Second review of 'Configuration and Evaluation of a Global Unstructured Mesh Model based on the Variable-Resolution Approach'

I appreciate the updates to the manuscript the authors have made. It is greatly improved over the initial submission, both in terms of the scientific results as well as stylistic presentation. In particular, I think the model solutions look improved in the case of added explicit diffusion (in this case, hyperdiffusion), which also makes the simulations more comparable to other, more mature, variable-resolution (VR) approaches in literature. The more complete analysis of the tropical cyclone (TC) in mesh transition regions is also nice and verifies that the numerics perform adequately in the presence of a 'strong' forcing for weather and climate applications.

I have a few notes listed below that either should be addressed (or at least considered) by the authors, editor, and GMD proof staff before final publication. However, I consider these minor and they do not require additional model simulations or deep analysis (generally clarification, figure modification, etc.), so I recommend **publication in GMD following minor revisions**.

One note, the authors make reference to 'the initial preprint' quite a few times in addressing changes from the original GMDD submission. While I (and other reviewers) clearly understand what is meant here, it may be worth ensuring that GMD is OK with this presentation, as it will be referencing parts of the original submission not directly included in the final published manuscript that most will directly download/access.

Comments on scientific results

- Lines 83-84. '... can capture smoother cloud patterns and smoother mid-level jet structures...' this is a bit ambiguous since 'smoother' could also mean 'lower resolution.' I believe what the authors are trying to say here is that a continuous discretization in a unified VR model does not include explicit (artificial) lateral boundary condition discontinuities one would find in a traditional nested model living inside a global solution (e.g., WRF).

- Lines 156-157. These two sentences are a bit vague. I assume by 'generic and flexible' the authors imply that there is an interface/coupling layer that allows one to add parameterizations that are developed in isolation to the model (provided they return tendencies that match what is required by the dynamical core). If these two sentences are to be left in, I would add a bit more clarification.

- Sections 2.3.1 and 2.3.2. It is worth noting that since different forms of explicit diffusion are applied to both the uniform (UQ) and VR meshes for both Smagorinsky and hyperdiffusion likely lead to some of the differences seen in the comparisons of Figs. 5 and 7 [Jablonowski and Williamson, 2011]. Generally, for VR models diffusion is applied in a way such that the explicit diffusion in the cells in the coarse/fine regions match their UQ counterparts. Far from the transition, the design goal is for the local numerics of a QU/VR pair to be indistinguishable from one another (e.g., Zarzycki et al. [2014], Park et al. [2014]).

  While it is not critical to the results here, it needs to be mentioned here that the different choices of diffusion between QU and VR means that a true apples-to-apples comparison is impossible. For example, I suspect one reason for the slightly counterintuitive results in Figs. 5 and 7 (i.e., lines 364-394) is due to addition diffusion in the VR runs, which will slightly increase error relative to an less diffused (and well-posed) UQ simulation of equivalent coarse resolution.

- Lines 380-388. A counterargument to applying a perturbation in both hemispheres is that the lack of specified baroclinic development in the southern hemisphere allows for large wave number errors associated with grid imprinting to be more overtly realized in the test than it would be in a more complex simulation (e.g., wavenumber 4 imprinting associated with cubed-sphere corners or wavenumber 5 imprinting associated with pentagons in a hexagonal mesh, as in Fig. S3a).

- Lines 508-515. It is worth noting that the environment in the Reed and Jablonowski TC is conditionally unstable, and therefore some of this noise is almost inevitably going to arise as horizontal gravity waves, etc. induce resolved-scale overturning in the formerly quiescent atmosphere. So while turning up hyperdiffusion can suppress these 'far-field' gridpoint storms, it is unclear whether that is a truly desirable outcome. One could imagine a case where a developer tunes a diffusive operator to eliminate these instabilities, but this results in an overdiffusive configuration for real-world convection in the deep tropics.

Considerations regarding figures and tables

- I would actually move Tables S1 and S2 into the body of the main manuscript and reference accordingly. I referred to these particularly frequently when cross-validating the VR acronyms, and anything that requires more than a single reference probably should be in the primary manuscript. Perhaps Table 1 can be moved to supplemental since it is implicitly referenced in the last two columns of Tables S1/S2.
- There are continental outlines in most of the figures, although all simulations are done in the absense of land models (and without any zonal asymmetries). I would add a small disclaimer when describing Fig. 1 or Fig. 3 that all outlines are only showed for spatial reference and do not represent land masses/surface forcing in the simulations.
- I would zoom in on the TC in Fig. 13 as the results described in the text are nearly impossible to see.
- Fig. 8 has a small kink in the 28 km contour (towards the southeast quadrant). I actually assume this is due to the small natural imperfections in a spherical tessellation (e.g., pentagons) but it may be worth noting in the manuscript that that contour isn't in error.

Typographical errors and grammar

This list is not meant to be exhaustive, but rather, a few obvious catches I noted while reading.

- Line 85. 'Based on a VR configuration...'
- Line 110. '... coupling) are in Z20 and Z19.'
- Line 118. '... that is, using a staggered finite-volume...'
- Line 160. '... study, the suite of Reed and Jablonowski...'
- Line 174. Splitting is a relatively niche subject, would reference something like Gross et al. [2018] for readers that would like additional detail.
- Line 306. '... examine the ability to resolve fine-scale ...'
- Lines 336-337. 'For G5B3X4,...'
- Line 376. '... or Gaussian grid were predominant.'
- Line 469. '... looks smooth and...'
- Line 530. '... with more realistic weather...'

References

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