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Interactive comment on "DCMIP2016: A Review of Non-hydrostatic Dynamical Core Design and Intercomparison of Participating Models" *by* Paul A. Ullrich et al.

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This paper gives an overview of the models that participated in the DCMIP2016 workshop on dynamical core intercomparisons. By itself the paper provides a useful reference on the current state of the art in regards to dynamical core development, highlighting the wide range of choices that have been made by modeling groups across the globe as well as highlighting some of the choices, such as equation sets, used in dynamical core design. As noted by the authors this paper is the first of an envisioned sequence detailing the models and their performance on a number of idealized test cases and it will be interesting to observe how the sequence develops and what can

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be learned from the intercomparison.

It is some achievement to condense the wealth of information needed to describe a range of modeling issues into one concise paper and the authors should be applauded for succeeding in such a difficult task. The paper is well written and provides a useful source of information to model developers and is therefore suitable for publication after a number of minor issues are dealt with.

Main Comments

1. The main issue that should be corrected in this paper is that not all of the models are covered in each of sections 3-7 describing aspects of the model formulations. This could be due a desire not to replicate information (if models share the same governing equations etc) but I think it would be useful if the reader could find the appropriate model description in each of sections 3-7. In detail I suggest:

    - Section 5 lists the equation sets used by each model but is missing the CSU, MPAS and NICAM models. It would be useful for the reader to add brief sections for these models, or if they are the same as some of the other models to combine them into the appropriate subsection.
    - Section 6 describes the diffusion mechanisms in each model but omits the CSU, DYNAMICO, FVM, MPAS and NICAM models. Since table 5 indicates these models to have explicit diffusion mechanisms then it would be good to add subsections for the missing models, or where appropriate combine them, e.g. CSU and DYNAMICO both use 4th order hyperviscosity which is covered in subsection 6.1 on ACME-A and so these models could be combined into a single section.
    - Related to the previous point the methods of diffusion & stabilization in table 5 and section 6 are somewhat different, for example some model subsec-

tions describe using sponge layers (FV3, ICON) but these are not listed in table 5 and the same applies to monotonic limiting for some models. Is it the case that table 5 only lists the principle methods of stabilization and diffusion? In which case I suggest adding words to this effect in the caption. I appreciate that it is beyond the scope of this paper to list in detail all the methods of stabilization and diffusion applied in all the models, maybe some words in the introduction to section 6 indicating that this section only covers the principle diffusion methods used?

- Section 6 lists the temporal discretization methods used but omits the methods used by the ACME-A, CSU and NICAM models, it would be useful it the methods used by these models was indicated in this section.

2. Section 2 gives a brief description of each model and as noted in the author contributions these are provided by the modeling teams themselves, however this has led to a rather uneven section where the model descriptions provide differing levels of detail. I think this section could use some editorial input to unify the descriptions. Based upon the sections for the rest of the paper I would like to be able to ascertain the following properties for each model from this section: equation set, horizontal grid and discretization, vertical grid and discretization, temporal discretization, principal diffusion and stabilization mechanisms and transport scheme. Only a couple of words to a sentence are needed and much of this information can be found in tables 2-5 but i think it would help readability to unify this description section.

3. The paper does a very good job of describing the key features of a wide range of models, however I would have been interested in seeing a specific section detailing the transport schemes used by the models in a similar fashion to Sections 3-7 (and including the information in table 2 if possible). However in order to avoid over lengthening the paper I suggest this could be covered to some extent by the descriptions in section 2. This would require details of the transport schemes

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used by ACME-A, OLAM and TEMPEST to be mentioned in the appropriate sub-sections of section 2.

Minor Comments

1. Table 1: Φ, $\delta\Phi$, $\dot{\zeta}$ and θ' are missing entries but listed in the prognostic variables of table 3.
2. The DCMIP2016 website lists HOMME, UZIM and NEPTUNE (NEP) as models taking part, I assume that HOMME is ACME-A, UZIM is CSU, if I'm mistaken then could these models be added?. Is there a reason NEPTUNE is not included in this paper?
3. Section 2.3: If Dubos and Dubery has been submitted this reference could be updated.
4. Section 2.7 'Icosahedral' should be 'ICOsahedral' in the subsection title to match the format of other model names.
5. Section 3.5, last line: Is it possible that the CCVT method produces polygons with less than 5 sides? If so this should be mentioned.
6. Section 3.7 last line. I don't think it is entirely correct that GEM uses two regional climate models on the patches of the YinYang grid. Qaddouri 2011 States that the numerics come from the original GEM latlong model which is used for medium range weather forecasts. I suggest changing this to "utilizing a pair of local area models based with the numerics from the GEM latitude-longitude model". If the GEM modeling team feel the current description is accurate then I am happy for it to be left as is.

7. Page 16, Line 8. The A-grid collocates all scalar and velocity components. To avoid confusion with the B- and E-grid (which only collocate velocity components) I suggest changing “co-location of all velocity components” to “co-location of all velocity components and scalar fields”.

8. Page 16 Line 9: To be consistent with the descriptions of the other grids I would add “which co-locates the vorticity, divergence and buoyancy variable.” after “and the Z-grid”.

9. Page 16 Line 14: There is a mix up of dimensionality of the mesh objects here, for a 3D mesh the C-grid stores velocities on faces not edges. I would suggest saying “as long as the number of horizontal faces is twice the number of volumes”.

10. Page 16 Lines 1 and 14-15: The maximum stable timestep size (if it exists) is given by a combination of factors such as the time scheme, horizontal and vertical discretization, grid staggering and waves supported in the equation set. The comments in this section give the reader the impression that staggering is the most important (or only) factor. I suggest that “for explicit timestepping schemes” is added after “timestep size” on line 1 and that the text on lines 14-15 from “but also” to the semi-colon is removed since I believe this statement is only true for a given choice of horizontal discretization (2nd order fd?) and defined explicit timestepping schemes.

11. Page 16 Line 18: In general I think it is a Poisson problem that needs to be solved for the z-grid rather than the more general Helmholtz problem.

12. Page 28 Line 14: Could a citation (at least title and authors) be given for this paper if it is under review.

Typos

1. Page 3 Line 12 “provide” -> “provides”
2. Page 20 Line 16 Missing “are” after “employed”
3. Page 33 Line 3 “is given” -> “are given”