



Approach to analysis of multiscale space-distributed time series: separation of spatio-temporal modes with essentially different time scales

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Natural systems are in general space-distributed, and their evolution represents a broad spectrum of temporal scales. The multiscale nature may be resulted from multiplicity of mechanisms governing the system behaviour, and a large number of feedbacks and nonlinearities. A way to reveal and understand the underlying mechanisms as well as to model corresponding sub-systems is decomposition of the full (complex) system into well separated spatio-temporal patterns (“modes”) that evolve with essentially different time scales.

In the report a new method of a similar decomposition is discussed. The method is based on generalization of the MSSA (Multichannel Singular Spectral Analysis) [1] for expanding space-distributed time series in basis of spatio-temporal empirical orthogonal functions (STEOF), which makes allowance delayed correlations of the processes recorded in spatially separated points. The method is applied to decomposition of the Earth’s climate system: on the base of 156 years time series of SST anomalies distributed over the globe [2] two climatic modes possessing by noticeably different time scales (3-5 and 9-11 years) are separated. For more accurate exclusion of “too slow” (and thus not represented correctly) processes from real data the numerically produced STEOF basis is used. For doing this the time series generated by the INM RAS Coupled Climate Model [3] is utilized. Relations of separated modes to ENSO and PDO are investigated. Possible development of the suggested approach in order to the separation of the modes that are nonlinearly uncorrelated is discussed.

1. Ghil, M., R. M. Allen, M. D. Dettinger, K. Ide, D. Kondrashov, et al. (2002) "Advanced spectral methods for climatic time series", *Rev. Geophys.* 40(1), 3.1–3.41.
2. <http://iridl.ldeo.columbia.edu/SOURCES/KAPLAN/EXTENDED/v2/ssta/>
3. http://83.149.207.89/GCM_DATA_PLOTTING/GCM_INM_DATA_XY_en.htm