**Seminar on Physics and Chemistry
of the Atmosphere
02.06.2023, SoSe 2023, IUP Bremen**

Regime-oriented causal model evaluation of Atlantic-Pacific teleconnections in CMIP6

Soufiane Karmouche[1,2], Evgenia Galytska[1,2], Jakob Runge[3,4], Gerald A. Meehl[5], Adam S. Phillips[5], Katja Weigel[1,2], and Veronika Eyring[2,1]

[1]University of Bremen, Institute of Environmental Physics (IUP), Bremen, Germany
[2]Deutsches Zentrum für Luft- und Raumfahrt (DLR), Institut für Physik der Atmosphäre, Oberpfaffenhofen, Germany
[3]Deutsches Zentrum für Luft- und Raumfahrt (DLR), Institut für Datenwissenschaften, Jena, Germany
[4]Technische Universität Berlin, Berlin, Germany
[5]National Center for Atmospheric Research (NCAR), Boulder, CO, USA

Abstract

The Pacific Decadal Variability (PDV) and the Atlantic Multidecadal Variability (AMV) are two important modes of long-term internal variability that significantly impact the climate system and its spatio-temporal changes. In this study, we use a regime-oriented causal discovery method (Karmouche et al, 2023) to examine the changing interactions between the PDV and AMV. The results of this analysis are used to evaluate the ability of models participating in the Coupled Model Intercomparison Project Phase 6 (CMIP6) to represent the observed changing interactions between the PDV, AMV, and their extra-tropical teleconnections.

Applying the regime-oriented causal discovery method to reanalysis time series revealed that the interactions between AMV and PDV differ from one regime to the other. The results also show that there are both direct and indirect connections between the Atlantic and Pacific oceans, which are established through various teleconnection patterns.

In order to evaluate the ability of climate models to represent these observed interactions, we applied the same regime-oriented causal discovery method to the CMIP6 Large Ensemble historical simulations. We show that several models performed well in simulating the observed causal patterns when AMV and PDV are "out-of-phase", and that the two models with the largest number of members generally outperformed other models in simulating observed causal patterns during longer regimes. This work shows how causal discovery on LEs complements the available diagnostics and statistics metrics of climate variability to provide a powerful tool for climate model evaluation.

Karmouche, S., Galytska, E., Runge, J., Meehl, G. A., Phillips, A. S., Weigel, K., and Eyring, V.: Regime-oriented causal model evaluation of Atlantic–Pacific teleconnections in CMIP6, Earth Syst. Dynam., 14, 309–344, https://doi.org/10.5194/esd-14-309-2023, 2023.