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A GROUP OF SOLAR CHANGES

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The author recently published[1] a new method of testing the variability of the sun. Heretofore such variation has been indicated only by successive observational values of the solar constant of radiation. The new method depends on the selection of moments when the sun is equally high above the horizon, the atmosphere equally clear, the quantity of atmospheric water vapor identical, and the month of the year the same, so that the temperature conditions will be substantially comparable, both around the recording instrument and in the atmosphere itself.

Under such circumstances, if they could be met ideally, the atmosphere, although it reduces the intensity of the sun's radiation, reduces it in the same proportion on every chosen occasion. Accordingly, the pyrheliometric measurements of total solar radiation made at such moments should show the same percentage variations of the sun as the solar constant observations, in which atmospheric influences are, as we suppose, eliminated. Since the most critical selection must admit some inequality in sky conditions, the new method is not applicable to individual days, but gives good results only for means of fairly numerous groups of days, such as occur in the course of a month of observing.

The new test of comparative pyrheliometry on selected days was applied to the observations of the months of July from 1910 to 1920,[1] omitting the years 1912 and 1913 when the great volcanic eruption of Mt. Katmai, Alaska, rendered the atmosphere so hazy that no suitable days could be found for comparison. The results are shown in figure 1, in which the single smooth curve represents the selected pyrheliometric observations, the dotted curve represents the hitherto published solar constant work, and the double full curve represents the variation of the Wolfer sun-spot numbers. It will be seen that, except for the year 1914, the new test is closely confirmatory of the solar variation shown by the published solar constant work, and that there is an exceedingly close correspondence between

[1] See Monthly Weather Review, May, 1926.

the variations of the sun's total radiation and the variation of the visible spottedness.

A second trial of the new method of testing solar variation was undertaken with the observations of the Smithsonian station at Mt. Montezuma, in Chile, from 1920 to 1926. The work was carried through for each of the twelve months of the year. In this method of working, one determines the general mean values, including all the selected days for all the months of a given name, as, for instance, the month of January, both for the selected pyrheliometry and for the published solar constant values. He then determines the percentage differences of the mean values of each individual month of

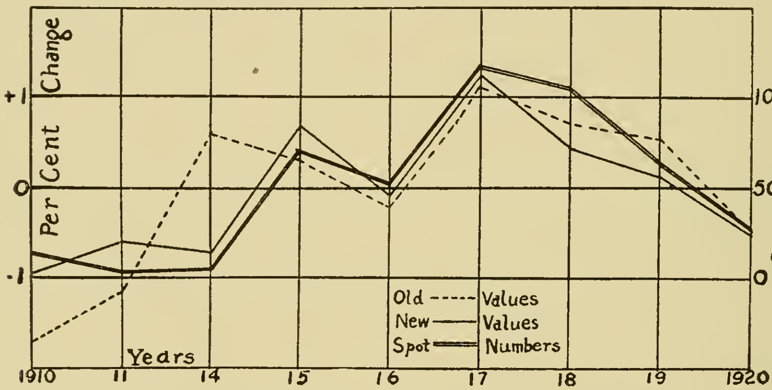

FIG. 1.—Selected pryheliometry, solar constant, and sun-spot numbers compared. Mt. Wilson work, Julys 1910-1920.

January for the series, from the appropriate general mean. If no changes of scale in the solar constant observations occur, the two series (pyrheliometric and solar constant) ought to show, within experimental error, the same march of the percentage deviations; but if, owing to the introduction of new observers, new methods of observation, or of reduction, the scale of the solar constant values is altered from time to time, then the correspondence between the two series is impaired. Such, indeed, proved to be the case at Montezuma. The accompanying table gives the collected results on selected pyrheliometry and solar constants for all months from 1920 to 1926.

I give the weights and the weighted mean percentage departures in each instance. It will readily be seen by comparing the differences of percentage departures, as given in italic type, that for considerable intervals these differences run along roughly alike from month to month and then abruptly change. In this way they indicate that several small changes of scale occurred in the solar constant observations.

TABLE 1.—*Percentage Departures of Selected Pyrheliometry and Solar Constant Values from General Means Montezuma, 1920 to 1926*

Weights assigned regarding numbers of days and character of observations

	Weight	Pyrheliometry	Solar constant	Solar constant minus pyrheliometry	Corrected solar constant	Weight	Pyrheliometry	Solar constant	Solar constant minus pyrheliometry	Corrected solar constant	Weight	Pyrheliometry	Solar constant	Solar constant minus pyrheliometry	Corrected solar constant	Weight	Pyrheliometry	Solar constant	Solar constant minus pyrheliometry	Corrected solar constant
			1920					1922					1924					1926		
January	....	....	....	....	....	5	+.11	+.91	+.80	+.50	7	+.50	−.21	−.71	+.15	5	+.41	+.06	−.35	+.41
February	....	....	....	....	....	3	−.39	+.14	+.53	−.27	7	−.45	−.11	+.34	−.39	4	+1.20	+.36	−.84	+.71
March	....	....	....	....	....	7	−.10	+.46	+.56	+.05	17½	−.38	−.04	+.34	−.32	11	+.48	+.36	−.12	+.71
April	....	....	....	....	....	3	−.35	+.10	+.45	−.31	16	−.58	−.33	+.25	−.65	22	+.03	−.12	−.15	+.23
May	....	....	....	....	....	2	−.55	.00	+.55	−.41	24	−.37	+.17	+.54	−.11					
June	....	....	....	....	....	2	+.38	−.05	−.43	−.46	16	−.28	.00	+.28	−.28					
July	....	....	....	....	....	....	....	....	....	....	18	−.68	−.17	+.51	−.45					
August	17	−.25	+.12	+.37	−.36	....	....	....	....	....	12	−.78	−.43	+.33	−.71					
September	14	+.42	+.65	+.23	+.17	2	−1.64	−.52	+1.12	−.93	13	−1.16	−.89	+.35	−1.09					
October	13	−.56	+.61	+1.17	+.13	5	−.72	−.38	+.34	−.79	17	−.23	−.11	+.12	−.39					
November	5	+.10	+.43	+.33	−.05	3	−1.26	−.48	+.78	−.89	16	−.09	−.28	−.19	−.56					
December	6	+.58	+.59	+.01	+.11	....	....	....	....	....	11	−.80	−.31	+.49	−.59					
			1921					1923					1925							
January	....	....	....	....	....	4	+.08	.00	−.08	+.36	8	−.64	−.54	+.10	−.82					
February	....	....	....	....	....	2	−.15	−.26	−.11	+.10	....	....	....	....	....					
March	....	....	....	....	....	9½	+.22	−.65	−.87	−.29	8	−.02	+.26	+.28	−.02					
April	....	....	....	....	....	14½	+.05	−.54	−.59	−.18	18	+.62	+.70	+.08	+.42					
May	....	....	....	....	....	8	−.24	−.64	−.40	−.28	23	+.49	+.42	−.07	+.77					
June	2	−.05	+.52	+.57	+.04	10	−.28	−.41	−.13	−.05	22	+.31	+.20	−.11	+.55					
July	3	+.64	+.67	+.03	+.67	6	+.41	−.26	−.67	+.10	10	+.79	+.29	−.50	+.64					
August	....	....	....	....	....	5	+.55	+.23	−.32	+.59	17	+.66	+.12	−.54	+.47					
September	4	+1.44	+.89	−.55	+1.25	17	−.24	−.07	+.17	+.29	23	+.47	+.03	−.44	+.38					
October	7	+.38	+.13	−.25	+.49	14	−.25	−.45	−.20	−.09	16	+1.04	+.14	−.90	+.49					
November	9	+.23	+.40	+.17	−.01	15	−.25	−.11	+.14	+.25	17	+.64	+.32	−.32	+.67					
December	7	+.13	+.21	+.08	−.20	3	+.13	−.34	−.47	+.02	9	+.46	−.06	−.52	+.29					

Weighted Differences

1920 Aug. to 1921 June....	+.48
1921 July	.00
1921 Sept. to 1921 Oct......	−.36
1921 Nov. to 1922 Dec.....	+.41
1923 Jan. to 1924 Jan......	−.36
1924 Feb. to 1925 Apr.....	+.28
1925 May to present	−.35

These changes in scale of solar constant values have been determined by averaging the differences (given in italics in table 1) throughout such intervals as they remained similar in magnitude. These intervals were found to coincide closely with intervals between known changes of procedure, which might have affected the scale of solar constant values. Based upon these facts, and allowing also for small watch errors, the corrections of table 2, in percentages, and in calories per square centimeter per minute, have been determined to reduce all Montezuma observations to the scale which prevailed from August, 1920, to June, 1921, and which is believed to accord closely[1] with the Mount Wilson scale of 1905 to 1920.

These corrections of scale depending on changes of procedure, and whose respective influences extend continuously for definite intervals of many months, having been applied to the percentage changes of solar constant values given in table 1, the resulting curves of solar variation for the twelve months of the year are given in figure 2, both as depending on selected pyrheliometry, and as depending on corrected solar constant values. The agreement between these curves is really extraordinary. It will be seen that a general similarity of the curves to those of the sun-spot variation is found, but it is not for all months as close as was found for the months of July, 1910, to 1920.

As meteorologists in various parts of the country are interested in theoretical and practical studies of the variation of the sun, I have thought best to furnish the following table 2 of monthly mean solar constant values as originally published and now corrected by taking account of the aforesaid changes of scale and of eccentricity of the watches of observers. The table begins with August, 1918, and ends with December, 1926. These values are not the final definitive ones which we shall publish soon, when the laborious recomputation of all recent solar constant results is completed, but they will probably differ very little from the final values. They lead to the curve given at the top of the accompanying figure 3. The Wolfer monthly mean sun-spot numbers for the same interval of years are plotted in the second line. It will be seen that while there is a general tendency for higher solar radiation when sun spots are numerous,

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[1] Thus from Monthly Weather Review, May, 1925, it appears that the method of selected pyrheliometry verifies the corrections of solar constant at Mount Wilson of 1919 and 1920, as given on pages 177 to 180 of Annals of the Astrophysical Observatory, Vol. IV. These citations indicate for Mount Wilson (mean of 100 values of 1918 to 1920, excluding July, 1918, and September, 1920) 1.950 calories. Correspondingly, table 2 gives 1.946 calories.

yet the correspondence of the two groups is not exceptionally close.

Figure 4, which was prepared some years ago to represent the relationship between solar constant values and sun-spot numbers, from all of the Mt. Wilson, Calama, and Montezuma observations at that time available, indicates that the increase of solar radiation

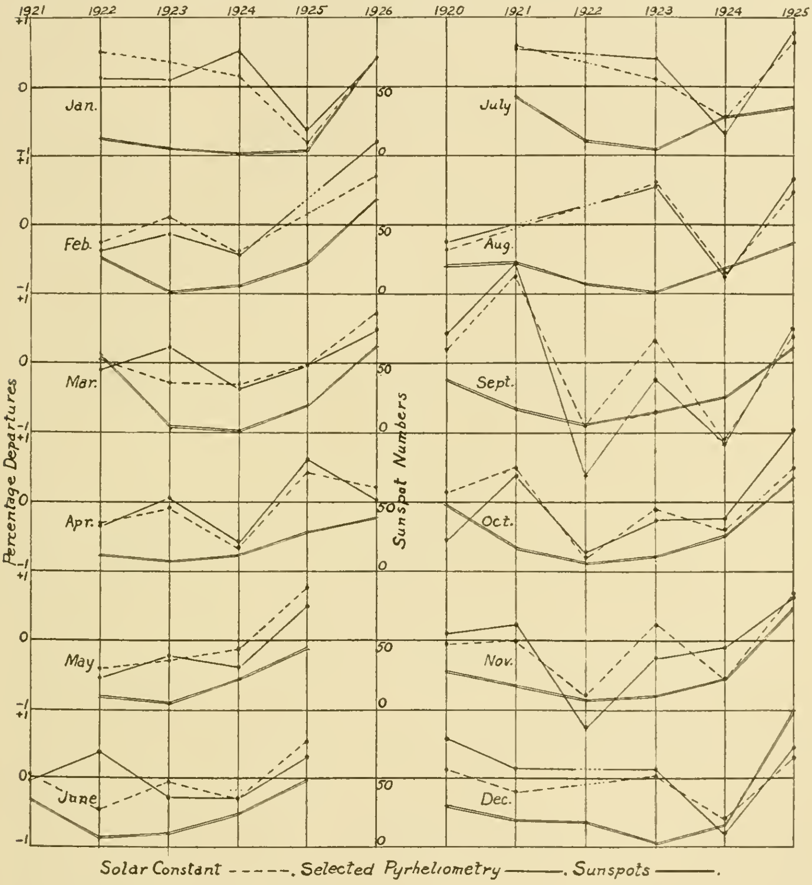

FIG. 2.—Montezuma observations, all months, 1920 to 1925.

attending a given increase of sun-spot numbers is decidedly greater when the total spottedness is small than when it is large. If this consideration is kept in mind in examining figure 3, it will be seen, in part, why the correspondence of the two curves is less marked than perhaps might have been expected.

However, a new, and, as it seems to me, very important consideration also influences the relationship between the two curves of

TABLE 2.—*Monthly Mean Solar Constant Values from Chilean Stations*

		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1918	Published	.....	.....	.....	.....	.....	.....	.....	1.954	1.944	1.939	1.941	1.962
	Corrected	.....	.....	.....	.....	.....	.....	.....	1.954	1.944	1.939	1.941	1.962
1919	Published	1.943	1.949	1.941	1.953	1.940	1.955	1.954	1.953	1.939	1.953	1.953	1.950
	Corrected	1.943	1.949	1.941	1.953	1.940	1.955	1.954	1.953	1.939	1.953	1.953	1.950
1920	Published	1.964	1.956	1.945	1.952	1.953	1.939	1.945	1.930	1.947	1.944	1.948	1.957
	Corrected	1.964	1.956	1.945	1.952	1.953	1.939	1.945	1.930	1.947	1.944	1.948	1.957
1921	Published	1.955	1.956	1.949	1.944	1.943	1.939	1.947	1.935	1.953	1.946	1.950	1.952
	Corrected	1.955	1.956	1.949	1.944	1.943	1.939	1.956	1.944	1.969	1.962	1.951	1.953
1922	Published	1.947	1.942	1.937	1.930	1.924	1.913	1.911	1.918	1.922	1.926	1.928	1.914
	Corrected	1.948	1.943	1.938	1.931	1.925	1.914	1.912	1.919	1.923	1.927	1.929	1.915
1923	Published	1.930	1.912	1.912	1.912	1.916	1.918	1.926	1.931	1.934	1.930	1.931	1.923
	Corrected	1.946	1.930	1.932	1.932	1.936	1.928	1.936	1.941	1.944	1.940	1.941	1.933
1924	Published	1.931	1.922	1.919	1.917	1.922	1.929	1.922	1.918	1.920	1.929	1.930	1.931
	Corrected	1.941	1.920	1.927	1.925	1.930	1.937	1.930	1.926	1.928	1.937	1.938	1.939
1925	Published	1.925	1.936	1.931	1.933	1.931	1.927	1.933	1.930	1.936	1.934	1.936	1.936
	Corrected	1.925	1.936	1.931	1.933	1.943	1.939	1.945	1.942	1.948	1.946	1.948	1.948
1926	Published	1.938	1.927	1.929	1.921	1.922	1.925	1.928	1.930	1.929	1.926	1.918	1.921
	Corrected	1.950	1.939	1.941	1.933	1.934	1.937	1.940	1.942	1.941	1.938	1.930	1.933

Reduction to 1920 Depending on Comparison of Solar Constants with Selected Pyrheliometry

Between dates	Per cent	Calories
1920 Aug. 1 to 1921 June 30	0.00	0.000
1921 July 1 to 1921 Aug. 31	+0.48	+0.009
1921 Sept. 1 to 1921 Oct. 31	+0.84	+0.016
1921 Nov. 1 to 1922 Dec. 31	+0.07	+0.001
1923 Jan. 1 to 1924 Jan. 31	+0.84	+0.016
1924 Feb. 1 to 1925 Apr. 30	+0.20	+0.004
1925 May 1 to present time	+0.83	+0.016

Further Reduction to 1920 Depending on Eccentricity of Second-hands of Watches Used in Pyrheliometry

Between dates	Per cent	Calories
1923 Feb. 1 to 1923 May 31	+0.2	+0.004
1923 June 1 to 1924 Feb. 29	—0.3	—0.006
1924 Mar. 1 to 1924 Dec. 31	+0.2	+0.004
1925 Jan. 1 to 1926 Dec. 31	—0.2	—0.004

figure 3. It is this: The results given in table 2 show a strongly marked periodicity of $25\frac{2}{3}$ months. I mentioned this discovery to Dr. Dayton C. Miller. At his invitation, I submitted, for harmonic analysis and synthesis by his celebrated machines, 77 successive months of solar constant results from June, 1920, to October, 1926. These he used as they are given in table 2, except that smoothed curves are drawn in some months of few observations. Dr. Miller's work is graphically shown in figure 5. The dotted curve is that which

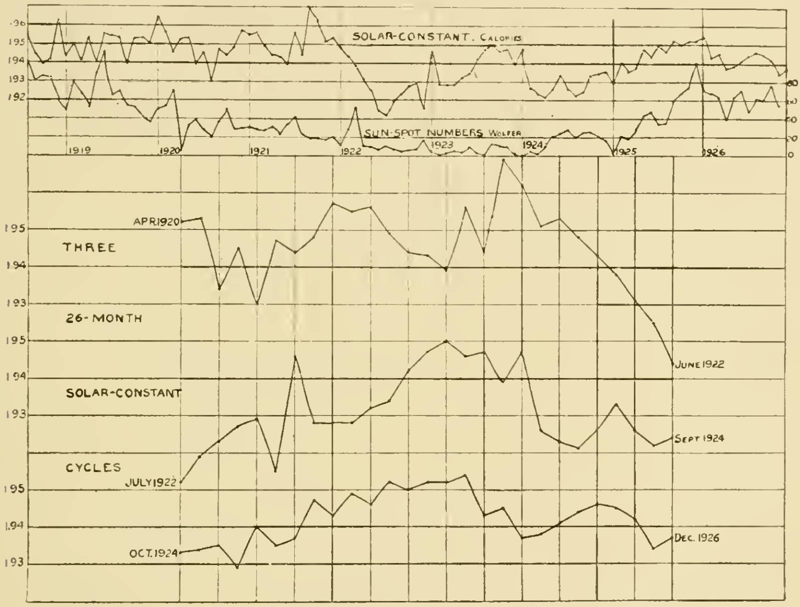

FIG. 3.—Monthly mean solar constant values, August, 1918, to December, 1926; sun-spot numbers; and indications of approximate 26-months regular periodicity in solar radiation.

I supplied. The full curve above it is synthesized from the first 30 harmonic components of it as determined by means of his machine. The first and second components are of little interest, as they give merely the effort of the machine to represent the 11-year sun-spot cycle with only $6\frac{1}{2}$ years of data. Periods of 77/3, 77/5, 77/6, 77/7, 77/9, 77/10, 77/12, 77/14 and 77/15 months, however, stand out with more or less distinctness. By far the strongest of them is the one of 77/3 or $25\frac{2}{3}$ months, but it seems to be associated with "overtones" (to borrow an expression from sound) of $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{4}$, and $\frac{1}{5}$ its period. This fundamental period of nearly 2 years and 2 months has been mentioned by many authors as associated with weather and crop harvests.[1]

The period 77/5, or $15\frac{2}{5}$ months, is approximately equal to that which Professor Dinsmore Alter has been discussing as $\frac{1}{9}$ the sun-spot period, in his publications on world precipitation. It appears also in its "overtones" of $\frac{1}{2}$ and $\frac{1}{3}$ period.

Finally there is the period of 77/7, or 11 months, which Clayton and I called attention to several years ago[2] as occurring in the solar

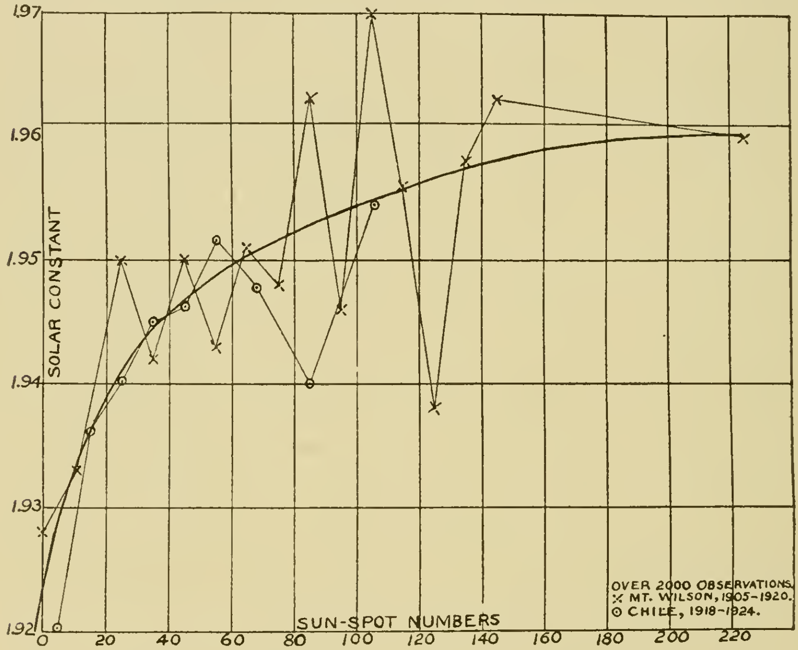

Fig. 4.—Increased sun-spot activity brings higher solar constant values.

radiation. Periods approximating this are also noted by several authors in weather phenomena.[3] An "overtone" of $\frac{1}{2}$ the period of 11 months is also distinguishable.

With his synthesizing machine, Dr. Miller built up the top curve of figure 5, and exterpolated it for several months beyond the data furnished him. Thus far the results from Montezuma have agreed well with this forecast of Dr. Miller which foretold a sharp rise of the solar constant. If, in the next few years, it should be found

[1] See Brunt, Quart. Journ. Roy. Met. Soc., Vol. 53, p. 16, and others.

[2] See Smithsonian Misc. Coll., Vol. 77, No. 5, p. 9, 1925.

[3] See Brunt, just cited, page 23.

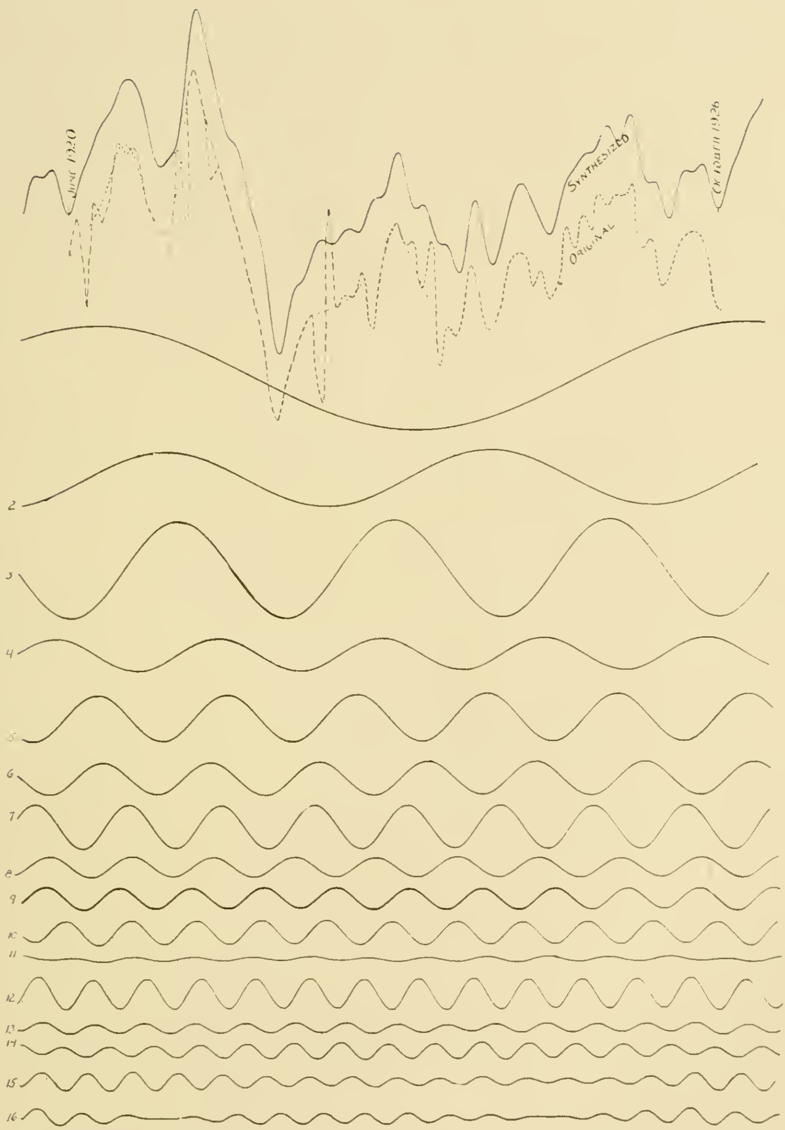

FIG. 5.—Harmonic analysis of monthly mean solar constant values.

that these definite uniform periodicities continue in solar variation, we shall be encouraged to predict the radiation of the sun for years in advance. If successful in such predictions, all that may hang upon solar variation will become equally predictable.

Contemplating the variation of the sun, one is inclined to ask whether all wave lengths take part proportionally in producing it, or whether, as one would naturally expect, the variation grows greater and greater towards shorter wave lengths. This question we answered in the latter sense several years ago, by the curves of figure 6. This indicates that, in fact, the red and infra-red vary almost not at

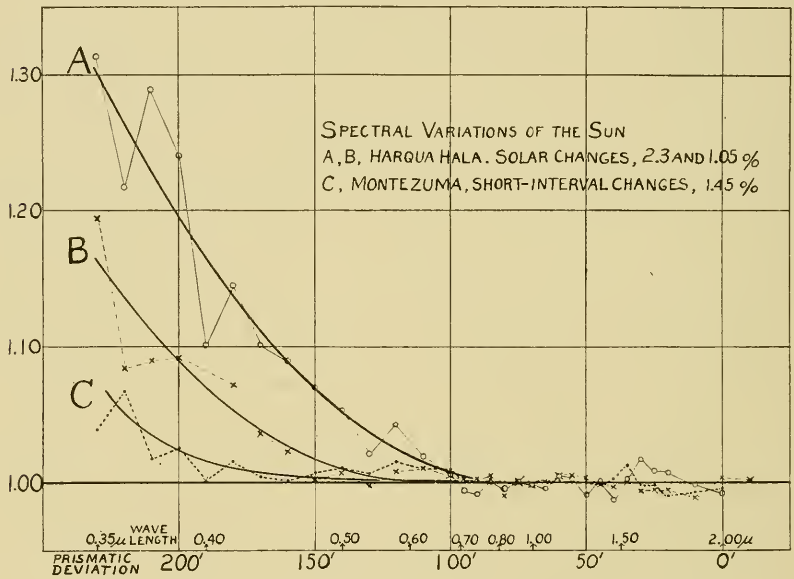

FIG. 6.—Solar variation localized in the violet and ultra-violet.

all; but that the solar variation keeps increasing, and very rapidly, as we go to the shorter and shorter wave lengths. With a range of only 2.3 per cent in total radiation, the ultra-violet, at wave length 0.35 micron, shows a variation in figure 6 of about 30 per cent. It would be supposed, in view of this, that if our observations should be continued to the limit of the solar spectrum, at 0.29 micron, we should find there, perhaps, as much as 100 per cent change. In other words, if the eye were sensitive to these extremely short wave lengths, it would see the sun twice as bright on some days as on others.

This expectation is confirmed by the observations of Dr. Pettit at Mount Wilson Observatory. By silvering a quartz lens, which thereby became opaque, except for a narrow range of wave lengths centering about 0.316 micron, he was able to select a very narrow region of ultra-violet spectrum, and compare its intensity outside the atmosphere with the intensity of the solar radiation in the green. The ratios of violet to green, in Pettit's monthly mean values, show a range of 60 per cent at a mean wave length of 0.316 micron.

It would naturally be expected that these large ultra-violet variations observed by Pettit would accompany exactly in point of time the variations of total radiation as determined by Smithsonian observations. Pettit has kindly communicated some of his results to me, and in figure 7 the two sets of observations are brought

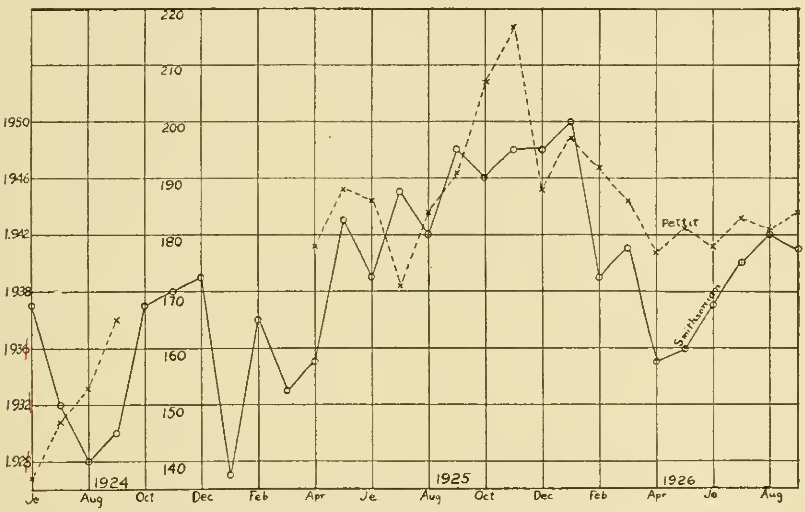

FIG. 7.—Comparison of Smithsonian monthly mean solar constant values with ultra-violet solar radiation values of Pettit.

together, with the scale of the ordinates of the Smithsonian work expanded to match that of Pettit. The agreement between the two series seems very satisfactory, in view of the fact that the range of total solar radiation is only about 1.5 per cent, so that one can not hope that the accuracy of the Smithsonian determinations is sufficient to give perfect correspondence on this very wide scale. Furthermore, Pettit has observed only on four days per month in the earlier part of his investigation; while in the latter part he has included every possible day, and among them some of doubtful uniformity of sky. In view of these circumstances it is not to be supposed that his monthly results are without considerable error.

Also, interestingly associated with solar variation are results recently communicated to me by Dr. Austin on the variation of inten-

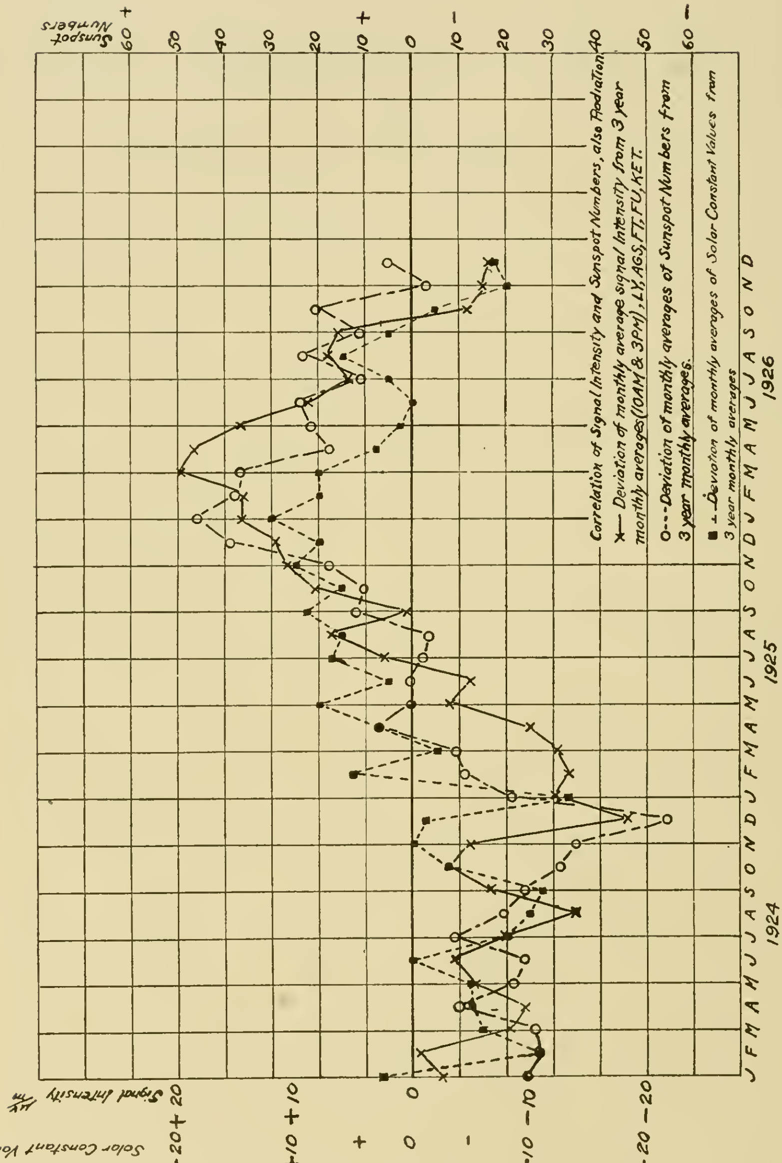

FIG. 8.—Correlation of long-range radio-signal intensity (Austin) with Wolfer sun-spot numbers, and Smithsonian monthly mean solar constant values.

sity of reception of long-range radio-transmission. Figure 8 gives three curves, as plotted by Austin. The first represents the monthly mean departures from a three-year's mean of the radio reception at Washington from several distant stations. The second curve shows similar departures of the Wolfer sun-spot numbers, and the third, the corresponding departures of the Smithsonian provisional solar constant values, given above in table 2. Dr. Austin has informed me that the probable error of his observations of individual days on radio reception is from 10 to 20 per cent, so that in the monthly means it must be from 2 to 4 per cent. The general accord of the three curves seems to indicate that the departures of monthly mean radio reception from average values are almost wholly dependent on the state of solar radiation.

In what has been said, we have been concerned only with long-interval changes of the solar radiation, and associated terrestrial phenomena. My colleagues and I have long believed that these changes are due to changes in the effective temperature of the sun's radiating surface, which depend on the activity of convection in the sun's substance. We have noted, also, solar fluctuations of such short intervals as a few days. These we attribute to the rotation of the sun which brings successively opposite to the earth regions of unequal radiating power, or perhaps, rather, of unequal absorbing or scattering power, on the sun's surface.

In harmony with this idea, the planets, which lie in different directions, viewed from the sun, will *successively* feel the changing influence of each inequality of the solar surface, as the rotation of the sun brings such inequalities into line with the planets successively. As the sun's equator is inclined to the ecliptic, the interval of time to be allowed differs a little from that which would be the case if the inclination were zero. Furthermore, if one observes from the earth some effect upon a distant planet, due to a variation of solar emission, the time of observation will be influenced by the time required for light to travel out to the distant planet and return to the earth. For the causal irregularity of the solar surface is moving by solar rotation while the light is on the way.

In Volume IV of the annals of Astrophysical Observatory, page 190, figure 13, a not unfavorable test of this hypothesis is given, depending on a comparison of observations by Guthnick of the planet Saturn as compared with Smithsonian observations of the solar constant of radiation.

While we are considering short interval solar variations, I give in figure 9 a series of curves taken from table 6 of Clayton's paper

TABLE 3.—*Mean Barometric Pressure Following Different Intensities of Solar Radiation*

Winter Half-Years 1918-1922

Station:		Winnipeg						Chicago						New York					
Normals:		.08						.18						.08					
			Days after						Days after						Days after				
Solar constant in calories	Number of cases	0	1	2	3	4	5	0	1	2	3	4	5	0	1	2	3	4	5
Above 1.971	37	.09	.05	.05	.03	.08	.05	.08	.11	.13	.06	.00	.01	.06	.09	.12	.19	.06	.05
1.961 to 1.970....................	71	.04	.04	.03	.06	.99	.05	.00	.06	.09	.07	.05	.07	.07	.08	.10	.18	.12	.14
1.951 to 1.960....................	127	.05	.05	.04	.03	.07	.08	.07	.05	.09	.09	.07	.09	.04	.07	.04	.05	.09	.07
1.941 to 1.950....................	114	.05	.03	.05	.10	.09	.06	.08	.09	.06	.10	.12	.10	.10	.14	.11	.10	.10	.13
1.931 to 1.940....................	64	.01	.00	.06	.02	.05	.00	.11	.08	.09	.06	.09	.13	.09	.10	.08	.07	.07	.07
1.921 to 1.930....................	41	.92	.97	.97	.97	.06	.06	.05	.05	.02	.04	.11	.09	.08	.02	.10	.04	.08	.16
Below 1.920	38	.96	.02	.00	.06	.04	.98	.04	.04	.00	.05	.10	.06	.10	.07	.07	.04	.12	.09

NOTE:—When the first figures in the table are .9, add 29 inches; when they are .0 or .1, add 30 inches to give the total barometric pressures.

entitled "Solar Radiation and Weather, or Forecasting Weather from Observations of the Sun,"[1] in which the barometric pressure for the cities of Winnipeg, Chicago, and New York, are compared, corresponding to conditions of high, medium, and low solar constant values. The data from which these curves are plotted are given in table 3. In plotting the figure, the dotted curves represent the march of barometric pressure corresponding to high solar constant.

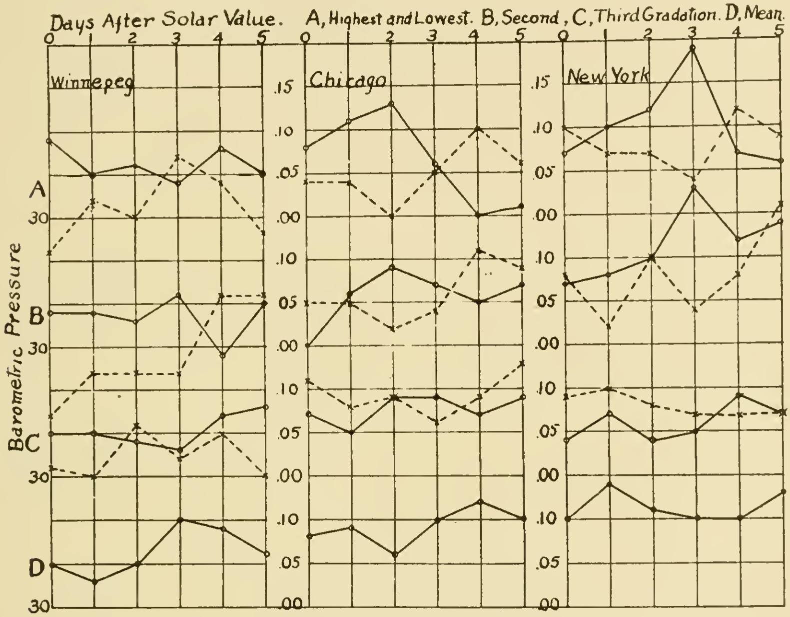

FIG. 9.—Barometric pressures attending and following high and low states of solar radiation.

In order to bring out what seems to me a strong case of continuity, I have brought together the pairs of barometric curves corresponding to the largest solar constant differences at the top of the figure, those corresponding to the smaller intervals lower down, and the mean at the bottom. It will be seen that for each of the cities the greatest deviation in barometric pressure corresponds to the greatest in solar constant, the next smaller to the medium in solar constant, and the least to the smallest difference in solar constant. The reader will perceive also that generally the full and the dotted curves run contrastingly like the right hand to the left. He will also see that the

[1] Smithsonian Misc. Coll., Vol. 77, No. 6. 1925.

largest pressure difference occurs at Winnipeg on zero day, at Chicago on the second day, and at New York on the third day after the solar constant event.

It is, of course, to be expected that any wave of disturbance of barometric pressure appearing in winter at Winnipeg on a certain day would drift eastward, and appear at Chicago and New York after about the intervals of time here shown. This is only ordinary well-known meteorological experience, and proves nothing as to the influence of solar variation. But that in the mean results of such numerous groups of cases there should remain residuals of the order of 0.15 inch in barometric pressure, and residuals so well exhibiting the principals of continuity and proportionality relative to a supposed cause seems to be, at least, very harmonious to the hypothesis that the assumed cause, solar variation, has a real relationship to the observed effects.

As it has been suggested to me that these results of Clayton's would perhaps be essentially modified had he been advised of the corrections to scale, mentioned in connection with table 2, I may add that his results concern only solar constant observations of the winter half-years between October 1, 1918, and March 31, 1922, during which only the few values of October, 1921, would be appreciably affected by the new changes of scale. It will appear, too, by inspection of figure 3, that this period was one of unusual freedom from great swings of the solar constant such as we attribute to general changes of the solar surface temperature, so that the fluctuations which he discusses will have been principally those of short interval.

From the various evidences assembled in this paper, added to many others previously published, my colleagues and myself are more and more encouraged to believe that our long investigation of solar variation will yield useful positive results.