

## ***Interactive comment on “Reduced complexity model intercomparison project phase 1: Protocol, results and initial observations” by Zebedee R. J. Nicholls et al.***

### **Anonymous Referee #3**

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Review of “Reduced complexity model intercomparison project phase 1: Protocol, results and initial observations” by Zebedee Nicholls and co-authors

The paper aims to introduce the motivation and rationale for a model intercomparison of reduced-complexity models. These models are commonly used to interpret (mostly global mean) temperature observations and complex model simulations. The paper introduces scientific questions which can be answered with this type of models, the experimental design and diagnostics, participating models, and shows first analyses of modeled temperatures for the historical period and scenarios for the next century. One important contribution to the ongoing discussion of differences between CMIP5 and

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CMIP6 is the finding, that about 46% of the additional warming at the end of the 21st century in CMIP6 compared to CMIP5 models stems from differences in the radiative forcing in SSPs and RCPs.

I applaud the endeavor to conduct an RCMIP. This will be very useful, both for people using single RCs but also the big group of people who are confronted with RC output without knowing how to evaluate them (both the impact user side and the GCM modeler side). However, the paper in its current format is weak and obscure and does not allow me to draw clear conclusions. It should not be too much effort to improve the paper, as it is mostly “just” improving the presentation, explanation, arguments, clarity. No new simulations are necessary.

#### Major comments

1) The differentiation between possible/future research questions and the ones addressed (and answered?) in this paper is unclear. I think possible questions do not belong into a paper. Anybody can come up with some vague questions. I read a paper to learn about what has been done and how I can use this for my own research. What somebody (who?) might be doing/planning/considering can be discussed in conferences etc. not in a scientific paper.

2) From a model intercomparison paper, I'd like to learn how I can use the output, which criteria have been used to select the models, which experiments have been conducted, . . . technical parameters, what can I learn from your effort. There are a lot of MIP-explaining papers out there. I suggest to imitate one of these in the structure and focus of the paper.

3) The interpretation of the differences between CMIP5 and CMIP6 scenarios is a major scientific contribution to the ongoing discussion. It is extremely relevant for writing the IPCC report. As such it belongs into a more visible, less technical journal and it needs to be highlighted. Here, this finding is buried towards the end of the paper and I get the sense that this is because the science behind this finding is actually not re-

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ally well understood, at least I don't from reading the paper. What's the relationship of this finding with the paper of Forster et al. 2019, who's estimate for the impact of the different scenarios (in CMIP5 vs 6) to surface temperature is much smaller.

Minor comments

Title: "initial observations" - these are modeling results, reformulate

line 12: output - in what

line 12: change in scenario - please explain much more thorough throughout the paper: Why has the scenario been changed? Were they not supposed to be traceable (i.e. SSP8.5 approx RCP8.5? How does this fit with the 46% additional warming due to different scenarios

line 15: "as first anticipated" - by whom and why?

line 16: "provide results available ..." which results? (the authors can pick/will find the results they need themselves. It's not a scientific finding to plan to provide results.)

line 28: "exploring interacting uncertainties" - explain which parts of the climate system can interact in these models - mostly they only contain surface temperature and some forcing agents and parameterized ocean heat uptake?

line 41: useful statistics - useful for what?

line 60: ... to understand their strengths, weaknesses and limitation so that we can make more confident, informed conclusions from their quantitative results" - yes, great, it would be good if all these points were indeed discussed in the conclusion in a clear manner.

line 75: what's a lifetime of an RCMIP?

line 75 following: For this paper, specify the questions you are actually answering. Here is mixed list is given of what is and could be done. Could/should/would is used much

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more in this paper than in usual scientific literature. For a MIP paper, a discussion of future/possible questions is fine, but these should be listed in one concise place and not dominate the paper.

line 77: "some aspects will receive less attention here than others" - and later: more precise language would help to make this a scientific and useful paper and not an opinion piece.

line 78: "what can they tell us about" ?

line 84: Experimental design: This section is not actually describe the experimental design fully. Or at least, after the section, I wouldn't be able to replicate what you did. From the title, I expect a list of experiments, their input, assumptions, rational, in a clear understandable fashion. Right now the section is a collection of random issues (a lot of detail about emission some specific scenarios, non about others)

line 96: What's the standard set of inputs from CMIP5 and CMIP6?

line 120: Diagnostics: I expect to learn how I can use this data. What's the available output? What's the rational for it?

line 128: How is an RC model defined? What's the criteria to be included in your comparison? Table one is a nice overview. I suggest to move even more information from the text into the table: What are the input variables and assumptions about them? On what data are they tuned?

Add a paragraph about similarities and differences among the models. What do they all share? Some of them seem to use the same basic equations. Are there classes of RCs? Could you draw a genealogy? Which ones are structurally more similar? Which ones are fully independent? From the text, I e.g. do not get a good sense of the difference between FaIR and CICERO-SCM.

line 156 what does it imply to have two or three timescales? line 433-436 I do not understand the sentence "These probabilistic ..." line 442-444 "Given that ..." is pure

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speculation. Somebody might be doing these experiments, who knows, maybe not, ... what's the purpose of this "information" here? Is this a call to the community that these experiments should be done? Are you planning to do them? Can I expect the results in phase 2? Maybe this is all about precision of formulation only? It's so vague, I don't know what to do with this information.

line 448: Developing a method ... "Such results would enhance ..." same as the point above: Are you suggesting to do this? Are you doing this? Should I do it? Why don't you do the research first and then tell me about the outcome?

line 464 following: Isn't this way too important to be buried in the Supplemental Material?

line 469: monotonic relationship?

line 472 "At this stage, this residual is most likely explained ..." and in two months you might change your mind or interpretation? Why not waiting with writing a paper until clear results and their interpretation materialize?

line 476 "A number of experiments have not been discussed here..." ...?

line 480 I can't follow.

Your "Conclusion" is an Outlook. Both, a conclusion and an outlook would be useful. I suggest to re-write the entire paper and discuss solely the models and (clarified) experimental set up and the \*results\* and then have one dedicated Outlook section with all your if/when/could/should/might items and maybe a clear plan for phase 2.

Fig.1 suggestions: Shade CMIP5 and CMIP6 models? There's too much information in this plot, I can't differentiate the lines. Maybe add panels with each RC to the SM?

Fig.2 a again, I can't see which information is relevant here. e.g. why are there not "hector" for SSP126. Stretch all plots into the horizontal. Why do the RCM lines stop earlier than the GCM line in panel c)? Use year 1, 2, 3 instead of 1850, 2000, ... this

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is very confusing for idealized experiments.

Table 2 "[TO DO ...]"

Fig.4 It's hard to see the point here (SM fig. 3 and 4 are much clearer). maybe change shading/colors? The information of the historical is not needed at this point anymore, the figures could start at year 2000 or so and then stretched. Maybe this would help to make the information more digestible? Adding versions of SM Fig. 3 and 4 could help to make this point stronger in the paper.

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Interactive comment on Geosci. Model Dev. Discuss., <https://doi.org/10.5194/gmd-2019-375>, 2020.

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