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Empirical modelling of ENSO dynamics: construction of optimal complexity models from data

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One of the main problems arising in modelling of data taken from natural system is finding of a phase space suitable for construction of the evolution operator model. The matter is we ususaly deal with strongly high-dimensional behavior and we are forced to construct a model working in some projection of system phase space corresponding to time scales of interest. Selection of optimal projecion is non-trivial problem since there are many ways to reconstruct phase variables from given time series, especially in the case when time series has a form of spatial field depending on time. Actually, it is sort of model selection problem, because, on the one hand, the transformation of data to some phase variables vector can be considered as a part of the model. On the other hand, such an optimization of a phase space makes sense only in relation to the parameterization of the model we use, i.e. representation of evolution operator, so we should find an optimal structure of the model togerther with phase variables vector.
In this work we suggest Bayesian approach to this problem: a prior set of the models of different complexity is defined, then posterior probabilities of each model from this set given the data are calculated, and the model corresponding to largest probability is selected. The suggested approach is applied to optimization of EMR-model of ENSO phenomenon elaborated by Kondrashov et. al. This model operates with number of principal EOFs constructed from spatial field of SST in Equatorial Pacific, and has a form of stochastic differential equations (SDE) system with polynomial parameterization of the right-hand part. Optimal values for both the number of EOFs and the order of SDE system are estimated from the time series generated by Jin & Neelin intermediate ENSO model.

References

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