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Empirical decomposition of climate data into nonlinear dynamic modes

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New approach to empirical data decomposition is presented. It is based on the nonlinear generalization of standard empirical orthogonal functions (EOFs) decomposition, i.e. the observed dataset is projected onto a curve which represents a nonlinear transformation from a hidden principal component time series to the space of observed variables. Both the parameters of the transformation and the time series of the modes are found together using bayesian approach. The simplest evolution operator for the mode is put into a prior restriction to provide smoothness of the time series. Finally, bayesian evidence technique is used to complete the task of correct choice of the smoothness and the mode nonlinearity degree.
The results are presented for a simple model example as well as for global sea surface temperature and sea level pressure data. The basic result is that nonlinear modes can reduce the data dimension more efficiently than EOFs. Also it is possible to treat known climate phenomena whose indices are defined from these data (annual cycle, ENSO, PDO) in terms of nonlinear modes.