Fourth International Conference on Earth System Modelling
4ICESM-70-1, 2017


# Construction of reduced empirical prognostic model by climate data

A. Gavrilov, A. Seleznev, D. Mukhin, E. Loskutov, and A. Feigin
Institute of Applied Physics of the Russian Academy of Sciences, Nizhny Novgorod, Russian Federation

Construction of an empirical model of evolution operator is only statistically justified when the dimension of its phase space is small enough: it is limited because of finite duration of the time series. Meanwhile, in climate analysis we deal with high spatial resolution data. It requires application of efficient dimensionality reduction methods before the construction of empirical prognostic model.
To deal with this problem we present a Bayesian approach to an evolution operator construction which includes two reduction steps. First, we apply dimensionality reduction methods to the data, particularly we compare the standard empirical orthogonal function decomposition and recently developed nonlinear dynamical mode decomposition [1,2]. It allows us to obtain the low-dimensional time series of principal components carrying the important part of dynamics of the system. Second, we construct a model of evolution operator for these principal components in the form of non-stationary stochastic nonlinear evolution operator. In this step we also optimize structure of time-embedded space (phase space) as well as nonlinearity of the model.
Together, these two steps equip us with a prognostic model for observed spatio-temporal field. We investigate and report the prediction capabilities of this prognostic model (from sub-seasonal to decadal) on the example of sea surface temperature data.
The study is supported by Government of Russian Federation (agreement #14.Z50.31.0033 with the Institute of Applied Physics of RAS).

1. Mukhin, D., Gavrilov, A., Feigin, A., Loskutov, E., & Kurths, J. (2015). Principal nonlinear dynamical modes of climate variability. Scientific Reports, 5, 15510. http://doi.org/10.1038/srep15510

2. Gavrilov, A., Mukhin, D., Loskutov, E., Volodin, E., Feigin, A., & Kurths, J. (2016). Method for reconstructing nonlinear modes with adaptive structure from multidimensional data. Chaos: An Interdisciplinary Journal of Nonlinear Science, 26(12), 123101. http://doi.org/10.1063/1.4968852