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Interactive comment on "Magnetosheath jet properties and evolution as determined by a global hybrid-Vlasov simulation" *by* Minna Palmroth et al.

Anonymous Referee #2

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Summary: This manuscript examines the physics of magnetosheath jets, using the results of a 5D vlasov simulation of the solar wind – magnetosphere interaction performed using the Vlasiator code. The simulation set up uses steady solar wind conditions, and several magnetosheath jets are reported to occur. The manuscript provides a detailed analysis of one jet in particular that is relatively large, and examines how three different identification criteria, previously published, capture the structure. The size of the jet is quantified, and is found to be consistent with experimental observations. Finally, the magnetosheath jet is shown to be associated with a variation in the upstream pressure that is caused by foreshock waves. The work provides a useful counterpoint to observational studies by showing for the first time that the different signatures adopted in different studies can in fact identify the same event, and therefore

help to unify understanding of what these structures are. It also provides a global view of the phenomenon, and contact is made with observations by estimating the size of the jet.

Overall, my primary concern with the manuscript is that it does not do full justice to what is a very interesting and important simulation result. It is important to compare the three identification criteria, but I think there is more that should be done. This relates to the physics questions about how the jets are formed and their impact on the magnetopause which will be of wider interest. I would be unwilling to recommend the manuscript for publication without addressing the following two points:

1) There is some limited discussion about the source of the magnetosheath jet, but the Vlasiator data surely allows for a much more detailed examination of the proposed formation mechanism and the nature of the ULF waves. In particular, it should be possible to generate some virtual spacecraft data for the upstream ULF waves (e.g. placed just upstream of the shock from where the jet arises) and see immediately if it is the formation of a SLAMS that happens here. Showing and discussing the data would significantly strengthen the manuscript. Similarly, how does the profile of the shock change as the ULF wave pressure front arrives and the jet begins to penetrate into the magnetosheath? Providing more information about the formation mechanism would significantly strengthen the paper and I think it would not be too difficult to extract this information.

2) I was surprised that there is no discussion about the impact of the jet on the magnetopause. In supplementary movie 1, at around t = 325 – 340 s, there is an oscillation of the magnetopause at x = 7.5, y = -4 (very roughly) which seems to follow directly from the arrival of the remnant of the jet. Two pulses traveling away from the impact point along the magnetopause are visible, and I wonder if this is reconnection triggered by the jet. Again I think it would significantly strengthen the paper to add information about the fate of the jet and its impact on the magnetopause.

Each of these would probably require more than one figure and the addition of several paragraphs of text or a section in the manuscript.

Further comments on the manuscript:

3) Evolution of the jet size. The jet size is quoted for one particular time, but it would be very good to provide more information about how the jet size changes. In particular, does the length parallel to the flow change more than the length perpendicular? This should be possible to extract from the simulation as well.

4) Jet occurrence. Watching the movies in the supplementary information, it seems that other jets do occur. Given the fact that the simulation is scaled to the Earth, is it possible to say anything about the occurrence rate and if this is consistent with observations?

5) Change in jet profile. It would be very useful from a spacecraft observation point of view to know how the profile of the jet - as would be observed by the spacecraft – changes with distance from the shock. Again this is something that Vlasiator would be able to show more clearly, and would be able to be extracted from the data.

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