The Ion Temperature Influence on the Formation of the Plasmasphere Spatial Structure

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We have studied the formation of the plasmasphere and upper ionosphere 3D spatial structure using the global numerical Upper Atmosphere Model [1]. We started from very low electron density. The field-aligned diffusion of ions causes the plasmasphere formation in a few days of modeling time. The resulting plasmasphere is nearly homogeneous in the longitudinal direction. It consists of the central region filled with H^+ ions and near-auroral areas (in the form of "horns" at the meridional cut) populated by a significant amount of O^+.

In the night ionosphere there are the regions of the increased electron density under these "horns", extending from the day sector. They are maximal in the first day of the calculation, and then are "melting". Another maximum exists in the equatorial region. It is also associated with the ions O^+[2].

Both of the above features exist independently of the spatial variations of the ion temperature. But there is one more region of the increased electron density in the mid-latitude night ionosphere, which doesn't appear if the T_i is assumed constant in the simulation. It appears on the 3-5th day of calculation. This indicates that it is associated with the accumulation of the H^+ ions.

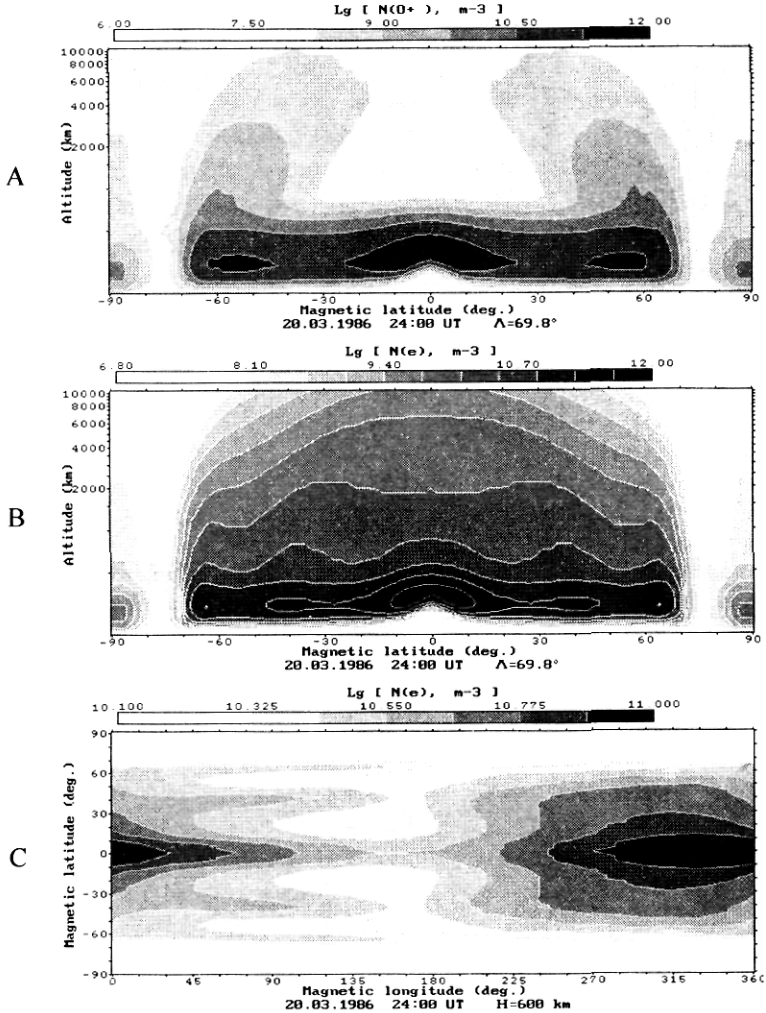

Fig.1 The forming of the plasmasphere structure:
A) the meridional cross-section of n(O+) at MLT 00:00
after the first day of modeling time
B) the meridional cross-section of n(e-) at MLT 00:00
after the 5th day of modeling time
C) the horizontal cross-section of n(e-) at 600 km
after the 5th day of modeling time

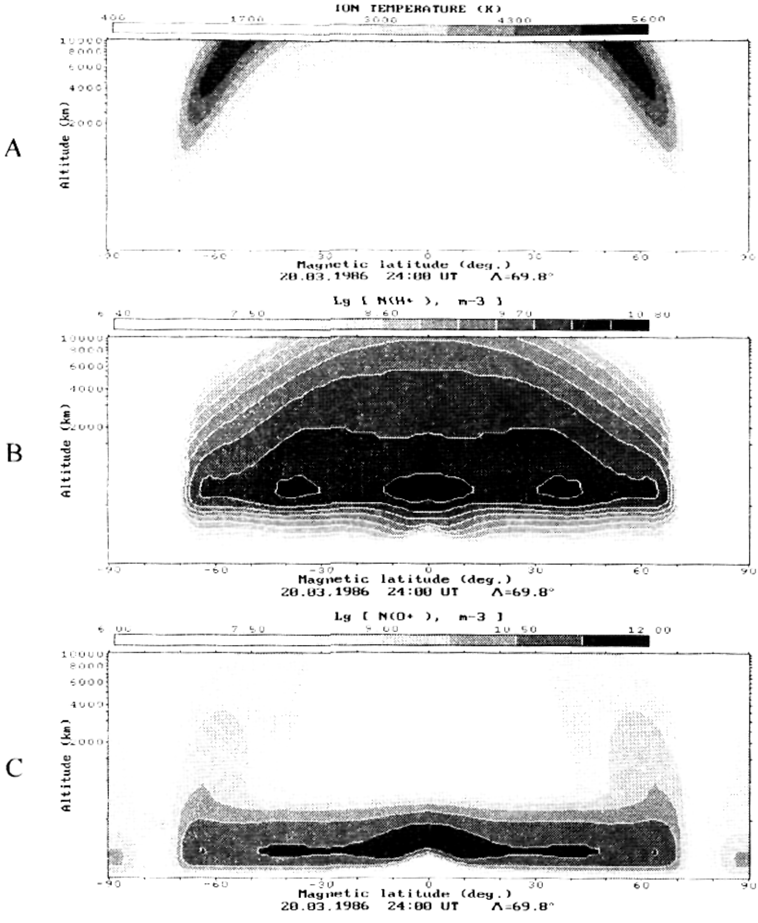

Fig. 2 The mid-latitude peaks of high electron content (the meridional cross-section along the meridian MLT 00:00 after the 5th day of modeling time): A – T_i, B – $n(H^+)$, C – $n(O^+)$

Formation of the mid-latitude peak is the result of coincidence of two factors. Daytime diffusion flow of ions, which fills the tube, increases with increasing T_i. On the other hand, the tube volume grows very rapidly with latitude. As the result, at the latitudes of 30-40° there is an area where a relatively small volume of the tubes coincides with power daytime flow of ions. In this area the daytime plasma accumulation is sufficient to maintain the night-time ionosphere. At the lower latitudes there isn't enough daytime flow speed (because of the low T_i), and at the higher latitudes the tube volume is too large, and plasma density remains small.

The appearance of these nighttime mid-latitude regions of the enhanced electron content was accounted by Knyazeva and Namgaladze [3] for the influence of the thermospheric wind. The results of this study show that the features of diffusion processes caused by the heterogeneity of T_i also contribute to their formation.

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1. http://uam.mstu.edu.ru
2. O.V. Martynenko, M.G. Botova. The role of ion diffusion in formation of 3-dimensional spatial structure of the plasmasphere // Physics of Auroral Phenomena: Abstracts of 33th Annual Seminar, 2010
3. M.A. Knyazeva, A.A. Namgaladze. An influence of the thermospheric wind variations on the enhanced electron density regions in the night-time ionospheric F2-layer and in the plasmasphere. Proceedings of the 6th International Conference "Problems of Geocosmos". – SPbSU, St. Petersburg, 2006 – pp. 91-94.