Geophysical Research Abstracts
Vol. 12, EGU2010-880, 2010
EGU General Assembly 2010

Basic dynamical model as an instrument for retrieval of non-observable variables from data

Dmitry Mukhin, Mikhail Kulikov, and Alexander Feigin

Institute of Applied Physics of Russian Academy of Sciences, Atmospheric Research, Nizhny Novgorod, Russian Federation (mukhin@appl.sci-nnov.ru)

Basic dynamical models (BDMs) of observed phenomenon are known an effective tool for investigation of dynamical properties of underlying system. BDM is a model describing dynamical processes with established time scale corresponding to investigated phenomenon; typically it is derived from the detailed model of the system including a full set of first-principals equations, by separation of “fast” and “slow” families of dynamic variables. As a result, “slow” families are assumed to be constant during the evolution, while “fast” ones are in the instantaneous equilibrium state which depends on model variables with considered time scale. Though this model has much smaller dimension than the “full” model, it (1) describes basic properties of system dynamics and (2) includes physically-based parameters and dynamic variables of studied system. These features allow us to consider BDMs as an instrument for extraction the information about non-observable characteristics of the system from data.

This report is devoted to the problem of estimation of unknown parameters and variables contained in BDM from short-period measurements of single variable of the system. The presence of strong noisy component in data of real measurements leads to need of correct Bayesian method for solution of this inverse problem providing unbiased estimation of sought values. We developed such a method for BDM in a form of the system containing both differential and algebraic equations. Appropriate form of posterior PDF was suggested; this PDF depends on both unknown parameters of the system and latent variables and includes non-trivial dynamic coupling between latent variables. Monte-Carlo-based method for statistical analysis of this PDF was elaborated.

Suggested method was successfully tested on toy models in a form of ODE producing dynamic chaos as well as on BDM model describing atmosphere photochemistry at low mesosphere altitudes. The last model includes two differential equations with periodical forcing for variables with character time scale about 1 day and five algebraic equations; altogether six trace gases are involved in the model. We solved the problem of retrieval water vapor concentration (entering the model as parameter) and trace gases concentrations (dynamic variables) using the time series of ozone measurements. Results obtained from both model simulations and real measurements will be discussed in the report.