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Geoscientific Model Development Discussions

Interactive comment on "An updated interparcel mixing algorithm in the Lagrangian advection scheme with shape matrix (LASM) v0.2" *by* L. Dong et al.

Anonymous Referee #1

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Overall comments:

This manuscript concerns further testing and a mixing algorithm change in the LASM model. The LASM model is a fully Lagrangian model that has the advantage of resolving steep gradients in the flow. A price to pay in these models is that one needs to use an interparcel mixing algorithm when the density of parcels in an area becomes too large (and LASM needs a global mass fixer to map variables to a fixed grid!). These mixing algorithms involve some engineering and ad-hoc tuning. The authors present a new and improved mixing algorithm and test the LASM model using several idealized test cases; including one involving reactive species.

The main novelty of this manuscript is the new mixing algorithm. Although the authors do not spend much space on the reactive species test case, the reviewer believes that provides new and interesting insights into physics-dynamics coupling with Lagrangian models.

The reviewer believes the manuscript could be published in GMD after major revisions. In particular, the authors should investigate the physics-dynamics coupling issue in much more detail. If this becomes a major part of the manuscript, the title of manuscript could possibly be changed to include "physics-dynamics coupling with Lagrangian models" or similar. The interparcel mixing algorithm testing should be more comprehensive. In all, section 3 needs to undergo major revisions as it should carry the bulk of the novelty/insights of the manuscript.

Below is a list of major comments. Minor comments are, at this stage, left out. Please have the manuscript proof-read by a native English speaker.

Major comments

1. A "novelty" of the manuscript is the new interparcel mixing algorithm which is a crucial part of any fully Lagrangian model. These mixing algorithms require a degree of engineering and trial-error experiments. The author's state that the generation of excessively small-large parcels in the "barotropic" test case motivated the development of an improved algorithm.

First of all, please provide more details on Figure 1 and 2. The reviewer does not clearly see what the authors are trying to explain with these Figures.

Secondly, testing the mixing algorithm on just a few idealized test cases seems to lack robustness testing. Do these tests span flow conditions found in realistic full model simulations? Could one compare the mixing algorithms in established models with the mixing algorithm in this manuscript? Could one do a turbulent flow and look at energy spectra for the tracers or some other mixing diagnostic (e.g., entropy measure

as proposed in Lauritzen and Thuburn, 2011, QJRMS)?

The mixing algorithms have tunable parameters: what values would the authors settle on for “real-world” applications?

2. Chemistry-tracer (physics-dynamics) coupling - section 3 and Figure 6:

Doing physics-dynamics coupling on the parcel grid leads to a noise-free solution while performing the coupling on the static mesh results in noise in Cl and Cl2. First of all, please provide details on the mapping from tracer grid to the static grid (Dong et al., 2014) and inform the reader how the tendencies are mapped from the static lat-lon grid to the Lagrangian grid. In particular, what variables are mapped: the product between mixing ratio and density or just mixing ratio? Is tracer mass conserved in the process?

Thereafter the authors are kindly asked to investigate further why doing the coupling on the static mesh leads to a noisy solution. Obviously the mapping from Lagrangian parcel space to the static mesh (and vice versa) preserves linear relations (since Cly is conserved!). Is it the mapping from parcel grid to lat-lon grid that results in noise, is it the mapping of tendencies from lat-lon to parcel grid that introduces noise, or both? Does the mass-fixer introduce noise? Could it be the large resolution difference between parcel grid (in areas of convergence) and 1 degree lat-lon grid?

The reviewer would like to see a much more comprehensive analysis and discussion of the physics-dynamics issue since that is one of the cruxes of Lagrangian models.

3. Section 2.4: This section reads as an internal planning document and should not be part of a journal paper.

Interactive comment on Geosci. Model Dev. Discuss., 8, 761, 2015.