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Quantifying causal pathways of interactions in the complex tropical climate system

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The focus of this work is to better understand the complex interplay between different subprocesses in the climate system, especially how tropical processes such as El Nino-Southern Oscillation (ENSO), the Indian Ocean Dipole, Tropical Atlantic Variability, and the tropical monsoons affect global climate.
Here a novel data-driven method is proposed based on: (1) a dimension reduction of the global surface pressure field yielding components that represent various known subprocesses such as ENSO or the North Atlantic Oscillation, (2) a causal reconstruction algorithm to detect which subprocesses are only indirectly interacting or are only spuriously correlated due to common drivers, and (3) measures to identify causal pathways in the reconstructed interaction network.
Two main results will be presented: (1) an hypothesis of a mechanism by which ENSO influences the Indian Monsoon within the surface pressure field. (2) In an explorative analysis it is shown that the method correctly identifies the major regions of upwelling convergence in the tropical oceans and also regions of strong downwelling. The approach provides a novel causal interaction perspective on complex spatio-temporal systems.

Reference: Runge, J., Petoukhov, V., & Kurths, J. (2014). Quantifying the strength and delay of climatic interactions: the ambiguities of cross correlation and a novel measure based on graphical models. Journal of Climate, 27(2), 720–739. doi:10.1175/JCLI-D-13-00159.1