Influence of polar cap patch scintillations on GNSS receiver performance during geomagnetic disturbed conditions

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When solar wind velocity and interplanetary magnetic field parameters show typical high-speed stream 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 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 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 in the night sector associated with the patches: A decrease in the F-region electron density and a lowering of the altitude of the F-region electron density peak. Often this is observed when an enhancement of the E-region electron density takes place at the same time. All together this indicate that the ion composition during these events is changing, giving rise to the electron density decreases south of the train of patches.

Using a multi-instrument observational approach, we analyzed ground-based sets of observations of, total electron content (TEC), rate of TEC change index, geomagnetic field variations, SuperDARN plasma convection, and electric field maps for identifying possible geophysical causes for radio communication malfunctioning during such events.