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Plasma density increase in the high altitude polar cap

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In general situation, the electron density in the ionosphere decreases with altitude. As for the latitudinal variation, the electron density is generally smaller in the polar cap than in the mid- or low-latitude region. Few reliable measurements have been made to estimate thermal electron density and temperature with a simple instrument such as Langmuir probe in the high-altitude polar cap region. For example, only the limited amount of the electron temperature and density data are available above altitude of 3000 km, where the density is generally less than 2.0∗10ˆ3 [/cmˆ3]. Since the plasma density significantly correlates with the solar activity, the general density profile becomes smaller for the minimum solar activity period.

Thermal Electron energy Distribution (TED) instrument onboard 'AKEBONO' (EXOS-D) satellite is operated in two modes; 1) DC mode to obtain the probe characteristic such as Langmuir probe, 2) SH (second harmonic) mode to estimate the electron energy distribution function based on Druyvesteyn method. In the SH mode, the electron temperature and density can be estimated even on the condition of low electronic density.

On the basis of statistical study of the Akebono observation for over 10 years, it is found that the electron number density occasionally increases up to 3.0-4.0∗10ˆ3[/cmˆ3] above altitude of 3000 km, where it is usually much smaller than 2.0∗10ˆ3[/cmˆ3] in the polar cap ionosphere. While the electron temperature is believed to be about 8000 K at such a high altitude, the temperature in the high density region is observed to be lower than that by several thousand degrees. It is noticeable that such an enhancement of the electron density is observed along with the occurrence of the geomagnetically active at solar maximum period. The high density region is observed to locally exist somewhere in the polar cap. In addition, it is obvious from the Suprathermal Mass Spectrometer (SMS) observations that the H+ velocity parallel to the upward field aligned direction is observed to be lower than the average at the same altitude. Also it is significant from the Low Energy Particle (LEP) observations that the downward flux of electrons with energy range of 15 - 50eV is smaller compared to that in the adjacent region.

Such high density plasma in the polar cap may be generated by plasma transport process. We would suggest the two possibilities as follows: 1) The high-density plasma slowly diffuses upwardly due to the large plasma pressure gradient, after dense plasma from the lower latitude enters into the polar cap by horizontal convection on the geomagnetically active times 2)The high density plasma at almost the same altitude in the mid latitude is transported to the polar cap by the anti-sunward convection during the geomagnetically active times, plasma is transported to the polar cap from the dayside of middle latitude.

Then, high-density and low-temperature plasma will be observed at high-altitude polar cap.

A characteristic feature of the high density plasma observed in the high-altitude polar cap is summarized as follows:

1) It is more frequently observed on the solar maximum condition.
2) The electron density enhancement is observed during the geomagnetically active period.
3) The high density region is observed to locally exist only in a part of the polar cap region.
4) The electron temperature inside the high density plasma region is lower than the averaged temperature at the same altitude.
5) The H+ ion velocity in the upward field-aligned direction is lower than the averaged velocity at the same altitude.
6) The downward electron flux in the energy range below 50eV is observed to be lower than that in the adjacent region.

In the presentation, we discuss the generation mechanism as well as more detailed result of the analysis.