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CGD Seminar Series

The fly in the ointment: Coupled climate models fail to simulate observed warming patterns, resulting in weakened constraints on future warming

Cristian Proistosescu

University of Illinois

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Time: 11am – 12pm

For Zoom information, please contact Tracy Baker tbaker@ucar.edu

For live stream information, visit the CGD Seminar Webpage

ABSTRACT

The pattern of changes in Sea Surface Temperatures (SSTs) over recent decades has been marked by enhanced warming in the western equatorial Pacific and cooling in the eastern Pacific and Southern Ocean. Current state-of-the-art coupled Atmosphere-Ocean General Circulation Models (AOGCMs) fail to reproduce this observed pattern.

Here we compare the coupled CESM1 and CMIP6 initial-condition large ensembles against Atmosphere-only GCMs forced with observed SSTs and sea-ice concentrations from the Atmospheric Model Intercomparison Project (AMIP) and against reanalysis.

Over the AMIP interval (1979-2014) the observed SST patterns lie outside the range of patterns generated by coupled models, even when taking into account the natural variability sampled by the large ensembles. Due to this discrepancy in SST patterns, several key metrics from the AMIP simulations also lie outside the range generated by freely running coupled models – critically among them the net radiative feedback.

Statistical analysis and simulations with a simple energy balance model show that this bias in SST patterns could account for the inability of high climate sensitivity CMIP6 coupled models to reproduce historical warming. If the bias is due to either a transient in the forced response or natural variability, then high long-term equilibrium climate sensitivity cannot be discounted using emergent constraints based on recent warming trends.

It remains an open question whether the problem in the coupled models lies with a bias in the forced response or insufficient natural variability. However, until the SST pattern bias is better understood, we cannot discount either the possibility of high climate sensitivity or very large inter-decadal climate variability.