Multi-frequency analysis of simulated versus observed variability in tropospheric temperature

Objective

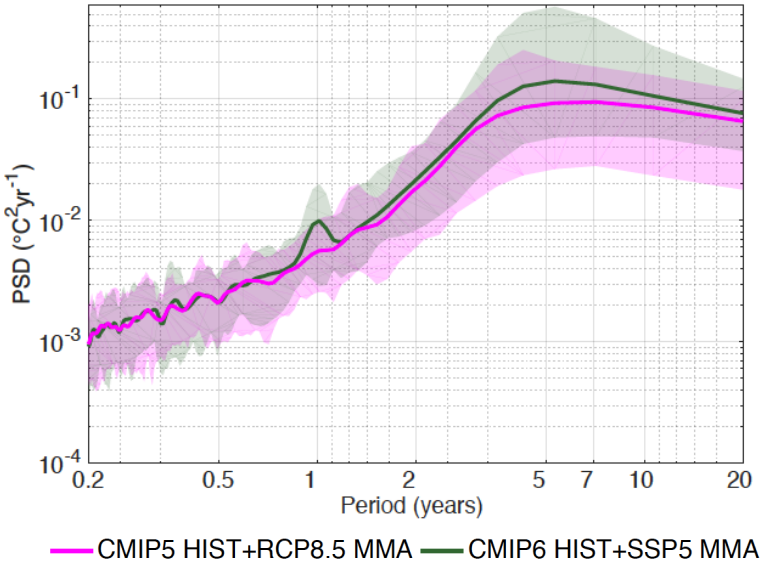
- To explore whether climate models (from both CMIP5 and CMIP6 ensembles) underestimate observed low-frequency variability of mid- to upper tropospheric temperature (TMT)

Research

- Develop a statistical framework to compare the spectral features of TMT variability in climate model ensembles and satellite data under different analyst choices (the satellite and climate model TMT data sets, the method for separating signal and noise, the frequency range considered, and the statistical model to represent observed variability).

Impact

- We find that on timescales of 5-20 years, observed TMT variability is (on average) overestimated by the last two generations of climate models. This result is relatively insensitive to different plausible analyst choices, enhancing confidence in previous claims of detectable anthropogenic warming of the troposphere and indicating that these claims may be conservative.
- A further key finding is that two commonly used statistical models of short-term and long-term memory have deficiencies in their ability to capture the complex shape of observed TMT spectra.



Comparison of the power spectral density of TMT in CMIP5 and CMIP6 models. Results are for a cubic signal removal strategy and are the average spectra for the HIST+RCP8.5 simulations performed with 37 different CMIP5 models and for the HIST+SSP5 simulations performed with 21 different CMIP6 models. All spectra were calculated for TMT data spatially averaged over 82.5N-82.5S. The analysis period is from January 1979 to December 2018. The shaded areas represent the 5th-95th percentile variability intervals on the power spectral densities.

Reference: Pallotta G., B.D. Santer, 2020: Multi-frequency analysis of simulated versus observed variability in tropospheric temperature. *Journal of Climate*, https://doi.org/10.1175/JCLI-D-20-0023.1