Project Details

ROSES ID: NNH06ZDA001N
Selection Year: 2007
Program Element: Independent Investigation

Topic: Investigate the Global Distribution, Sources and Effects of Large Electron Density Gradients at Middle and Low Latitudes

Project Title:
Large Scale Variability in Space and Time of Total Electron Content (TEC) Storm-Time Ehancements Driven by Penetration Electric Fields

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Summary:
The largest changes in the terrestrial ionosphere occur during geomagnetic storms. During such events, electric fields of magnetospheric origin penetrate to middle and low latitudes; Joule heating and particle precipitation cause expansion, winds and composition changes in the thermosphere. The entire ionosphere, as portrayed in the parameter Total Electron Content (TEC), can be enhanced to levels far above pre-storm values, conditions that have major consequences on GPS navigation systems now used widely (particularly in FAA systems). Examples of storm enhanced densities (SEDs) have been portrayed using GPS diagnostics during several remarkable events, termed super-storms, during the current solar cycle. Ongoing studies are needed to track such effects as a function of season and phase of the solar cycle in order to characterize the variabilities in the gradient scenarios. Most of the events examined to date single out the American longitude section near 70 W for maximum effects, due to the dominance of electrodynamics in this region of maximum dipole tilt.

While the physics of the negative phase is well known (enhanced loss rates), virtually no attention has been given to the negative phase as a source of severe spatial gradients, and thus of equal importance to those associated with SEDs. Here we propose a study of TEC during 180 geomagnetic storms observed during a previous solar cycle (#20) spanning the years 1967-1978. This unique database comes from Faraday rotation measurements of radiobeacon signals from geostationary satellites using the AFCRL network of stations from Greenland to the Caribbean. Using data from this crucial longitude sector, we propose a comprehensive study of both sources of TEC gradients and their variability s with season, solar cycle, and severity of the geomagnetic storm.

The TEC data in question exist in fully reduced form in a series of unpublished research reports funded by the Air Force. The PI was co-author on all three of these reports and thus they are fully available for research and applications to current space weather issues.

A prediction scheme for the types of ionospheric positive phase storm possibilities (prompt dusk effects vs. delayed or absent ones) was proposed decades ago using a small sample of these earlier datasets, but never fully tested with later data. We propose to do that now. Finally, to understand the nature of large TEC gradients at the special longitudes of dipole tilt in the North American sector, we will conduct a companion study using ionosonde data from Hobart, Tasmania, where the sub-auroral conditions comparable to those at 70 W occur in the southern hemisphere.

A small PI-led team can address these major issues of direct relevance to LWS research targets due to the readily available dataset and demonstrated expertise in storm studies.

Publication References:

no references