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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 #3

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This manuscript offers a summary of the schemes available in the TRACMASS Lagrangian analysis code and provides a comparison of their application to two numerical models. As numerical models increase in resolution it is important that the development of Lagrangian tools keeps pace, such that they can provide accuracy and computational efficiency. These are difficult to achieve in 'offline' Lagrangian analyses. The latest developments, and their usefulness as outlined here, are important and will be of use to the community.

The manuscript is well written, and I find the analyses to be useful and the figures to be helpful. While the derivations have already been provided in earlier work (such as the cited de Vries and Döös 2001 article), which risks making the paper unnecessarily

bulky, it is useful to be able to consider and compare the two different schemes in a single article and I do not object to it. Following some minor corrections and clarifications that I have listed below, I recommend the article for publication.

General considerations:

1) In section 3 it appears to be taken at face value that the time-dependent case represents a 'model truth', to which the other cases are compared. The sentence on P2 L15 suggests that it is "logical" to use a stepwise-stationary scheme that analyses output at the model time-integration frequency. Is there some way of clarifying/demonstrating that the time-dependent solution is the most realistic solution to the model transports? I suppose that a real 'truth' could be calculated by outputting the model at every model integration step and then performing the stepwise-stationary analysis. Since this is obviously very laborious, perhaps the authors can provide an easier description.

2) - P13: L26-29. In order to be able to better interpret those studies that have used the fixed timestep scheme, it would be useful to know if the values provided on e.g. P13 L26-29 are sensitive to the number of particles used and the time period over which the particles are seeded. Is it possible that the fixed GCM time step scheme converges (closer) towards the other schemes when a long(er) seeding period is used along with a large(r) number of particles? In this case, the streamfunctions could be compared to an Eulerian streamfunction that is taken as the actual model truth.

Similarly, do the number of particles used in the experiments constitute a "large ensemble".

3) In the absence of having tested a suite of models, I think the authors could be clearer in places (e.g. P15 L20) that their results are specific to the resolutions of their chosen models. While the increased accuracy of the method will certainly translate to a consideration of lower resolution models, the relative importance is likely going to decrease. Perhaps for certain applications the fixed timestep solution could be just as meaningful as the time-dependent one, if a large enough number of particles are

integrated?

Specific comments:

- P1 L3-4. I find a "limited period of time" to be a pretty vague description. Something more like "... stationary for set intervals of time between saved model outputs" might be clearer.

- P1 L13 At this point in the article, "more accurate" seems ambiguous as to whether it is more accurate w.r.t the time-dependent case or w.r.t itself. Perhaps a change to "increasingly more accurate" would make it clearer.

- P3 L12: superscript n is not defined until P4. Also, n is sometimes used as a subscript, presumably by mistake (e.g. P3 L24).

- P3 L30: It is not made clear why it is more advantageous or why the direct calculation would be any more accurate than is done by the model. Is it because of the interpolation that is applied by TRACMASS?

- P4 L7: If Tracmass can work on models in which a variable vertical resolution is also spatially dependent, as stated on P3, then should delta_z in equation 8 also have subscripts i,j?

- P4 L10: delta_t_G is defined only later on.

- P4 L14: I'd have thought convention normally has k=0 as the surface grid cell, not the bottom.

- P4 L17: It appears that a numbered list is started here, but I'm not sure why.

- equation 13: This has already been written of line 24 of the previous page. Accordingly, could equations 14 and 15 also be moved up to where that previous definition of hydrostatic balance is given, which seems a more natural place for these equations to go? Currently they are returning the discussion to horizontal velocities after having discussed vertical velocities.

- P5 L5-9: I feel this section would be more helpful if given at an earlier point in the paper, plus it is largely repeating what was stated on P3 L13.

- P5 L16: Perhaps say here that this is done for V and W too.

- P5 L28: Typo Eq (1).

- P6 L2. Regarding "if this is not the case", it is not clear whether this is referring to U(r1) or U(r2) being positive, or both.

- P7 L11-15: It should perhaps say here that both the fixed time step and the stepwise stationary cases will be tested.

- Equation 24: typo on the second line of the equation, in the first F term - a subscript n. Similar typo in equation 38.

- Figure 2: What is a 'region' here, and why only three of them in subplot (a)? Also, given that the stepwise-stationary method can also include temporal interpolation, it should be stated here that these solutions are for the time-dependent case.

- P9 L15: It is not clear whether "this case" is referring to the time-dependent or step-wise case.

- P9 L18. The "following subsection" or 'this subsection'?

- Section 3.1: There is no mention of Figure 5.

- Figures 5 onwards: Isn't I_s=1 the same as the fixed GCM time step?

- P13 L2: It should perhaps be clarified that this is now referring to improvements in the GCM, not the Lagrangian model.

- P13 L18: Figure 9 shows neither a subtraction nor the stepwise-stationary case.

- P13 L20-21: I don't understand this sentence, which appears to contrast with those on lines 26-29 in the same paragraph.

- P14 L11: Instead of saying "for some time", which is ambiguous, I would suggest something more like "for the duration of a user defined intermediate time step between model output fields". Also, the use of the past tense here doesn't work well, especially since the next sentence is in the present again.

- P14 L13: Similarly, instead of "is in steady state" I would say something more like "is steady during each time step".

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