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Geoscientific Model Development Discussions

Interactive comment on "The CSIRO Mk3L climate system model version 1.0 – Part 1: Description and evaluation" *by* S. J. Phipps et al.

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This is a clear and concise manuscript which thoroughly describes a low resolution coupled AO-GCM. I found the manuscript easy to follow, the model well described and the evaluation well laid out.

As a general comment, I would have liked to see some discussion of how this model's sensitivity compares with the parent GCM. The evaluation of the steady state shows good performance of the low-resolution model. But how does its climate response (transient and/or equilibrium) compare with the high-resolution version? It is a key question to know have the changes required to enable a low resolution version affected the CHANGES you would see in a climate change experiment. See, for example, Jones et al (2005, Clim. Dyn.) on the tuning of the FAMOUS low-resolution model to see that

the climate sensitivity can vary markedly during the tuning/calibration phase.

I also wonder why you choose to do a pre-industrial simulation and evaluate against present day observations. You note in several places that the comparison may not be valid due to the different periods. So why not do a present day simulation and compare with present day observations? Clearly this isn't perfect either as the real present-day state is not in steady state with the forcing, but this will be a smaller error than a pre-industrial vs present day comparison. Especially when evaluating the atmosphere model with prescribed present day SSTs (as per an AMIP experiment) then this should make a very good comparison... In fact, given the speed of the model you could run the full 20th century in 2 days and do a really nice model-obs evaluation... This would strengthen your comparison considerably.

I would also like a bit more in-depth discussion/opinion on some of the things you find. The presentation of the "what" is well done, but you could add more of the "so what". e.g you have a temperature drift of 0.015 K/century, which sounds small, but a sea-ice drift of +30% in the southern hemisphere. What does this mean for a user? What would this mean if you wanted to run a glacial-inter glacial transition? Would it be serious?

I have only read the supplementary material briefly, but found no problems with it. As far as I could tell any questions I could think of I would have been able to find an answer. I recommend publication after addressing these and a few more minor issues listed below.

Chris Jones.

1. p.221, lines 2-5. Strictly it would be better to cite CMIP3 and CMIP2 activities, rather than IPCC AR4 and TAR reports.

2. p.221. Would be useful to explicitly name the models you compare to here – e.g. for the Hadley Centre GCM, the high-resolution parent model is HadCM3, the low-resolution version is FAMOUS. (Note, better to cite Jones et al., 2005, Clim. Dyn.

which is the published peer-reviewed version of the technical note you cite as Jones et al. 2004).

3. p.225, line 12. Here, and occasionally at other points you mention observed quantities (here sea-ice). But these won't be available for you target simulation periods? So can you clarify how you spin-up palaeo climate simulations without the required observed SSTs/sea-ice?

4. p.226, line 1. do you really have a dynamic vegetation model here? (in which case some evaluation of the simulated vegetation is required). Or by "seasonally varying vegetation fractions" do you mean leaf-area-index?

5. p.229. Line 17-22. can you explain why coupled and offline runs require different ocean timestepping? Is this a time-saving measure? Why need 20 minutes in standalone but 1 hour coupled?

6. p.231, lines 15-21. you list the quantities passed from atmos to ocean. What about radiation. Is that included somehow in your heatflux? Is there any penetration of light into the surface ocean?

7. p.231, lines 25-27. It would help me (a non-expert in various techniques of flux adjustments) to explain more fully what you mean by the term flux-adjustments. My previous use of these has involved a two step process of relaxing the ocean SSTs and salinity to a climatology, and then diagnosing the fluxes required to do this and to apply these subsequently to counter any climate drift. It seems here your technique is subtly different, involving corrections to both fluxes and state variables – is that right?

8. p.233, line 26. You quote 60% and 85% of earth surface agreeing with obs. But given you prescribe SSTs and they cover 2/3 of the world is this really a good fraction? Can you rather quote the fraction of land/ocean area that agrees (i.e. mask out the areas you fix!)

9. p.235. Line 18. You mention pre-industrial GHGs – what other GHGs than CO2

do you use? Can you list all of the input radiative forcings this model requires? What about aerosols? And other natural forcings (volcanoes, solar, orbital??)

10. p.235. Line 20. you discuss problems are particularly bad near the tropopause. How do you define the tropopause here? We found problems with FAMOUS because the prescribed ozone concentration was not well enough resolved vertically to capture the tropopause and we would occasionally get stratospheric ozone concentrations in the troposphere. You might want to check how you prescribe ozone around the tropopause level – as this may be a source of your errors.

11. p.237. When discussing sea-ice can you give a bit more discussion? You dedicate 4 figures to sea-ice so you should dedicate more text I think. e.g. you appear to have a too small seasonal cycle of NH extent, but too big seasonal cycle in ice volume. Is this realistic? Does it mean you preferentially grow ice downwards instead of outwards?

12. section 5. can you describe what aspects of the World Ocean Atlas temperatures you use? What date? Do you impose a seasonal cycle? What time resolution? Don't assume the reader is familiar with what's in this dataset.

13. sec.6. You run for 4000 years and then assess the years 200-1200. Why not use the full run? Why analyse so close to the beginning?

14. p.242. You're right that spatial resolution makes it harder to simulate dynamical features such as ENSO. Can you comment on implications of this? e.g. does it limit the uses of such a model? It may not be an important feature of millennial scale simulations, but you couldn't use this model for seasonal forecasting for example... what other restrictions should a potential model user know about?

15. p.244, sec 6.2.2. the southern hemisphere sea ice expands by about 30% - this sounds relatively serious. Can you expand on why this is and comment on whether this prevents the use of the model on any timescales? Is this just a spin-up issue? Have you tried asynchronous spin-up techniques?

16. sec 6.2.4. Is this trend in ACC linked to the sea-ice? Can you comment maybe if one might drive the other?

17. sec 6.2.5. summary – last line. When you say "more realistic sea ice" - I think you mean "more fully spun-up"? Or do you really mean that your initial state is not close to reality?

18. p.247, line 17. you say flux corrections are "inherently undesirable" - what happens when you run without them? Have you tried developing a non-flux adjusted version? When we developed FAMOUS we found a simple change to the north Atlantic bathymetry (removing Iceland) was sufficient to allow better northward heat transport and allow us to run without flux corrections. You may find if you try it that only relatively small changes are required for Mk3L also.

19. p.247 last line, "whole new class of scientific questions"... such as what? Can you suggest what you would use such a model for?

20. more generally, one key aspect of reduced resolution models is the concept of "traceability" - to enable not just science with the model, but to help guide use and development of the higher resolution counterpart. Can you comment on the relationship between Mk3L and CSIRO state-of-the-art high res models (e.g. those being used in CMIP5)? Are they related? What are the differences in resolution, speed, process complexity, performance etc...

21. I notice in figure 1 you have Iceland in the atmosphere model – but in the text you say you don't have it in the ocean model. How does the coupling deal with these mismatches between components?

22. if palaeo runs are your motivation presumably you want to regularly change the models coast line/sea-level etc. Is this easily done?

Interactive comment on Geosci. Model Dev. Discuss., 4, 219, 2011.