Project Details

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Program Element: Focused Science Topic

Topic: Atmosphere-Ionosphere Coupling During Stratospheric Sudden Warmings

Project Title:
On the Global Dynamics of the Time-Dependent and Three Dimensional Ionospheric Response to Sudden Stratospheric Warming Events

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Summary:
Sudden Stratospheric Warming (SSW) events in the lower atmosphere polar regions represent a unique type of meteorological phenomena that exhibits significant dynamical coupling of the troposphere-stratosphere-mesosphere-ionosphere system. SSW events are caused by rapid changes in the mean stratospheric zonal flow accompanied by an enhancement in planetary wave activity, which as a result can produce large perturbations in the electrodynamics and electron density at ionospheric heights even at low-latitudes. It is now recognized that, for a better specification of the ionospheric variability, a better understanding of SSW events and the coupling with the upper atmosphere is needed. Much of our knowledge of the ionospheric variability during SSWs, however, has come from observation made independently and only at a few locations. Nevertheless, these observations have provided important basic information about the SSW effects in the ionosphere. A broader, more global, observational capability and more comprehensive analyses are required to unambiguously reveal the global response of the ionosphere to SSW events.

The overall goal of this proposal is to elucidate the global ionospheric signatures associated with SSW events in the Northern and Southern Hemisphere. To reach this goal, we will answer the following science questions:
a) What is the time-dependent three-dimensional (latitude, longitude, altitude) response of the ionosphere to SSW events and how does the ionosphere evolve through the SSW recovery phase?
b) How do the effects of SH SSW events on the equatorial and low-latitude ionosphere compare with those due to the NH SSWs?
c) What is the global structure of the lunar semi-diurnal perturbation in the ionosphere and to what extent is it modified by the SSWs?

To answer these questions we will use four-dimensional (latitude, longitude, height and time) images of the global distribution of the ionospheric electron density. These images will be obtained using a variety of data sources and the Ionospheric Data Assimilation Four-Dimensional (IDA4D) algorithm. An investigation of the variability in the electron density images and underlying electrodynamic processes taking place during the most recent SSW events will be aided by unique observations of equatorial electric fields made by the Ion Velocity Meter (IVM) instrument onboard the Communication/Navigation Outage Forecasting System (C/NOFS) satellite. The results of the proposed work will provide a comprehensive, global characterization of the ionospheric response to different types and magnitudes of SSW events. Our analysis will provide the time evolution of the ionospheric disturbances associated with SSW events. We anticipate that these results will contribute to test and validate numerical modeling and other theoretical efforts put forward by other members of the LWS Focus Team.

Publication References:

Summary: no summary

Reference: Azeem, I.; Crowley, G.; Honniball, C.; (2015), Global ionospheric response to the 2009 sudden stratospheric warming event using Ionospheric Data Assimilation Four-Dimensional (IDA4D) algorithm, Journal of Geophysical Research: Space Physics, Volume 120, Issue 5, pp. 4009-4019, doi: 10.1002/2015JA020993