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Atmospheric Chemistry and Physics
Discussions

Interactive comment on "Atmospheric processes affecting the separation of volcanic ash and SO_2 in volcanic eruptions: Inferences from the May 2011 Grímsvötn eruption" *by* Fred Prata et al.

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Response to reviewer 2

We thank Arnau Folch for his comments.

General

He is correct in saying that our hypothesis of partial column collapse is speculative, but we feel it is a plausible explanation that the data supports. In light of the comment

we have emphasized the speculative nature and included some alternate possibilities, including the idea that ash aggregation and fall-out could have contributed to the "sloughing" of the ash curtain without a column collapse.

In terms of how the fine ash was released at low levels, we think that a more likely mechanism is that the partial collapse of the column or "sloughing" due to aggregates falling through the column and reducing vertical thrust, would have been sufficient to prevent fine particles from reaching greater heights. It seems unlikely, according to the observations, that a new source of fine particles was generated by a secondary smaller eruption (although such eruptions may have contributed to ash generation later)– which could also explain fine particles at low levels. The presence of fine particles is confirmed in the observations so there is no argument that they were not present. We have added a sentence to discuss the likely origin of the fine particles at low levels.

Minor comments

Pg3. Line 1. The point here is that without considering dynamical processes happening inside the column, such as aggregation and fallout, column collapse, or "sloughing", current models may misrepresent the total mass of fine particles in the plume. Current satellite observations can distinguish between a volcanic plume consisting mostly of SO_2 and one consisting mostly of ash, but most dispersion models are initialized with either one or the other of these constituents. This is critical at the start of an eruption, where it is more likely that both constituents are present and subsequent separation is likely. In general, most forecasts are good. But without considering separation, which implies that both sources should be modeled, there is potential to forecast the movement of a volcanic ash cloud, when in fact it is largely an SO_2 cloud. This seems to be what happened during Grímsvötn. In fact two problems arose: first the cloud moving north and the spreading eastwards and westwards was predominantly SO_2 and very high (> 10 km); secondly, the ash cloud moving south and then eastwards towards Scandanavia, was low and much less “massive” than believed.

Pg5. Line 9. Corrected.

Pg6. Line 4. Reference added.

Pg7. Line 1. Our sentence was misleading and we have corrected it according to the comment.

Pg7. Line 16. Yes, I guess that is strictly true, except larger eruptions emit more particles and gases and these spread more and for longer giving more possibilities for an instrument in polar orbit with a very narrow swath to observe them. A case can be made for having more lidars in space.

Pg11. Figure 5. Correction made.

Pg12. Line 15. Correction made.

Pg16. Line 6. We were referring to the mass of fine particles and have corrected the last part of the sentence to “. . .which is an order of magnitude smaller in erupted mass of fine particles than the eruption.”

Pg24. Line 11. Reference included: this was an oversight.

Pg24. Fig. 14. Caption changed to “from the surface to three flight levels: FL200 (20,000 ft in red), FL350 (35,000 ft, in green dashes), and FL550 (55,000 ft blue dots).”

Pg28. Line 5 and Line 22. Corrected.

Figure 15. The plume top altitude from the radar time series is imposed to allow us to compute the source condition required to produce a plume rising to the observed altitude. The plume model includes the effect of wind and other atmospheric conditions (temperature, pressure, humidity).

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