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Atmospheric loss during major geomagnetic storms - Cluster observations

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The rate of ion escape from the polar ionosphere is known to vary by orders of magnitude, depending on the geomagnetic activity. However, the upper limit of the escape rate during the largest geomagnetic storms is not well constrained. Here we studied six major geomagnetic storms between 2001 and 2004 using Cluster data. Cluster is a constellation of four satellites flying in tetrahedral formation around Earth in a polar elliptical orbit. The six major storms were chosen to fulfill the criteria of a minimum Dst <-150nT or Kp >7+. Since the shape of the magnetospheric regions (plasma mantle, lobe, and inner magnetosphere) are distorted during large magnetic storms, we use both plasma beta and ion characteristics to define a spatial box where the extreme event was observed. Once the spatial regions are defined by this method, we look at the relative enhancement of the flux during extreme events for that region. Data from the full year when the storm occurred is used as a reference for the relative enhancement. For this part, we analyzed oxygen ions data only because hydrogen ions may have solar wind origin. The storm time data for most cases showed up as a clearly distinguishable second peak in the distribution toward the largest fluxes observed. The O+ escape flux increased by approximately 1.5 to 2 orders of magnitude during the six major storms as compared to the yearly average.