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Discussions

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Interactive comment

Interactive comment on "Modeling volcanic ash aggregation processes and related impacts on the April/May 2010 eruptions of Eyjafjallajökull Volcano with WRF-Chem" *by* Sean D. Egan et al.

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article

Comment 1: *"Is the 10x10 km grid size adequate to discribe the near-source aggregates (<15km distance from the volcano)? Could you consider a nested higher resolution grid over Iceland to address these processes? This may not be important for the long range transport since anyhow the bigger particles will be removed from the model but it could provide more insight on the processes and probably improved deposition fluxes near the erruption."*

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Discussion paper

This study built off work by Costa et al. (2010) and Folch et al. (2010, 2015) who used the simplified version of the Smoluchowski equation in this work to study near vent deposition. As such, our efforts focused on the study of ash aggregation processes' effects on distal volcanic ash transport, so attention was paid to the distal plume. The large spatial extent necessary for studying the distal plume required a lower resolution to allow for feasible computational times.

WRF-Chem is capable of much higher resolution model studies and these parameters could be used to study near vent aggregation phenomena, like was done in Costa et al. (2010) and Folch et al. (2010). Furthermore, this study could benefit from a nested domain over the vent, however this was computationally not feasible with the compute time available to our group.

The conclusions section of the paper has been updated to include:

> "As stated, the majority of volcanic ash aggregation occurs proximally, especially when high water vapor concentrations are present in the eruptive column. Future studies of volcanic ash near the vent should consider including a nested, high resolution domain over the source to allow for the study of proximal ash fall. We will add a discussion of this to the conclusions portion of the paper in order to highlight the capability of WRF-Chem to include nested, high resolution domains, and add that the equations used also apply to near vent, proximal aggregation.

Comment 2: *"Please check that the references are provided in chronological order throughout the text."*

All references have been updated chronologically.

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Discussion paper

Comment 3: *"In line 92 " As an example, FALL3D is typically initialized with a WRF model run that is executed prior to the dispersion model. Modeling particle dispersion with WRF-Chem is, therefore, as computationally feasible as running these models since in many cases, a mesoscale, gridded model must be run for their initialization". Indeed, but you can run multiple faster Lagrangian dispersion simulations with different configurations using a single meteorological output (e.g. WRF) which may be important for determining aviation hazard under different emission scenarios."*

We agree with your comment and will revise the text. Lagrangian dispersion models clearly have their place in aircraft hazard mitigation, especially since they can provide a number of different solutions based on perturbed initial conditions with relatively little computational requirement. The wording of the background has changed to include:

> "WRF-Chem may augment Lagrangian dispersion models by providing output that is constrained by a number of physical processes, to include aggregation, that are typically not included in dispersion models. Additionally, WRF-Chem may benefit research modeling, allowing researchers to study the effects of numerous microphysical processes on volcanic ash, including aggregation, as well as environmental feedback such as those discussed by Hirtl et al. (2015)."

Comment 4: *"One peak concentration was observed at 15:30 UTC on April 19, which was not re- solved by WRF-Chem (Fig. 8b). Typical of any Eulerian air quality model, WRF-Chem tends to diffuse ash concentrations, an effect that is also dependent on the model res- olution." I suggest that you should elaborate more on this mismatch between model and observed ash concennntrations. Such high peaks are the primary threat for aviation and moreover these are observed at about 2km elevation which may imply approach or takeoff heights thus increasing the potential danger. This may not be* *due to Eulerian diffusion otherwise one would expect a more uniform reduction of the concentration fields. Could you please check the concentration at the surounding grid-points to check if possibly such concentrations exist and are misplaced by the model ?"*

We conducted an analysis of the surrounding grid cells. Laterally there was agreement in the model output with decreased ash seen in the i and j directions. Vertically, however, there was an increase in ash seen aloft, however it was not as extensive as the DLR observed peak. We believe this is Eulerian diffusion since the areas under the curve between the times at this peak agree between the model and observations. The text has been updated to include:

> "An analysis of the surrounding grid cells in the vertical and horizontal did not contain this peak, however the next vertical grid cell in the positive k contained higher ash concentrations. This analysis, along with analysis of the integrated volcanic ash over the time span of the peak, lead to the conclusion that this the lack of peak concentration in the model is a result of model diffusion."

Comment 5: *"Without aggregation, the only sinks for volcanic ash are via settling or via the plume traveling out of the model domain." . Don't you condider also the wet removal from incloud and below cloud processes?"*

The volcanic ash settling routing included in WRF-Chem does remove ash faster in the presence of water vapor. It does this by increasing the effective size of the particles, and therefore the fallout rate of ash, with increasing relative humidity. There is no coupling to rain effects, however, such that rain interactions with volcanic ash are not included. Only the relative humidity fields are taken into account. The text was updated as follows:

"Without aggregation, the only sinks for volcanic ash are via settling, which is dependent on gravity and water vapor concentration, or via the plume traveling out of the model domain."

Comment 6: *"I would suggest to extend the sensitivity analysis including not only the total domain mass but also the maximum traveling range from source for the various bins."*

Because e-folding time is correlated with distance, a distance sensitivity study would be a recast of this data. The paper may benefit from another figure that details this in terms of distance for each bin, however. We will consider doing so for each bin and if generated will be referenced in the discussion alongside the current e-folding time sensitivity study analysis.