Reply on RC3

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Author comment on "ROMSPath v1.0: offline particle tracking for the Regional Ocean Modeling System (ROMS)" by Elias J. Hunter et al., Geosci. Model Dev. Discuss., https://doi.org/10.5194/gmd-2021-400-AC4, 2022

Referee 3,

Thank you for your comments on our manuscript titled "ROMSPath v1.0: Offline Particle Tracking for the Regional Ocean Modeling System (ROMS)". We appreciate the thoughtful and useful comments and will address them point by point below.

"While this project motivated the changes that were made to the code, it's not necessarily the most effective means for demonstrating the improvements. It would have been more informative to illustrate the results with simpler, idealized examples that are more easily diagnosed and transferrable to other applications. For example, the improvements in performance from splitting the advective and turbulence time steps will clearly provide model speed-up, but it'd be helpful to provide guidance on how much speedup users can expect for typical simulation parameters. Similarly, it is not surprising that using higher resolution grids will increase the resolved dispersion of particles, but it'd be useful to provide more context on how the increase in dispersion with nested grids compares with theoretical expectations."

"Among the stated aims are to "improve the model's efficiency, accuracy, and generality" [47-48], so that end, it would enhance the presentation to provide more generalizable examples of how these code updates improve the model. "

We agree that a broader analysis of the parameter space associated with the computational speed and model skill of ROMSPath, including a series of runs on idealized model grids for each model, would be valuable. However, as referee 3 notes, this work was motivated by a single project with specific scientific objectives. A larger study of type referee 3 recommends would be an independent investigation and is not realistic given the available resources and time. The improvements illustrated in the manuscript are significant enough that we believe publication is warranted.

"The examples with initially vertically uniform particle distribution illustrate how particle dispersion depends on having the random walk algorithm coded correctly, but I am left wondering whether the clustering of particles near the pycnocline in the ROMSpath case has a physical basis due to flow characteristics

or is instead some residual error (that is nevertheless a big improvement on the LTRANS result). "

Given the 4-d nature of these simulations, it is unlikely the minor increase in particle density seen in figure 5 are due to residual error. As the particles spread in space the vertical distribution of particles at any given horizontal point is less uniform. Further, even in the canonical case in fig. 3 of Visser et al (1997), there are some random increases in particle density at the diffusivity minimum.

Visser, A. (1997). "Using random walk models to simulate the vertical distribution of particles in a turbulent water column." Marine Ecology Progress Series 158: 275-281.

[11]   is "OPT" a commonly used acronym? It's unfamiliar, and quick search did not turn up other instances of it. The added confusion to readers with creating a new acronym does not seem to be worth the savings in keystrokes or ink.

This acronym does not seem confusing to us. Offline and online particle tracking are terms used in existing literature (e.g. van Sebille et al, 2018) and it is natural to use an acronym for a phrase used repeatedly, such as "offline particle tracking". However, to minimize any confusion we will emphasize the acronym in the introduction, switching (line 38) "referred to as offline particle tracking (OPT)" to "referred to as offline particle tracking (hereafter designated OPT for readability)"

van Sebille, E., et al. (2018). "Lagrangian ocean analysis: Fundamentals and practices." Ocean Modelling 121: 49-75.

[22]   Perhaps note in the abstract that the manuscript provides examples of the how the improvements affect the performance of the code?

We will add a comment.

[41]   "that calculate particle trajectories for a variety of applications" can be deleted.

Yes, we agree.

[45]   "It is not uncommon for users to modify OPT models to add novel processes for individual studies. Here, we describe alterations and additions to an existing OPT code, the Lagrangian TRANSport model (LTRANS), to add specific larval behaviour and improve the model's efficiency, accuracy and generality." These statements seem contradictory. If most users add their own processes and you are adding your own specific behavior, how does that improve generality? Please clarify.

It is not that the larval behavior itself adds generality, but as part of our project we added specific larval behavior while also improving generality, for example by adding functionality for nested grids and stokes drift and wet/dry cells. We will clarify this in the text.

[195]   is the Stokes drift necessarily output at the same times as the ROMS fields?

Yes, and the same spatial grid. It requires front end processing of stokes velocities into the correct format.

[232]   Do the details of the Doppio implementation on data assimilation and nudging matter for ROMSpath? If not, suggest removing for clarity.

In as far as the hydrodynamics are being used as ROMSPath input, yes. We are using Lopez et al. (2020) as a primary reference for the DOPPIO hydrodynamic model setup. Lopez et al. (2020) did not use nudging and nesting, so we need to describe these differences.

López, A. G., et al. (2020). "Doppio – a ROMS (v3.6)-based circulation model for the Mid-Atlantic Bight and Gulf of Maine: configuration and comparison to integrated coastal observing network observations." Geoscientific Model Development 13(8): 3709-3729.

[245]   Similar to the previous comment, it's not clear if the details on the time stepping are important for ROMSpath (e.g., recommended output interval) or specific to the goals of this science project. For this manuscript the focus should be on the former, and the latter would be more appropriate for a manuscript reporting on the scientific results.

Time stepping details are very important for reproducibility. Typical ROMS output is saved hourly or 3 hourly, due to disk space constraints. We saved hydrodynamic data every 12 minutes and used that as input to ROMSPath.

[331]   As with OPT, "CM" is unnecessary, and is more a source of confusion than clarity.

CM is not used often so does not warrant an acronym. We will update that.

[334]   "LTRANS OTP fails to reproduce the off-shelf transport" Why is that? What aspect of the code modifications led to this improvement?

This is explained in section 4.1 (Coordinate system), describing the results comparing LTRANS, ROMSPath and ROMS floats. Changing ROMSPath to the ROMS eta/xi coordinate system reproduces off-shelf transport by ROMS floats. Whereas the coordinate system used by LTRANS does not, because of the error introduced in the LTRANS grid transformation.

[Fig 4]   It's confusing to have the center of mass line on all 3 plots since the rest of the info in each panel is just a snapshot in time, whereas the line represents the trajectory over time. It's also hard to distinguish the center of mass lines from the dots. Suggest removing the center of mass lines since, as noted in the text, it is not a particularly good metric as the particles get strained out.

 While the center of mass is not the best metric, it is still useful to see where the center of mass paths diverge. It is informative to see these paths in figures 4a and 4b, although they are unnecessary in other panels.

[353]   Why does decreasing the advective time step mitigate the clustering problem in LTRANS?

Good question, most likely it's that the error introduced in the turbulence parameterization

scales with the time step. So a larger timestep= larger error. We plan to illustrate this in a supplemental figure.

[354]   "numeric[al] efficiency...tens of thousands of particles" It'd be worth quantifying the speedup in efficiency gained by splitting the turbulence and advection steps, assuming an appropriate ratio for them. Presumably it depends on how computationally expensive the advection and turbulence calculations are? Does it depend on the number of particles, or just become more noticeable with increasing numbers of particles?

The speed change is difficult to quantify. Depending on the configuration we saw speed changes from 20% increase in speed to a 400% increase. It depends on the system I/O speed as well as turbulence calculations. Yes, more particles translate to longer compute times.

[Fig 5]   As mentioned above, ROMSPath also appears to have clustering near the turbulence minimum, but much less so. If LTRANS were run with the correction to the sign error in the code, would it give a result similar to ROMSPath, or are there other factors contributing to the difference?

If the sign correction was changed in LTRANS, split time-stepping is implemented to mitigate the clustering.

[393]   "wave swell was onshore during this time period" Isn't swell usually onshore, and increasingly so as it approaches the coast? Perhaps the idea is that the wave direction was aligned with main axis of the estuary?

The wave field over time is variable over the width of the shelf. And not all of the domain of interest is in very shallow water. So it seem prudent to be specific about the direction of the waves for this test case.