

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

Anonymous Referee #1

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This paper discusses a relevant topic, not adequately addressed in the literature. Ash particles injected in the stratosphere have a rather short lifetime, but may in principle play a local important role in the radiative budget of the stratosphere after major volcanic eruptions, with potential impact on surface temperatures and on stratospheric transport, thus affecting the dispersal of SO₂ and sulfate aerosol clouds.

The authors discuss well and in a comprehensive way two volcanic episodes (Pinatubo – tropics and Katmai – midlatitudes) and reach the conclusion that fine ash may have a substantial impact on the local scale but only minor impact on the evolution of the sulphate aerosol cloud in the stratosphere. The latter is the key point, since these aerosols have a stratospheric lifetime of the order of two years and can then affect radiation, climate and ozone photochemistry, with a signal on sea surface temperatures

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and then of longer climate scales.

However, the authors' strategy fails, in my opinion, in the way they design sensitivity experiments to better explore the role of fine particles. Infact they couple the two basic numerical simulations for Pinatubo and Katmai with two sensitivity experiments where the emissions are ten times larger. This would suggest that only the magnitude of the injected ash could affect the early stages of the sulfur dispersal. On the other hand, the coupling of the local heating due to ash particles and sulphur aerosols with local and global meteorological conditions may have a significant role in assessing the role fine ash could play in modifying the large scale transport of sulphate aerosols. It is then 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.

Several papers in the literature (including some from the same authors of the present manuscript) have discussed the importance of the QBO phase and synoptic scale meteorological conditions for the initial dispersal of the aerosol cloud and its residence time in the tropical latitude band and in the whole stratosphere. It would be important to study to what extent the fine ash radiative heating can impact the transport of SO₂ and sulphate aerosols in different "background" conditions of QBO and synoptic scale winds. In my opinion this is particularly relevant for the tropical eruption case, and conclusions from these suggested new sensitivity experiments would make the paper conclusions more robust and general.

For the above reasons, I suggest publication of this paper once the numerical study of the tropical eruption case has been completed with additional sensitivity experiments.

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