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Geoscientific
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Discussions

Interactive comment on "The CSIRO Mk3L climate system model version 1.0 – Part 2: Response to external forcings" *by* S. J. Phipps et al.

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Review of Phipps et al., "The CSIRO Mk3L climate system model version 1.0 – Part 2: Response to external forcings"

This is a well written and clear manuscript which documents the response of the CSIRO Mk3L model to various external climate forcings, from realistic, historical forcings that can be compared with observational evidence to stronger idealised forcing that can be compared with other climate models under similar scenarios. The paper is a follow-on from Part 1 which documented the model set-up itself and spin-up and control performance.

The paper clearly achieves its objectives of showing that Mk3L model broadly captures

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the key features of observed climate changes in response to various past external forcings, and also that it's future projections are likely to be compatible with other (much more computationally expensive) GCMs.

My only main recommendation would be to better understand how the model can simultaneously have a low TCR and a high ECS. Both values are shown to be within previous GCM ranges, but it seems strange to be at the high end in one and the low end in the other. The two are not independent and are generally related (see AR4 ch. 8) – so what are the causes and implications of this? We found with FAMOUS (Jones et al 2006) very strong sensitivity of ECS to tuning parameters – have you investigated if this is true with Mk3L too and whether this jointly affects TCR and ECS? It would be valuable to know the reasons behind what affects the sensitivity.

Aside from this I have just a few minor corrections/clarifications as listed below.

Chris Jones

1. Although technical details of the model are comprehensively covered in "Part 1" of this pair of papers, it might be useful for the reader to recap briefly in the intro on the relative timings/performance of Mk3L and how to obtain it for general use. (e.g. something like "Mk3L can run 1000 model years in just X days on a XXX capability PC...")

2. it seems a shame that non-CO2 GHGs cannot be explicitly included and must be rolled into a single Co2-equivalent value (page 3370). Are there any plans to do so? Although probably valid for radiative forcing, treatment of CO2 and non-CO2 GHGs separately would allow one to explore non radiative effects of CO2 (such as on plant productivity or ocean acidification), but this would be hampered if other GHGs such as methane were included in the CO2 values used by the model. Although not yet a carbon-cycle GCM, can you comment if this is planned for a future version?

3. p. 3375 – why not increase the CO2 back to 280 during this period? Surely you

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want to finish at your pre-industrial forcing state?

4. In section 3, you present compelling arguments that the acceleration technique does not significantly affect the surface climate – but what about components with longer timescales? Presumably ocean heat content for example differs when a very large acceleration is used? Can you show how this differs and discuss how important this might be for analysis?

5. Section 4 – Last Millennium. Can you outline if there are any differences between your experimental design and the CMIP5 protocol?

6. p.3383 – you say anthropogenic aerosols can't be included – but you could fold these into your CO2e value as you have done with other GHGs? Clearly this wouldn't be precise, but better than neglecting them entirely. As you comment later, omitting them leads to too much warming.

7. p.3383, why use the control state to initialise the last millennium run when you have a transient 6k run – would this not be better suited?

8. Is M2009 the best dataset for model evaluation over the instrumental period? How does it compare with other datasets?

9. p.3393 – you mention differences between methodology (slab model versus running coupled model to equilibrium) – but having a fast model like Mk3L would allow you to test techniques such as the Gregory method (2004, J. Clim: sudden 4xCO2 step change – see CMIP5 simulation protocol) for diagnosing ECS in a coupled model. You could asses how well this technique gets the final equilibrium sensitivity.

10. Sec 5.6 – can you explain the mechanism of changes in deep water formation? Are they driven by SST changes to stratification, or changes in freshwater input? This section should include discussion of recent work that shows how stability (and reversibility) of Atlantic overturning depends on freshwater transport into the basin. See Hawkins et al, (2011, GRL) and Drijfhout et al. (2010 Clim. Dyn.)

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11. There is a recommendation for IPCC AR5 draft chapters to use map projections beginning at 190W for land or 20E for ocean quantities. You might find this a good practice to adopt.

12. Fig 15 – can you order your panels consistent with other figures? (a,b on top, c, d below)

Interactive comment on Geosci. Model Dev. Discuss., 4, 3363, 2011.