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HIGH-LATITUDE IONOSPHERE STRUCTURE IN DAYSIDE SECTOR ON GROUND-BASED AND SATELLITE MEASUREMENTS

L. V. Shestakova,* A. E. Stepanov,* V. L. Khalipov,* A. P. Mamrukov,* L. D. Filippov,* E. K. Zikrach* and V. V. Afonin**

* *Institute of Cosmophysical Research and Aeronomy, 31 Lenin Avenue, 677891 Yakutsk, Russia*
** *Institute of Space Research, 84/32 Profsoyuznaya Street, 117810 Moscow, Russia*

ABSTRACT

We report electron density measurements from satellite Cosmos-900 the presence of high-latitude dayside troughs. The trough minima near noon are localized at 70-74^0 invariant latitude during indisturbed periods and at 60-70^0 invariant latitude during disturbed periods. The localization and dynamics of equatorial boundary of dayside polar cusp by oblique sounding of F-region from ground-based stations and by simultaneous measurements of precipitating particles from satellite are revealed. A comparison of statistical data of dayside troughs and reflections from dayside cusp shows that a trough minimum near noon is localized by 3-4^0 equatorward of the cusp. The obtained results are discussed.

SATELLITE'S MEASUREMENTS OF ELECTRON DENSITY, TEMPERATURE AND PRECIPITATING PARTICLES IN THE DAYSIDE SECTOR OF THE AURORAL ZONE

Ionization troughs in latitudinal distribution of electron density (Ne) in the dayside sector (08.00-16.00 MLT) were first found by outer ionosphere sounding (Wildman *et al.*,1976;Tulunay *et al.*,1978;Grebowsky *et al.*,1983) and then it was confirmed by ground-based measurements (Mamrukov *et al.*,1988). Observations from Cosmos-900 (C-900) satellite showed that dayside troughs are stable formations and are observed independent of season.Plasma density on board C-900 was measured by the ion trap with floating potential; the satellite's orbit is quasi-circular with altitude about 500 km, the orbital period is 94.4 min and the inclination is 83^0. In connection with sufficiently large inclination measurements along the orbit can approximate the latitudinal profile of Ne for fixed time. The orbit interval from 40^0 to 80^0 is covered by the satellite for several minutes. For March,1977 - August,1979 the 127 dayside latitudinal profiles in the Northern hemisphere for the different seasons and magnetic conditions were analysed. The periods with Kp=0-2 corresponds to quiet magnetic conditions, and Kp=3-5 to disturbed conditions. The analysis shows that in winter and equinox seasons the dayside troughs are clearly seen and are regularly observed at Ne latitudinal profiles. In summer and day time they are seen less clearly and during the quiet conditions they are not observed at latitudinal profiles. In most cases the following sequence of Ne latitudinal changes is observed in day time: the regular Ne middle-latitude level is represented by the sharp ionization decrease and, then by the sharp rise which forms the polar edge of the dayside trough. The extent of the enhanced Ne ionization region in latitude is about 2-3 degrees.

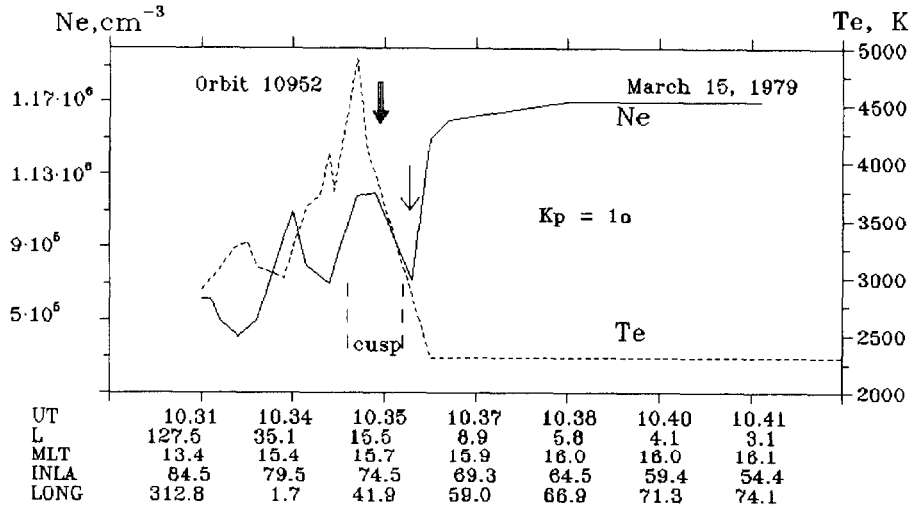

Fig.1 The meridional profiles of electron density and temperature for March 15, 1979 by C-900 measurements. Satellite's altitude is 360 km.

As a typical example in Figure 1 the dayside latitudinal Ne profile on March 15, 1979, for magnetoquiet conditions, is shown. In 1979 the solar activity maximum was observed and Ne magnitudes reached large values. From Figure 1 it is seen that near invariant latitude IL=71.5^0 a sharp decrease from Ne = 1.2x10^6 cm^{-3} to Ne = 7x10^5 cm^{-3} is observed. The dayside trough minimum observed in this pass is located IL=72.5^0 (marked by thin arrow). In the poleward direction a rise in Ne occurs and at IL=75^0 the electron density is about 10^6 cm^{-3}. A rise in Te begun in the trough region and the electron temperature reaches the highest values at latitudes of the ionization polar peak (marked by thick arrow). It can be supposed that the described Ne and Te latitudinal structures correspond to the ionospheric projection of the dayside polar cusp.

GROUND-BASED AND SATELLITE MEASUREMENTS OF THE DAYSIDE POLAR CUSP

The localization of the large-scale inhomogeneous structures of the high-latitude ionosphere by ground-based ionosounde data is described in detail in (Khalipov *et al.*,1977;Mamrukov *et al.*,1988). The oblique reflections occur at sharp latitudinal gradients of Ne near the polar edge of the main ionospheric trough and equatorial boundary of the dayside cusp. The ray-tracing of the short radiowaves in the ionosphere allows one to define the horizontal distance to the reflecting region. The same method was used by us for localization of characteristic oblique radio-reflections in dayside MLT sector. In this paper the ionospheric measurements with transmitter-receiver horizontal antenna at high-latitude Tixie Bay (IL=65.1^0) and Kotelny Island (IL=69.5^0) stations are used. It is a sufficiently high-potential antenna with the amplification coefficient about 15 at the operating frequency: 5 MHz. The main maximum of the radiation at this frequency is directed at an angle of 25^0 to the horizon. During quiet geomagnetic conditions, the dayside oblique radio-reflections are mainly registered at heights of 1000-1400 km. At recalculation to the horizontal distance from Tixie Bay station it gives the invariant latitude of 75-79^0, and from Kotelny Island station - about 80^0. The radio-reflection origin at these latitudes allows us to suppose that oblique radiowave reflections happened from large-scale inhomogeneities in the dayside polar cusp/cleft region.

In October,1984 and February, 1985 (06.00-18.00 MLT) 129 passes with the cusp/cleft region observations by DMSP satellites were registered. Continuous measurements of the cusp by F7 and F9 DMSP in this period were courtesy provided by David G. Sibeck (The Jonhs

Hopkins University Applied Physics Laboratory, Laurel, Maryland, USA). For the same period 266 measurements of the equatorial boundary of the dayside cusp/cleft region by ground-based data were registered. Satellite and ground measurements of the equatorial boundaries grouped for different values of Kp-index from 1 to 4 are presented in Figure 2. Cusp measurements by DMSP satellites are marked by the crosses and ground station data, by circles. As can be seen the two kinds of cusp observations show closely compatible latitudinal locations of boundaries for all values of Kp. The curves in Figure 2 signify the approximating lines calculated by standart least squares method. So, the average location of the cusp is shifted from IL=80^0 at Kp=1 to IL=75^0 at Kp=4. At a treatment of C-900 data in dayside sector the minimum of the high-latitude trough was determined as well as at the description of Figure 1. Its locations is marked by dark circles in polar plots (Fig.3 A and Figure 3 B). The A - plot is constructed for Kp=0-2, the B - plot for Kp=3-5. The approximation of the dayside trough position is marked by thin lines. The average location of the equatorial cusp boundary obtained by satellite and ground measurements is marked by solid thick lines. It is seen that cusp/cleft model boundary is northward from the dayside minimum region of the electron density. The average position of the dayside Ne minimum is observed by 2-4^0 equatorward of the cusp. To clear up the position of the dayside Ne troughs relative to the main ionospheric trough the latitudes of latter are marked by the points for different conditions of the disturbance. In the condition of the weak and moderate disturbance after 16.00 MLT the average position of the main ionospheric trough is as if extension of the dayside trough, forming the one untwisting spiral (Figure 3,A). After 06.00 MLT the Ne trough due to influence of the solar radiation is not observed. In the disturbed conditions the average positions of the comparing structures are not coincided near 16.00 MLT sector.

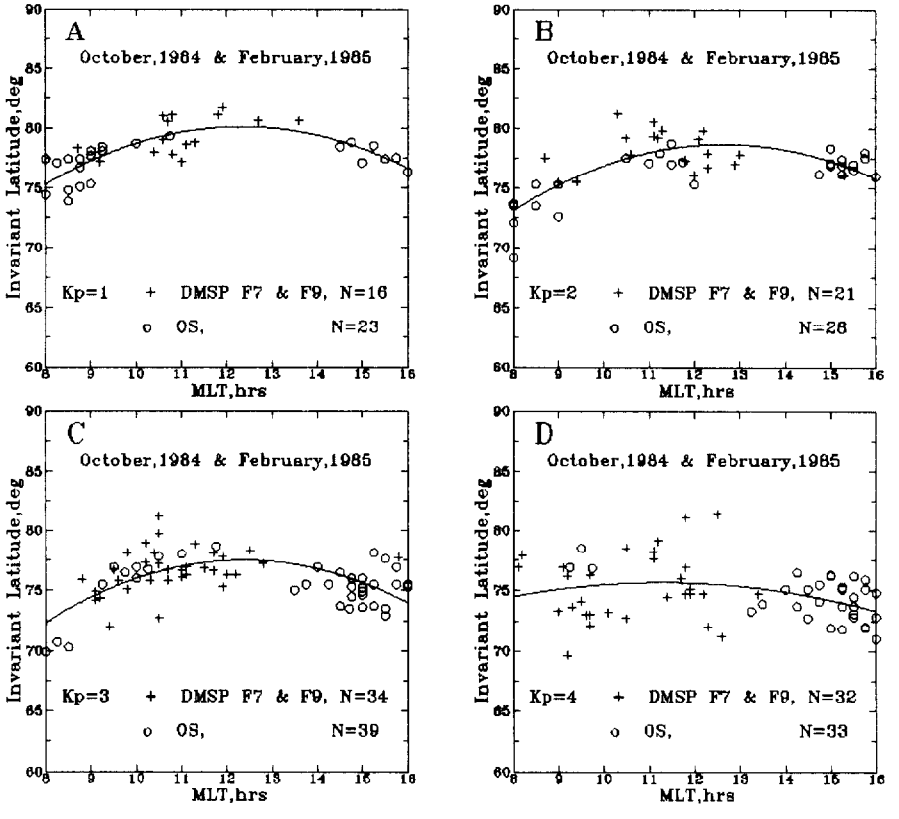

Fig.2 Comparison of the satellite and ground-based measurements of equatorial cusp/cleft boundaries for different disturbance conditions.

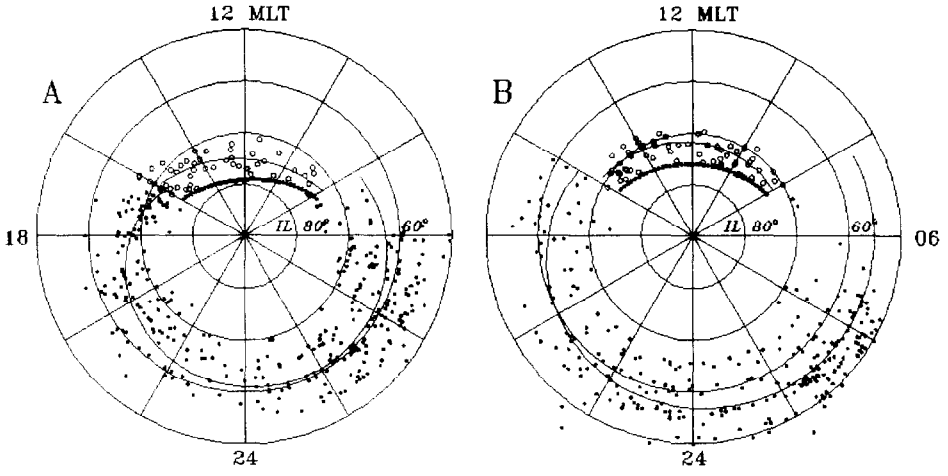

Fig.3 Polar plots illustrating the positions of the dayside and main ionospheric troughs: A - for Kp=0-2, B - for Kp=3-5. Positions of the dayside Ne trough are marked by open circles and main Ne trough - points. Solid thick line is average position of the equatorial boundary of the cusp/cleft region.

CONCLUSION

1. By measurements of the thermal ionosphere plasma aboard C-900 satellite and the precipitating electron of the dayside cusp aboard DMSP satellites, the characteristic polar peaks in latitudinal Ne and Te distributions (about 2^0) are established which are the ionosphere signature of the dayside polar cusp.
2. Using the ionosonde located at IL=65^0 and equipped with the horizontal rhombic antenna for oblique sounding, one can carry out systematic monitoring of the dayside polar cusp/cleft region.
3. It is shown that dayside electron density minima are localized by 2-4^0 equatorward of the cusp. The structure of the dayside trough at 16.00 MLT is adjacent to main ionospheric trough.

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