Project Details

ROSES ID: NNH10ZDA001N
Selection Year: 2011
Program Element: Sun Climate

Project Title:
The Impact of Spectral Solar Irradiance Variations on the Atmosphere and Climate: Model Simulations and Observations

PI Name: William Swartz
PI Email: bill.swartz@jhuapl.edu
Affiliation: Johns Hopkins University/Applied Physics Laboratory
Project Member(s):
- Jackman, Charles H; Collaborator; NASA Goddard Space Flight Center
- Fleming, Eric L.; Collaborator; Atmospheric Chemistry and Dynamics Branch
- Stolarski, Richard S; Co-I; Johns Hopkins University
- Lean, Judith L; Collaborator; Naval Research Laboratory;
- Oman, Luke D; Collaborator; NASA Goddard Space Flight Center;
- Douglass, Anne Ritger; Collaborator; NASA Goddard Space Flight Center

Summary:
We propose a coordinated analysis of atmospheric observations and targeted simulations obtained from a state-of-the-art atmospheric chemistry and climate model in order to quantify the impact of solar output variations on global climate over a wide range of timescales, including both direct and indirect effects of the solar cycle and the spectral dependence of the solar irradiance. This proposed work addresses several objectives of the Living With a Star Targeted Research and Technology program. Two spectral solar irradiance (SSI) datasets will be used in this investigation: (1) a reconstruction (Lean et al.) based on satellite observations, long-term proxies of solar activity, and a solar model, and (2) SSI from the partial solar cycle observed by the SOlar Radiation & Climate Experiment (SORCE) inferred for a complete solar cycle. These SSI datasets are quite different in the amplitude and phase of their spectral dependence. Recent studies based on these datasets show that the Lean and SORCE SSI can produce very different atmospheric and climate responses in models, and initial comparisons with observations of stratospheric temperature and ozone appear more consistent with the SORCE SSI. There are inconsistencies between the recent studies in the patterns of atmospheric response, however. What other fingerprints of solar cycle response can be confirmed by observations in order to clarify our understanding of this problem? What are the implications for solar cycle sensitivities under different atmospheric conditions, such as pre-industrial times?

Using the Goddard Earth Observing System Chemistry-Climate Model (GEOS CCM), with fully coupled radiation-dynamics-chemistry, we will investigate the atmospheric response to the 11-year solar cycle as represented by the Lean and SORCE SSI. We will: (1) Investigate the mechanism of the 11-year solar cycle on direct atmospheric heating and photolysis. (2) Simulate stratospheric responses to the Lean and SORCE SSI datasets and compare the model output with satellite and ground-based observations of ozone, temperature, and other constituents to determine which view of the SSI is more consistent with observations. (3) Extend the investigation into the troposphere and compare model output with observations for evidence of the solar cycle and its mechanism(s) of impact. (4) Simulate the sensitivity of the atmospheric response to solar cycle variations under atmospheric conditions representative of earlier eras (e.g., pre-CFCs, pre-industrial). This sensitivity study will allow us to infer historical solar cycle effects, such as during the Maunder Minimum.

Publication References:

Summary: no summary

Reference: Swartz, W. H.; Stolarski, R. S.; Oman, L. D.; Fleming, E. L.; Jackman, C. H.; (2012), Middle atmosphere response to different descriptions of the 11-yr solar cycle in spectral irradiance in a chemistry-climate model, Atmospheric Chemistry and Physics Discussions, Volume 12, Issue 3, 2012, pp.7039-7071, doi: 10.5194/acpd-12-7039-2012