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Geoscientific Model Development Discussions

Interactive comment on "The Parcels v2.0 Lagrangian framework: new field interpolation schemes" *by* Philippe Delandmeter and Erik van Sebille

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General comments

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This manuscript describes the upgrades leading to version 2.0 of the Parcels lagrangian drift code, with emphasis on new field interpolation schemes. A short section is devoted to mathematical validation of the new schemes, and a longer section is devoted to a demonstration study of floating microplastics. The manuscript is well written, with few typos. Figures, in particular the field diagrams, are very clear and useful. In

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general the paper demonstrates and documents nicely the accuracy, power and flexibility of the Parcels software, and is as such worthy publication In GMD. My only major concern about this paper, as commented below, is that the study of floating microplastics does not address very directly the new field interpolation schemes, which are the major focus of this paper.

Specific comments

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- The new interpolation schemes addresses z and sigma as vertical coordinates. However, the widely used ocean model HYCOM uses a hybrid combination, with z-coordinates near the surface and sigma-coordinates below. Please comment whether the existing schemes are applicable to native HYCOM-output, or if such an extension would be simple/feasible, and eventually whether it is planned for the (near) future.

- It could also be commented whether there are any specific plans to support unstructured grids in the (near) future.

- The paper addresses various types of fields, but does not mention file formats. E.g. would any CF-compatible netCDF-file be directly ingestible by Parcels 2.0? What would be the approach for using model-specific output formats, including non-netCDF?

- In section 2.1.1 velocities are referred to as “zonal” and “meridional”, and in Section 2.2.1 it is said that longitude and latitude are 1D arrays for rectilinear grids. Does this imply that only lon-lat (Plate Caree) and Mercator grids are supported, and not other projections such as e.g. polar stereographic?

- Is the coastline always considered to be land-pixels of the ocean model, or does Parcels 2.0 also support using e.g. vector coastlines such as GSHHS? This affects e.g. the question about impermeability (i.e. that ocean currents do not have an onshore component). The interpolation schemes assures impermeability at the coast, which is a good property, but this would be difficult to assure if the same ocean models is not

used for the landmask. And with nested grids, each ocean model would then need to use their own coastline to assure impermeability?

- The WaveWatch Stokes drift is only available up to 80 degree North, nevertheless the simulations including Stokes drift shows particles further north. Is the Stokes drift simply neglected northwards of 80 degrees, instead of deactivating the particles?

- With the Nemo 1/4 degree model, more MP is trapped along the Norwegian Coast than with the 1/12 model. Can you explain why this is the case?

- The sensitivity study of Section 4 addresses “floating microplastics”. It is not stated specifically, but I assume this means that the MP is considered to be at the very surface all the time? If so, this has some implications which should be commented. E.g. have in situ measurements (e.g. Kukulka, 2012, Kooi, 2016) shown that MP particles are mixed deeper in the water column with increasing wind speeds. This implies that the real Stokes drift is less than the surface Stokes drift, which is presumably used in this study?

- Figure 8 shows e.g. that the effect of adding Stokes drift, is that more particles are kept at the Norwegian coast, and less is advected into the Arctic Ocean. However, it is very hard to see this from Figures 6 a) and d), probably due to the logarithmic scale. What is the reason for choosing a logarithmic scale on Figure 6 and 7?

- Section 4.2 explains that impermeability condition applies to the ocean current advection, but that Stokes drift and diffusion allow stranding. However, if diffusion is regarded as unresolved (sub-grid) ocean currents, these should in principle also not have any onshore component. This would imply that the amount of stranding is overestimated.

- It would also be nice to have some short comments about the implementation of the new interpolation schemes. Are these programmed in Python, or in C? Are they programmed at a lowest level (i.e. the equations as shown in this paper), or are some external higher level Python libraries used? Any comments about computa-

tional time/performance would also be welcome, either in general terms (fast, very fast, slow. . .) or as numerical metrics.

- As mentioned under the General Comments, the study of floating microplastics does not appear to test specifically the new interpolation schemes, apart from demonstrating that fields of different grids may be used and combined. NEMO input is on a curvilinear C-grid, whereas CMEMS input is on an A-grid (rectilinear?), but the vertical coordinates (z or sigma) are not mentioned. However, if the plastics is considered to be at the surface all the time, the vertical interpolation is not even used in this study. A more direct validation/test, would e.g. be to compare two simulations with 3D-drift with the CMEMS/NEW data set in respectively native coordinates (C-grid curvilinear), and the regridded (A-grid rectilinear) data as used in this study. In addition to quantifying the differences (hopefully small?) of the spatial distribution/drift for such a case, it would be interesting the get an idea about the difference in computational time, where using pre-regridded data would be expected to be faster.

Technical comments

- Figure1: it could be commented that all 4 combinations of horizontal and vertical grids are possible.

- Both in Section 2.1.1 and 2.1.2 there are unnumbered sub-headings names “2D field” and “3D field”. This could lead to confusion when jumping back and forth between pages/sections.

- Section 2.1.1, line 15. The meaning of this sentence is unclear: “The interpolation must use local information in the cells.”

- Section 2.2.1 says that data is read lazily, which is a nice property. Is this based on external libraries such as dask, or is it explicitly programmed in Parcels?

- There are links to the interpolation code, which is said to be independent of Parcels.

Does this mean that it is implemented as a stand-alone library which is used by Parcels, or is it (also) directly included in the Parcels codebase?

- Throughout the paper, Microplastics is abbreviated as MP, which is fine. However, for the figure captions it might be useful to be explicit, as figures are sometimes used/read out of direct context of the paper.

- Figure 7: Could also comment here that scale is logarithmic.

- Page 14, line 14: please give the Ifremer FTP address (or refer to the data availability section at the end)

- Page 15, line 9: “consisting at” -> “consisting of”.

- Page 16, line 4: could specify that 1/4 degree is longitude, and 1/8 degree is latitude.

- Page 16m line 12: “even if this” -> “even if the”

- The North West shelf reanalysis is referred to as “CMEMS”. However, CMEMS provides a lot of different data, also including NEMO. Thus I would recommend using a more specific reference, such as e.g. “NWS”.

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