Geosci. Model Dev. Discuss.,
doi:10.5194/gmd-2015-275-SC1, 2016

Geoscientific Model Development Discussions

Open Access

EGU

GMDD

Interactive comment

Interactive comment on "A High-order Staggered Finite-Element Vertical Discretization for Non-Hydrostatic Atmospheric Models" *by* J. E. Guerra and P. A. Ullrich

J. Guerra

jeguerra@ucdavis.edu

Received and published: 25 February 2016

Thank you Colin for your feedback. I would like to comment/reply to your points here:

1) You're absolutely correct here. Another review pointed this out and we will make the omission. Indeed, the solution fields depend on the basis and not on the local resolution due to node placement within an element. We have added "grid stretching" to our code recently in order to implement grid clustering correctly. This feature is currently being tested and is NOT included in the results for this paper.

2) We do cover this point in the validation section in the 6th assumption stated. However, we may repeat this in the introduction to make things clearer.

3) We do touch on the trade-off when increasing vertical order in a straight forward way. (Pg. 30, line 3) The code is undergoing an overhaul that includes improvements to the data structures, enabling vectorization, and improving parallelization. This is currently being tested.

4) We agree that "interfaces" is not optimal. However, it does serve its purpose and maps well to the nomenclature chosen for the interpolation and differentiation operators. We could use the acronyms "GLL" or "LGL" to refer to these locations.

5) Agreed.

6) We apply boundary conditions to kinematic variables only. No-flux conditions are used at the top and bottom boundary respectively.

7) We are still testing/researching various partitioning strategies so we have not settled on any one set where we can work on developing an appropriate preconditioner. However, our code does implement a direct solver on the generalized and diagonalized Jacobian (computed analytically or numerically). We settled on the GMRES without a preconditioner for this study to be consistent for all test cases, and because we observe that it is the most reliable solver.

8) This point may appear subtle, but arises from the vertical momentum equation in advective form as given in the text. Using the product rule you can write the transport term equivalently eliminating the vertical derivative of potential temperature. We call that "theta-flux" form and that corrects the issue in the Charney-Phillips configuration. A variational treatment of the equations involving integrals would also not suffer from this. We felt it necessary to include this observation because it is an example of staggering effects on the nonlinear equations as opposed to what is known for linear/wave dynamics.

9) A simple answer: we don't want to take 4 derivatives of a 3rd order polynomial to compute the hyperviscosity operator.

10) Correct and we will add language here to specify that this is true for nonlinear problems with advection, no explicit dissipation, and centered schemes.

Interactive comment on Geosci. Model Dev. Discuss., doi:10.5194/gmd-2015-275, 2016.

Printer-friendly version

Discussion paper