

Ann. Geophys. Discuss., referee comment RC1
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Comment on angeo-2021-64

Anonymous Referee #1

Referee comment on "*Menura*: a code for simulating the interaction between a turbulent solar wind and solar system bodies" by Etienne Behar et al., Ann. Geophys. Discuss., <https://doi.org/10.5194/angeo-2021-64-RC1>, 2022

The authors present a method-focused article introducing a new hybrid particle in cell code "Menura", consisting of a kinetic treatment for ions and a fluid treatment of electrons. As discussed in the manuscript with appropriate detail, the code utilizes a standard CAM-CL (Matthews, 1994) algorithm with zero electron inertia, fields in the Darwin limit, polytropic electron pressure and smoothing via a hyper resistivity in Ohm's law. The authors demonstrate the core functionality of this code using a standard set of successful tests: wave dispersion relations, two-stream instabilities and Landau damping. The key innovation with this code is its ability to self-consistently simulate a field of decaying turbulence first, then drive a solar wind obstacle within that field of turbulent fluctuations. Given current and growing interests in non-laminar and time-dependent flow interactions, this code/method is likely to generate important scientific results in the future. Although I'm disappointed that the results of the final simulation are not discussed in this manuscript, I think it is reasonable to lay the groundwork with this methods-focused paper first. However, before I can recommend publication I have several specific comments I would like to see addressed:

- There are several very long, run-on sentences in the introduction that are quite difficult to parse (e.g. lines 14-25). Typos and unclear reference formatting (see next point) may compound the issue. I understand the points the authors are making, but I think this section would benefit from clearer editing.
- References are confusingly formatted. The manuscript text reads as if the expected format should be given as "...planetary plasma environments, at Mars (Ramstad et al. 2017),...", rather than with only the year in parentheses. Please amend throughout the manuscript.
- Line 83: "Figure 6" should refer to "Figure 1" here, or else there is a missing figure.
- Line 121: Menura implements a polytropic equation of state (equation 6), with associated index k chosen by the user. Can the authors ensure that the chosen index k is given for each subsequent simulation discussed in the manuscript. For example, Line 155 mentions that different indices have been used, but not what those indices are.
- Line 130: Similarly, Menura implements a hyper-resistivity term in Ohm's Law. Can the authors discuss the value of hyper-resistivity η_h and $n_{h,vacuum}$ used for each simulation? The authors note on line 254 that no resistivity or hyper-resistivity is used for the comet frame test runs, however, it is not made clear whether that is also true for the other reported runs.

- Line 150: The first physical test is noted to consist of a 2D spatial domain (line 146), though the results are given only along the 'main' spatial dimension x , i.e. $B(x,t)$. Are the results achieved through taking a cut through the 2D domain (e.g. $B(x,y=y_0,t)$), or by averaging along the second dimension?
- Line 166: The authors note that a 'very high number of macro-particles per grid node' is needed to resolve Landau damping, and later note that this amount may be infeasible for global simulations. Can the authors include in the manuscript how many particles-per-node were necessary to achieve the result shown in Figure 3?
- Line 185, 192, 209, etc.: I believe the units of the wavenumbers k should be given in units of $\text{di}0^{-1}$, rather than $\text{di}0$.
- Section 5.4: Can the authors provide any details on how well the code scales to larger numbers of processes?
- Tables 1 and A1 require captions.
- Tables 1 and A1 also seem to be redundant. A1 is exactly the same as 1 save for the addition of the electric field normalization E_0 . I suggest removing Table A1 and including the electric field normalization in Table 1.

Typos:

- Line 3: "field" > "fields"
- Line 16: "event-full" > "eventful"
- Line 16: "further in" > "furthering"
- Line 26: "shading" > "shining"
- Line 79: "license" is repeated, remove the second instance.
- Line 74: "models" > "model"
- Line 163: "capture" > "captured"
- Line 247: "simulation" > "simulations"
- Line 259: "insure" > "ensure"
- Line 268: "as well are" > "as well as"
- Line 345: "consist in" > "consists of"
- Line 354: "How do the additional energy, stored..." > "How does the additional energy stored..." (including removing comma)