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# IONOSPHERIC PLASMA BLOB CHARACTERISTICS AFTER GROUND-BASED AND SATELLITE MEASUREMENTS

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On the basis of analysis of ionospheric data of the Yakut meridional chain of ionosoundes (Tixie Bay, L=5.57 and Kotelny Island, L=6.00) and the Cosmos-900 satellite the ground-based and satellite signatures of large-scale blobs of ionization in auroral and polar cap zones are revealed. The ionospheric stations of vertical and incidence sounding register plasma blobs, mainly, in the midnight and morning sector of local time. The satellite measures them in the polar cap and auroral zone in various sectors of local magnetic time. The satellite and ground data show, that in some cases for the period of observations several plasma blobs are registered. Cases of registration of ionization blobs at the polar edge of the main ionospheric trough are revealed. A seasonal course of occurrence frequency of plasma blobs in the polar cap and auroral zone after ground and satellite data has an expressed maxima in winter months. Horizontal scale sizes of blobs (129 cases of measurements from the satellite in northern hemisphere) have two peaks on 200-400 km and 600-700 km.
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**Introduction**

The term " a large-scale blob of ionospheric plasma " is used to describe the phenomenon in the chain "dayside polar cusp/cleft region - polar cap - nightside auroral zone ", which is identified by optical, ionosounde and satellite measurements [1]. The first descriptions of large-scale blobs of ionospheric plasma were based on measurements from the station of incoherent-scattering in Chatanica [2]. The following active study of these formations in the polar ionosphere after the data from satellites and ground-based stations [3-10] has revealed the following main parameter and characteristics of blobs: a blob is a region of non-locally enlarged electron concentration, that is 2-10 times above the background level, with scale sizes of the order of 100 - 1000 km in the horizontal direction; the plasma blobs are drifted in the antisolar direction across the polar cap with velocities 250 - 1000 m/s; electron temperature inside a blob is low and nonstructural, specifying that energetic particles in it are not precipitated, when the blob drifts through the polar cap by electric field of magnetospheric convection (**E x B**); there were detected the cases, when blobs can be formed simultaneously in geomagnetically conjugated regions.

Still unclear is the question of the generation mechanism of large-scale blobs in the polar cap. By results of experimental research and model calculations there were suggested various mechanisms [1,9,11-15], in which there are dayside region and cusp/cleft region, mainly, of blob origin.

**Experimental Results and Discussion**

*Ground-based measurements*. The data of high-latitude ionospheric stations of vertical and oblique incidence sounding from Yakutia meridional chain ($\lambda$= 130°) - Tixie Bay (L = 5.57) and Kotelny Isl. (L = 6.00) for 1981-82, 1986 and 1990-91 were analyzed. The period, that was processed for the analysis, covered an interval approximately from 18.00 to 06.00 LT (09.00 UT - 20.00 UT; LT = UT + 9 hours). The stations worked in the standard mode each 15 min.

On Fig.1, the typical sequence of ionograms is shown, in which the reflections from plasma blobs are registered. Variations of the critical frequency of F2-layer above the Tixie Bay station for this day (December 8, 1981) show, that after 11.00 UT Tixie Bay is located in diffuse auroral zone, poleward from the polar edge of the main ionospheric trough. From 13.00 UT till 16.00 UT the increase of ionization (up to ~ 7 MHz) is observed, which we associate with passing of the first blob of ionization above the station. Then a short-term decrease of the electron density followed and the second blob of ionization started to be observed. Ionogram obtained at 16.30 UT at a high level of absorption (fb = 4 MHz), registers reflections from F2-layer with foF2 = 5.0 MHz (Fig.1a). Consequent ionogram demonstrates a typical situation, when station of ionospheric sounding is located in diffuse auroral zone (foEsr = 3.4 MHz, foF2 = 6.0 MHz), but an oblique reflection from the polar blob, coming closer, north of the station (h ' = 470 km, foblob = 9.5 MHz) is observe in addition. At 17.15 UT it becomes the main structure (Fig.1c). At the same time the level of ionization in an E- layer created by precipitating electrons of diffuse auroral zone did not change (foEsr = 3.4 MHz). The velocity of plasma blob movement is about 400 m/s.

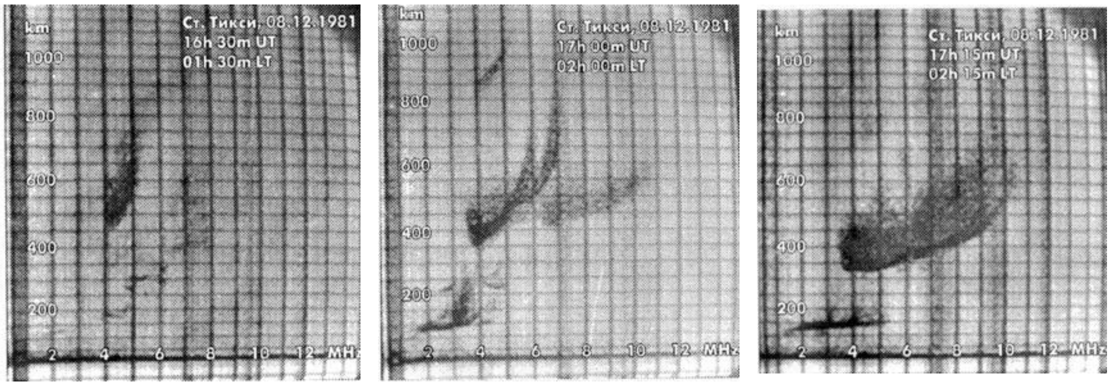


**Fig.1**. The sequence of ionograms on December 8, 1981 from Tixie Bay station.

*Cosmos-900 satellite measurements*. We also processed materials of Cosmos-900 satellite for 1978-79. The orbit of satellite is quasi-circular with apogee altitude about 500 km, period is 94.4 min, and inclination 83°. The measurements of the electron density and temperature at the satellite altitude enveloping the range of invariant latitudes from 60 up to 90° were analyzed. For the considered period (November, 1978 - August, 1979) was processed more than 700 passes in northern and southern hemispheres (407 passes in northern and 325 - in southern). The plasma blobs were determined after the satellite data on following signatures: the increase of electron concentration more than 2 times above the background level; the temperature of electrons at the background level; the horizontal scale sizes should be more than 100 km;

On Fig.2 the example of registration of large-scale blob of ionospheric plasma by satellite in the polar cap, at 9651N pass on December 21, 1978 is shown. The satellite registered at this pass two plasma blobs (marked I and II). Horizontal scale sizes along the trajectory of the satellite are about 170 and 650 km, and the density of electrons in the maxima of blobs is 4.3 and 5.7 times more, than in the background level of density (about $10^5$ см$^{-3}$), respectively. The electron temperature during registration of blobs is at the usual level of 1700-1800°K.

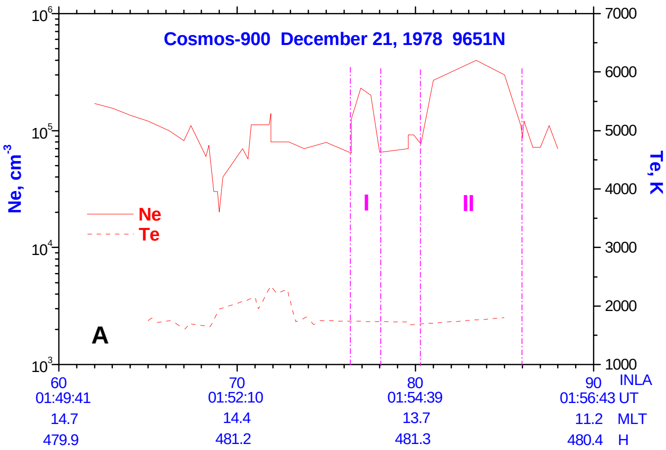


**Fig.2.** Plasma blobs registration in the polar cap after the Cosmos-900 data in the northern hemisphere**.**

Fig.3 presents the locations of observed plasma blobs in the northern hemisphere. The lines represent sections of the satellite trace, where plasma blobs are observed. It is seen, that blobs can be registered at 60-65° of invariant latitude in the morning sector of MLT, that is at latitudes of main ionospheric trough polar edge.

Fig.4 shows the distribution of horizontal scale sizes of plasma blobs along the satellite trace that are observed for the registered 129 cases in the northern hemisphere. We see, that there are two peaks between 200-400 km and 600-700 km.

Fig.5 illustrates the occurrence frequency of plasma blobs after the ground and satellite data as a function of the month of the year. It is seen, that the blob occurrence frequency maximum, both after the ground and satellite data, is observed in winter months, whereas in summer months the blobs are not practically observed. It is possible to explain it, apparently, so that in summer months they are difficult to identify because of large background density of the ionosphere. The dashed line shows seasonal course, obtained in the southern hemisphere after Cosmos-900 data.

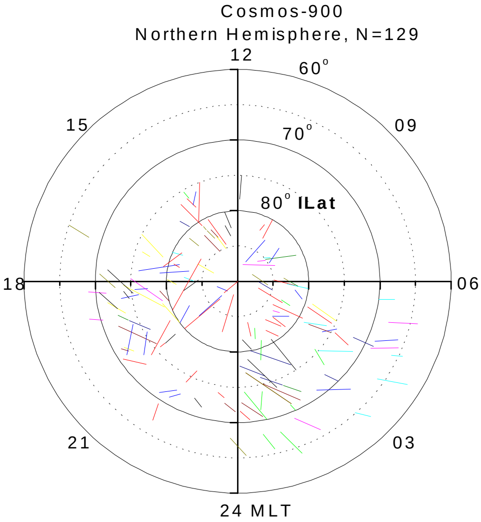


**Fig.3.** Location and horizontal scale size of polar plasma blobs after Cosmos-900 data in the northern hemisphere.

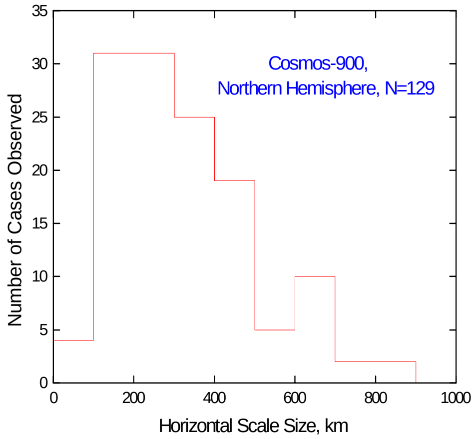


**Fig.4.** Horizontal scale size distribution of the 129 plasma blobs in the northern hemisphere after Cosmos-900 data.

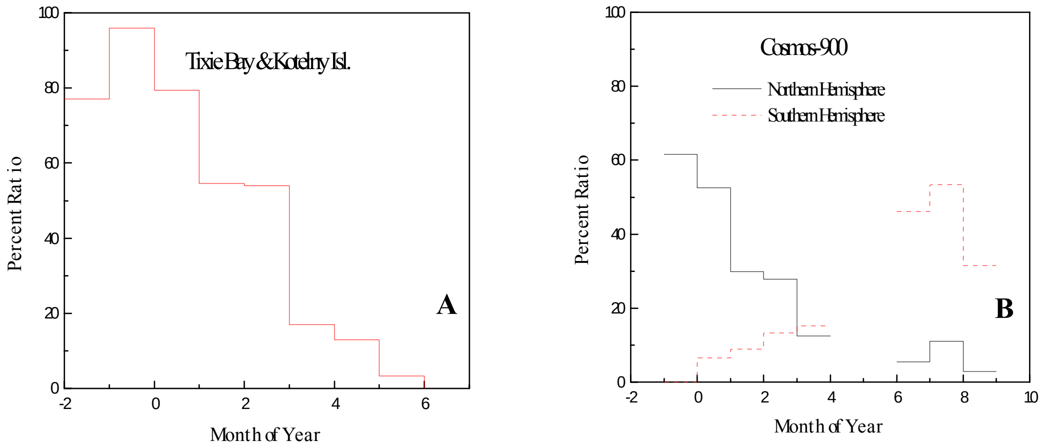


**Fig.5.** Occurrence frequency of plasma blobs versus month after ground-based (A) and satellite (B) data.

## Conclusion

On the basis of analysis of high-latitude ionospheric data from Yakut meridional chain (Tixie Bay and Kotelny Island stations) and Cosmos-900 satellite for winter, equinox and summer months the following results are obtained:

1. In the evening-morning sector of the local time, from Tixie Bay station located at invariant latitude of 65.1$^{o}$, it is possible to observe large-scale blobs of ionospheric plasma, convecting through the polar cap from the dayside region.

2. Both satellite and ground data show, that in some cases for the period of observations, several plasma blobs are registered.

3. Horizontal scale sizes of blobs (129 cases of measurements from satellite in the northern hemisphere) have two peaks at 200-400 km and 600-700 km.

4. The seasonal course of plasma blobs occurrence frequency in the polar cap and auroral zone after the ground and satellite data has an expressed maxima in winter months.

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