Thoughts on the Application of TSIS/SORCE SSI in the IPCC CMIP Modeling Efforts: Why the coupled model must be used

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All the modeling centers that participated in the IPCC CMIP modeling effort adopted the same SSI data set, the one by Lean et al. (2011). We compared it (hereafter, L11) with three other SSI data sets, namely the EMPirical Irradiance REconstruction (EMPIRE) by Yeo et al. (2017), the TSIS 1.5-year SSI measurement, and the 14-year SSI measurements by SORCE (MuSIL). While the L11 and EMPIRE agree with each other within 0.8Wm^{-2} for the total solar irradiance, the agreement indeed is achieved by a large offset between the visible and the near-IR bands. At the RRTMG-SW bandwidth, the L11 – EMPIRE difference can be as large 6 Wm^{-2}. Compared to the TSIS and MuSIL SSI, L11 underestimated the irradiance over 0.44-0.63um by 4 Wm^{-2} and overestimated that over 0.76-1.24um by 2-4Wm^{-2}. At higher spectral resolution, it becomes even clear that, in the visible portion of the spectrum, the SSI differences between TSIS and MuSIL is a factor of ten smaller than those between CESM and EMPIRE.

The opposite discrepancies of L11 and TSIS/MuSIL between the visible and near-IR cast a doubt on the use of prescribed-SST runs to assess the solar impact on the climate, as the spectral albedo of snow and ice has a distinctive dichotomy behavior across such two spectral regions. Only fully-coupled run with sea ice interactively responding to the imposed SSI can fully reflect such impact. We used TSIS and MuSIL SSI to constrain the SSI used NCAR CESM, then run different configurations to further elaborate on this point.