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Comment on angeo-2022-28

Anonymous Referee #1

Referee comment on "Effect of intermittent structures on the spectral index of the magnetic field in the slow solar wind" by Xin Wang et al., Ann. Geophys. Discuss., https://doi.org/10.5194/angeo-2022-28-RC1, 2022

The manuscript "Effect of Intermittent Structures on the Spectral Index of Magnetic field in the Slow Solar Wind" by X. Wang and co-authors deals with the investigation of the intermittent properties of solar wind magnetic field fluctuations as measured by the spectral slope of their power spectral density. The paper is well written and the topic is within the scope of ANGEO. However, there are some missing aspects that need to be properly framed out and considered before it can be accepted for publication.

Major comments

- The paper accounts for finding a relationship between the spectral exponent and the level of intermittency in slow solar wind streams observed at 1 AU by WIND. The results shown in the paper are not new since a close correspondence between intermittency and changes in the 2nd-order scaling properties has been well established. The main novelty is only the observed analytical relation (fit). I would suggest the authors to carefully revise the manuscript to clearly state this. There is a huge literature on the correction of the scaling properties due to intermittency as well as many improved cascade models have been proposed to revise the original Kolmogorov results.
- The authors claim, indeed, that the steeping of the spectrum is closely connected with intermittency. However, this could be only partially true since different spectral slopes are observed if looking along different directions with respect to the mean field. As the authors say there is a huge literature on the anisotropy of spectral slopes but they introduce a measure of the level of intermittency based on the trace of the PVI (so, something isotropic) and then also evaluate spectral slopes for the trace of the magnetic field fluctuations. Thus, my question is: how the presented results could be biased by anisotropy of magnetic field fluctuations? A possible check could be performed by looking at the dependence of the spectral slope across different directions as a function of the threshold crossing of the PVI along the different directions again. Would the results be robust or is there any dependence on the predominance of fluctuations along a specific direction?

In other words, what is the difference between an interval with $|PVI_j|>2$ but $|PVI_k|<2$ and an interval with $|PVI_j|>2$ for all j=x,y,z?

- Another important point is that by only looking at the 2nd-order exponent could not be sufficient to fully characterize the intermittency. Indeed, as shown in literature (the authors, for example, mentioned the work by Veltri and Mangeney, 1999), intermittency is strictly related to multifractality that can only be measured by looking at the high-order scaling properties. It would be interesting to compare the intermittency magnitude with some multifractals indicators of intermittency as the multifractal width or the amplitude of the singularity spectrum (some parameters have been introduced in literature, see papers by Macek, Wawrzaszek).
- Another crucial point is the definition of the threshold above which an interval is considered intermittent, i.e., the PVI threshold. Indeed, the authors used a threshold of 2 since "The Gaussian distributions are located between the PVI range [-2,2]". However, the definition of PVI is indeed a measure of the level of fluctuations with respect to an average level, i.e., something that resembles a standardization procedure. Did the authors performed the sensitivity of the results based on the choice of the threshold for identifying an intermittent interval?

Additional detailed comments

- Line 3: I would suggest to clarify that "an **analytical/functional** relationship…" has not been shown yet.
- Line 4: the term "intermittency magnitude" could be biased by the definition, it would be better to use the classical notation of "intermittency level".
- Line 59: again here an analytical relation has not been shown yet, while several cascade modes have found intermittency corrections to the spectral slope.
- Lines 74-75: I am not sure the whole interval from 2005 and 2013 is characterized by an undisturbed solar wind (there are different transients indeed). I would suggest to state that the selected intervals all correspond to undisturbed solar wind conditions (if this is the case).
- Line 77: please change "~" with "—".
- Line 124: is it 15 s or 150 s as stated in line 114?
- Line 209: did you check that this is not an Alfvénic stream and then the spectrum should be $f^{-3/2}$? If this is the case, this means that there is an intermittency correction.
- Line 232: which kind of discontinuities? This is important to understand which situation is presented.
- Line 235: could the maximum value be biased by the anisotropy of fluctuations? I mean is this really representative of something new or simply a reflection of a spectrum of anisotropic fluctuations?
- Line 244: there is a recent literature on the scaling properties and intermittency levels with Parker Solar Probe (see papers by Alberti, Cuesta, Matthaeus).