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Solar Signals in CMIP-5 Simulations: The Stratospheric Pathway

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The 11-year solar cycle component of climate variability is assessed in the full suite of models taken from the Coupled Model Inter-comparison Project, phase 5 (CMIP-5). Multiple linear regression is used to estimate the climatic effects over a typical solar cycle, with a focus on both the stratosphere and the stratospheric influence on the surface.

The analysis specifically focuses on the 13 CMIP-5 models that resolve the stratosphere (high-top models), and compares the simulated solar cycle signature with reanalyses data. The analysis is performed by applying multiple linear regression to estimate the solar component of zonal mean temperature and wind from the historical period covered by CMIP-5 simulations ($\sim$1850-2005). The 11-year solar cycle component of climate variability is found to be weaker in terms of magnitude and latitudinal gradient around the stratopause in the models than in reanalysis. The peak in temperature in the lower equatorial stratosphere ($\sim$70 hPa) reported in some studies is found in the models to depend on the length of the analysis period, with the last 30 years yielding the strongest response.

A modification of the Polar Jet Oscillation (PJO) in response to the 11-year solar cycle is not robust across all the models, but is more apparent in models with high spectral resolution in the shortwave. The observed North Pacific high-pressure surface response during solar maximum is only simulated in some models, of which there are no distinguishing model characteristics. However, there is some evidence that the North Atlantic surface response is better reproduced in the high-top models over the low-top models.