

An Attempt to give an Index to the Activity of pc-type Pulsations and its Applications to the Analysis of Geomagnetic Storms.

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概 要

pc型脈動の活動度に index を与える試みについては既に前論文に於て詳細に述べたところであるが、今回その具体的事象への応用に当つて、P-index 設定の経緯並びにその有用性について再述すると共に、地磁気嵐解析への応用の一端として、地磁気嵐時に於ける P-index の推移及び P-index 日変化に擾乱日変化が存在するか否かの問題について追究してみた。今回の調査からは pc 型脈動の活動度変化には Dst に相当する嵐時変化は明らかに存在しその統計的变化型態も明瞭に引き出すことが出来たが、SD に相当する擾乱日変化についてはその存在は全く否定的であると考えられる結果を得た。

§ 1. P-index

In the previous paper, the author attempted to express quantitatively the activity of pc-type pulsations using the P-index defined there. Geomagnetic pulsations in middle and low latitudes are divided into two principal classes, pt and pc, from their characters appearing on the magnetograms; this classification, which has been recognized surely by many investigators, was defined in the resolution of the General Meeting of I. A. G. A. at Tront, 1957. In addition to these two classes pt and pc given to rather typical events, many phenomena of pt-like and pc-like pulsations exist. The pc-type pulsations treated here mean the group of pc and pc-like pulsations, which have rather smooth and sinusoidal trace on magnetograms with shorter periods than about 40 sec, where it is not needed that they have long continuities. To use P-index in place of occurrence frequency or rough measure of activity is the first progressive step for the quantitative analysis of the activity of pc-type pulsations. The index P has the 10 grades, 0 to 9, and the maximum-double-amplitude of pc-type pulsations in each 5 minutes interval determines the value P for that interval.

In this paper, this index is applied to the records of the induction magneto-

grams at the Memambetsu Observatory during the period of the IGY. The location of this station is as follows,

	Latitude	Longitude
Geographic	43°55'N	144°12'E
Geomagnetic	34.°0 N	208.°4 E

The induction magnetograph at this station has two large horizontal loops and a vertical one, buried in the earth, as detectors. Its recording speed is 12 mm/min., and the sensitivity is about 0.07 γ /sec/mm in the horizontal component. P-index is given here to the horizontal component only.

As mentioned in the previous paper, the scaling criteria of P-index is decided in the similar way as that of K-scale. The lower-limit-values of each grade of P-index as shown in Table 1, the name "P-scale" being given for the scale.

Table 1

P	P-scale for Memambetsu									
	0	1	2	3	4	5	6	7	8	9
Lower-limit-values of each index in γ /sec	0.00	0.04	0.07	0.13	0.22	0.34	0.49	0.67	0.88	1.12

In the previous paper, the study of the accumulative distribution and the diurnal variation of the P-index was worked for the equinoctial and solstitial months in the period of the IGY. Moreover, the relation between the activity of pc-type pulsation and the geomagnetic activity or storms was also studied, and its conclusion was as follows,

(1) pc-type pulsations are generally active in the geomagnetically disturbed period.

(2) Occasional appearance of the great typical diurnal variation of hourly-sums of P-index in the undisturbed period, does not mean any relation between the activity of pc-type pulsation and geomagnetic activity, but they have also a tendency to appear in the period following rather high geomagnetic active period.

(3) The increase of hourly-sum of P-index in the storm-period is characteristic, especially in the sudden increase of P-index at the time of storm commencement. They have no connection with its typical diurnal variation-form.

But, in the previous paper, the analysis of components of the variation in the storm period has not been worked so satisfactorily, because the general diurnal variation could not be sufficiently eliminated owing to insufficiency of data. Then, in this paper, the author adds more data and studies the storm-time variation (Dst) and the disturbance-diurnal variation (SD) of the P-index.

§ 2. Storm-time variation and disturbance-diurnal variation in the P-index

Analyses are done in regard to 41 geomagnetic storms, which are all of storms with larger maximum range than 100γ in the horizontal component of geomagnetic field at Memambetsu during the IGY, from July 1957 to December 1958. P-indices are measured for 4 days beginning at 48 hours before the storm commencement.

Then, for the purpose of eliminating the ordinary diurnal variation and deriving the storm-time variation in P-index, the superposed-epoch-method making 0 h (in storm-time) the centre is adopted here, and this results are shown in Fig. 1 and 2, which show the statistical results in hourly-sum of P-index, ΣP , and P-index itself, respectively. As it is evident in Fig. 1 the hourly-sum of P-index, ΣP , grows up suddenly at the time of storm commencement. This fact is more minutely indicated in Fig. 2. As this figure shows the plot of P-index itself, which is decided in each 5 minutes interval, it is surely confirmed that the change of the activity of

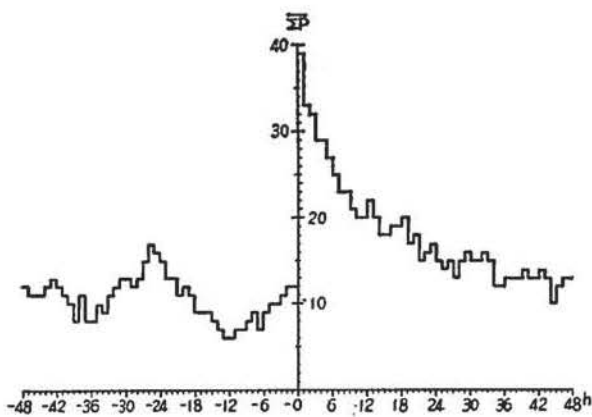


Fig. 1. The change of the hourly-sum of P-index, ΣP , for 4 days beginning at 48 hours before the storm commencement.

pc-type pulsations commences at about the same time of storm commencement.

From these figures, it may be known also that the activity of the pc-type pulsations decreases smoothly and exponentially in the course of storm time beginning immediately after the sudden increase mentioned above.

This decrease continues about 36 hours, and after the period P-plot becomes flat. The figure of P-plot for the period before the storm commencement

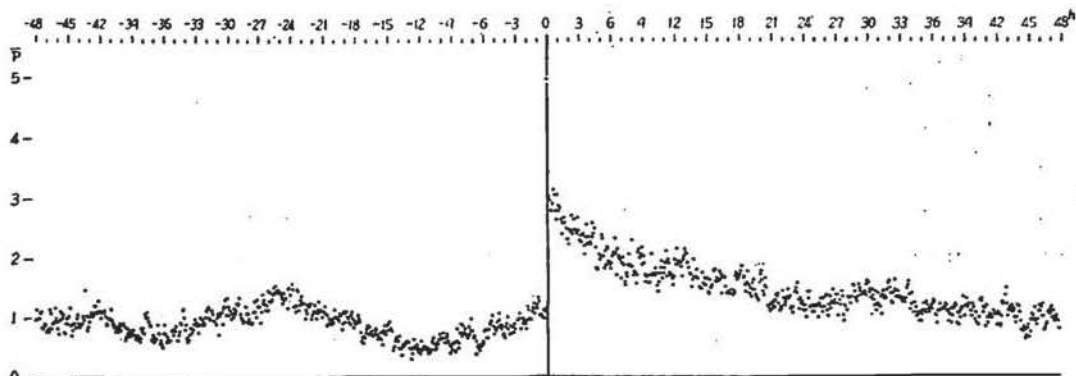


Fig. 2. The change of P-index itself [for 4 days beginning at 48 hours before the storm commencement.

shows some diurnal-variation-like change. It may be due to the insufficient elimination of ordinary diurnal variation. If more sufficient volume of data are available, the curve becomes perhaps flat on their mean level. The mean level is nearly equal to the flat portion after the storm. From these fact, it can be said that pc-type pulsations, in their activity, have a characteristic storm-time variation corresponding to the Dst in the ordinary geomagnetic field during the period of storm, and this storm-time variation is named as "P-Dst" in this paper. The P-Dst continues about 36 hours from the storm commencement, and its change is exponential.

Next, the author studies whether the disturbance diurnal variation, corresponding to the SD in the ordinary geomagnetic field, exists or not in the daily change of P-index during the storm period. To compare the diurnal variation of P-index in geomagnetically disturbed days with that in ordinary days, the hourly-sums of P-index, ΣP , in 24 hours following to the storm commencements are arranged in local time. Mean diurnal variations thus obtained are shown in Fig. 3, where the broken and full lines show the diurnal variation in the first day of storm and the day immediately before the storm commencement, respectively. Just before the storm the diurnal variation is statistically nearly equal with the diurnal variation averaged over 4 months, December 1957, March, June and September 1958, which has been reported in the previous paper and reproduced here in Fig. 4. The local

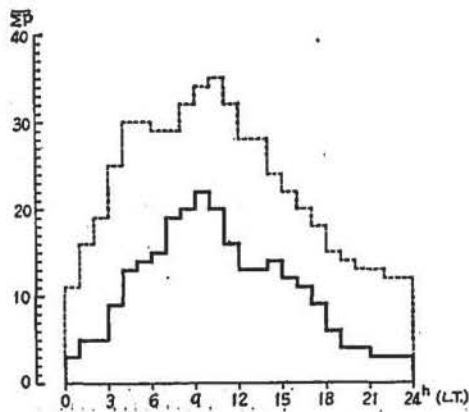


Fig. 3 The diurnal variation of the hourly-sum of P-index, ΣP , in 24 hours following (broken line) and preceding (full line) to the storm commencement.

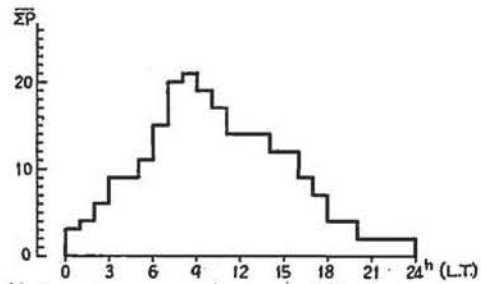


Fig. 4 The diurnal variation of the hourly-sum of P-index, ΣP , averaged over 4 months, December 1957, March, June and September 1958.

time mean P in storm days keeps higher level than that in general days, but any significant difference is not found between their diurnal variations, except the difference between their mean levels. Comparing Fig. 3 with Fig. 1, it is obvious that the difference of their levels is due to the storm-time variation, P-Dst. That is, in this present study, the author could not detect any evidence to say that there exists the component of the disturbance-diurnal-variation, corresponding to the SD of the

ordinary geomagnetic field, in the daily change of P-index during the storm period.

§ 4. Conclusion

For the estimate of activity of pc-type pulsation for the short time-interval it is needed to express faithfully its change, though labour for computation becomes much more with shortening the time interval. The author adopted here the five minutes interval and 10 grades of maximum amplitude in view-point of simplicity of works and possibility of extensive applications.

The author is confident of that the P-index is very effective method at present for analysis of the activity of pc-type pulsation.

The abstracted results in this study are arranged as follows. The activity of pc-type pulsations have the characteristic storm-time variation, P-Dst, which has the sudden and instantaneous increase of P-index at just the same time as the storm commences, and is followed by the smooth and exponential decrease to the pre-storm level. But there is little or no difference between the diurnal variation eliminating P-Dst on a day of storm and the general day's diurnal variation; in other words, no evidence was found that there exists, in the activity of pc-type pulsation, the disturbance-diurnal-variation corresponding to the SD of ordinary geomagnetic field on a day of storm.

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