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SOLAR MAGNETISM AND WORLD WEATHER

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Dr. Abbot looking at an impressive graph comparing forecast with observed precipitation at St. Louis, Missouri, 1866-1957.

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SOLAR MAGNETISM
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IN MY PAPER *Sixty-Year Weather Forecast*¹ I employed 23 approximate harmonics of 273 months to compute from *World Weather Records*, 1854 through 1939, the probable monthly percentage of normal precipitation at St. Louis, Missouri, from 1866 through 1957. This computed long-range forecast was graphically compared with observation through 1939 on a tabulated sheet 20 feet long and 1 foot wide, which was rolled upon a container for "Quaker Oats." I occasionally show this tabulation to visitors at my home. It invariably excites surprise to see the good agreement 1866 to 1940 between observed and predicted monthly precipitation. By permission of Mr. Don. Byers, I show two photographs taken from different distances, showing portions of the long graph.

I have improved my methods and published papers graphing long-range predictions of precipitation at 55 cities, and temperatures at 10 cities. In these are employed 27 exact harmonics of 273 months. All of these newer predictions converge on the date December 1949, but the predictions continue to December 1970. They relate to monthly and 4-monthly intervals, and are based on observations published in *World Weather Records*.

It lately occurred to me that though the period $\frac{273}{2}$ months is not strong in the variation of the sun's direct radiation, and was not used in my papers, yet since it is so important in solar and terrestrial magnetism, and in sunspot frequency, it might, through magnetic and electrical influences, be *indirectly* important for world weather.

¹ Smithsonian Miscellaneous Collections, volume 128, No. 3, 1955. (Publication 4211.)

About 60 years ago Dr. George E. Hale discovered magnetic poles in sunspots. As years passed, it was observed that *polarities reversed* at the beginning of each "Wolf sunspot cycle" of about $11\frac{1}{3}$ years length. So the "Hale cycle" of polarity in sunspots is 2 Wolf cycles, or about 273 months. I needed a long interval of comparison between forecast and observation to test my new idea, and employed the St. Louis result, extended by later tabulations found in my publication, *A Long-Range Forecast of United States Precipitation*,² to make up the results shown graphically in Figure 1.

Forecasts and observations for St. Louis are shown graphically in 4-month mean intervals in A and A₁, B and B₁, extending a full century from 1866 through 1965. Predictions are shown dotted, observed values are in full lines. In C and C₁ are graphed, on the same scale as A, B, the percentage differences B-A, B₁-A₁. At D, D₁ are curves showing approximately the nine Wolf sunspot cycles, 1866 through 1965. The following tabulation distinguishes the alternate representatives of the double Wolf cycle discovered by Hale.

<i>Group. No.</i>	<i>Extent</i>
I	1866-3 to 1878-2
II	1878-3 to 1889-3
III	1889-3 to 1901-1
IV	1901-3 to 1912-2
V	1912-2 to 1922-3
VI	1923-1 to 1934-1
VII	1934-1 to 1944-1
VIII	1944-1 to 1954-2
IX	1954-2 to 1964-1

On account of the close scale of years for the curves A, B, and C, it is difficult to see clearly the combined magnetic and radiation effect of $\frac{273}{2}$ month's period on long-range predictions. For clarity I computed the mean course of the first four groups of the foregoing tabulation, and smoothed it by the formula $\frac{1}{10}(a+2b+4c+2e+f)$, and the same for all four curves of Group II. The two resulting curves are repeated alternately in full and dotted lines for the 100 years at E, E₁. It then becomes apparent that a gradual rise occurs from about the middle of each full line to the middle of the following dotted line, and that minor overriding humps occur at average intervals of about

² Smithsonian Miscellaneous Collections, volume 139, No. 9, 1960. (Publication 4390.)

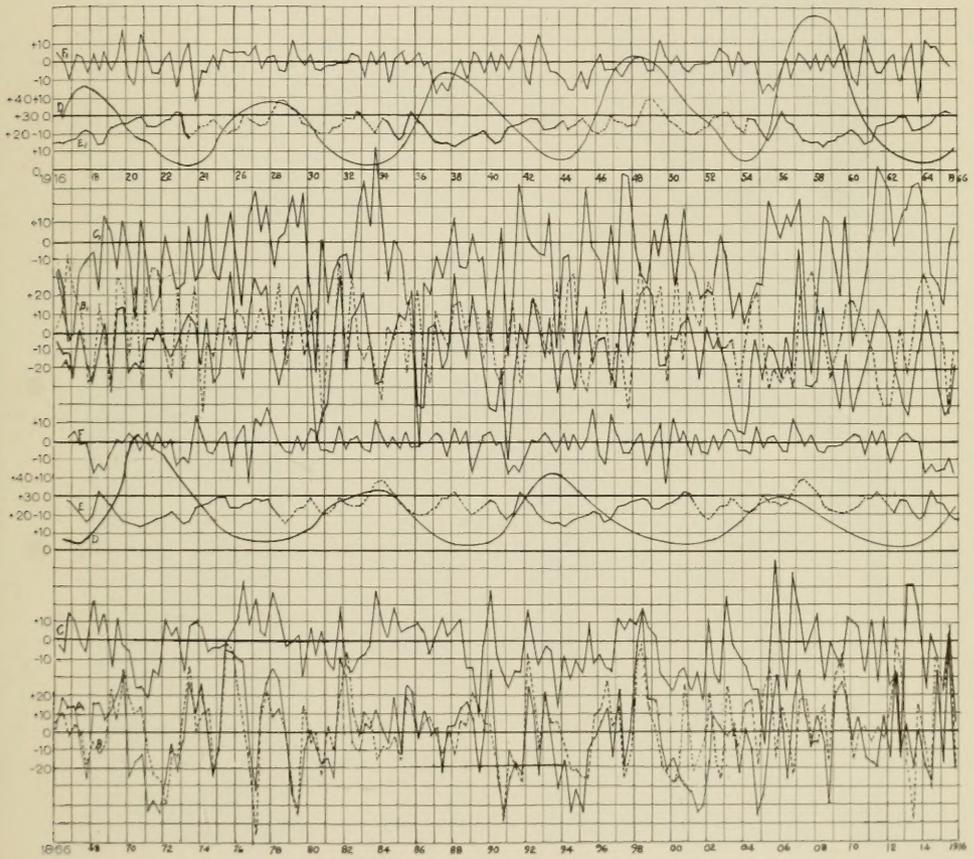
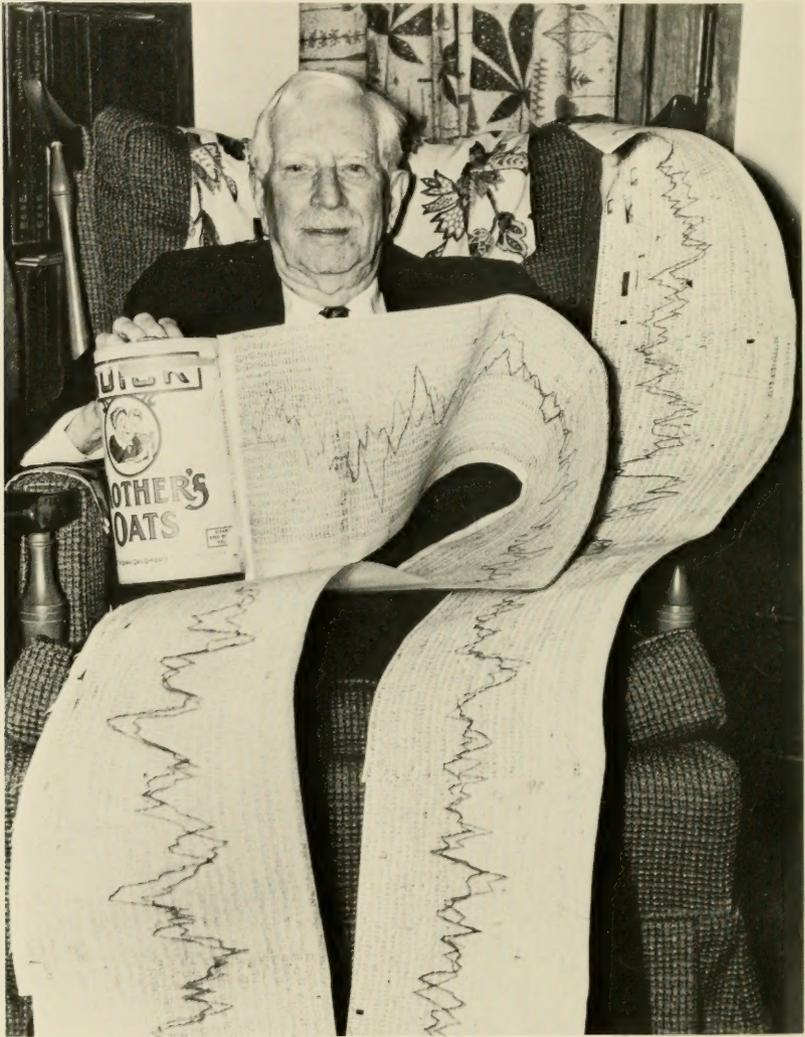


FIGURE 1.—Solar magnetism and St. Louis precipitation, years 1866 to 1966.
 For description see text preceding.



Another view of Dr. Abbot swathed in the 20-foot long graphic comparison of predicted and observed weather at St. Louis, Missouri, from 1866 through 1957.

25 months. The range in amplitude of the resulting main unit (combining full and dotted curves) of about $\frac{273}{2}$ months is about 20 per cent of normal precipitation at St. Louis.

The addition of this combined magnetic-radiation effect must materially improve my predictions, based heretofore only on the 27-period family of exact harmonics of 273 months. To measure its importance I added the new values from E, E₁ to the previous results graphed as A, A₁, subtracted the combined 4-month computed values from the observed observations, and found the mean departures. The intervals of the full lines in E, E₁ were treated separately from the intervals of dotted lines. To compare with these results I computed for the same intervals, separately, the means of 4-month departures between A, A₁ and B, B₁. The results of the comparison are as follows:

Average differences between observed 4-month precipitation and corrected forecasts—

For Groups I, III, V, VII, IX ± 7.8 percent of normal precipitation.

For Groups II, IV, VI, VIII ± 4.8 percent.

Average difference between observed and 4-month precipitation as heretofore published computed from 27 exact harmonics of 273 months:

For groups I, III, V, VII, IX ± 17.2 percent.

For groups II, IV, VI, VIII ± 15.5 percent.

So it appears that the employment of Dr. Hale's discovery, using the 27 harmonic periods together with the 28th period, $\frac{273}{2}$, yields considerable improvement in long-range forecasting at St. Louis over the century.

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