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GEOMAGNETIC Sq-VARIATION DURING NIGHT-TIME

By

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Abstract

Concerning the geomagnetic Sq-variation, many papers have discussed variations during day-time. In fact, that is the main part of Sq-variation, but, on a close investigation, Sq-variation during night-time shows a systematic morphology. In this paper, using the data of the Second Polar Year, some special methods of statistical investigation on Sq are shown, and a distinct seasonal difference is detected. In the course of study, Non-Cyclic-Change and non-systematic errors are discussed from the stand-point of statistical investigation of geomagnetic variations. The research is not finished and investigations of the asymetric part centered at mid-night must be undertaken. This result of data-arrangement will serve to discuss the base-value of the geomagnetic field at the respective observatories, and also to supply original data for theoretical investigations such as the wind-system in the ionosphere and the conductivity-anomaly of the earth's interior.

1. Introduction

According to the definition, the geomagnetic Sq-variation (Sq) is an average state on geomagnetically quiet days (Ota [1968]). The Sq-field which causes Sq is conventionally expressed by an overhead current-system as shown in Figs. 1 and 2, which are expressed by magnetic equipotential lines (Hasegawa and Ota [1948]). As an attempt of an expression of Sq, day-time-variation is shown in the previous paper (Ota [1954]). The idea of this paper is the following standpoints:—as for morphological investigation Sq shows nothing during night-time, but this neglects small amounts of variation from sunset to sunrise. Recently, the accuracy of instruments has become good, and so an order of gamma ($10^{-5}\Gamma$) may be discussed in an investigation of data-arrangement. Thus, the above neglect which means no Sq during night-time is to be reconsidered. In this paper, using the geomagnetic data of the Second Polar Year, which are satisfactly arranged for statistical investigations, variations during night-time are detected, separate from those during day-time.

It is obvious that Sq during day-time is a large variation compared with that during night-time, and so some amount of variation affected by the former is seen on magnetograms near the hours of sunset and sunrise. Therefore, for the purpose of detecting night-time-variations the writer picks out variations during serveral hours centered at mid-night, when geomagnetic variations are not affected by Sq during day-time. Next, we have to take into account Non-

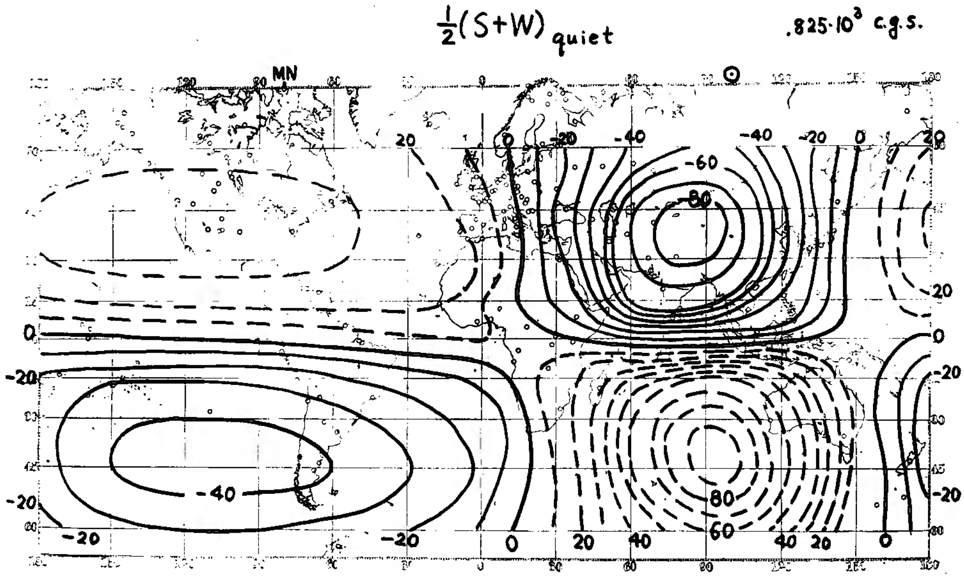

Fig. 1. Equipotential line, annual mean of Sq.
(after M. Hasegawa and M. Ota [1948])

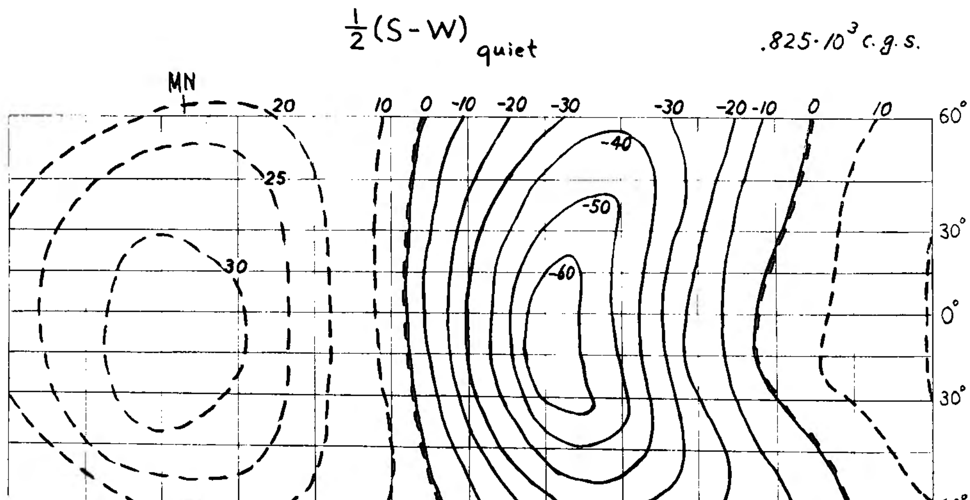

Fig. 2. Equipotential line, seasonal difference of Sq.
(after M. Hasegawa and M. Ota [1948])

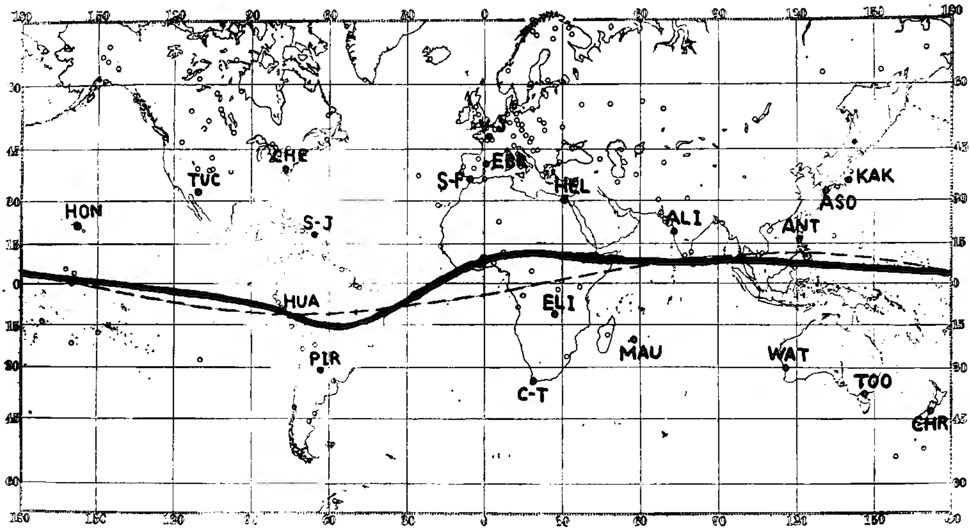

Fig. 3. Distribution of the observatories used here.

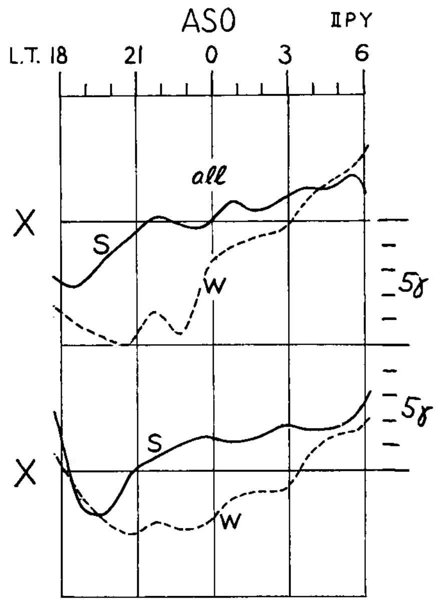

Fig. 4. Night-time-variation, X-component, observed at Aso during II PY.
Upper : mean of all days.
Lower : mean of international quiet days.
S : June solstice.
W : December solstice.

Cyclic-Change (NCC). As Sq during night-time is very small (less than a few gamma per hour), this problem is to be treated with care. Though a satisfactory method was not found, the writer decided to discuss the seasonal difference between summer and winter, and this is the reason why NCC will be eliminated by calculating the difference between the two curves of night-time-variations.

2. Treatment of data

Data used here are the average states of Sq of the June solstice (S, Su: mean of May, June, July and August) and of the December solstice (W, Wi: mean of November, December, January and February) in the middle latitude. Fig. 3 shows the distribution of the observatories used here. It may be usually considered that some disturbances are included in Sq. In order to verify this, a preliminary treatment was done, using the data of the Aso Magnetic Observatory in Japan. Fig. 4 shows night-time-variations of quiet days and of all days. In this consideration, it is implied that average state of all days is more disturbed compared with that of quiet days. By the curves in Fig. 4, it is easily seen the following tendencies:—the first, NCC of all days is larger than that of quiet days; the second, annual mean-state of the variations (S+W) is not distinguishable between curves of all days and of quiet days; the third, seasonal difference of the variations (S-W) for disturbance-effect is not seen, as also shown in Fig. 5. By these facts it may be said that seasonal difference is not affected by geomagnetic disturbances, if NCC is excluded, and shows a systematic character.

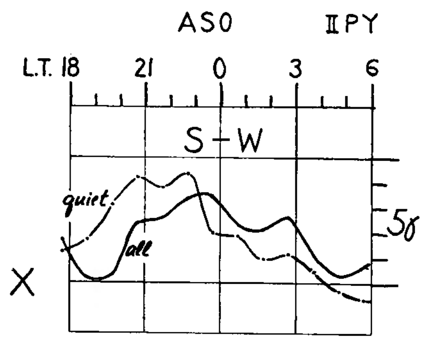

Fig. 5. Seasonal difference (S-W) of night-time-variation, X-component, observed at Aso during II PY.
All : mean of all days.
Quiet : mean of international quiet days.

3. Results of data-treatment

The statistical results for the seasonal differences (S-W) are shown in

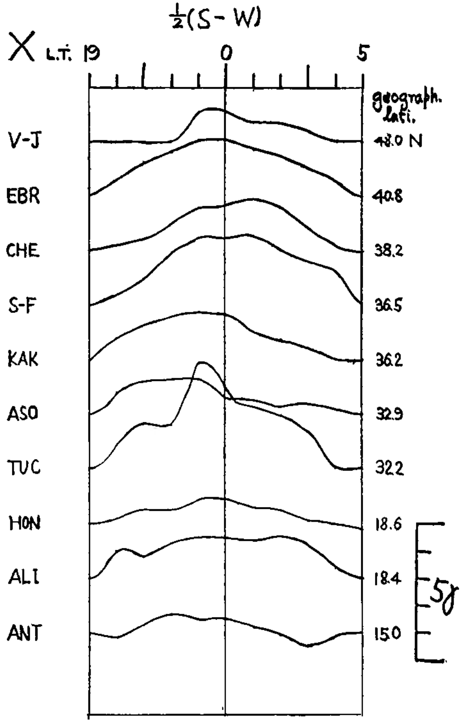

Fig. 6–1. Seasonal difference of night-time-variation, X-component.
(The observatories in the north hemisphere)

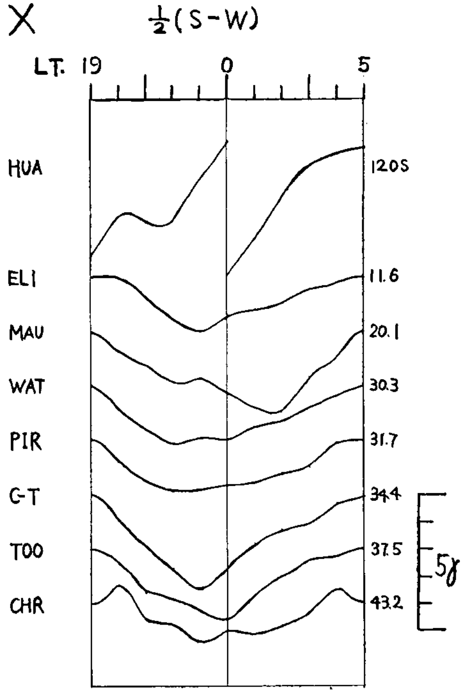

Fig. 6–2. Seasonal difference of night-time-variation, X-component.
(The observatories in the south hemisphere)

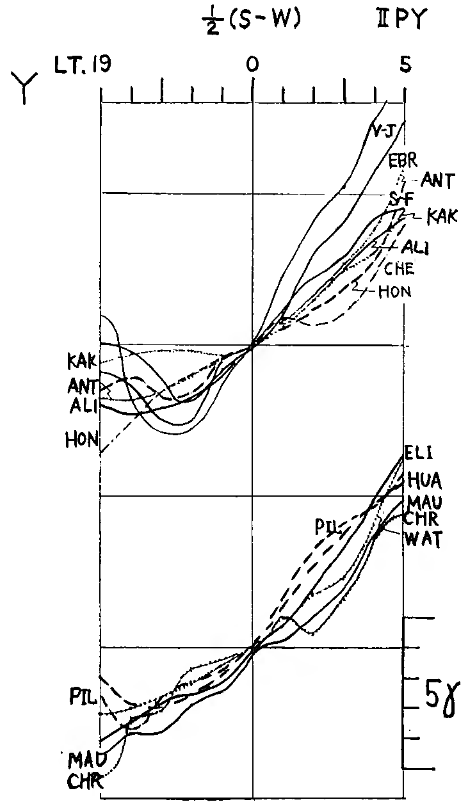

Fig. 7. Seasonal difference of night-time-variation, Y-component.

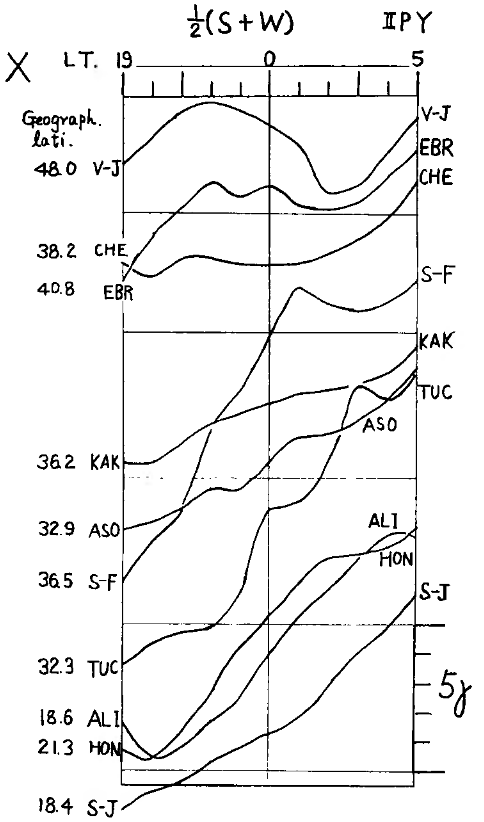

Fig. 8-1. Annual mean of night-time-variation, X-component.
(The observatories in the north hemisphere)

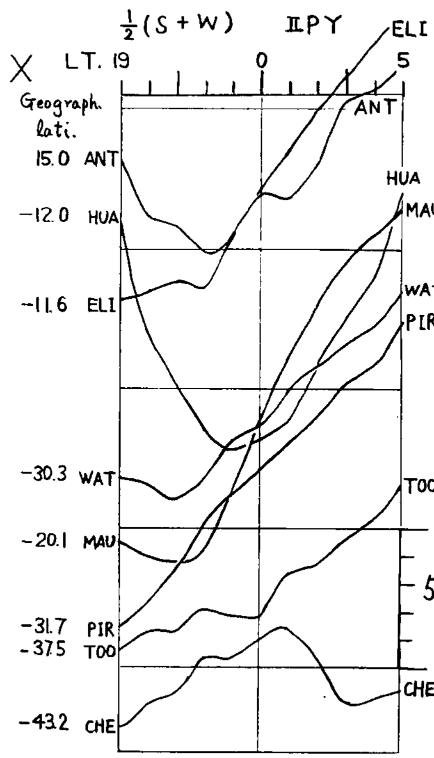

Fig. 8-2. Annual mean of night-time-variation, X-component.
(The observatories in the south hemisphere)

Figs. 6 and 7, and the annual means (S+W) in Figs. 8 and 9. As described in the previous article, we cannot find any systematic character of night-time-variation for both components X and Y of the annual mean-state, as shown in Figs. 8 and 9. On the contrary, a systematic result is seen in the seasonal difference, which shows distinct features for each hemisphere except the magnetic equator (HUA). The writer interprets this to mean that the X-component at the magnetic equator includes the Y-component, because an axis of Sq-variation is deflected from the axis applied here (geographical axis). It is most important to make clear non-systematic errors, which have to be discussed by the theory of error. In this paper numbers of days for respective curves in the figures are about 120 and sufficiently large for statistical investigation. That is why means of all days are adopted instead of means of international quiet days.

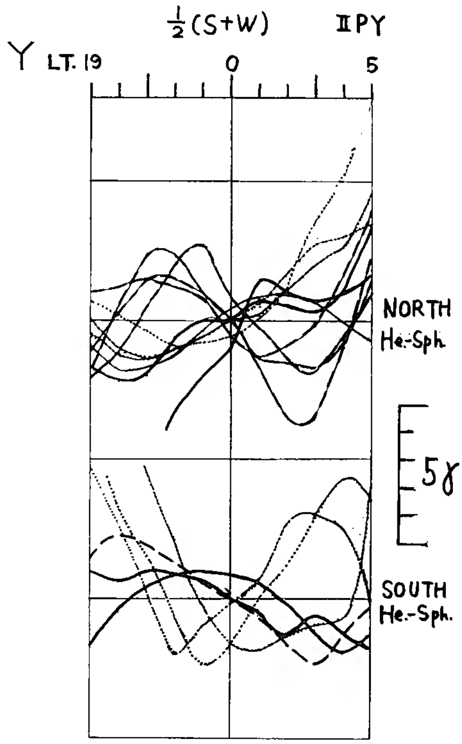

Fig. 9. Annual mean of night-time-variation, Y-component.

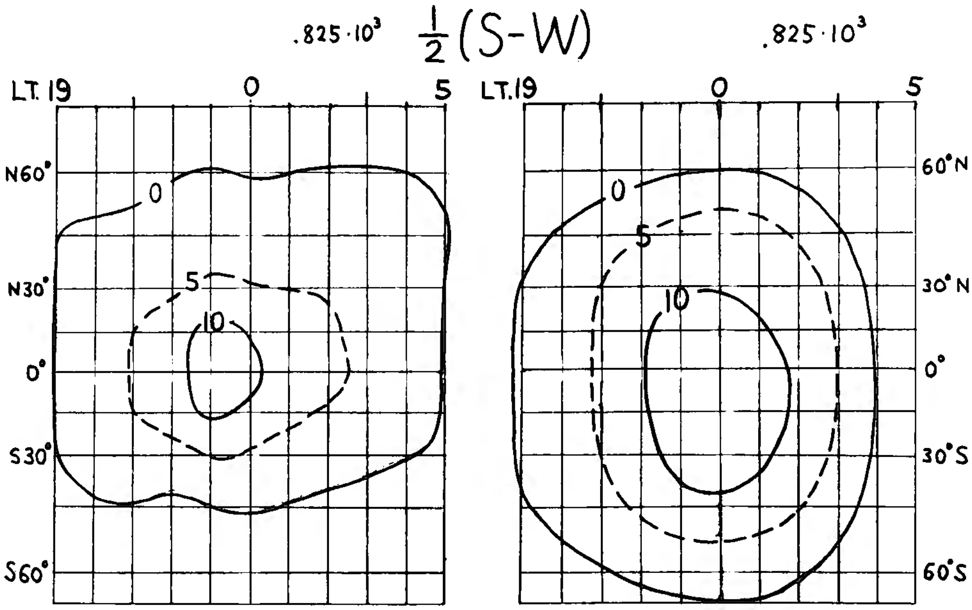

Fig. 10. Equipotential line for night-time-variation, seasonal differences.
(Left) the present result.
(Right) the conventional one.

4. Average state of night-time-variation and a comparison with the conventional one

Using the results of data-treatment described in the previous article, a map of magnetic equipotential lines is shown in Fig. 10 (left). Fig. 10 (right) is a part of night-time redrawn from the conventional one, Fig. 2, and serves to compare it with the present result (left). Some differences are seen in these two, but the comparison has no meaning, as they are to be essentially the same. Differences, if they exist, are caused by the zero-line of potential.

5. Conclusion

This investigation is continuing now. On precise investigation, it becomes clear that an asymetric part centered at mid-night is seen. This fact implies some difference between geomagnetic variations at the evening side and those at the morning side. Discussions of this problem will be published later. This problem will serve to define the base value of the geomagnetic field.

References

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