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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Atmospheric impact of the 1783-1784 Laki eruption: Part I Chemistry modelling" *by* D. S. Stevenson et al.

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General Comments:

The authors describe a model study of the impact of the eruption of the Laki. By taking into account feed-backs on the oxidant chemistry they show that depletion of oxidant fields (mainly H2O2) prevents excessive amounts of sulfate aerosol formation. The study is well written, interesting and relevant. I have some minor comments, which are listed below. I recommend the manuscript for publication in ACP, after taking the minor corrections into account

Minor comments:

- I recommend to use the same units throughout the manuscript. Especially, the random use of Tg S, Tg SO2, Tg H2SO4 and Tg H2SO4.2H2O should be avoided. I

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recommend Tg S, which is most frequently used in prior publications.

Abstract:

- the model produced 122 Tg SO2 in about 8 months.

- when giving the amounts produced and lifetimes; also give the pre-industrial and industrial case numbers, otherwise these numbers are meaningless.

- Most previous studies, that did not account for feedbacks in atmospheric chemistry ?

1. Introduction:

- The crucial factor for what?

- What is a 'dry fog'?

- It would be useful to mention what kind of methods were used by the previous studies Thodarson, Stothers, etc., to arrive at their estimates of aerosol formation. Did they use an atmospheric transport model like in this study?

- Regarding the Highwood and Stevenson study, resume in a few sentences what is the outcome of this study.

- Later in the text there is reference to a publication on the sulfur cycle by Stevenson, and another paper by Derwent. A short description of main strengths and weaknesses of the model describing the sulphur cycle are relevant for this study.

2. Chemistry transport model:

- All tests described have been done with previous model version. As mentioned STOCHEM has been strongly developed in the last years, what is done about testing the present version?

- Simulate diffusive mixing, that is turbulent diffusive mixing I presume.

- Mention to how many km a vertical resolution of 25 hPa corresponds.

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- I can't find any information on how clouds are treated in the langrangian framework. Are they transported like the air parcels. It is quite important for sulphur chemistry.

- Section 2.2: do you only consider reaction on sulphuric acid aerosol, or rather on sulphate aerosol in general? Do you use a fixed size distribution for the aersosol.

- Section 2.3: Perhaps I am not fully aware of the concepts in Langrangian modelling, but I don't understand: 'if no airparcels are present'. Does this mean there is no (or only very shallow) boundary layer? In general, what would be the equivalent thickness of an 'Eulerian' model layer in which emissions from the surface are placed?

- Table 2: Make a column with Total.

- Section 2.4. Scavenging rates are taken from Penner. Does this mean you do not use the information on rainfall and clouds in the model? Please explain. Here and later: do you also consider wet deposition of SO2 (not much based on Henry's law, but perhaps more if considering reactive scavenging.)

- Convection: how does it consider SO2?

- It should be mentioned already here, that the influence of aerosol on photolysis rates was not included. Likewise can you elaborate on the effects of the large amounts of SO2 on radiative transfer.

3. Experiments

- Explain why you use only 2 years of climate model simulations, generally it is advisable to use 10 years to obtain a better statistical coverage.

- Can you give an estimate of how much of the emissions finally ended up above the tropopause of the model?

- The split of 72-25 was achieved by modeling , of what?

- Give an uncertainty number on the 61 Tg S

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- To give a minimum=lower limit for the amount

4. Results

- Figure 1 I am somewhat surprised by the large amounts of SO2 found in the tropical upper troposphere lower stratosphere after 3 months of transport, can you elaborate on the transport mechanisms.

- section 4.6. Here I find some information on the previous studies on the Laki eruption, however I still find it rather brief. I think it should become clearer why you think your method is an improvement compared to the older studies.

5. Conclusions.

Like in the abstract when giving numbers please also give the numbers in present and past, to give a reference framework.

Interactive comment on Atmos. Chem. Phys. Discuss., 3, 551, 2003.