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Interactive comment on "Pangolin v1.0, a conservative 2-D transport model for large scale parallel calculation" *by* A. Praga et al.

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Authors' Responses to Comments of Reviewer #1

Thank you very much for the valuable comments. We have considered each comment and taken actions to address them. Below are the details of our responses:

Order of the scheme

Based on theoretical considerations Pangolin should indeed be second-order accurate but in practice the numerical convergence order only shows a first-order accuracy. The

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loss of accuracy also blurs the difference between the unlimited version and the one with limiter. Compared to the other schemes, the decrease on the accuracy seems larger, but most of them use a larger stencil for derivative computations. To investigate this, we will study the impact of a larger stencil for both zonal and meridional gradient calculations. We will also study higher-order schemes for the computation of gradients and fluxes at the boundary of the cells. We expect to increase the order of accuracy but at the expense of computational efficiency.

Comparison to state-of-the-art schemes and scalability

Comparing the performances of two parallel models is no easy task as efficiency is highly dependent on both hardware and software. From a software point of view, compiler version and options, along with the various optimizations in the code –especially related to the memory– can have a large impact on the results. The only safe comparison would be to run the two models on the same machine, ideally with the third-party code developers. However, this would require a fair amount of work to port and tune the model, along with a close cooperation with the model developers. As such, it is out-of-scope for the present paper.
Nevertheless, reviewer 1 rightly points out that our statement on scalability was too strong due to the rather low number of cores used. We will follow his/her suggestion and continue the strong scaling study: the number of cores will increase for a fixed domain size until communication overhead become prominent. This will serve to determine the minimal number of unknowns per domain and will make comparison with other models easier. If deemed appropriate, references to the parallel performances of other models will be made.

Minor changes

These changes will be applied in the new version of the paper.

Authors' Responses to Comments of Reviewer #2

Comparison to other CTMs

According to reviewer 2, we claimed that the final version of Pangolin will be faster than current CTMs. No such statement can be found in the article, and if that conclusion can be deduced from the paper we will make it clear in the revised manuscript. Our objective is to obtain an efficient parallel model, but we do not claim that we have "the" solution. The goal of this paper is to present the current state of Pangolin, which contains an advection scheme and a specific grid to alleviate the pole issue and easily implement an efficient parallel model. We strive to explain why current results about accuracy and scalability are encouraging and justify further development for a fully-featured CTM.

Extension to a transport scheme and a full 3D model

Reviewer 2 is right to point out we only have only worked on a 2D advection model at the moment. This is of course a first step, but an important one since it is the dominant transport mode on the horizontal at large scale. Although the model is formulated on a specific horizontal grid and with an adapted domain decomposition, extension to 3D should not be more difficult than for any other CTM. Vertical advection will be treated in flux-form and will be adapted to the vertical coordinate used. Special care will have to be taken to insure that the winds are non-divergent at large scale (for instance using

GMDD
7, C1991–C1994, 2014

the so called "omega equation"), a difficulty encountered in all CTM that use external winds. Additional discussions on the steps required to extend Pangolin to a full 3D model will be included in the new version of the article.

Non-divergent winds

It is perfectly possible to use divergent winds in Pangolin since the preprocessing step of correcting the winds can be removed, although at the global scale, 3D atmospheric flows are considered incompressible. Since we do not expect to use Pangolin with divergent circulations, we have preferred to focus on the model performances on non-divergent test cases. As discussed above, we will need to carefully treat the problem of mass conservation and vertical velocities with the extension of Pangolin in 3D. In addition, transport by unresolved processes like convection and vertical diffusion will have to be also treated.

Comparison of parallel performances

We refer to the section *Comparaison to state-of-the-art schemes and scalability* given in the answer to the first reviewer.

Specific comments

The different improvements and clarifications asked by reviewer 2 will be addressed in the revised version of the paper.

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GMDD

7, C1991–C1994, 2014