Geophysical Research Abstracts
Vol. 14, EGU2012-6221, 2012
EGU General Assembly 2012

Dynamical complexity in geomagnetic activity indices: revelations from nonextensive Tsallis statistics, entropies, wavelets and universality concepts

G. Balasis

National Observatory of Athens, Institute for Space Applications and Remote Sensing, Athens, Greece
(gbalasis@space.noa.gr, +302106138343)

Dynamical complexity detection for output time series of complex systems is one of the foremost problems in physics, biology, engineering, and economic sciences. Especially in geomagnetism and magnetospheric physics, accurate detection of the dissimilarity between normal and abnormal states (e.g. pre-storm activity and magnetic storms) can vastly improve geomagnetic field modelling as well as space weather forecasting, respectively.

Nonextensive statistical mechanics through Tsallis entropy provides a solid theoretical basis for describing and analyzing complex systems out of equilibrium, particularly systems exhibiting long-range correlations or fractal properties. Entropy measures (e.g., Tsallis entropy, Shannon entropy, block entropy, Kolmogorov entropy, T-complexity, and approximate entropy) have been proven effectively applicable for the investigation of dynamical complexity in Dst time series. It has been demonstrated that as a magnetic storm approaches, there is clear evidence of significantly lower complexity in the magnetosphere. The observed higher degree of organization of the system agrees with results previously inferred from fractal analysis via estimates of the Hurst exponent based on wavelet transform. This convergence between entropies and linear analyses provides a more reliable detection of the transition from the quiet time to the storm time magnetosphere, thus showing evidence that the occurrence of an intense magnetic storm is imminent.

Moreover, based on the general behavior of complex system dynamics it has been recently found that Dst time series exhibit discrete scale invariance which in turn leads to log-periodic corrections to scaling that decorate the pure power law. The latter can be used for the determination of the time of occurrence of an approaching magnetic storm.