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Interactive comment on "Statistical study of linear magnetic hole structures near Earth" *by* Martin Volwerk et al.

Anonymous Referee #1

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The manuscript discusses the interesting topic of linear magnetic holes or magnetic depressions upstream of Earth. These structures have attracted much attention recently as their generation mechanism is still a point of debate. Authors use MMS data, which are new, and provide a new point of view on categorizing these structures based on their internal plasma properties. However, I have a few concerns regarding data usage that I think should be considered and clarified.

Major comments:

Authors indicated that they use MMS data when the orbit apogee was in the upstream solar wind. However, the FPI instrument was often shut down beyond 20 R_E in the solar wind even though the FGM instrument might have been in operation. So, I am a little doubtful about the statistics beyond 20 R_E. Have the authors checked whether

for each event in their study there are simultaneous FPI measurements? Automated computer programs sometimes select the closest available data point when there is a gap in the data.

In addition, the FPI instrument is not a solar wind monitor, and it is not optimized to measure cold plasmas such as the solar wind. Therefore, it tends to underestimate the solar wind density, while overestimating the temperature. Although this issue can perhaps be justified by the fact that it exists for all events; nonetheless, I think a statement must be added to the text where you introduce the data (∼Line 48), reminding readers of this issue, and that the conclusions are drawn under such condition.

Similarly, differences in density and velocity of electrons versus ions, and between burst versus fast mode data, as shown in the figures, are instrument effects. I suggest using ion moments to present the solar wind plasma density and velocity.

After reading through the manuscript, it appears that the third category, "sign change", of magnetic holes are mostly foreshock events (e.g. HFAs, foreshock cavities). Are you suggesting a new term for these structures? Foreshock anomalies are not related to mirror mode waves and classifying them as magnetic holes seems like mixing two different types of plasma phenomena.

Here are some other minor comments:

Line 46: Do you mean 2017/18?

Line 64: "This resulted in 426 LMH", Please specify if these events are down selected from a larger dataset, or for how many of these events FPI data are available.

Line 66-70: Are you using fast mode or burst mode data? I think it is the former. If that is the case, then it should be mentioned here explicitly. I also suggest removing the burst data that are overplotted on some of the figures. If data from both modes are used, then some explanation on how they are used together is expected here.

Line 74 and Fig. 2: You display different types of LMHs in Fig. 2, but you have not

introduced them yet. Maybe consider moving this figure to the end of the section.

Line 87-90: Have you considered including additional conditions similar to Criterion 4 in Madanian et al. (2020) in your search algorithm to exclude these structures?

Fig. 9 and the caption: These measurements are made in the magnetosheath, behind the bow shock, not in the foreshock.

Fig. 10: As you described in the Introduction section, you are not interested in foreshock events. Figures 10 and 11 obviously show foreshock events. So what is the rationale for these figures? They don't seem to add much context to your objectives.

Line 201: This time period is different than the one mentioned in the Introduction section? Did you include 2018/19 data?

Line 205: The event breakdown in different categories does not quite add up to the total of 426 events.

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