Comments on paper "A mass conserving and multi-tracer efficient transport scheme in the online integrated Enviro-HIRLAM model"

March 13, 2013

1 General comments

In this paper, a new conservative advection scheme for the multi-tracer transport problem is presented. The scheme is based on the locally mass conserving semi-Lagrangian method (LMCSL), it is shape preserving and computationally efficient. It has been developed and tested in the chemical-weather prediction model Enviro-HIRLAM.

The presented algorithms, backed by results on several test cases, are a useful contribution to existing methods and I believe that this work can be of value for the semi-Lagrangian modeling and chemical-weather community. Therefore my recommendation is to accept this paper for publication after some minor revisions have been made.

2 Specific comments

1. **Sections 4.1, 4.2**: can the authors improve the presentation of the ILMC filter, in particular can steps 4 and 6 be better explained avoiding the term "necessary"?

2. **Section 5.1**: According to the authors, it is not in the scope of this paper to validate the presented NWP hindcasts against observations. I think that validating the impact of LMCSL-3D, for example on extra-tropical geopotential height field observations, is a good way of testing if the mass-wind inconsistency mentioned in the paper has any systematic impact on the forecast and I would encourage the authors to do so. I suggest that if such results are available to include a summary otherwise you can leave it as future work.

3. **Section 5.2**: It would be interesting to discuss what is the local impact of LMCSL-3D on the plume. Fig. 5 gives only global information (plots a global budget diagnostic). Something similar to Fig. 6 would be desirable to reveal the "local" performance of the scheme. Two relevant issues:

   (a) Point sources are anomalous cases, hard tests for semi-Lagrangian schemes. Given how badly with respect to mass conservation the standard SL scheme performs I suppose that the conservative LMCSL-3D must be changing substantially the solution (extreme values of plume, shape, spread). How does the tracer field advected by LMCSL-3D compares with the same field advected by the standard non-conserving semi-Lagrangian? Is it possible to make a judgement (even qualitative) which states a preference between LMCSL-3D or the standard scheme when other factors beyond mass conservation are considered? For example, ignoring mass conservation, which simulation appears more accurate or realistic?

   (b) How does LMCSL-3D compares to the mass conserving global filters of section 5.3? Both approaches restore mass conservation but does the more local approach of LMCSL-3D has any advantage in this case?

4. **Section 5.3**: in this section DEPDEP is the benchmark or reference solution. I appreciate the virtues of DEPDEP, however, I think that this choice needs to be better explained. There is a hint in the caption of Fig. 2 but I would ask the authors to expand this slightly and include it in a more central part of the paper.

3 Spelling and other minor comments

1. In section 3, for the interests of clarity, in the second paragraph before equation (1) is introduced, please start with the continuous equation being discretized.

2. A few spelling mistakes:

   (a) p3738, 3rd line please change "requires" to "require".

   (b) same page, last sentence in paragraph after equation (2), last sentence, I think is better to change "and is only calculated once, and then reused ..." to "there are only calculated once and then re-used".

   (c) p. 3748 second paragraph before the end, change "has different impact" to "have different impact"

   (d) same page, please change "specie" to "species"

   (e) p. 3749 third line from the bottom, replace: "can bee seen" by "can be seen"

   (f) p. 3754 first line, please change "provides" to "provide".

   (g) p. 3766, Fig. 7 caption: fifth sentence appears incomplete and should be starting as "Fourth row: largest nehgative..."