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Causal Discovery as a novel approach for CMIP6 climate model evaluation

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Causal discovery algorithms are machine learning methods that estimate the dependencies between different variables. One of these algorithms, the recently developed PCMCI algorithm (Runge et al., 2019) estimates the time-lagged causal dependency structures from multiple time series and is adapted to common properties of Earth System time series data. The PCMCI algorithm has already been successfully applied in climate science to reveal known interaction pathways between Earth regions commonly referred to as teleconnections, and to explore new teleconnections (Kretschmer et al., 2017). One recent study used this method to evaluate models participating in the Coupled Model Intercomparison Project Phase 5 (CMIP5) (Nowack et al., 2019).

Here, we build on the Nowack et al. study and use PCMCI on dimension-reduced meteorological reanalysis data and the CMIP6 ensembles data. The resulting causal networks represent teleconnections (causal links) in each of the CMIP6 climate models. The models' performance in representing realistic teleconnections is then assessed by comparing the causal networks of the individual CMIP6 models to the one obtained from meteorological reanalysis. We show that causal discovery is a promising and novel approach that complements existing model evaluation approaches.

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