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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Simulation of the climate impact of Mt. Pinatubo eruption using ECHAM5 – Part 2: Sensitivity to the phase of the QBO" *by* M. A. Thomas et al.

Anonymous Referee #1

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Simulation of the climate impact of Mt. Pinatubo eruption using ECHAM5- Part2: Sensitivity to the phase of the QBO

by Manu Thomas et al.

This paper presents part 2 of simulating the Mt. Pinatubo eruption by investigating the QBO sensitivity in the ECHAM5 model. Understanding the combined QBO-volcanic effect is of high interest for the scientific community for a better understanding of the (chemical) tracer transport but also of the dynamical processes evolved. In that respect the results of this paper can be regarded as of high originality and of high interest for the scientific community. However, there are some inconsistencies regarding the QBO

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Interactive Discussion
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modulation of the polar winter northern hemisphere in the "pure QBO" response. In these the Holton and Tan mechanism is not simulated, although the QBO response is captured in the AOQ response. This is result which is not self-consistent with each other. For solving this problem, the authors may wish to discuss these problems further in the ms or to carry out a more detailed analysis or set up some additional model runs trying to figure the contradictions out (as suggested below).

General comments:

One possible explanation could be that for 1) the "pure QBO" response is calculated from the QBO+obsSST and the obsSST runs whereas 2) the AOQ response is calculated from the AOQ minus the climSST response. That's why the authors hypothesis that the SST effect is much stronger than the QBO effect and that it is highly non-linear. It might make also a difference to calculate both anomalies the same way whether from climSSTs or from obsSSTs. For this it would be helpful to carry out further analysis calculating the QBO+obsSST minus clim SSTs as well or to simulate the only QBO+climSST minus climSST response as well. The authors may also wish to further discuss the contradictions in greater detail with relation to existing literature. Regarding to the outreach the major conclusions are possibly affected as well.

Minor comments:

Abstract:

- Line 1-3 too detailed QBO informations for an abstract.

- Line 11-12 "the QBO signature in the LS temperature is well captured" here you mean only for the tropics? Otherwise contradiction to the other conclusion line 13-15.

- Introduction: Line 19-21 repetition of the first sentences from the abstract. I suggest cutting out the sentences in the abstract.

Page 9241:

ACPD

8, S4555–S4560, 2008

Interactive Comment

- Line 2: change to "(refer Baldwin et al. 2001 for details)"

- Line 11: add the reference van Loon and Labitzke 1987/88 who were the first on this subject!

- Move the Chattopadhyay and Bhatla 2002 sentence after the reference Mukherjee et al 1985 line 15, such the Indian summer monsoon references are placed together.

- There is a significant difference between the tropical and extratropical QBO response which has to be clarified within the introduction. The QBO also plays an important role in the trace gas distribution, but where exactly? I guess you are referring to the tropics here, which should be added. In the following sentence you are referring to the planetary wave activity-QBO relation which is dominant in the extratropics. These details have to be added!

Page 9242:

- Line 4: "show the same decay rate" of what?

- Line 8-13 repetition with the abstract.

- Line: 18-20 list of references; add important and earlier QBO model studies as well e.g. Scaife et al and Untch et al.

Page 9243

- Line 8 change to "were compiled by Stenchikov et al (2002)"

- Line 10-11 change to "with observed SSTs and QBO phases"

- Line 18: "In the vertical the core domain and the boundary" unclear

- Why don't you simply use the opposite signal for the QBO phase during the Pinatubo eruption? There must be some more background behind it why are you carrying out such a complicated approach?

- Line 28: How high is the anti-correlation? Give numbers.

ACPD

8, S4555–S4560, 2008

Interactive Comment

Page 9245:

Section 3.1: You should add at the beginning that you are calculating the difference between the (observed QBO+SST) signal and the (observed SST) signal. This is very important here and somehow might get lost from section 2.

- Line 26: "colder by up to -1.5K" The meaning of this sentence is unclear to me. Where in the tropics or in polar latitudes? It belongs to which phase of the QBO? Be more precise with the description otherwise it is very hard to follow your description. The sentence starts with: "It can be clearly seen" and ends with "personal communication Punge and Giorgetta" contradicts each other.

Page 9246

- Line 2 warm temperatures should be high temperatures

- "This explains why the high temperatures anomalies observed during the westerly QBO shear" where again? unclear.

- Main results of section 3.1.2: "This study contradicts the study by Holton and Tan (1980) that the westerly phase of the QBO favors a strengthening of the polar vortex" The results of the "pure QBO" response remain physically unclear. Do you have also the chance to check differences between obsQBO+climSSTs and climatological SSTs? This is what I would call a "pure QBO" response. Other model studies show a clear Holtan and Tan mechanism, so your results are unexpected. Did you check the possibility of errors in the model code implementing the QBO nudging or in the graphic scripts as well? Maybe your results are a robust feature, and then a QBO forcing with climatological SSTs should give a different response in accordance to the Holtan and Tan mechanism. Maybe this would be a better forcing to compare with for this purpose? This point is very essential to the major results of your paper part II and need some more clarification.

Page 9247:

ACPD

8, S4555–S4560, 2008

Interactive Comment

- Line 6 change order of appearance of the two plots first the opposite phase of the QBO Fig 4a and the observed QBO phase 4b.

- Line 3 and 23: $<$90% significances are not shown here.

- Line 14: Change to "lower temperatures".

- Section 3.2: The model results in section 3.2 are consistent and are not in contradiction with the QBO phases. Why should these experiments differ incl. the aerosol effects? There is one difference that for these plots, you subtracted the AOQ simulation from the control runs with clim SSTs. Maybe this is something you should also do for the "pure QBO runs" but then you can not distinguish anymore between the QBO and the obsSST forcing. (see comments above)

Conclusions:

- 3.: This is not entirely the case, there is a shift of the polar vortex towards N. Europe plus a weakening. It is hard to interpret the pictures as there are no details given for the contour intervals, which seem to change irregular.

- 4.: "The dynamical response" see comment on paper part I.

- 5.: Change to "Lower temperatures"

- Line 21: change to "poleward of 60N"

- Line 22: double the.

Table and figures:

- Table 1 does not become quiet clear as table 2 in part I.

- Figures 1, 4 and 6: plot the figures from 90S to 90N, add the contour intervals.

- Figure 2: Add the QBO phases by a horizontal line as in Fig. 4. c) How is the net QBO plot calculated? Details are missing!

ACPD

8, S4555–S4560, 2008

Interactive Comment

- Figure 3: Plots are shown from 20N to 90N? Three different shadings for 90, 95 and 99% significances can't be seen on the plots.

- Figure 5 has irregular contour intervals, please give informations.

- Figure 6: Starts in 20S? Give informations and extend to 90N.

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8, S4555–S4560, 2008

Interactive Comment