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Interactive comment on "Initial fate of fine ash and sulfur from large volcanic eruptions" *by* U. Niemeier et al.

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We thank the anonymous referee 1 for his comments. He mentioned the impact of the meteorological conditions on our results:

'It is necessary to use the numerical model for other sensitivity experiments, for studying the impact of the non-linear coupling of fine ash local heating with meteorological conditions, in particular the QBO phase and strength of monsoon winds for tropical eruptions.'

According to this comment, we changed the focus of the simulations described in the manuscript. Instead of showing summer eruptions under slightly different meteorological conditions for Mt Katmai and Mt Pinatubo, we included results of winter eruptions. The results of an assumed Mt Pinatubo winter eruption are described in more detail as

they consider a different strength and directions of monsoon winds.

In our simulations we used the MAECHAM5 model with 39 vertical levels. The model version has no QBO in the free-running setup. This could only be obtained by nudging of equatorial stratospheric winds (Giorgetta and Bengtsson, 1999). In the currently used setup the model calculates easterly winds in the stratosphere, which agrees well with the QBO phase during the Pinatubo eruption. The comparison to measurements shows the capability of the model in the used version to well simulate the transport processes in the easterly phase. The opposite QBO phase differs not only in the horizontal wind direction, but also the sinking and rising processes are changed.

Punge et al (2009) simulated the QBO effect on stratospheric long range transport, showing changes mainly during the transition between phases of the QBO. Anyhow, these processes are slow compared to the lifetime of fine ash particle in the stratosphere. Therefore only in case of a strong wind-share in the levels between 30 hPa and 50 hPa we expect an influence on our conclusion on the impact of fine ash. Furthermore, the application of the nudging technique would also alter and therefore falsify the impact of the volcanic emissions on the flow pattern. We therefore dispense to set up additional sensitivity experiments with respect to the QBO but discuss this aspect in the paper.

The tropospheric meteorological conditions in the South-Asian region distinguish between summer and winter monsoon. This is reflected in the stratosphere by easterly winds over the Asian continent in summer and westerly winds in winter and slower easterly wind speed in the equatorial region in winter. We therefore followed the suggestion of referee1 and set up an additional sensitivity experiment with respect to the monsoon phase. It turned out that in an assumed winter eruption of Mt. Pinatubo we see a reduced westerly transport of the volcanic cloud and additional parts of the cloud are transported towards the North-East. But theses differences in the flow pattern do not change our main conclusion on the impact of ash. The heating rates are increased due to ash, causing a slightly stronger westerly transport of the volcanic cloud. The overall impact of the ash is similar to the case described in the original manuscript.

The situation is different in the more northern latitudes. In a winter eruption of Katmai the ash has almost no impact due to the short daytime length and the low heating rates. This indicated again the importance of the radiative heating on the transport of the volcanic cloud in case of a large eruption.

References:

Punge, H. J., P. Konopka, M. A. Giorgetta, and R. Müller (2009), Effects of the quasi-biennial oscillation on low-latitude transport in the stratosphere derived from trajectory calculations, J. Geophys. Res., 114, D03102, doi:10.1029/2008JD010518.

Giorgetta, M. A. and L. Bengtsson (1999), Potential role of the quasi–biennial oscillation in the stratosphere–troposphere exchange as found in water vapor in general circulation model experiments, J. Geophys. Res., 104, 6003–6019

Interactive comment on Atmos. Chem. Phys. Discuss., 9, 17531, 2009.