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Investigation of Average Prediction Time for Different Meteorological Variables By Using Chaotic Approach

Evren Özgür and Kasım Koçak
Istanbul Technical University, Department of Meteorology, Istanbul, Turkey (ozgurev@itu.edu.tr)

According to nonlinear dynamical system approach, it is possible that the time evolution of a system can be represented by its trajectories in phase space. This phase space is spanned by the state variables which are necessary to determine the time evolution of the system. Atmospheric processes can not be represented by linear approaches because of their dependency on numerous independent variables. Since a small changes in initial conditions lead to significant differences in prediction, long term prediction of meteorological variables is not possible. This situation can be explained by the term "sensitive dependence on initial conditions". In the study, it was tried to determine the average prediction time for different atmospheric variables by applying nonlinear approach. In order to apply the method, the first step is to reconstruct the phase space. Phase space has two parameters which are time delay and embedding dimension. Mutual Information Function (MIF) can be used to determine optimum time delay. MIF considers both linear and nonlinear inner-dependencies in a given time series. To define phase space, embedding dimension must be identified correctly. Embedding dimesion is the number of necessary state variables which describe the dynamics of a system. The algorithm to define embedding dimension is False Nearest Neighbors (FNN). After constructing the phase space by using time delay and embedding dimension, the maximum Lyapunov exponent was introduced. Lyapunov exponent is related to the exponential divergence or convergence of nearby orbits in the phase space. A dynamical system which has positive Lyapunov exponent is defined as chaotic system. Because meteorological variables can be controlled with large numbers of independent variables, time series of meteorological variables might be produced by a chaotic dynamical system. By using phase space and maximum Lyapunov exponent value, average prediction times of different parameters were calculated successfully.

Keywords: Phase space, chaos, Lyapunov exponent, prediction