Geophysical Research Abstracts
Vol. 15, EGU2013-11706, 2013
EGU General Assembly 2013

Nonlinear multiscale dynamics of the atmosphere and climate: Cross-frequency interactions in the air temperature

Milan Palus
Academy of Sciences of the Czech Republic, Institute of Computer Science, Prague 8, Czech Republic (mp@cs.cas.cz)

The complex dynamics of the Earth atmosphere and climate evolve on a wide range of temporal and spatial scales. Analyses of the low-frequency variability on seasonal to decadal time scales have led to detection of oscillatory phenomena possibly possessing a nonlinear origin and exhibiting phase synchronization between oscillatory modes extracted either from different types of climate-related data or data recorded at different locations on the Earth [1-4]. We study nonlinear interactions between dynamics on different temporal scales in about a century long records of daily mean surface air temperature from various European locations using conditional mutual information together with the Fourier-transform and multifractal surrogate data methods [5]. Information transfer from larger to smaller scales has been observed as the influence of the phase of slow oscillatory phenomena with periods around 6-11 years on amplitudes of the variability characterized by smaller temporal scales from a few months to 4-5 years. The overall effect of the slow oscillations on the inter-annual temperature changes within the range 1-2 K has been observed in large areas of Europe.

Acknowledgement

This study is supported by the Czech Science Foundation, Project No. P103/11/J068.

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