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Geoscientific Model Development Discussions

Interactive comment on "The Lagrangian analysis tool LAGRANTO – version 2.0" *by* M. Sprenger and H. Wernli

Anonymous Referee #3

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General comments

This article describes a new analysis tool building on an existing air mass trajectory model, LAGRANTO, that was originally written by one of the authors and has been used extensively by their group and other researchers worldwide. The various new aspects described embed the trajectory code within a diagnostic front end or user interface which itself has capabilities. A particularly innovative aspect is the ability to select trajectories iteratively using criteria that depend on the results of trajectory calculations (e.g., trajectories released from a certain geographic location, experiencing ascent greater than 600hPa and crossing the PV tropopause). Although trajectory calculations have been used in this way by many authors, the capability for other users to do such calculations efficiently is new. The functionality is powerful because the

standard output of the trajectory model can be used to restart trajectories at any timepoint, applying a range of selection criteria to identify a subset of trajectories for the next calculation.

As far as I can tell the trajectory model itself has not changed, so this article does not describe development of a model, but of a new user interface to an existing model. While there are novel aspects in the functionality of the tool, the article seemed much too long for describing them. It reads more like a mix of review and detailed user guide, rather than an exposition of new scientific development. I recommend a major revision to trim down to a more concise article focussing on the new capabilities and science opportunities offered by the new front end to LAGRANTO, and moving the syntax and instructions to a system user guide, which perhaps could be linked to in supplementary material. For example, Section 3.4 has some clever ideas but the paragraphs are full of script-based commands that interrupt the flow of the discussion and make the article difficult to read. I believe that the command language would be better described in systematic user guide documentation, rather than within text discussion.

Specific comments

1) l.10: Not all these models solve the trajectory equation (1) iteratively. They all solve it numerically and perhaps with sub-steps as in Runge-Kutta schemes, but these are not iterative.

2) Eqn(1): Important to note that u(x,t) since if the wind field were steady (time-independent) then the trajectories could be integrable using a streamline method.

3) l.13: It is also not true that these trajectory models all use data in pressure coordinates and integrate vertical position using omega. Some use alternative vertical velocities depending upon the input data level type.

4) In Section 3.1 it is mentioned that different vertical coordinates can be used within LAGRANTO including hybrid-pressure and isentropic coordinates. The second para-

graph in Section 3.1 appears to indicate that even if the input data is given on alternative vertical levels that LAGRANTO still integrates (1) in pressure coordinates using omega. Is this true, or does LAGRANTO v2 support the use of different vertical velocities, such as theta-dot (heating) in isentropic coordinates?

5) l.26: Although it may be true that LAGRANTO v2 offers the user a ready-made tool that can combine selection criteria and enable efficient calculation, it should be noted that the same calculations could be performed (and have been in the literature) using other existing trajectory models, perhaps with less user friendly methods of selecting trajectories.

6) Para 3, Intro: The review here misses the use of trajectory calculations in the stratosphere which was has been extensive since the 1980s. In particular, the long-time integration of trajectories was tested quantitatively using balloons in the MATCH experiment.

7) l.25: "to identify objectively"

8) end section 1: The authors state that "possibilities are further increased due to the novel features of LAGRANTO v2". However, I am not convinced that this is true. LAGRANTO v2 appears to make it easier for new investigators to conduct novel investigations along similar lines to those that have been published, but it seems to me that they could achieve this without the v2 front end if they had the required know how.

9) Section 2: The authors have chosen to develop a command line interface to LAGRANTO v2 which could work well with a script approach to designing experiments. However, I imagine that it would be possible instead to develop a widget/button driven user interface with the same functionality. This is the reason why I think the specifics of using the interface need to be in a separate user guide. However, the authors could comment on the rationale for the approach they have taken.

10) Section 3.1: "vertically de-staggered" is not a standard use of English. Suggest

re-wording and explaining a little.

11) Eqns (2)-(4): Although the scheme described here is the same as in LAGRANTO v1, it requires some justification. There are several other alterative numerical methods that would be higher order and therefore more accurate when the wind field is sufficiently smoothly varying. It is similar to the midpoint, or second order Runge-Kutta method. A key point with the basic (first order) forward scheme is that it is unstable even for simple flows such as circling around a steady vortex (trajectories spiral outwards). Is the LAGRANTO scheme stable (like the midpoint scheme)?

12) Section 3.3, l.15: It does seem a weakness that trajectories can cross below ground. This is avoided by design in some models by using the lower boundary condition on vertical velocity when interpolating velocity to particle locations. It is possible to do this in pressure or hybrid (eta) coordinates.

13) INPOLYGON: what does a "spherical polygon" mean? It seems like an inappropriate description to me since a sphere has only one curved face.

14) Section 4.4: For back trajectories it is also necessary to read the input wind records in reverse order as well as rotating the wind vectors by 180deg.

15) Figure 6 caption: "All panels . . ."

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