Project Details

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Project Title:
Implementation and Validation of Solar Variability in Radiation Code RRTMG_SW

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Summary:
Multiple hypotheses exist to explain the observed impacts of the 11-year solar cycle on the climate of Earth. The top-down or downward control mechanism suggests that while the direct impacts of ultraviolet (UV) variability over the solar cycle are contained in the stratosphere, important dynamical processes translate these anomalies downward and hemispherically, altering winter weather and the positions of the jet stream and mid-latitude storm tracks. To accurately model this UV variability, radiation schemes in climate models must have sufficient spectral resolution to model both the absorption of radiation by gases and the wavelength dependence of the UV variability. However, the faster radiation codes currently used in general circulation models (GCMs) typically have fairly broad spectral bands and therefore cannot account for these processes.

In this project, we will establish the capability for accurately parameterizing solar variability into our fast radiative transfer model RRTMG_SW, the operational shortwave radiation code in numerous climate prediction models, including the upcoming version 5 of the Whole Atmosphere Community Climate Model (WACCM), which is a widely-used model for the study of solar cycle impacts on climate. We will introduce two well-regarded specifications of solar variability into RRTMG_SW, as well as allow the code to handle a user s arbitrary specification of the spectral variability of solar irradiance. These improvements will take advantage of the internal spectral resolution of RRTMG_SW, which is needed to accurately parameterize solar variability effects, in contrast to alternate approaches that merely scale individual spectral bands in the code. These changes will be validated against corresponding calculations by line-by-line radiative transfer models for a number of key test atmospheres. The improved model will be incorporated into version 5 of WACCM (WACCM5) and a series of simulations will be performed to quantify the degree to which model predictions improve when the radiative impacts of solar variability are properly accounted for and to enhance our understanding of the impacts of the intra-spectral solar variability on surface climate.

By improving the ability of RRTMG_SW to account for the radiative impact of solar variability, the proposed work will allow the improvement of our understanding of how and to what degree variations in the solar radiative & output contribute to changes in global and regional climate over a wide range of time scales , a key strategic goal of the NASA Living With a Star (LWS) program. In addition, the planned radiation code improvements and subsequent WACCM5 modeling experiments will allow advancement of our understanding of the coupling of the upper and lower atmosphere and the processes responsible for transmitting solar variations to the Earth s surface where they can modulate global and regional climate. Furthermore, the radiation code development work proposed is directly targeted at evaluating the spectral detail necessary for proper treatment of the radiative and photochemical response to solar spectral variability.

Publication References:

no references