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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.

M. A. Thomas et al.

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Answers to the comments of Anonymous Referee #2

We would like to thank the reviewer for the very constructive and informative comments that have led to improvement of the manuscript. Please find below our responses to your comments.

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Section1, Introduction:

The introduction part of this manuscript has been re-written to include the limitations of the previous studies and hence, the motivation.

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Could you cite the recent work by Bo Christiansen J climate 2008 te the end of introduction?

- I have cited Christiansen's work in the introduction.

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Section 2, Model and datasets used which values of prescribed gases (CO2, CH4, N2O, CFCs) have you used?

- The volume mixing ratios of the gases are included in the text.

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Section 3, set up: A figure of the Singapore winds is given in part-2 of this paper. A referral is included.

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Lines: 12-15, PAGE 9216:

-Re-written as "Hence, Aer1, Aer2 and Aer3 give the simulated climate response to aerosol forcing under different boundary conditions. So, Aer1 gives the response under climatological SST as boundary conditions, Aer2 the response under observed SST (El Nino effects of 1991/92) as boundary conditions and Aer3 under both observed SST and QBO."

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Section 4, Results and discussion: Page 9216:

-This sentence is re-phrased as "In this paper, we choose the stratospheric tempera-

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ture to characterize the direct aerosol radiative effects and 30 hPa geopotential and 2m temperature to analyze the circulation response in the winters following Mt. Pinatubo eruption"

Section 4.1, line22:

-By "well structured anomalies" we mean the observed spatial pattern when the QBO forcing is included. The pure aerosol responses, Aer1, Aer2 and Aer3 do not show this observed structure in the 30 hPa temperature anomaly.

Line 26-27 and section 4.2:

- First, a separate paragraph on ERA40 data and on how the anomalies are calculated has been included in the section 'Model and Datasets used' . Here, Aer1, Aer2 and Aer3 are the climate responses to aerosol forcings under different boundary conditions. Aer1, Aer2 and Aer3 are single responses and are compared with ERA40 to pin-point the climate response that arises only due to the aerosol forcings and how they differ under different boundary conditions. Or in other words, it gives us an idea of the percentage of the total climate response can be attributed to the aerosol forcing alone.

Page 9218, lines 3-5:

-It is difficult to infer the El Nino-alone or QBO-alone response from observational studies due to the influence of other forcings + feedbacks. So, that is why in the case of El Nino response alone, we rely on modelling studies.

Page 9218, Line 20:

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-Text added in the manuscript "This asymmetry between strong cold and weak warm equatorial temperature anomalies at 30 hPa results from the bias in climatological temperature of the reference simulation Ou, which misses the long term net effects of the QBO (Punge and Giorgetta, 2008). Hence Figure 3(e) shows a combination of this climatological bias in equatorial temperature at 30 hPa of Ou and the actual phase related QBO signal evolving in OQu over the displayed time period. The resulting asymmetry of cold and warm equatorial anomalies at 30 hPa (Fig. 3(e)) occurs also in Figures 3(h) and 3(i). In the latter case this is obvious in comparison with Figure 3(j) of ERA-40, where the reference climatology includes the long term effects of the QBO (cf. Part-II of this paper for more details on the role of the QBO phase)."

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Why in the pure aerosol response with climatological SSTs (Aer1) there is no cooling of the polar vortex? and why the cooling in the second winter following the eruption is weakly reproduced just by AER3?:

-This could mean that the cooling of the polar vortex that is weakly simulated in the second winter in Aer3 is as a result of a combination of factors and not produced by aerosol forcing alone.

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A curiosity: Have you looked at winds at extratropical latitudes? (I am thinking of contours in ALT(from the surface to the model top)-TIME(as figure 3) for zonal mean zonal wind at 60N/S and polar T) Do you have any comment about it?

-Although this is an interesting feature, it is beyond the scope of this paper. Nevertheless, we are continuing our analysis also for the extratropics.

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In the first winter following the eruption, the ENSO effect seems to be the dominating effect (figure 4g), maybe you could specify it at the end of section 4.2:

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-I have included your suggestion in the text.

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Curiosity: have you seen if the February anomaly in the lower stratosphere and at the surface is different with respect to the beginning/mid of the winter?

-We have focussed in this paper on the seasonal winter mean In a next step we will look in more detail into the single months.

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Page 9223, 11-15: why do you define the ERA40 pattern (I think) as the "observed volcanic pattern"? same question as before, how have you defined the ERA40 anomaly?

- In this study the ERA40 pattern is defined as the observed pattern after Mt. Pinatubo eruption. ERA40 dataset is a reliable dataset produced from all the meteorological observations available. Consequently these anomalies represent not only the effect of the volcanic forcing, but also internal variability of the atmosphere, like the QBO in the stratosphere, and the climate system, like ENSO. A description of the ERA40 data set used for validation of our results and the computation of the anomalies are included in the "Model and data" section. The anomalies are calculated as a difference of the fields for the Pinatubo period (June 1991 - May 1993) from the mean climatology. Monthly data for 43 years are used for the computation of the mean climatology.

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Figure 5 is small, if it is not complicated to enlarge it that would be fine Have you looked at the SLP patterns?

- The figures will be enlarged in the final version. We have decided to focus on the 2m temperature as the most prominent feature (Northern Hemisphere Winter Warming) that can be discussed with the quantity.

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Description of ERA40 should be included in the dataset section:

-A description of the ERA40 data set used for validation of our results and the computation of the anomalies are included in the "Model and data" section.

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Textos: This has been corrected.

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