Redistribution of High-Altitude Plasma During Storms

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During geomagnetic storms, particularly when prompt penetration electric fields (PPE) occur, the equatorial plasma can be lifted to very high altitudes and then diffuse along magnetic field lines to higher than normal latitudes. During these cases very high plasma density (total electron content (TEC) greater than 200 TECU) can be found at these higher latitudes. Shortly after the PPE lifts the equatorial plasma to higher altitudes, at least in the US sector, phenomena known as storm-enhanced density (SED) can occur. SEDs occur in the post-noon time frame and consist of a very high density bulge that seems to occur in the southern USA and Caribbean region, followed by a narrow plume of high density plasma that flows into the high-latitude throat near local noon, and across the polar cap.

An outstanding research question is: Exactly how is the high density SED plasma, particularly in the bulge related to the PPE and lifting of the equatorial plasma? Ionospheric imaging of electron density and TEC seem to show a gap in density between the poleward extent of the equatorial plasma and the equatorial extent of the SED plasma. Further, there are magnetic storm events where SEDs do not form (November 2004 as a good example).

This paper will investigate the relationship between the equatorial high altitude plasma distribution during magnetic storms, and the initiation and evolution of the SED feature. We will examine eight separate storms from 2003-2006 using the ionospheric data assimilation algorithm IDA4D. In particular we will focus on time periods when LEO satellite GPS TEC data is available from CHAMP, SACC, GRACE and the COSMIC constellation (2006 and beyond). These data sets directly measure the TEC above the satellites, and therefore are good tracers of the high altitude plasma distribution. IDA4D ingests these data sets and uses them to get an improved image of the plasma density for the topside ionosphere and plasmasphere. The resulting 4D images of high altitude densities will be cross compared for the various storms and the similarities and differences will be studied and correlated with various geophysical parameters such as the interplanetary magnetic field (Bz), Dst, hemispheric power, cross cap potential, PPE, equatorial vertical drifts, and the interplanetary electric field. The overall objective is to elucidate the physical relationships that govern the redistribution of equatorial plasma during storms, and the generation and evolution of SEDs.