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Interactive Comment

Interactive comment on "Using the UM dynamical cores to reproduce idealised 3-D flows" *by* N. J. Mayne et al.

P.A.U. Ullrich (Referee)

paullrich@ucdavis.edu

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1 General Comments

The manuscript "Using the UM dynamical cores to reproduce idealized 3-D flows" by Mayne et al. examines the UM dynamical cores in light of test cases of intermediate complexity: That is, tests which require multi-year integration times and are used to determine the temporally-averaged statistical behavior of a model. Three such tests are performed, including the Held-Suarez test, an Earth-like planet with realistic stratosphere and a tidally locked Earth-like world. The differences between UM dynamical cores are assessed in light of these experiments, and differences between New Dynamics (ND) and ENDGame (EG) dynamics are identified. Although the paper reads

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very much like a technical document and does not contain any particularly surprising results, overall it is an interesting read and is an important addition to the literature for verification of model correctness and consistency.

2 Specific Comments

1. On page 3684 the author states that the Held-Suarez test is useful for increasing confidence in the predictions of GCMs. There are two main complaints about the Held-Suarez test that should be taken in consideration: (1) most atmospheric models produce almost identical results for this test and (2) the lack of a reference solution or list of known invariant quantities prevents verification of model results (so it is unclear if a given model is actually producing a correct result). Although this last point is (briefly) addressed in the last sentence of section 3.5, it is likely worthwhile to make it earlier in the paper (and in more detail) so as to confront this criticism more directly.

2. Also on Page 3684: How would a short-term test of intermediate complexity, such as Reed and Jablonowski (2011) fit into this framework? [Reed, Kevin A., and Christiane Jablonowski. "An analytic vortex initialization technique for idealized tropical cyclone studies in AGCMs." Monthly Weather Review 139.2 (2011): 689-710.]

3. On page 3691 the authors state "There has also been a change in the spatial discretization such that the meridional velocity is defined at the pole." Strictly speaking the concept of a “meridional velocity” is undefined at the pole, since it would be multi-valued depending on the choice of longitude. Can the author clarify this point?

4. On page 3693 the authors define the temperature shift as a “slow” physical pro-

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cess. Presumably this has some meaning in the context of the dynamical core (ie. it is a process which is applied outside of the iterative cycle) that should be included.

5. Some additional details would be desirable for the dry static adjustment. Further, this process is not a component of the standard Held-Suarez test; so do the authors anticipate it will affect the results?

6. Page 3694: "The literature sources ... all used GCMs which adopt pressure or σ as their vertical coordinate, .. whereas the UM is height-based." Side note: The MCore model utilizes a height-based coordinate presents results for a Held-Suarez simulation [Ullrich, P.A. and C. Jablonowski (2012) "MCore: A nonhydrostatic atmospheric dynamical core utilizing high-order finite-volume methods." J. Comp. Phys., Volume 231, Issue 15, pp. 5078–5108, DOI: 10.1016/j.jcp.2012.04.024]

7. Page 3702: It appears that the zonal jet experiences a meridional shift between the ND and EG dynamical cores (apparent in Figure 9, bottom panel). In particular, EG seems to lead to a zonal jet which is slightly closer to the poles. Is this also responsible for the shift present in Figure 11? Please provide some additional discussion of this point.

8. Page 3705: I disagree that Fig. 13 (EG) agrees qualitatively with the Heng et al. (2011b) results. The temperature field for EG is quite noisy, and there is clear disagreement at sigma = 0.525. Similarly ND seems to be more consistent with Heng et al. (2011b) than EG in Fig. 15, sigma = 0.525. These results are discussed in some detail on page 3706-3707 in contradiction to this earlier statement.

9. Page 3705: What qualifies consistency to be "excellent"?

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10. Throughout: A common criticism of the atmospheric science literature is that results are typically only compared in the "eyeball norm" in order to verify consistency. Is there any way to provide quantitative measures of agreement/disagreement in this text?

3 Technical Comments

1. Equation (6) and (7): Please show that τ_{rad} and τ_{fric} are a function of spatial position (latitude + pressure?)
2. Figure 16: Is there a reason the results from ND aren't shown in this plot?
3. Figure 21: There seems to be a plotting error at phi = 90.

Interactive comment on Geosci. Model Dev. Discuss., 6, 3681, 2013.