Project Details

ROSES ID: NNH05ZDA001N
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Program Element: Independent Investigation

Topic: Shock acceleration of solar energetic particles by interplanetary CMEs

Project Title:
Solar Induced Variations of Stratospheric Ozone: Improved Observational and Diagnostic Analysis

PI Name: Lon L. Hood
PI Email: lon@lpl.arizona.edu
Affiliation: University of Arizona, Tucson
Project Member(s):
- McCormack, John P; Collaborator; Naval Research Laboratory
- Marsh, Daniel Robert; Collaborator; National Center for Atmospheric Research

Summary:
The objective of the proposed work is to more completely determine and interpret the observed stratospheric ozone response to solar variability on both the 11-year and 27-day time scales as a function of altitude, latitude, and season.

On the 27-day time scale, we will apply correlative and regression methods to (a) determine the altitude dependence of 27-day ozone responses in the lower stratosphere using a combination of SAGE II, UARS MLS, and EOS Aura MLS data; (b) determine the dependence of the 27-day response on latitude, season, and QBO phase in the upper stratosphere using primarily Version 8 SBUV(/2) ozone profile data; and (c) distinguish statistically among possible solar forcing mechanisms (e.g., solar UV flux, solar and magnetospheric particle fluxes, Galactic cosmic ray flux).

On the 11-year time scale, we will apply a multiple regression statistical model to re-evaluate the 11-year solar UV induced response of stratospheric ozone using three complementary and independent data sets: (1) the recently released Version 8 SBUV(/2) ozone profile data set extending from 1979 through 2003 (with anticipated updates); (2) the recently completed Version 19 UARS HALOE data set extending from October 1991 through August of 2005; and (3) the SAGE II ozone profile data set extending from 1984 through 2000. We will also explore use of the HALOE and SAGE II data as external calibrations for the SBUV(/2) data. In order to diagnose the physical causes of the observed 11-year ozone response, we will carry out statistical analyses of other HALOE measured quantities (e.g., NO + NO2, temperature) and will study the results of collaborative two- and three-dimensional model simulations. We will specifically collaborate with Drs. John McCormack of NRL and Dan Marsh of NCAR for this purpose. Preliminary comparisons of a recent 50-year simulation of the NCAR WACCM v. 3 model, which includes no QBO but incorporates the effects of energetic particle inputs and uses observed sea surface temperatures as a lower boundary condition, shows that the model 11-year ozone response is similar to the observed response.

As stated in the LWS TRT Summary (Appendix A.21 of the ROSES-2005 NRA), ``LWS will provide understanding of the effects of solar variability on terrestrial climate change . . .''. The observed solar cycle variation of stratospheric ozone is a fundamental constraint on sun-climate models that include stratospheric effects of solar ultraviolet and energetic particle inputs. The observed ozone response to 27-day solar UV forcing is also a basic constraint on sun-climate models. In addition, the need for the proposed research in the near future and the expectation of a significant scientific impact are supported by: (a) the recent availability of improved long-term remote sensing data sets including the Version 8 SBUV(/2) and UARS HALOE data sets; and (b) preliminary comparisons of the observed 11-year ozone variation with a recent 3D model simulation showing a potentially very good agreement. The latter comparisons indicate that the planned approach toward using collaborative model simulations for a variety of solar inputs and boundary conditions to identify causal mechanisms will be fruitful.

Publication References:

no references