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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 #1

Received and published: 16 November 2017

SUMMARY: The Quasi-Biennial Oscillation (QBO) is the largest mode of tropical wind variability and, with a period of approximately 28 months, one of the largest regions of interannual variability in the atmosphere. Its basic mechanism has long been understood, yet a realistic representation of its behavior, structure, along with accurate seasonal QBO forecasts are often difficult to realize in global atmospheric models. These limitations are being addressed by the SPARC QBOi program. This paper describes the QBOi planned experiments and participating models, along with descriptions of requested output and targeted diagnostics. In addition, this paper includes comparisons of participating gravity wave drag parameterizations (GWDP), a key driver of the modeled QBO circulations. The goals, experiments, and relevant model parameters are

well documented. The figures are excellent and appropriate to the discussion. The abstract and tables are clear and complete. Results from the GWDP comparisons show that characterizing the wave sources (launch altitudes and wave amplitudes) is more important than the details of the parametrized wave propagation and breaking, at least in obtaining consistent results across models. Overall this is a well written documentation of a significant modeling community effort to improve global models for climate and seasonal forecasting.

STRENGTHS: This paper highlights the many factors that can influence the QBO, from model numerical advection schemes to the important GWD by both resolved and parameterized waves. It forms a crucial baseline reference for further QBOi publications and should be a useful reference for QBO studies outside of the QBOi program.

WEAKNESSES: No major weaknesses. A few minor comments are listed below. The third key question concerning the QBO and CO2 could be rewritten to be more focussed. A couple of additional references are provided in the comments below that should probably be included.

RECOMMENDATION: This manuscript can be published with very minor revisions as suggested below. It should include the two additional references listed below and clarify the third key question.

MINOR COMMENTS:

Page 4, Line 5,: Are there any anticipated difficulties with closing offline momentum budget studies? Maybe that could be discussed here or in the Diagnostics section.

Page 4, Lines 27-29: This section provides a fairly comprehensive list of models with QBO-like variability. The current NASA GEOS model has QBO-like variability (Molod et al., 2015) and should be included as well. Reference: Molod, A., Takacs, L., Suarez, M., and Bacmeister, J.: Development of the GEOS-5 atmospheric general circulation model: evolution from MERRA to MERRA2, Geosci. Model Dev., 8, 1339-1356,

https://doi.org/10.5194/gmd-8-1339-2015, 2015.

Page 7, Lines 13-14: In this third key question about CO2 and climate, does “present-day climate” refer to changes in present climate from recent CO2 changes? Maybe this question needs to be further explained or more focused.

Page 9, Line 1: This section (Process Studies) outlines using the hindcasts to examine wave dissipation and momentum deposition in detail. While mentioned in the future plans in section 6, including an initial time in the spring of 2016 as the anomalous equatorial wind profiles occurring just after the disruption winter of 2015-16 would provide an interesting challenge to both the parameterized and resolved waves.

Page 18,: Lines 3-6: The importance of numerical advection schemes is noted but the specific schemes used are not given for each model. Also, could more detail be given about the relation between the BD-Circulation and specific advection schemes? Do certain schemes consistently give a faster BD circulation?

Page 19, Line 3: The title of the subsection includes the phase “. . .feedbacks when interactive chemistry is included”, however the subsection mostly discusses the ozone climatology for use without interactive chemistry. Maybe the title should be modified or more discussion of potential ozone feedback added.

Page 19, Section 5.1: This section discusses only a subset (13) of the QBOi models. While mentioned in Appendix B, maybe a sentence could be added here to note this restriction. In particular, are the results likely to be different for the Lindzen schemes? Also, I think this should be Section “5” rather than “5.1”.

Page 23, Line 3: “ENSO”; This might be a good place to reference a noted connection between the QBO disruption and ENSO: Barton, C. A., & McCormack, J. P. (2017). Origin of the 2016 QBO disruption and its relationship to extreme El Niño events. Geophysical Research Letters, 44. https://doi.org/10.1002/2017GL075576

VERY MINOR COMMENTS

The following references in the reference section do not appear to be in the text:

Page 30, Line 24: Giorgetta et al., 2013

Page 30, Line 35: Hazeleger et al., 2012

Page 34, Line 1: Stevens et al., 2013

Page 34, Line 21: Warner and McIntyre, 2001

Page 30, Lines 15-19: The “a” and “b” are missing from the two Gerber et al. 2016 references.

Page 31, Line 24: The “a” is missing form the Kim et al. 2015 reference.

Page 33, Line 28: Serva et al., is misplaced in the reference list.

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