On the relation between the ENSO cycle, its irregularity and decadal variation

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Abstract

A minimal model of ENSO able to reproduce the irregular cyclical nature and distinct spatial pattern of decadal variability is considered. Consisting of a stochastically forced damped oscillator in which the forcing statistics have certain very likely general characteristics, the model is validated by fitting to the leading Principal Oscillation Patterns of several long historical data sets. Two phases are identified from the data. The peak ENSO phase (El Niño and La Niña) and the developing (precursor) or decay phase.

Observed power spectra are used to constrain model parameters including decay time and period of the oscillator, as well as the stochastic forcing statistics. The decay time of the oscillator is estimated at 9 months which interestingly corresponds with the practical ENSO prediction limit. The dependence of the decay time estimate on the spectral peak width provides a robust estimate as this feature is strongly constrained by observational data. It is shown show that the precursor pattern has relatively greater decadal weight compared with the peak series indicating dominance of the precursor pattern on decadal time scales. A possible explanation for the difference in ENSO and decadal oscillation spatial patterns is proposed based on this greater decadal weight of the precursor ENSO phase deriving from both an unequal stochastic forcing of the two phases as well as a small correlation between them.