

Interactive
Comment

Interactive comment on “Emulating IPCC AR4 atmosphere-ocean and carbon cycle models for projecting global-mean, hemispheric and land/ocean temperatures: MAGICC 6.0” by M. Meinshausen et al.

Anonymous Referee #3

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The authors present a new/updated version of the simple climate model MAGICC. Simple climate models are a convenient tool to assess the climate's response to different emission scenarios. As such, an earlier version of MAGICC has been used in the IPCC's fourth assessment report.

In my opinion the further development of simple climate models is an important task for the scientific community, as emulations are used to determine the possible outcome of changes in climate policies.

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This is an important paper as it highlights the problems associated with emulations in general and discusses the reasons for shortcomings in previous emulations. I have used simple climate models frequently in the past and it is both interesting and frightening to see how they perform in emulations. I have no problems with the general contents of the paper.

However, having said that, I have two main concerns which should be addressed in a revised version:

1. A lot of work has been done and I can understand the temptation to cover all of it in great length and detail. However, in its current version the paper is far too long. I would suggest either cutting the paper down substantially or, alternatively, split it in two, with one part dealing with the mere technicalities of the improved model (e.g., in the form of a technical note), and the other part dealing with applications of the model. In its present form the main point of the paper, which is IMHO the emulation of different scenarios, gets somehow lost.

2. Quite a substantial part of the paper is written in a rather imprecise and vague, at times even rather unscientific language, which unfortunately tends to disguise the quality of the (huge amount of) work done.

To quote just one example (p. 6157): "In summary, imperfect knowledge with regard to the forcings in CMIP AGCMs leads to ambiguities as to whether differences in their climate responses are due to different climate responses or ..."

I suggest a careful review of the whole text and general tightening up of the paper. Especially the use of "climate response" and "climate feedback" should be carefully checked. Such a revision will most probably also cut down the length of the paper substantially.

Specific comments:

p. 6156, l. 9: "structurally different"; different AOGCMs use different parametrisations;

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"structure" is IMHO not the right word to use in this context

p. 6156, l. 16 and following: "parameterisation" is a word that should feature in this paragraph

p. 6156, l. 17 "what key processes should be included and how they should be modelled." rather prosaic

p. 6156, l. 21 "In practice, a strict separation between these two types of uncertainties is not possible." Why not?

p. 6158, l. 1 "to separate radiative forcing and climate response uncertainties in AOGCMs"; please clarify

p. 6158, l. 9 "coupled responses" do you mean the response of coupled models?

p. 6164, l. 6 "for contributions from black carbon" contributions to what?

p. 6174, l. 25 "the procedure minimises the weighted least squares" weighted with what?

p. 6176, l. 17 This is an interesting comparison!

p. 6178, l. 23 "RMSE of 0.46" Is this value unchanged from the value you got for calibration method I?

p. 6179, l. 28 "had the same physics (i.e., the same climate sensitivity, ocean mixing, etc.)" One of those imprecisions. Unlike ocean mixing, climate sensitivity is not a process itself, but rather a reaction to processes. It is a feature of the model resulting from the model's reaction to forcings, interaction of different physical processes, feedbacks etc.

p. 6182, l. 10f "After 1970, the forcing adjustments approximately offset each other and start turning negative ..." Imprecise. After approx. 1970 they are negative.

p. 6191, l. 1 "key quantities of AOGCMs" Delta T is the quantity being emulated, but it certainly is not the only key quantity simulated by an AOGCM

p. 6191, l. 13 "structural dependence" please clarify

p. 6191, l. 16 "interdependence" what does that mean?

p. 6194, l. 6 "A consequence of this is that calibrations will over- or under-estimate the climate feedbacks of an AOGCM." Imprecise.

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p. 6197, l. 19ff "... whether differences in climate response are truly due to different climate responses or ..." Imprecise; please clarify.

p. 6216, l. 6ff Confusing; please tighten up and clarify.

p. 6216, l. 13 "AOGCMs often show a land-ocean-warming ratio (RLO) that decreases over time but stays above unity ..." Sutton et al. ("Land/sea warming ratio in response to climate change ...", GRL, 34, 2007) note that the RLO is "fairly constant in time"; see also Huntingford and Cox ("An analogue model to derive additional climate change scenarios ...", Clim Dyn, 16, 2000) and Joshi et al. ("Mechanisms for the land/sea warming contrast ...", Clim Dyn, 30, 2008) You might want to amend/reconsider ... Please comment.

p. 6126f The purpose of the amended heat exchange formulation is to make the exchange more sensitive to changes in ocean temperature as opposed to land temperature changes. Now for certain combinations of parameters negative exchanges, i.e., from ocean to land, are possible, even if the change in land temperature is already larger than the change in ocean temperature. Is that correct? Please comment.

Technical corrections:

p. 6159, l. 17 "on average"

p. 6159, l. 25 "with regard to"

p. 6162, l. 26 "with respect to"

p. 6163, l. 17 "(Wigley, 1991b)"

p. 6164, l. 19 "allows for"

p. 6166, l. 10ff "optimizing a smaller (I) or larger (II,III) set of ... using idealized scenarios only (I,II) or ... as well (III)."

p. 6168, l. 23 "parameters"

p. 6170, l. 6 "The forcings"

p. 6177, l. 14 "For others"

p. 6178, l. 1 "0.206" Why are you giving additional significant numbers? It was 0.21 before.

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- p. 6178, l. 25 "of the original AOGCM's" original or actual?
- p. 6181, l. 6 "on average"
- p. 6182, l. 26 "differences"
- p. 6183, l. 2 "manifest themselves"
- p. 6187, l. 19 "to match as well" I think you mean "to find a constant climate sensitivity that allows to match the rather high forcing part ... equally well as ... "
- p. 6188, l. 1 "represents"
- p. 6188, l. 13 "Table 4 taken from Meehl et al. (2007)." The Table caption says Randall et al., 2007.
- p. 6188, l. 28 "similar to those in"
- p. 6191, l. 28 "under-"
- p. 6192, l. 5 "temperature evolution above 1980-1999" I suppose you mean the evolution between 1980 and 1999?
- p. 6194, l. 3f why the brackets?
- p. 6195, l. 13 "calibrations are done"
- p. 6195, l. 19 "data was not available"
- p. 6197, l. 11 "sensitivity estimates"
- p. 6198, l. 6 "Scientists"
- p. 6215, l. 2 "energy balance equation"
- p. 6215, l. 7 alpha is not explained
- p. 6217, l. 7 "Some AOGCM runs"
- p. 6217, l. 19 "can lead to changes over diagnosed" Over?
- p. 6217, l. 20 "Hansen et al. (2005) show that"
- p. 6218, l. 6f "response after a change in forcing ... parameters are adjusted."
- p. 6218, l. 12 "scales the"
- p. 6218, l. 16 wrong Greek letter?
- p. 6219, l. 1 "are both, the geographical and the vertical distribution"
- p. 6219, l. 13 "normalising"
- p. 6219, l. 18 "normalised"

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- p. 6220, l. 2 "which in turn depends on"
 - p. 6240, Table 1 I might have missed it, but I think you do not explain what the scenarios are. Esp. important for 20c3m and commit, which are not so obvious.
 - p. 6244, a "These climate sensitivities were"
 - p. 6253 Table caption "M6.0 tuning"
 - p. 6261 The Figure is rather small, but I could not find "c)"
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