General comment

This manuscript concerns with the investigation of magnetic field fluctuations in three coronal mass ejection (CME)-driven sheath regions at 1 AU with their speeds ranging from slow to fast. The main findings are related to the intermittent and turbulent properties of sheath regions which are also compared and described by means of a common intermittent model as the p−model. The authors suggest that turbulent properties in sheaths resemble that of the slow solar wind, that they are partly similar to those found in terrestrial magnetosheath, and that they can vary considerably within the sheath. In my opinion the results look very interesting and support the view of the complex formation of sheaths and their role in generating fluctuations. The manuscript reads well, contains new results useful for a wide community, and its focus is within the scope of Annales Geophysicae. I have some concerns regarding the presentation of the results and their possible improvements.

We thank the referee for the detailed reading of our manuscript and constructive comments. We have revised the paper accordingly. Our detailed responses are found from below.

Remarks

1. Fig. 2 and Fig. 4: why to show both figures instead of only considering Fig. 4? I think it contains much more information than Fig. 2 since it can be easily used to investigate a lot of turbulent properties (as usual) as the (non-)Gaussian behavior. Moreover, I would suggest to go further into the description of non-selfsimilar properties evident in Fig. 4 for the benefit of the reader.

Figure 2 gives important information regarding normalized solar wind fluctuations that are not visible from the other plots in the paper. For example, allowing to see fluctuations exceeding sqrt(2) and 2, signifying fluctuations with significant rotations (over 90 degrees) and those that are at least partly compressional. This type of plots have also been included in some recent solar wind fluctuation studies to which we compare our results in the text (e.g., Chen et al., 2015; Matteini et al., 2018; Good et al., 2020). We now emphasise this in the text and to clarify we have gathered explanations to the beginning of Section 3.2 where Figure 2 is first discussed.

2. Page 14, lines 19-20: the authors say that "the Kraichnan-Iroshinikov form fits yield consistently larger p-values than the Kolmogorov form fits, but both indicate high intermittency". I suggest the authors to carefully consider some implications of this statement. Both theories are based on similar assumptions although scaling-law behaviors are obtained from HD and MHD equations. So, how to reconcile both theories? I mean the sheaths should be described as a fluid or magnetofluid system? This could affect the larger p−values the authors obtained. Moreover, how to assess the suitability of the p−model for modeling scaling exponents? From Fig. 6 it seems that some cases are not exactly reproduced through a p−model (for example the event on 14 Dec 2006). I would suggest to add a more detailed discussion on these aspects, on possible improvements to simple multifractal models and their suitability in describing sheaths scalings. Furthermore, what about exploring the behavior of singularities and of singularity

spectrum derived from scaling exponents? This could also give more information about symmetries and/or irregular/regular behavior of the fractal nature of sheaths. Finally, for the simple benefit of the reader I suggest to only show the
best fits through p−models in Fig. 6 instead of several p−values

These are all very relevant points. It indeed appears that the used models give partly contradictory results and it is reasonable to question to what extent they can be used to describe turbulence in CME driven sheaths. We have also now replaced the p-model figure to show the results for the sum of the structure function(similar to Pei et al., 2016, added as a reference) instead of the Bz component. The results are now calculated over five timescales in the inertial range (6 to 96 seconds). We thank the reviewer for interesting suggestions for a deeper analysis, but would like to save them for future work. We have however extended the discussion and do not make so strong conclusions based on the p-model. The analysis indeed hints that these models may not be well suited to describe turbulence in CME driven sheaths. Also we now cite Pagel et al.,2002 that deviations from g(3)=1 and g(4)=1 can give rise to false non-intermittent signatures. Agreement with Kraichnan form would suggest that sheaths behave more like magnetofluid, we mention this in the text now. This is consistent with sheaths having generally clearly enhanced magnetic field magnitudes. We also refer now to Li et al., 2012 who argued that in solar wind spectra would steepen from Kraichnan-like to more Kolmogorov-like spectra due to presence of intermittent current sheets.

We would like to keep the colored lines in the Figure 6 as they show how observed (lime) points do not fit to standard p-model curves (i.e. do not follow their shapes in most cases). We have however made these lines slightly fainter so that they are more in the background.

Minor remarks

suggest to carefully check through the text some inconsistency between text and figures' captions in terms of the magnetic field component used in the analysis.
If I correctly understood the authors show only results for Bz, while through the text and in figures' captions there are some discrepancies.

Corrected

Page 7, lines 20-23: is it possible to measure the degree of compressibility/Alfvénicity?

Figure 3 gives information about compressibility. In addition, this information comes also from Figure 2 where large dB/B values (> 2) suggest that fluctuation must be at least partly non-compressible (i.e. non-Alfvénic)

Page 7, line 28: it seems to me that it is not a universal property but it depends on the scale. Could the authors comment on this?

We are not sure where the reviewer refers to this comment.

Page 8, line 11: to see how Gaussian are distributions I suggest to also normalize the pdfs with respect to the standard deviations.

As this info shown more clearly in Figure 4 we now refer to Section 3.5.1 at this point (and discussion there).

Page 9, line 20: why only three timescales to determine spectral indices?

For the kinetic range we cannot include more timescales due to Wind time resolution available. However, we have now included five time scales for the inertial range. This resulted in some changes in the indices, but the main conclusions of our study remain.

Table 2: I suggest to add errors on spectral indices.

We have added standard errors of deviations from the fitting in Table 2 in parenthesis.

Page 11, Line 21: please check the consistency between components used for the analysis.

We have added PDFs for Bx and By components to Supplementary Materials. The PDFs look overall very similar, but the Bz has somewhat more extended tails than Bx/By. This is also visible from Figure 1 as larger amplitude changes in Bz than in the other components. This could imply slightly larger intermittency for the Bz component. We have also now replaced the structure function for Bz shown in Figure 6 with the sum of structure functions for each component.

Figure 3: please correct "intertial" with "inertial". Moreover, I suggest to enlarge the frequency range of dashed-line fits to cover more decades.

We have corrected "inertial" in the figure and also a few similar typos elsewhere in the paper. We also now include 5 timescales to calculate the slopes in the inertial range and accordingly show the dashed-line to cover these extended decades.

Figure 6: please correct the form of the values of p and parameters. The same number of decimal places should be used for the values and the standard deviations. Moreover, it could be useful for the reader to directly compare the different phases (pre-SW, near-shock, mid-sheath, and near-LE) in the same panel to highlight the different level of intermittency

We have corrected these. We think the standard p-model curves also allow the reader to sufficiently compare between the events.