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Interactive comment on "Evolution of fractality in magnetized plasmas" *by* Víctor Muñoz et al.

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The manuscript features a nice study of fractality in timeseries, describing a way to expose intermittent behavior by means of the scatter diagram of Figure 1. Then the manuscript shows conclusively that in cases of intermittency the fractal dimension decreases. This is the case for Dst and solar-flare index timeseries (Sections 3 – 5), one-dimensional MHD turbulence shell models (Sections 6, 7) and two cases of magnetic clouds (Section 8).

Despite the intuitive, valid fractal analysis, I feel that the manuscript does not have many new elements to showcase. The reference to turbulence in efforts to physically connect solar, interplanetary, and magnetospheric timeseries is biased in its framework. The manuscript effectively shows the effect of intermittency in the fractal dimension of timeseries, regardless of turbulence. Intermittency is a term that is broader than turbulence: turbulent timeseries may be intermittent, but not all intermittent timeseries stem from turbulent systems.

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Discussion paper

The scatter diagram of Figure 1 creates some “dust-like” fractals in case of intermittency (in this case, storm-time dips in Dst). Dust-like structures typically give rise to a fractal dimension smaller than Dmax – 1, where Dmax is the embedding (i.e., Euclidean) dimension of the studied space. In Figure 1, Dmax=2, hence the dust-like structures in the lower-left part of the image show a fractal dimension D < 1 (see, e.g., Schroeder, M,: Fractal, Chaos, Power Laws. Minutes from an Infinite Paradise, Freeman, New York, NY). If no significant intermittency is present, one is left with the upper right part of Figure 1 that typically gives 1 < D < 2.

Interpreting intermittency in general as turbulence and drawing physical conclusions from it is the main drawback of the manuscript. This leads to insufficiently justified conclusions such as the correlations between D from Dst timeseries and the solar flare / coronal indices over tens of days (Figure 9). Indeed, there is connection if an eruptive flare (flare + coronal mass ejection) leads to a magnetospheric storm within 1 – 3 days. However, the correlation seen in Figure 9 is not due to physics but due to the fact that any two intermittent timeseries with intermittent excursions roughly matching in time will show similar correlations. I am afraid this is a common fallacy, appearing in several interdisciplinary studies of timeseries giving, not surprisingly, incidental correlations.

Another unjustified conclusion is the one drawn from Figures 7, 8, namely that “results suggest that the box-counting dimension consistently decreases when the storm approaches” (p.8; top). However, the decrease is not due to the storm but due to the pre-storm disturbances (hours > 1400 and up to the storm’s onset). These disturbances are not necessarily related to the storm. Similar disturbances appear at times < 500 hours in the absence of a storm. Not surprisingly, D in this interval is very similar to the pre-storm D that is indeed decreasing. Again, it is the (most likely incidental, as it starts ∼300 hours prior to the storm) minor intermittency in the timeseries that causes the decrease in both cases, regardless of the storm. Finding a unique pre-storm signature is the challenge here and the manuscript does not seem to contribute significantly to this cause.

The above issues render the penultimate conclusion of the manuscript (p.14) also biased. I see no point in re-doing the analysis unless more physical and statistical arguments for the apparent correlations are used alongside the analysis of the fractal dimension.

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