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Infering phase coherence from climate data

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We present a modern method used in nonlinear time series analysis to investigate the relation of two oscillating systems with respect to their phases, independently of their amplitudes. We overcome the difficulties coming along with low frequency fluctuations typical for climate data by a novel geometric approach, that efficiently filters out variations of the mean. The potentials of this concept in comparison to conventional methods are illustrated by an application to a paradigmatic example from climatology: We study the difference of the phase dynamics between El Niño/Southern Oscillation (ENSO) and the Indian Monsoon on inter-annual time scales. Distinct epochs can be identified, especially two intervals of phase coherence, 1886-1908 and 1964-1980, corroborating earlier findings from a new point of view. We also detect so far unknown periods of coupling which are invisible to linear methods. The high time resolution of the method reveals a possible dependency of the coupling on volcanic radiative forcing. We study this hypothesis utilizing a conceptual model.