Project Details

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Program Element: Focused Science Topic

Topic: Understanding Physical Processes in the Magnetosphere--Ionosphere / Thermosphere / Mesosphere System During Extreme Events

Project Title:
Response of the mesosphere, thermosphere and ionosphere to extreme solar flare events

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Summary:
We propose a comprehensive study of the response of the mesosphere, thermosphere and ionosphere (MT-I) to extreme solar flare events. Our goal is to quantify how the electron density profile can be perturbed during these extreme events and assess the consequences of these perturbations for radio wave propagation through the ionosphere. Our study will include model calculations beginning with the solar flux emitted by the sun down through the thermosphere and F region ionosphere to the lowermost mesosphere/D-region base where enhanced ionization has been inferred in past events. Our calculations will include a new estimate of the soft X-ray and extreme ultraviolet (EUV) flare spectrum, appropriate to extreme flares, which combine the results from numerical simulations with empirical constraints. This flare spectrum will be used in a hierarchy of models of the ionosphere, including the 3D ionosphere/plasmasphere model (SAMI3), the National Center for Atmospheric Research (NCAR) Thermosphere-Ionosphere-Mesosphere General Circulation Model (TIMEGCM) and a 1D model of the D and lower E regions (OASIS). The TIMEGCM simulations will calculate the thermosphere composition, temperature, and wind in response to our new extreme Xray/EUV emission estimates; this data will be used as input to SAMI3 to calculate the ionosphere/plasmasphere response. The perturbation to the neutral nitric oxide abundance will be used as input to the OASIS D region model. We will validate our model simulations with previously observed extreme flares such as the October 2003 events and their associated perturbations to TEC, nitric oxide and D/E region electron densities. As part of our calculations, we will perform explicit calculations of radio wave absorption for large to extreme flare event using several Naval Research Laboratory developed radio wave propagation codes for direct comparison to available observations. We will then extrapolate our validated models to even more extreme events (e.g. Carrington type events) to address questions such as what might be the maximum electron densities that can occur in the ionosphere and to provide information that can aid the assessment of potential societal impacts of extreme space weather events.

Publication References:

no references