Project Details

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Selection Year: 2012
Program Element: Focused Science Topic

Topic: Atmosphere-Ionosphere Coupling During Stratospheric Sudden Warmings

Project Title:
Investigating the Temporal Evolution of Mesospheric Dynamics Before, During, and After Recent SSW Events Using a High-altitude Data Assimilation and Modeling System

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Summary:
This proposal addresses two key scientific questions: (1) How do the global-scale dynamics of the mesosphere and lower thermosphere (MLT) respond to recent stratospheric sudden warming (SSW) events? (2) What are the relevant multi-scale wave-wave interactions among Rossby waves, tides, and gravity waves that determine the ionospheric response to SSWs? The objective is to identify the physical mechanisms responsible for observed SSW-ionosphere correlations during three separate SSW events in the Northern Hemisphere winters of 2005-06, 2007-08, and 2008-09, when geomagnetic activity was extremely low.

To achieve this objective, the proposed investigation will combine and study observations-based meteorological products from a global high-altitude atmospheric data assimilation system (DAS) with model simulations from the latest version of the Whole Atmosphere Community Climate Model (WACCM). The DAS will be based on the existing high-altitude version of the Navy Operational Global Atmospheric Prediction System (NOGAPS), known as NOGAPS-ALPHA (Advanced Level Physics-High Altitude), which assimilates both operational tropospheric and stratospheric observations and research mesospheric and lower thermospheric (MLT) observations from NASA s TIMED (Thermosphere Ionosphere Mesosphere Energetics and Dynamics) and Aura satellites to produce global synoptic analyses of the atmospheric state (e.g., winds, temperature, and constituents) from the surface to ~90 km every 6 hours. WACCM is a state-of-the-art global coupled chemistry-climate model of the neutral atmosphere extending from 0-130 km.

NOGAPS-ALPHA global meteorological analyses will be used to diagnose the spatial and temporal evolution of the main dynamical drivers in the MLT (i.e., planetary waves, tides, and gravity waves) before, during, and after specific SSW events. WACCM simulations constrained by NOGAPS-ALPHA DAS fields will be conducted and used to determine the impact of SSW-related mesospheric variability on the neutral atmosphere up to 130 km, making it possible to recreate neutral atmospheric forcing for specific SSW periods up to the lower boundary of the ionosphere. The results of these simulations can be used as lower boundary conditions for ionospheric models to validate proposed SSW/ionosphere coupling mechanisms. In addition, ensembles of free-running (i.e., unconstrained) WACCM simulations will be performed to determine the sensitivity of the MLT dynamical response to the effects of both orographic and non-orographic gravity-wave drag.

The proposed investigation will provide the first definitive description and understanding of the complete chain of events linking large dynamical changes in the polar winter stratosphere during the SSWs of 2005-6, 2007-08, and 2008-09, to large observed changes in a variety of ionospheric properties. In addition to representing a fundamental advance in our scientific understanding of the dynamics of the global Earth system, this research will provide relevant quantitative information for improving and validating Earth system prediction models of the coupled atmosphere-ionosphere system.

Publication References:

no references