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Evaluation of the chemistry and climate impact of the new solar forcing dataset for CMIP7 using the Whole Atmosphere Community Climate Model

Douglas Kinnison[1], Daniel Marsh[2], and Simone Tilmes[1]
[1]NCAR, Atmospheric Chemistry Observations & Modeling, Boulder, CO, United States of America (dkin@ucar.edu)
[2]School of Physics and Astronomy, University of Leeds, Leeds, United Kingdom

The solar forcing dataset prepared for the 6th round of the Coupled Model Intercomparison Project (CMIP6) has been used extensively in climate model experiments. Recently, an International Space Science Institute (ISSI) Working Group was established to revisit the solar forcing recommendations in order to define a roadmap for building a revised solar forcing dataset for the upcoming 7th round of CMIP (Funke et al., 2023). This new dataset will introduce changes in the radiative forcing of climate either directly, or indirectly via changes in atmospheric composition. In CMIP6, the solar forcing consisted of both a total solar irradiance (TSI), along with a spectrally resolved solar irradiance (SSI). The TSI for solar minimum was set to 1360.8±0.5Wm^{-2} and the SSI covered the 10nm to 100mm spectral region. A similar approach is proposed for CMIP7 except for two major aspects of the reconstruction: 1) the definition of the reference spectrum for the quite Sun; 2) the temporal variability. The major difference between the proposed CMIP7 SSI quite sun reference spectrum and that used for CMIP6 is the spectral shape. The new SSI spectrum has an irradiance that is 1-5% higher in the visible band and lower by 1-2% in the Near-IR wavelength range (1000-2000nm). The solar temporal variability in the CMIP6 and CMIP7 reconstructions are based on both the NRLSSI2 and SATIRE reconstructions. These reconstructions have been improved in preparation for CMIP7 and the aim is for both reconstructions to use the same reference spectrum and be driven by the same solar proxies. In this work we used the Whole Atmosphere Community Climate Model (WACCM) to examine the chemical and climate implications of the proposed CMIP7 solar forcing updates compared to the CMIP6 approach. WACCM is a chemistry-climate model that extends from the surface to 140km. The horizontal resolution is ~1degree. WACCM has a detailed representation of chemical and dynamical processes from the troposphere through the lower thermosphere. We examined the “chemical only” impacts of the solar forcing choice by running WACCM in the specified dynamics mode using NASA Modern-Era Retrospective analysis for Research and Applications Version 2 (MERRA2). The “climate” impacts were derived by running the model with interactive dynamics coupled to a deep ocean. Conclusions from this work will support the development of the next version of WACCM for participation in the CMIP7 assessment.

Funke, B., Dudok de Wit, T., Ermolli, I., Haberreiter, M., Kinnison, D., Marsh, D., Nesse, H., Seppälä, A., Sinnhuber, M., and Usoskin, I.: Towards the definition of a solar forcing dataset for CMIP7,

Geosci. Model Dev. Discuss. https://doi.org/10.5194/gmd-2023-100.