On the Correlation of Radio Transmission with Solar Phenomena *

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A DAILY character figure for radio transmission is obtained from the data of the short-wave transatlantic telephone circuits of the American Telephone and Telegraph Company. The New York-London circuits are in practically continual use so that they furnish data from which a character figure, representative of the whole 24 hours, may be derived. Such figures are based on the ratio of uncommercial to total time and thus are indirectly dependent on field strengths.

In order to facilitate plotting, these character figures were reduced to 3 group indices. Figure 1 shows the indices arranged to bring out the twenty-seven-day recurrence tendency. This is demonstrated by the apparent bunching of the spots into more or less vertical columns. Terrestrial magnetic data are shown alongside in similar form for comparison.

The recurrence tendency is well enough marked in the chart so that useful predictions of future behavior may be made. The chart is kept up to date and then by inspection a prediction may be made for any day not more than twenty-seven days distant. Some idea of the probable accuracy may also be obtained from the chart by noting whether the day in question falls, for instance, in the middle of a major sequence or on the ragged edge of a poorly defined one. Such probable accuracy is expressed by modification of the prediction with the words "probably" or "possibly."

The correlation between the two phenomena is good enough so that predictions of activity of one nature may be made from the chart of the other type of activity. For instance it would be possible to predict the radio behavior from the magnetic chart alone. This method has been found to yield the same order of accuracy as that using the radio chart alone.

Daily predictions of the behavior of the radio circuits from either the radio or magnetic chart have been correct 62 per cent of the time. Similar predictions of the magnetic data from the magnetic chart have

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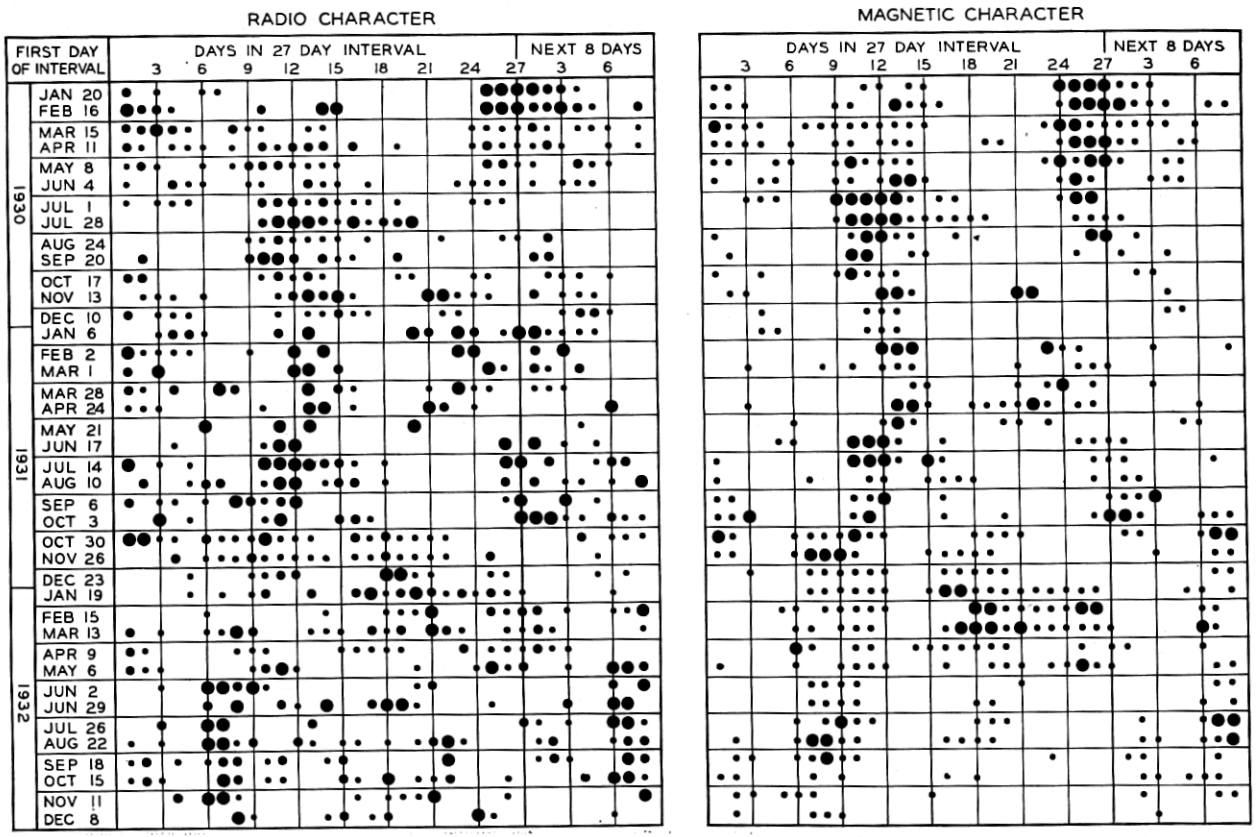

Fig. 1—Relative day-to-day record of short-wave radio transmission over the North Atlantic Ocean and terrestrial magnetism activity for 1930, 1931 and 1932, demonstrating the 27-day recurrence tendency. The dot size corresponds to the severity of disturbance.

been correct 71 per cent of the time. These figures have been determined solely on the basis of "disturbed" or "undisturbed" and modification of the forecasts by the words "probably" and "possibly" have not been taken into account.

This method of making predictions, even in its present state, is of definite use commercially. Special forecasts of the same nature have proved useful in planning certain experimental studies.

Well defined sequences of activity of an approximately 27-day period are also apparent in data of solar phenomena, particularly those relating to sunspots, bright and dark hydrogen flocculi,[1] and prominences. An attempt to link such solar sequences with the terrestrial ones noted above in a cause and effect relationship was not, however, very successful. For several well marked radio (and magnetic) sequences it was found that no single type of solar activity could be identified in such a manner as to exhibit a clear cut relationship. For some of the sequences there was some form of solar activity near the center of the sun at the time of each radio disturbance but such activity varied between recurrences in heliographic latitude and longitude and in kind.

A similar indefinite result was found by starting with the solar sequences and attempting to match the terrestrial data with them. For instance an area on the sun approximately in heliographic latitude + 10° and longitude of 315° to 329° exhibited the presence of either hydrogen flocculi, prominences, or sunspots or combinations of these on each transit across the face of the sun from October 21, 1932 to February 9, 1933, a total of five transits. Sunspots appeared in this region on the last four transits and their identity over this period of time was noted at Mt. Wilson Observatory.[2] Although the times of central meridian crossing of this area fall within a well defined sequence [3] on the radio chart (between days 6 and 9 on the left at the bottom of the chart) the absence of activity on this solar area for earlier recurrences of the radio sequences tends to vitiate the relationship between radio disturbances and those types of solar activity which were observed. Nevertheless, the reality of the 27-day period in radio is strong indication that solar activity is responsible, even though not convincingly identified in detail.

Various other criteria were used for segregating the solar data for correlation. For instance, a study of the solar distribution of flocculi

[1] Hydrogen flocculi are clouds of hydrogen gas observed with a spectrohelioscope set on the hydrogen line H_α.

[2] *Publ. Astr. Soc. Pac.*, 45, 263, 53, Feb. 1933.

[3] This sequence is considerably strengthened by increasing the number of group ndices into which the data are divided.

and spots on terrestrially disturbed and quiet days shows a maximum and minimum, respectively, about 13° west of the center (one day past); see Fig. 2. These curves are interpreted as indicating that the

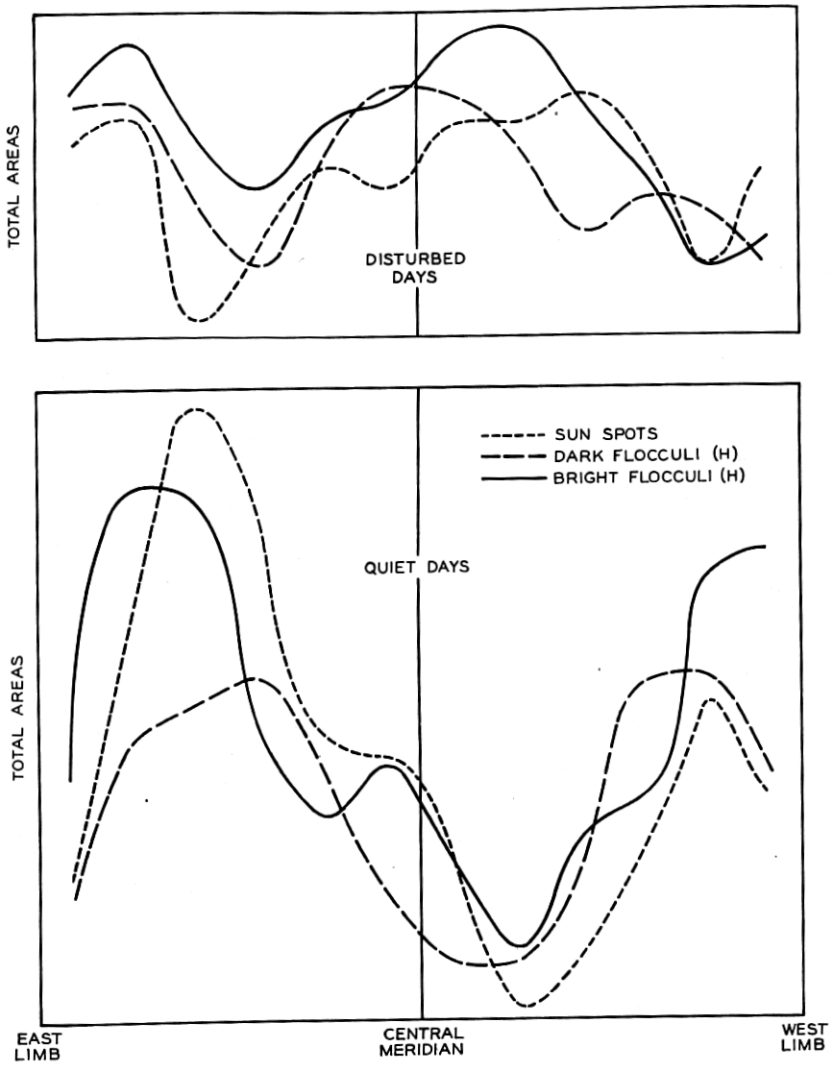

Fig. 2—Distribution across the solar disc of solar phenomena on terrestrially disturbed and quiet days.

most probable position of flocculi and spots on disturbed days is 13° west of the center of the solar disc and that on quiet days it is other

than in this region. The one-day interval from the center is interpreted as the time taken for the propagation of the disturbance from the sun to the earth.

Probably one reason for the indecisive nature of the results is to be found in the intermittent manner in which the solar data are necessarily obtained. It seems likely that considerably more success might be obtained in determining the solar-terrestrial relationships, if the solar disc could be watched continually on a world-wide program of observation, as Hale [4] has suggested, to record all solar outbursts and so to increase the completeness of the solar data until they approach those of the terrestrial.

[4] *Astrophys. Jour.*, 73, 408, 1931.