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Interactive comment on "Evaluation of oceanic and atmospheric trajectory schemes in the TRACMASS trajectory model v6.0" *by* Kristofer Döös et al.

Anonymous Referee #1

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In this manuscript, the authors present a summary of the latest version of TRACMASS code, to be used to calculate trajectories of virtual particles in the ocean and atmosphere. In particular, they focus on the different time stepping schemes, explicitly comparing the skill and efficiency of stepwise stationary against linear interpolation schemes, to show that the latter is more accurate and faster (for the same accuracy) than the former.

In general, this is a well-written and interesting manuscript, that delves into a major question in the field: how to best calculate virtual particle trajectories. However, I have a number of major comments that I would like to see the authors address before I think the study could be published

1) Given that the authors have named this version v6.0, it would be good to summarise how it is different from the previous versions. What's new? In particular, almost all of the equations and derivation in section 2 were also presented in De Vries and Döös (2001). Given that this time-dependent option has apparently been in TRACMASS for so long, why focus on it now in version 6.0? If only the explicit comparison against the stepwise stationary algorithm for real-life applications such as NEMO and ERA-Interim is new, then this should be much clearer reflected throughout the manuscript (including the title)

2) The authors state on numerous occasions that their code is 'mass-conserving', but without actually proving this. Also, there is a key difference between 'mass conserving' and 'accurate'. A hypothetical scheme where particles are motionless and don't move will be mass-conserving, but not very accurate. The authors seem to conflate the two concepts a bit. Chu and Fan (2014) showed that this linear uncoupled interpolation scheme is in fact not the most accurate, so it would be good to see a response to that paper here. How does linear temporal interpolation affect mass conservation and accuracy, as well as the agreement with tracer fields (see also page 2, line 3)?

Minor comments:

- page 1, line 24: perhaps good to define what's meant with a 'grid cell' here. A model grid cell?

- page 2, line 14: What type of 'continuous interpolation' is meant? Spline? Linear?

- page 3, line 23: This discussion of mass and volume interchangeability in OGCMs of course is only true in hydrostatic models (also page 4, line 17).

- page 6, line 20: This comment about how TRACMASS works on any vertical grid has been made already, and there is probably no need to mention it again here

- page 8, line 6: Are there any physical interpretations for α, β, γ and δ? In particular for α, what kind of flow is α

> 0 versus α < 0?

- page 10, line 14: The terminology of grid cell boundaries is a bit confusing at times. Here it is called a ‘wall’, even though it is not a land-sea boundary. I suggest to carefully go through the manuscript to standardise the wording used to distinguish ocean-ocean (or atmosphere-atmosphere) grid faces from land-ocean faces.

- page 10, line 27: Would be good to explicitly mention which root-solving algorithm is used.

- page 11, line 28: ‘Conveyor Belt’ is a simplistic term here, better to call it thermohaline circulation?

- page 11, line 29: How are the particles seeded in the vertical? At all depth levels?

- page 12: There appears to be no reference to Figure 5 in the text between the first references to Figure 4 and Figure 6?

- page 16: refer to Lacasce (2008) here, for the standard work on the statistics of particle dispersion in the ocean?

- Figure 4: What does the colouring of the trajectories represent? And it might also be useful to add a grid with selected longitudes and latitudes, so that reader unfamiliar with the Agulhas region can orient themselves (that latter point also for Figure 9)

- Figure 7: Beyond showing the mean distance, would it also be useful to show the spread (e.g. the one standard deviation of each line with time)?

- Figure 8: The presentation of Fig 8 is not ideal, because most lines fall on top of each other. I appreciate that this is the whole point of the Figure, but a quick reader might be confused where the other lines are. Is there no better way to show that 6 of the 7 lines essentially lay on top of each other?

Type-os etc:

- page 2, line 18: Replace ‘always’ with ‘typically’?
- page 2, line 23: ‘behind these can be found’
- page 5, line 23: should be Eq (19)?
- page 9, line 16: Eq 32 should not be part of this list?
- page 9, line 18: There is no following subsection, there is just the text below
- page 10, line 10: use ‘domain’ rather than ‘”box”’?
- page 10, line 28: ‘r’ at end of line misses subscript i
- page 11, line 20: ‘implies that they’
- page 12, line 16: ‘distances have been possible to compute since all’

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Discussion paper