Atmos. Chem. Phys. Discuss., 8, S4533–S4540, 2008
www.atmos-chem-phys-discuss.net/8/S4533/2008/

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Simulation of the climate impact of Mt. Pinatubo eruption using ECHAM5 – Part 1: Sensitivity to the modes of atmospheric circulation and boundary conditions" *by* M. A. Thomas et al.

Anonymous Referee #3

Received and published: 7 July 2008

Simulation of the climate impact of Mt. Pinatubo eruption using ECHAM5- Part1: Sensitivity to the modes of atmospheric circulation and boundary conditions

by Manu Thomas et al.

This paper presents extensive model simulations of the Pinatubo eruption, distinguishing between single forcing effects. The observed aerosol and ozone, SSTs and QBO fields are taken into account for the pre- and post-Pinatubo period. This model study is also to my knowledge the first comprehensive approach to address all these single

effects of the post-Pinatubo signals in the atmosphere as it is clearly stated by the authors. The results are well illustrated and contain high originality in the scientific field. The diagnostics used to analyse the model ensemble are appropriate and the figures presented are of high quality. However the paper needs few clarifications and some corrections, which I listed below in my general and minor comments.

General comments:

In general the introduction could be improved by a little bit of rework. I suggest grouping the volcanic effects into dynamical, radiative and chemical processes as you are addressing these three with your model study. You may also wish to differ between direct and indirect volcanic effects.

In your abstract you say, that the model is not able to reproduce the "dynamical response" (an indirect effect). The only thing you show in the ms is the surface response and how it is different between the model forcings. You are not showing e.g. wave propagation differences, which could help to analyse and understand the dynamical response in more detail. Therefore, I suggest avoiding the interpretation of a dynamical response of your model results as you are not analysing dynamical processes in more detail.

Some details on the figure captions and the figures need to be added as given in my list below.

Minor comments:

Abstract:

- Line 1-8. Very general remarks about major volcanic eruptions in the abstract, which I would suggest to shift into the introduction.

- Line 19: "show some observed features" which are? Not precise.

- The pure QBO and ocean response (line 21) and the strong El Nino effects (line 24)

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should be summarized and discussed together.

- Add the significances of the results in the abstract.

Introduction:

- Needs some re-writing. Distinguish between direct and indirect effects of volcanic eruptions and between radiative, chemical and dynamical effects! The results given in the introduction is not separated between observational and model results. This is important as your model results also suffer from deficiencies.

- Line 8 "thereby changing atmospheric circulations" Provide a reference for this.

- Line 13 Definition of the middle atmosphere, do you mean the stratosphere, mesosphere and thermosphere here like in Andrews et al 1987?

Page 9212

- Line 5: "indicating a link between" are you questioning the volcanic impact here?

- Line 16: ocean state is not equal SST

- Line16-17 transition to Pinatubo eruption is missing here, very abrupt change.

- Line 22 "None of the ˆmodelˆ simulations" addˆˆ

- Line 27 to 4 (next page) put these general sentences before the end of the introduction.

Page 9213:

- ECHAM5 stands for?

- 16-17 repetition of the word "follows"

- line 20: "increased ˆfrom 4ˆ to 6" add ˆˆ

- line 20-23: Any more improvements or changes in the radiation code to add?

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- line 24: "are estimated" better are extrapolated

- line 25: "every time step" which is?

Page 9214:

-line 4-5: change to "which is based on observations for the period 1980-1991"; avoid the repetition "following"

- Do you use a zonal aerosol climatology?

- Line 12: "This data set makes use" expression

- Line 18-19 change to "compiled by Stenchikov et al 2002"

- Line 25: 1.2 mug/g corresponds to how much DU/km?

- Maximum ozone loss at polar regions is? In which altitude does it occur?

Page 9215:

- Line 16: SIC?

- Line 20: "run made" expression

Page 9216:

- Line 7 Why is the QBO not nudged to higher pressure levels as it seems to be important for the atmospheric response as results from e.g. Gray et al. demonstrate?

- Experimental set up: I have rather problems to understand table 2 and the differences between the experiments. E.g. what is really the difference between Aer3 and AOQ experiments? Maybe you can think of a clearer way to illustrate the experimental set ups?

Page 9217:

- Line 4-9 This is a general section on the Pinatubo eruption which might better go

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into the introduction? A motivation is missing in the introduction why you are carrying out these specific experiments, see also my general comment (radiative-dynamical-chemical effects)!

- Line 14-16: "In this case ... the effects of El Nino". Repetition see Page 9216.

- Line 23 Significances are not shown in figure 3?

Page 9218:

- SH simulations: where does the maximum ozone loss occur at southern polar latitudes? Maybe you are already above the vertical level of the maximum ozone loss showing the typical temperature increase in the vertical above the ozone hole?

- Line 11 "El Nino ...cools the tropics" The cooling in the tropics might be more due to a direct effect of the El Nino via the static stability changes and a higher tropopause occurs simultaneously and not via a time delay through wave propagation.

- The cooling in the tropics is less by what degree?

Page 9219:

- Role of the SH ozone hole? How does it look like w/o the observed ozone field as input?

- ERA40 data description must come before e.g. in the model and data section? Write ERA40 out and give some details incl. references. Maybe add something on how good the data quality is in the SH stratosphere? Only use the abbreviation $>$ ERA40 data

- Line 25 ff Fig 5 should be figure 4

Page 9220:

- Line 2. Add, what is observed in ERA40?

-Line 7-8: change to "over the pole and Siberia...over the East coast of N. America"

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- Line 25-30: "the polar stratosphere is disturbed in both winters" This is not really correct in my eyes. In the first winter you have a southward shift plus a weakening of the polar vortex and the second winter the pv is disturbed.

- Figure 4. No significances are mentioned in the description here.

Page 9221

- Middle East $>$ Mediterranean

- Fig 4 is Fig 5 here.

- Line 23-24 95 and 90% significances are shaded the figure caption says 99% ? Contradiction, please clarify.

Page 9223:

- Line 8: colder temperature should be lower temperature

- Line 27-28 "could not reproduce this dynamical response" change to ˆwinter warmingˆ as you are not showing any wave propagation analyses you are only showing the surface anomalies.

Conclusions: Page 9224:

3. "The pure aerosol response ...is insensitive to the boundary conditions" Isnt there a shift of the PV between clim SSTs and obs. SSTs?

Page 9225:

- Conclusion point 4: I think the QBO effect is not simulated realistically at high latitudes? Contradiction also to part 2 of the paper. I guess you mean the tropical response here? (The problem of the model to reproduce the Holton and Tan mechanism of the QBO shown in Fig. 4g, will be addressed by the comments for part2.)

- Conclusion point 7: Contradiction between the first and the last sentence, please clarify the response for the first and the second winter!

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- Line 19: Why "even" in the IPCC models?

- Line 20-21: Maybe it is not a dynamical response in your model study? If your model does not show the correct surface response, one has to question that there is a pure clear dynamical response. As you are not giving any results for the dynamical response /wave propagation characteristics) it is hard to interpret more about these processes. So better change to ˆsurface responseˆ w/o interpreting too much into it (see also general comments above).

- How about adding in the conclusions, that this is the first study of this kind showing the clear individual effects during the Pinatubo eruption?

I miss a link and outlook to part 2 of the paper. This is missing but should be already motivated within part 1.

Table and figures:

Table 2: remains rather unclear to me.

Fig 1-3 and 5: Plot the figures from 90N to 90S!

Fig 2. Add the QBO phases in figure2 as in part 2 Fig. 4. It is very hard to know when which QBO phase occurs without telling or showing the readers.

Add the contour intervals to the figures captions, you are using irregular intervals and you also change between model and ERA40 data.

Fig. 3 Does not show significances as its say in the text.

Fig. 4 The order of appearance is not good to follow the text and to compare the plots with each other. I would suggest to group 1991/92 together and then to right show the 1992/93 winter all together. You don't show the same hemispheric section between model and ERA40 data. You are showing 20 to 90N? Change this and add the info to the figure caption as well.

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Fig 5 is far too small, hard to recognize anything. The plots start in 10S or..? Add this info. ERA40 goes from 30S to 90N this is not the same section as for the models, or?

Interactive comment on Atmos. Chem. Phys. Discuss., 8, 9209, 2008.

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Interactive Comment