

Interactive comment on “Magnetospheric chaos and dynamical complexity response during storm time disturbance” by Irewola Aaron Oludehinwa et al.

Anonymous Referee #2

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The authors present a thorough analysis of 9 years of Dst Index and Solar Wind data (vBs) using several methods for detecting their degree of chaoticity. Considering the solar wind electric field as the "input" to the magnetospheric system and the Dst Index as the "output" series, they apply the methods of Maximal Lyapunov Exponent, Approximate Entropy and Delayed Vector Analysis to showcase that during months of low geomagnetic activity the chaoticity of the Dst series remains high, while during months of moderate and high activity, it drops significantly, indicating a reduction in dynamical complexity. The same is not discovered in the vBs series, which consistently show a high degree of chaoticity, regardless of the level of disturbance, thus indicating that the Solar Wind remains a stochastic system.

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The paper is very interesting, showing novel results and very educative, as it carefully describes the employed methodology. It does need some improvement in the language though and could also benefit from a few extra details about the data processing. When these are met, I would gladly recommend it for publication.

Some of my key points are below. For the rest, as well as several editorial remarks, please see the attached pdf file and the annotations therein.

Section 2: Why 9 years? Why not include a couple more and cover the entirety of solar cycle 24? I will not insist on repeating the analysis for the full 11 year period, but I think it would be useful to address the reason since it will probably be one of the first questions that readers will have.

What is the sampling rate of the data series? I assume that for the Dst the sampling time used was 1-hour, but it should be mentioned in the paper as well, perhaps somewhere in this paragraph. The same also for the vBs series.

You include the categorization by Dst, but from the Results section I realized that the analysis is being performed separately for each month in the data, and that each month is classified as Minor, Moderate or Major, but I don't think I saw anywhere the description of how this is done. I assume that each month is being classified based on its minimum Dst value, but it should be written explicitly somewhere in this section. Also, perhaps it would be better to change the definitions from "minor, moderate and major geomagnetic storm" to "month of minor, moderate and major geomagnetic storm activity" in the entirety of the paper.

Section 2.2 Was there a binning used for the AMI calculation? How many bins?

Section 2.3 I think that in the original method by Kennel, they use only one neighbor for each point, namely the nearest neighbor. In this, I read: "the algorithm search for neighbour $P(j)$ such that, $|P(i) - P(j)| < \epsilon$, where ϵ is a small constant", which implies that there might be more than one nearest neighbors. Have I understood that correctly

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or is it just miswritten?

Additionally, I think the sentence "If the distance of the iteration to the nearest neighbor ratio exceeds a defined threshold (ϵ)," should be re-written to be more clear what is meant.

Also, the definition of the final quantity is not very clear. I assume that the final metric is the percentage of nearest neighbors, but I cannot be certain if you are using something else. Please clarify this in the text.

Section 2.4 What time 't1' did you use when applying the method?

In your description of the method there is no mention of any replacement, so it is not clear what is meant by the sentence "M is the total number of replacement steps". I assume you imply the same as the method described in the Wolf 1986 paper, so please add the full paragraph "We look for a new data point that satisfies two criteria reasonably well: its separation, $L(t_1)$, from the evolved fiducial point is small, and the angular separation between the evolved and replacement elements is small. If an adequate replacement point cannot be found, we retain the points that were being used."

Section 3 Sometimes figures are referenced as "figure (5)" and other times as "Figure 5" and I believe I saw one instance of "figure 5" (with lower case 'f'). I would prefer if the authors chose one style and maintain it for the whole paper. Personal preference: the second.

Did you apply the DVV method on the vBs data series? It might be useful to show one example to showcase how a stochastic signal looks, or at the very least mention in the text that the results obtained look similar as the ones for the Dst for months of minor activity. (that is assuming that they did indeed prove the stochastic nature of solar wind, as the other measures did)

Section 4.1 I do not understand why the longitudinal asymmetry of CMEs would imply

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an increase in chaotic behaviour. Please elaborate more on this.

Please also note the supplement to this comment:

<https://npg.copernicus.org/preprints/npg-2020-47/npg-2020-47-RC2-supplement.pdf>

Interactive comment on Nonlin. Processes Geophys. Discuss., <https://doi.org/10.5194/npg-2020-47>, 2020.

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