ON THE QUESTION OF THE GEOGRAPHICAL DISTRIBUTION OF MAGNETIC DISTURBANCES IN ANTARCTICA

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Abstract

Full Text

GEOPHYSICS

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ON THE QUESTION OF THE GEOGRAPHICAL DISTRIBUTION OF MAGNETIC DISTURBANCES IN ANTARCTICA

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As a result of a study of magnetic disturbances at high latitudes, based on observations from 28 stations, including observations of the Soviet high-latitude airborne expeditions of 1948–1950 and of the drifting station SP-2, we ([1]) showed that the isolines of the simultaneous occurrence of the maximum of morning magnetic disturbances constitute a system of spirals emerging from the belt of uniform magnetization of the Earth. This result gives grounds for believing that the ideas of Birkeland and Størmer ([2,3]) concerning the nature of magnetic disturbances are valid to a considerably greater degree than had been thought until recently.

Fig. 1. Diagram of the simultaneous occurrence of the maximum of morning magnetic disturbances (numbers at the isolines are hours of universal time): *a* —magnetic stations; *b* —lines of simultaneous occurrence of the maximum of morning disturbances; *c* —zones of maxima of magnetic disturbances.

It is of great interest to verify how far the regularity of the geographical distribution of morning magnetic disturbances established for the Arctic is valid for Antarctica (Fig. 1). On the basis of Birkeland' s experiments with the terrella and of the results of Størmer' s mathematical analysis of the motion of electrically charged particles in the field of a magnetic dipole, and from the fact that the northern magnetic pole is situated in the southern hemisphere of the Earth, it follows that, if the isolines of the simultaneous occurrence of the maximum of morning magnetic disturbances in the Arctic have the form of spirals emerging from the belt of uniform magnetization and unwinding clockwise, then in Antarctica they should constitute a system of spirals unwinding counterclockwise.

In the forthcoming International Geophysical Year, much attention will be devoted to the study of magnetic disturbances in Antarctica. Therefore, the formulation of certain assumptions concerning possible regularities of magnetic disturbances in the unexplored regions of Antarctica is of interest, since the processing of subsequent observations will make it possible to test their validity.

We know data on the diurnal variation of magnetic activity and on the time of occurrence of its maximum only for three Antarctic stations, used in Stegg' s paper ([4]) (Table 1).

Table 1

Stations	ϕ	λ	Φ	Time of the morning maximum, local	Time of the morning maximum, Greenwich	Greenwich time counted from the isoline
Cape Evans	77°,6	166°,4	78°,9	9h	22h	20h
Cape Denison	67,0	142,7	75,5	12	2—3	3
Gauss Land	66,0	89,6	76,1	10	4	8

To verify, for Antarctica, the validity of the conclusion drawn from observations in the Arctic, the system of spirals in Fig. 1, in accordance with the laws of motion of electric particles in the field of a magnetic dipole, was drawn so that the spirals unwound counterclockwise. Then the resulting system of spirals was superposed on a geographical grid on which the locations of the three Antarctic stations mentioned had been marked. By bringing the pole of uniform magnetization in the drawn system of spirals into coincidence with the pole of uniform magnetization in Antarctica and rotating the system of spirals until it most closely agreed with the observed data presented in Table 1, we find that when the 3-hour spiral is made to coincide with the point corresponding to Cape Denison, where the morning maximum occurs at 3 hours Greenwich time, the spiral corresponding to 20 hours passes through the Cape Evans station, and the spiral corresponding to 8 hours passes through the Gauss Land station (Fig. 2). Examination of the result obtained shows that, for the Cape Evans and Cape Denison stations, the observed data agree to within 1—2 hours with what

Fig. 2. Presumed geographical distribution of the maximum phase of morning magnetic disturbances in Antarctica. 1 –Cape Evans; 2 –Cape Denison and 3 –Gauss Land

Figure 2: Fig. 2. Presumed geographical distribution of the maximum phase of morning magnetic disturbances in Antarctica. 1 –Cape Evans; 2 –Cape Denison and 3 –Gauss Land

is obtained if the conclusions derived for the Arctic are extended to Antarctica, and only for the Gauss Land station is there a discrepancy of the order of 3–4 hours.

Fig. 2. Presumed geographical distribution of the maximum phase of morning magnetic disturbances in Antarctica. 1 –Cape Evans; 2 –Cape Denison and 3 –Gauss Land

The agreement obtained may be regarded as quite good if one takes into account that: a) the isolines of simultaneous occurrence of the maximum of morning magnetic disturbances were drawn for the Arctic, especially in the region of interest to us, schematically; b) the calculated position of the pole of uniform magnetization both for the Arctic and for Antarctica may differ somewhat from the true one; and, finally, c) for Antarctica we have data at our disposal for only three points, which moreover are situated comparatively close to one another. To this it should be added that the observations at these stations were carried out in different years. It is also necessary to note that, in accordance with the Earth' s rotation from west to east and with the longitudes of the stations, the morning maximum of magnetic disturbances occurs earliest at Cape Evans (22 hours), then

at Cape Denison (3 o' clock) and latest of all at Gauss Station (4 o' clock), i.e., in the same way as in the Arctic.

Thus, there is reason to believe that the regularities in the geographic distribution of morning magnetic disturbances are, apparently, to a high degree of accuracy the same for both the Arctic and the Antarctic (with the sole difference that the spirals, which are isolines of the simultaneous occurrence of the maximum of morning magnetic disturbances, unfold clockwise in the Arctic, and counterclockwise in the Antarctic). In addition, some of Birkeland and Størmer' s conclusions on the nature of magnetic disturbances, as well as the ideas of Bennett and Hulburt [5] on applying the idea of self-focusing streams of electrically charged particles to the theory of the motion of solar corpuscular streams and their penetration into the Earth' s atmosphere, receive yet another convincing confirmation.

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Note: Figure translations are in progress. See original paper for figures.