I-5. Ionospheric Disturbances

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Date	Time	Paper Numbers
Sept. 11	15 : 30 – 17 : 30	from I–5–1 to I–5–10
Sept. 12	11 : 30 – 13 : 30	from I–5–P1 to I–5–P4

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INTERNATIONAL CONFERENCE ON COSMIC RAYS AND THE EARTH STORM Part I

I-5-1. Variability of F2 Layer Critical Frequencies During Ionospheric Disturbances*

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Lately the scientists have taken a great interest in magnetic—ionospheric disturbances. However, if magnetic field variations during disturbances are rather well known at present, the information on variations in ionosphere during disturbances is rather limited and in main reduced to the knowledge of average regularities. It is known that $F2$ layer is subjected to the greatest changes during disturbances. The investigation of its parameter variability is of great interest both from the theoretical point of view and for predicting radio communication frequencies under disturbed conditions.

The present paper considers variability of $F2$ layer critical frequencies with time and in space in disturbed periods. For small time intervals (up to 20 min) $foF2$ variability was considered by the materials of more frequent observations than usual at the following stations: Leningrad, Moscow, Sverdlovsk, Irkutsk, Rostov and Alma-Ata during several disturbances of 1953. The declination of the observed $foF2$ from the sliding monthly median values ($\Delta foF2$) were computed and then the $\Delta foF2$ change from one moment to another ($\delta\Delta foF2$) was considered. Probability distribution curves of various $\delta\Delta foF2$ for different time intervals (see, ex. Fig. 1) showed, that for all stations during the period up to 20 minutes the probabilities of changes, greater thah ± 0.4 Mc is practically equal to zero. This shows a great stability of $\Delta foF2$ during disturbances within the 20 minute period considered.

$\Delta foF2$ variability for greater time intervals (from 1 to 6 hours) was considered by computing the coefficients of linear correlation (ρ) between $\Delta foF2$, divided by different time intervals (Δt). Fig. 2 represents the change of ρ with Δt, obtained by the data of the Moscow ionospheric station for September and October 1952. One can see, that ρ remains larger than 0.5 during 3–4 hours, that

* This paper was read by A. I. Lebedinsky.
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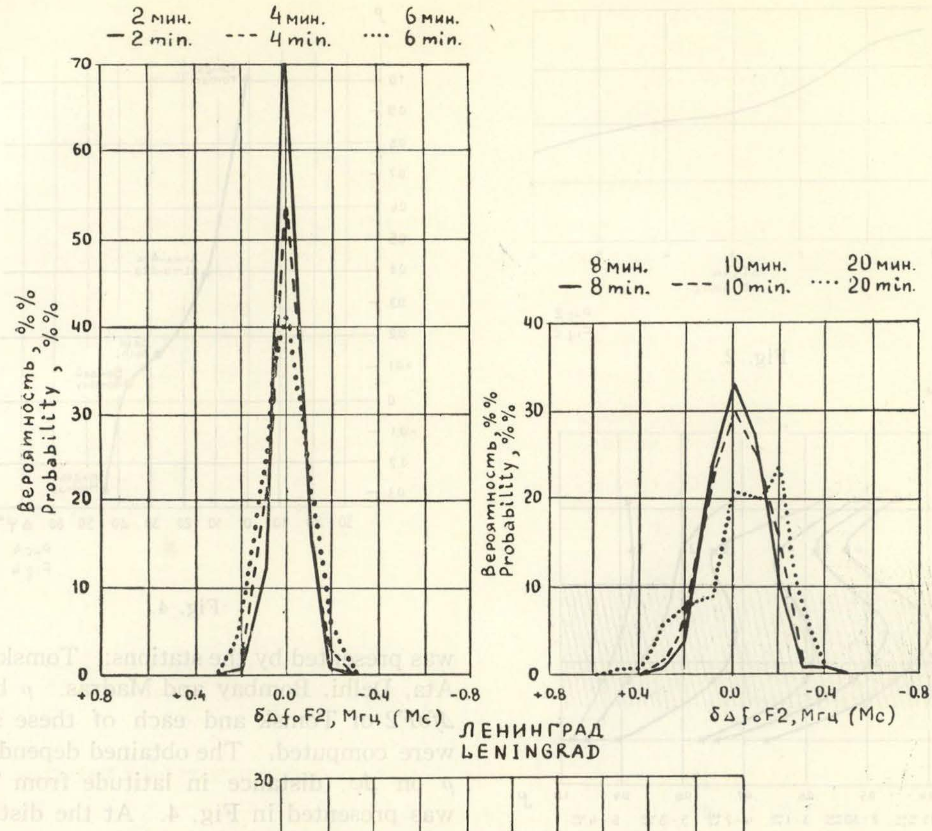

Fig. 1.

is, during disturbances $\Delta foF2$ is not subjected to great changes, and $foF2$ declining much from normal average values remains rather stable during several hours.

The comparison of $\Delta foF2$ variability on disturbed and quiet days shows that they are almost equal and even variability on disturbed days is somewhat less than on quiet ones.

The comparision of $\Delta foF2$ variability in different years does not reveal its dependance on the phase of 11-year cycle of solar activity.

Valiability change with latitude was considered. For this case there was chosen a chain of the Canadian stations, situated within a small range of longitudes and at the latitudes from 81.5N to 49.9N (Fletchers, Resolute Bay, Baker Lake, Churchill, Winnipeg). ρ for $\Delta foF2$ divided by 15 min, 30 min, 1, 2, 3 and 4 hour intervals were computed for the ionospheric storms of September 1957. The change of ρ with latitude was presented in Fig. 3, which shows that $\Delta foF2$ variability increases (ρ decreases) with latitude. Its additional minimum in the auroral zone (shaded region) was superposed on the

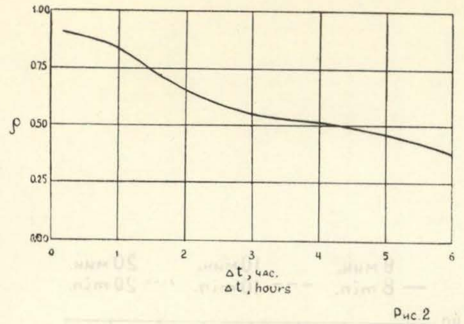

Fig. 2.

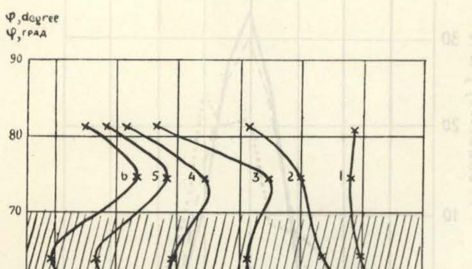

Fig. 3.

Table I.

	Moscow-Sverdlovsk	Moscow-Tomsk	Moscow-Irkutsk
Universal time	0,47	0,31	0,06
Local time	0,38	0,13	0,01

total decrease of ρ with the latitude increase.

$\Delta foF2$ space variability was studied by the materials of the latitudinal and longitudinal chains of stations. The stations Moscow, Sverdlovsk, Tomsk and Irkursk were chosen as a longitudinal chain. ρ for $\Delta foF2$ of Moscow and each of these stations were computed at the same moment by universal and local time for great and very great storms of 1948 (see Table I).

It is evident, that the connection between $\Delta foF2$ at the stations being approximately 20° away in longitude (Moscow-Sverdlovsk) is already small, and at greater distances it is practically absent. A latitudinal chain

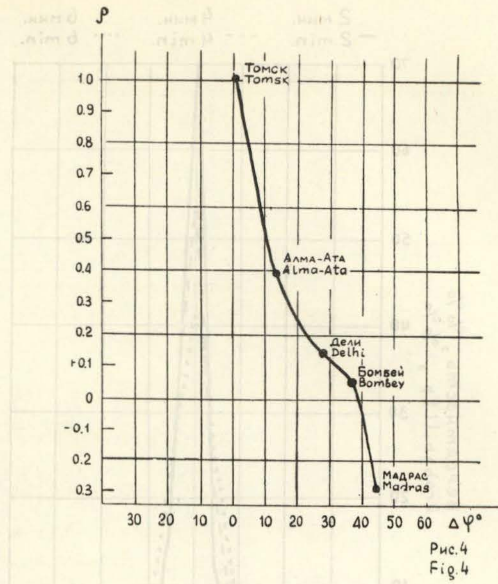

Fig. 4.

was presented by the stations: Tomsk, Alma-Ata, Delhi, Bombay and Madras. ρ between $\Delta foF2$ of Tomsk and each of these stations were computed. The obtained dependance of ρ on $\Delta\varphi$ (distance in latitude from Tomsk) was presented in Fig. 4. At the distance of about 10° in latitude ρ becomes smaller than 0.5. With distance increase between the stations ρ gradually decreases, passes the zero and becomes negative. It means that while at the stations of moderate latitudes (Tomsk) we observe negative $\Delta foF2$ during disturbances, at the near-equatorial stations (Madras) they become positive.

As a result of examining $\Delta foF2$ latitudinal and longitudinal variability during disturbances it is possible to consider that the observation data of one station may be spread only within small region (approximately for 10° in latitude and 20° in longitude) during disturbances. In order to have a possibility to predict $foF2$ by current ionospheric data it is also necessary to have information from the world-wide network of stations. Predicting may be done by extrapolation of $\Delta foF2$ synoptical charts.

Summarizing the above said it is possible to consider that if $\Delta foF2$ changes with time during disturbed periods at each point are not great, the changes of $\Delta foF2$ in space from one point to another are rather prominent.

Discussion

Aono, Y.: How long is the distance between the stations of each group?

Lebedinsky, A.I.: Between Moscow and Sverdlovsk about 2000 km, between Moscow and Tomsk about 3000 km and between Moscow and Irkutsk about 4000 km.

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INTERNATIONAL CONFERENCE ON COSMIC RAYS AND THE EARTH STORM Part 1

I-5-2. Charged Particles in the Earth's Magnetic Field and the Ionospheric F2 Layer

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Summary

It is suggested that large fluxes of ionospheric electrons and protons spiral along magnetic lines of force of the earth's field to establish an equilibrium condition between the *F2* layers of magnetic conjugate points in opposite hemispheres such that equal fluxes of ionised particles are found at both places. Several features of the behaviour of the *F2* layer can be explained on the basis of this hypothesis, and experimental observations of *F2* layer critical frequencies provide evidence of the interdependence of the ionospheres at magnetic conjugate points.

It is further suggested that the ionosphere may be an important source of electrons trapped in the Van Allen radiation belts, if ionospheric electrons of thermal energies travelling between hemispheres are accelerated and undergo changes in pitch angle during magnetic storms, like the higher energy trapped particles.

1. The critical frequency for the reflection of radiowaves from the *E* and *F1* layers of the ionosphere generally shows a simple time dependence on the solar zenith angle. The critical frequency for the *F2* layer (f_0F2) shows much more complex variations, however, and so far no simple explanation has been found for many aspects of its behaviour, some of which are listed below:

a) The time of diurnal maximum value of (f_0F2) varies with place and season.

b) The diurnal maximum (f_0F2) max. is higher in winter than in summer.

c) The average value of (f_0F2) over a year is higher in the northern than in the southern hemisphere.

d) (f_0F2) max. varies with longitude for places at similar geographic latitudes.

e) (f_0F2) max. shows a greater dependence on geomagnetic than geographic latitude, although there is a close correlation between (f_0F2) max. and the intensity of solar electromagnetic radiation over the eleven year solar cycle.

It is suggested here that large fluxes of ionospheric protons and electrons from the *F2* layer travel along the lines of force linking two magnetically conjugate points, to establish a near equilibrium condition between the ionospheres in opposite hemispheres such that equal fluxes of ionised particles are found at both places. In this case the number of electrons and ions in the *F2* layer would depend on the ionisation processes in the upper atmosphere occurring not only at the place of observation, but also at the magnetic conjugate point in the opposite hemisphere. In other words, ionisation in the *F2* layer should depend on combined conditions at both intersections of lines of force of the earth's magnetic field with the earth's atmosphere.

2. Vestine (1960) has calculated the approximate intersections of the lines of force