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Evidence of auroral oval TEC enhancement and simultaneous plasma patch break-off events in the Arctic and Antarctic ionosphere during the initial phase of a geomagnetic storm event at equinox, 26 September 2011

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A moderate geomagnetic storm during 26-27 September 2011 instigated ionospheric TEC responses in the high latitude regions, imaged in this dual-hemispheric study using the ionospheric reconstruction tool MIDAS (Multi-Instrument Data Analysis System). This case study showcases the current capabilities of GPS inversion tomography at high latitudes, given the improvement in ground-based receiver distribution in the polar reaches during the last decade.

Several interesting features of the high latitude response are highlighted. During the initial phase of the storm (Dst+ increase signature), a ring feature in the TEC was imaged around the position of the Arctic auroral oval that persisted for over an hour. Verification of the auroral oval position and incident particle precipitation was provided by the SSUSI ultra-violet imager and SSJ/4 spectrometer on-board the polar-orbiting DMSP satellites. Shortly after the ring feature dissipated, two consecutive and defined plasma patch break-off events occurred within the North American sector, with anti-sunward convection then circulating the TEC enhancements over Greenland and Iceland. Apparent during the main phase of the storm (Dst- signature), these break-off events were likely triggered by switching periods of the interplanetary magnetic field (IMF) from southward (Bz-) to northward (Bz+) under constant By+ conditions projected at the magnetopause. A coincident patch break-off event was imaged in the Antarctic in the local dawn-noon sector; this simultaneity may be attributed to the more balanced incidence angle of the IMF during equinox upon the Northern and Southern hemispheres. Finally, the ionospheric trough was identified over Scandinavia and Europe as a clear band of depletion between the storm-enhanced dayside electron density and expansion of the auroral zone during the main phase of the storm.

This study demonstrates that, in combination with other instruments, GPS tomography has become a useful tool providing a unique view on the physical processes occurring in the Arctic and Antarctic ionospheres.