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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.

Anonymous Referee #1

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Review of ‘Simulation of the climate impact of Mt Pïnatubo eruption using ECHAM5 - Part I’ by Thomas et al.

This paper presents modelling results concerning the impact of Mt. Pinatubo eruption on the atmosphere. The authors use the ECHMA5 GCM to study the sensitivity of the volcanic model-calculated response to a range of model input conditions/forcings (SST, QBO and ozone changes). The objective is to investigate whether different aspects of the modelled response to volcanic forcing are sensitive to different set ups in the GCM. They use ERA-40 data to validate part of the simulations. Using multiple ensemble

runs combining the different forcings, they show how different boundary conditions influence the volcanic response in the GCM. The methodology is sound and properly described. The paper is well written and clear. The results will be useful to scientists studying the climatic impact of large volcanic eruptions. However, I have a number of recommendations that, I think, would improve the paper (see below). In summary, I recommend publication after minor revisions.

In section 4.2, the ‘observed’ response calculated from ERA40 is used to assess the quality of the simulations. How are the anomalies calculated? Deviations from a running mean in observations time series? It would be very helpful to explain how the ‘observed’ response is derived. And I suggest to derive the model-calculated anomalies in the same way to ensure consistency in the observed-versus-model anomalies comparisons. There is also a potential problem in deriving the ‘observed’ response to the volcanic forcing. In the model, the mean response and its statistical significance are derived from ensemble runs. Apparently, the Pinatubo eruption is only one volcanic event and so, in a sense, the Pinatubo observations correspond to 1 member of the PDF. In order to estimate the ‘observed’ mean response and the width of the PDF, one would need to consider, for example, 10 similar volcanic events by analogy with the model ensemble runs. Therefore, the authors should be very cautious with quantitative comparisons. I would suggest to highlight this point.

The different model simulations are partly evaluated based on comparisons with the ‘observed’ response. Unfortunately, the authors do not explain how the response to the Mt Pinatubo forcing is derived from observations. Is it deviations from an extrapolated running mean or from the previous 10 year average? The response in the model simulations should be derived as much as possible in the same way as it is done with the observations to be able to compare like to like.

Abstract, l2: short-lived but can trigger climate shifts.

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Interactive Comment

Abstract: the terms ‘pure responses’ is not defined, so it is not clear what it means. Overall, the abstract could be ‘sharpened’ in order to make clear what the paper brings.

P9211, l18: Too strong claim. Part of the natural variability is unexplained or at least not proven to originate from the non-linearity of the dynamics of the circulation of the middle atmosphere

P9212, l17: What does ‘pure’ mean? Do the authors mean the averaged effects of volcanic forcing (averaged of simulations with different boundary conditions) or the part of the volcanic effects that is independent of the boundary conditions or the effects for each model set up?

P9214, l2: Strange set up. The concentrations of CH4, N2O and CFC drop in the stratosphere with very small mixing ratios in the upper stratosphere. Why are the mixing ratios of these radiatively active gases assumed to be constant?

P9216, l1-7: The nudged simulations are not really fully interactive CCM simulations. I would suggest to indicate what kind of limitations the tropical QBO nudging bring in terms of couplings/interactions.

P9216, l13: There is some confusion here. Aer2 is supposed to correspond to the response to volcanic forcing under observed SST. Observed SSTs also include the surface cooling due to the Pinatubo aerosols. Therefore, it is difficult to see Aer2 as the aerosol response under another boundary condition when some part of this boundary condition is also the atmospheric response to the volcanic perturbation.

P9217, l5: rather 1 or 2 months (Read et al, grl, 93).

P9217, l9-10: Too high. Please provide references for this 40 km.

P9219, l19-21: it is figure 4, not 5.

P9220, l1: Is the anomalously strong vortex observed in the second year after the

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Pinatubo eruption a robust feature? In other words, is it statistically significant? It is difficult to be certain from only one volcanic event.

P9223, l20-21: this sentence needs to be rephrased.

P9224, conclusions:

Points 3 and 6 seem to contradict each other. I suppose that the response of the atmosphere mentioned in point 6 is not the same as in point 3 (lower stratospheric temperature). Which atmospheric response is discussed in point 6?

Point 5: cooling over Middle East and Greenland. Again, are these regional features robust just for one volcanic event or are they observed every all the large volcanic eruptions? Without the range of observed responses to volcanic events, it is difficult to conclude unambiguously regarding discrepancies between observed and model-calculated anomalies on a regional scale.

P9225, l18: The last part is a bit obscure. The variables tested were temperature and geopotential height. Why conclude that the ‘radiative response’ is correctly simulated? I ma not sure that I understand what ‘radiative response’ means here?

Also, does ‘remain a challenge’ means the dynamical response is not correctly simulated? Which part of the response?

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

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Interactive Comment