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Geoscientific Model Development
Discussions

Interactive comment on "Numerical integrators for Lagrangian oceanography" *by* Tor Nordam and Rodrigo Duran

Anonymous Referee #2

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In this paper the authors investigate the accuracy of different ODE integrators for computing drifter trajectories from pre-computed velocity fields, as often used in Lagrangian oceanography. The authors give a detailed and comprehensive background of commonly used methods with fixed timestep sizes, as well as variable timestep methods, and propose a set of special-purpose variations of the latter to better deal with sampling errors due to the temporal discretisation of the flow field. These are of particular interest, since they can increase the accuracy of the method significantly, while reducing the number of "rejected" steps when approaching a temporal discontinuity in the sampled velocity field.

Overall, I very much enjoyed this paper, both, for its detailed background into an important aspect of Lagrangian oceanography, as well as its analysis of the benefits of

the new variations of variable timestep integrators proposed. As the topic discussed is deeply rooted in practical considerations of dealing with pre-computed velocity fields, I find this work highly informative and appropriate for this journal. Nevertheless, I have a few comments that I hope can help to further clarify and improve this paper. Once addressed I would like to recommend this paper for publication.

Comments:

1) Section 4.1: All three data sets have the same constant temporal resolution of 1 hour. Since of of the key advantages of the proposed time-varying integrators is to better treat temporal discontinuities in the sampled flow field, I'm wondering if varying temporal resolutions might have an impact on the analysis as well? Some clarification, either in section 4 or 5 would help here, or possibly even an additional test case with a known analytical solution and different temporal resolutions could be used to highlight this (something akin to 3.2, but comparing fixed / time-varying / special-purpose integrators).

2) Section 4.4: "We used only the surface layer of the data sets", but then 3D spline interpolators are used. Are the experiments considering 2-dimensional trajectories or 3-dimensional ones? Please clarify.

3) Section 5.: "Number of evaluations of the right-hand side was chosen as a measure of work, as it is more objective than the runtime of the simulation" is almost immediately followed by "We note that higher-order interpolation is more computationally costly than lower order interpolation." While both statements are correct in their own context, they seem a little contradictory here. A small clarification could help clarify this.

Moreover, while I agree that the number of evaluations is an important metric to evaluate the efficiency of different numerical integrators, the overall time-to-solution is often the final metric in practice. The final paragraph of 5.2 hints at this, but I'm left wondering if a graph plotting error vs. run-time could be used to highlight the points here more clearly?

4) Section 6: "The most striking conclusion from the results presented above," This reads more like a continuation of the discussion above, rather than a conclusion in its own right. Maybe re-structure a little to independently re-state the objective and key findings of the paper, as is to some extend done later in the section?

Minor details:

* Link to data sets strictcly requires ‘https://‘ in the URL. Please adjust footnote on p. 12.

* The code repository on github is very neat (much appreciated!), but I could not find the Jupyter notebooks mentioned in the text. (In case I just missed them, maybe a link in the README in the repo would help people find them quickly?)

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