The ionosphere-magnetosphere anomaly during the SURA – ISS experiment

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The plasmasphere boundary is the least stable and therefore is the most favorable as a factor rendering an active influence on the auroral processes. Our presentation addresses the study of the specific pattern of the subauroral ionosphere marked with the anomalous positions of the plasmapause, the equatorial boundary of the mid-latitude (main) ionospheric trough, and the light-ion trough under quiet solar and geophysical conditions near the magnetospheric shell with the McIlwain parameter L = 3.

The anomaly was identified on the base of the active experiment data measured during the SURA heating facility operation on October 2, 2007. The experiment was a part of the SURA–International Space Station (SURA–ISS) program in the framework of the DEMETER satellite mission. DEMETER satellite orbit crossed the SURA facility latitude, a point of maximum approach being 400 km westward from SURA position. Sharp plasma density fall at 56ºE and signs of strong plasma density and electron temperature instabilities appearance support the assumption that the plasmasphere border is located quite here, being considerably southward from its usual position. At the same place energetic electron beams and heavy ion density start to increase sharply. The oxygen ions become the dominating ones.

Further joint analysis of the orbital data from DEMETER and ISS, together with results of complex ground based measurements, shows that the revealed effect, which is characteristic to the premidnight sector located to the North of the Moscow–SURA line, is not local. It was observed in a vast territory, extending from the West to the East along the same L-shell, at least from Sweden to Kamchatka. This conclusion was confirmed by the analysis of the meridional distributions of the F2 peak plasma frequencies provided by GPS radioprobing of the ionosphere.

The comparison of these observational data with the model latitudinal–longitudinal and meridional distributions of the F2 peak plasma density was made. We present the latitudinal cross sections of the ionosphere calculated by SMI (Russian Standard Model of the Ionosphere) and IRI 2007 models for the longitude of Moscow (37.2° E) and different latitudes from 50° to 65° N for the period of the experiment. The profiles of plasma concentration were calculated for the interval of 100 to 2000 km with a vertical step of 10 km and the 1° step along the latitude. URSI coefficients were used for F2 peak parameters (hmF2 and foF2) calculation and NeQuick option was used for height profile restoration. This case and calculations of the latitudinal–longitudinal distributions of the peak F2 critical frequency both have not a scintilla of evidence of the discussed phenomenon.

The IRI model is not quite applicable for the subauroral ionosphere, where the ionosphere-magnetosphere interactions play an important role. This model does not take into account in full volume geomagnetic field variations, whereas they are a decisive factor determining the position of the midlatitude trough and the structure of the F2 layer. It is shown that the existing models of the ionosphere fail to represent the observed phenomenon adequately. Thus, in our opinion, the identified effect is quite interesting from the point of view of ionosphere-magnetosphere coupling physics and for practical forecasting of the HF communication and operation conditions of the navigational systems at subauroral latitudes.