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Linear dynamical modes: new variables for empirical prognostic model of ENSO variability

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A new empirical model for analysis and prediction of spatially distributed time series is proposed. The model is based on linear dynamical mode (LDM) decomposition of the observed data which is derived from a recently developed nonlinear dimensionality reduction approach [1]. The key point of this approach is its ability to take into account simple dynamical properties of the observed system by means of revealing the system's dominant time scales. In other words we obtain the low-dimensional time series of principal components carrying the important part of dynamics of the system. The LDMs are used as new variables for construction of empirical model in the form of low-dimensional stochastic system [2]. In this step we also optimize structure of space of states (phase space) as well as nonlinearity of the model.
The method is applied to sea surface temperature anomaly field in the tropical belt where the El Nino Southern Oscillation (ENSO) is the main mode of variability. The advantage of LDMs versus traditionally used empirical orthogonal function decomposition is demonstrated for this data. It is also shown that the new model has a competitive ENSO forecast skill in comparison with the other existing ENSO models.

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[2] Ya. Molkov, D. Mukhin, E. Loskutov, A. Feigin, 2012: Random dynamical models from time series. Phys. Rev. E, Vol. 85, n.3.