Reduction of the field-aligned potential drop in the polar cap during large geomagnetic storms

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Photoelectron observations by the FAST satellite show that a field-aligned potential drop larger than ~10 V above about 3900 km altitude was frequently (~83%) identified on open magnetic field lines in the polar cap during geomagnetically quiet periods under sunlit conditions [Kitamura et al., 2012]. The typical magnitude of the field-aligned potential drop is about 20 V. While the location of the field-aligned potential drop has not been determined, the potential drop would further accelerate outflowing ions toward the lobe region. If a similar field-aligned potential drop is present during geomagnetic storms, it will affect transport paths and acceleration of outflowing heavy ions from the ionosphere to the plasma sheet and the ring current region, where heavy ions often become dominant during large geomagnetic storms.

We have studied photoelectron flows and the inferred field-aligned potential drop in the polar cap during 1 major (min. *SYM-H*: –115 nT) and 3 intense (min. *SYM-H*: –490- –320 nT) geomagnetic storms, which occurred in the periods when the apogee of the FAST satellite was at high latitudes, and the footprint of the satellite paths in the polar cap was under sunlit conditions in most of times. In contrast to the ~20 eV potential drop during geomagnetically quiet periods, the field-aligned potential drop sometimes almost disappeared (smaller than ~5 V) continuously during one satellite traversal of the polar cap. This result indicates that the acceleration of ions by a field-aligned potential drop in the polar cap and the lobe region is smaller during the main and early recovery phases of large geomagnetic storms compared to during geomagnetically quiet periods.

Under small field-aligned current conditions, the number flux of outflowing ions should be nearly equal to the net escaping electron number flux. There is a clear monotonic correlation between the net escaping electron number flux and the magnitude of the field-aligned potential drop; a large net escaping electron number flux corresponds to a small magnitude of the field-aligned potential drop [Kitamura et al., 2012]. Since ions with large flux originating from the cusp/cleft ionosphere flow into the polar cap during geomagnetic storms [e.g., Kitamura et al., 2010], the net escaping electron number flux should increase to balance with the enhanced ion outflows. Thus, the enhanced net escaping electron number flux would reduce the magnitude of the reflection potential drop.