EGU24-15830, updated on 08 Oct 2024
https://doi.org/10.5194/egusphere-egu24-15830
EGU General Assembly 2024

Validating ENSO Feedbacks in Climate Models Using a Causal Discovery Method

Emma Schultz[1], Dim Coumou[1], and Michael Massmann[2]
[1]Vrije Universiteit Amsterdam, IVM, Water and Climate Risk (e.c.j.schultz@vu.nl)
[2]WHU, Otto Beisheim School of Management, Economics Group, Econometrics and Statistics
(michael.massmann@whu.edu)

The El Niño-Southern Oscillation (ENSO) stands out as the dominant driver of climate fluctuations on interannual timescales. As ENSO causes extreme weather events in the Pacific region and beyond, it has wide ranging socio-economic impacts. Over the past decades, a strengthening in the temperature gradient is observed between the Western and Eastern Pacific. However, climate model simulations do not depict this strengthening trend. Here we explore if the Bjerknes feedback is well represented in climate models, and if not whether this could explain the discrepancy between the observed and modeled trends. The Bjerkness feedback represents the dominant feedback processes between atmosphere and ocean that drive ENSO variability. A causal discovery method, the PCMCI algorithm, is used to construct causal networks of key variables in the Bjerknes feedback: near surface temperatures, sea level pressure and trade winds across the Pacific Ocean. Causal networks are constructed for time periods 1950-1982 and 1982-2014, based on both reanalysis data and climate model simulations. The observed changes between causal networks based on the early and later period are examined. The analysis reveals a strengthening causal influence of trade winds on sea level pressure and temperatures in networks based on reanalysis data. This significant strengthening trend is absent in networks based on climate model simulations. As an increased influence of the trade winds would have a cooling effect on Central and Eastern Pacific, this might explain why there is no observed warming in the Central and Eastern Pacific over the past decades, and thus a strengthened temperature gradient. The lack of this strengthening causal influence of trade winds in climate models might thus explain why the models do show a warming over the Eastern Pacific, weakening the temperature gradient.