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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Uncertainties in modelling the stratospheric warming following Mt. Pinatubo eruption" *by* F. Arfeuille et al.

Anonymous Referee #4

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The authors investigate the stratospheric warming following the Pinatubo eruption derived from SAGE II extinction data. Using the state-of-art SAGE II retrieval algorithm including most recent updates in the processing algorithm and a data filling procedure in the opacity-induced "gap" regions, the authors derive aerosol size distributions from the relative small SAGEII wavelengths to properly reproduce extinction coefficients at much longer wavelengths. Comparing different methods/ approaches they show that the SAGE.4λ method, which is based on a fitting procedure to the four SAGE II wavelengths shows the best agreement to observed extinction file. Testing the SAGE.4λ dataset in the global CCM SOCOL leads to enhanced aerosol-induced stratospheric heating compared to observations and many other models while the warming at the tropical tropopause could be reproduced by this method.

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Interactive Discussion
Discussion Paper

General comment:

While in the first part the different methods are compared quite sufficiently, I agree with reviewer 2 that the discussion of the stratospheric temperatures is largely incomplete missing previous work and important aspects (QBO, vertical resolution) see specific points below Overall, I recommend publication after revisions, see specific comments below:

Specific comments:

Title: The title reflects only a small part. I think the word “extinction” belongs to the title.

Abstract:

The sentence “This suggests that the overestimation of the stratospheric warming after the Pinatubo eruption arises from deficiencies in the model radiation codes rather than an insufficient observational data basis” is misleading and could easily be misunderstood. It doesn’t reflect the statement of the “Conclusions” where this conclusion is related to models with “. . .. volcanic forcings with longwave extinctions for the Pinatubo eruption lower than found in this study for the aerosol peak around40–50 hPa”

Methods:

-The method section could be restructured in a more concisely way, in particular the introduction part starting from line 21 page4605 to line20 page 4606. For example the authors talk in this part about four methods, and then they explain in three subsections the 1st the 2nd and the 4th method now named as 3rd method. The three model approaches AER/, AER9 and AER10 are also introduced somehow arbitrarily at different places. I suggest to introduce the three satellite methods at first and then add the model based approach as 4th method describing the AER7, AER9 and AER10_ASAP simulations together.

-The AER model set up/simulations could be explained in more detail in the manuscript. I miss some general information, e.g. vertical resolution of the model, meteorological

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wind fields of AER7 and AER9, the way how the optical parameters are calculated, is the .additional aerosol heating taking into account in the simulations etc. etc.

-Also the SOCOL simulations/model set up could be explained in a couple of sentences. I miss some information about the horizontal and in particular the vertical resolution. Is the model running in a climatological mode or with prescribed SST ?

Results/Conclusions:

-For the short wave wavelengths the different approaches are compared to SAGE measurements as references which are somehow the backbone of the applied methods. I suggest an additional comparison of SW flux anomalies with ERBE satellite data as a more independent approach.

-The overestimation of the stratospheric temperature anomalies after the Pinatubo eruption in ECHAM4 is not a new story. I am aware of the various efforts of the Zürich group in the last years to understand this effect. Hence, I am a little bit surprised to find no references in this paper to the earlier work e.g. Heckendorn et al. (2009) and an assessment of the current results with respect to the old ones. This is definitely missing in the current paper.

-Another important aspect in the discussion of the overestimation of the stratospheric warming following Pinatubo is missing: the vertical resolution of the global models. It might not only be the radiation code of the models, it might also be the relative coarse vertical resolution of most global models in the stratosphere of more than one kilometer. Observed vertical stratospheric aerosol profiles after the Pinatubo eruption (e.g. Deshler et al, 1993) show relative thin stable aerosol layers. This effect should at least be discussed in the paper

Figures:

-Fig 9 and Fig 10 could be combined, eventually also with Fig 6, so six panels in total (one has to be added Extinction 5.26 mum EQ). In the upper row the extinction profiles

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for the tropics could be displayed, in the lower row the ones for 35 N. This would give a nice easy overview figure for the behavior of the different methods at different wavelengths.

-Fig 10 One can hardly see the horizontal line

References:

Heckendorn et al 2009 Environ. Res. Lett. 4 045108 (12pp) doi: 10.1088/1748-9326/4/4/045108

Deshler, T., B. J. Johnson, and W.R. Rozier, Balloonborne measurements of Pinatubo aerosol during 1991 and 1992 at 41°N: Vertical profiles, size distribution, and volatility, Geophys. Res. Let., 20, 1435-1438, 1993.

Interactive comment on Atmos. Chem. Phys. Discuss., 13, 4601, 2013.