Project Details

ROSES ID: NNH08ZDA001N
Selection Year: 2009
Program Element: Focused Science Topic

Topic: Determine the possible role of galactic cosmic ray particles as a source for cloud condensation nuclei in the troposphere and lower stratosphere.

Project Title:
Understanding the Thermospheric and Ionospheric Response to Solar Flares

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Summary:
An understanding of both the thermosphere and the ionosphere, two tightly coupled, overlapping regions of the atmosphere, is important for a number of research and space weather applications: (1) examining increased satellite drag due to heating of the atmosphere (2) examining where and when GPS signal degrading caused by strong gradients of electron density will occur; (3) determining when and where high frequency signals will be strongly scattered or lost due to ionospheric scintillation; (4) examining the role of ionospheric and thermospheric dynamics on the climatology of the lower atmosphere; and (5) determining how the ionosphere influences the magnetosphere through ionospheric conductance and outflow.

Energy enters the thermosphere and ionosphere through many different sources, but two of the most important are the solar extreme ultraviolet (EUV) brightness and the high-latitude Joule heating. The solar EUV is present at relative high levels all of the time, while the high-latitude Joule heating primarily occurs during aurorally active time periods. For many years, models have been run assuming that the solar EUV driving is constant, or slowly varying, for long periods of time (e.g., 24 hours), utilizing proxy models of the flux based on single wavelengths in the solar spectrum (i.e., F10.7). Recently, many researchers have realized that significant variations in the solar spectrum may be missed by doing this, and therefore, much of the physical driving of the model was lacking. Because there has been so little research done on the thermospheric and ionospheric response to the variability in the solar EUV spectrum, there is significant uncertainty in how the upper atmosphere behaves during impulsive increases in the EUV brightness (i.e., during flare events). We propose to address the following four questions related to this topic:

- What effect do solar flares have on the thermospheric density, temperature structure and winds?

- How long does the atmospheric effect of solar flares last?

- How does preconditioning of the thermosphere and ionosphere affect the response of the atmosphere to solar flares?

- How does the shape of the temporal behavior of the flare affect the thermospheric and ionospheric reaction to the solar EUV?

- How does the spectral distribution of the flare affect the thermosphere and ionosphere response?

In order to study these topics, we will utilize a global ionosphere thermosphere model (GITM), data from multiple NASA and ESA supported instruments (i.e., GUVI and SEE on the TIMED satellite, EVE data from SDO, when and if available, and data from the CHAMP satellite), a rigorous data analysis program and newly developed data assimilation techniques, which will allow us to better determine whether preconditioning of the thermosphere and ionosphere has an important effect on the response to solar flares.

Publication References:

Summary: no summary

Reference: Pawlowski, David J.; Ridley, Aaron J.; (2009), Modeling the ionospheric response to the 28 October 2003 solar flare due to coupling with the thermosphere, Radio Science, Volume 44, CiteID RS0A23, doi: 10.1029/2008RS004081

Summary: no summary

Reference: Pawlowski, David J.; Ridley, Aaron J.; (2011), The effects of different solar flare characteristics on the global thermosphere, Journal of Atmospheric and Solar-Terrestrial Physics, Volume 73, Issue 13, p. 1840-1848, doi: 10.1016/j.jastp.2011.04.004

Summary: no summary

Reference: Zhu, Jie; Ridley, Aaron J.; (2014), The effect of background conditions on the ionospheric response to solar flares, Journal of Geophysical Research: Space Physics, Volume 119, Issue 6, pp. 5060-5075, doi: 10.1002/2014JA019887

Summary: no summary

Reference: Zhu, Jie; Ridley, Aaron J.; (2014), Modeling subsolar thermospheric waves during a solar flare and penetration electric fields, Journal of Geophysical Research: Space Physics, Volume 119, Issue 12, pp. 10,507-10,527 , doi: 10.1002/2014JA020473