Geophysical Research Abstracts
Vol. 12, EGU2010-11797, 2010
EGU General Assembly 2010

Fractal and multifractal models for extreme bursts in space plasmas.

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Space plasmas may be said to show at least two types of “universality”. One type arises from the fact that plasma physics underpins all astrophysical systems, while another arises from the generic properties of coupled nonlinear physical systems, a branch of the emerging science of complexity. Much work in complexity science is contributing to the physical understanding of the ways by which complex interactions in such systems cause driven or random perturbations to be nonlinearly amplified in amplitude and/or spread out over a wide range of frequencies. These mechanisms lead to non-Gaussian fluctuations and long-ranged temporal memory (referred to by Mandelbrot as the “Noah” and “Joseph” effects, respectively). This poster discusses a standard toy model (linear fractional stable motion, LFSM) which combines the Noah and Joseph effects in a controllable way. I will describe how LFSM is being used to explore the interplay of the above two effects in the distribution of bursts above thresholds, with applications to extreme events in space time series. I will describe ongoing work to improve the accuracy of maximum likelihood-based estimation of burst size and waiting time distributions for LFSM first reported in Watkins et al [Space Science Review, 2005; PRE, 2009]. The relevance of turbulent cascades to space plasmas necessitates comparison between this model and multifractal models, and early results will be described [Watkins et al, PRL comment, 2009].