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Publication date:
2016

Document Version
Publisher's PDF, also known as Version of record

Link back to DTU Orbit

Citation (APA):
Analysis of High-Latitude Ionospheric Processes During HSS and CME-Induced Geomagnetic Storms

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Key Points

- Vertical electron content (VTEC) maps inferred from Greenbank GNSS stations are used for the first time to investigate differences in ionospheric disturbances caused by high speed streams (HSS) and coronal mass ejections (CME).
- TEC mapping reveals pronounced negative storm phase and significantly decreased polar patch formation due to increased atmospheric heating.
- On the day following the HSS event (Nov, 4, 2016) a solar radio burst (SRB) caused anomalies in European and Greenian air navigation. We present our findings related to this rare event.

Observations and Mapping Technique

From the total number of 62 QMNET stations 16 were selected. This selection was based on their geographical location, location and distance to each other. The goal was to provide an event distribution along the coastline, which resulted in the best PPI coverage. The white area in the right side panel of Fig A shows an example PPI distribution for a given epoch.

The geosat-2 GNSS receivers are capable of tracking several observables, such as geostationary orbit (GSO) or GTO and PH-1 ionospheric and ionospheric background. Moreover, monitoring near-Earth objects (NEO) and solar wind and geomagnetic impacts (JPL, GNMS) to obtain VTEC values which then were mapped to PT, as can be seen in Fig B for details on JPL GNMS. Moreover, (1998). Fig D shows how the time development of polar patches can be monitored in a synoptic-map-type in the VTEC maps. The time interval between snapshots is 15 minutes.

Relative plasma drifts are of the order of 1300 km in the polar-cap region, which in many respects at least 4± sampling rate is defined. A wave

Fig A presents a schematic showing our current understanding of the complex structure of an ionospheric CML. An example of a larger CML-driven ionospheric storm in the 19 February 2016 highly complex structure, with large storm, which had the largest impact on the disturbance storm-time (DST) index that year. The geomagnetic storm was the result of two powerful earth-directed CMEs.

Fig B shows the ionosphere structure of HSS and its typical structure in solar electric field. The event lasted 3-4 days and the storm, therefore how could air navigation be impacted by solar-originated phenomena?

Solar Radio Burst and Ray Tracing During the Event

Fig D displays a schematic on 4 November 2016 at the Greenland station of the W-tube solar proton event network. Similar signatures observed at the Greenland stations which were under solar wind conditions or in the dayside magnetosphere.

The geomagnetic storm shows the total intensity of SRB (kV GSE, 2016), which start approximately 13:45 UTC and continued for 4 hours. It was observed the day following the 3 November HSS-related geomagnetic disturbances presented in this paper. This SRB disturbed the original auroral ground regions of the auroral observers in northern Greeneland.

Questions:

1. Where these disturbances related to the HSS-induced ionospheric storm?
2. Was the ionospheric storm following this storm above the aurora borealis the day of the storm. Therefore, how could air navigation be impacted by solar-originated phenomena?

Facts about the airport: 1. (1) The wire-frame of Fig A shows a HSS event on the day of the storm. Therefore, how could air navigation be impacted by solar-originated phenomena?

Tire of incidence for the received erroneous location signal: (1) The wire-frame of Fig A shows a HSS event on the day of the storm. Therefore, how could air navigation be impacted by solar-originated phenomena?

The E-region (100 km) of the ionosphere is outlined for angles larger than -10.1 degrees, and the F-region in ionospheric effects larger than -13 degrees.

Regression of the location frequency for plasma frequencies from 10 to 15 MHz:

A radio burst (log THET, 2015) for a value frequency less than -3 degrees (less re-affected in the E advances) of the region of the ionosphere. Radio bursts last less than 150 milliseconds (for weekdays between 0° and 5°) were re-affected in the E and F region of the ionosphere. Observations:

(1) The waves were detected in the 5 November HSS event. It was caused by a SRB on the following day.

(1) It is possible to have solar radio bursts (of 10.5 MHz) to impact the ground antenna of a new ground radio and the airplane ionospheric radio.

Summary

For the first time we compared ionospheric effects of HSS and CME-driven storms at high-latitudes. There were similarities and also differences observed in the development of the storms. (1) Both storms are capable of clearing negative phase, which results in an increase of TDI-breaking down into patches and a decrease in patch formation in general throughout the Greenland sector. The negative phase due to the PCN index started to increase indicated energy input into the high-latitude. (2) The rate of PCN increase was clearly different for the two types of storms. (3) The impact of the physical processes responsible for the negative phase have less pronounced impact on the ionospheric effects. We also investigated observed storm influence on airbone navigation at high-latitudes in order to determine the possible causes of the radio communication disturbances. This effort may lead us to a better understanding of the phenomenon and might help develop communication hardware that is more resistant to such effects.

Bibliography


