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Comparison between the storm-time plasma density enhancement and DyFK simulations in the polar magnetosphere

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The Polar, IMAGE, and Akebono satellites observed electron density enhancements up to about two orders of magnitude in the polar magnetosphere during geomagnetic storms. Kitamura et al. [submitted to JGR] showed that the electron density at about 9000 km altitude exceeded 100 /cm^3 in wide regions in the polar cap and auroral zone during the main phases and near the minima of the SYM-H index during the geomagnetic storms. However, whether the density enhancement during geomagnetic storms can be explained by the known mechanisms or not has not been studied yet. We used the Dynamic Fluid Kinetic (DyFK) models to simulate the enhanced electron density during the main phase of the geomagnetic storm occurred on June 6, 1989 in order to quantitatively study the mechanism.
The DyFK model can treat two processes which have been considered to be important for plasma outflow: Electron heating due to the soft electron precipitations and wave heating by broadband ELF waves. Observational data obtained in the cusp by the Akebono and DMSP-F9satellites during the main phase are used as input of the simulations. Intensity of broadband ELF waves at gyrofrequencies of $O^+$and H^+ions in an altitude range of 1600-12,800km is obtained by the Akebono satellite at about 8000 km altitude. The flux and characteristic energy of electron precipitations are observed by the DMSP-F9 satellite at about 840 km altitude.
During the main phase of the June 6 event, the Akebono satellite observed enhanced electron densities of >100 /cm^{3}in the polar region at 8000-10,400km altitude in the polar cap. The flux of ion upflows measured by the DMSP-F9 satellite in the cusp reached up to $8*10^9$ /cm^2/s mapped toward 1000 km altitude. The simulated ion density and flux at the DMSP altitude in the cusp and the simulated electron density at the Akebono altitude in the polar cap are about one order of magnitude lower than those observed by the satellites. Since the field-aligned velocities of the ions in the polar cap in the simulation are consistent with the Akebono observations, we think that the lower density in the simulation at the DMSP altitude when the simulated flux tube entered the cusp is the cause of the lower densities and flux. In order to obtain more consistent densities when the flux tube entered the cusp, we are planning to use the field line interhemisphere plasma (FLIP) model which can treat closed flux tube in the subauroral zone, expected to lead higher densities in the ionosphere.

Keywords: ion upflow, cleft ion fountain, ion outflow, Akebono satellite, DMSP