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The SATIRE-S model and why getting solar cycle spectral irradiance trends correct is so important

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There is currently a wide range of potential spectral solar irradiance (SSI) solar cycle (SC) amplitudes suggested by observations and models. Therefore, SSI SC changes are still not fully understood. The magnitude of the SC flux changes has a direct impact upon the temperature and chemistry of the Earth's atmosphere. To contribute to an understanding of the solar-climate connection, it is critical that we, as the solar community, communicate effectively with the climate community, providing uncertainties in SSI data and assessments of possible SSI options.

We present the SATIRE-S reconstruction in the context of these SSI datasets. SATIRE-S is a physically based, consistent SSI reconstruction over the last three solar cycles. It shows different SC spectral variability at all wavelengths compared to the NRLSSI model, widely used in climate research. Most-importantly, SC changes in the ultra-violet (UV) can be twice as large in SATIRE-S as NRLSSI. Typically NRLSSI provides a lower limit of SC SSI UV variability. SORCE satellite observations provide SC magnitudes at the upper limit of variability, exceeding that of SATIRE-S by a factor of three at some UV wavelengths. There is currently no way to be certain if any of these three SSI datasets, or others, is correct.

We also present the SSI datasets in terms of their impact on stratospheric ozone, within a 2D atmospheric model, as an example of why it is important to get SC changes correct. Using NRLSSI results in the 2D atmospheric model, we see a decrease in ozone concentration at all altitudes from solar maximum to minimum. SATIRE-S and SORCE/SOLSTICE observations instead show an increase in ozone concentration in the mesosphere. The magnitude of the increase in the mesosphere when using SOLSTICE also depends greatly upon the version of the data, which means that studies using different data versions of SOLSTICE may lead to different conclusions. These results highlight why an accurate understanding of SC SSI changes, and their uncertainties, are essential for the climate community that uses our work.