Geophysical Research Abstracts
Vol. 16, EGU2014-16086, 2014
EGU General Assembly 2014

Cross-scale interactions and information transfer in atmospheric dynamics

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Complex dynamical phenomena in the Earth atmosphere and climate typically involve a wide range of temporal and spatial scales. In studies of the low-frequency variability on seasonal to decadal time scales oscillatory phenomena have been detected that probably posses a nonlinear origin and exhibit 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]. In this study we focus on 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.

References

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