Analysis of strength of coherency and multi scale variations in complicated real time series

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It is well known that nature is complex in its structure and dynamics, representing a superposition of different temporal and spatial scales. This unavoidable complexity or non-linearity of the physical world manifests itself in the difficulty of constructing a reliable description of the dynamics of processes in real systems, even using tools of modern nonlinear time series analysis. At the same time, these processes are not always random and usually have some inherent dynamical high- or low-dimensional structure. The qualitative description and quantitative evaluation of the dynamics of such processes between overall randomness and clear determinism remain as a major scientific challenge. One of the possible methods of dynamical description is based on evidence that such complex, highly nonlinear processes are nevertheless characterized by linear long- or short-range linear correlations and scaling of their linear properties. So, although formerly the nonlinear part of dynamics was often considered as non-informative noise, it has become clear that the complete evaluation of linear properties before or during nonlinear analysis of complex dynamics is an important task. From this point of view, in the present research evaluation of changes in the strength of coherency in real data sets by using the first zero crossing of the autocorrelation function, as well as multi-scale analysis based on the CWT of different time series, have been carried out. Namely, earth crust hourly tilts, daily mean air temperature, and geomagnetic field daily time records in Georgia for the last 20 years have been analyzed. Nonlinear analysis of these time series was carried out separately. It was shown that modern linear methods are sensitive to the changes encountered in complicated real time series even when their nonlinear dynamical properties are impossible to differentiate, or nearly so. It was also found that the linear characteristics of different model and real high-dimensional time series are subject to considerable quantitative variations depending on time scales.