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Interactive comment on "Vlasov simulation of electrons in the context of hybrid global models: A Vlasiator approach" *by* Markus Battarbee et al.

Anonymous Referee #1

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This is interesting draft describing inclusion of electron physics into the global hybrid simulations. Topic is very important, and such improved models are expected to provide useful and crucial information about many magnetopsheric plasma processes. Thus, paper should be published in AnGeo! However, some clarifications are needed before publication. I have one general suggestion, and set of specific comments.

Beside the reconnection, the electron physics in the magnetotail (the simulation domain shown in this study) includes: (1) electron adiabatic heating during earthward convection and transport (e.g., doi:10.1002/2015JA021166, 10.5194/angeo-31-1109-2013) (2) generation of electron anisotropy at plasma flow fronts and plasma injections and further relaxation of this anisotropy via whistler wave generation (e.g., doi:10.1103/PhysRevLett.106.165001, 10.1002/2016GL069188, 10.1029/2018GL079613) (3) formation of strong field-aligned and transverse electron currents in the magnetotail current sheet (e.g., doi:10.1029/2007JA012760, 10.1002/2016GL072011) (4) electron-ion decupling and formation of strong electric field in thin current sheets (e.g., doi:10.1029/2018JA026202, 10.1002/2016JA023325) (5) electron precipitation altering MI coupling (e.g., doi:10.1007/s11214-016-0234-7) It would be very useful to discuss which of these processes can be described by the presented model.

Comments: *Line 43: Do you mean “reconnection in Harris current sheet”? please, separate reference to the analytical model (Harris 1962) and numerical simulations

*Line 70: please, add reference to doi:10.1002/2015GL063946

*Lines 149-154: if I understand correctly, Authors exclude pressure gradient term, but include electron inertial term. This is quite unexpected solution. Ratio of electron inertial term and pressure gradient is of the order of Ve*R/T/Vtˆ2 where Ve is the bulk electron speed, R and T are typical spatial and temporal scales, and Vt is the electron thermal speed. To make this term much larger than one (neglect pressure versus inertia), one needs to consider processes with the evolution rate R/T»Vtˆ2/Ve i.e. much faster than electron thermal speed that is the largest speed in solar wind, magnetosheath, magnetotail plasmas. Authors should explain why they can use the Ve*R/T/Vtˆ2»1 assumption in the magnetosphere.

* Fig6a: Do Author suggest that this anisotropy results after 1s from the initially isotropic Maxwellian distribution? This time seems to be large in comparison with plasma time-scales (inverse plasma frequency), but should be very small in comparison with global plasma/magnetic field motion responsible for betatron acceleration. Additional clarifications are needed here to explain how electrons can be heated transversely so quickly.

* Fig6a: I see Tper/Tpar ratio around 1.5, what is quite large ratio for magnetosphere. Do Authors observe whistler wave generation by anisotropic electrons and following relaxation of this anisotropy?

*Line 299: electron-scale waves at PSBL are driven by electron beams from the reconnection region. Do Authors observe such an acceleration?

*Lines 301-304: note, typical electron anisotropy in the magnetotail Tpar/Tper>1 is formed by cold (subthermal) electron populations. Is this the case in simulation?

*Fig6, velocity distributions: almost all shown distributions demonstrate a certain nongyrotropy (although weak): non-circle shape in v_perp1, v_perp2 plane. Such nongyrotropy is expected in the close vicinity to the reconnection region, but should be explained outside of this region where electrons are well magnetized .

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