ERRATA

Page	Line	Read	For
27	12 (from the bottom)	has	had

On the Correlation between the Frequency of the Earth-Current Pulsation and the Solar Activity

By Kazuo Yanagihara

Although a number of studies has been made of the pulsations of the geomagnetic field and earth-currents, it seems uncertain whether they are more frequent in disturbed or in quiet epoch of the sunspot 11-year cycle. It may be partly due to the difficulty of the study which arises from the fact that the so-called "pulsations" may be classified into several kinds of types and origins. Moreover, the study becomes more complicated because the higher the sensibility of the measuring apparatus becomes, the more numerously the pulsations are found.

In the classification of pulsations concerned, H. Hatakeyama[1] found from the comparison of the amplitudes of the geomagnetic pulsation both at Toyohara and Kakioka that there were two kinds of pulsations, one of which was caused by the polar origin and the other by the equatorial origin. Meanwhile, it seems to the author that the pulsations of different periods have many different characters, especially in the local time frequency distribution of the occurrences, as T. Terada's results[2] of investigation on the magnetic pulsations observed at Misaki had shown that during the daytime, waves of 0.5～1 minutes periods predominate, whereas during the night hours longer periods 1.5～2.5 minutes are more frequent. In earth-currents, similar results were found by H. Hatakeyama[3], though the critical period was shifted to the shorter side.

Through the registration of earth-currents at Kakioka by ordinary recorder covering about two recent sunspot cycles, most frequent occurrence of pulsations are found (i) in the night hours as the waves of longer period or those accompanied by the "Bay-type" variation and (ii) in the daytime, especially in the early forenoon of the storm time, as the waves of shorter period. In respect to the amplitude, the greater ones are found in night hours. The pulsations of the case (ii) are characterized by the continual series of the waves of shorter period through several hours

or even half a day, though sometimes they can be divided into many groups of the wave trains. In this case their amplitudes are not so great generally. On the other hand, in the record of the time derivative of the magnetic field, say dH/dt, the pulsations of such a type might be found most distinctly throughout a day, because the $1/\sqrt{T}$ law relating the amplitude of the earth-current variation to the magnetic variation must be replaced by 1/T in the relation between the variation of dH/dt and that of the magnetic field, where T is the period of the variation concerned.

For the statistical study of the pulsations of the earth-currents, the above facts make it favourable to adopt the pulsations of the type (i). Since those pulsations with greater amplitude occur mostly as rather isolated wave trains with longer period, it is possible to study those characteristics through many years by ordinary electrograms, of which the time scale is about 15 mm per hour at Kakioka, provided that photographic traces are constantly kept sharp.

Firstly, the local time activity distribution of those pulsations during storms has been studied in order to test whether or not the pulsations of the type (ii) cease to occur in the night. On the first day of the main magnetic storms which occurred in the period, Mar. 1947–July 1948, the maximum amplitudes of the earth-current pulsations occurred in each hour interval at Kakioka are taken. In Fig. 1, the means of those maximum amplitudes for each three hours in local time are shown.

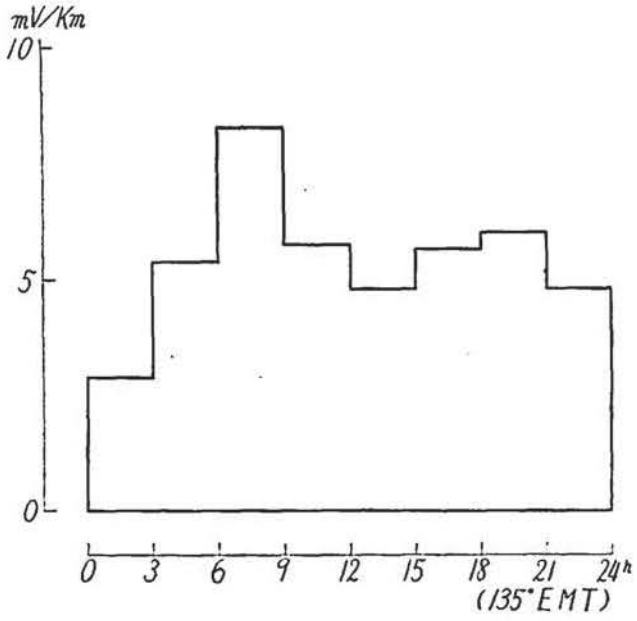

Fig. 1. Local time distribution for the mean of maximum amplitudes of the earth-current pulsations. (type (ii))

In this distribution, the pulsations of the type (i) are also contained, but the period adopted above is at and near the sunspot maximum time, when the occurrence of the type (i) is less frequent, as shown in the latter part of the present paper.

It is interesting that the two maxima of the mean maximum amplitude are

found near 6 h and 18 h in local time, though the study of it is not a purpose of this paper. The occurrence of the pulsation of the type (ii) is the least frequent in three-hour interval of 0h–3 h; that is a favourable result for the statistical study of the other pulsations frequently found around midnight.

In the further work, the author has used the pulsations which occurred in five-hour interval beginning at 23 h in local time. At Kakioka, the eastward component is the most prevalent one of the amplitude of the earth-current variation, and the range of the diurnal variation in the component is about 20 mV/km. Therefore, the pulsation, whose amplitude exceeds 20 mV/km in that component, is the distinct variation in the above mentioned interval.

Thus the day in G. M. T. on which the pulsation whose amplitude exceeds 20mV/km are found in that interval, is called here the "disturbed day", so far as the pulsation concerns. As regards the upper limit of the period of the pulsation concerned, 3 minutes is adopted, since it is known from the preliminary morphorogical works that the periodic variation of period longer than 3 minutes has some different characteristics from that of the pulsations mentioned above.

Annual sums of the numbers of the "disturbed day" for 20-year period, 1934 ~1953, is shown in Fig. 2, together with the annual mean relative sunspot numbers. It is clearly seen in the figure that the pulsation activity correlates to the sunspot activity with high but "negative" correlation coefficient. The slight increase in the curve near the sunspot

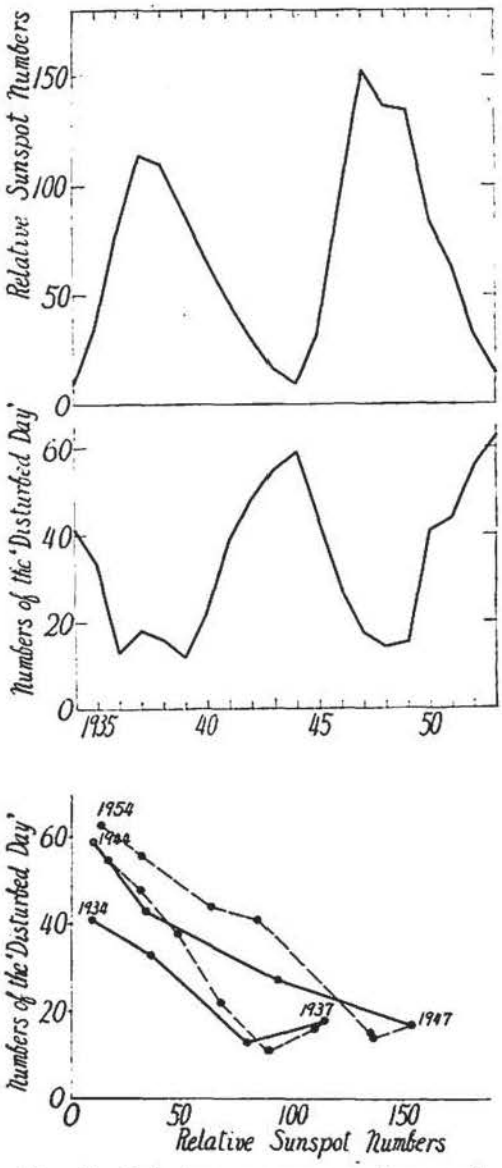

Fig. 2. Relative sunspot numbers and numbers of the "disturbed day".

maximum year might be caused by the addition of the pulsations in the storm times.

In the geomagnetic field, it is not possible to study the corresponding pulsations without the quick run magnetograms with high sensibility, because of their small amplitude. Generally speaking, the earth-current variation is statistically related to the geomagnetic one by $1/\sqrt{T}$ law in amplitude though the effective anisotropic conductivity of the earth brings complicated circumstances into the earth-currents phenomena. Therefore, it seems to be certain that the above "inverse proportionality" which means here that the correlation coefficient is "negative" is hold also between the geomagnetic pulsation and solar activities.

It is obvious that most frequent finding of the pulsations in quiet years of the geomagnetic or earth-ourrent activity is not due to the difficulty of finding those on disturbed records, because the lower limit of the amplitude, 20 mV/km, is too large to escape from our seeking.

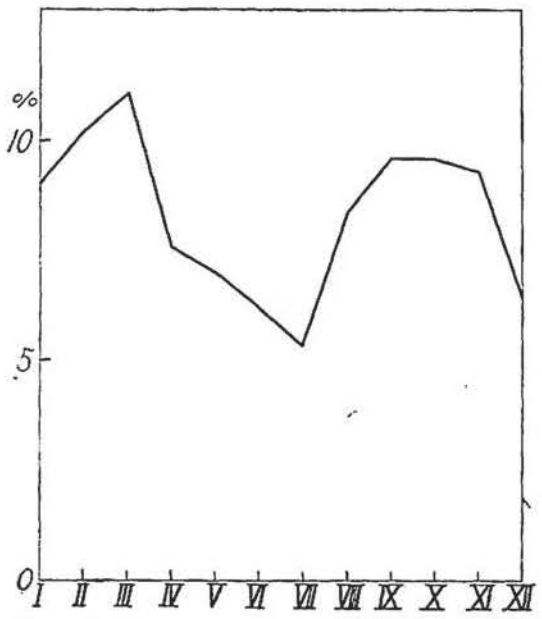

Fig. 3. Frequency distribution of the "disturbed day" for each month.

Our result of inverse proportionality between the pulsation and sunspot activity cannot be considered to be due to the direct solar origin, but it may be caused by the increased conductivity of the ionosphere in and near the sunspot maximum years.

It is worthwhile to turn our attention to the annual variation of the frequnency of the disturbed day defined here. The twelve monthly mean percentage of the frequency of those disturbed days are shown in Fig. 3. The curve is not so smooth, but rather a double wave with the maxima near equinoxes is pronounced; that is the normal annual variation for the earth-currents or geomagnetic activities.

References

(1) H. Hatakeyama, Geophys. Mag., Vol. 12, (1938), 173.
(2) T. Terada, Jour. College Sci. Imp. Univ. Tokyo, Vol. 37 (1917).
(3) H. Hatakeyama, Geophys. Mag., Vol. 12, (1938), 189.