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Chaos-dynamical computational method of forecasting evolutionary dynamics of environmental systems: Atmospheric pollutants dynamics

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Abstract content
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The aim of our present study is (1) to present new computational complex approach to studying and forecasting dynamics of environmental systems, based on using non-linear analysis and chaos theory methods such as wavelet and fractal formalism, mutual information, correlation integral, false nearest neighbour algorithm, Lyapunov exponent's analysis, surrogate data, stochastic propagators method, memory, Green's functions approach; (2) to identify the concentration space-temporary evolution dynamics for CO₂, CO, NO₂, SO₂ in the atmosphere of industrial cities (Amsterdam, Gdansk and Odessa) during the 2003-2009 (3) to present new prediction computational model to forecasting the atmospheric pollutants evolutionary dynamics (new "Geomath" technology). The simple way to identify the chaos in time series is as follows:
(1) To determine time delays, the concept of mutual information is used;
(2) To determine attractor dimensions, it is used the correlation integral method and false nearest neighbours algorithm;
(3) To refine the data, we use surrogate data sets;
(4) we evaluate the Lyapunov's exponents.
All dynamical and topological invariants have been computed. We develop a new non-linear prediction method and compare the predicted values with both last one hundred data and nine hundred random data in the series. As an example, the real and predicted concentrations of CO₂, CO, NO₂, SO₂ etc in Gdansk, Amsterdam and Odessa regions are presented. Our results can be considered as first examples of quite satisfactory short-range forecasts for the air pollutants.

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