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Supporting Information for

The relation among the ring current, subauroral polarization stream, and the geospace plume: MAGE Simulation of the March 31 2001 Super Storm

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Movie S2 Evolution of the total electron content (TEC) and the plasmapause during the storm.

Movie S3 Evolution of the ring current and the plasmapause during the first period of southward interplanetary magnetic field (IMF).

Introduction

The supporting information contains two figures and two movies. Figure S1 shows the choices of the values of the contour lines in Figure 9 and 10 can describe the spatial distribution of the variables very well. It is reasonable to use the contour lines to represent the location of the plasmapause, ring current pressure, electron pressure, etc. Figure S2 shows Figure 3 from

"Plasmasphere response: Tutorial and review of recent imaging results" (Goldstein, 2006). It shows the observed spatial relationship between the storm-time plasmasphere and the partial ring current, which is similar to our simulation results as shown in Figure 10 and Movie S3.

Movie S1 - S3 are made from the simulation data with 2-miniute interval and 1-minute interval respectively. The simulation data has been converted into readable format for the Tecplot360 scientific visualization software. Movie S1-S2 are produced at 10fps and Movie S3 are produced at 20 fps in the MP4 format. Due to the limitation of the software, the time tag in the movies cannot be shown in HH:MM:SS format. It is counted in minutes from 16:00:00 UT 03-31-2001 when the simulation starts. The variable description in Movie S1 is the same as Figure 2. Movie S2 shows the plasmapause and TEC evolution from the beginning to the end of the storm main phase. The top left panel shows the equatorial plane view of the plasmapause (thick black contour line) and TEC color contour. The top right and lower panels show the ionospheric view of TEC in the SM coordinate and in the geographic coordinate respectively. The electric potential contours are plotted by thin black lines in all three panels, with dashed lines for negative values. Movie S3 shows the evolution of the ring current and the plasmapause during the first period of southward IMF. The electric fields transport both the ring current plasma and the plasmaspheric plume plasma toward the dayside. Since hot ions also follow the gradient and curvature drift, when the ring current particles penetrate to lower L shells, they overlap with the plasmapsheric plume near the dusk side. This process is consistent with the IMAGE satellite results as shown in Figure S2.

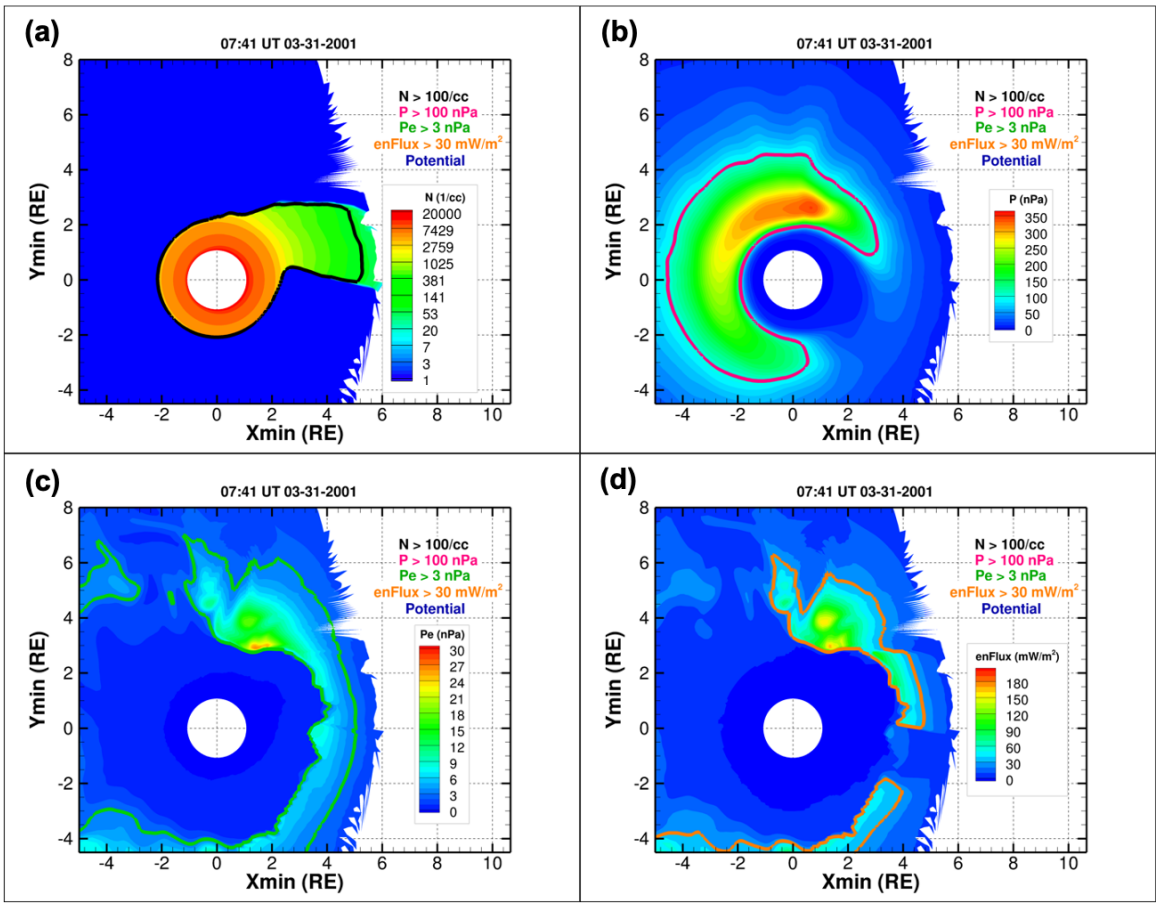

Figure S1. Colormap and corresponding color-coded contour lines used in Figure 10 and 11. The variables are (a) flux-tube-averaged plasmaspheric density, (b) plasma pressure, (c) electron pressure and (d) diffuse electron precipitation energy flux projected onto the equatorial plane. In each sub-figure, the physical quantity is mainly distributed inside the region enclosed by the contour line.

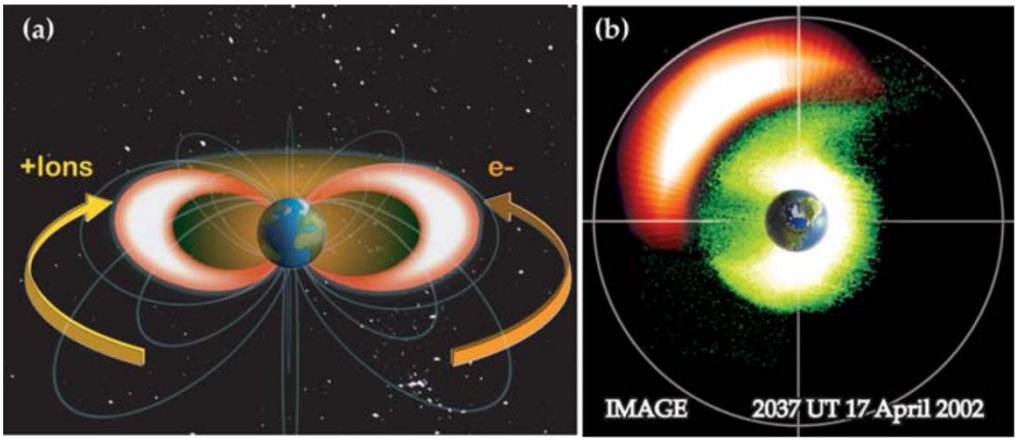

Figure 3. (a) Illustration of idealized ring current, format identical to that of Figure 1a. The ring current is the orange torus surrounding the Earth. Westward (eastward) magnetic drift of ions (electrons) indicated by the yellow (orange) curved arrow. (b) Global composite image of the inner magnetosphere (Pulkkinen *et al*., 2005). IMAGE HENA proton pressure (10–60 keV, 0.5–0.8 nPa) image has been overlaid onto Figure 1b. The HENA image shows the partial ring current that has been injected by a substorm. The plasmasphere and ring current are roughly spatially complementary, although there is some overlap near dusk, at the eastern edge of the plasmaspheric plume. (HENA image courtesy of P. C. Brandt; EUV image courtesy of B. R. Sandel).

Figure S2. Figure 3 of "Plasmasphere response: Tutorial and review of recent imaging results" (Goldstein, 2006) (b) shows the complementary shape of the plasmapause and the ring current in the composite image of the ring current (IMAGE HENA image in orange) and the plasmasphere (IMAGE EUV image in green). Spatial overlap between the ring current and the plasmaspheric plume is seen near the dusk side.

Movie S1 Evolution of the equatorial plane view of the ring current pressure, the ionospheric FAC, the ionospheric view of TEC and the equatorial plane mapping of the plasmapause and the TEC during the storm.
Movie S2 Evolution of the total electron content (TEC) and the plasmapause during the storm.
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Reference

Goldstein, J. Plasmasphere Response: Tutorial and Review of Recent Imaging Results. *Space Sci Rev* **124,** 203–216 (2006). https://doi.org/10.1007/s11214-006-9105-y