Review of MWR-D-11-00132

Sensitivity and Interpretation of Zonal Mean Climate from Two Atmospheric General Circulation Models with Different Dynamical Cores

In this paper the authors have made use of NCEP reanalysis data, Held-Suarez tests and aqua planet simulations to compare two atmospheric general circulation models with different dynamical cores. The intercomparison yields several interesting results regarding the underlying numerics of these models, which are of definite scientific significance. However, although I generally like the topic as covered by these authors, I believe that significant cleanup is necessary in order to bring this manuscript up to publication standards.

1 Broad Comments

1. For English readers, there does not seem to be readily available resources describing the IAP dynamical core. In section 2, a very brief overview of some of the features and numerics of the IAP model is given, but it is significantly lacking for somebody with the aim of understanding the source of the extra diffusion which is described later. I suggest cleaning up this section and adding a more thorough model description. If there is enough room, a side-by-side comparison of IAP and CAM would be desirable.

2. The intercomparison between dynamical cores described in this paper is largely qualitative, based on supposed outliers in observed fields. For instance, explain terms such as "grossly similar" (page 8). It may be desirable to quantify these differences via some sort of statistical measure, hence giving the reader an idea of the *statistically significant* differences between these two models.

2 Specific Comments

3. With regards to the usage of CAM3.1 in IAP: Do you use the identical tuning constants within the two models, or is CAM3.1 physics retuned to provide more consistent results with IAP?

4. Page 4, bottom: In section 2, please explain whether IAP uses a conservative finite-difference formulation of the primitive equations or if it relies on mass / energy fixers.

5. Page 5, second paragraph: You state the subtraction of a stratified background is a unique feature of the IAP dynamical core. However, a hydrostatic background state is used in several other models including, for instance, NICAM (Tomita and Satoh, 2004) and in the mesoscale models of Giraldo and Restelli (2008).

6. Page 5, second paragraph: Please explain the "nonlinear iterative time integration method." Also, what do you mean by "internal consistence according to physical laws"? What is a "flexible leaping-point scheme"? Do you mean a leap-frog timestep scheme?

If so, please explain why this is flexible. This whole paragraph is largely unreadable and needs to be cleaned up.

7. Page 5, bottom: You state that the model uses the same initial conditions. Presumably there would be differences in the initialization due to the different model treatments, i.e. since IAP is a grid point model versus CAM3.1's spectral truncation that may result in statistically insignificant differences between the two models. Can you comment on this briefly?

8. Page 10, bottom of page: Aqua-planet experiments do not have topography, so how can the treatment of the surface topography impact the results of these models? Do you mean the boundary layer treatment?

9. Page 18, top of page: You have stated that the IAP model is both energy conservative and more diffusive than the CAM-EUL model. Presumably any form of diffusion in the model would lead to destruction of kinetic energy – please explain how IAP maintains the energy balance assuming that the diffusion is more significant.

3 Technical Comments

1. Page 3, top: add "the" before "Chinese Academy of Sciences"

2. Page 3, top: add "the" before "1980's"

3. Page 3, line 15: change "of" to "modeled by"

4. Page 4, line 6: "opposite sensitivities" should be "opposing sensitivity"

5. Page 4, bottom: please provide a reference for Arakawa's C grid staggering

6. Page 4, bottom: change "the vertical levels 26" to "26 vertical levels"

7. Page 5, top: change "128 grids" and "256 grids" to "128 grid points" and "256 grid points", respectively

8. Page 5, line 19: change "of simulations in" to "of the simulations over"

9. Page 6, line 8: explain the acronym "AMWG"

10. Page 8, line 19: change "observation in the" to "observations of the"

11. Page 9, line 15: change "feature" to "features" and "atmosphere is" to "atmosphere are"

12. Page 11, last line: change "weaker poleward" to "weaker poleward transport"

13. Page 16, line 4: change "low troposphere" to "lower troposphere"

14. Figures 1–9: change "counter intervals" to "contour intervals"

4 References

Tomita, H., and M. Satoh (2004), A new dynamical framework of nonhydrostatic global model using the icosahedral grid, Fluid Dynamics Research, 34(6), 357 400, doi:10.1016/j.fluiddyn.2004.03.003.

Giraldo, F. X., and M. Restelli (2008), A study of spectral element and discontinuous Galerkin methods for the Navier Stokes equations in nonhydrostatic mesoscale atmospheric modeling: Equation sets and test cases, Journal of Computational Physics, 227, 38493877, doi:10.1016/j.jcp.2007.12.009.