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Comment on angeo-2020-89

Anonymous Referee #2

Referee comment on "Ion distribution functions in magnetotail reconnection: global hybrid-Vlasov simulation results" by Andrei Runov et al., Ann. Geophys. Discuss.,
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The paper provides a comprehensive documentation of ion (proton) velocity distributions obtained within a 2D hybrid Vlasov simulation of global solar wind/magnetosphere interaction causing magnetotail reconnection and plasmoid ejection. This is the first self-consistent result of this kind obtained on a global realistic scale. The resulting distributions show good consistency with previously published Themis observations (supplemented by an additional new figure) and MHD/test particle simulations. This may be seen as both validation of the Vlasiator results and the non-self-consistent test particle results. I have only minor points of clarification.

Speiser orbits are particular orbits in magnetotail like fields with finite B_z that consist of quasi-adiabatic gyro motions outside the neutral sheet, turning into a meandering motion when the particle enters the central current sheet (together with an approximate half-gyration around the finite B_z), and become gyromotions again when the particle exits toward higher latitude on the same or the opposite side. It is not clear whether the author refer to such motion or just to the meandering part, which is an indication of non-adiabaticity. While distributions, such as in Fig. 6, are an indication of non-gyrotropy, it is not clear how they would indicate specifically Speiser type orbits.

Page 2, line 11: The original term used by Liu et al is "dipolarizing" flux bundle, as is used also later in the paper. One might, however, argue that "dipolarizing" implies "increasing B_z ," which probably was not intended by Liu and i would not object to leaving this as is.

Page 3, line24: The previous sentence refers to Fermi acceleration, causing the field-aligned beams. Simply change: "This" to "The" and a bit later eliminate "thus." Also, the two effects are the same: adiabatic convection toward increasing B is, in the moving frame, the betatron effect.

Page 5, line 25: Shouldn't this be a "cylinder" rather than a "sphere"?