

## **Multi-point and multi-instrument observations analyzed for the study of ionospheric electron density perturbations during periods of intense geomagnetic activity**

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Ionospheric electron density perturbations occurred during 7 to 10 March 2012, as a result of a series of magnetospheric disturbances, have been studied using data from geomagnetic observatories, ground based ionosondes and GNSS receivers and spacecraft observations from ACE and, DMSP missions. Analyzing the interplanetary causes in each phase of this disturbed period, in comparison with the total electron content (TEC) disturbances, we have concluded that the interplanetary solar wind controls largely the ionospheric response. An interplanetary shock detected at 0328 UT on 7 March caused the formation of prompt penetrating electric fields in the dayside that transported plasma from the near-equatorial region to higher in altitudes and latitudes forming a giant plasma fountain which is part of the so-called dayside ionospheric super-fountain. The super-fountain produces an increase in TEC which is the dominant effect at middle latitude, masking the effect of the negative storm. Simultaneously, inspecting the TEC maps, we found evidence for a turbulence in TEC propagating southward probably caused by large scale travelling ionospheric disturbances (LSTIDs) linked to auroral electrojet intensification. On 8 March, a magnetospheric sudden impulse at 1130 UT accompanied with strong pulsations in all interplanetary magnetic field (IMF) components and with northward Bz component during the growth phase of the storm. These conditions triggered a pronounced directly driven substorm phase during which we observe LSTID. However, the analysis of DMSP satellite observations, provided with strong evidence for Sub-Auroral Polarization Streams (SAPS) formation that erode travelling ionospheric disturbances (TID) signatures. The overall result of these mechanisms can be detected in maps of de-trended TEC, but it is difficult to identify separately each of the sources of the observed perturbations, i.e. auroral electrojet activity and LSTIDs, super-fountain and SAPS.