761.1	23.2	20.5	78	16.7	Good	Bright	ESE	4
14	24	14 14	16 59 S	113 09	762.0	23.2	20.1	75	16.1	Fair,hazy	Bright	ExS	4
15	25	14 21	19 29 S	114 08	763.3	23.0	20.1	77	16.2	Good	Bright	E	4
16	25	14 36	19 31 S	114 08	763.3	23.0	20.1	77	16.2	Good	Bright	E	4
17	26	16 24	22 06 S	114 26	764.5	22.7	19.7	76	15.7	Good	Bright	E	3
18	27	13 26	23 27 S	114 47	764.9	23.4	20.5	77	16.6	Good	Bright	ExN	3
19	29	16 36	25 07 S	115 32	765.3	22.8	19.6	75	15.5	Good	Obscured	ExS	8
20	30	14 28	28 18 S	115 06	765.3	22.2	19.5	78	15.6	Very good	Bright	NE	3
21	Dec 1	13 25	29 21 S	114 44	766.2	23.5	19.5	69	15.0	Very good	Bright	NE	3
22	2	13 13	30 40 S	114 14	768.0	23.2	19.6	72	15.3	Fair	Dim	NE	3
23	4	16 44	30 58 S	109 30	763.7	22.3	19.3	76	15.3	Good	Bright	W	5
24	5	14 13	28 37 S	108 42	762.2	22.8	21.0	85	17.8	Good	Bright	WNW	4
25	13	14 04	28 21 S	109 11	766.6	23.2	20.5	78	16.7	Good	Bright	E	4
26	17	14 55	31 40 S	109 09	765.1	20.6	16.8	68	12.4	Good	Bright	SE	4
27	18	13 31	31 58 S	108 48	765.1	20.5	16.8	69	12.5	Good	Bright	NNE	4
28	20	16 38	34 18 S	106 31	765.2	19.8	18.9	92	15.9	Good	Bright	NE	3
29	26	13 23	40 26 S	97 33	773.7	18.8	17.7	90	14.6	Very good	Bright	NxE	1
30	30	16 44	34 03 S	91 27	768.2	18.7	16.0	76	12.3	Good	Ptly obscured	SExE	4
	1929												
31	Jan 1	14 19	32 09 S	89 02	767.3	24.5	19.3	62	14.2	Very good	Bright	Calm	0
32	4	10 41	31 46 S	87 17	765.4	21.0	16.0	60	11.1	Good	Bright	NW	2
33	5	10 58	31 05 S	86 37	765.2	20.7	17.8	76	13.8	Good	Bright	W	3
34	8	16 35	24 45 S	82 07	762.8	20.0	16.8	73	12.7	Good	Bright	SExS	4
35	12	13 54	16 28 S	78 35	758.3	22.8	19.0	70	14.6	Good	Bright	SExS	4
36	13	10 38	14 14 S	77 57	759.2	23.0	20.0	76	16.0	Good	Bright	SE	4
37	Feb 5	12 09	12 04 S	77 10	758.7	23.6	22.2	89	19.4	Fair,hazy	Faint	N	1-2
38	6	8 52	11 58 S	78 36	759.8	23.7	20.6	76	16.6	Good	Faint	SxE	4
39	7	8 17	10 26 S	79 46	760.8	25.1	22.0	76	18.3	Good	Bright	SSE	3
40	8	14 11	9 59 S	82 25	758.4	25.1	22.3	79	18.8	Fair	Intermittent	SxW	4
41	8	15 56	10 00 S	82 32	757.6	24.7	22.0	79	18.5	Fair	Intermittent	SxW	4
42	8	17 46	10 00 S	82 42	758.0	24.3	21.8	80	18.3	Fair	Intermittent	SWxS	4
43	9	13 29	10 29 S	84 19	758.0	25.0	21.3	72	17.2	Good	Bright	SSE	2
44	11	17 07	10 42 S	86 15	757.2	24.9	21.5	74	17.5	Good	Bright	SxW	2
45	12	14 28	11 11 S	87 44	757.3	24.1	20.7	74	16.6	Good	Bright	S	4
46	13	13 11	12 39 S	89 52	758.9	23.7	21.0	79	17.3	Good	Bright	S	5
47	14	15 04	14 38 S	92 36	759.3	22.8	19.9	77	16.0	Good	Bright	S	4
48	15	15 34	15 44 S	95 17	760.2	23.2	20.1	75	16.1	Fair	Bright	SSE	4
49	16	16 30	15 09 S	98 13	760.2	24.0	20.7	74	16.7	Good	Faint	SE	4
50	17	14 06	14 43 S	101 05	759.8	24.2	20.8	74	16.7	Good	Bright	SE	5
51	17	14 39	14 44 S	101 11	759.8	23.8	20.8	77	16.9	Good	Bright	SE	5
52	18	13 18	14 17 S	103 30	760.2	25.0	21.7	75	17.8	Fair,hazy	Bright	SExE	4
53	19	17 07	13 28 S	106 27	758.5	24.4	22.2	83	19.0	Good	Bright	SExE	4
54	20	16 24	12 51 S	108 32	757.3	25.5	22.0	74	18.1	Good	Intermittent	ESE	3
55	21	14 59	12 34 S	110 27	757.6	25.3	21.7	73	17.7	Good	Bright	ExS	4
56	22	13 52	12 36 S	112 33	759.5	26.0	22.0	71	17.8	Good	Bright	ExS	4
57	23	14 27	12 32 S	115 28	757.6	26.3	22.4	72	18.4	Good	Intermittent	ESE	4
58	24	13 42	12 43 S	117 44	757.7	27.0	23.0	71	19.1	Good	Intermittent	ExN	3
59	25	16 50	12 59 S	119 47	757.7	26.7	23.0	73	19.2	Good	Intermittent	ExS	4
60	26	14 51	13 04 S	121 37	758.8	27.0	22.9	71	18.9	Fair	Faint	ExS	4

on the Carnegie, Pacific Ocean, 1928-1929

Clouds									Balloon disappearance due to	Notes
Lower			Middle			Upper				
Kind	Amt.	Dir.	Kind	Amt.	Dir.	Kind	Amt.	Dir.		
Nb,St	10	...	...	...	...	...	...	...	Nb-cloud	
Cu,Fr-Cu	7	W	...	...	...	...	...	...	Cloud	
Cu,Fr-Cu	7	W	...	...	...	...	...	...	Observer	
Cu,St-Cu	7	SWxW	...	...	...	...	...	...	Thin Cu-cloud	
Cu	5	S	A-St	1	*	Ci	2	SSE	Cloud	
Cu	0	*	A-St	0	*	Ci,Ci-St	5	...	Distance,sails	Slightly hazy
...	...	...	A-Cu	1	*	Ci,Ci-St	2	SSE	Distance	
Fr-Cu	2	SSE	...	...	...	...	...	...	Distance	
Cu,Fr-Cu	2	*	...	...	...	...	...	...	Distance	
Cu,Fr-Cu	2	ESE	...	...	...	...	...	...	Haze	Hazy
Fr-Cu	4	ESE	...	...	...	...	...	...	Haze,distance	Hazy
Fr-Cu	4	ESE	...	...	...	...	...	...	Haze,distance	Hazy
Cu,Fr-Cu	4	ESE	...	...	...	...	...	...	Distance,clouds	
Cu,St-Cu	1	*	A-Cu	2	ExS	...	...	...	Distance,clouds	
Cu,Fr-Cu	2	E	A-St	0	*	...	...	...	Distance,clouds	
Cu,Fr-Cu	1	E	A-St	0	*	...	...	...	Distance,clouds	
Fr-Cu,St-Cu	2	E	...	...	...	...	...	...	Cloud	Tandem balloons used
Cu,Fr-Cu	3	ExN	...	...	...	...	...	...	Distance,clouds	
Cu,Fr-Cu	8	ExS	...	...	...	...	...	...	Clouds	
Cu,Fr-Cu	1	*	...	...	...	...	...	...	Distance	Tandem balloons used
St-Cu,Cu	0	*	...	...	...	...	...	...	Distance	
Fr-Cu	0	*	...	...	...	Ci-St	9	...	Clouds	
Fr-Cu	0	*	A-St	2	...	Ci-St	8	...	Clouds	
Fr-Cu,Cu	1	WNW	...	...	...	Ci-St	9	...	Ci-clouds	
Fr-Cu,Cu	4	E	...	...	...	...	...	...	Clouds	Clouds increasing
Fr-Cu,Cu	3	SE	...	...	...	...	...	...	Clouds	
Cu	0	*	A-St,A-Cu	1	*	Ci-St	8	...	Distance	
...	...	...	A-St	0	*	Ci-St	9	...	Clouds	
Cu	0	*	A-St,A-Cu	0	*	...	...	...	Distance	
Cu,Fr-Cu	6	SExE	...	...	...	...	...	...	Cloud	
Cu,Fr-Cu	6	S	...	...	...	...	...	...	Cloud	
Cu,St-Cu	1	*	...	...	...	...	...	...	Cloud	
Fr-Cu,St-Cu	1	*	...	...	...	Ci-St	9	...	Distance	
Fr-Cu	0	*	A-St	0	*	...	...	...	Distance	
Fr-Cu	0	*	A-St,A-Cu	4	SE	...	...	...	Distance	
Cu	0	*	A-Cu	4	SW	...	...	...	Distance	
...	...	...	A-St,A-Cu	8	...	...	...	...	Clouds	
Fr-Cu	0	*	A-St,A-Cu	8	...	...	...	...	Into clouds	
...	...	...	A-St,Cu	1	*	Ci-haze	...	S	Haze,distance	
Fr-Cu	6	SxW	...	...	...	Ci-haze	3	...	Against clouds	
Fr-Cu	4	SxW	...	...	...	Ci-haze	6	...	Into clouds	
Fr-Cu	2	SWxS	...	...	...	Ci-haze	4	...	Distance,haze	
Fr-Cu	0	*	A-Cu	0	*	...	...	...	Distance	
Fr-Cu	1	SxW	A-Cu	1	WNW	...	...	...	Clouds,distance	
Fr-Cu	2	S	A-Cu	0	...	...	...	...	Distance	
Fr-Cu	3	S	...	...	...	...	...	...	Clouds,distance	
St-Cu	1	*	...	...	...	...	...	...	Sails,distance	
St-Cu	0	*	...	...	...	Ci-haze	0	...	Bursting(?)	
St-Cu	9	SE	...	...	...	...	...	...	Into clouds	
Fr-Cu	0	*	...	...	...	...	...	...	Heavy rolling	
Fr-Cu	0	*	...	...	...	...	...	...	Distance	Heavy rolling
Fr-Cu	0	SExE	...	...	...	...	...	...	Distance	Heavy rolling
Cu,Fr-Cu	0	*	...	...	...	...	...	...	Distance	Heavy rolling
Cu,St-Cu	9	ESE	...	...	...	...	...	...	Into clouds	
Cu,Fr-Cu	4	ExS	...	...	...	...	...	...	Into clouds	Very heavy rolling
Fr-Cu	0	*	...	...	...	Ci-St	3	N	Heavy rolling	
Fr-Cu	4	ESE	...	...	...	...	...	...	Heavy rolling	
Cu,Fr-Cu	8	...	...	...	...	Ci	0	...	Against clouds	Heavy rolling
Cu,Fr-Cu	3	ExS	...	...	...	Ci	4	...	Clouds,distance	
Cu	3	ExS	A-St,A-Cu	3	...	Ci	3	...	Into clouds	

Table 8—Data regarding pilot-balloon flights on

No.	Date	Local apparent time	Position: Latitude	Position: Long. west of Gr.	Pressure	Temperature: Dry	Temperature: Wet	Humidity: Rel.	Humidity: Abs.	Visibility	Sun	Surface wind: True dir.	Surface wind: Force Beaufort
	1929	h m	° '	° '	mm	°C	°C	o/o	mm				
61	Feb 27	10 16	13 20 S	123 59	760.2	27.6	23.1	68	19.0	Good	Bright	ExS	5
62	Mar 1	10 21	16 26 S	127 58	760.3	28.9	23.7	65	19.4	Good	Bright	ExS	3
63	2	13 17	17 00 S	129 55	759.7	28.3	24.0	70	20.2	Good	Bright	E	4
64	3	10 46	17 07 S	131 39	761.1	28.9	24.0	67	19.9	Very good	Bright	ExS	3
65	4	13 21	17 11 S	133 27	760.0	28.4	24.2	71	20.5	Good	Bright	ExS	3
66	5	13 14	17 04 S	135 30	760.2	28.7	24.3	70	20.6	Good	Bright	SExE	3
67	6	14 46	17 14 S	136 56	759.1	29.3	24.2	66	20.1	Good	Bright	NExE	1
68	7	13 57	17 27 S	139 08	758.8	29.2	24.0	65	19.8	Good	Bright	NExE	0
69	10	13 49	18 02 S	144 14	760.1	29.7	24.9	68	21.2	Fair, hazy	Obscured	NExN	1-2
70	11	17 32	18 14 S	146 19	759.8	26.0	23.0	78	19.6	Fair	Obscured	NWxN	2
71	12	16 08	17 46 S	148 25	758.6	27.8	24.8	78	22.0	Good	Bright	NWxN	3
72	22	13 17	17 36 S	151 46	758.2	28.0	24.7	76	21.7	Good	Bright	[NW]	[2]
73	23	13 21	17 08 S	152 45	759.1	29.8	24.8	67	21.0	Good	Bright	NExE	1
74	24	10 23	16 53 S	153 34	761.2	30.0	25.0	67	21.3	Good	Bright	ESE	3
75	25	13 51	16 30 S	156 13	757.8	29.0	25.8	78	23.3	Good	Intermittent	E	4
76	27	11 40	15 44 S	160 33	756.6	29.0	26.0	79	23.7	Good	Bright	NExE	4
77	28	13 16	15 31 S	162 04	756.1	29.9	25.4	70	22.1	Very good	Bright	NExE	2
78	29	13 15	15 14 S	163 28	756.2	30.5	25.8	69	22.6	Good	Intermittent	Calm	0
79	30	15 38	14 42 S	166 03	755.2	28.7	25.1	75	22.1	Good	Bright	SxW	2
80	31	13 14	14 41 S	168 01	756.3	29.2	25.5	74	22.6	Good	Bright	NxE	3
81	Apr 1	15 09	14 22 S	170 19	756.0	29.0	25.7	77	23.1	Good	Intermittent	NWxW	3
82	22	13 47	12 36 S	171 35	757.4	29.5	25.8	75	23.1	Good	Intermittent	ESE	4
83	23	13 35	11 10 S	171 32	756.1	29.2	25.6	75	22.8	Very good	Intermittent	SSE	4
84	24	16 40	8 22 S	171 14	754.9	29.0	25.7	77	23.1	Fair	Bright	ENE	2
85	25	14 19	7 28 S	171 53	755.3	31.2	26.0	66	22.6	Fair	Obscured	Calm	0
86	25	16 10	7 19 S	171 56	755.3	30.1	25.8	71	22.8	Good	Intermittent	NExE	1-2
87	26	16 48	6 23 S	172 25	755.2	29.8	25.7	72	22.7	Good	Bright	NExN	1
88	27	10 51	5 10 S	172 24	757.1	31.1	25.8	66	22.3	Good	Bright	N	1
89	28	16 43	3 27 S	172 46	755.4	28.6	25.0	75	22.0	Good	Bright	ENE	3
90	29	10 50	1 51 S	173 28	757.1	28.2	25.2	79	22.5	Fair	Bright	E	4
91	30	13 16	0 32 N	174 05	755.8	27.7	24.6	78	21.7	Fair	Bright	E	5
92	May 4	16 54	8 32 N	179 19	756.7	27.3	24.5	80	21.7	Fair	Intermittent	NExN	5
93	5	13 47	9 28 N	179 47	757.4	27.2	23.9	76	20.6	Good	Bright	ExN	5-6
94	7	13 33	13 39 N	182 49	759.3	27.1	23.7	75	20.3	Fair	Bright	ExN	5
95	9	13 38	16 36 N	188 22	758.8	26.7	23.7	78	20.5	Fair	Bright	ExN	5
96	13	10 56	20 11 N	198 46	762.1	26.8	22.2	67	17.8	Good	Bright	ENE	4
97	14	13 40	19 25 N	201 46	759.8	26.9	22.2	67	17.7	Fair	Intermittent	ESE	5
98	15	13 14	18 36 N	204 06	759.3	27.1	24.2	79	21.2	Good	Bright	SExE	4
99	16	11 15	17 30 N	206 31	760.2	28.2	24.8	76	21.8	Good	Bright	ESE	4
100	17	13 10	16 04 N	209 16	759.3	27.8	24.1	74	20.7	Fair	Bright	ESE	5
101	19	15 24	13 56 N	214 22	757.2	27.1	24.6	82	22.0	Good	Bright	ExN	3
102	26	13 24	16 14 N	215 53	757.3	29.0	25.1	73	21.9	Good	Bright	ExN	4
103	27	13 38	18 44 N	216 01	758.8	28.7	25.2	75	22.3	Good	Intermittent	ExN	4
104	28	15 22	21 50 N	215 47	759.2	28.8	24.4	70	20.7	Good	Bright	ExS	3
105	29	13 13	23 32 N	215 56	760.0	28.0	24.7	76	21.7	Good	Bright	SE	4
106	30	10 59	25 11 N	215 56	760.8	28.1	24.1	72	20.5	Good	Bright	SSE	3
107	Jun 1	10 50	28 22 N	216 00	758.2	26.0	23.5	81	20.5	Good	Bright	SxE	4
108	3	13 16	31 08 N	215 46	758.1	20.5	18.3	81	14.7	Poor	Thin cloud	WxS	4
109	3	13 35	31 09 N	215 47	758.1	20.5	18.6	84	15.1	Poor	Thin cloud	WxS	4
110	5	15 55	34 15 N	219 08	756.0	23.3	21.2	83	17.8	Fair	Intermittent	SW	4
111	25	16 32	34 55 N	218 47	761.3	23.3	20.6	78	16.8	Fair	Bright	E	3
112	26	14 09	36 04 N	217 42	763.8	22.0	20.2	85	16.9	Fair	Dim	SE	2
113	27	14 40	36 41 N	216 12	763.4	22.1	20.1	84	16.6	Good	Faint	SSW	2
114	29	13 36	37 52 N	214 31	764.6	18.0	15.4	76	11.8	Very good	Bright	ExS	3
115	30	13 42	38 10 N	212 55	764.8	18.6	17.3	88	14.2	Good	Bright	SE	2
116	Jul 1	13 18	38 47 N	212 14	766.3	18.0	15.5	77	12.0	Good	Bright	SExE	2
117	2	13 58	39 56 N	210 22	764.7	15.9	13.7	79	10.7	Good	Bright	SExS	3
118	3	14 00	40 27 N	208 40	763.7	14.2	12.0	78	9.4	Good	Faint	[SE]	[3]
119	21	13 57	47 45 N	142 22	761.0	12.5	10.8	82	8.9	Good	Bright	WxN	6
120	21	14 19	47 45 N	142 22	761.0	12.3	10.8	84	9.0	Good	Bright	WxN	6

the *Carnegie*, Pacific Ocean, 1928-1929—Continued

Clouds									Balloon disappearance due to	Notes
Lower			Middle			Upper				
Kind	Amt.	Dir.	Kind	Amt.	Dir.	Kind	Amt.	Dir.		
Fr-Cu	0	*	...	...	...	...	...	...	Distance	Heavy rolling
Cu,Fr-Cu	0	*	A-St	0	*	...	...	...	Distance	Balloon went across bow
Cu,Fr-Cu	3	E	...	...	...	...	...	...	Distance	
Cu,Fr-Cu	1	ExS	...	...	...	...	...	...	Distance	
Cu,Fr-Cu	1	*	...	...	...	...	...	...	Bursting(?)	
Cu,Fr-Cu	3	SExE	...	...	...	Ci	3	...	Clouds,distance	
Cu,Fr-Cu,St-Cu	6	SxW	...	...	...	...	...	...	Bursting	
Cu,Fr-Cu	2	...	...	...	...	...	...	...	Distance	Main engine running
Cu,St-Cu,Cu-Nb	10	S	...	...	...	...	...	...	Into clouds	
Cu,Cu-Nb	5	...	A-St	5	...	...	...	...	Clouds	
Cu	3	NWxN	...	...	...	Ci-St	4	...	Clouds	
Cu	1	*	...	...	...	Ci-St	5	...	Distance,clouds	
Fr-Cu	2	NExE	...	...	...	Ci	2	...	Distance	
Cu	1	*	A-Cu,A-St	0	...	Ci-St	4	...	Distance,sails	
Cu	1	*	A-St	3	...	Ci-St	4	...	Into clouds	
Fr-Cu	2	...	A-Cu	1	...	Ci,Ci-St	3	...	Distance,clouds	
Cu,Fr-Cu	3	NExE	A-St,A-Cu	3	W	...	...	...	Sun,clouds	
Cu,Cu-Nb	5	W	...	...	...	...	...	...	Behind cloud	
Cu,Cu-Nb	3	*	...	...	...	Ci,Ci-St	5	...	Clouds,distance	
Cu,Fr-Cu	2	NxE	A-Cu	1	...	Ci,Ci-St	2	...	Distance	
Cu	6	NWxW	...	...	...	Ci-St	2	...	Into clouds	
Cu,Cu-Nb	8	ESE	A-Cu	1	...	...	...	...	Into clouds	
Cu	4	SSE	...	...	...	...	...	...	Distance	
Fr-Cu	3	ENE	...	...	...	Ci-haze	3	...	Ci-St-haze	
Cu,Fr-Cu,Cu-Nb	9	NE	...	...	...	...	...	...	Into clouds	
Fr-Cu,Cu-Nb	3	NExE	...	...	...	Ci-St	3	...	Distance,Sun	
Cu,Fr-Cu,Cu-Nb	5	NE	...	...	...	...	...	...	Cu-Nb-cloud	
Fr-Cu	1	*	A-Cu,A-St	5	N	Ci-St	4	...	Into cloud	
Fr-Cu	2	ENE	...	...	...	Ci	2	...	Distance	
Fr-Cu	1	E	...	...	...	Ci-St	8	...	Distance,haze	
...	...	...	...	...	...	Ci-haze	...	...	Distance	
Cu,Fr-Cu,Cu-Nb	6	NExN	A-Cu	0	...	...	...	...	Distance	
Cu	2	ExN	...	...	...	...	...	...	Clouds,distance	Very heavy roll,pitch
Fr-Cu	3	ExN	...	...	...	...	...	...	Distance	Heavy roll,pitch
Cu,Cu-Nb	...	ExN	A-Cu	1	...	...	...	...	Clouds	
Cu,Fr-Cu	4	...	...	...	...	...	...	...	Into cloud	
Cu,Fr-Cu	4	ESE	...	...	...	Ci-St	6	...	Ci-haze,clouds	
Cu,Fr-Cu	4	SExE	...	...	...	...	...	...	Distance	
Cu,Fr-Cu	3	ESE	...	...	...	...	...	...	Distance	
Cu,Fr-Cu	3	ESE	...	...	...	Ci-St	0	...	Clouds,distance	Very heavy rolling
Cu	1	ExN	A-Cu	1	W	Ci,Ci-St	1	...	Clouds	
Fr-Cu	2	ExN	...	...	...	...	...	...	Distance	
Cu,Cu-Nb	5	ExN	...	...	...	...	...	...	Clouds,distance	
Fr-Cu	1	ExS	...	...	...	...	...	...	Bursting	
Fr-Cu	0	SE	...	...	...	Ci-St	7	...	Bursting(?)	
...	...	...	A-Cu,A-St	0	*	Ci-St	7	...	Ci-St-clouds	
Cu	0	*	A-St	1	SxE	Ci-St	8	...	Distance,clouds	
...	...	...	A-St	10	...	...	...	...	Haze,overcast	
...	...	...	A-St	10	...	...	...	...	Haze,overcast	
Cu	5	SW	A-St	5	...	...	...	...	Clouds	
Cu,Fr-Cu	4	...	A-Cu	5	...	...	...	...	Clouds	
...	...	...	A-St	10	...	...	...	...	Clouds	
...	...	...	A-St,A-Cu	10	...	...	...	...	Into clouds	
...	...	...	...	...	...	Ci-haze	5	...	Distance,haze	
...	...	...	...	...	...	Ci-haze	5	...	Ci-haze	
...	...	...	...	...	...	Ci-haze	5-10	...	Ci-haze	
St-Cu	2	*	...	...	...	Ci-haze	3	...	Distance,haze	
...	...	...	A-St	10	...	...	...	...	Into clouds	
Cu	4	SW	...	...	...	...	...	...	Into cloud	
Cu	4	SW	...	...	...	...	...	...	Clouds	

Table 8—Data regarding pilot-balloon flights on

No.	Date	Local apparent time	Position: Latitude	Position: Long. west of Gr.	Pressure	Temperature: Dry	Temperature: Wet	Humidity: Rel.	Humidity: Abs.	Visibility	Sun	Surface wind: True dir.	Surface wind: Force Beaufort
	1929	h m	° '	° '	mm	°C	°C	o/o	mm				
121	Jul 23	13 20	44 13 N	137 30	764.2	13.2	11.0	77	8.7	Fair	Bright	WSW	4
122	26	13 30	39 32 N	129 19	767.6	17.0	13.6	69	10.0	Good	Obscured	NExN	5
123	Sep 8	15 55	31 24 N	129 10	761.1	22.0	17.4	64	12.6	Good	Bright	NNW	3
124	9	11 06	30 26 N	130 51	763.4	21.8	17.3	64	12.6	Good	Bright	NWxN	3
125	9	11 22	30 25 N	130 52	763.4	21.9	17.7	67	13.1	Good	Bright	NWxN	3
126	10	16 01	29 07 N	132 52	[761.6]	23.0	18.0	62	13.0	Fair	Bright	NExN	3
127	11	15 21	28 08 N	134 31	761.3	24.0	18.0	56	12.5	....	....	NExE	2
128	12	13 15	27 41 N	135 36	762.3	23.8	18.6	61	13.5	Good	Quite bright	SxE	2
129	13	10 49	27 01 N	137 40	763.8	23.6	19.0	65	14.2	Very good	Bright	SExE	2
130	14	14 48	26 40 N	139 12	762.3	25.3	21.0	68	16.5	Good	Med. bright	Calm	0
131	16	13 57	26 11 N	142 10	763.1	25.2	21.1	70	16.7	8[a)]	Bright	SExE	3
132	16	14 26	26 11 N	142 10	763.1	25.2	21.0	69	16.6	7	Bright	SExE	3
133	16	15 00	26 11 N	142 10	763.1	24.9	20.9	70	16.5	7	Bright	SExE	3
134	17	13 40	25 01 N	143 48	764.7	27.2	22.2	65	17.6	8	Bright	E	3
135	17	14 40	25 01 N	143 48	764.7	26.3	21.7	67	17.2	8	Bright	E	3
136	18	13 53	23 58 N	145 47	764.0	25.7	20.9	65	16.1	6	Bright	ENE	4
137	20	15 42	22 47 N	151 47	760.3	26.3	22.3	71	18.2	6	Bright	E	4
138	21	14 00	22 15 N	153 48	[760.6]	27.7	23.8	72	20.2	7	Bright	ExN	2
139	22	17 42	21 37 N	156 08	760.5	26.3	23.4	78	20.1	6	Bright	ExS	3
140	Oct 3	15 17	23 53 N	159 41	762.7	27.0	22.4	67	18.0	8	Bright	ExS	5
141	4	15 31	26 51 N	160 38	763.2	26.2	22.0	69	17.7	8	Bright	ExN	5
142	5	15 15	29 30 N	161 18	764.1	25.7	22.1	73	18.2	8	Bright	ExN	4
143	6	11 06	31 39 N	161 01	767.8	24.9	22.0	78	18.4	9	Bright	ExS	3
144	7	16 07	33 03 N	160 35	768.0	24.0	21.5	80	18.0	8	Bright	ENE	2
145	9	13 55	34 00 N	156 32	[759.2]	....	....	..	....	7	Bright	WxS	5
146	9	14 21	34 00 N	156 32	[759.2]	24.1	21.4	79	17.8	7	Bright	WxS	5
147	10	11 07	33 36 N	154 32	763.8	21.5	17.7	69	13.3	6	Bright	NWxN	1
148	11	13 30	33 38 N	151 22	.....	25.0	22.7	82	19.6	7	Bright	SW	5
149	11	13 47	33 38 N	151 22	.....	25.0	22.7	82	19.6	8	Bright	SW	5
150	13	13 30	33 27 N	145 18	759.6	21.6	17.7	69	13.2	7	Bright	NWxN	2
151	17	11 15	27 24 N	138 09	764.4	24.5	20.6	70	16.2	9	Bright	[SxW]	[2]
152	18	13 23	25 57 N	137 11	[762.6]	23.6	18.8	64	13.9	9	Bright	SExS	2
153	19	13 20	24 54 N	137 44	[761.7]	22.0	19.8	82	16.2	8	[Bright]	ExN	2
154	23	14 38	15 52 N	136 55	[758.0]	25.0	21.2	71	17.0	8	Bright	ENE	4
155	26	11 04	11 21 N	138 38	759.5	27.7	23.7	72	20.0	8	Bright	NWxN	2
156	27	14 56	9 52 N	139 54	[759.3]	29.0	24.0	66	19.9	8	Bright	[E]	[2]
157	28	14 52	8 32 N	140 46	759.4	28.0	24.1	72	20.6	8	Intermittent	ExN	2
158	29	14 27	7 39 N	141 32	757.0	27.5	24.3	77	21.2	7	Bright	E	3
159	Nov 4	13 41	2 58 N	149 53	[756.1]	26.9	23.6	76	20.2	6	Intermittent	SExS	3
160	5	13 29	0 36 N	151 33	[755.0]	27.0	23.9	77	20.7	8	Bright	SExE	5
161	6	13 55	2 07 S	152 26	754.4	27.4	23.8	74	20.3	7	Bright	E	5
162	6	14 25	2 11 S	152 26	754.4	27.4	23.7	73	20.1	7	Bright	E	5
163	7	13 43	5 01 S	153 33	[755.5]	28.3	23.9	69	20.0	7	Bright	NExE	4
164	8	13 16	6 44 S	155 12	[755.2]	27.8	23.7	71	19.9	7	Bright	ENE	4
165	9	15 44	8 19 S	157 14	754.3	29.0	25.0	72	21.8	8	Bright	NExN	4
166	11	15 16	9 26 S	159 10	[754.7]	29.1	24.9	71	21.5	6	Hazy	[NE]	[3]
167	14	14 30	11 39 S	163 05	756.5	31.3	24.0	54	18.7	7	Bright	SWxS	1
168	15	13 59	12 04 S	165 04	754.4	30.2	25.0	66	21.2	7	Bright	NExE	1
169	16	14 46	13 00 S	167 18	754.1	30.9	22.7	49	16.6	8	Very bright	Calm	0
170	17	13 50	13 40 S	168 33	755.1	31.6	25.1	59	20.6	7	Bright	Calm	0
171	17	14 15	13 40 S	168 35	755.1	31.5	25.1	60	20.7	7	Bright	Calm	0

* Indicates clouds on horizon.

a) Beginning with flight No. 131 of September 16, 1929, the _Carnegie_, Pacific Ocean, 1928-1929—Concluded

Clouds									Balloon disappearance due to	Notes
Lower			Middle			Upper				
Kind	Amt.	Dir.	Kind	Amt.	Dir.	Kind	Amt.	Dir.		
Cu	2	*	....	...	...	Ci-haze	...	*	Distance,haze	
Cu,St-Cu	10	...	....	...	...	....	...	...	Into clouds	
....	...	...	....	...	...	....	...	...	Clouds	Sky 3/4 clouded
....	...	...	....	...	...	....	...	...	Clouds	Sky 1/3 clouded
....	...	...	....	...	...	....	...	...	Into clouds	Sky 1/3 clouded
....	...	...	....	...	...	....	...	...	Into clouds	Sky 1/2 clouded
....	...	...	....	...	...	....	...	...	Sails	Sky 1/3 clouded
Cu	2	SE	....	...	...	....	...	...	Distance	Horizon slightly hazy
Haze	0	*	....	...	...	....	...	...	Distance	Horizon slightly hazy
Cu	5	S	....	...	...	Ci	1	...	Distance	
Cu	4	...	....	...	...	....	...	...	Clouds	
Cu	5	...	....	...	...	....	...	...	Into clouds	
Cu	2	...	....	...	...	....	...	...	Cloud	
Cu	1	...	....	...	...	....	...	...	Cloud	
Cu	1	...	....	...	...	....	...	...	Bursting	
Cu	1	...	....	...	...	....	...	...	Distance	
Fr-Cu	3	ENE	....	...	...	....	...	...	Into cloud	
Fr-Cu	1	ENE	A-St	1	...	....	...	...	Clouds	
Cu	1	*	....	...	...	....	...	...	Distance	
Cu-Nb	7	...	....	...	...	....	...	...	Cloud	
Cu	3	...	....	...	...	....	...	...	Sun	
Cu,Fr-Cu	5	...	A-Cu	1	...	....	...	...	Clouds	
....	...	...	A-St	5	...	....	...	...	Distance,clouds	
Cu	3	NE	....	...	...	Ci	1	...	Distance	
Cu	7	SW	....	...	...	Ci	1	...	Haze,clouds	
Cu	5	SSW	....	...	...	Ci	1	...	Haze,distance	
....	...	...	....	...	...	....	...	...	Distance	Cloudless sky
Cu,Fr-Cu	7	SW	....	...	...	....	...	...	Clouds	
Cu,Fr-Cu	7	SW	....	...	...	....	...	...	Clouds	Clouds increasing
Cu	5	NNW	A-St	1	...	Ci	5	...	Ci-clouds	
Cu	1	S	....	...	...	....	...	...	Bursting(?)	
Cu	1	...	....	...	...	....	...	...	Distance	
Cu	1	...	....	...	...	....	...	...	Distance	
Cu	3	NE	....	...	...	Ci	1	...	Clouds	
Cu	3	...	....	...	...	....	...	...	Cloud	
Cu	4	...	....	...	...	....	...	...	Distance	
Cu	5	...	....	...	...	....	...	...	Clouds	
Cu	4	ExS	....	...	...	Ci	1	...	Clouds	
Cu	7	...	....	...	...	....	...	...	Clouds	
Cu	4	...	....	...	...	....	...	...	Distance	
Cu	3	ExN	....	...	...	Ci-St	2	...	Distance	
Cu	4	ExN	....	...	...	Ci-St	2	...	Distance	
Cu	4	NNE	....	...	...	Ci-St	3	...	Clouds,haze	
Cu	1	...	....	...	...	Ci	1	...	Distance,haze	
Cu	2	NNE	....	...	...	Ci	4	...	Haze	
Cu	4	...	A-Cu	4	...	....	...	...	Clouds	
Cu	1	...	A-Cu	1	...	Ci-St	4	...	Haze,distance	
Cu	3	...	....	...	...	Ci-Cu	2	...	Distance	
Cu	1	...	....	...	...	....	...	...	Distance	
Cu	5	...	....	...	...	....	...	...	Cloud	
Cu	5	...	....	...	...	....	...	...	Clouds	

[] Indicate approximate values.
the scale of visibility 0 to 9 was used.

FIGURES 1 - 46

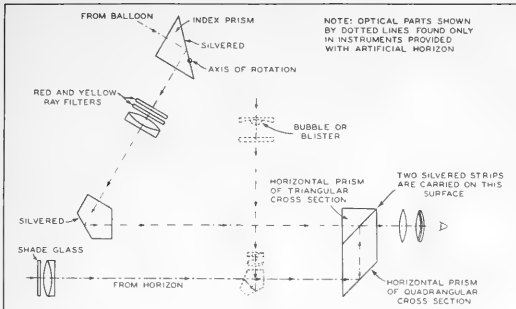


FIG. 1(A)

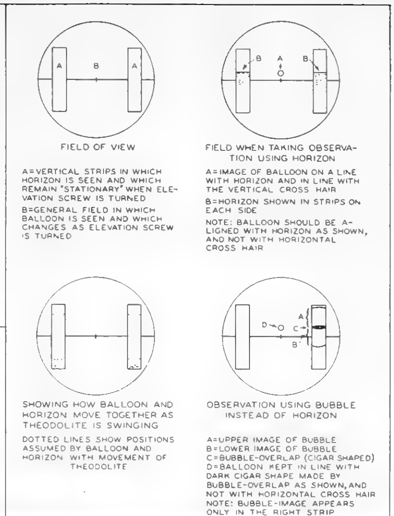


FIG. 1(B)

FIGS. 1 AND 2—SHIPBOARD THEODOLITE

FIG. 1—(A) SKETCH OF OPTICAL SYSTEM; (B) FIELD OF VIEW UNDER DIFFERENT CONDITIONS

FIG. 2—(A) INSTRUMENT MOUNTED ON TRIPOD SHOWING COUNTERWEIGHT; (B) DETAILED VIEW

FIG. 2(A)

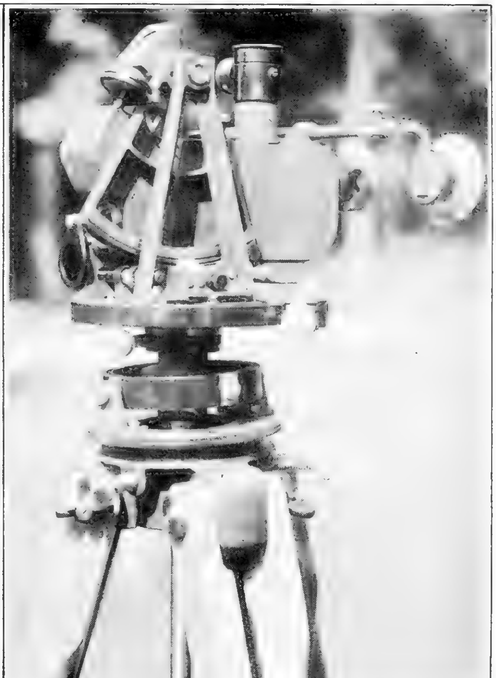


FIG. 2(B)

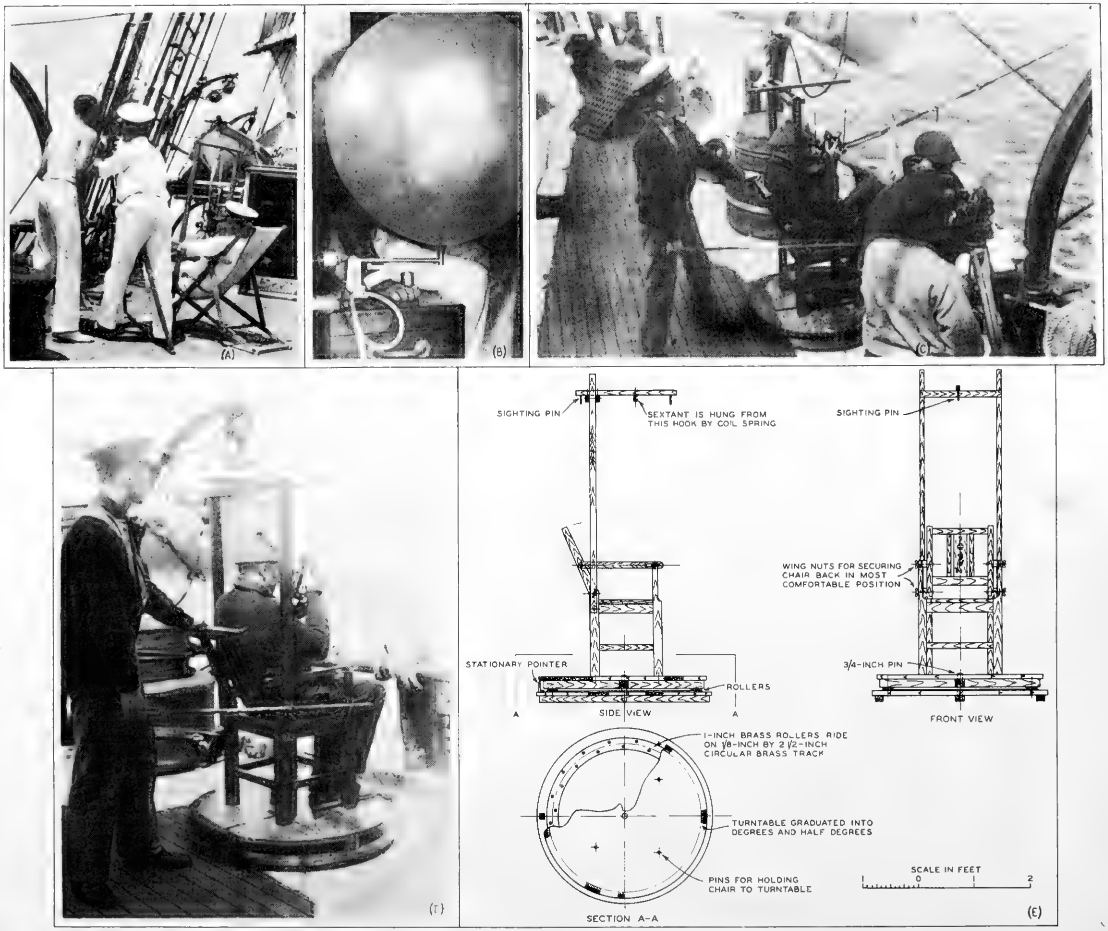


FIG. 3—PILOT-BALLOON OBSERVATIONS ON THE <u>CARNEGIE</u>

(A) OBSERVING WITH SHIPBOARD THEODOLITE AND SEXTANT; (B) WEIGHING APPARATUS FOR "DEFINITE INFLATION"; (C) AND (D) SPECIAL CHAIR FOR OBSERVING WITH SEXTANT FOLLOWING BALLOON; (E) DETAILS OF SPECIAL CHAIR

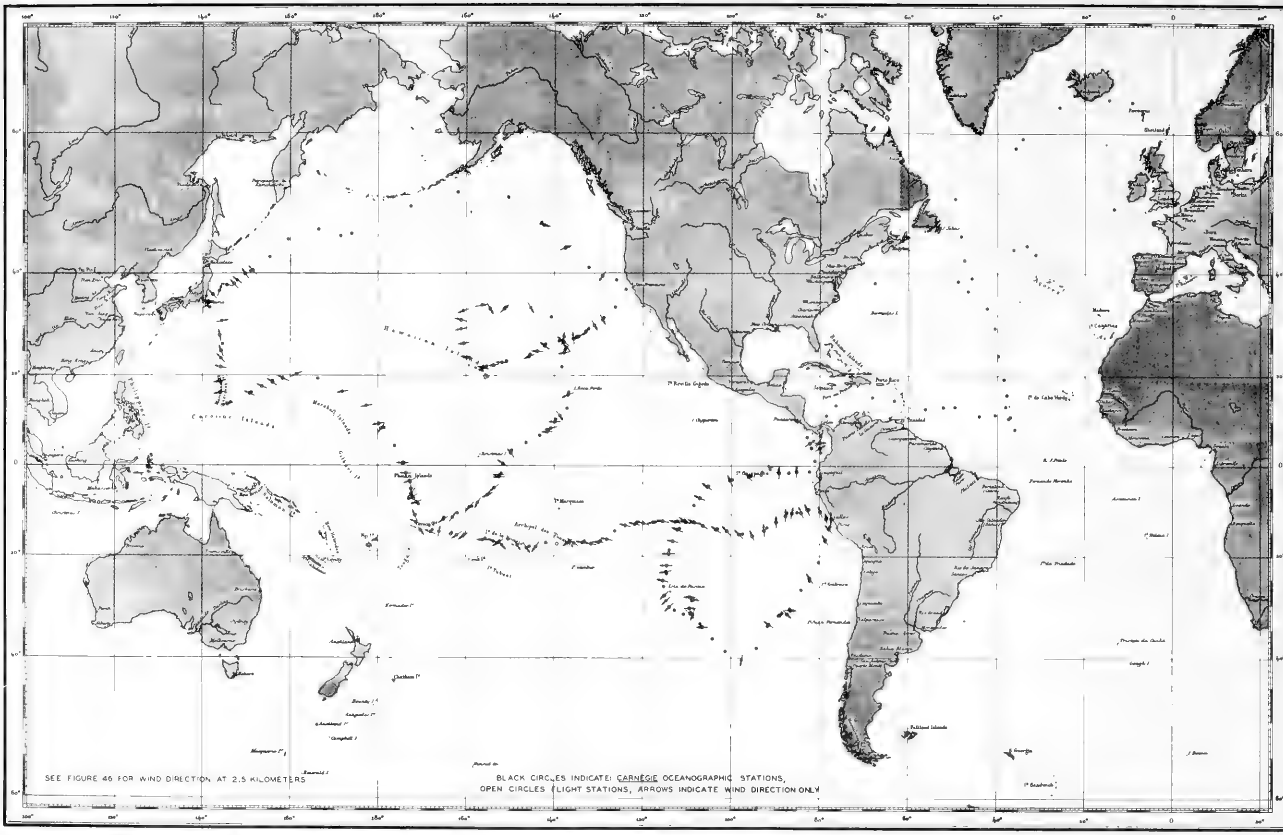


FIG. 4—WIND DIRECTION AT SURFACE, PACIFIC OCEAN, FROM CARNEGIE PILOT-BALLOON FLIGHTS, 1928–1929

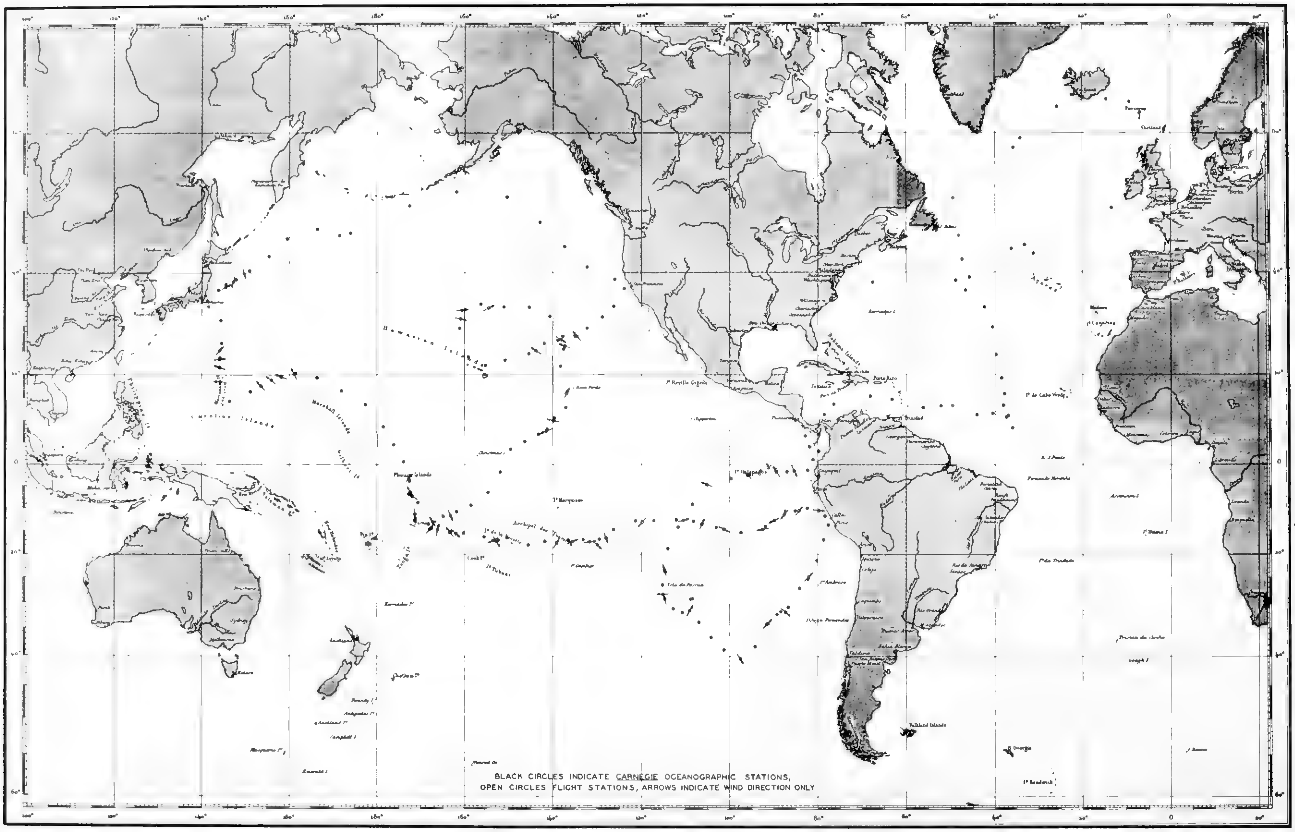


FIG. 5—WIND DIRECTIONS AT HEIGHT 5 KILOMETERS, PACIFIC OCEAN, FROM CARNEGIE PILOT-BALLOON FLIGHTS, 1928-1929

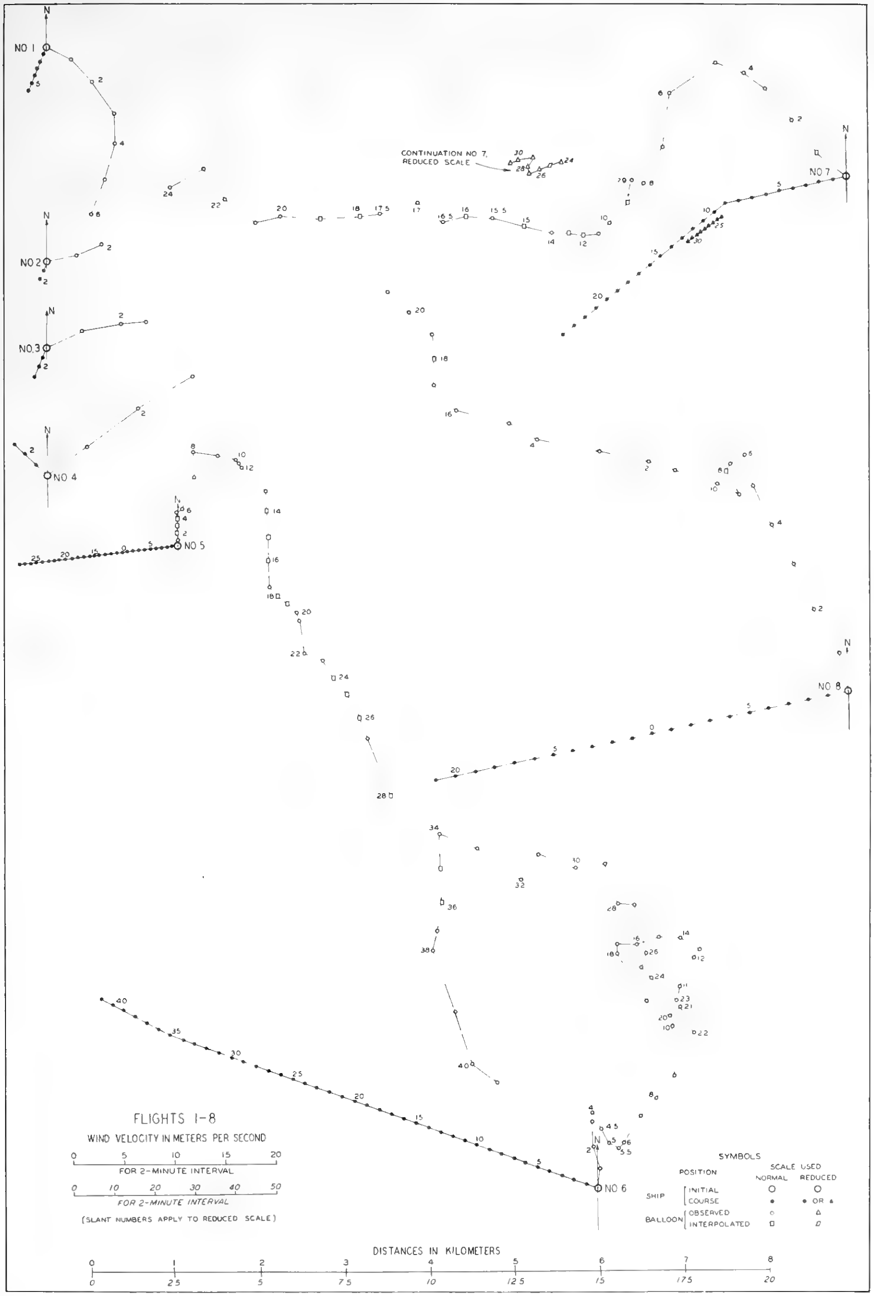


FIG. 6 — PLOTTING-BOARD GRAPHS POSITIONS SHIP AND BALLOON, PACIFIC OCEAN, FROM CARNEGIE PILOT-BALLOON FLIGHTS OCTOBER 27 TO NOVEMBER 17, 1928

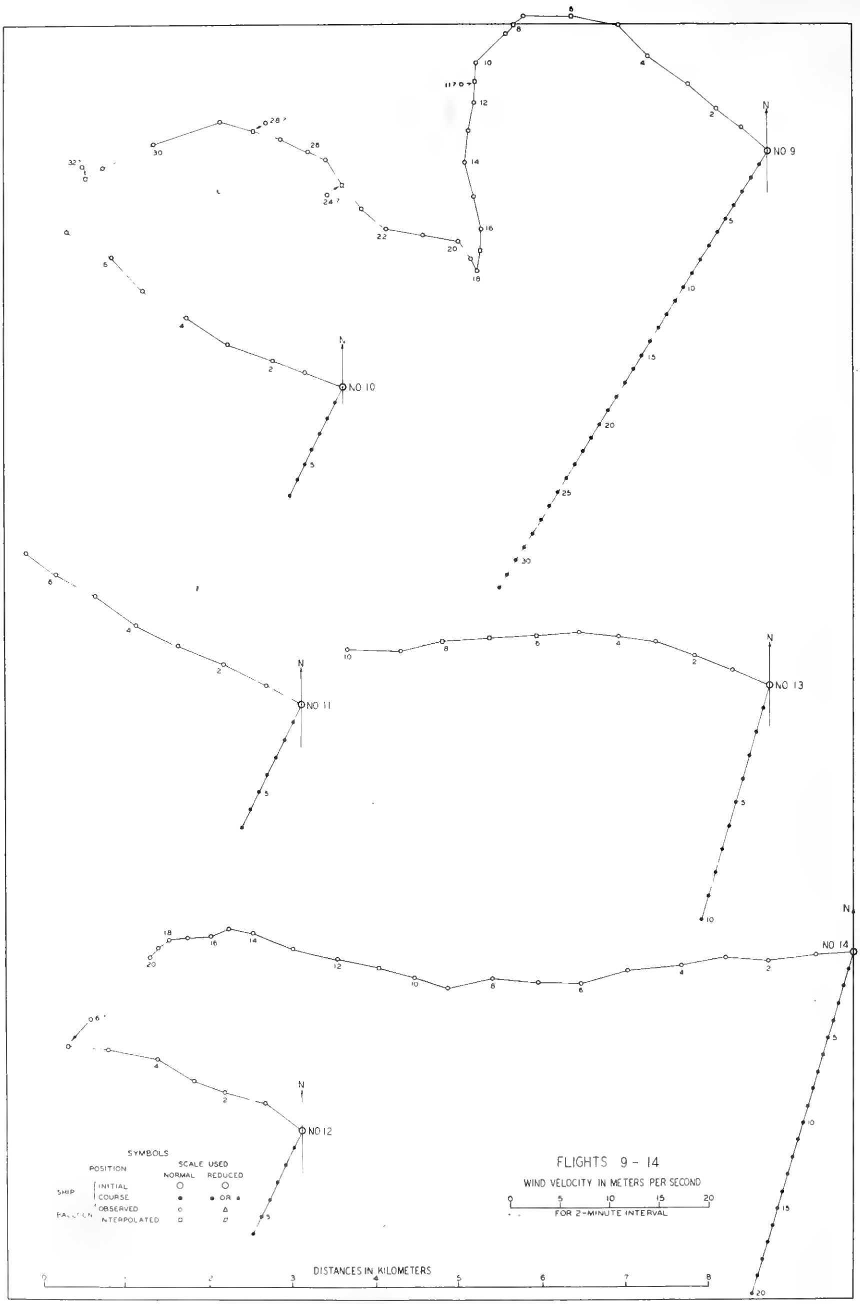


FIG 7 — PLOTTING-BOARD GRAPHS POSITIONS SHIP AND BALLOON, PACIFIC OCEAN, FROM CARNEGIE PILOT-BALLOON FLIGHTS NOVEMBER 19–24, 1928

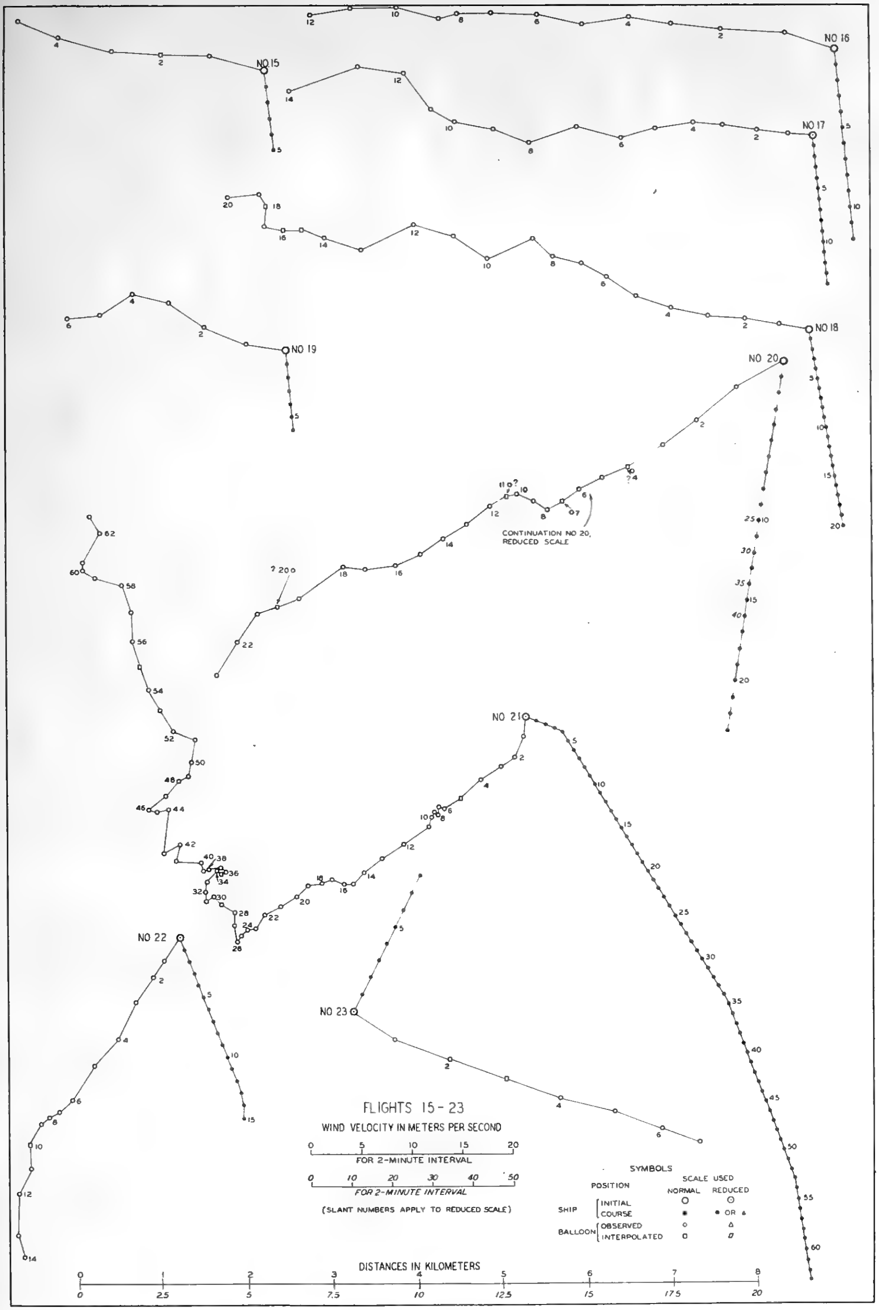


FIG. 8 — PLOTTING-BOARD GRAPHS POSITIONS SHIP AND BALLOON, PACIFIC OCEAN, FROM CARNEGIE PILOT-BALLOON FLIGHTS NOVEMBER 25 TO DECEMBER 4, 1928

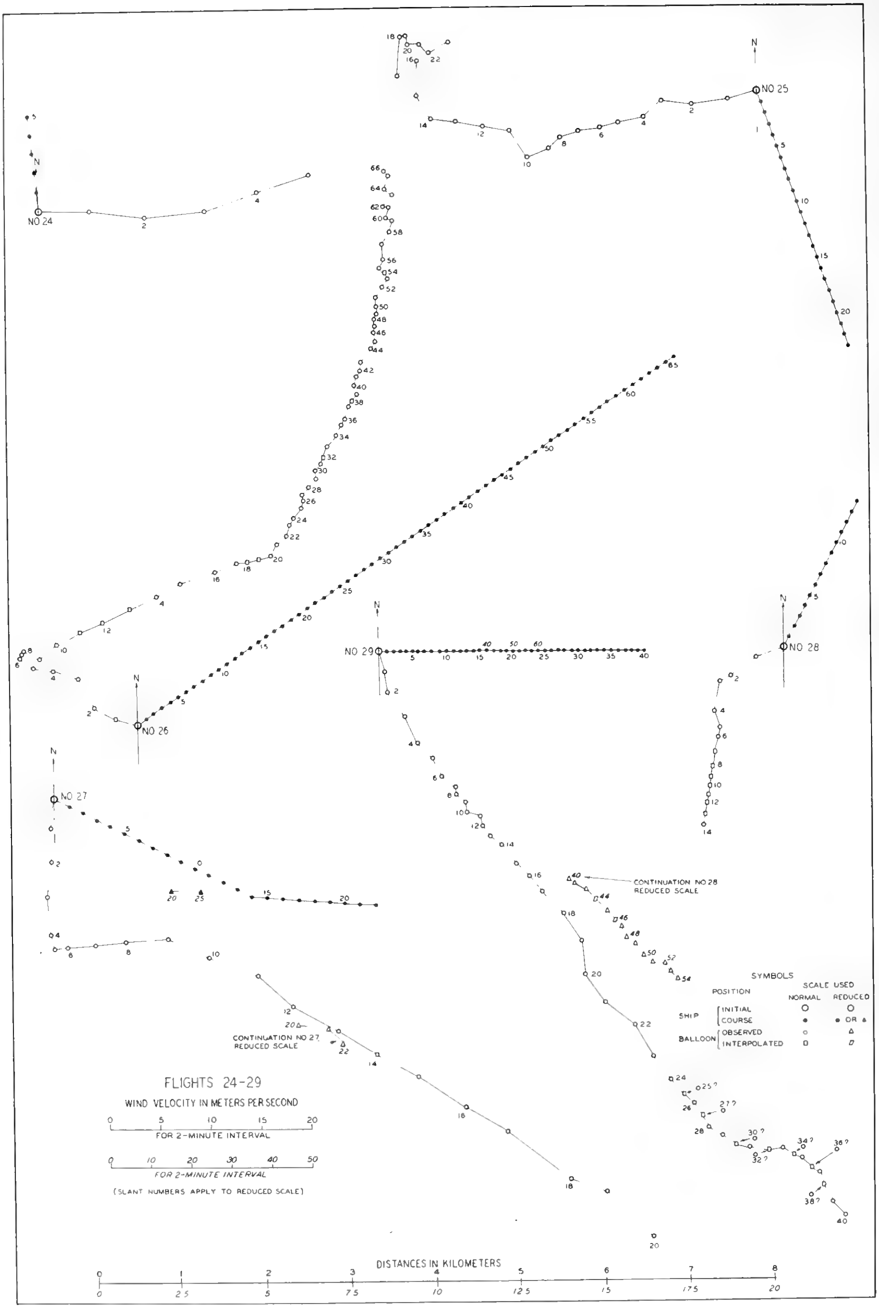


FIG 9 — PLOTTING-BOARD GRAPHS POSITIONS SHIP AND BALLOON, PACIFIC OCEAN, FROM CARNEGIE PILOT-BALLOON FLIGHTS DECEMBER 5-26, 1928

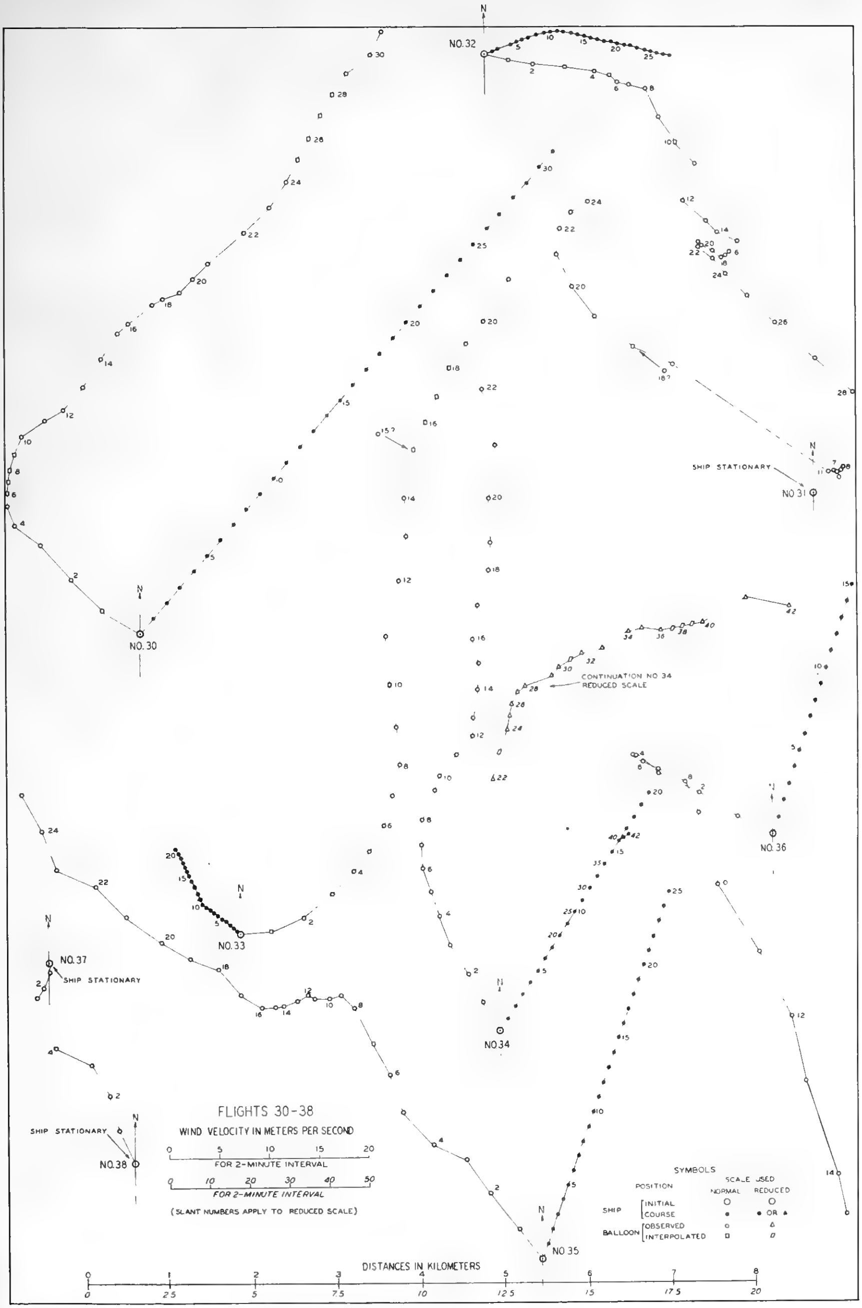


FIG. 10—PLOTTING-BOARD GRAPHS POSITIONS SHIP AND BALLOON, PACIFIC OCEAN, FROM CARNEGIE PILOT-BALLOON FLIGHTS DECEMBER 30, 1928 TO FEBRUARY 6, 1929

FIG 11 — PLOTTING-BOARD GRAPHS POSITIONS SHIP AND BALLOON, PACIFIC OCEAN, FROM CARNEGIE PILOT-BALLOON FLIGHTS FEBRUARY 7–13, 1929

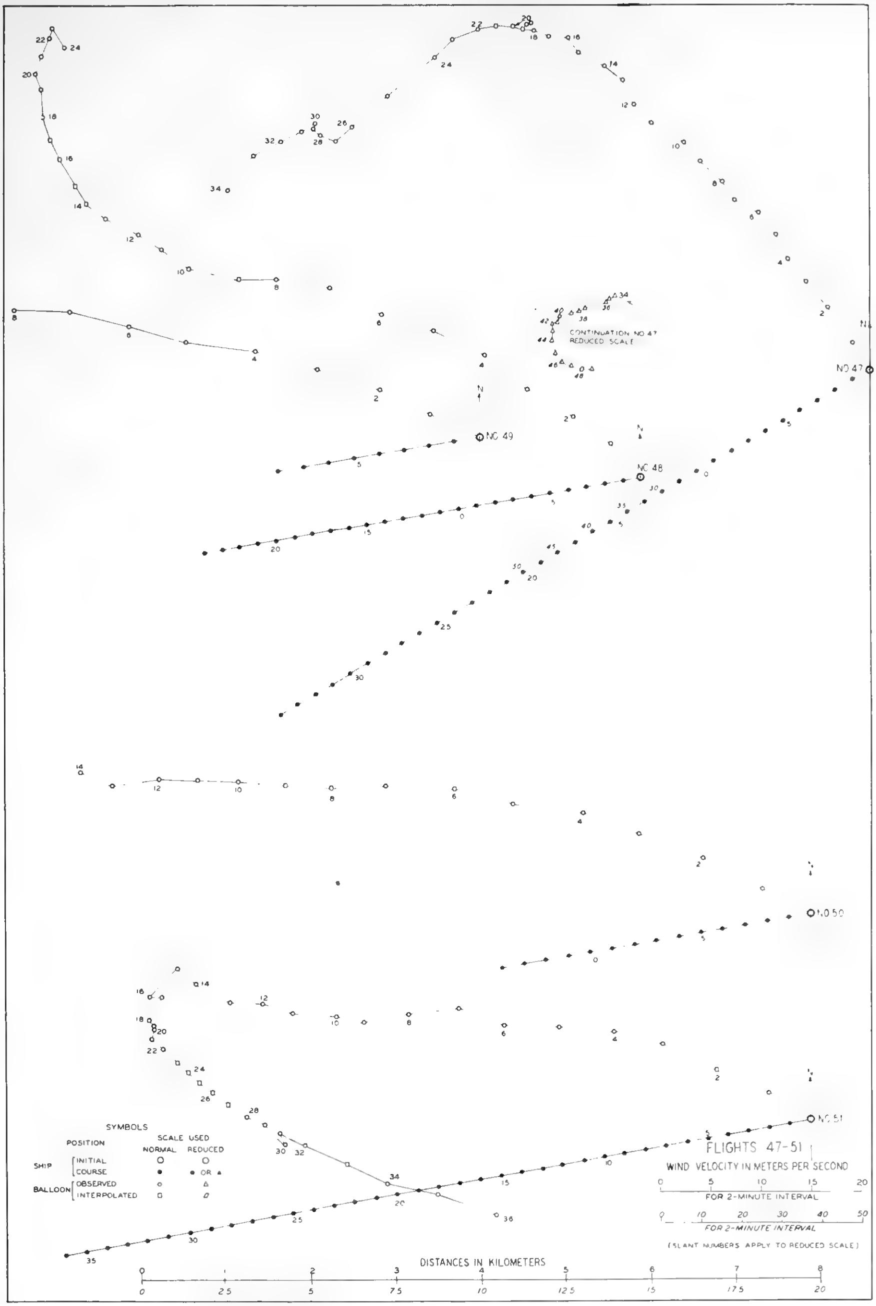


FIG. 12—PLOTTING-BOARD GRAPHS POSITIONS SHIP AND BALLOON, PACIFIC OCEAN, FROM CARNEGIE PILOT-BALLOON FLIGHTS FEBRUARY 14–17, 1929

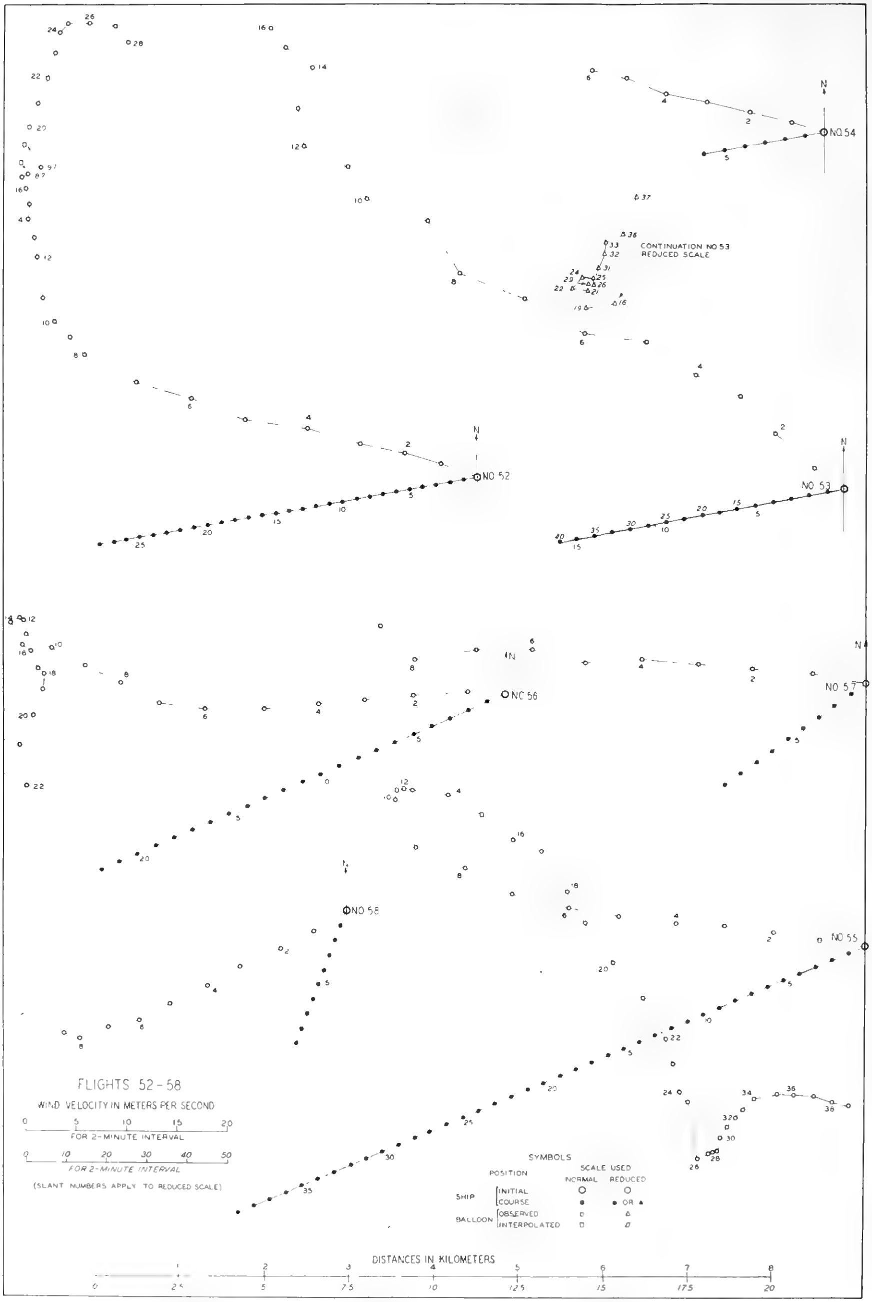


FIG 13—PLOTTING-BOARD GRAPHS POSITIONS SHIP AND BALLOON, PACIFIC OCEAN, FROM CARNEGIE PILOT-BALLOON FLIGHTS FEBRUARY 18-24, 1929

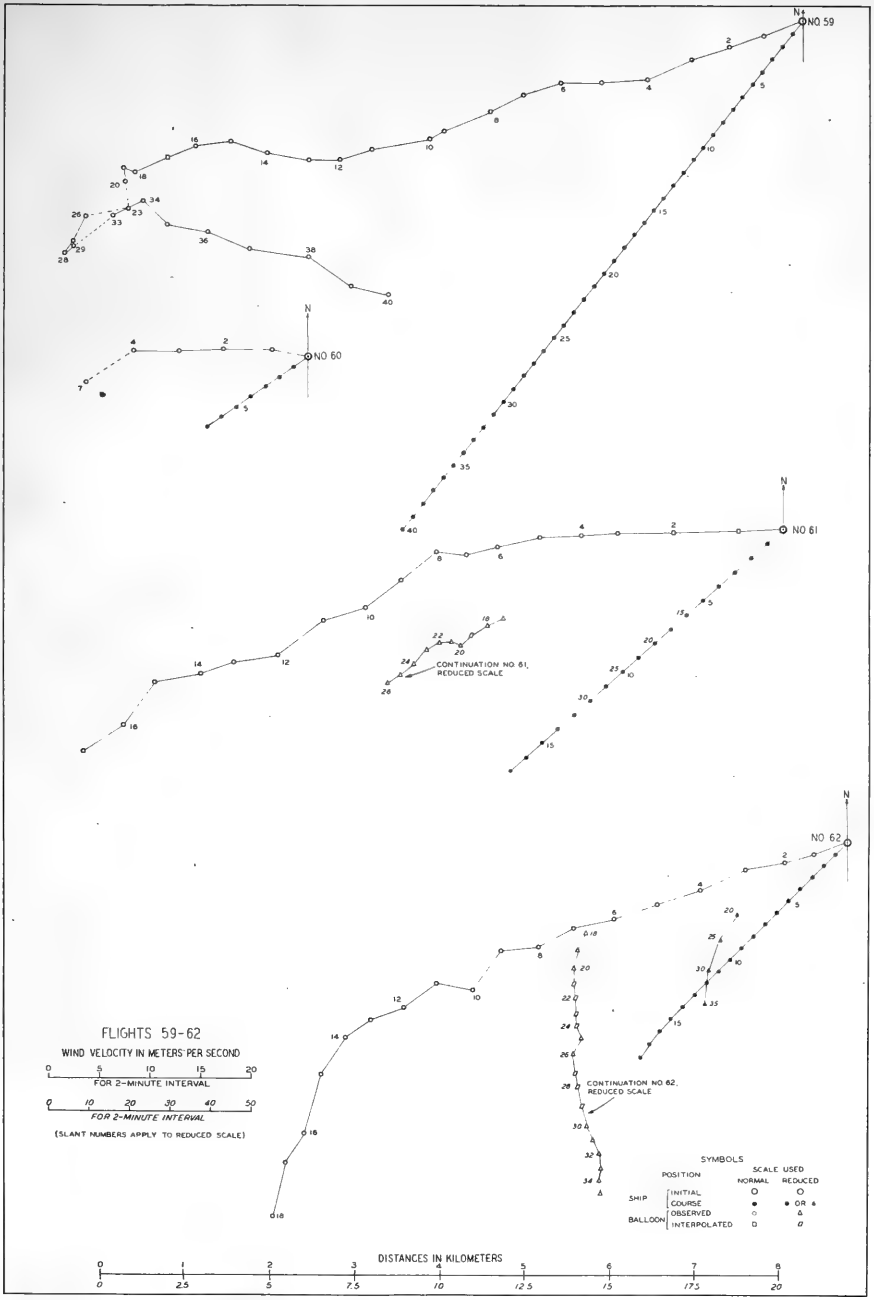


FIG. 14—PLOTTING-BOARD GRAPHS POSITIONS SHIP AND BALLOON, PACIFIC OCEAN, FROM CARNEGIE PILOT-BALLOON FLIGHTS FEBRUARY 25 TO MARCH 1, 1929

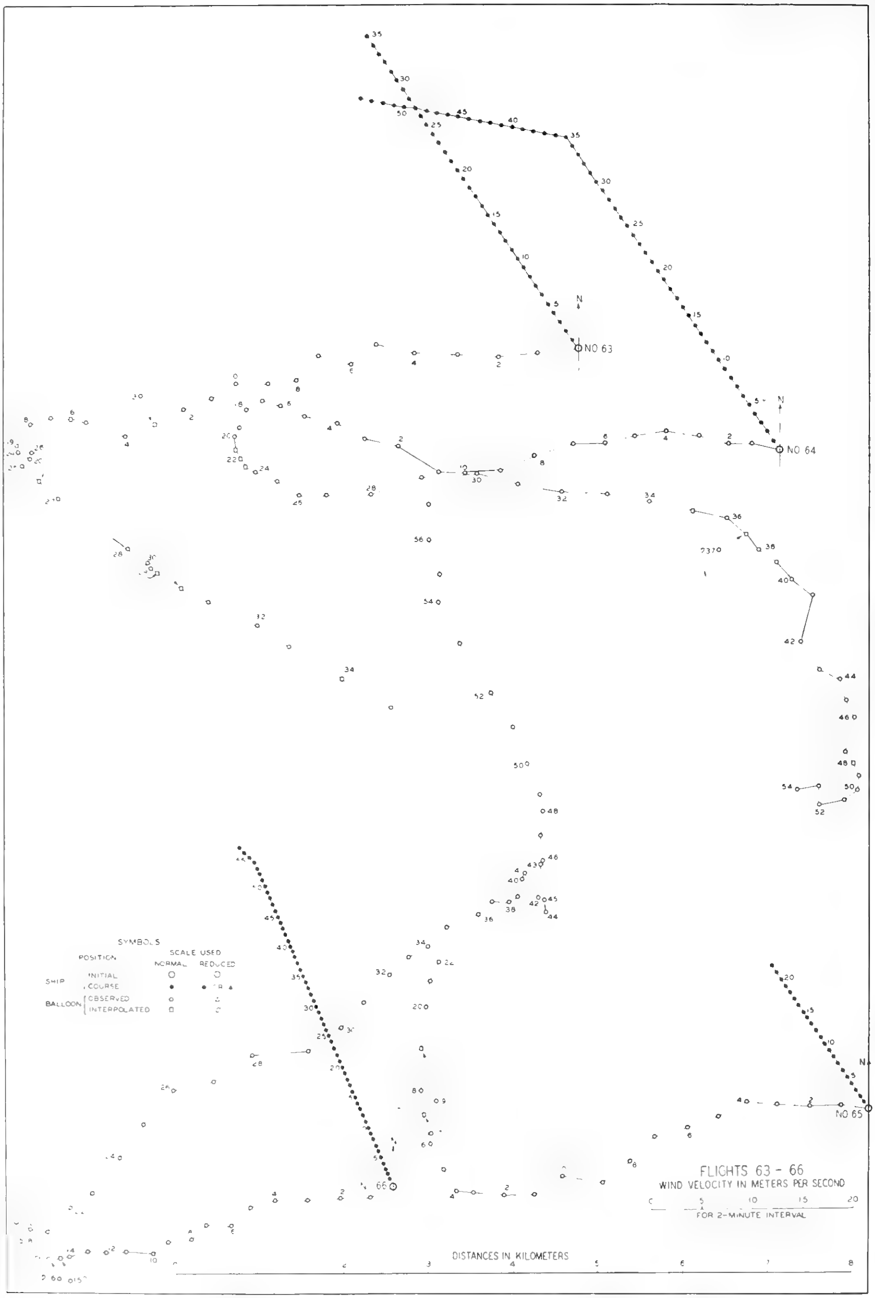


FIG 15—PLOTTING-BOARD GRAPHS POSITIONS SHIP AND BALLOON, PACIFIC OCEAN, FROM CARNEGIE PILOT-BALLOON FLIGHTS MARCH 2–5, 1929

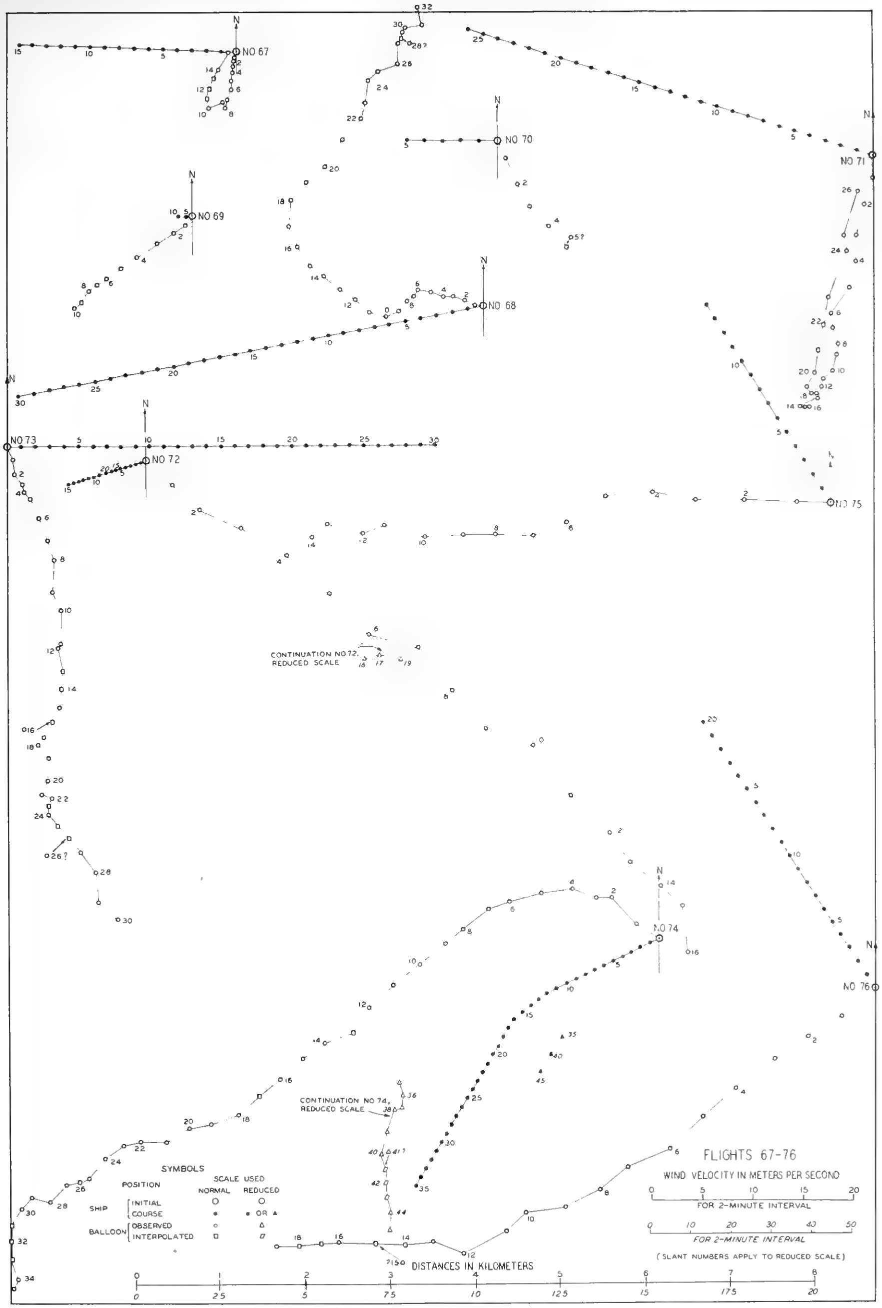


FIG. 16— PLOTTING-BOARD GRAPHS POSITIONS SHIP AND BALLOON, PACIFIC OCEAN, FROM CARNEGIE PILOT-BALLOON FLIGHTS MARCH 6-27, 1929

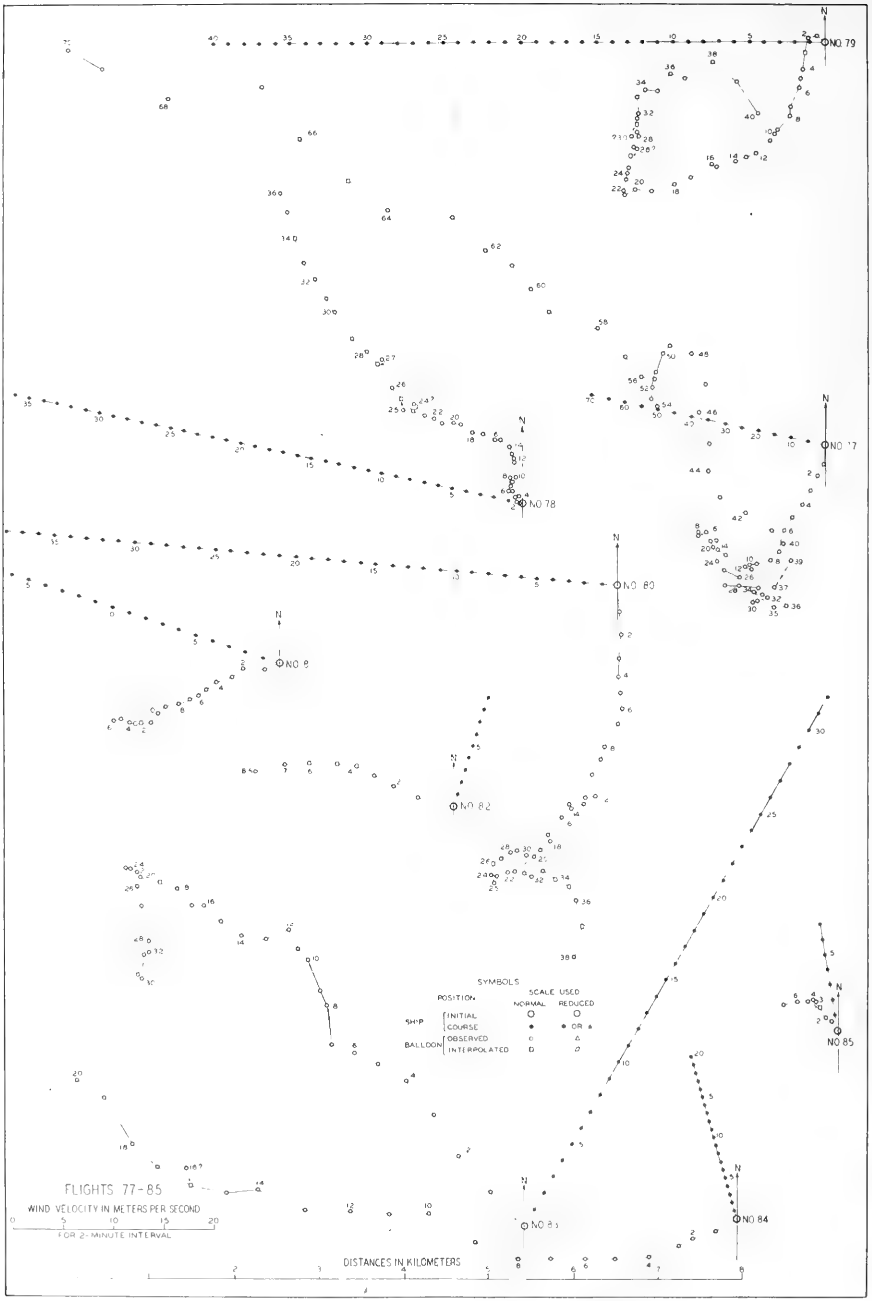


FIG 17—PLOTTING-BOARD GRAPHS POSITIONS SHIP AND BALLOON, PACIFIC OCEAN, FROM CARNEGIE PILOT-BALLOON FLIGHTS MARCH 28 TO APRIL 25, 1929

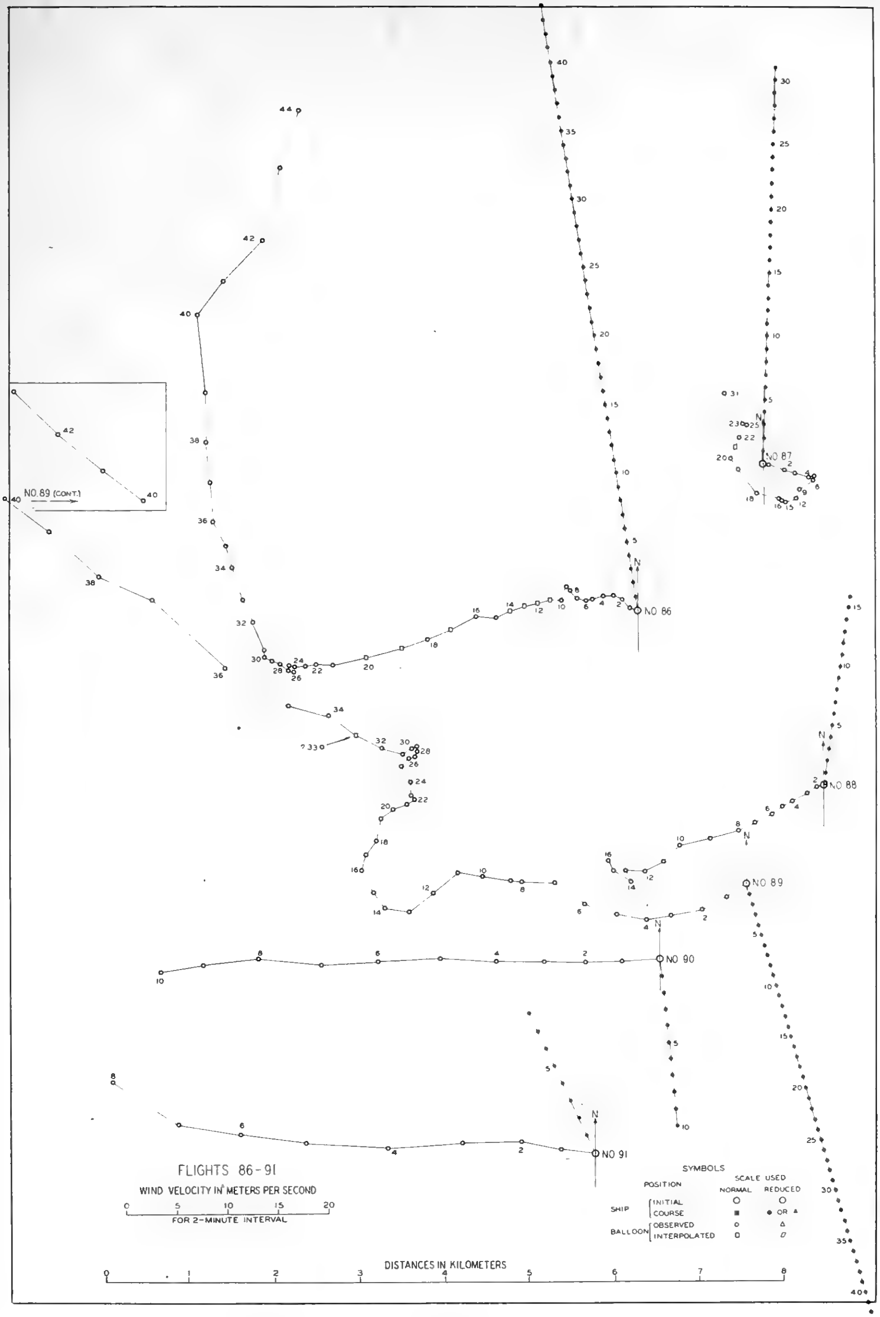


FIG.18—PLOTTING-BOARD GRAPHS POSITIONS SHIP AND BALLOON, PACIFIC OCEAN, FROM CARNEGIE PILOT-BALLOON FLIGHTS APRIL 25–30, 1929

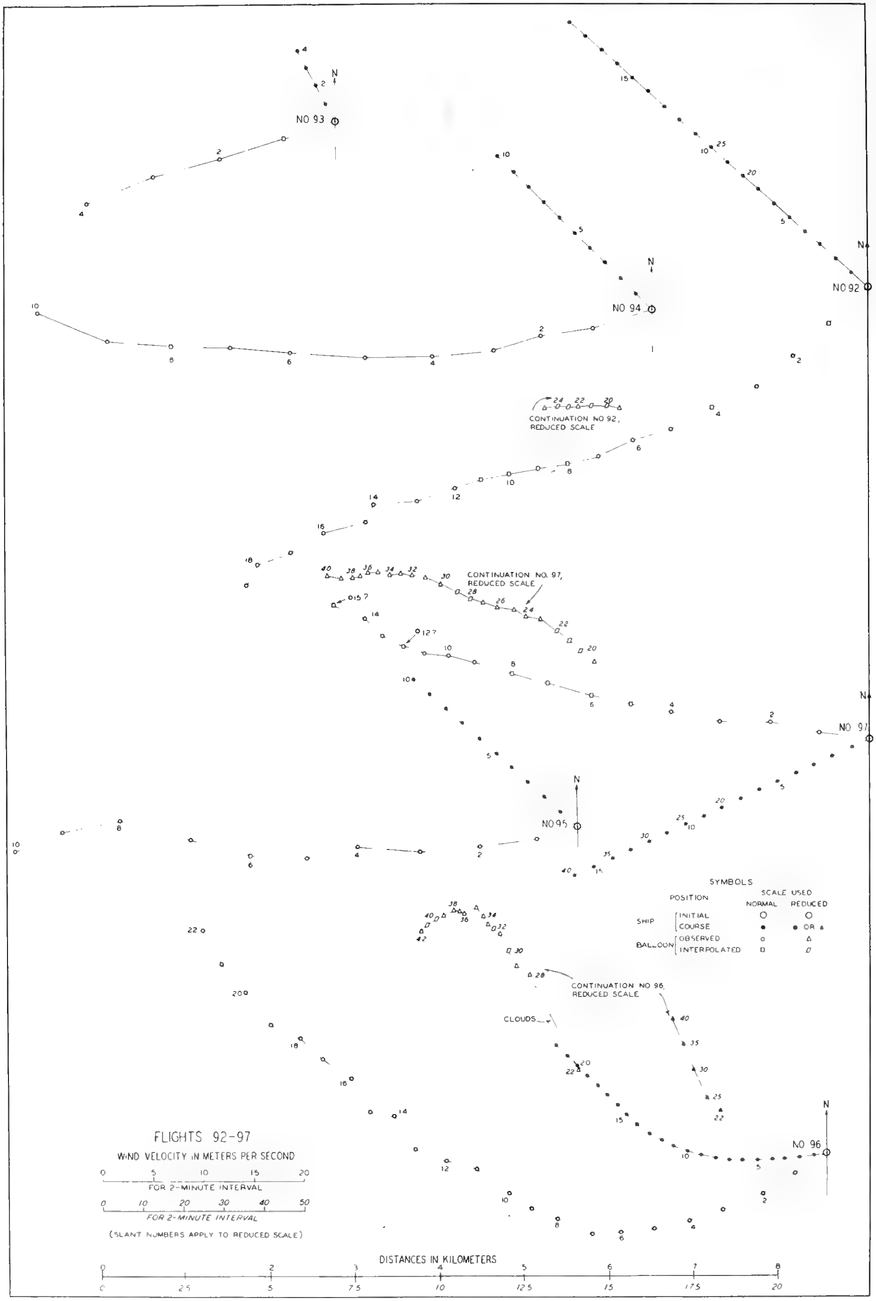


FIG. 19—PLOTTING-BOARD GRAPHS POSITIONS SHIP AND BALLOON, PACIFIC OCEAN, FROM CARNEGIE PILOT-BALLOON FLIGHTS MAY 4-14, 1929

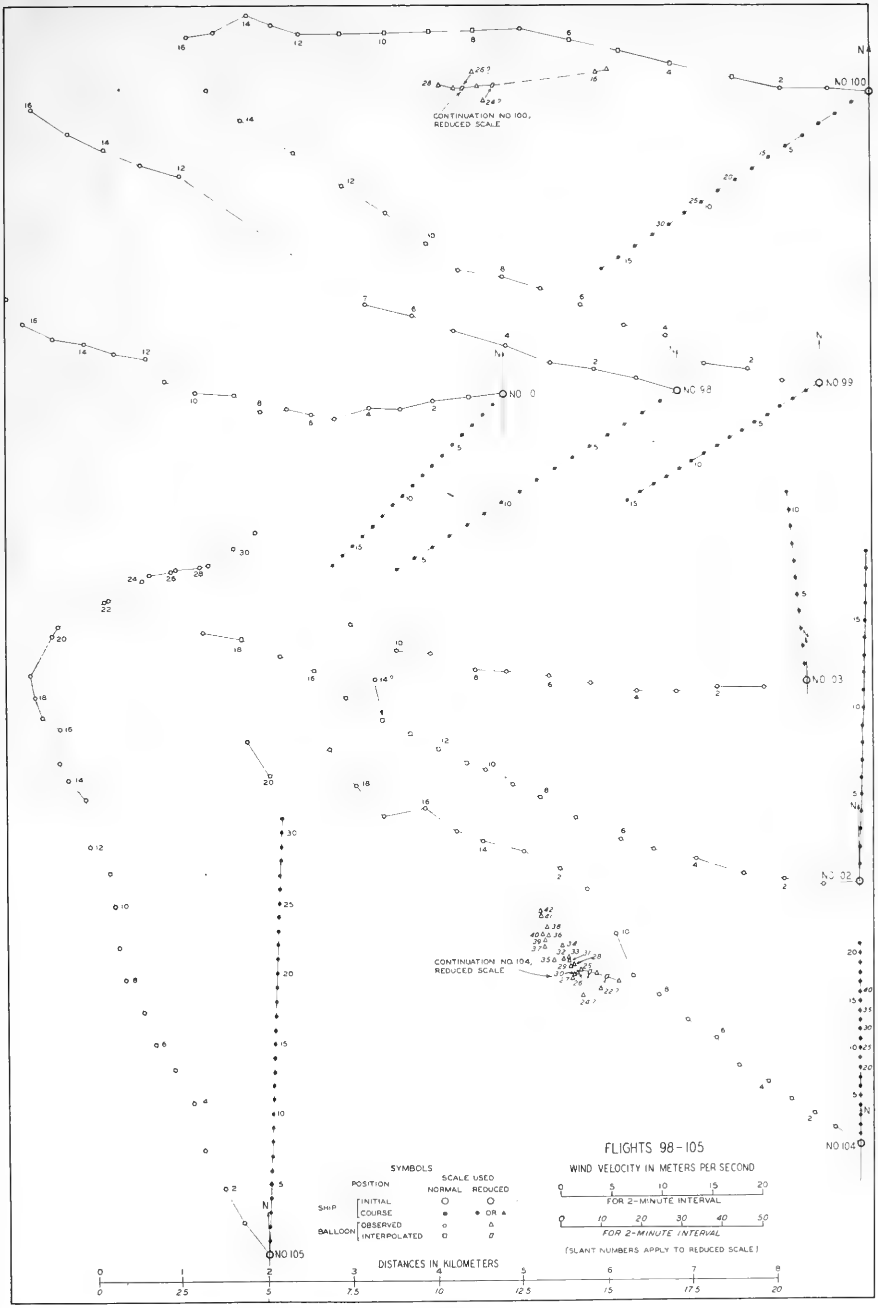


FIG. 20—PLOTTING-BOARD GRAPHS POSITIONS SHIP AND BALLOON, PACIFIC OCEAN, FROM CARNEGIE PILOT-BALLOON FLIGHTS MAY 15-29, 1929

FIG 21— PLOTTING-BOARD GRAPHS POSITIONS SHIP AND BALLOON, PACIFIC OCEAN, FROM CARNEGIE PILOT-BALLOON FLIGHTS MAY 30 TO JUNE 30, 1929

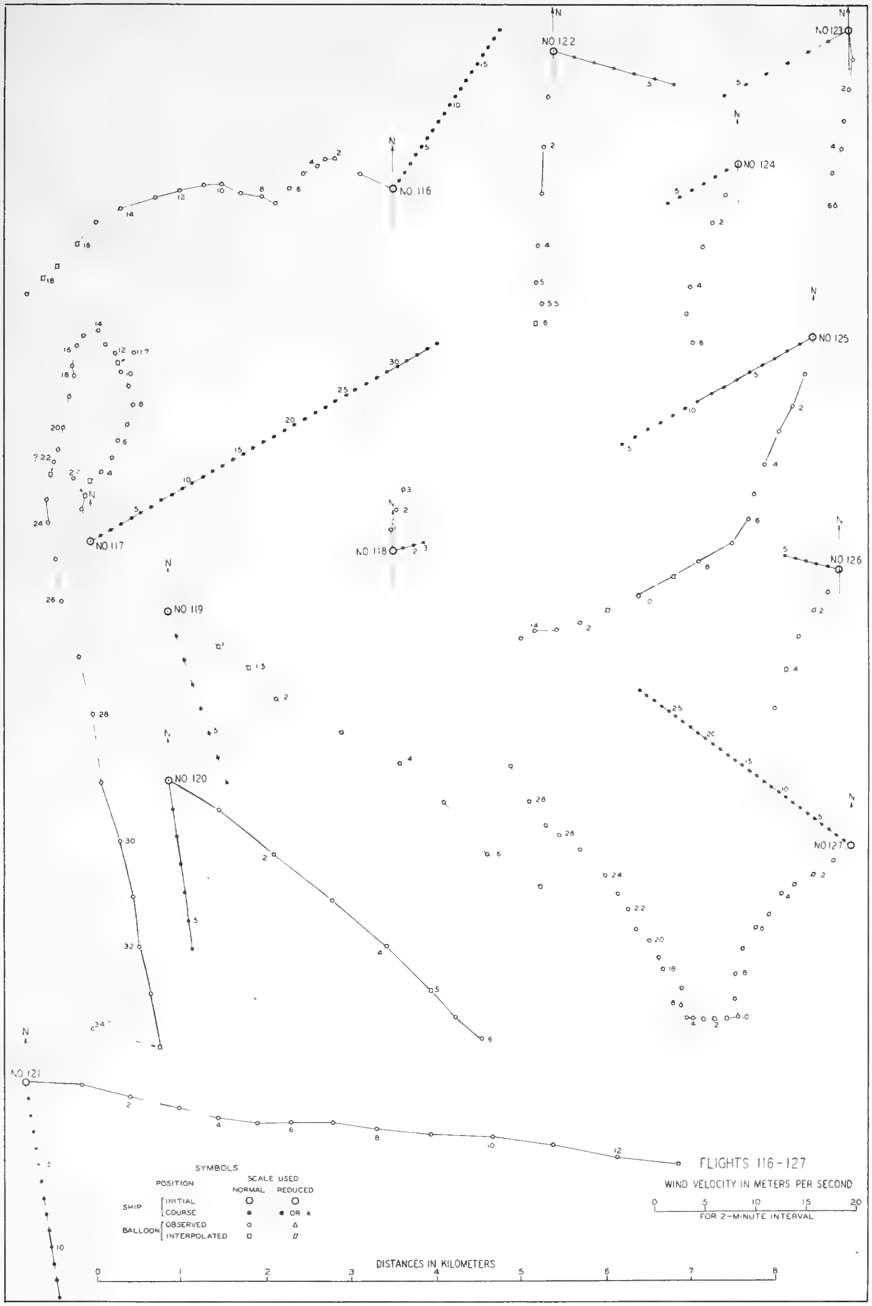


FIG. 22—PLOTTING-BOARD GRAPHS POSITIONS SHIP AND BALLOON, PACIFIC OCEAN, FROM CARNEGIE PILOT-BALLOON FLIGHTS JULY 1 TO SEPTEMBER 11, 1929

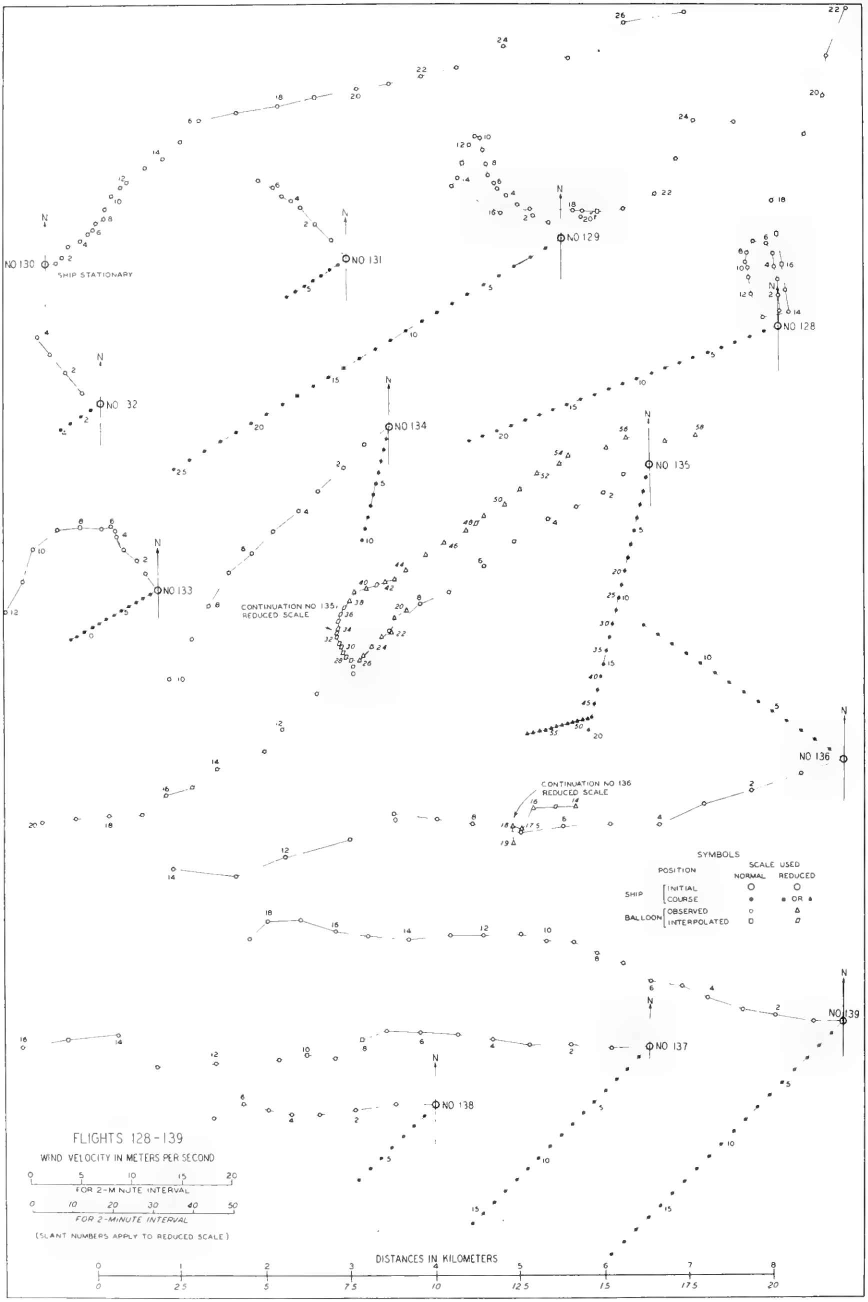


FIG 23—PLOTTING-BOARD GRAPHS POSITIONS SHIP AND BALLOON, PACIFIC OCEAN, FROM CARNEGIE PILOT-BALLOON FLIGHTS SEPTEMBER 12-22, 1929

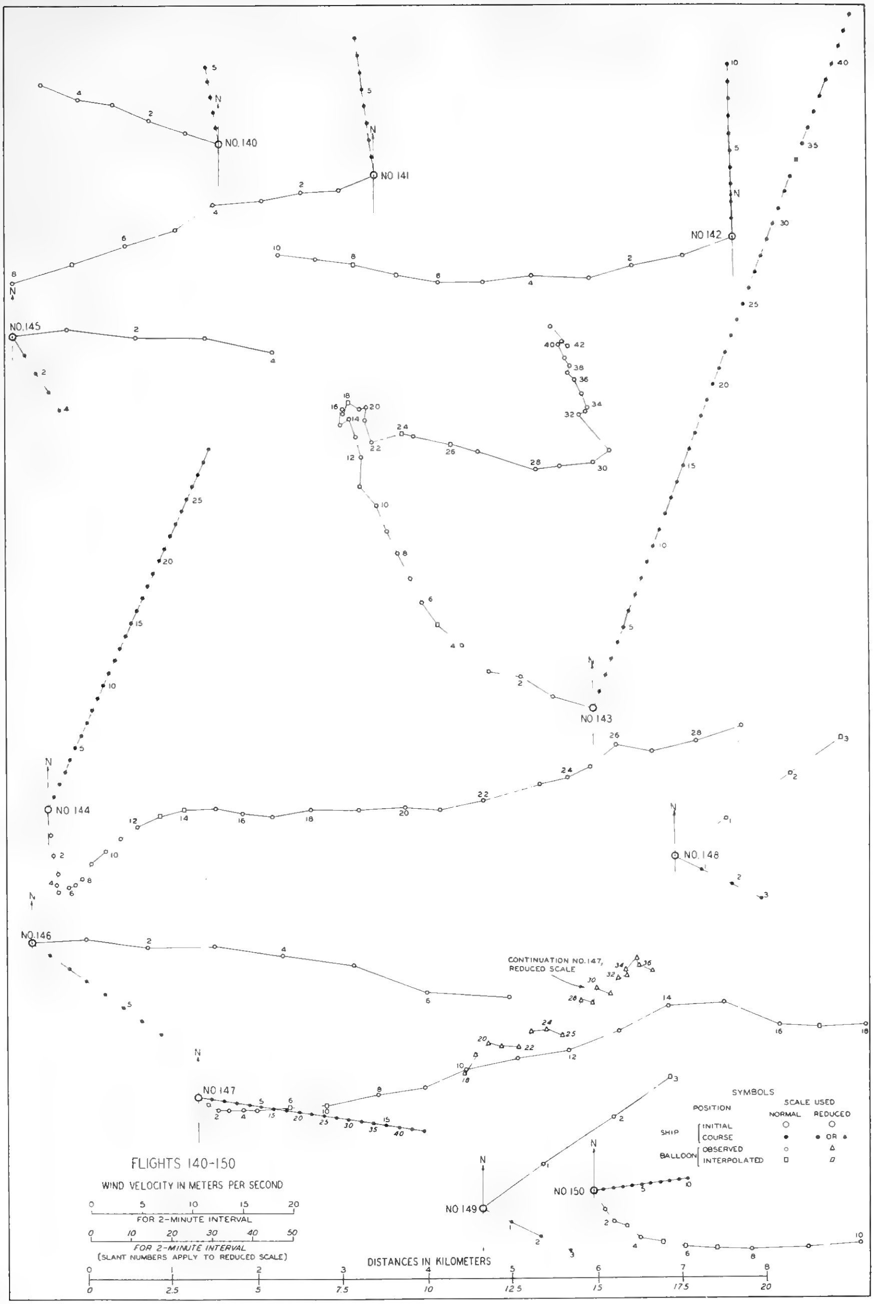


FIG 24—PLOTTING-BOARD GRAPHS POSITIONS SHIP AND BALLOON, PACIFIC OCEAN, FROM CARNEGIE PILOT-BALLOON FLIGHTS OCTOBER 3-13, 1929

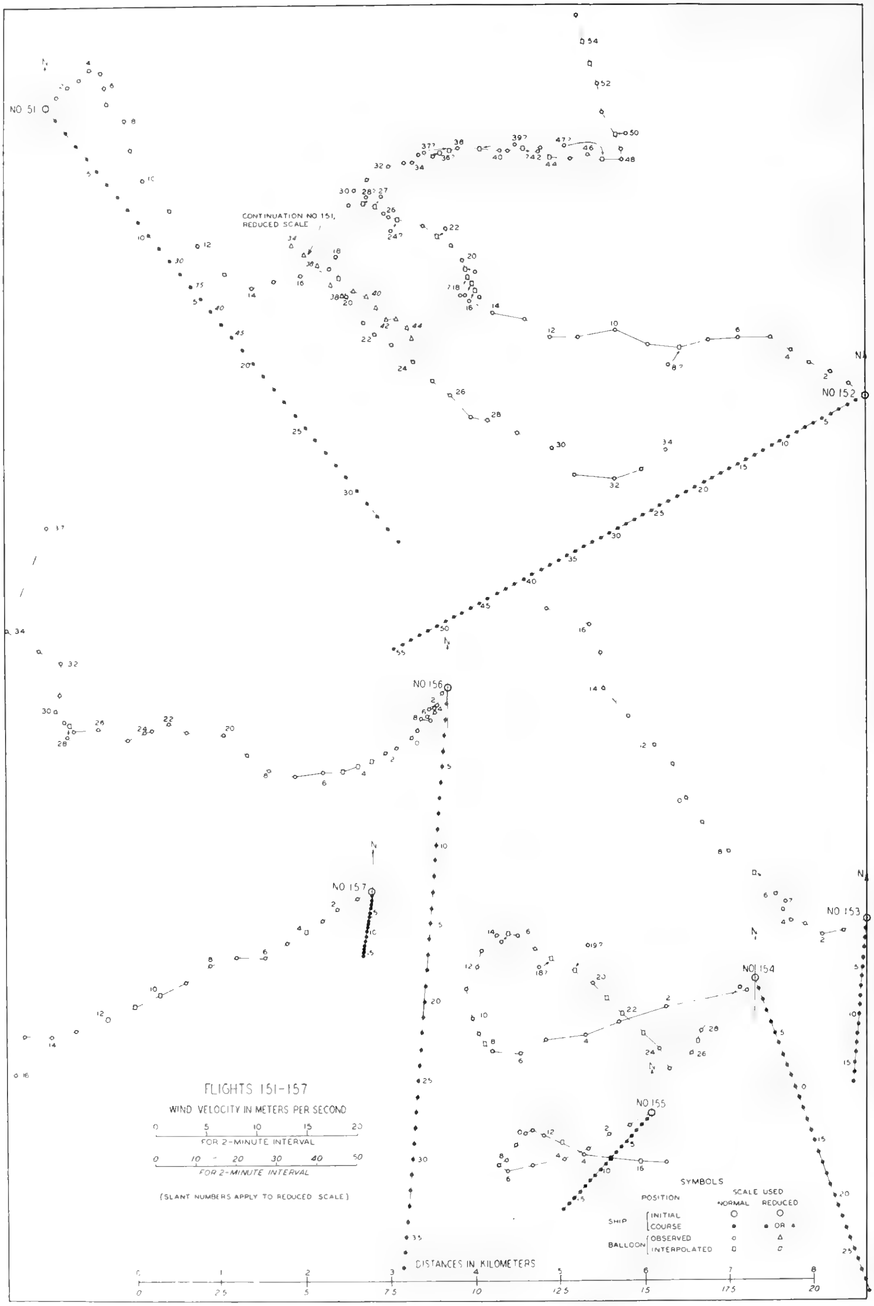


FIG 25—PLOTTING-BOARD GRAPHS POSITIONS SHIP AND BALLOON, PACIFIC OCEAN, FROM CARNEGIE PILOT-BALLOON FLIGHTS OCTOBER 17–28, 1929

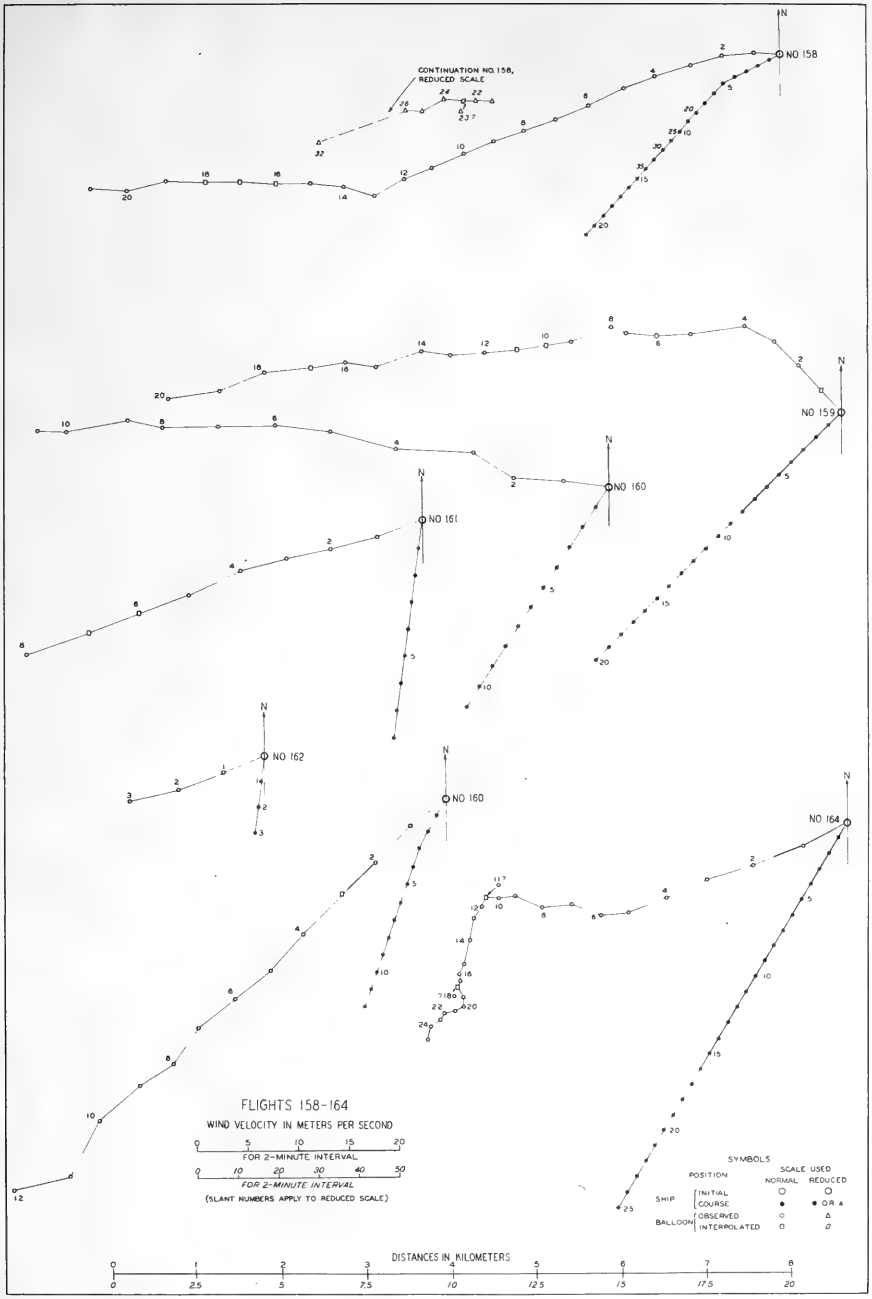


FIG. 26—PLOTTING-BOARD GRAPHS POSITIONS SHIP AND BALLOON, PACIFIC OCEAN, FROM CARNEGIE PILOT-BALLOON FLIGHTS OCTOBER 29 TO NOVEMBER 8, 1929

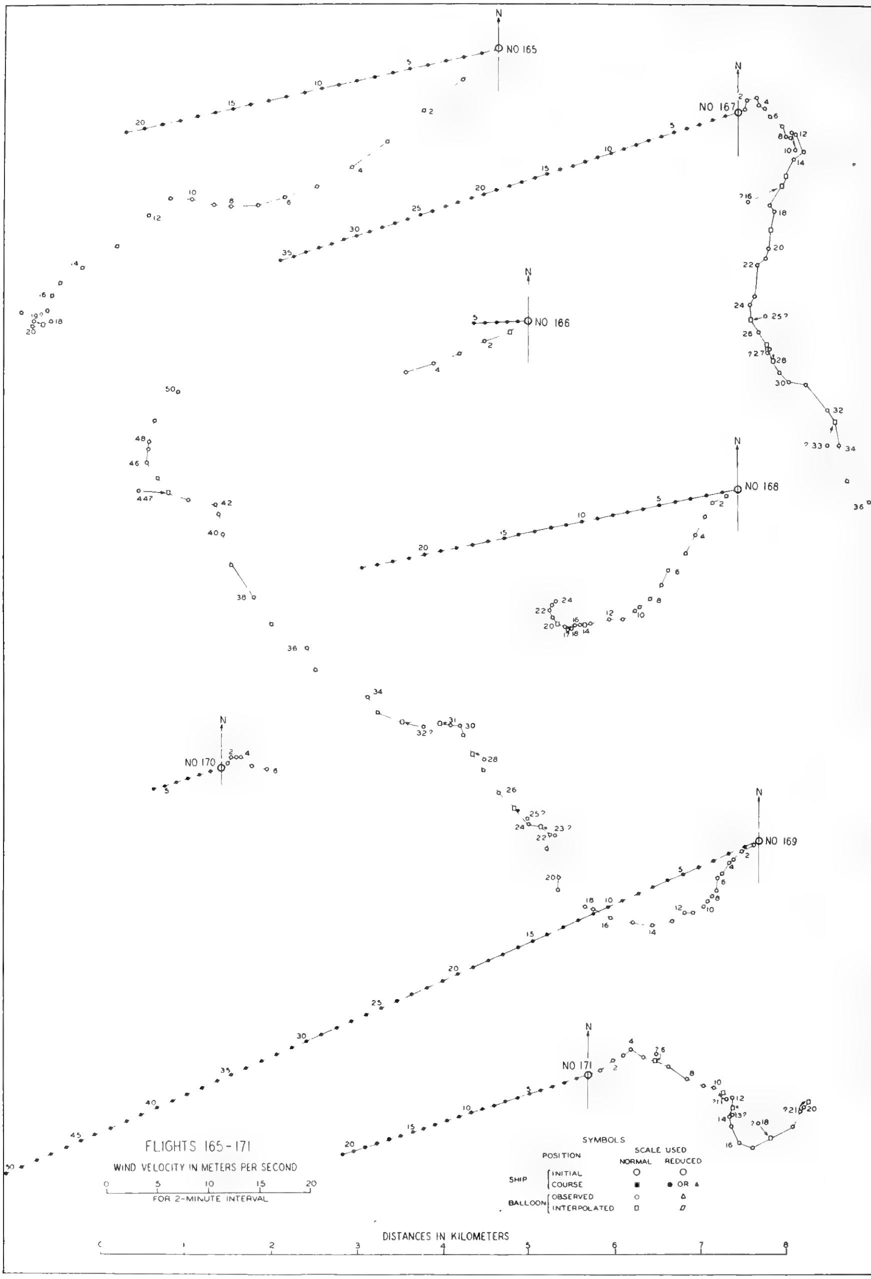


FIG 27— PLOTTING-BOARD GRAPHS POSITIONS SHIP AND BALLOON, PACIFIC OCEAN, FROM CARNEGIE PILOT-BALLOON FLIGHTS NOVEMBER 9-17, 1929

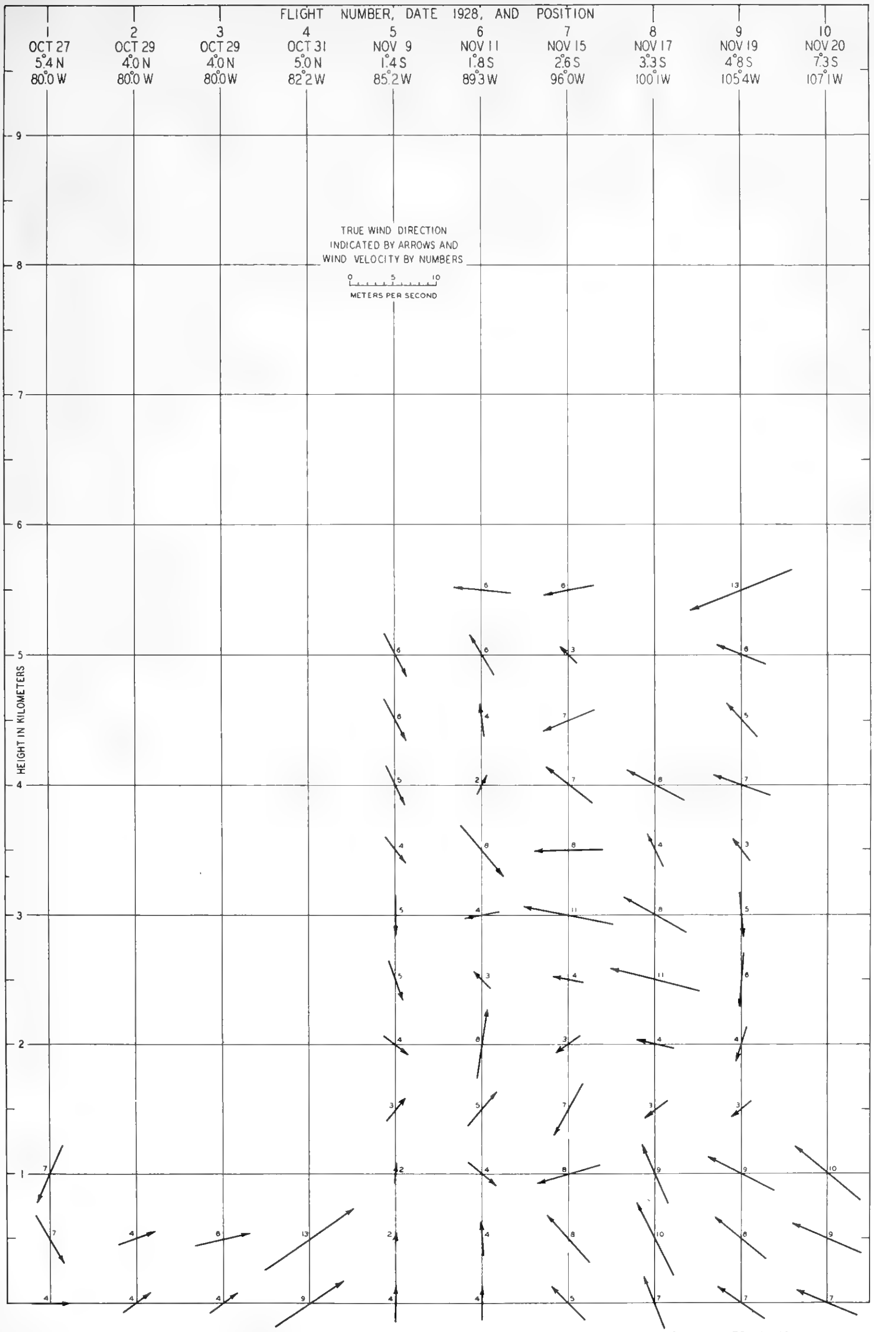


FIG. 28—WIND DIRECTIONS AND WIND VELOCITIES, PACIFIC OCEAN FROM CARNEGIE PILOT-BALLOON FLIGHTS, 1-10

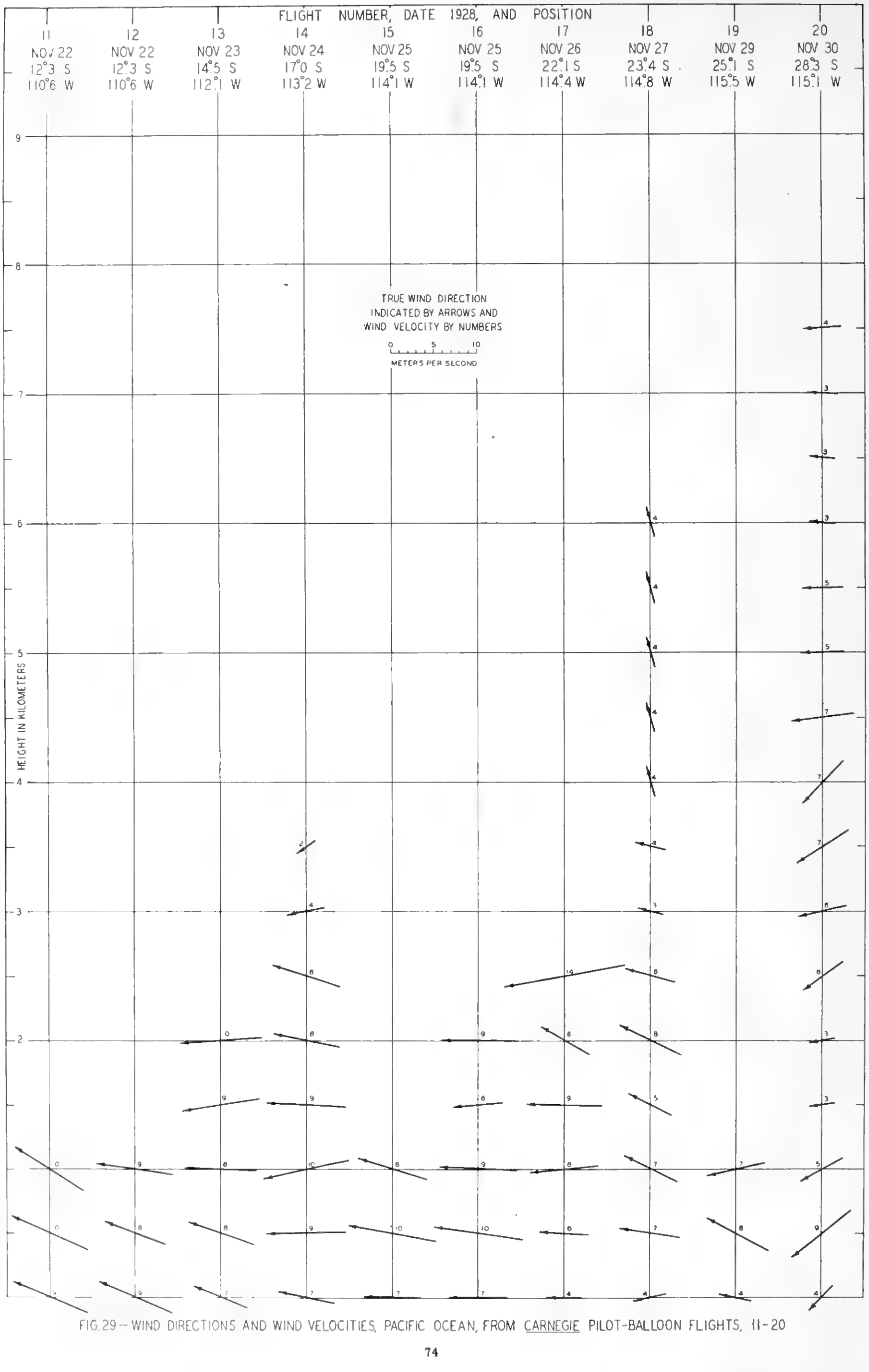


FIG. 29—WIND DIRECTIONS AND WIND VELOCITIES, PACIFIC OCEAN, FROM CARNEGIE PILOT-BALLOON FLIGHTS, 11-20

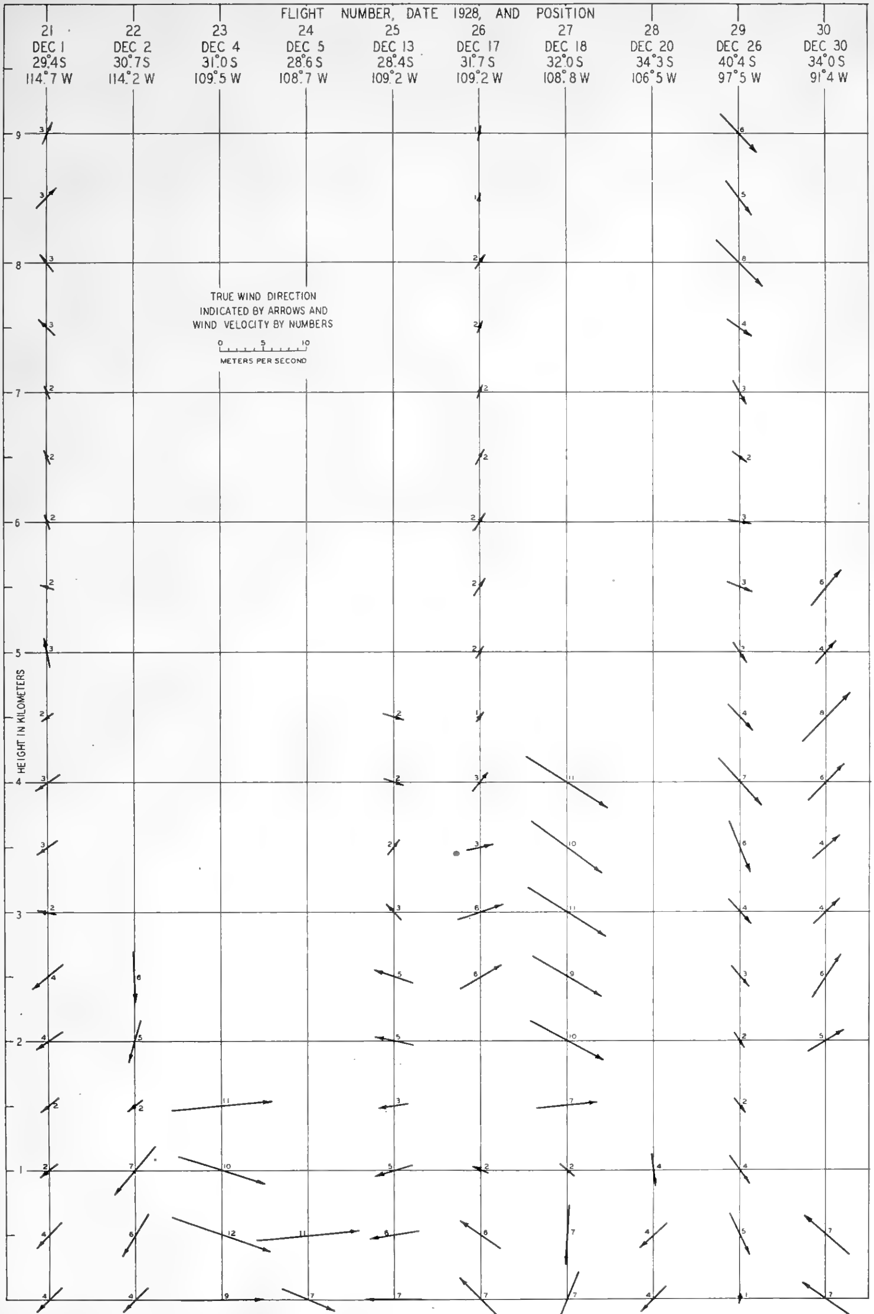


FIG. 30—WIND DIRECTIONS AND WIND VELOCITIES, PACIFIC OCEAN, FROM CARNEGIE PILOT-BALLOON FLIGHTS, 21-30

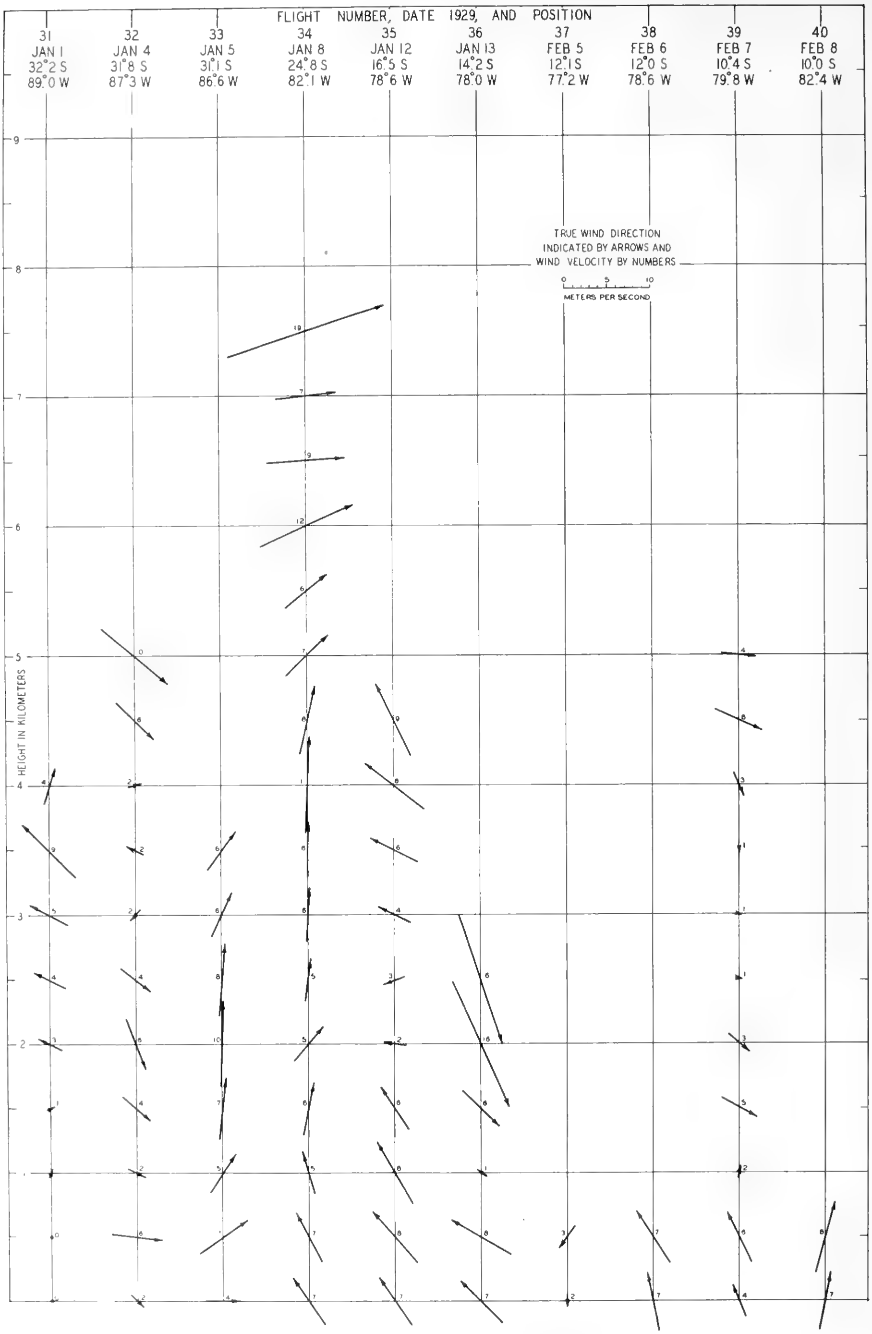


FIG 31—WIND DIRECTIONS AND WIND VELOCITIES, PACIFIC OCEAN, FROM CARNEGIE PILOT-BALLOON FLIGHTS, 31–40

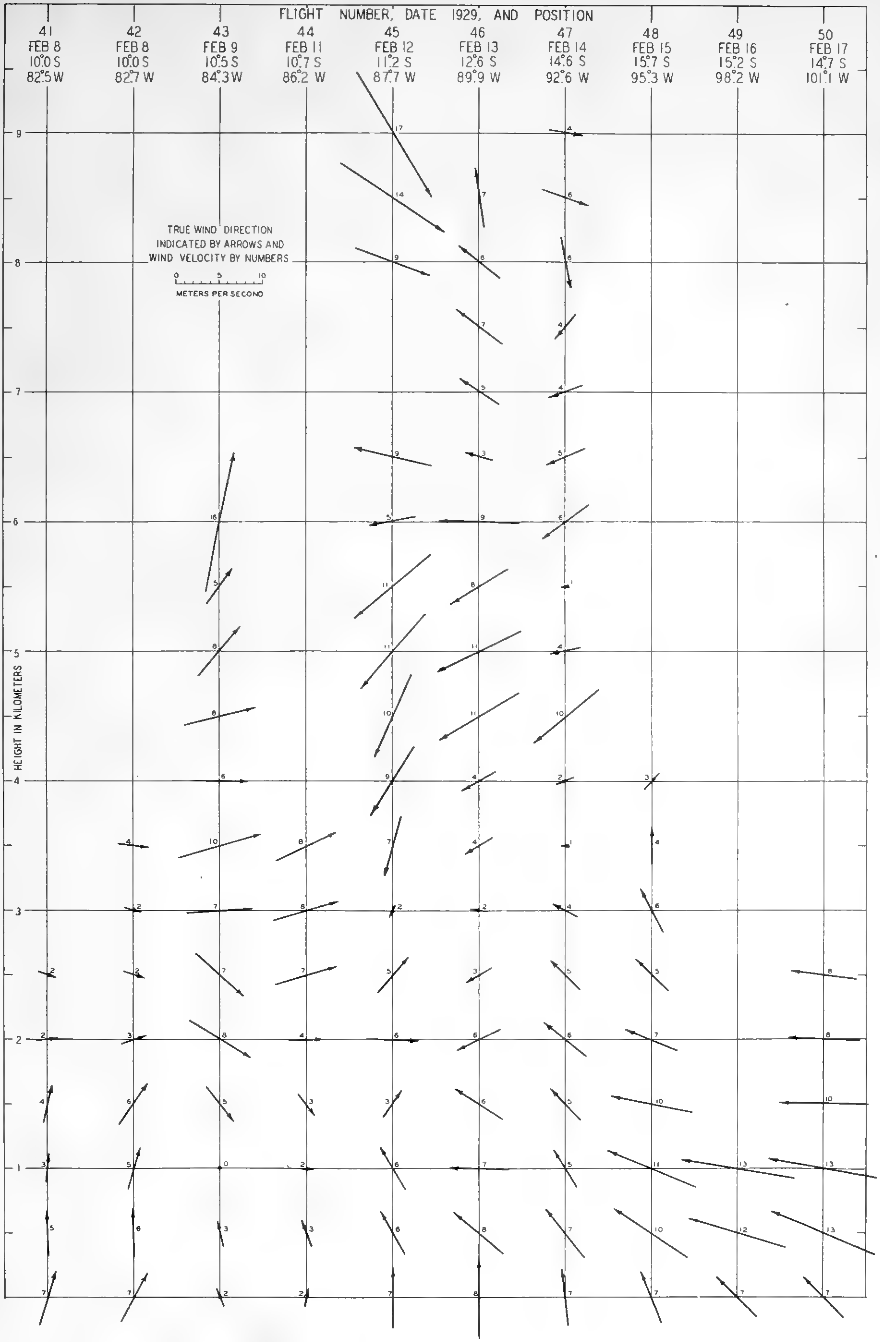


FIG. 32—WIND DIRECTIONS AND WIND VELOCITIES, PACIFIC OCEAN, FROM CARNEGIE PILOT-BALLOON FLIGHTS, 41-50

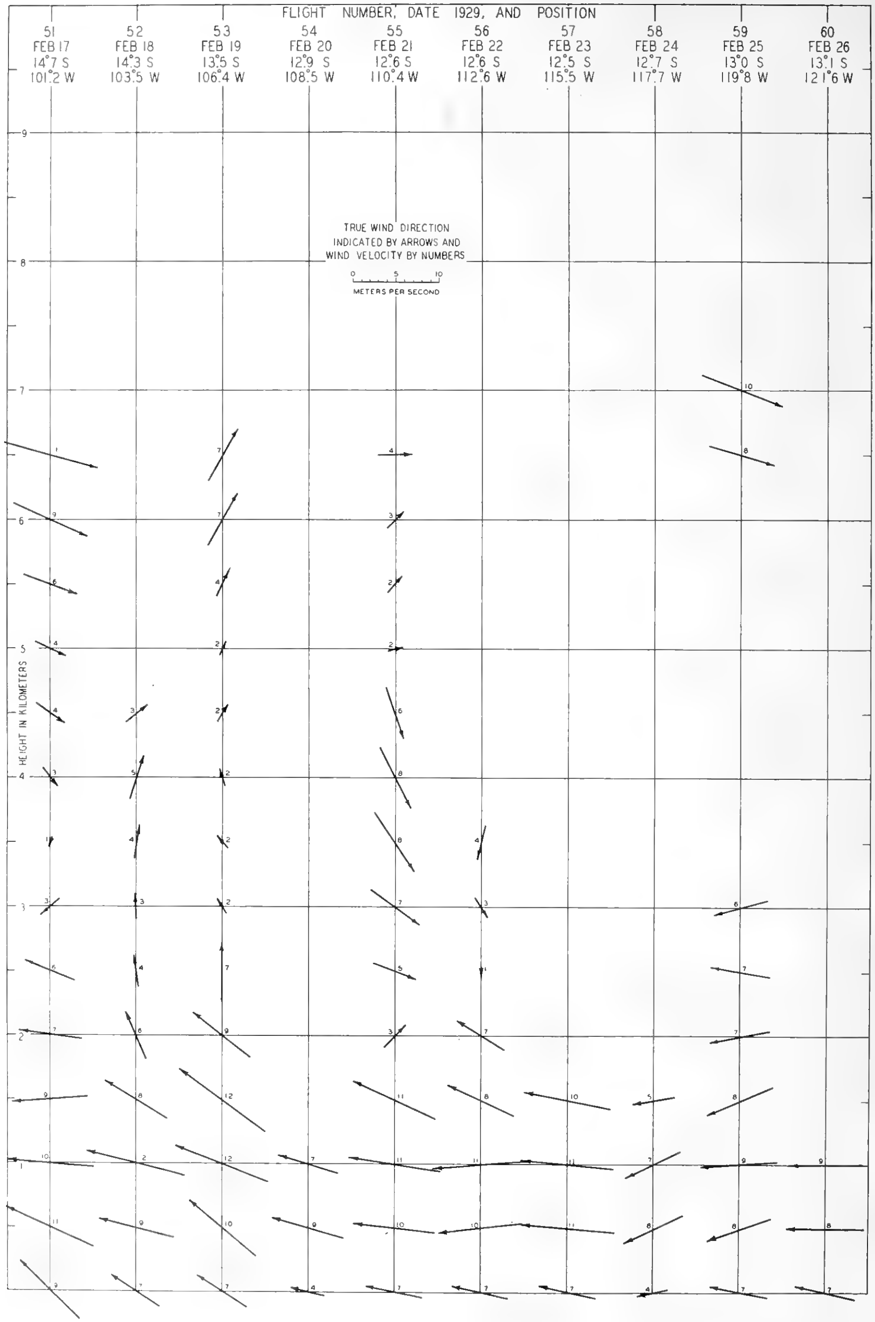


FIG 33—WIND DIRECTIONS AND WIND VELOCITIES, PACIFIC OCEAN, FROM CARNEGIE PILOT-BALLOON FLIGHTS, 51-60

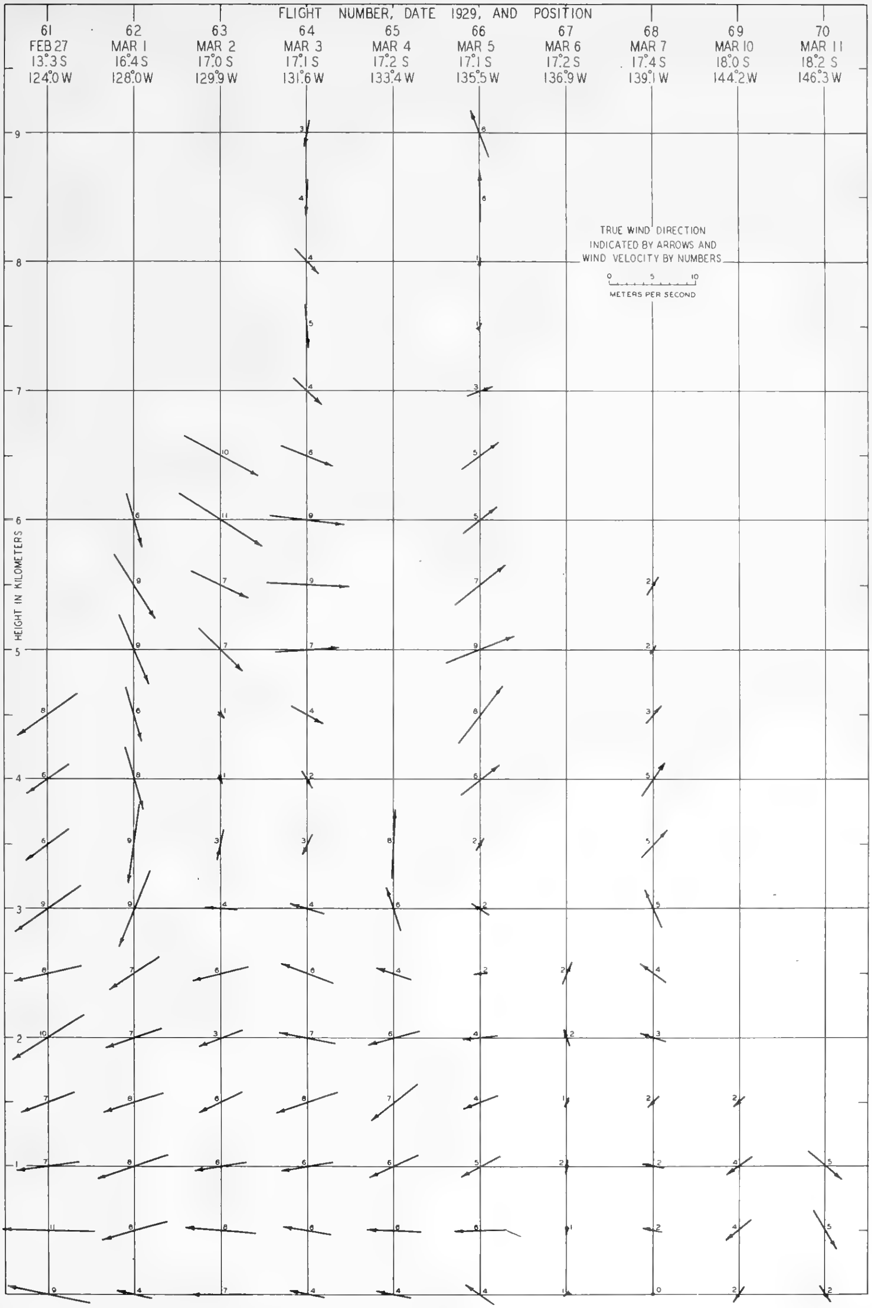


FIG. 34—WIND DIRECTIONS AND WIND VELOCITIES, PACIFIC OCEAN, FROM CARNEGIE PILOT-BALLOON FLIGHTS, 61-70

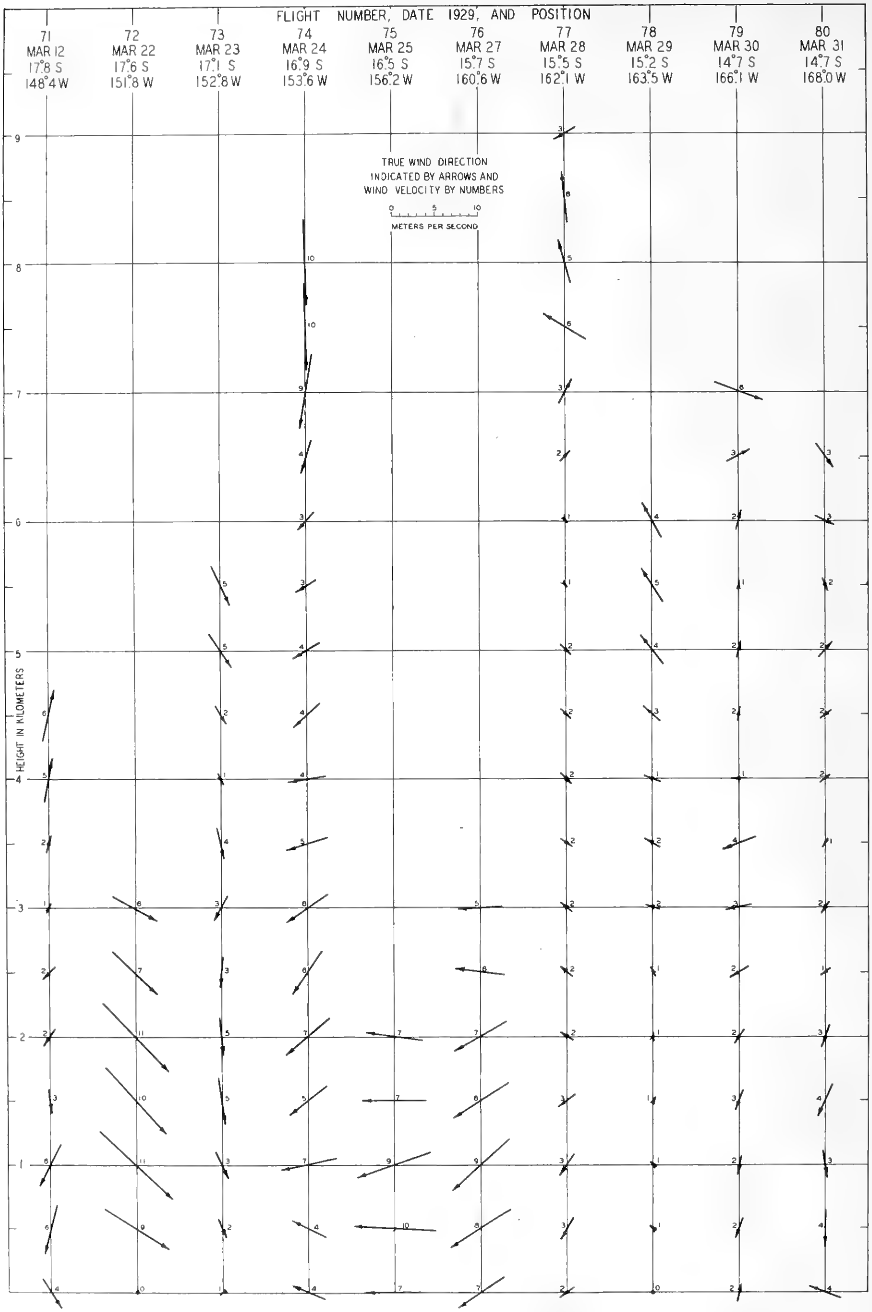


FIG 35—WIND DIRECTIONS AND WIND VELOCITIES, PACIFIC OCEAN, FROM *CARNEGIE* PILOT-BALLOON FLIGHTS, 71-80

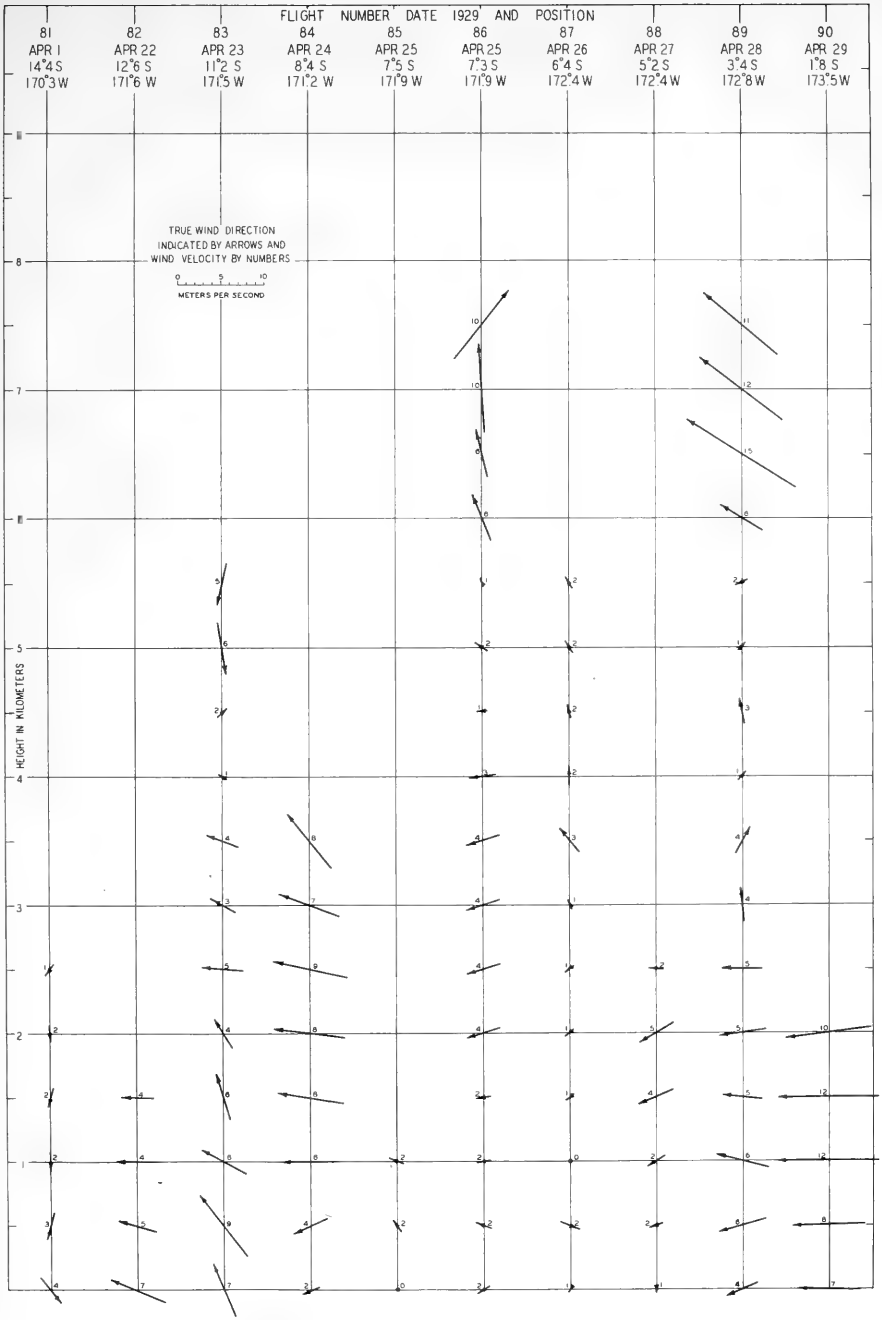


FIG 36—WIND DIRECTIONS AND WIND VELOCITIES, PACIFIC OCEAN, FROM <u>CARNEGIE</u> PILOT-BALLOON FLIGHTS, 81-90

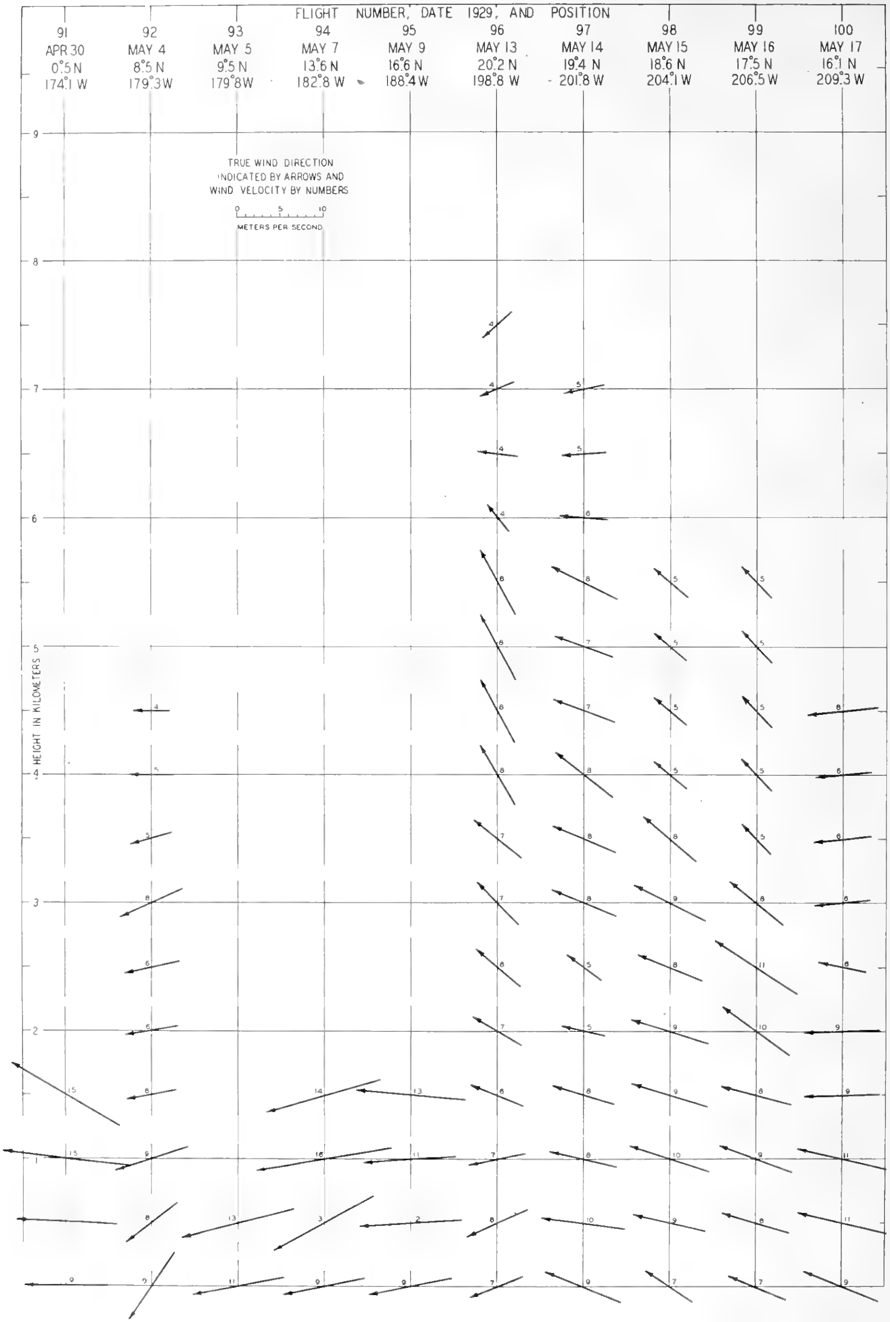


FIG 37 — WIND DIRECTIONS AND WIND VELOCITIES, PACIFIC OCEAN, FROM CARNEGIE PILOT-BALLOON FLIGHTS, 91-100

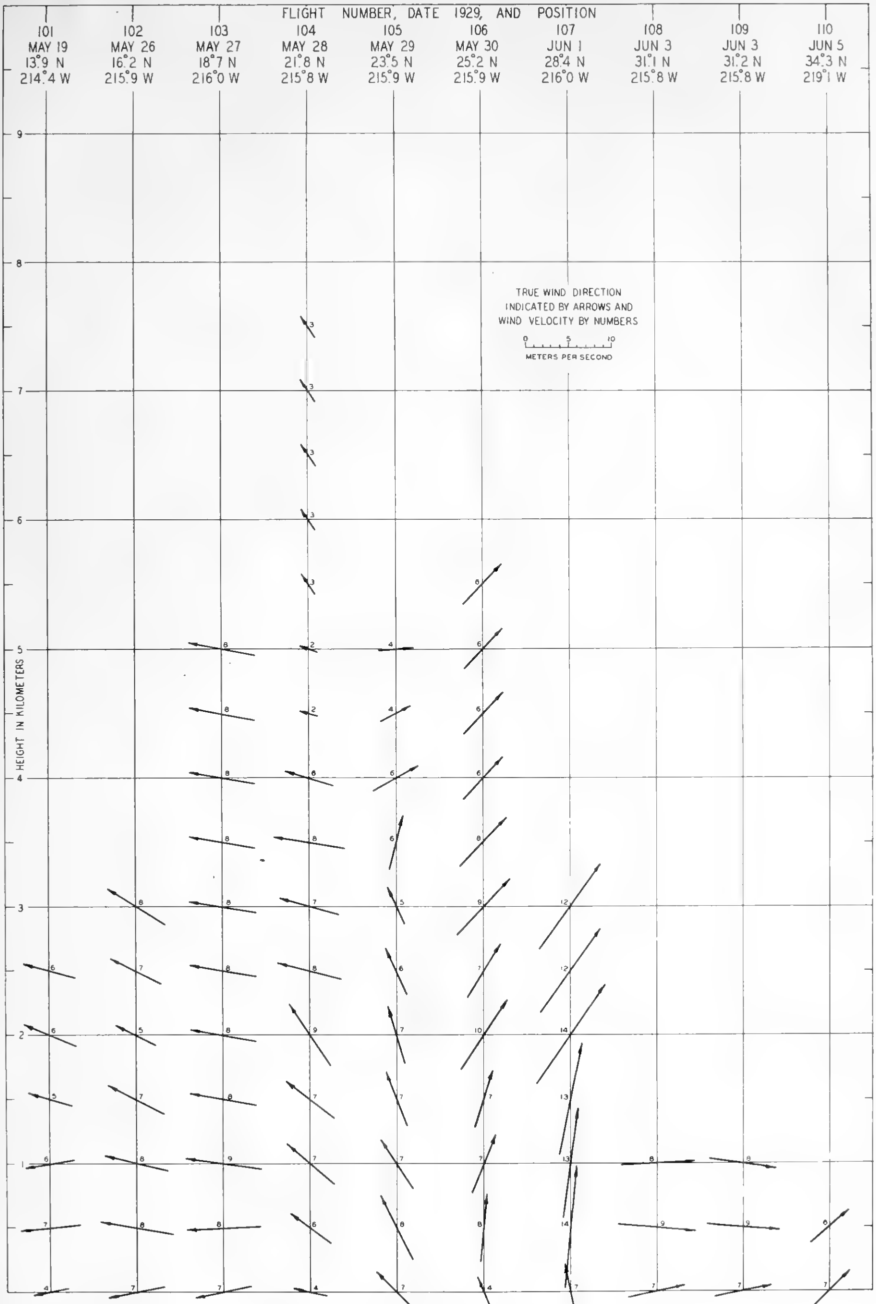


FIG. 38—WIND DIRECTIONS AND WIND VELOCITIES, PACIFIC OCEAN, FROM CARNEGIE PILOT-BALLOON FLIGHTS, 101–110

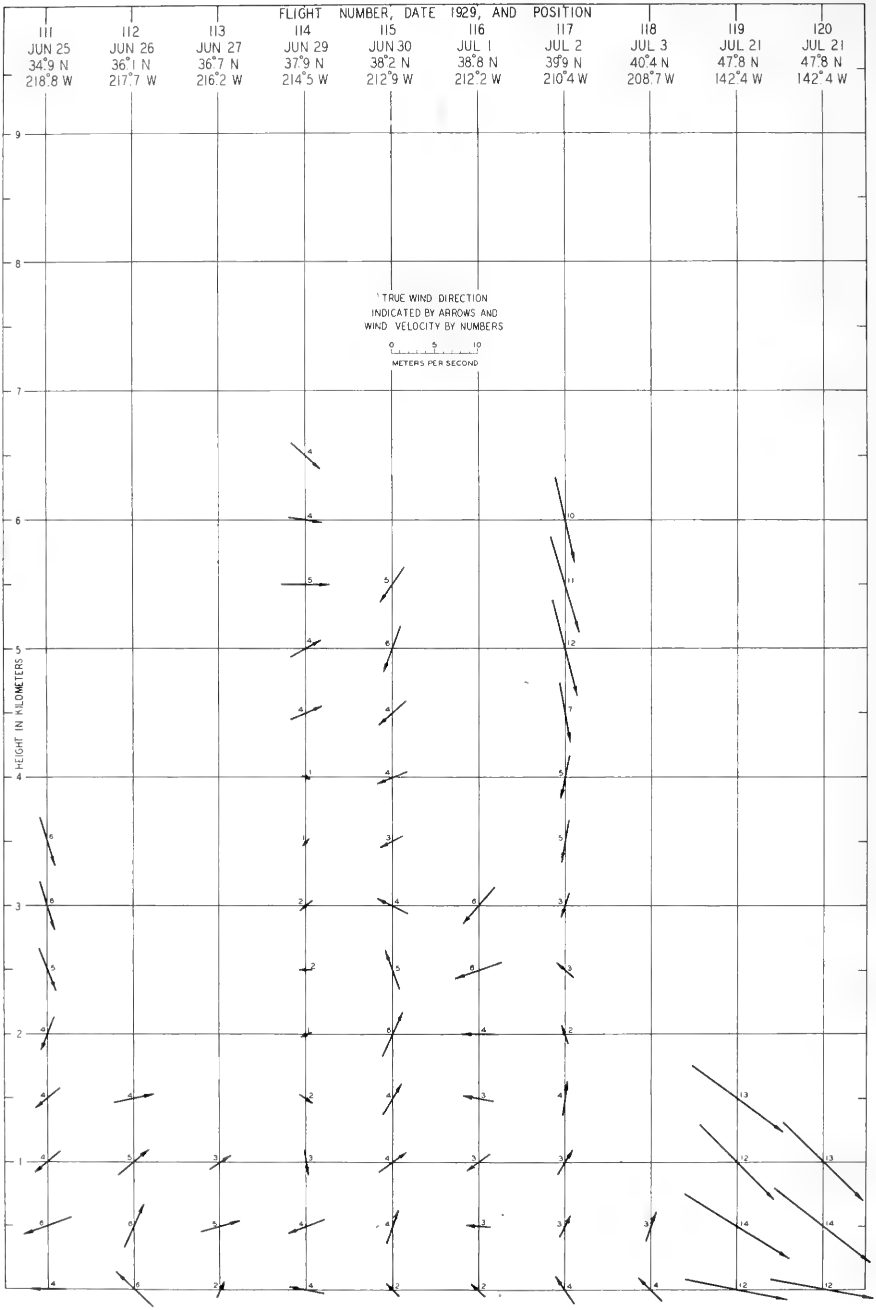


FIG. 39—WIND DIRECTIONS AND WIND VELOCITIES, PACIFIC OCEAN, FROM CARNEGIE PILOT-BALLOON FLIGHTS, 111-120

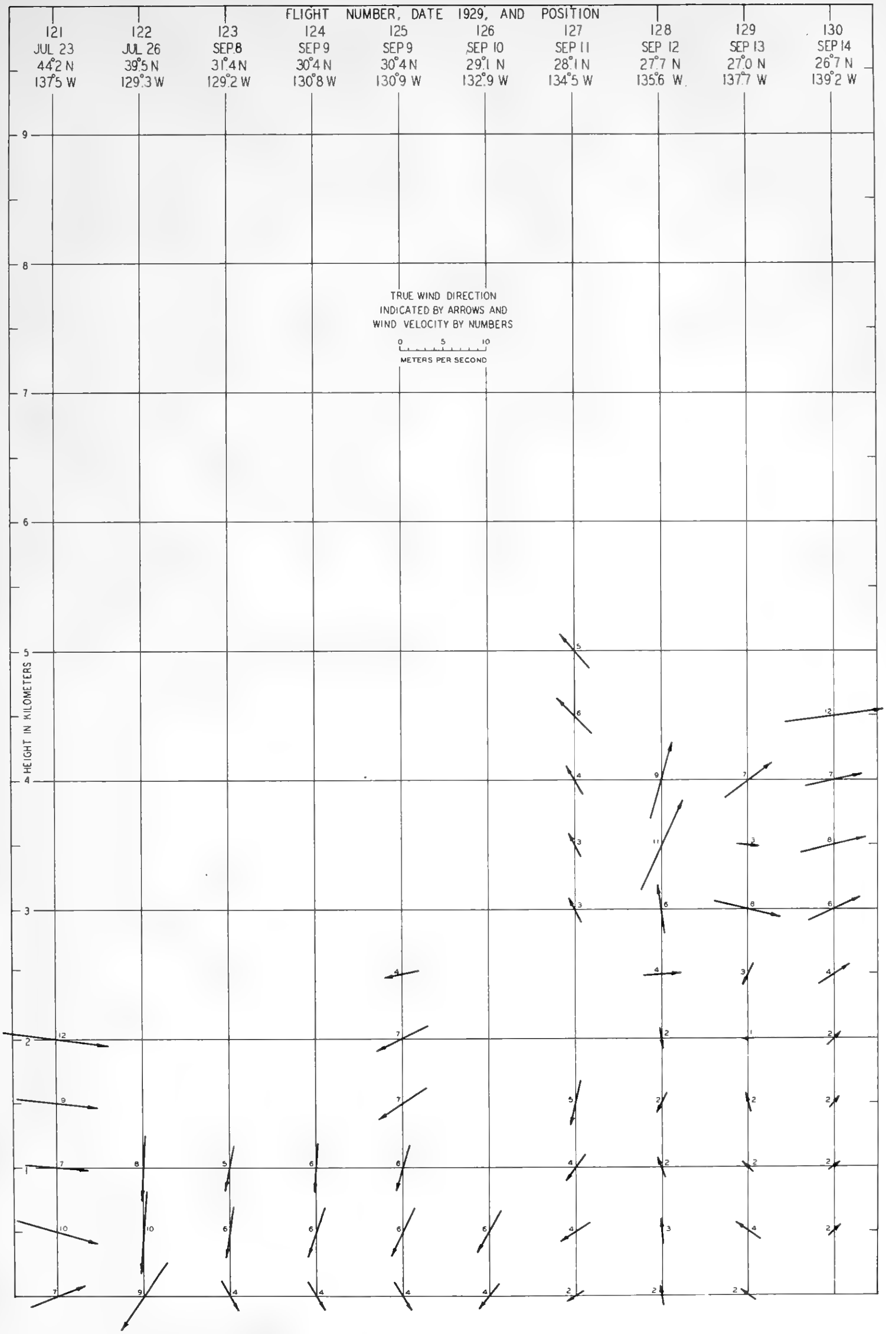


FIG. 40—WIND DIRECTIONS AND WIND VELOCITIES, PACIFIC OCEAN, FROM CARNEGIE PILOT-BALLOON FLIGHTS, 121–130

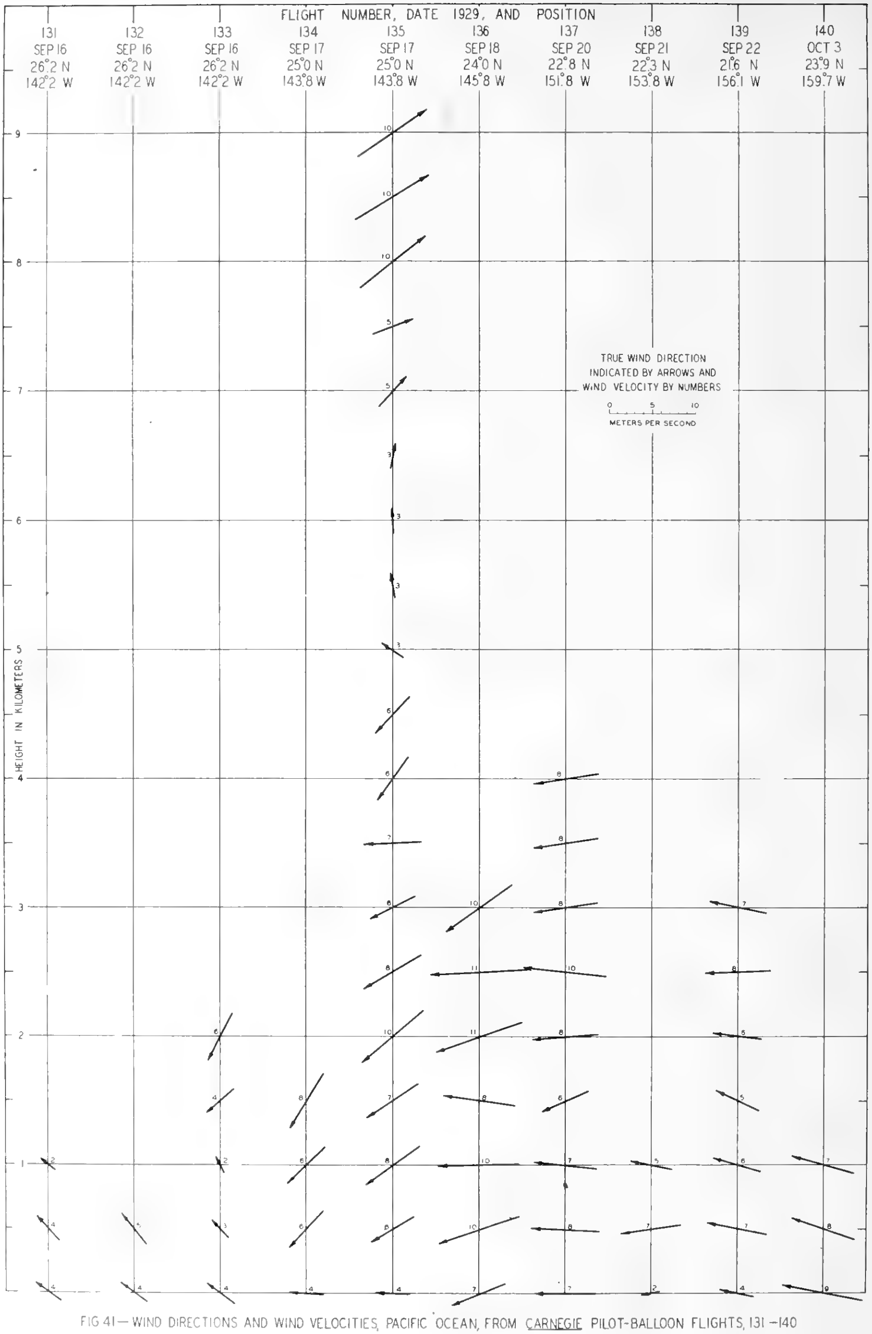


FIG 41—WIND DIRECTIONS AND WIND VELOCITIES, PACIFIC OCEAN, FROM CARNEGIE PILOT-BALLOON FLIGHTS, 131–140

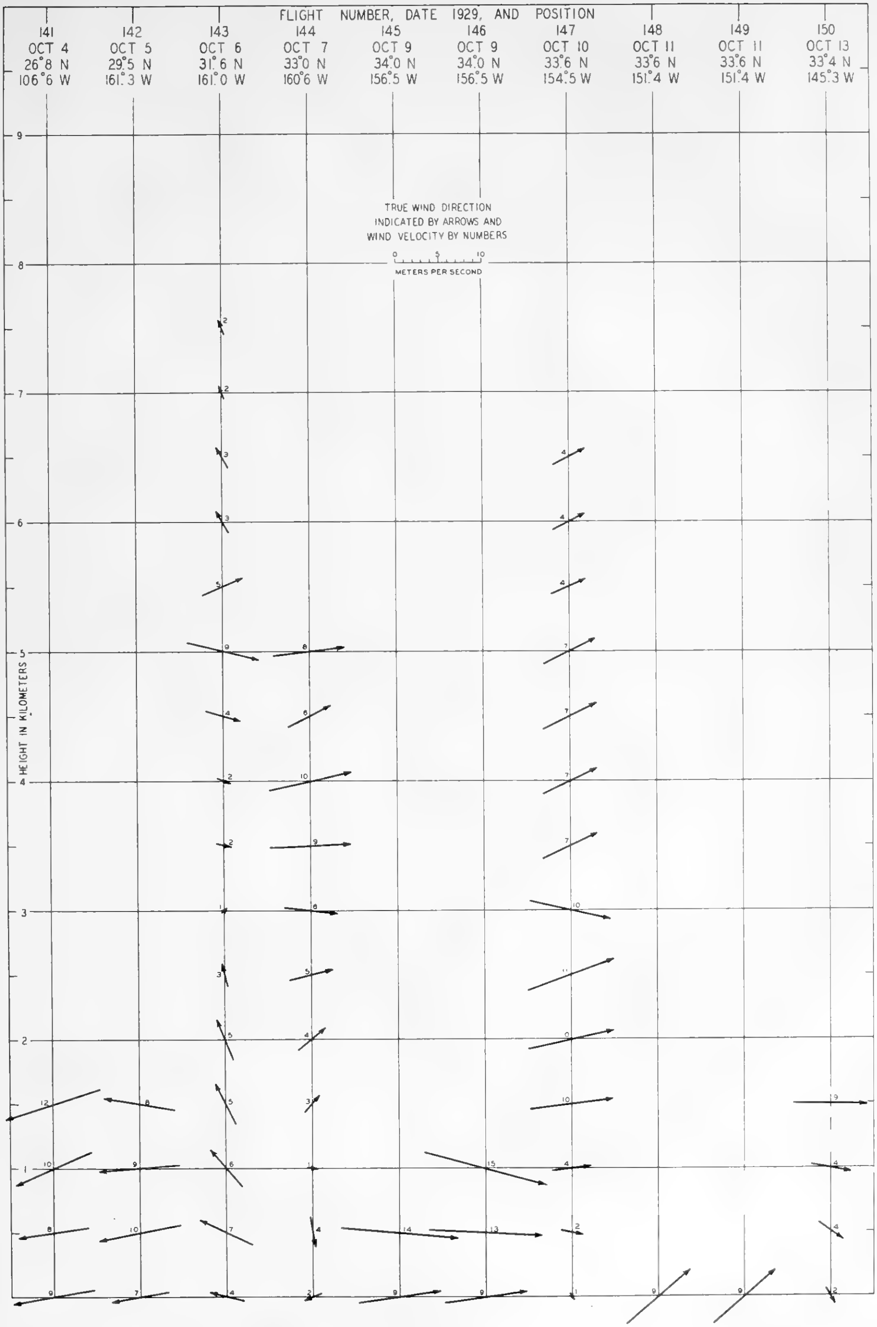


FIG 42—WIND DIRECTIONS AND WIND VELOCITIES, PACIFIC OCEAN, FROM CARNEGIE PILOT-BALLOON FLIGHTS, 141-150

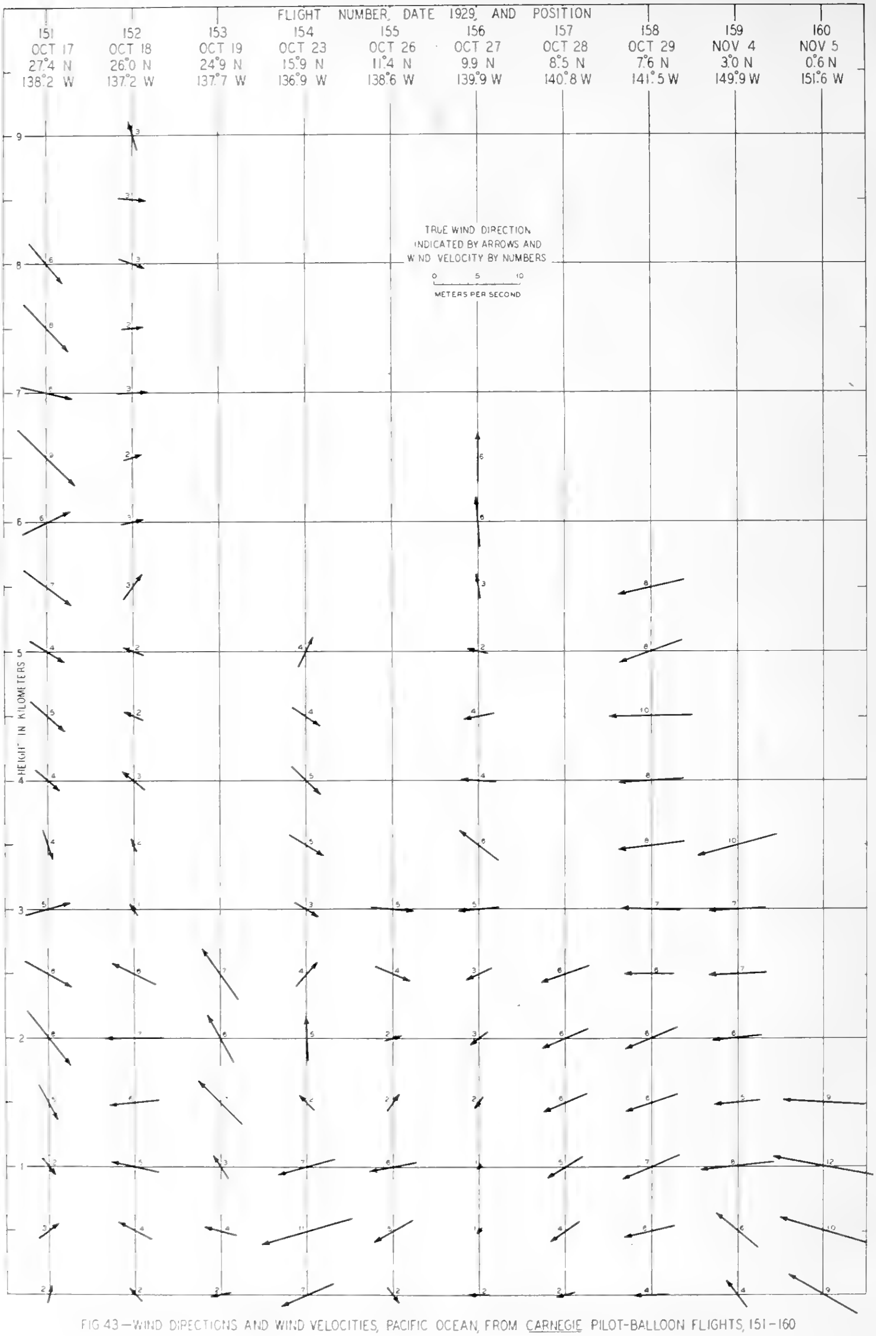


FIG 43—WIND DIRECTIONS AND WIND VELOCITIES, PACIFIC OCEAN, FROM CARNEGIE PILOT-BALLOON FLIGHTS, 151-160

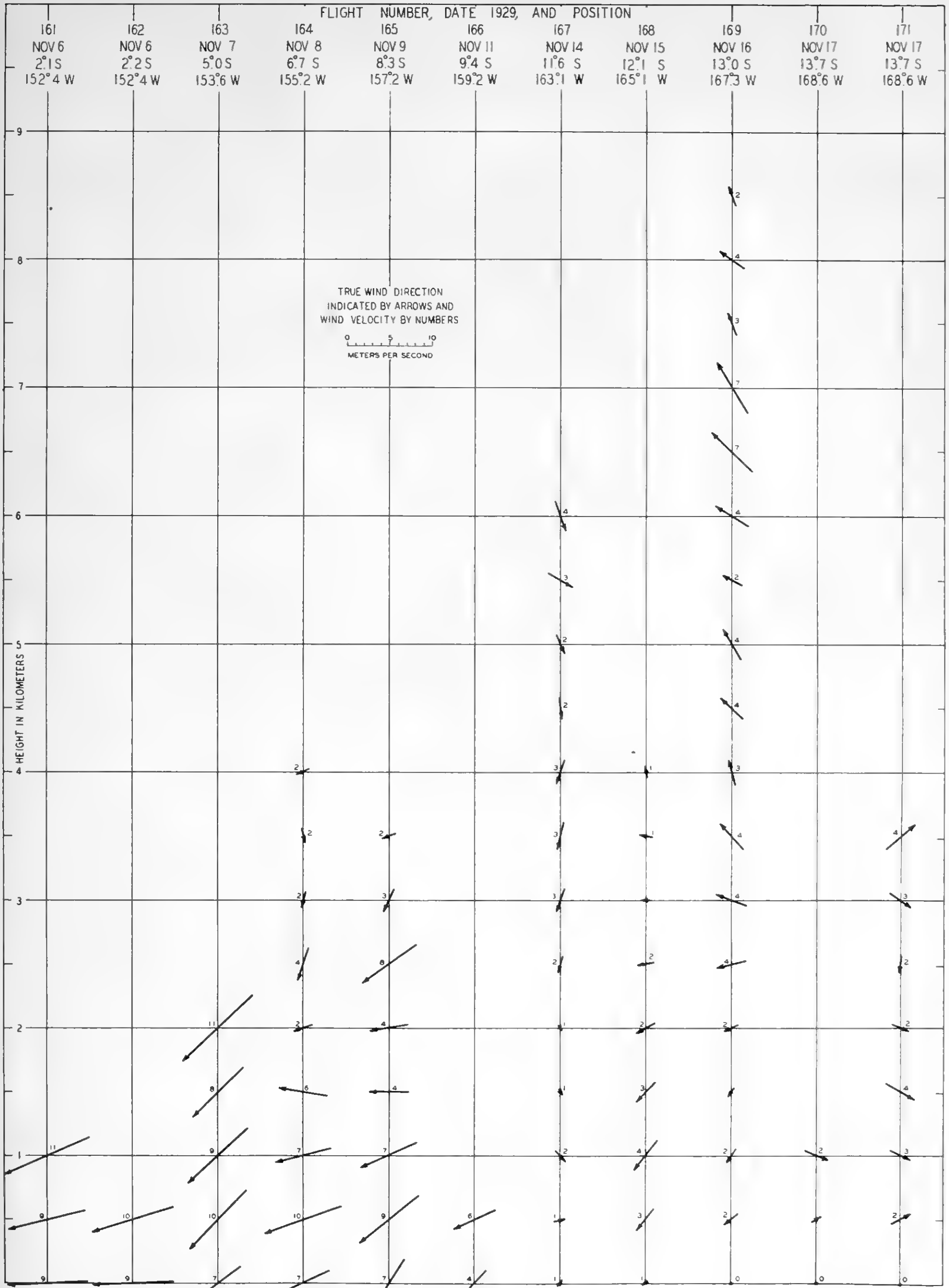


FIG 44—WIND DIRECTIONS AND WIND VELOCITIES, PACIFIC OCEAN, FROM CARNEGIE PILOT-BALLOON FLIGHTS, 161–171

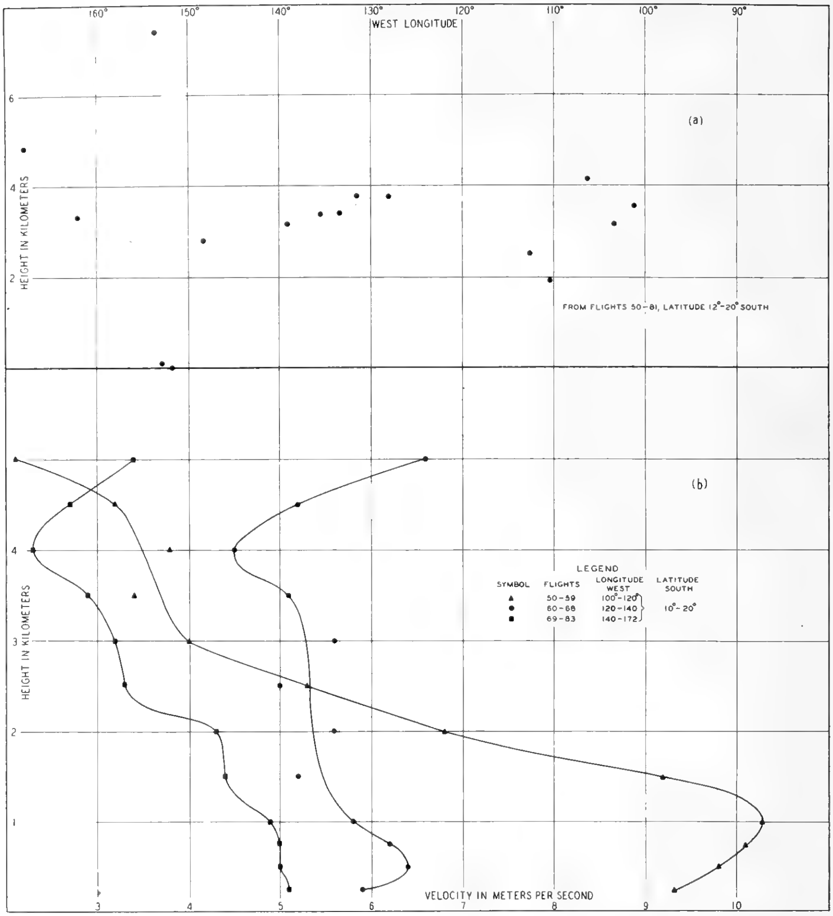


FIG 45— (a) HEIGHT FIRST APPEARANCE WEST-WIND COMPONENT (b) VELOCITY UPPER WINDS FROM CARNEGIE PILOT-BALLOON FLIGHTS, PACIFIC OCEAN, 1929

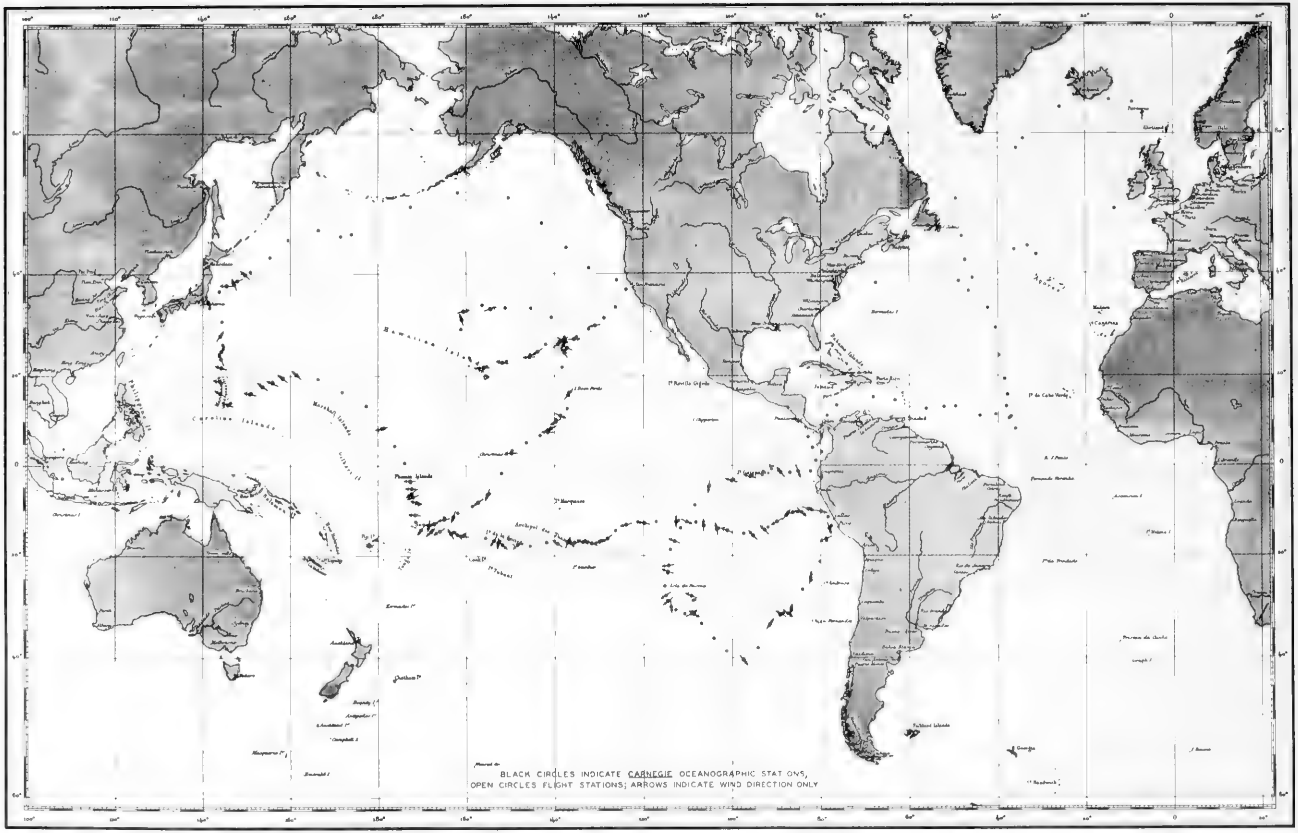


FIG. 46—WIND DIRECTIONS AT HEIGHT 2.5 KILOMETERS, PACIFIC OCEAN, FROM CARNEGIE PILOT-BALLOON FLIGHTS, 1928–1929

INDEX