

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

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### **Summary**

The paper describes the new version of Parcels, v2.0. The new version includes new interpolation schemes for tracing particles which allow for various vertical coordinates and staggered grids. As the paper presents these new and necessary features of Parcels I recommend it should be published, but only after some re-working of the text and also using a 3D test case rather than a 2D case.

### **Major comments**

C1

The authors spend quite some time deriving and explaining the new interpolation schemes for z and s coordinates on staggered grids, which is a new feature of Parcels. I'm therefore a bit puzzled that the showcase in the Results section is only for surface drift. I would strongly recommend the authors to change the showcase to some example with subsurface 3D flow, so that we can see the z or s coordinates in action.

The writing is in need of revising (see specific comments further down). In particular, I struggled with Page 6, Line 23 to Page 9 Line 20, which did not flow well and was at times confusing. This section needs a bit of re-writing and re-structuring. I also found Section 2.1.1 to be very abstract and I had to wait until Section 3 before the methods to be described in a more practical sense. I would strongly urge the authors to either put Section 3 directly after 2.1.1 or somehow merge the two sections so that the definitions of interpolation schemes are directly followed by how it is done in practice.

### **Minor overall comments**

On the large scale I find that the authors over-use the word "different" as a synonym for "various", and I often found that the word could simply be omitted to make the paper easier to read.

Parcels is referred to as being developed to meet the exa-scale challenge, when velocity fields and tracer fields become massive and traditional Lagrangian codes will struggle. However, none of the examples in the paper are what I would refer to as "very large data sets", and there are no results regarding Parcels run time, memory use etc. I would therefore change the focus a little bit and re-phrase the introduction and also throughout the paper to describe Parcels as flexible and user-friendly, which

C2

seems to be the big advantage of using Parcels, rather than focusing too much on computational efficiency.

### Specific comments

Page 1

Line 19: I would re-write to say "can, in turn, be used to analyse the global ocean dynamics given the flow field from the model." Followed by "The flow field can also be taken from observations, e.g. land-based measurement . . ."

Page 2:

Line 2: "and many other types", "etc."

Line 26: "We then validate . . ."

Line 29: "the results."

Page 5:

I'm wondering if Fig 2 is really necessary. The staggering of grids is also shown in Fig 3, and indices could also be added to Fig 3, thus making Fig 2 redundant.

Page 6:

Line 15: "in the cells, and interpolating"

Line 16: "formulation. For instance, such interpolation"

Line 18: While I enjoy citations, it is enough to just cite Jonsson et al. 2015 (the Tracmass code) and Doos et al 2017 (a thorough model description paper).

Line 23: If I understand this section correctly, you calculate fluxes on the cell faces, then interpolate fluxes to particle position, and then interpolate cell face area to the particle position, and divide flux by area to find velocity? The section starts by defining

C3

the velocity and ends by defining the Jacobian, which makes it a bit confusing for the reader to follow how velocities are interpolated from the model grid to the particle position. It would make more sense to start by defining the fluxes U,V, then how they are interpolated to the particle position, and then describe how velocities are found.

Line 24: "(Fig 2b). Velocities are not found by linear interpolation but, like in finite-volume schemes, they are approximated by linearly interpolating the fluxes (U0,U1,V0,V1) at the cell faces (fig 3b) and dividing by the cell face area."

Line 26: Should it be ". . . the velocity and any position (x,y) is derived as a function . . ."?

Page 7

Line 5: These are the velocities on the model grid? The section should end with an expression for how u,v are found. Line 9-11: The last two sentences seem out of place. Instead, you could add ", where indices are chosen to conform with the NEMO model (Madec et al)" on Page 6, Line 24.

Line 17:  $l$  is the model vertical index? Conforming with NEMO model?

Page 8:

Line 1: what is meant by "do not resolve exactly a uniform velocity"? Do you mean "do not result in a uniform velocity"

Line 6: remove "different"

Page 7:

Line 5: "and their respective fluxes are"

Line 6: I like this Table. Could you do the same thing for the 2D case and also add to Fig 3? It would be a lot shorter, but I think it could be informative.

Line 9-12: Replace with "We can compute the fluxes through grid faces [12,13,14,15] (in blue, Fig 4), [16,17,18,19] (in red), and [8,9,10,11] (in green) using the continuity equation. The flux through [12,13,14,15] is . . ."

C4

Line 13-14: Is this only for fixed  $z$  coordinates? In the case of  $z^*$  or  $\sigma$  coordinates, the cell thickness varies in time which must be taken into account. If the time-varying part is taken into account here, please explain how.

Line 16: What does the "+" superscript mean? What is the difference between  $U^+$  and  $U$ ?

Page 10:

Line 5: "four grid objects"

Line 13: "which should not be used for C-grids"

Line 16: "... describe the new objects which were added ..."

Line 27: "... regions, which may overlap or not ..."

Line 28: remove "different"

Line 29: "... order in which they ..."

Page 11:

Line 3: "... is the velocity given in ..."

Page 13

Line 5: "... transported through ..."

Line 10-13: "... studies have focused on marine litter in the southern part of the North Sea (Neumann) and have included diffusion and wind drift to their model as well as used a higher resolution."

Line 23: "NEMO-N006" is not a standard I am familiar with, at least it does not ship with NEMO v3.6. Are you referring to the ORCA0083-N006 simulation, which is similar to ORCA0083-N001 used by Grist et al 2014 and Kjellsson & Zanna 2017?

Line 26: "... at horizontal resolutions of nominally 1/4 and 1/12."

Line 26: What is the vertical coordinate used, i.e. which interpolation scheme is used here?

C5

Page 14

Line 7: Full disclosure: this is the reason why I'm often sceptical about CMEMS data for particle modelling. All data is interpolated from the model grid to some other grid and not necessarily in a conservative way. Could you say a few words here about how this interpolation was done by CMEMS. Would you get identical results if the CMEMS data came on the native C-grid from the NEMO model?

Line 9: "... data, which will be ..."

Line 10: Again, which vertical coordinate is used? Is this also interpolated by CMEMS?

Line 28-29: After "(Gutow 2018)": "Here we distinguish two flow types, the first based on NEMO and CMEMS data which has impermeable boundary conditions at the coast, and the second which includes Stokes drift and diffusion thus allowing beaching."

Page 15

Line 5: "... advection." Line 6: "... are run, where if the particle beaches, it stops moving."

Page 16

Line 5: what is meant by "travelled at least once by a cell"? That the cell has been visited by at least one particle?

Line 10: remove "different"

Line 15: "... no validation of mesoscale dispersion has been done for those simulations there ...". I am fairly sure Andrew C has done some validation (AMOC strength, AABW volume etc.), but probably not for particle dispersion near the grid scale.

Line 20-22: I don't fully understand this sentence. By "differences generated in the first year" you mean "within the first year we see more transport into the Kattegat and Skaggeak leaving fewer particles for transport along the Norwegian coast"? There are some differences along the Norwegian coast and Barents Sea (less deep blue

C6

regions for Fig 6c).

Line 27-28: "... how adding diffusion impacts the face of MP."

Line 28: "reduced by 68%" is in relation to NEMO 1/12?

Page 18

I don't understand the caption of the figure. Do you mean "fraction of particles visiting each different region at least once" or "for each grid cell, fraction of particles that have visited that grid cell".?

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Interactive comment on Geosci. Model Dev. Discuss., <https://doi.org/10.5194/gmd-2018-339>, 2019.