plus 0.284 times the variation of the March pressure-difference Zikawei—Miyazaki plus 0.149 times the variation of the January pressure Sidney, N. S. W.

Table 5 presents the departures of the calculated values of the variations of the August temperature for Nemuro-Miyako from the actual values.

TABLE 5. *Differences between the calculated and actually observed values of* q (*variation of the mean August temperature for Nemuro-Miyako*), *as computed by the formula*

$$q=0.117x+0.284y+0.149z.$$

| Years. | x | y | z | Variation of mean August temperature Nemuro + Miyako. q | | |
|---|---|---|---|---|---|---|
| | | | | Calculated. | Observed. | Calculated − Observed. |
| | *mm.* | *mm.* | *mm.* | °*C.* | °*C.* | °*C.* |
| 1884 | −11.0 | −0.4 | −2.8 | −1.8 | −2.2 | +0.4 |
| 1885 | + 9.7 | 0.0 | +2.8 | +1.5 | +1.6 | −0.1 |
| 1886 | − 7.3 | −1.1 | +0.8 | −1.1 | +2.6 | −3.7 |
| 1887 | − 7.2 | +1.5 | −2.3 | −0.7 | −1.8 | +1.1 |
| 1888 | + 6.7 | −1.6 | +0.5 | +0.4 | −0.4 | +0.8 |
| 1889 | + 9.1 | −0.1 | +0.9 | +1.2 | 0.0 | +1.2 |
| 1890 | + 0.7 | +1.5 | +1.7 | +0.8 | +0.8 | +0.0 |
| 1891 | −11.5 | −0.5 | −2.6 | −1.8 | −1.9 | +0.1 |
| 1892 | + 3.4 | +1.0 | +0.5 | +0.8 | +1.1 | −0.3 |
| 1893 | + 1.0 | −1.4 | −2.5 | +0.1 | −0.2 | −0.3 |
| 1894 | + 6.1 | +0.4 | +1.8 | +1.1 | +0.6 | +0.5 |
| 1895 | − 8.0 | −0.7 | +1.0 | −0.9 | −1.8 | +0.9 |
| 1896 | −10.1 | +1.0 | −0.7 | +1.1 | +1.7 | −0.3 |
| 1897 | + 4.8 | −1.3 | −1.1 | −0.0 | −1.1 | +1.1 |
| 1898 | − 4.5 | +1.4 | +1.7 | +0.2 | +0.4 | +0.2 |
| 1899 | −10.1 | 0.0 | −4.9 | −1.9 | −0.9 | −1.0 |
| 1900 | + 4.4 | −0.2 | +5.9 | +1.3 | +2.2 | −0.9 |
| 1901 | + 2.1 | 0.0 | −2.7 | −0.2 | −0.5 | +0.3 |
| 1902 | −11.0 | −1.8 | −0.8 | −1.9 | −3.9 | +2.0 |
| 1903 | + 5.5 | +1.0 | +3.5 | +1.4 | +1.8 | −0.4 |
| 1904 | +14.6 | +0.9 | −0.8 | +1.9 | +2.1 | −0.2 |
| 1905 | −20.7 | −0.1 | −0.2 | −2.4 | −3.9 | +1.5 |
| 1906 | +15.1 | +0.6 | +0.5 | +2.1 | +1.2 | +0.9 |
| 1907 | − 3.0 | −0.2 | −1.9 | −0.8 | +3.2 | *−4.0 |

* Calculated and observed values are of opposite sign.

6. *On the possibility of forecasting the August temperature for northern Japan.*—In northern Japan the August temperature is the dominant factor [2] for the rice crop of the year. When the air temperature in August is higher than the average Japan may expect a good harvest. On the contrary when the August temperature is lower than the normal we are to anticipate a very bad harvest. In recent times 1902, 1905, and 1913 had abnormally cool Augusts. In consequence there was failure of the rice crop, which resulted in a terrible famine in most of northern Japan. Attention of scientists has been called to the cause of this abnormal low temperature. Forecasting the approximate temperature for August many months in advance is the problem that confronts [the Japanese]. Some of them have found a close relation existing between the hydrographical and meteorological phenomena off our east coast, and have proposed to take systematic observations of sea temperature for the prediction of the general character of the summer. But it is not easy to make systematic observations of sea temperature. Moreover there is at present no special organization or institute for making systematic hydrographical observations on our [Japan's] coast. I have therefore intended, in default of better, to make a tentative application of statistical methods for the solution of the problem. My method of seasonal forecasting is based on the facts that the temperature variation in northern Japan for August is in harmony with that of the April pressure difference, Azores—Iceland, and that of the March pressure difference, Zikawei—Miyazaki. But, as in all efforts at the solution of seasonal forecasting, there are some tantalizing exceptions in this harmony of the pressure and temperature variations. Hence we can not hope to establish a definite law of prediction or to calculate the approximate August temperature many months in advance.

But the regression equation $q=0.115x+0.648y$, imperfect as it is, will serve to show at least the sense of variation of the air temperature of the coming August at the beginning of May when we have the telegraphic reports of the mean pressures at Ponta Delgada and Stykkisholm for April and those at Zikawei and Miyazaki for March. When the Sydney, N. S. W., pressure for January is available the regression equation

$$q=0.117x+0.284y+0.149z$$

is to be used.

It must be remarked here that the number of years for which data are available is inadequate for a correct knowledge of the relationships involved and the factors available are scanty. Hence future information and the introduction of new factors [3] are likely to modify the relative importance of the terms involved in the above equations to an appreciable extent.

[2] A detailed discussion on the relation between the rice crop and the temperature, together with the correlation with the pressure variations, Azores-Iceland, Zikawei-Miyazaki, etc., will be given in a further note.

[3] The variation of the pressure at Cordoba, Argentine Republic, for April is in harmony with that of the August temperature in northern Japan.—*Author.*

551.590.2 : 551.578.1

## SUN SPOTS, MAGNETIC STORMS, AND RAINFALL.[1]

By HENRYK ARCTOWSKI, Ph.D.

[Dated: Hastings-on-Hudson, N. Y., Sept. 13, 1917.]

Utilizing the results of Wolf's daily sunspot observations, Loomis noticed the fact that on the days of magnetic storms the sunspot relative numbers are much above the average and that secondary maxima occur 4 days before and 3 days after those of magnetic disturbances.

Recently this fact has been partially verified by Lord Kelvin.

On the other hand it is well known that Terby, then later Marchand, and finally Maunder, have admitted that magnetic storms frequently coincide with the passage of a sunspot through the central meridian—that Veeder, on the contrary, advocated a predominant influence of the appearance of sunspots on the eastern limb and that Riccò noticed the fact that very frequently magnetic disturbances occur about 45 hours after the passage of a sunspot through the meridian.

Without further statistical verification Arrhenius deduced from Riccò's observations that the magnetic storms are due to particles, carrying negative electricity, conveyed from the sun by the pressure of radiation.

Since the correlation noticed by Loomis really exists, at least as far as the principal maximum is concerned, it seemed interesting to me to verify which of the three hypotheses concerning the position occupied by the sunspots producing auroras and magnetic storms is correct.

It is easy to understand the importance of the question.

[1] Author's abstract of "Note sur une corrélation entre orages magnétiques et la pluie;" "Positions héliographique des taches solaires et orages magnétiques." Par *Henryk Arctowski.* Mem.. Soc. degli spettrosc. ital., 1917. 6 (ii): 33-36.

A sunspot may be considered as a rupture of the photosphere.

The radiations of a sunspot are different from the average radiation of the photosphere.

The correlation between the frequency variation of sunspots and the magnetic phenomena is a well-established fact.

Therefore, one may suspect in sunspots some *particular kind of radiation*, capable of producing our terrestrial magnetic disturbances and polar auroras.

Now the question is: Can simple statistics settle the question of the nature of this radiation?

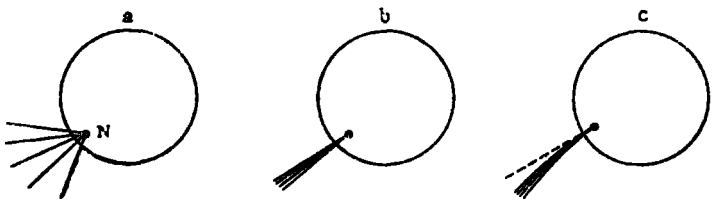


FIG. 1.—Sketch illustrating three different manners in which possible solar radiations might be sent out into space from a sunspot N.

Suppose a sunspot $N$ (fig. 1). For the radiation producing the magnetic storm one may presume the three cases $a$, $b$, and $c$, sketched in.

Considering, for the days of magnetic storms, the distribution of sunspots separately east and west of the central meridian, and making the tabulations according to the distances from the center of the solar disk, we will have to find:

In case $a$, no particular maxima except such maxima as may be due to the effect of perspective.

In case $b$, a maximum of most central positions. In case $c$, 2 maxima, one east, and the other west of the central meridian, for positions of about 45° from the center of the disk.

I made the calculations for the dates of magnetic storms observed in Porto Rico during the years 1903 to 1908; for those observed at Bombay from 1874 to 1892; and also for those observed at Greenwich from 1882 to 1903; and from the numerical results thus obtained I conclude that the hypothesis of Terby, as well as that of Veeder, may be discarded and that Arrhenius' theory does not explain the facts.

I will simply give the figures for the days of beginning of the 60 most active storms observed at Greenwich. Expressed in per cent of the total areas occupied by sunspots these figures are for each tenth of the solar radius:

| Solar longitude. | Tenth of the sun's radius. | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| | % | % | % | % | % | % | % | % | % | % |
| 0°–180° | 4.96 | 2.68 | 4.93 | 1.24 | 2.69 | 11.05 | 2.15 | 3.44 | 1.06 | 0.08 |
| 181°–360° | 0.01 | 1.31 | 3.52 | 6.50 | 12.85 | 7.91 | 12.00 | 8.34 | 5.58 | 4.69 |

The prevailing positions of spots for the days of magnetic storms, are therefore such that we have to admit that the radiations producing the storms are restricted pencils of rays, deviated from the normal and propagated from the sun to the earth with a velocity similar to the velocity of light.

If this radiation consists of $\beta$ rays, as has already been supposed by A. Brester and others, the deviation in particular cases will, perhaps, give some information on the fluctuations of the intensity of the magnetic field in sunspots.

In order to verify the assumption that we have really to deal with $\beta$ rays I made some more calculations.[2]

One of the most characteristic properties of $\beta$ rays being to produce the condensation of vapors, if the magnetic storms are due to $\beta$ rays, we may evidently expect a correlation between rainfall and magnetic storms. The observations made in Batavia from 1886 to 1899 give, for the days of magnetic storms (190 in all) and for the days preceding and following these days, perfectly convincing figures.

The totals expressed in millimeters are:

| −6 | −5 | −4 | −3 | −2 | −1 | 0 |
|---|---|---|---|---|---|---|
| 933 | *1195* | 1075 | 735 | 1117 | 1120 | *1450* |
| +1 | +2 | +3 | +4 | +5 | +6 | +7 |
| 933 | 913 | 838 | *1034* | 928 | 837 | 873 |

The secondary maxima observed 5 days before the date of the magnetic storms and 4 days afterwards may be considered as a confirmation of Loomis' observations.

The Greenwich data of 1882 to 1903 give a similar result for the secondary maxima, but for the days of magnetic storms rainfall in Greenwich is at its minimum.

But we may notice that Montigny observed in Brussels that the twinkling of the stars is more pronounced on the days of magnetic storms than before and after those days. This shows evidently that condensation would take place at Brussels or at Greenwich, just as at Batavia, if the atmospheric conditions were favorable.

This leads to the question whether magnetic storms may occur only under anticyclonic conditions prevailing in high latitudes? Or, taking into account the researches of Störmer and Birkeland, then only when the atmospheric conditions are favorable for the penetration of $\beta$ rays to lower altitudes.

The consequence is that the rainfall data not only verify the $\beta$ rays hypothesis but that other correlations with different orders of meteorological phenomena may also be expected.[3]

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## LOCAL WIND OF THE FOEHN TYPE NEAR SAN FRANCISCO BAY.

By BURTON M. VARNEY, Instructor in Geography.

[University of California, Berkeley, Cal., Nov. 15, 1917.]

Dynamic warming of air by descent from mountains into valleys or onto plains is a well-recognized meteorological phenomenon. It occurs notably in the Swiss valleys on the north side of the Alps, under the control of areas of low barometric pressure moving across central Europe. The [dry] chinook winds over the high plains of the western United States and Canada are of similar origin. A wind of the foehn type, produced in a somewhat similar fashion, though controlled rather by high pressures than by low, is occasionally felt at Berkeley, Cal., where the University of California maintains a meteorological station. This wind, blowing from the east or northeast, causes, if it lasts for more than a few hours, very dry atmospheric conditions at Berkeley, and in the summer time uncomfortably high temperatures. This is in strong contrast to the cool, rather moist westerly wind

[2] The reader's attention is here asked to Störmer's memoir in Journal of Terrestrial Magnetism for September, 1917, wherein Störmer shows that, as far as the production of the aurora is concerned, it is difficult to harmonize the facts with the hypothesis that the aurora is due to negatively charged particles ($\beta$ rays).

[3] A brief note on Brester's theory of the sun was published in the MONTHLY WEATHER REVIEW for October, 1917, p. 485.

Relations between sunspots and rainfall have been discussed in this REVIEW for February, 1907 (35:72), and July, 1907 (35:309).—C. A., jr.