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INTERNATIONAL CONFERENCE ON COSMIC RAYS AND THE EARTH STORM Part I

I-5-P3. Morphology of Ionospheric Storms

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Some statistical studies carried out by Japanese workers are summarized in the first part of the paper. Ionospheric disturbances in the polar region are shown in the second part. The polar disturbance is characterized by the anomalous increase in the *F2* electron density which has the close connection with the black-out and the *Es* ionization in the auroral zone.

§1. Several years ago, the *F2* layer disturbance was studied with great interest by many workers in Japan as well as all the world. It was shown by Sinno[1] and Obayashi[2], independently, that the deviation of the maximum electron density in the *F2* layer at a stormy time is composed of the *Dst*-like part and the *Ds*-like part. Obayashi[3] showed the patterns of the averaged deviation in f_0F2 and $h'F$ according to local time. In a middle latitude, the depression of electron density is maximum in the morning.

Assuming the electrostatic field which makes the *Sd* currents flow in the ionosphere, we explained these statistical results on the basis of the drift theory[4], and Sato[5,6] succeeded in explaining the individual events not only in the middle latitudes but also at the equator and near the auroral zone. However, he concluded that, in the polar region, the *F2* layer disturbance is difficult to understand by taking simply account of the drift motion[7]. Obayashi[8] pointed out that the phase of the *F2* layer disturbance changes according to the stormtime. From the statistical study, he concluded that the phase is almost constant at an active stage of a magnetic storm, but in the last stage of a magnetic storm, the phase is retarded gradually. In other words, the disturbance pattern moves round the earth with the sun at first, but at the last stage, it remains fixed on the earth. Maeda and Sato[9] classified the *F2* disturbances into the two types according to whether they are positive or negative, and they showed the dependency of the occurrences of both kinds on season and latitude. The negative disturbances occur predominantly in all season in the high latitudes, but the positive disturbances, on the other hand, are apt to occur in the low latitudes. In the middle latitudes, the positive disturbances are apt to occur in winter. Sato[6] showed that the magnitude of disturbances of both kinds increases with the increasing sunspot number and the geomagnetic activities. He also detected the disturbances in f_0F1 and f_0E, and pointed out the same tendency as in the *F2* layer[10].

§2. In the polar region, we can find another type of increase of the electron density in the *F2* region. Considerable increases of the *F2* electron density were observed at many stations in the polar region for about a day preceding the *SSC* of the magnetic storm of Sept. 25, 1958. In Fig. 1, the horizontal lines correspond to the normal value. The electron density fluctuates at a high level, and the peak maximum are recorded simultaneously at several stations in the high

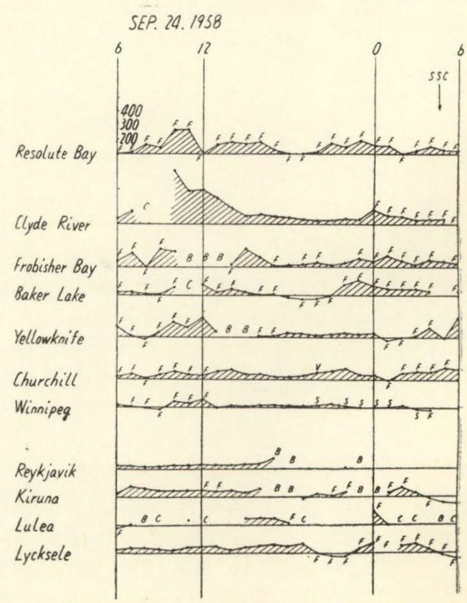

Fig. 1.

latitudes. These anomalous increases in the *F2* density can be seen in many other examples. At a peak maximum, there appears very often an intense *Es* ionization in the neighbouring region. At 10 U.T. on Oct. 21, 1958, the intense *Es* ionization appeared in the closed areas in the left-hand diagram in Fig. 2, and the abnormal increase of f_{min} is indicated by the shaded area. The right-hand diagram shows the anomalous increase in the *F2* density amounting to 196% of the normal value. At the same time, a bay-type magnetic disturbance was recorded at Big Delta (258°E, 64.5°N). Fig. 3 shows the copy of the *H*-trace. We can find great number of examples. It is characteristics of this type of phenomenon that the area of the intense *Es* ionization in the night hemisphere and the area of the abnormal absorption in the day-hemisphere are facing each other across the pole where the *F2* electron density increases anomalously. According to Hakura's study[11] of black-outs, their occurrence predominates in the day-side hemisphere, and the maximum occurrence is shifted westward with increasing distance from the pole after *SSC*. With respect to the *Es* ionization at stormy times, the diurnal variation of the upper quarter values of f_0E_s for each station are shown in Fig. 4 as a function of latitude. The horizontal lines indicate 4 Mc/s of f_0E_s. It is seen from the figure, that the most active region lies at the latitude of Baker Lake, and that the time of maximum activity shifts to the east with increasing polar distance. That is in strong contrast with the black-out. Therefore, we find the greatest opportunity for the simultaneous occurrence of the f_{min}-anomaly and the intenes E_s ionization near the midnight point in the auroral zone, where the geomagnetic disturbance is most active.

Indeed, the spiral patterns of the appearance of the intense E_s ionization are often seen for several hours soon after a *SSC*. From this

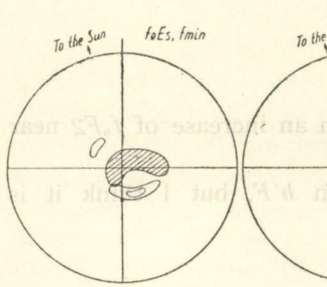

Fig. 2.

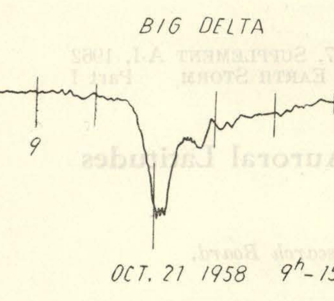

Fig. 3.

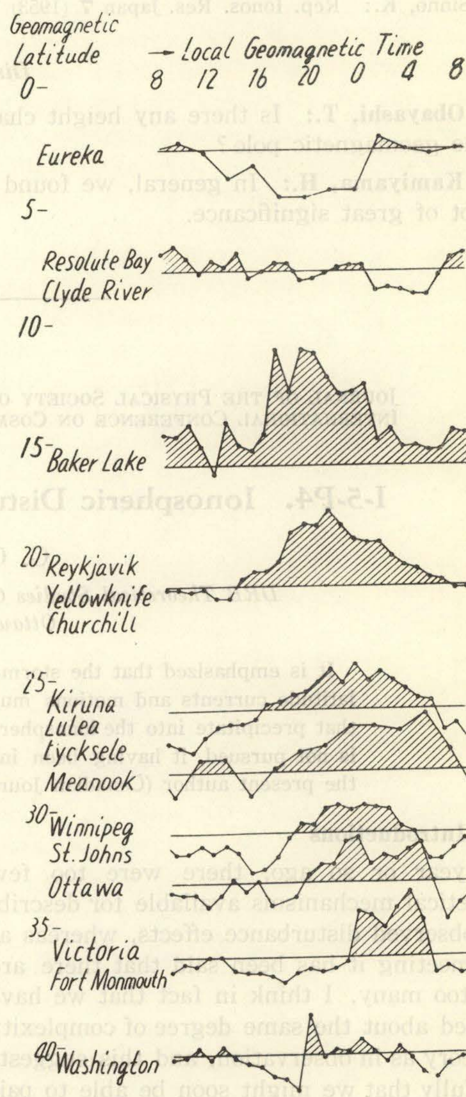

Fig. 4.

evidence and the statistical analysis, we may conclude that the negatively charged particles make a great contribution to the E_s ionization at the auroral latitude. A bay-type magnetic disturbance often appears at about midnight in the auroral zone, where the abnormal increases of f_{min} and f_0E_s are observed simultaneously. I am not sure what mechanism is operating there, but I feel that some of the features of the *F2* layer storm in the middle latitudes mentioned above may be explicable on the basis of the auroral zone phenomena.

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Discussion

Obayashi, T.: Is there any height change associated with an increase of f_0F2 near the geomagnetic pole?

Kamiyama, H.: In general, we found a slight decrease in $h'F$, but I think it is not of great significance.

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INTERNATIONAL CONFERENCE ON COSMIC RAYS AND THE EARTH STORM Part I

I-5-P4. Ionospheric Disturbances at Auroral Latitudes

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It is emphasized that the storm-time electric fields associated with high-latitude currents and motions must be of major concern to the particles that precipitate into the ionosphere. Detailed development of this theme is not pursued, it having been initiated elsewhere by W. I. Axford and the present author (Canadian Journal of Physics, October 1961).

§ 1. Introductions

A year or so ago, there were too few theoretical mechanisms available for describing observed disturbance effects, whereas at this meeting it has been said that there are now too many. I think in fact that we have reached about the same degree of complexity in theory as in observation, and this suggests hopefully that we might soon be able to pair off the theoretical mechanisms one by one with the observed characteristics. It is the purpose of this present paper to indicate a starting point for such a process.

As a first step towards this end, I shall present a limited and extremely over-simplified picture of the observations at auroral latitudes. From a part of this picture I shall make a theoretical inference, and then develop certain theoretical 'facts' on the basis of that inference. I term as 'facts'