Session: C25 Poster: W14B

ENSO's decadal dance viewed through a local Lyapunov lens.

Christina Karamperidou[†]; Mark Cane; Andrew Wittenberg; Upmanu Lall
[†] Columbia University, USA
Leading author: ck2424@columbia.edu

Decadal variability of ENSO is present in historical and paleo records, and has been simulated by a hierarchy of dynamical and statistical models. The ENSO variability in the IPCC AR4 Coupled GCMs ranges from constant periodicity or amplitude to significant inter-decadal variability in both period and amplitude. While long runs of intermediate dynamical models that exhibit inter-decadal and inter-centennial variability, such as the ZC model, have been a subject of numerous studies, only recently have long runs of coupled GCMs, such as the GFDL CM2.1 2000-yr control run, become available. The presence of such rich variability in the absence of external forcing that could induce persistent regimes, along with the length of the simulation, provides new ground for investigation of the causes of long-term modulation of ENSO behavior and the implications for predictability at multiple time-scales from the short-range to the decadal. In this work, we investigate the limits of predictability in the context of dynamical systems theory. In particular, we use the Local Lyapunov Exponents (LLEs) of the NINO3 time series as a measure of predictability of the ENSO system. LLEs are useful in characterizing predictability locally in the attractor of a weakly chaotic system that likely passes through phases of increased or decreased predictability. The LLEs are calculated from the results of two models that have fairly realistic ENSO simulations and exhibit rich inter-decadal and inter-centennial variability in the absence of external forcings: a 150,000-yr run of the intermediate ZC model, and a GFDL CM2.1 2000-yr control run. It is of interest to compare this metric of predictability between a relatively simple model that includes only the tropical Pacific ENSO system, and a fully developed coupled GCM that allows for interactions between the ENSO system and the other components of the global climate system. Furthermore, such an analysis provides a means of classifying epochs of distinct ENSO behavior that could lead to identification of initial states that are favorable or not for increased predictability at inter-decadal scales. We discuss possible explanations for the variability in predictability and the differences in the results of our analysis between the ZC and CM2.1 models. The relation of the LLE statistics to predictability estimates derived from CM2.1 idealized forecasts of the CM2.1 control run is also discussed.