Geosci. Model Dev. Discuss.,
https://doi.org/10.5194/gmd-2017-187-RC2, 2017

Geoscientific Model Development Discussions

Interactive comment on "Overview of experiment design and comparison of models participating in phase 1 of the SPARC Quasi-Biennial Oscillation initiative (QBOi)" *by* Neal Butchart et al.

Anonymous Referee #2

Received and published: 21 November 2017

Summary: The paper lies out the rationale for QBOi, defines several experiments that will allow scientific questions about the QBO to be answered, and gives some detailed information on the participating models. Not being an outright expert on the QBO, my view is that the experiments have been well thought out and that the paper will form an adequate basis for QBOi. Weaknesses of the paper include that in a few places unnecessary options are given to the participants that may complicate the evaluation of the results. Also some forcings could be specified in more detail, in order to reduce ambiguity. Furthermore, I am not sure enough relevant detail is conveyed about the internal make-up of the models to allow analysts to understand why models behave the way they do. Maybe an additional appendix could be written, consisting of one-

paragraph descriptions of the individual models, highlighting particular aspects of their make-ups that the PIs consider to be relevant for their simulation of the QBO, that go beyond just their representation of parameterized GWD. Finally, in some places I was unclear as to the function of this paper: The title suggests that the paper is about defining the experiments and describing the models, but in places the text talks about the performances of the models, which I consider out of scope for this paper. Such a discussion of model performance should be reserved for subsequent papers that conduct the scientific analysis.

I recommend publication of the paper subject to answering these comments and also considering the below minor issues:

P1L2: Capitalize "General Circulation and Earth System Models".

P1L4: "Verisimilitude" is an unusual word in this context. While I appreciate stylistic richness, perhaps consider replacing with something more widely understood, such as "realism".

P2L9: has -> have

P2L24: has -> have

Figure 1: Perhaps a sentence can be written about the Unified Model family. HadGEM2-CC produces a realistic QBO, HadGEM2-AO, HadGEM2-ES, and the ACCESS models do not. What is it about HadGEM2-CC that produces this difference in behaviour? Higher lid, more levels in the stratosphere?

P4L31: Cut out "fragile – which is to say"

P5L18: Insert "," after "experiments".

P6L4: You say elsewhere that a 100-year simulation would be preferred. I suggest to remove the options of 3x30 years here and elsewhere. Otherwise you just complicate the analysis and might introduce problems with ensuring that the 3 ensemble members

are sufficiently independent of each other.

Figure 2: I suggest not to fill in the area under the curves in red, blue and black. These areas are overlapping, impossible to see in places and difficult to distinguish. One way to simplify this is to recognize that black is the mean annual cycle (i.e. it's periodic). If you subtract this off the other two signals and display the difference, the figure may become easier to read.

P7L4: For the purpose of clarity, perhaps spell out explicitly what the 1xCO2, 2xCO2, and 4xCO2 mixing ratios actually are (e.g. 300 ppmv, 600 ppmv, 1200 ppmv, or whatever the numbers should be). Also what are the mixing ratios for other GHGs (CH4, N2O, etc.) for these experiments?

P7L19: Insert "some" before "models".

P7L25: I would replace "9-12 months" with 12 months. Otherwise you may get an unnecessary diversity of responses there. Also spell out which reanalyses are supposed to be used here.

P8L14: ditto.

P9L22: What is a "vertical resolution equivalent to the model resolution"? Would it not be easier to say that data are requested on model (hybrid-pressure, in most cases) levels? In this case surface pressure and a recipe for the calculation of model level pressure need to be provided, or full pressure fields for hybrid-height models.

P12L6: Experiment 5A is designed for coupled AOGCMs, so the statement is inaccurate, but maybe models without an option to couple to an ocean can just skip this experiment. (Experiment 5A talks about an "appropriate initialization" of the ocean: What is that? Please provide more detail.)

P19L3: I do not understand why the ozone forcing for models without interactive chemistry is not prescribed. This will be an uncontrolled and unnecessary source of inter-model variations, compounded by the lack of any requirements to document any ozone

forcing used. Since almost all models listed will not have interactive ozone, prescribing ozone, and perhaps also conducting a sensitivity experiment using a variant ozone climatology, might be interesting to include. It would be straightforward e.g. to require models without interactive ozone chemistry to use the CMIP6 historical ozone climatology. An option here is to request variant simulation where ozone is varied from CMIP6 to whatever individual groups prefer, to get an idea about the influence of this choice.

P24L12: Again, I suggest to replace the two options with a simple requirement to produce a single 100-year simulation.

P24L23: To remove ambiguity and make everyone's lives easier, the CO2 volume mixing ratio reached in 2002 should be numerically stated here. (How about the other GHGs?)

P25L15: Replace "9-12 months" with "12 months".

P26L9: Why not require the data on ECMWF model levels, and ditto for other fields? This way no information is lost to interpolation.

Figure 7, section 5.1, appendix B: This is moving into the territory of comparing model performance, which I think would be out of scope for this paper. This off-line comparison is actually an interesting scientific exercise itself, but does not quite fit into this paper, the thrust of which is on describing the QBOi experiments. The brevity of presentation afforded to it here also does not quite do it justice. Please consider expanding this into a compact stand-alone publication (which might be submitted to GMD and would be an interesting companion paper to this one).

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