Forecasts of Niño-34 SST Anomalies Based on Empirical Mode Reduction

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We apply the empirical mode reduction (EMR) methodology (Kravtsov et al. 2005) to a dataset of sea-surface temperature anomalies (SSTA) in order to obtain linear and nonlinear, stochastically forced models of the El Niño-Southern Oscillation (ENSO). EMR assumes that the system's variability is driven by spatially coherent, additive noise and constructs a model in the phase space of the dataset's leading empirical orthogonal functions. Multiple linear regression has been widely used to obtain inverse stochastic models; it is generalized here in two ways. First, the dynamics is allowed to be nonlinear by using polynomial regression. Second, a multilevel extension of classic regression allows the additive noise to be correlated in time; to do so, the residual stochastic forcing at a given level is modeled as a function of variables at this level and the preceding ones. The number of variables, as well as the order of nonlinearity, is determined by optimizing model performance.

The 1950--2002 Kaplan et al. (1998) extended SSTA dataset (IRI/LDEO Climate Data Library, January 1950--December 2002), over the (60N--30S, 30E--110W) area, is used for both model training and validation: the models were estimated on 1950--1995 data, and verified on 1996--2002 data; the latter include the strong 1997-1998 El Niño event (Kondrashov et al. 2005). Seasonal ENSO dependence is captured by incorporating additive, as well as multiplicative forcing with a 12-month period into the first level of each model. Our best two-level quadratic and linear models have a better ENSO hindcast skill than their one-level counterpart. Estimates of skewness and kurtosis of the models' simulated Niño-3 index reveal that the quadratic model reproduces better the observed asymmetry between the positive El Niño and negative La Niña events. The quadratic model also outperforms the linear one in predicting the magnitude of extreme SST anomalies.

The current NINO-34 forecast of the quadratic model (Fig. 1) is based on data from January 1950 through May 2008, and predicts near normal conditions through December 2008. The error bars correspond to one standard deviation of the ensemble forecast.

References:

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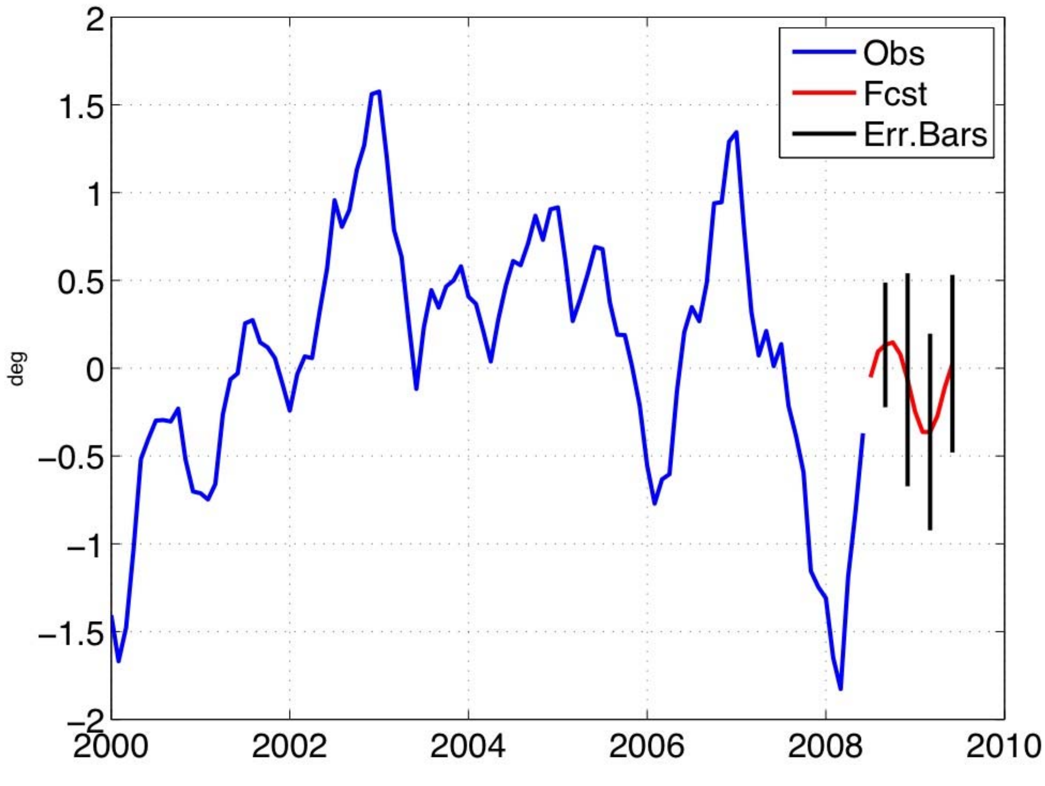

Obs
Fcst
Err.Bars
deg
2
1.5
1
0.5
0
−0.5
−1
−1.5
−2
2000
2002
2004
2006
2008
2010