LATEST ADVANCES IN WEATHER FORECASTING AT A LONG RANGE BY SUNSPOTS AND PLANETARY POSITIONS

JEROME S. RICARD, S. J.

Reprinted from Popular Astronomy, Vol. XXI, No. 3
March, 1913

LATEST ADVANCES IN WEATHER FORECASTING AT A LONG RANGE BY SUNSPOTS AND PLANETARY POSITIONS.

JEROME S. RICARD, S. J.*

The sunspot is not yet fully understood, nor is meteorology, nor planetary influence, nor electromagnetism. However much we may imagine we know about these subjects, no well-trained mind can deny that much more remains to be learned. Hence we do not feel disposed to agree with those who say these fields have been investigated and found wanting so much that our knowledge of the causes of phenomena remains in the *statu quo* of the old ignorance. Much more is now known of the sunspot than, say, ten years ago, thanks to Dr. Hale of Mt. Wilson and his devoted and learned staff, not to mention others in and out of the United States. Meteorology, too, has advanced to a knowledge of causes undreamt of before, and our wireless systems of telegraphy have opened new avenues of indefinite progress. Planetary influence on both sun and earth has been subjected to rigid tests and marvelous results have been obtained.

Hence it were but little surprise if at no distant date, there were a complete turning of tables. The very men, who had been, as it were, relegated to an obscure corner and belittled as aspirants to scientific treasures beyond reach, will be the very ones that a grateful posterity will hail as benefactors of the race. We have special reference to such painstaking students of nature as have spent from ten to fifty years of their useful lives in tracing the complicated phenomena of astronomy, meteorology, seismology and biology to their proximate and ultimate causes, and yet have been so modest as to avoid self-assertion and even publicity during the experimental period of their proceedings.

Not only is the sunspot now better known in itself, but also in its relation to aero-physics, the jealous department where every man is wiser than his neighbor and the mixed up total of individual wisdoms, if only photographed, might be exhibited as the picture of general unknowableness. The modest quota contributed by the Santa Clara Observatory may be described as follows:—

As long as the period of maximum frequency of sunspots lasted, a desire for simplicity of view and result dictated that we should confine ourselves to a study of the western limb, which had at first attracted

* Director of the Observatory, University of Santa Clara, California.

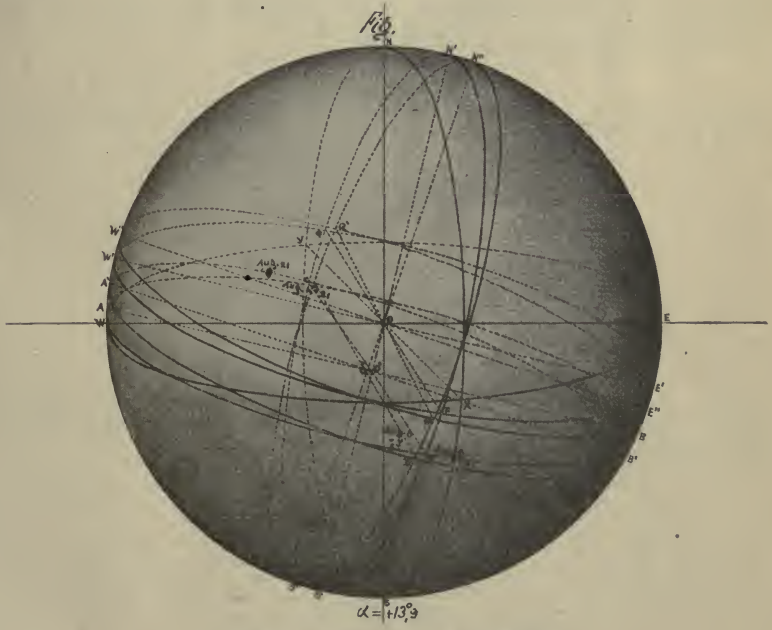
our attention as the scene of coincidences between disturbances on the sun and disturbances on the earth. As a result of a simple but very direct investigation, which we have carried on uninterruptedly since the year 1900, when an 8-inch equatorial was installed, the 3-day law concerning the western limb was found to hold generally and in consequence we published it. Of this article in Popular Astronomy April 1911, 1100 copies were ordered by W. T. Foster of Washington for free distribution among friends, including astronomers and meteorologists of note, and a translation into French was made by Jean Mascart then of the Observatory of Paris, now Director of the Observatory of Lyons.

At that epoch of our pioneering, it sounded passing strange that the western limb should thus appear to be in direct communication with the western coast of the United States in preference to any other coast that we had knowledge of. And it was only natural that certain reflecting minds should put in a demurrer to what they called a theory, and we called a fact of observation, which we could not explain and did not care to explain so long as the fact stood. Meanwhile time went on and, to our great discomfort, the period of minimum frequency set in. We had been using the 3-day law, had tested it in every kind of way by issuing forecasts which, all in all, held for semi-monthly periods.

But during this time of minimum frequency there were not, except very seldom, any visible spots that we could with any degree of certainty locate as having to be at some future time, within three days distance from the western limb. Sometimes there were no spots at all; at other times, they were mere vanishing apparitions and so, on the whole, it looked as a complete denudation of the solar surface. And yet we sorely wanted some sort of sun trouble in order to forecast disturbances on the earth. Past observation came to our rescue; we had often noticed that faculae could be fairly well descried on the eastern limb, which on the way across, became lost in the effulgence of central light and finally recovered visibility within 45° or 50° from the western limb. We had noticed, too, as had other observers often before, that the so-called dark spots underwent every kind of change in the midst of facular fields. They would leap into view suddenly; become drowned the next day; and then float again the following day. Witness the little spot in the faculae of October 20, 1912.

We therefore arrived at the conclusion that a solar disturbance, once started, would continue until it was supplanted by a new one, or until it got a new lease of life from a new cause that came into play, thus making the old focus of disturbance the seat of the new one. Nodon of the astronomical society of Bordeaux had noticed the same thing. However it would cost nothing to experiment, and note the results and observe what help it might bring to the forecaster.

The experiment has so far proved a great success, the reality having always corresponded to anticipation and this not only with regard to the western limb, but the eastern limb also and the central meridian both in front and in back. By this new discovery the task of forecasting earth's weather by the sun's weather, if the expression be allowed, becomes mere child's play and the weatherman can plunge as deeply into the future as prudence may dictate. There will always be difficulties from new disturbances on the sun, which might occur so far out of place as to upset the previous calculations. Hitherto our limit of forecasting has been one month, during which, and especially at the end of which, failure or success is carefully ascertained from the weather map. If any slips have occurred, an investigation immediately follows and it shows constantly that one solar disturbance had been overlooked or another had set in out of harmony with the one or the ones that had been used as bases of calculation. But what is worthy of note in this connection, is that a recalculation, by the 3-day law applied universally, based on the omitted spot or the new one, brings a result that is entirely in harmony with the dates of the real meteorological events of the past month.



AN ISOMETRIC PROJECTION OF THE SUN

Showing the group of August 8, 1910 in front and back, illustrating the method of forecasting siesmic and meteorological disturbances by the experimental theory of position. (Courtesy of Dr. A. Porta, associate observer, University of Santa Clara, Calif.)

To put the whole process in a nutshell: Observe the sun. If you see a spot or a facula, find its heliographic latitude and longitude, taking Central Meridian as the zero line. Roughly speaking, a spot takes twelve and one half days to go from limb to limb in front and a little over fourteen days from limb to limb in back (Synodic period). Or, to state the fact more pointedly, it takes six and one fourth days from eastern limb to Central Meridian on this side, six and one fourth more days from Central Meridian on this side to western limb, then seven days from the western limb to Central Meridian on the other side and finally seven more days from there back to eastern limb, traveling at the rate of 14.4 degrees a day. The longitude of the spot converted into days and combined with its rate of motion will tell at once what day of the month the spot will be three days distant from Central Meridian this side or that and from both limbs. The dates thus obtained may be set down for the appearance of new areas of low pressure, or storms, on the westernmost part of the Pacific Slope, Washington, Oregon, California, Arizona. Further investigation of the most delicate kind, promises to show how the observed latitude of the spot may be utilized for telling approximately where the storm will strike.

A few examples, not imaginary, but of actual observation, will make the calculation of stormy periods clear.

EXAMPLE I.

On Oct. 17, 1912, a facula stood one day in.	Hence it stood on
Central front .....Oct.	22¼
Western limb ..... "	28½
Central back .....Nov.	4½
Eastern limb ..... "	11½
Central front ..... "	17¾
Western limb ..... "	24
Central back .....Dec.	1
Eastern limb ..... "	8

Subtracting 3 from each one of these dates, we get the following stormy periods for this coast:—

Oct.	19¼	to	22¼
"	25½	to	28½
Nov.	1½	to	4½
"	8½	to	11½
"	14¾	to	17¾
"	21	to	24
"	28	to	Dec. 1
Dec.	5	to	8

EXAMPLE II.

On Oct. 20, another facula was 1½ days in. We have therefore:

Central front	Oct.	24¾
Western limb	"	31
Central back	Nov.	7
Eastern limb	"	14
Central front	"	20¼
Western limb	"	26½
Central back	Dec.	3½
Eastern limb	"	10½

Proceeding as in Ex. I, we get the following stormy periods:—

Oct.	21¾	to	24¾	
"	28	to	31	
Nov.	4	to	7	
"	11	to	14	
"	17¼	to	20¼	
"	23½	to	26½	
"	30½	to	Dec.	3½
Dec.	7½	to	10½	

EXAMPLE II.

Also on Oct. 17, the facula of Oct. 14 stood 1½ days from western limb. Hence:—

Western limb	Oct.	18½
Central back	"	25½
Eastern limb	Nov.	1½
Central front	"	7¾
Western limb	"	14
Central back	"	21
Eastern limb	"	28
Central front	Dec.	4¼
Western limb	"	11¼

Operating as above we have for the stormy periods:—

Oct.	22½	to	25½	
"	29½	to	Nov.	1½
Nov.	4¾	to	7¾	
"	11	to	14	
"	18	to	21	
"	25	to	28	
Dec.	1¼	to	4¼	
"	8	to	11¼	

In examples II and III, the faculae stand in such favorable positions that the results sensibly agree. Example I stands for separate storms. Accordingly in our forecast for November published on October 30, prominence is given to the periods based on faculae of October 14 and 20, while attention is also called to November 1, 8, 14, 21, 28, December 5, for either the augmenting of already extant warm waves or the approach of new ones, as per example I. A magnificent verification is just now going on, this being November 5, 1912. If there was only one facula or spot doing service for twenty-seven days, there would be only four storms during that time. But if there were several, either they would happen in critical positions or not; in the first case, the storms would coincide and intensify each other both in depth and area; in the second, they would be separate and one follow on the heels of the other at distances of 1, 2, 3 days. *

---

* The forecasts of Ex. I, II, III were from 30 to 40 days in advance. They were a strange novelty to us, requiring careful combination and segregation. The opportunity was thereby offered of making a rare test and the result has been watched with anxious care. At the present date, January 22, 1913, in compliance with a request from POPULAR ASTRONOMY, we append, in parallel columns, first, a list of the real storms, as found in the official weather chart of the U. S., which occurred from October 19 to December 5, 1912, and, second, a list of dates announced from mere solar observation covering the same period, The agreement between reality and prognostication appears to be so exact that the error if any is either negligible or explicable. It all seems a great triumph for sunspots and likewise for planetary meteorology, since the planets are successfully used in getting the same dates quite independently and also in forecasting solar disturbances.

EXAMPLES I, II, III, COMBINED AND ORDERED.

The Weather Map	*By Sunspots*
Oct. 19 – 23	Oct. 19 – 22
" 24 – 26	" 25 – 28
" 28 – 30	" 28 – 31
Nov. 1 – 3	Nov. 1 – 4
" 5 – 7	" 4 – 7
" 8 – 9	" 8 – 11
" 11 – 15	" 11 – 14
" 18 – 20	" 18 – 21
" 20 – 21	" 21 – 24
" 25 – 27	" 25 – 28
" 27 – 28	" 28 – Dec. 1
" 28 – Dec. 3½	" 30 – Dec. 3
Dec. 5 – 8	Dec. 5 – 8

The above cannot be mere coincidence, far less guesswork.

The result of the new experience briefly amounts to this:—

There are in all four *critical* positions: three days before the spot reaches the western limb; three days before the spot reaches the Central Meridian in back; three days before the spot reaches the eastern limb; three days before the spot reaches the Central Meridian in front. We mean to say that when a solar disturbance reaches any one of these four positions, a new storm arrives on the Pacific Coast, either rising from the ocean directly or descending from Alaska or ascending from the mouth of the Colorado in Baja California.

The anomaly of Western limb being alone responsible for storms on this Coast and thence over the whole or part of the United States, is thus removed and we have instead one harmonious whole governed by the three-day law. This great fact is the solid foundation on which rests the claim, made by a respectable number of serious scientists, that the connecting link—the *causa intermedia*—between sun and planets is electromagnetism, which, while knowing no distinction between front and back, has its own peculiar laws of action that set at naught the views of the uninitiated. With a view to remove a number of well-meant difficulties, we beg leave to offer the following remarks:—

The idea that a sunspot is a cosmic cause, the effect of which, if any, must be equally distributed throughout the whole earth, is adhered to with the greatest tenacity. It is, as it were, the rostrum from which certain otherwise very estimable writers deliver their elegant sentences to the admiring throng beneath. Otherwise stated the principle is this: the sunspot is a universal cause; therefore its effect, if any, must be universal. Hence if it causes magnetic storms, earthquakes, aurorae atmospheric upheavals, these have to cover the whole earth. But as they never do so, the inevitable conclusion follows that it has nothing to do with them.

How this idea got to be so wide-spread and deep-rooted is hard to understand. Possibly it may have arisen as certain other popular errors, now condemned by science, have arisen; viz, we generally believe the reports of our senses even in regard to objects which transcend their capacity and we do not pause long enough to apply to them the ordinary criteria by which the reason tests the data of experience. We see for instance how the sun sheds its light wherever no obstacle intervenes; we see, too, how the sunspot looks down on the whole earth and then the unwarranted conclusion comes that as the light penetrates everywhere, so the sunspot, if at all efficient, must have its effect visible everywhere. Unfortunately this hurried conclusion belongs to the sensible order and deals with an object with regard to which the senses may deceive, and should therefore be distrusted until the reason, after due examination, approves of their decision. It is to be feared that

otherwise very respectable scientists may not be careful enough to see whether this inference agrees with the findings of scientific observation. They would thus be in danger of accepting it too hastily as an axiom on which to base themselves while discussing the possibility or impossibility of foretelling, not only the weather but also earthquakes, from the presence of sunspots in general or in certain positions.

While personally we take no special interest in that so-called axiom, since our method of forecasting prescinds from it and depends entirely on the physical basis of observation and has nothing to do with the metaphysics of the case, yet, as we have time and again noticed that certain writers and speakers, whose turn of mind brings them to pay attention to the feeble attempts we have made in forecasting, show an inclination to go much more by that axiom than by the encouraging results so far achieved, we have thought it worth while to dwell somewhat upon this matter and offer some helpful reflections that may pave the way to a better understanding.

First of all, we could direct attention to another and less doubtful axiom, namely that "Whatever is received follows the manner of being of the recipient", which is sufficiently evident in itself and the application of which presents no difficulty. Thus spoke the schoolmen. In more intelligible language, we might possibly say. "The reception of the influence of a given activity depends very much, sometimes entirely, on the form, nature, situation and disposition of the recipient." In the light of this axiom, even on the admission of the universality of solar causation, sunspots included, it would not follow that the effect must be everywhere and equally distributed on the whole earth, because the receiving subject might not be disposed at all or very differently disposed in different localities. Those who attribute every weather change to purely local influences under the general agency of the sun, fully understand the pertinence and value of this remark: magnetic and electrical conditions, topography, altitude, air distribution, moisture, present temperature, geological conditions, are all different. The axiom is well recognized in physics in the *law of cosines* for radiant heat and the intensity of light. One has only to glance at the formula $I = \frac{Q}{D^2} \times \cos h$ to see how the reception of solar radiation of both heat and light is enormously affected by the distance and the angle of the receiving surface.

In the above equation,*

* Vid. Ganot's Physics, 15th Ed., Art. 421; Young's Gen. Astron. rev. Ed., p. 136.

I = intensity of the effect,
Q = amount received, per unit area,
D = distance of the cause,
h = angle between impingent activity and the normal to the receiving surface.

Class-room formulae, however, might be questioned when transferred to the immensely greater laboratory of nature. For instance in December the sun is nearly 3,000,000 miles nearer to us than in July. If therefore a thermometer could be properly installed anywhere in our latitudes so that the receiving surface was normal to the incident ray, it would be warmer in December than in July. Of course, the experiment has not been tried; but if it were, we feel rather skeptical about the result. At any rate, physical science admits the axiom quoted, and this is sufficient for our purpose.

Another idea that should claim attention is the fact that if, as is generally done, we suppress altogether any external influence except the general effect of the sun upon the earth, and therefore fall back entirely upon mere local agencies for the formation and advance of storms, one is at a loss to see how particular agencies of a mere local character can account for the transcontinental and even trans-oceanic character of many of our terrestrial storms. For instance, how will you explain that a big storm in the northwest, say west of Alaska, will descend upon the States of Washington, Oregon, California and even Arizona, then cross over the Rocky Mountains, the prairie, the Eastern States, plunge into the Atlantic Ocean and finally invade Western Europe, unless we suppose similar agencies always of a local character are to be found all along the track of the storm-center? But an alignment of such purely local causes, conspiring to give us a storm of the above-mentioned sort, is not only not likely, but is actually disproved by the daily meteorological observations of the Weather Bureau, taken simultaneously right along the track of all the storms that pass over the United States. The obvious inference is that every storm, far from being originated by local influences or conditions, does itself originate its own conditions and carries them along with it. The next inference would seem to be that a cosmic cause, one altogether foreign or external to the earth, is the parent of our atmospheric disturbances and that, general in character though it may be, there is some other force in the recipient than a mere local affair which defines, particularizes, and localizes the Cosmic force, in spite of any universal character that one may be pleased to endow it with.

Hence one who reasons is inclined to wonder somewhat at the hastiness of those who jump at conclusions regarding matters so complex and so recondite that they have baffled the many efforts of honest and

laborious scientists of the present and past centuries. But the wonderment increases and rises rather high when we see such representatives of science as Professors Lagrange of Belgium, Gockel of Germany and Nordmann of Paris, either openly or covertly, declare that sunspots being a general, universal, cosmic cause, it is futile to appeal to them with a view to account for certain terrestrial phenomena, such as weather and earthquakes, which are always more or less local.*

Relying on the apparently solid basis that a universal cause must needs have a like effect, they gravely tell us that if, by sunspots or what amounts to the same, critical planetary positions, it rains in Portland, Oregon, it should also rain in Santa Clara, Calif. Or if a hurricane rages at Acapulco it must also rage in Cuba and Porto Rico. The conclusion is forced beyond due limit, exaggerated, illogical to a degree, so much so as to constitute a case of *non sequitur.* We are not aware that any trained meteorologist or habitual observer of the sun in its various aspects, has ever dared go so great a length.

In the third place, it might be urged that a twelve year experience at this observatory has traced an invariable connection between sunspots, dark or brilliant white, with the advent of new storms on the Pacific Coast, and that as these storms are very particular and definite as to depth, area and track it follows that in virtue of the invariable connection just mentioned, either the spots themselves are particular definite causes, or if they are general causes, their influence is defined and particularized by some terrestrial force which is not merely local; or, if it be urged that other storms are simultaneously started in other parts of the world, which a wider experience will no doubt prove to be true, yet each of them is still certainly definite and particular in depth, area and track, and does not cover the whole earth as it is claimed it should, if our conclusions are true. The above is equally cogent if applied to the planets in certain definite positions which are claimed by nearly all philosophical meteorologists to be the simultaneous causes of spots as disturbances on the sun, and of storms on earth as disturbances in our atmosphere.

Fourthly, the sunspots are great centers of magnetic force, as shown by the most exact and delicate experiments at Pasadena, Calif., and by an entirely different method at this observatory. But the field of a magnet is very different as you pass around from one pole to the other As the earth revolves and rotates in that field, every different part of it must be differently affected. Add to this the magnetism of the earth

---

* (Vid—Bulletin de la Société Belge d'Astronomie No. 3, 1910—Scientific American Supplement, Aug. 17, 1912.—Le Matin, Paris, Sept. 8, 1912.)

itself with its poles and equator and the various agonic and isogonic, aclinic and isoclinic lines which will emphasize the difference. Thus, then, the earth and the sun with its spots are two huge magnets and the effects of neither of them single or combined are exactly the same everywhere; rather they exhibit so great and so complex differences as to demand an extension of our present knowledge of mathematics. Now it is well known that the movement of certain metallic substances in a various and varying magnetic field, generates a various and varying electric current, and conversely. It is electromagnetism, to which, in all likelihood, the variations of our weather and seismic phenomena are mostly due, a theory supported by eminent meteorologists of the most modern type and to which we feel greatly inclined as the only one that stands examination and which, it is to be hoped, every succeeding experiment will corroborate.

Thus then the reader can see for himself that the axiom under discussion, that a universal cause has a like effect, in the sense in which certain writers take it when they naively tell us that if, by sun spots it rains in Athens, it must also rain in Constantinople; or, if there is an earthquake in Patagonia, the whole earth must shake, runs amuck with physical science and ignores the facts of electromagnetism as demonstrated by Faraday, Clerk Maxwell and Ampere, not to mention other names of undisputed authority.

Once more, people seem to forget that the sunspot, dark or brilliant white, has a sidereal period of a little over twenty-five days and a synodic period of a little over twenty-seven days and that its effectiveness is as great on the other side of the sun as on this side. This repeated experiment at this observatory has abundantly proved, especially during the present period of least frequency. Once on the field, the activity of a solar disturbance lasts very long, very likely until it is replaced by another or becomes revivified by the activity of some new heliocentric conjunction or opposition, with or without a simultaneous quadrature about the line from Jupiter to Saturn. Further observation will soon furnish a solution of this last mooted point.*

On the other hand, it should carefully be borne in mind that a large number of real storms, especially during the summer of a given locality or country, will pass through altogether unnoticed: invisibly they are mighty oscillations of the barometric curve, and sensibly only a hot wave. There are no clouds, very little wind, no rain, no electric displays and yet the very substance of a storm is passing over people's heads. We would place the essence of a storm in a barometric change above

* Vid Nodon, Bulletin de la Société Belge d'Astronomie. Feb. 1912.

and below the semi-diurnal oscillation. And it may be affirmed without fear of contradiction that there is no place on earth exempt from the stormy barometric change. Barometrically speaking, there is no difference or very little difference between winter and summer; but there is always a seasonal difference in solar force, moisture and temperature.