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Polar cap patch signatures during geomagnetic disturbed conditions

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Train of polar cap patches are a signature of disturbed conditions in the ionosphere-magnetosphere system. When solar wind (SW) velocity and interplanetary magnetic field (IMF) parameters show typical high-speed stream (HSS) behavior, trains of electron density patches occur in the polar cap moving from the dayside ionosphere across the pole towards the night sector region of open and closed magnetic field lines.
A region of depleted electron densities towards the south of the train of patches are observed moving with the patches. On the boundary and in the depleted region, plasma instabilities in the E and F-region are observed leading to severe scintillations that at times have severe space weather effects for aviation communication and GNSS-receiver's loss-of-lock at high latitudes.
Two other ionospheric effects also occur as a signature of the train of patches: A decrease in the F-region electron density and a lowering of the altitude of the F-region electron density peak. This is often associated with an enhancement of the E-region electron density at the same time. All together this indicate that the ion composition during these events is changing, giving rise to larger electron density decreases south of the train of patches.

We present the dominant high-latitude ionospheric physical processes during high solar wind speed conditions with IMF Bz variations being negative, and compare them with typical coronal mass ejection (CME) storm effects. Using a multi-instrument observational approach, we analyzed sets of observations of total electron content (TEC) and rate of TEC index (ROTI) data (obtained from GNSS ground stations in Greenland, Iceland, and Scandinavia) for identifying the geophysical causes of the radio communication malfunctioning. In addition, we used ground-based data of magnetic field variations, thermosphere O/N2 ratios (from TIMED/GUVI) and SuperDARN plasma convection and electric field maps to identify the signatures of polar cap patches. From the combined data sources, we reconstructed the storm-induced geophysical ionosphere dynamics of the train of polar cap patches.