Title:	Investigating the Effect of Parametric Non-Uniformity on Synchronization in Models of El Nino Event
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Abstract:	The emergence of oscillations in models of the El-Nĩ no effect is of ut- most relevance. Here we investigate a coupled nonlinear delay differential system modeling the El Nĩ no/ Southern Oscillation (ENSO) phenomenon, which arises through the strong coupling of the ocean-atmosphere system. In particular, we study the temporal patterns of the sea surface temperature anomaly of the two sub-regions. For identical sub-regions we typically ob- serve a co-existence of amplitude and oscillator death behavior for low delays, and heterogeneous oscillations for high delays, when inter-region coupling is weak. For moderate inter-region coupling strengths one obtains homogeneous oscillations for sufficiently large delays and amplitude death for small delays. When the inter-region coupling strength is large, oscillations are suppressed altogether, implying that strongly coupled sub-regions do not yield ENSO. Further we observe that larger strengths of self-delay coupling favours oscil- lations, while oscillations die out when the delayed coupling is weak. This indicates again that delayed feedback, incorporating oceanic wave transit ef- fects, is the principal cause of oscillatory behaviour. So the effect of trapped ocean waves propagating in a basin with closed boundaries is crucial for the emergence of ENSO. Further, we show how non-uniformity in delays, and difference in the strengths of the self-delay coupling of the sub-regions, af- fect the rise of oscillations. The trends are similar to the uniform system. Namely, larger delays and self-delay coupling strengths lead to oscillations, while strong inter-region coupling kills oscillatory behaviour. The difference between the uniform case and the non-uniform system, is that amplitude death and homogeneous oscillations are predominant in the former, while oscillator death and heterogeneous oscillations are commonly found in the latter. Interestingly, we also find that when one sub-region has low delay and another has high delay, under weak coupling the oscillatory sub-region induces oscillations in sub-region that would have gone to a steady state if uncoupled. Thus we find that coupling sub-regions has a very significant ef- fect on the emergence of oscillations, and strong coupling typically suppresses oscillations, while weak coupling of non-identical sub-regions can induce os- cillations, thereby favouring ENSO.
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