Electron density enhancement in the polar region during a geomagnetic storm

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In the polar region from the ionosphere to the magnetosphere of the Earth, the electron density enhancement during geomagnetic storms was reported by several studies [Tu et al. 2007; Kitamura et al. 2010a; 2010b]. Kitamura et al. [2010a; 2010b] reported that the electron density enhancement occurred depending on geomagnetic activity, and suggested that the high density plasma were generated by cleft ion fountain in the cusp and transported widely in the polar cap due to ionospheric convection. They also reported that the electron density enhancement was found not only around the cusp region but also in the nightside auroral region. The following two explanations were suggested: (1) The enhanced convection transported the high density plasma generated by cleft ion fountain into the auroral region. (2) The auroral particle precipitations caused the ion outflow from the ionosphere and generated the high density plasma in the auroral region.
In order to perform detailed investigation on what cause the electron density enhancement in the polar region during geomagnetic storms, we compared electron density distributions in the polar region in geomagnetically disturbed (Kp>4) and quiet (Kp<3) conditions. In the analysis, we used the electron number density data derived from plasma wave data measured in an altitude range from 275 to 10500 km and in a geomagnetic latitude range larger than 75 deg. in periods from November 1989 to February 1990 and from November 1990 to February 1991 by the Plasma Waves and Sounder (PWS) experiment onboard the Akebono satellite. In the event of electron density enhancement observed on February 15, 1990 during geomagnetic storm (Dst:-99n), the electron number density was 811 /cc at an altitude of 7384 km, at geomagnetic latitude of 75.37 deg., and in 10.85 MLT. According to Kitamura et al. [2009], the average electron density in this region is 17 /cc. This event can be explained to be caused by cleft ion fountain since it was found around cusp region. In the event of electron density enhancement observed on January 28, 1990 during geomagnetic storm (Dst:-55nT), the electron number density was 700~1500 /cc in auroral region (geomagnetic latitude: 70-75 deg.). The enhancements of auroral electron and ion fluxes were found by Low-Energy Particle (LEP) detector onboard the Akebono satellite at the same time as the electron density enhancement. Quantitative comparison among the enhanced electron density, the ionospheric convection velocity in the polar cap, and flux of auroral particles will be needed in order to clarify which factor is dominant.

