Large ensembles unable to simulate observed multi-decadal trends in SST and SLP

Robert Jnglin Wills*[1], Yue Dong[2], Cristian Proistosescu[3], Kyle Armour[2], and David Battisti[2]

[1]University of Washington – 1301 West Green Street M/C 104 Urbana, IL 61801, United States
[2]University of Washington – Box 351640 Seattle, WA 98195, United States
[3]University of Illinois – 1301 West Green Street M/C 104 Urbana, IL 61801, United States

Abstract

The observed increase in global sea surface temperatures (SSTs) over the past several decades is characterized by intensified warming in the North Atlantic and western Pacific and relatively little warming in the Southern Ocean and eastern equatorial Pacific. The Pacific SST trends are consistent with a strengthening of the Walker circulation. In contrast, state-of-the-art coupled climate models generally display a weakening of the Walker circulation and enhanced warming in the eastern equatorial Pacific. To determine the roles of anthropogenic forcing and internal multi-decadal variability in causing the difference in the warming pattern and Walker circulation trends between observations and models, we investigate the ability of 11 climate model large ensembles (each with at least 20 ensemble members) to reproduce the pattern of SST and sea-level pressure (SLP) trends over 1979-2020. We find that the observed SST and SLP trends fall well outside the range of modeled trends in many parts of the tropics and subtropics, including by more than six ensemble standard deviations in some regions. We apply a signal-to-noise maximizing pattern analysis to isolate the spatiotemporal evolution of the difference between models and observations and find biases both in the monotonic trends and in the pattern of Pacific decadal variability. Our work identifies key climate model biases in anthropogenic trends and Pacific decadal variability, which need to be addressed to accurately attribute recent climate changes and better predict regional climate change in the coming decades.

Keywords: Climate variability, climate change, large ensembles, ocean warming, Walker circulation

*Speaker