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Geoscientific Model Development Discussions

Interactive comment on "The operational eEMEP model for volcanic SO_2 and ash forecasting" *by* Birthe Marie Steensen et al.

Anonymous Referee #1

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General Comments:

In general, this manuscript is a dense read, mainly because it presents a huge scope of work. Two new species are added to the EMEP MSC-W model, SO2 and volcanic ash, each with their own physics (e.g. sedimentation). Operational use of the model is described in which satellite observations are used to invert for a source term. Sensitivity of the model to meteorological conditions is presented using ensemble forecasts. Finally, results are compared with satellite observations, ground-based lidar, and output from models using other numerical schemes.

This work could be presented as two manuscripts, possibly separating SO2 from ash. But as it is, this manuscript is reasonably well-written, presents material of interest to the journal audience, is sufficiently novel to warrant publication, and passes all the

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Discussion paper

other limiting criteria (adequate citations, figures of high-quality, sufficient details provided for reproducibility). I recommend that this manuscript be published, but suggest the authors consider a few of the specific comments listed below.

Specific Comments:

At the end of section 2, where the operational set-up is discussed, the authors give a nice description of the scheme used for real-time comparison with satellite retrievals and for inverting for source terms. Section 3 is more of an investigation on the sensitivity of the model to variations in the meteorological conditions by running eEMEP with 24 ensemble cases. At the end of section 3, however, there is a discussion of ensemble runs in an emergency forecast environment. It is not really clear how the ensembles are used in forecasting. Are they available in real-time? It looked like this was just a retrospective on the Bardarbunga event. If ensembles are used, is the source-receptor inversion used with each realization of the ensemble?

It is not really clear what is the range of variability in the ensembles. They seem to be primarily subdivided based on the description of cloud physics. As opposed to explosive eruptions that simultaneously release SO2 and ash, Bardarbunga was primarily fire-fountaining with a continuous surface emission of SO2. I would think that the main discriminating aspect of the meteorology is the characterization of the planetary boundary layer and how vertical diffusivities are calculated. In Hawaii, low-level winds within the boundary layer play a critical role in the SO2 advection, especially the diurnal variations (sea-breeze, nocturnal katabatic winds, etc.). The VMAP project has found that they need to calculate meteorology with WRF at a resolution of 1 km over the Big Island in order to capture the surface winds properly. Is this not as important in Iceland?

Section 4 focuses a bit more than necessary on the benefits of including gravitational sedimentation. It is widely recognized in the volcanic ash dispersion modelling community that it is the dominant removal process for ash > 64 um. It become less and less important with smaller and smaller particles, to the point where it is negligible compared to the effects of wet scavenging or aggregation. The vertical position of distal ash will be very sensitive to the characterization of the grainsize distribution and on the specific source terms used (mass-loading as a function of height and grainsize at the vent). It is difficult to compare model results with lidar data as evidence supporting including or neglecting sedimentation since the airborne grainsize distribution above the lidar station is not really known.

I would like to commend the authors on making the source code for their model publicly available.

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