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Geoscientific Model Development Open Access Discussions

Interactive comment on "The spectral element method on variable resolution grids: evaluating grid sensitivity and resolution-aware numerical viscosity" *by* O. Guba et al.

Anonymous Referee #2

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The authors present a dissipation method for multi-resolution grids, based on hyperviscosity. It allows to run simulations seemlessly on meshes characterized by a transition between a high-resolution region and a low-resolution domain. The anisotropy of the elements is taken care of by using a tensor hyperviscosity formulation.

While the development of flexible resolution dynamical cores for geophysical models is progressing rapidly, it is important to focus on the ability of each model component to handle this variable resolution, and the tuning of the dissipation is one step towards this objective. While the idea of a tensor hyperviscosity formulation is not new, the present study clearly demonstrates the advantages of this method for multiscale geophysical simulations. In addition to showing that the tensor-based hyperviscosity is

better at handling transition zones, this study also demonstrates that the approach is less impacted by the quality of the mesh.

I have a concern with the simulations performed for the Williamson Test Case 5. For multi-resolution runs, the authors only compare simulations on the highly distorted grid using scalar hyperviscosity with simulations on the low connectivity mesh using tensor viscosity. This comparison does not allow to isolate the effect of the tensor hyperviscosity - which is the main idea of the paper - from the effect resulting from different mesh qualities. I think the authors should compare tensor and scalar hyperviscosity on the same mesh to isolate the effect of the hyperviscosity operator. Different meshes can be used to show that the tensor operator is less dependent to the grid quality, but only one parameter should be changed at once, to isolate the effect of the different parameters.

For this reason, I recommend the article to be published after minor revisions, mainly consisting in isolating the effect of tensor hyperviscosity on Williamson TC5. As well, several typos are present in the text, that would deserve an additional proofreading (some of them are mentioned in the specific comments).

Specific comments

- p4084, l23
  flow-depended → flow-dependent
- p4084, l3
  valance → valence
- p4086 l2
  "replaces $\nu\Delta^2$ by $(\nabla \cdot \tau\nabla)\Delta$"
  It seems to me that the last Δ should be removed.
- p4086, eq2-3 I agree with the first reviewer when he asks for a detailed derivation

of equations (2) and (3) from (1)
I do not understand how to do this derivation and, unless I miss something, equations (2) and (3) are not dimensionaly correct.

- p4092 l 3
  the x8 family have → has

- Figure 5, caption
  a closeups → a closeup

- p4092 l25
  This halo and is then → This halo is then

- p4094 line 12
  According to formula for → According to the formula for ??

- Figure 6
  This figure is too small. It is impossible to see anything or read the labels except by zooming on the pdf version.
  Please add the units in the small captions

- p4095 l14
  less noise the refined → less noise in the refined

- p4095 l16
  then → than

- p4095 l5
  solution from computed → solution computed

- p4095 l10
  and to tensor → and tensor

- Figure 10 The figures are quite small and colorbar labels difficult to read. The three captions are not correct: 10^6 should be replaced with 10^{-6}

- p4095 l6
  leads to slightly less error that is → is a word missing?

- p4086 l6
  The authors state that the loss of convergence is partly due to the uncertainty in the reference solution. This should not be the case if the reference solution has been computed using a sufficient resolution (which seems to be the case here, see p4098). Further, the convergence plots follow a quite straight line. If the loss of convergence was due to the reference solution, the model would converge normally up to a residual error. Then, the error would stagnate at this residual error.

Interactive comment on Geosci. Model Dev. Discuss., 7, 4081, 2014.