Project Details

ROSES ID: NNH11ZDA001N
Selection Year: 2012
Program Element: Sun Climate

Project Title:
Solar Influence on Climate Inferred from the Radiant Energy Budget and Diabatic Circulation of the Middle Atmosphere

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Summary:
We propose to investigate the influence of solar variability on the climate of the atmosphere from the tropopause into the thermosphere. We will do this by computing time series of the radiant energy budget at high vertical and temporal resolution throughout this entire region of the atmosphere from ~ 15 km to ~105 km. All terms in the radiant energy budget will be rigorously derived from extant satellite observations dating from 1978 through at least the year 2013, a 35-year time span. This approach enables comprehensive examination of the effects of solar variability directly within the atmosphere - in the energy budget - where it is first manifest. The examination of satellite data starting in 1978 also enables the differentiation of the effects of increasing carbon dioxide (CO2) from those due to solar variability. Atmospheric CO2 has increased approximately 20% since 1978. We also propose to compute the diabatic circulation from the energy budget in order to diagnose the effects of changes to the energy budget on atmospheric dynamics.

The results of this work will be far-reaching. First, the long-term time series of radiant heating and cooling throughout the entire middle atmosphere will enable direct determination of the influence of the Sun on the climate of this region. Previous studies have examined solar influence on temperature and species. However, the variability in those parameters is a direct consequence of the effects of solar variability on the energy budget. The proposed work will identify the occurrence of solar variability at its origin within the atmosphere. Second, the computation of the diabatic circulation will enable a direct assessement of the role of solar variability plays in altering the dynamics of the middle atmosphere. This is essential to understanding how solar variability may be communicated down into the troposphere through changes in the dynamics of the middle atmosphere. Finally, we will generate millions of profiles of radiant heating and cooling of the middle atmosphere. These data will be made publicly available to directly test and assess the radiant and chemical physics of multidimensional models of the middle atmosphere. Validation of model energetics is an essential first step in assessing a model s predictive capability.

The proposed research will utilize multiple satellite datasets including the Limb Infrared Monitor of the Stratosphere (LIMS) instrument (1978-79); the Upper Atmosphere Research Satellite (1991-2000); the Thermosphere-Ionosphere-Mesosphere Energetics and Dynamics (TIMED) satellite (2001-present); the AURA satellite (2004 present); and the Solar Radiation and Climate Experiment (SORCE) satellite (2003-present).

Publication References:

Summary: no summary

Reference: Verkhoglyadova, O. P.; Mannucci, A. J.; Tsurutani, B. T.; Mlynczak, M. G.; Hunt, L. A.; Redmon, R. J.; Green, J. C.; (2015), Localized thermosphere ionization events during the high-speed stream interval of 29 April to 5 May 2011, Journal of Geophysical Research: Space Physics, Volume 120, Issue 1, pp. 675-696, doi: 10.1002/2014JA020535

Summary: no summary

Reference:
Mlynczak, Martin G.; Hunt, Linda A.; Marshall, B. Thomas; Russell, James M.; Mertens, Christopher J.; Thompson, R. Earl; Gor

dley, Larry L.; (2015), A combined solar and geomagnetic index for thermospheric climate, Geophysical Research Letters, Volume 42, Issue 10, pp. 3677-3682, doi: 10.1002/2015GL064038

Summary: no summary

Reference: Weimer, D. R.; Sutton, E. K.; Mlynczak, M. G.; Hunt, L. A.; (2016), Intercalibration of neutral density measurements for mapping the thermosphere, Journal of Geophysical Research: Space Physics, Volume 121, Issue 6, pp. 5975-5990, doi: 10.1002/2016JA022691

Summary: no summary

Reference:
Mlynczak, Martin G.; Hunt, Linda A.; Russell, James M.; Marshall, B. Thomas; Mertens, Christopher J.; Thompson, R. Earl; (2016), The global infrared energy budget of the thermosphere from 1947 to 2016 and implications for solar variability, Geophysical Research Letters, Volume 43, Issue 23, pp. 11,934-11,940, doi: 10.1002/2016GL070965