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The importance of the covariation of the geographical distribution of SSTs and deep convection for tropical tropospheric temperature trends 1980-present

Stephan Fueglistaler (1,2), Thomas Flannaghan (2), Stephen Po-Chedley (4), Isaac Held (3), Claire Radley (2), Ming Zhao (3), and Bruce Wyman (3)

(1) Princeton University, Geosciences, Princeton, United States (stf@princeton.edu), (2) Program in Atmospheric and Oceanic Sciences, Princeton University, (3) Geophysical Fluid Dynamics Laboratory, Princeton, (4) University of Washington, Seattle

Enhanced upper tropospheric warming relative to the surface in the tropics is a prominent feature of numerical model simulations, but it has been suggested that models overestimate this warming compared to observations for the period 1980 to present. Here, we focus on the factors controlling atmospheric temperature trends in numerical model calculations with prescribed Sea Surface Temperatures (SSTs). CMIP5 model runs show a remarkably large spread in tropical temperature trends over the period 1980-2008 despite being forced with observed SSTs. Here, we show that the model trends are consistent with the atmospheric temperature profile being tightly constrained by the surface layer conditions in regions of deep convection. Large trend differences arise from the use of two different SST data, the "HURRELL" and the "HadISST1" data. These two SSTs
have very similar tropical average trends, but differ substantially in the warmest percentiles where most deep convection occurs. The models' temperature trend differences in the tropical troposphere reflect the trend differences in the regions of highest SSTs.
Further, we show that trend differences in model calculations using
identical SSTs is strongly related to differences in the geographical pattern of strong precipitation (used as a simple proxy for deep convection) between models, and between ensemble runs of a model. The time series of precipitation weighted SSTs can explain more than half of the variance in temperature trends. The variance in trends between ensemble members of the same model, and between ensemble means of different models, is similar. However, the decrease in variance upon averaging over ensemble members is modest compared to the expected scaling for independent samples, which provides evidence for systematic differences between models in their response in the geographical distribution of convection to changes in SST patterns.