Data-driven Nonlinear Dynamical Models for Forecast of Climate Variability

*Alexander M Feigin[1], Dmitry N Mukhin[1], Andrey S Gavrilov[1], Aleksey F Selesnev[1], Evgeny M Loskutov[1]

1. Institute of Applied Physics RAS

We apply new methodology of empirical modeling and forecast of nonlinear dynamical system variability [1] to study of climate systems' variability. The methodology is based on two approaches: (i) nonlinear decomposition of spatially distributed data [2], that provides low-dimensional embedding for further modeling, and (ii) construction of empirical model in the form of low dimensional random dynamical (“stochastic”) system [3].
The methodology abilities are demonstrated by modeling and forecast of ENSO system variability. Three monthly data sets are used: global sea surface temperature anomalies, troposphere zonal wind speed, and thermocline depth; all data sets are limited by 30 S, 30 N and have horizontal resolution 1^0x1^0.
We compare results of optimal data decomposition as well as prognostic skill of the constructed models for different combinations of involved data sets. We also present comparative analysis of ENSO indices forecasts fulfilled by our models and by IRI/CPC ENSO Predictions Plume.

[1] A. Gavrilov, D. Mukhin, E. Loskutov, A. Feigin, 2016: Construction of Optimally Reduced Empirical Model by Spatially Distributed Climate Data. 2016 AGU Fall Meeting, Abstract NG31A-1824.
[2] D. Mukhin, A. Gavrilov, E. Loskutov , A.Feigin, J.Kurths, 2015: Principal nonlinear dynamical modes of climate variability, Scientific Reports, rep. 5, 15510; doi: 10.1038/srep15510.
[3] Ya. Molkov, D. Mukhin, E. Loskutov, A. Feigin, 2012: Random dynamical models from time series. Phys. Rev. E, Vol. 85, n.3.

Keywords: Nonlinear Dynamical Model, Forecast of Climate Variability, Nonlinear Data Decomposition