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Interactive comment on "Asymmetries in the Earth's dayside magnetosheath: results from global hybrid-Vlasov simulations" *by* Lucile Turc et al.

Anonymous Referee #3

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The paper describes the Earth magnetosheath response to the solar wind inflow using the Vlasiator code. The focus is put on the various asymmetries of plasma and magnetic parameters in three cases with varying IMF orientation and Alfven Mach number. The results are then compared to an analysis of THEMIS observations which was published previously (Dimmock et al.'s papers). The objectives are sound, the code and the analysis appropriate, however a number of key points make the paper not mature enough in the present form. They are listed first, then minor issues follow.

Major points:

- References: the references to previous works are not adequate. Concerning hybrid

codes for the magnetosheath, the literature was already vast before Vlasiator and 6D simulations of solar wind / planetary plasma interactions exist, e.g. Travnicek et al., 2007 (GRL), Hercik et al., 2013 (JGR), Modolo et al., 2017 (PSS), ... For magnetosheath asymmetries, see the works with Cluster data of Génot et al., and with ISEE data of Tatrallyay et al. For the discussions on Alfven Mach number effects see Lavraud & Borovsky, 2008.

- Foreshock effects: it seems to me that the foreshock effects are over emphasized. Actually the perturbations linked to turbulence processes in the magnetosheath are more directly connected to effects associated to the physics of the parallel shock than to the foreshock itself which lies upstream of the shock. In that respect I disagree with the last sentence of the abstract and similar statements in the paper (for instance l353). Could the authors demonstrate why the foreshock is so important and for which effects it should be distinguished with the parallel shock?

- Kinetic effects: on l300 simulation results on density asymmetry are opposed to those coming from an analysis of MHD equations. The authors point to kinetic effects. Why is it that kinetic effects matter specifically on this issue and not on other where simulations and MHD match? This requires more discussion. Even though this may be outside the scope of the paper, a comparison with 3D MHD simulation (for instance available at CCMC) would help pointing to specific kinetic effects inherent to the Vlasiator code.

- Global approach: the model is 2D in space and the magnetopause is not completely resolved such that a model magnetopause needs to be used. This puts limitation on the term "global" to qualify the simulations. I wonder if the compression/expansion in this limited 2D space can be adequately compared with the real 3D situation. Could the authors discuss this aspect? or point to literature as this has surely been already addressed.

- Scales: could the authors give information on the temporal and spatial scales resolved in the simulations? And compare them to typical scales like inertial lengths and typical periods (inverses of plasma/cyclotron frequencies). How does this compare with the 150s used for averaging magnetosheath parameters? This would help the interpretation of density variability mentioned l289 for instance.

- Set-up: it is not clear to me why run 1 is set up in the XZ plane and arguments are sought for to justify it mimics correctly the XY plane. Why not using a proper set up in the XY plane from the start?

- Observations: for comparing observations and simulations the same statistical methodology should be employed, i.e. median or average for both, contrary to what is done in the paper.

Minor points:

- l95: ‘warranted’. Do the authors mean ‘mandatory’?

- Figure 1: mismatch between central / outer legends and d and e labels.

- l400: snaller

- l427: ‘statistical’. Do the authors refer to observations here?

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