

TABLE 2.—Values of the solar constant of radiation. From bolographic studies.

Date.	Hour angle. West.	Air mass.	Calories per square centimeter per minute.		Solar constant; for mean distance of the sun.
			At the earth's surface.	Outside the atmosphere.	
1902.					
October 9	0 6	1.425	1.42	2.20	2.19
October 15	1 31	1.624	1.44	2.21	2.19
October 22	3 01	2.415	1.30	2.18	2.16
1903.					
February 19	1 01	1.642	1.35	2.34	2.28
February 19	2 22	2.003	1.20	2.31	2.25
March 3	0 59	1.429	1.34	2.31	2.26
March 25	2 01	1.454	1.19	2.29	2.27
March 26	1 57	1.438	1.16	2.11	2.10
March 26	2 59	1.754	1.05	2.09	2.07
April 17	2 45	1.463	1.19	1.97	1.99
April 28	1 07	1.145	1.29	2.23	2.27
April 29	2 26	1.308	1.05	1.93	1.97
General mean					2.167
Mean of results prior to March 26, 1903					2.229
Mean of results after March 26, 1903					2.080

general mean, the means also of observations before and after March 26, when, for some unexplained reason, a fall of about 10 per cent was noted in the computed solar constant. The observations of February 19,<sup>5</sup> March 25, 26, and April 29, 1903, appeared to be entitled to the greatest weight among those given, on account of the regularity of the actinometric curves of those days and the closeness with which the plotted points for determining the atmospheric transmission coefficients lie upon straight lines, as shown for two of the days in question on fig. 1.

#### FORM OF THE NORMAL SOLAR ENERGY SPECTRUM OUTSIDE THE EARTH'S ATMOSPHERE AND THE PROBABLE TEMPERATURE OF THE SUN.

The reader has no doubt noted that, by applying corrections for atmospheric and instrumental absorption, the bolographic spectrum energy curves may be reduced in form as well as in area to represent the distribution of energy in the spectrum of the solar beam outside the atmosphere. This has been done in several instances, and in doing so the curves have been transformed from the prismatic to the normal wave-length scale by taking account of the prismatic dispersion, and several of these curves are plotted on fig. 3. In these curves no account is taken of selective absorption bands, whether solar or terrestrial, smoothed curves only being given.

It will be noted that there is a fair agreement in general form between these independently derived curves, and that they unite in fixing the wave length of maximum energy at about  $0.49 \mu$ .<sup>6</sup> Their agreement would be more exact, there can be little doubt, if it were not for the large and variable absorption of the silvered surfaces in the optical apparatus for wave lengths at and beyond the region of maximum energy. The transmission of the spectroscopic at a wave length of  $0.45 \mu$  has varied on this account at different times from 33 per cent to 15 per cent, whereas at wave lengths of  $1 \mu$  and thereabouts the transmission always approaches 90 per cent. The spectroscopic mirrors are resilvered about once in two months and the siderostat mirrors still oftener.

Wien has derived a law connecting temperature with wave length of maximum radiation, which is expressed as follows, where  $T$  is the absolute temperature and  $\lambda_{max}$  the wave length of maximum intensity of radiation expressed in microns:

$$\lambda_{max} T = \text{constant.}$$

<sup>5</sup> February 19, 1903, was the most extraordinary day as regards absence of water vapor in the atmosphere which has ever been noted here. The great water-vapor bands  $\phi$   $\psi$  in the infra-red spectrum were nearly filled up, and the long wave length side of the band  $\Omega$  presented an almost unrecognizable appearance.

<sup>6</sup> The wave length of maximum energy determined by Mr. Langley on Mount Whitney was about  $0.52 \mu$ .

The value of this constant for the radiation of a "black body" or perfect radiator as determined by Paschen,<sup>7</sup> Lummer and Pringsheim,<sup>8</sup> and others is about 2900, while for bright platinum Lummer and Pringsheim give 2630 with values for other substances intermediate between these.

Taking the higher value in connection with the observed position of maximum in the solar energy curve outside the atmosphere, we find that as regards the wave length of maximum radiation the sun's radiation may be assumed comparable to the emission of a "black body" at  $5920^\circ$  absolute. Readers will draw their own conclusions as to the probability that the solar temperature actually lies near this value. It may be remarked that a further correction of the energy spectrum curve for the selective absorption of the solar envelope would undoubtedly reduce the wave length of maximum radiation still further, and would thus incline us to the view that the interior of the sun is at a higher temperature than the above considerations alone would indicate.

#### TREES AS FORECASTERS OF RAIN.

By CURTIS J. LYONS, Honolulu, Hawaii, dated October 15, 1902.

With respect to the query on page 315 of the MONTHLY WEATHER REVIEW for June, 1902, as to whether leaves of trees and shrubs turn up their lower sides previous to rain, the fact is this: A steady wind does not cause the leaves to turn in this way, because the leaves adjust themselves on the twigs of the tree or shrub to the wind in that particular direction. But a sudden change in wind seems to take the leaves unawares, and they immediately show their undersides until they become accustomed to the new direction. That is exactly what takes place before a thunderstorm. A change from trade wind to southerly or westerly wind here always shows the under side of the leaves. Curiously enough a sudden gust while the writer was reading the note in the WEATHER REVIEW gave an instance of the very thing in question.

#### CLIMATOLOGY OF COSTA RICA.

Communicated by Mr. H. PITTIER, Director, Physical Geographic Institute.  
[For tables see the last page of this REVIEW preceding the charts.]

*Notes on the weather.*—On the Pacific slope, the rainfall was exceptional for the season, with strong northerly winds and much dampness. In San José, pressure and humidity were normal, with a slightly lower temperature; after the 8th it rained most of the time, with a heavy and cold northeast wind. Sunshine one hundred and one hours against a normal of one hundred and fifty-eight hours. The instability of the weather delayed the coffee picking, and the strong and damp winds, quite unusual at this time of year, were very prejudicial to the public health. On the Atlantic slope the rainfall was excessive, causing everywhere inundations and landslides. The only way of communication with Port Limon, i. e., the Costa Rica Railroad, has been interrupted for a distance of 13 miles, and has suffered many other damages.

*Notes on earthquakes.*—December 16, 10<sup>b</sup> 36<sup>m</sup> a. m., slight shock NW.-SE., intensity II, duration 3 seconds. Another slight earthquake was reported from Tres Rios on the 20th.

#### THE POLAR AURORA OF OCTOBER 30-NOVEMBER 1, 1903.

Communicated by JAMES PAGE, United States Hydrographic Office, dated Washington, December 14, 1903.

During the night of October 30-31, and again during that of October 31-November 1, observers aboard vessels in higher latitudes report having witnessed remarkable displays of the aurora borealis or northern lights. The phenomenon was observed in both the Atlantic and Pacific oceans. (See the report of the steamship *Victoria* given below.) Its occurrence was not simultaneous throughout, different observers recording the appearance and disappearance of the lights at different instants of absolute

<sup>7</sup> Paschen, *Astrophysical Journal*, IX, 306, 1899.

<sup>8</sup> *Verhandlungen d. Deutschen Phys. Ges.* III, 37, 1901.

time; nor was it everywhere apparent, certain observers reporting the display, others in the same neighborhood failing to mention it.

In the following list the reports follow each other in the order of longitude.<sup>1</sup>

Night of October 30-31.

October 31, 2:30 a. m. [3:54 a. m.], latitude 57° north, longitude 21° west, aurora borealis in northern sky. British steamship *Oilfield*, O'Niell. Report by Officer Walker.

October 31, 1:30 [4:18] to 2:30 a. m. [5:18], latitude 50° north, longitude 42° west, aurora borealis in north-northwest. Danish steamship *Norge*, Gundel. Report by Officer Anderson.

October 31, 2 a. m. [4:56], latitude 48° north, longitude 44° west, northern lights showing in rays and waves; at 6 a. m. [8:56] became red, blending into a dark purple; the clouds, between masses of nimbus, showing white on top and olive green to black. British steamship *Weehawken*, Harding. Report by Officer M. J. Kay.

October 30, 7 p. m. [10:20 p. m.], latitude 45° north, longitude 50° west, had a splendid northern light; it covered the whole north part of the sky. German steamship *Phoebus*, Schierhorst. Report by Officer Gerdelmann.

October 30, —, latitude 46° north, longitude 50° west, aurora borealis. British steamship *Ethiopia*, Lunsdane. Report by Officer McDonald.

October 31, —, latitude 44° north, longitude 54 west, saw a magnificent aurora borealis. Dutch steamship *Rotterdam*, Stenger. Report by Officer Prijl.

October 31, at daybreak [8:40-9:40 a. m.], latitude 46° north, longitude 55° west, remarked an exceedingly strong northern light with reddish color. German steamship *Frisia*, Leuenfels.

October 31, 5 to 6 a. m. [8:52-9:52 a. m.], latitude 43° north, longitude 58° west, very strong northern lights, radiated, changeable from red to bright, visible above an arc of 45°. Danish steamship *Dania*, Paulsen. Report by Officer Jørgensen.

October 30-31, latitude 39° north, longitude 68° west, after the moon had set, about 2 a. m. of October 31 [6:38 a. m.], a strange phenomenon manifested itself. The whole northern sky was illuminated with a pale light; this lasted until morning. Although very far south for this, we were without doubt in view of the aurora borealis. French steamship *America*, Bouleuc. Report by Officer Besseyre.

October 31, latitude 40° north, longitude 70° west, from midnight to 4 a. m. [4:40-8:40 a. m.], northern lights. German steamship *Geestemunde*, Hellmeyer. Report by Officer Gerdelman.

October 30-31, latitude 33° north, longitude 76° west, aurora borealis seen during the night. British steamship *Bawtry*, Jackson. Report by Officer Mills.

October 31, 2 a. m. [11:32 a. m.], latitude 49° north, longitude 143° west, saw the northern lights very visible to the eastward. American steamship *Victoria*, Truebridge. Report by Officer Kenny.

Night of October 31-November 1.

November 1, 1 a. m. to 5 a. m. [1:08 to 5:08 a. m.], latitude 58° north, longitude 2° west, a strong northern light was seen in the direction north by east, through east, to southeast. I never saw such a strong northern light before. Dead calm at the time. Danish steamship *L. P. Holmblad*, Anderson. Report by Officer Hansen.

October 31, 8 to 12 p. m. [8:08 p. m. October 31 to 12:08 a. m. November 1], latitude 59° north, longitude 2° west, brilliant display of aurora borealis extending over the whole sky. British steamship *Appalachee*, Simpson. Report by Third Officer Simpson.

October 31, 8 p. m. [8:40 p. m.], latitude 49° north, longitude 10° west, saw a beautiful northern light. American steamship *Kroonland*, Dorrud. Report by Officer Eisleben.

October 31, toward midnight [Nov. 1, 1:08 a. m.], latitude 55° north, longitude 17° west, brilliant display of aurora borealis. British steamship *Sarmatian*, Pitts.

October 31, 8:30 p. m. [9:54 p. m.], in latitude 51° 18' north, longitude 20° 55' west, wind south (true), blowing very strong, with barometer at 29.79 and falling smartly, the sky at north-northeast became suddenly illuminated with bright light, which rapidly diffused the whole of the northern half of the heavens with bright shafts of light, all converging to a focus at the zenith with large areas of copper-colored light, changing to a very dark red and traveling from north-northeast to west, contrasting strongly with the white shaft of light and making the display one of exceptional character and beauty, the whole display lasting for ten minutes. Flashes two and three to the second with intervals of several seconds. British steamship *Columbus*, McAuley. Report by Second Officer Bentley.

October 31, 10:40 p. m. to November 1, 4 a. m. [12:24 to 5:44 a. m.], latitude 56° north, longitude 26° west, aurora borealis in northern sky. British steamship *Oilfield*, O'Neill. Report by Officer Walker.

October 31, 7 p. m. [9:08 p. m.], latitude 41° north, longitude 34° west, observed the rays of a north light, which lasted about five minutes and

then disappeared. German steamship *Sicilia*, Bachmann. Report by Third Officer Oettjen.

October 31, 8:30 p. m. [10:50 p. m.], to November 1, 2 a. m. [4:20 a. m.], latitude 52° north, longitude 35° west, strong northern lights were seen from north-northeast, through north, to southwest. Danish steamship *Norge*, Gundel. Report by Officer Andersen.

October 31, latitude 51° north, longitude 37° west, the whole night electric appearance of the northern lights. German steamship *Standard*, Shuiter. Report by Second Officer Schulte.

October 31, latitude 46° north, longitude 47° west, the northern lights rose to a great height, assuming all the colors of the rainbow, the rays bending and meeting in a point a few degrees south of the zenith; afterwards changing to white and showing throughout the night (October 31-November 1) in flashes, rays and waves, at times lying in the zenith like cirrus. British steamship *Weehawken*, Harding. Report by Officer Kay.

October 31, at midnight [November 1, 3:08 a. m.], latitude 45° north, longitude 47° west, northern lights showing very bright. British steamship *Eagle Point*, Bovey.

October 31, latitude 49° 55' north, longitude 48° 00' west, during all the night northern light. German steamship *Deutschland*, Dallsdorf.

October 31, latitude 46° north, longitude 49° west, 10 to 11:30 p. m. [November 1, 1:16 to 2:46 a. m.], very light flashes flying up in quick succession in the northern horizon from northwest to northeast (northern lights). Dutch steamship *Ocean*, Boysen.

October 31, 8 to 12 p. m. [October 31, 11:20 p. m., to November 1, 3:20 a. m.], latitude 44° north, longitude 50° west, saw the aurora borealis faintly in the sky. British steamship *Manchester Inventor*, Parry. Report by Officer Dolg.

October 31, 10 p. m. [November 1, 1:52 a. m.], latitude 43° north, longitude 58° west, northern lights were visible. British steamship *Ohio*, Ward. Report by Officer Kendrick.

October 31, latitude 48° north, longitude 65° west, 6 to 10 p. m. [October 31, 10:20 p. m., to November 1, 2:20 a. m.], noticed a strong northern light, sometimes covering the western part of the sky completely; color of the light was reddish. German steamship *Frisia*, Von Leuenfels.

October 31, latitude 41° north, longitude 60° west, during the night the light of aurora borealis was seen over 25° altitude. Austrian steamship *Lacroma*, Paravic. Report by First Officer Ticco.

In addition to the above, brilliant auroras were observed on October 26, November 16, 18, and 21.

Telegraph wires and cables, from the Pacific coast eastward throughout America and Europe, report very general and intense ground currents, lasting about eight hours in Chicago and eight to twelve hours in Europe. At New York City this began about 2 a. m. October 31, and continued for seven hours. It was generally considered as the worst electrical disturbance experienced in the United States for thirty-five years past. In Europe, telegraphic disturbances were most serious in Switzerland and France, but were not noticed in Austria, Italy, or Denmark. However, such reports as these have a very indefinite significance, owing to the fact that very different sorts of apparatus are used by the various telegraphic services. Brilliant auroras were recorded at most stations from Oregon to Newfoundland, beginning at 1 a. m., and ending at 5 a. m.

At Chicago the climax occurred at 8:30 a. m., having begun about midnight.

A preliminary report by Father de Moidry of a remarkable magnetic perturbation which manifested itself at the Zi-Ka-Wei Observatory, Shanghai, China, simultaneously with the above auroral display, has been received. The opening paragraph of this report is as follows:

October 30, at 10 hours (Greenwich civil time 1h. 55m. p. m.), our three needles underwent a sudden fluctuation, a frequent preliminary of the more important storms, sinking after a quarter of an hour into profound calm. During October 31 the condition of agitation was resumed, reaching a climax at 21-22 hours (Greenwich civil time 13-14 h. p. m.). At this moment the total amplitude of the most rapid oscillation was:

For D .....	23.5'
For H .....	388γ
For Z .....	137γ

The perturbation continued until November 1, twenty-two hours. An idea of the excessive character of this disturbance may be gathered from the fact that the greatest untroubled diurnal oscillation of the declination measured at Zi-Ka-Wei since 1877 was but 14.5' in six hours of time, July 12, 1884. The above displacement of 23.5' occupied but fourteen minutes of time.

<sup>1</sup> Some of this data was published in the Pilot Chart of the North Atlantic Ocean for December, but additional data has been added by Mr. Page. The ship's local time of observation has been converted into Greenwich time by the Editor and is inserted in the text in brackets.—C. A.