The Annual Cycle of Complexity in the Fractal Properties of Japanese Air Temperature Records

Reik Donner (1,2,3), Noboru Tanizuka (4), Takahide Sakamoto (4,5)

(1) Dresden University of Technology, Institute for Transport and Economics, Dresden, Germany (donner@vwi.tu-dresden.de, 0049 351 46336809), (2) Max Planck Institute for Physics of Complex Systems, Dresden, Germany, (3) Potsdam Institute for Climate Impact Research, Research Domain IV Transdisciplinary Concepts & Methods, Potsdam, Germany, (4) Graduate School of Science, Osaka Prefecture University, Sakai, Japan, (5) Electrical Engineering Course, Osaka Municipal Ikuno Technical High School, Osaka, Japan

Fractal dimensions have already been extensively used for characterising the properties of long-term temperature records. In this study, we investigate whether different estimators can also be used for the detection of temporally varying dynamical complexity in such time series, in particular, interannual variations of fractality. As a particularly promising approach, we compute dimension estimates based on principal component analysis (PCA) as well as its univariate form, the singular system analysis (SSA), in order to quantify the variable strength of spatial and temporal correlations among a set of temperature records from Japan.

In order to decide whether or not there is a statistically significant relationship between varying fractal properties of the time series and large-scale climatological phenomena acting on considerably longer time scales, we apply different linear as well as nonlinear methods of time series analysis. Our results are critically compared with those obtained from similar data sets covering other regions of the world, providing information about the potential sensitivity of short- and intermediate-term nonlinear climate variability in different regions to corresponding long-term variations.