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Atmospheric Chemistry and Physics Discussions

ACPD

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Interactive Comment

Interactive comment on "Stratospheric SO_2 and sulphate aerosol, model simulations and satellite observations" *by* C. Brühl et al.

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We thank referee # 2 for his suggestions for improvement. The focus of the paper is on stratospheric sulphur in general. Pinatubo was included for evaluation purposes as indicated at the beginning of chapter 3.1. Just recently again several papers on modeling of Pinatubo were published. In our opinion it is not useful to add another one to this subject. We will include some sentences on this in the introduction.

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Interactive Discussion

Discussion Paper

1 Major comments

1) In contrast to SO_2 COS is not soluble in cloud and rain water. It has a much longer lifetime and is observed by several satellite instruments in the stratosphere, for example by ACE-FTS (Barkley et al., 2008) and MIPAS on ENVISAT. The observed distribution agrees well with the model results. Decay by photolysis is maximum at the altitude of the Junge layer (Brühl et al., 2012). In the model we have a burden of about 50 ktS COS above 20 km and about 30 ktS aerosol.

2) More information on surface boundary conditions for SO_2 will be provided. We use the EDGAR 2000 emissions and consider also a climatology for tropospheric volcanic SO_2. A paper in preparation by Höpfner et al. (will be cited, 2013b) shows that enhanced SO_2 above the tropical tropopause is related mainly to volcanoes (see also NASA SO_2 website) but not to Asian pollution. In Figure 12 of Höpfner et al. (2013a) the volcanoes and the injected mass are indicated. From mid 2008 to 2011 occured 4 strong eruptions while in 2003 and 2004 were only 2 very weak ones, explaining the difference in observed SO_2. In the model only a very small fraction of tropospheric SO_2 penetrates the tropical tropopause because of wet removal in convective clouds (see also figure in supplement).

3) The water vapour increase after Pinatubo is also shown by the Boulder balloon sounding observations and is not in contrast to satellite observations (e.g. Hurst et al., 2011).

4) We use a recent SAGE-II/III version corrected for cloud effects (V6.2, Thomason, 2011 and 2013, personal communication, will be included in manuscript).

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2 Additional comments

Abstract: 11396-2: Will be slightly modified. *6:* More details are given in section 2. Textbook knowledge should not be repeated in the abstract. *9*: It is both, see below. *12:* OK, together with a modification requested by referee I.

Introduction: Will be expanded, see also comments to referee I.

Model set up: 11397-20: These details are in the cited reference (Brühl et al., 2012) but we can repeat some more here. T42 means 'triangular truncation at wavenumber 42 (for spherical harmonics)'. *22:* We use the SO_2 mass derived from OMI/TOMS data and inject it in a region where the resulting aerosol is observed by SAGE. The text will be expanded for more clarity. *11398-12:* In the literature are several different settings. Our choice results as best fit out several test simulations for a big volcanic eruption (text will be modified).

Stratospheric Aerosol, Pinatubo: 11398-25: We use SAGE V6.2. The text will be improved, also we better refer to Thomason et al. (2008) and Thomason (2013, personal communication) here. The simulation with 14 Mt based on older SAGE data will be removed for clarity, as also requested by referee I. Instead we include a sensitivity simulation where 17 Mt were injected on 1 July, with maximum injection at the longitude of the volcano. The suggested references will be included. *11398-24,26:* The sentences will be corrected as suggested. The referee is right, that it is good to mention also 'solar occultation' here. *11399-4:* will be skipped. *11399-11:* OK, but the details are in the given references. *11399-16:* Captions? *11400-3/5:* Will be expanded, Hurst et al. (2011) will be cited too. *11400-14/15:* I looked into these 'data' and did't like some rather odd wiggles. *11400-26:* Here was a mistake that will be corrected (see comment to referee I). *11400-29*: Thanks for the information but this should not be written in the manuscript since it would degrade the cited paper.

Background and medium volcanoes: 11401-6/7: I will mention also Reventador and

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Ruang in Table 1. However, MIPAS data (Höpfner et al., 2013b) and also the NASA SO_2-database (see acknowledgements) indicate the SO_2 from Nyiragongo makes it to the lower stratosphere. *11401-9/10:* Will be modified for clarity. This refers again to the NASA SO_2-database. Unfortunately the MIPAS data cannot be used for initialization because of datagaps in the plumes due to particles (see next section). Also, the individual MIPAS data are still not public, except for plots. *11401-25/28:* We show both because aerosol mixing ratio is the prognostic quantity in our model (see also Brühl et al., 2012). *11402-5/10:* We will improve the wording. Due to meteorological noise there is no significant signal more than about 4 months after an event. It was not the purpose of Fig. 12 to show that there is a longterm significant response.

Stratospheric SO_2: 11402-15/20: I try to improve the figure for better visibility of the discussed effects. There will be also a figure in the supplement which shows monthly averages as MIPAS which will considerably reduce the volcanic peaks. See also Figure 7 in Höpfner et al. (2013a). *11402-20/25:* The faster spreadout to midlatitudes might be due to different meteorology, a shift in the QBO phase or due to initialization. I will say more on this. There was an eruption already in August 2002 and one in September which were not included explicitly in the model but merged with 2 other volcanoes erupting in November 2002. This should explain the delay compared to MIPAS. I will improve the wording.

3 References

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