Wind Systems for the Geomagnetic S_d Field

Horizontal wind-systems in the ionospheric E -region required to produce the solar daily magnetic variation on disturbed days (say, S_d) are deduced along the same line as in the case of S_q [1, 2]. The data used are the horizontal intensity of the geomagnetic S_d -variations* at 62 stations over the world for the mean solstice during the International Polar Year, 1932–33. The harmonic coefficients of the North (ΔX) and East (ΔY) components are plotted in Fig. 1. The dotted (for ΔX) and full (for ΔY) lines show a smooth distribution of the coefficients, where the curves between 60°N and 60°S are derived from the potential of the S_q [3] and S_D [4] fields* for the mean solstice (see Table 1), and the curves in latitudes higher than 60° are deduced directly from the distribution of the coefficients.

The distribution of electrical conductivity on disturbed days is assumed as follows:

$$\begin{Bmatrix} \sum_{xx} \\ \sum_{yy} \\ \sum_{xy} \end{Bmatrix} = \begin{Bmatrix} \sum_{xx0}(\varphi) \\ \sum_{yy0}(\varphi) \\ \sum_{xy0}(\varphi) \end{Bmatrix} \Psi(\varphi, t),$$

where φ is the latitude, and t the local time. The values of $\sum_0$'s are given in Table III (Model B) of a

Fig. 1 Latitude-distributions of the harmonic coefficients for the geomagnetic North (ΔX) and East (ΔY) components of the geomagnetic S_d -variations for the mean solstice. The dotted (for ΔX) and full (for ΔY) lines show a smooth distribution of the coefficients.

* In this paper, the disturbance-daily variation S_D is defined as the average daily variation on five international disturbed minus quiet days (i. e., $S_d - S_q$), so that $S_d = S_q + S_D$, and S_D seems an average of the diurnally varying part D_s of magnetic storms.

Table 1. Spherical harmonic coefficients for the geomagnetic S_q - and S_D -fields analyzed in the form

$$V = r_0 \sum_n \sum_m (a_n^m \cos mt + b_n^m \sin mt) P_n^m(\cos \theta),$$

using the Second Polar Year data. (Unit= r)

S_q				S_D		
m	n	a_n^m	b_n^m	n	a_n^m	b_n^m
1	2	8.40	-2.35	2	-0.71	-6.85
	4	-1.75	0.40	4	-0.23	-1.97
	6	0.21	0.12	6	0.53	-0.46
2	3	-4.15	1.69	3	2.32	-3.46
	5	0.14	-0.15	5	-0.94	0.38
	7	-0.02	0.22	7	0.06	-0.69
3	4	1.42	-0.86	4	-0.38	0.57
	6	0.30	-0.02	6	-0.19	0.53

Fig. 2 Latitude-distributions of $\Psi(\varphi, t)$ at intervals of two-hours.

previous paper [5], and the latitude distributions of $\Psi(\varphi, t)$ at intervals of two hours are illustrated in Fig. 2 which is reasonably deduced from $f_o E$ and $f_o E_s$ of the ionosphere at sunspot-minimum.

The total electric field for S_d is calculated by using the geomagnetic intensity and the conductivity prepared above, and the dynamo equation is solved, consequently S_d wind-systems are obtained. Since the method of treatment is the same as that for the S_q -winds [2], its detailed descriptions are not repeated here. The distributions of wind-velocity thus obtained are shown in Fig. 3 for each of the diurnal and semi-

diurnal components, and the winds for S_q [1] are also shown in Fig. 4 for comparison. It is seen from these figures that the wind-velocity for S_d in the polar regions is very great (about 200~400 m/s) as compared with that for S_q , and the wind-pattern is also different from that for S_q , especially in the auroral zone. From these results we may conclude that in order to interpret the diurnally varying part of magnetic storms by a dynamo theory, without assuming an exceptionally enhanced conductivity in the polar regions as made by Jacobs and Obayashi [6], strong polar wind-systems which are quite different from those for the S_q -field are required.

Fig. 3 Wind-systems for the S_d -field, viewed from above the North pole :
(A) the diurnal and (B) the semi-diurnal component.

Fig. 4 Wind-systems for the S_Q -field, viewed from above the North pole :
(A) the diurnal and (B) the semi-diurnal component.

References

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