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Atmospheric Chemistry and Physics Discussions

Interactive comment on "The impact of the 1783–1784 AD Laki eruption on global aerosol formation processes and cloud condensation nuclei" *by* A. Schmidt et al.

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On behalf of all authors of this study we would like to reply to the comments of reviewer 1 (shown in bold).

The authors used an aerosol microphysics model, called GLOMAP, implemented in a chemical transport model TOMCAT. Using this coupled model, the authors simulated the effect of the 1783-84 AD Laki flood lava eruption on aerosol (microphysical) properties. This study provides additional findings in the impact of the Laki flood lava eruption and so I recommend the paper for publication. However, I don't find the findings in the paper particularly interesting.

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Interactive Discussion

Discussion Paper

As far as we are aware our work is the first to investigate a long-lasting, high-latitude eruption such as 1783 AD Laki using a global aerosol microphysics model (GLOMAP). All previous studies used General Circulations Models (GCMs) investigating the conversion of SO_2 to SO_4 aerosol, the SO_4 aerosol dispersal and its climatic impact (in terms of direct forcing). In contrast, we investigate the impact of the eruption on total particle concentrations; cloud condensation nuclei number concentrations and we do budget microphysical processes. We believe that our study provides valuable additional information on a Laki-style eruption as the framework we are using provides a dataset that will in future allow to assess the aerosol indirect effects, which have not been taken into account in any previous study. We also discuss the impact of the season in which such an eruption commences on microphysical processes and show that complex, non-linear processes drive the evolution of the aerosol size distribution – none of the previous studies aimed to provide such information.

This is not just another modelling study; the model framework chosen is fundamentally different from a GCM and recent studies such as Timmreck et al. (2009) highlighted the importance of investigating volcanic perturbations using frameworks such as GLOMAP.

1. The findings added by the present study are meaningful if the chosen model delivers accurate simulations. The paper does not provide any solid investigation into the accuracy of the model. When GLOMAP-TOMCAT uses current aerosol emission, for example, can it realistically simulate the observed aerosol in the atmosphere? Does the model capture the observed vertical profile of aerosol? Does the model locate aerosols with respect to cloud as well as the observation?

Both, GLOMAP and the chemical transport model (TOMCAT) have been fully assessed for modern conditions. We amended section 3.3.2 to be clearer about that. We fully agree with the referee that our paper doesn't provide detailed information on the performance of both models under modern-day conditions; however, it is not within the scope of this study to do so. Mann et al., 2010 provide a full description and evaluation of the

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GLOMAP-mode model. Moreover, GLOMAP-mode results were submitted to the A2-CTRL-2006 AEROCOM intercomparison project (http://dataipsl.ipsl.jussieu.fr/cgi-bin/AEROCOM/aerocom/surfobs_annualrs.pl) Our previous studies such as Spracklen et al. (2005a,b); Manktelow et al. (2007,2009) and Mann et al. (2010) all show that GLOMAP is capable of simulating realistic aerosol concentrations throughout the atmosphere.

2. The authors compare their findings with those in previous modeling studies by Stevenson et al. (2003) and Oman et al. (2006a), in section 3.3.1. First, I recommend that the comparison be made in a way that readers can better understand the overall difference. A table is a good option.

We followed the referee's advice and added a table and further discussion under section 3.3.1 comparing our model diagnostics with those from previous modelling studies together with estimates reported in the literature.

Second, is GLOMAP-TOMCAT more accurate or less accurate than the other models?

The table under section 3.3.1 shows a fair amount of consistency between our and previous modelling studies. The main discrepancies concern the deposition of sulphate to Greenland and the residence time of sulphate (please see reply to referee 2 for further discussion of this issue and amended sections 3.3.1 and 3.3.2 in our paper where we also discuss where we regard GLOMAP as superior when compared to previous modelling frameworks used to study the Laki eruption).

Just using a different model is not particularly interesting, though the chosen model gives information on aerosol microphysical properties.

We believe that we did not just use another model – the methodology and the scope of the study is completely different from previous modelling studies. In future, the majority of GCMs will treat aerosol microphysical processes (i.e. they will have an aerosol

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component) adding another level of complexity - our study aimed to assess the impact on aerosol microphysical processes thus we chose to use GLOMAP-mode.

Interactive comment on Atmos. Chem. Phys. Discuss., 10, 3189, 2010.