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Nonlinearity in global teleconnection patterns

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The climate system and its individual components, including the atmosphere, are inherently nonlinear. This nonlinearity is typically reflected in the series of measured or simulated climate variables, but its exact nature and measurable magnitude vary substantially not only with the specific signal under investigation, but also with various aspects of the analysis setup. In many situations, linear approximation of the relationships within the climate system is deemed sufficiently accurate – and indeed, most of the methodology employed across the contemporary climatological research relies on purely linear techniques. Even so, the assumption of linearity is only occasionally verified, more often simply presumed to hold.

In this contribution, attention is paid to deviations from linearity in climate responses related to various teleconnections, linking large-scale internal climate variability modes to local weather patterns. By employing several nonlinearity-quantifying statistics, ranging from simple measures of asymmetry in the regression coefficients to more formal surrogate-data based tests, it is shown that substantial geographical variations exist in the nonlinearity manifestations worldwide. Temperature and precipitation response patterns pertaining to prominent oscillatory modes such as North Atlantic Oscillation, El Niño – Southern Oscillation, Atlantic Multidecadal Oscillation or Pacific Decadal Oscillation are shown and studied with regards to the degree of detectable nonlinearity; potential for more realistic capture of the respective relationships by specific nonlinearity-sensitive techniques is also discussed.

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