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Variation of radiation belt electrons and O+ ions observed by FAST at low latitudes during magnetic storms

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It is observationally known that the O+ ion population becomes an important contributor to the ring current during large magnetic storms. Its importance in terms of energy density increases with increasing geomagnetic activity. On the other hand, the processes responsible for this dramatic composition change of the ring current are still under debate. Enhanced polar outflows during geomagnetically active periods are considered to be responsible for the composition change. However, the link between the outflows and high-energy ring current is not clear due to the lack of low-energy ion observations in the inner magnetosphere inside GEO (R~6.6 Re). Penetration of radiation-belt electrons into instruments makes direct observations of low-energy ions difficult in the inner magnetosphere. A correction method to remove this background is also one of key elements needed for inner magnetospheric missions in the future.

The Electrostatic Analyzer (ESA) onboard the FAST satellite had been operated in the mid-latitude regions above ~45 degrees for the past 4 years and observed ions below 30 keV. Radiation belt contamination is quite uniform in energy. Utilizing this feature, we developed an automated method to subtract the radiation contamination from ESA data and estimated the background counts and ion moments during several magnetic storms. Comparison between the estimated background and energetic particle data at GEO orbits indicates that electrons with energies of 0.5-1.5MeV are the main contributor to the background. The background count variation during a magnetic storm from April 11, 2001 indicates that the outer radiation belt electron fluxes decreased dramatically during the storm main phase and recovered from the inner L shells (ILAT~53-55 degrees) during the rapid recovery phase. Finally, the peak flux of the penetrating population moved to higher latitudes, near to its pre-storm position.

The data after the background correction enable us to monitor behavior of low-energy (below 30 keV) ions as a function of ILAT in a particular MLT range. For example, O+ ions appeared in the inner magnetosphere at the beginning of the April 11, 2001 storm and became the major ion component in the inner magnetosphere during the storm. Preceding the development of the O+ ring current, large numbers of O+ ions comprising multiple energy bands below 12 keV were observed at low latitudes (50-60 degrees). The ionospheric O+ are transported to the inner magnetosphere during the storm, and the observation suggests that it contributes, at least partially, to the O+ ring current during the large storm. On the basis of these observations, the supply mechanisms of O+ ions to the storm-time ring current will be discussed.