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Atmospheric Chemistry and Physics Discussions

Interactive comment on "The influence of eruption season on the global aerosol evolution and radiative impact of tropical volcanic eruptions" *by* M. Toohey et al.

Anonymous Referee #1

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The influence of eruption season on the global aerosol evolution and radiative impact of tropical volcanic eruptions

M. Toohey, K. Krüger, U. Niemeier, and C. Timmreck

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This is a great paper that will certainly help further understanding of the climate effects of volcanic eruptions. Not only is this study novel, but it's very well done. I especially like the introduction of the sensitivity metric and the idea of looking at time-integrated AOD and radiative forcing. I think these will be useful in assessing volcanic eruptions in future studies. I recommend publication with revisions.

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General comments

- One of the conclusions you draw from your study (mostly Section 3) is that the AOD and radiative effects are independent of the longitude of the eruption. I would suggest you downplay this, as you're essentially verifying a well known result.

- As you state in your conclusions, there is much more work needed in this study. It will be very useful to see simulations of eruptions at 15°S and on the equator. Changing the phase of the QBO would also be really good to see, as that is known to have a really significant effect on aerosol distribution.

- In your time integrations, I don't understand why you stopped at 2 years. There are still aerosols in the atmosphere after this, and integrating longer can only help you achieve more robustness of your conclusions. You state (page 22454, line 21) that the length of time you integrate over doesn't matter, but that's only true if you integrate for long enough that the radiative effects of the volcanic eruption drop to zero. Pinatubo aerosols were found in the atmosphere longer than two years after the eruption. I think integrating over all 4 years of your simulations would make a lot more sense.

- There's no discussion of effective radius for the E700 experiment, which seems odd. This would go a long way toward explaining why your aerosols fall out after a couple of years and what the AOD and radiative effects are. Also see specific comments for Sections 2.2 and 4.

- On your figures, if at all possible, using the same scales for all of the axes would be really helpful. Also, when you show negative anomalies, putting the axes markers in proper numerical order is less confusing (i.e., make the curves go down for anomalies that are more negative). Figures 5-7 and 10-11 should have a legend.

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Specific comments

Abstract: When you mention sensitivity, a brief definition would help, especially since this is your own construction.

Section 2.1:

- Say what data set you used to prescribe SSTs

- Is SO2 radiatively active in the model? (This is relevant for my comments later on the E700 eruption)

- Using fixed SSTs is sufficient for your experiment, since you're only looking at AOD and surface shortwave RF, but you should state this.

Section 2.2:

- Line 14: Tg instead of Mt

- Line 23: Be careful with the term "atmospheric response" since you're using fixed SSTs. It might be more helpful to say what you mean.

- Lines 24-25: Other supereruption simulations have shown that it takes a LOT longer than 4 years to reach small levels of atmospheric loading of aerosols. I'm not about to say which modeling studies are correct, but putting your results into the context of the existing literature could be useful.

- Line 1: Is your background case (the control run) present day?

- Line 8: June 15 and July 1 aren't that different. Were your results so different that it warranted the extra simulations?

Section 3:

- Page 22450, Line 17: Repetitive use of "larger"

- Page 22451, Lines 18-19: AOD is very dependent upon effective radius, so your AOD measurements should tell you whether the aerosol size in your model is giving you the right answer.

Section 4:

- Page 22452, Lines 20-23: This is an odd sentence. Is it really necessary?

- Page 22453, Lines 16-20: Can this be explained by natural hemispheric asymmetry of the BDC?

- Page 22454, Line 19: What, specifically, do you mean by "total radiative impact"?

- Page 22454, Line 26: I have no problem with the units you use, but you should give the scaling factor to convert to J/m2.

- Page 22455, Line 17: Showing deposition rates would be really helpful, as this has a strong seasonal dependence and could be part of your explanation.

- Page 22456, Lines 1-4: An explanation of why the aerosols are lofted higher for the January eruption would be really helpful. What dynamics mechanisms are at play? Is this model-dependent?

- Page 22456, Lines 5-10: Kravitz and Robock said a summer high latitude eruption would have a larger integrated radiative impact. Are your results consistent? Is this about how long it takes for the aerosols to move from the tropics to higher latitudes?

- Page 22457, Line 7: Do climate models do this erroneously?

- Page 22457, Line 27: 30 K seems like a LOT just for sulfate aerosols. Does this include the radiative impact of SO2 as well?

- Page 22459, Line 12: Again, a discussion of effective radius would help you be more conclusive than "it may be"

Section 5:

- Page 22462, Lines 26-27: The Gao et al. study was based on actual data, which is necessarily all-sky. So according to them, isn't it true that season of eruption is less significant than in your clear-sky simulations? Does this contradict what you said in lines 9-10?

- Page 22463, Line 1: Be careful with this. There's a big difference between 17 Tg and 700 Tg, and the sensitivity response does not appear to be linear with injection amount.

- Page 22463, Line 25: Another interesting idea for future work is where the cutoff is, i.e., at what magnitude of injection does the season start to become important?

- Page 22464, Lines 29ff: Ocean memory of the cooling is probably a lot more important than a latent heat flux analysis, especially in terms of the integration that you do.

Figures:

- Figure 1: You might want to check the updated version of the Sato et al. data: data.giss.nasa.gov/modelforce/strataer

- Figure 4: Doing zonally averaged cloud maps can be problematic (e.g. monsoons), so mentioning this would be useful. Also, it would be helpful to state your methods in more detail, i.e., that you calculated the anomaly first and then did the zonal averaging.

- Figure 5 (and similar): Orange and red are too similar. Could one of these be green?

- Figure 5: Doing the grey shading around zero would be much more helpful, so you can actually see if the black line is still within the noise (like you did in the discussion of Figure 7).

- Figure 10: This figure suggests that you have aerosols piling up against the vortex. Is that what's happening? Then what makes them fall out? A discussion of this would be nice.

Interactive comment on Atmos. Chem. Phys. Discuss., 11, 22443, 2011.