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Dynamics of the ring current during severe magnetic storms

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During severe magnetic storms, the strong ring current extensively modifies the electromagnetic and particle environment. The strong ring current, which can be driven by the convection electric field, alters the local magnetic field and generates the Region 2 type field-aligned currents. To remove the space charge deposited by the field-aligned current, Pedersen currents are established in the ionosphere. As a consequence, the convection electric field is significantly distorted during the severe magnetic storms. Post-midnight enhancements of tens-of-keV ion flux as seen by IMAGE/HENA during large magnetic storms can be explained by the distortion of the convection distribution on the morningside. On 20 November 2003, an intensive storm took place with Dst reaching -472 nT. Data from the polar orbiting NOAA satellite shows that the ion flux with an energy range of 30-80 keV started decreasing immediately after the commencement of the recovery phase. This rapid decay cannot be attributed to the usual charge exchange with neutral hydrogen. Denser neutral hydrogen normal or stronger pitch angle diffusion taking place globally is necessary to explain the rapid loss. Better models of neutral hydrogen and pitch-angle diffusion will confirm the hypothesis. The inflation of the magnetic field due to the enhanced ring current also has important effects on storm dynamics. Simulated ENA images agree better with the IMAGE/HENA observation when we introduce the inflated magnetic field model. However, the magnetic field model used in the simulation is not self-consistently coupled with the ring current. In the future, a realistic and self-consistent magnetic field, in which the force balance is completely satisfied, is necessary for better understanding of the electromagnetic coupling of the inner magnetosphere and the subauroral region.