

Geosci. Model Dev. Discuss., referee comment RC2  
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## Comment on gmd-2021-30

Anonymous Referee #2

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Referee comment on "Particle-filter-based volcanic ash emission inversion applied to a hypothetical sub-Plinian Eyjafjallajökull eruption using the Ensemble for Stochastic Integration of Atmospheric Simulations (ESIAS-chem) version 1.0" by Philipp Franke et al., Geosci. Model Dev. Discuss., <https://doi.org/10.5194/gmd-2021-30-RC2>, 2021

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The manuscript presents an inversion method (particle filter based) to derive the volcanic ash emission profiles by converting two-dimensional ash loading data from, for e.g., geostationary satellites to three-dimensional emission data. Similar to previous studies the authors combine observations and ensemble simulations. The novel aspect of the method lays mainly in its ability to estimate the errors and uncertainties in the derived emissions. The authors use the inversion system for two notional sub-Plinian eruptions of the Eyjafjallajökull and show that the method's accuracy strongly depends on wind shear conditions.

The methods are valid and the results are interesting for the remote sensing and modeling communities. I have no major comments but few remarks that should be addressed before publication.

### General comments:

- The method quantifies the uncertainty with respect to the injection height and vertical wind profile but there is no hint of the uncertainty in the assimilated quantity, i.e. ash mass loading. The satellites do not measure this quantity directly. Rather, it is a retrieved parameter based on brightness temperature. The retrieval has its own limitations and uncertainties. Most importantly, in the first few hours of the eruption the umbrella cloud is quite large and thick so the ash retrievals are either missing or subjected to large uncertainties. Therefore, the authors should discuss the limitations of the method from this perspective.
- The authors assume that the only parameter relevant for the ash transport is the wind. What about the particle size and aerosol dynamics? How does the method address the uncertainties with respect to processes like particle growth and sedimentation? Ash aggregation leads to particle growth and enhances the removal. Please discuss the

limitations of the method from this perspective.

- The text is very difficult to read. It starts right in the title and then continues with the odd formulation of the first two sentences in abstract. In many places throughout the paper, the verb comes in a passive form at the end of a long sentence. This makes the text very difficult to follow. Please consider writing in an active form and avoid long sentences. Especially sections 1 and 2 contain lots of odd formulations and difficult passages. Section 3 is easier to follow but has some generic formulas related to validation processes. Please move all the formulas and their explanations to section 2.

### **Specific comments:**

L1-5 (Abstract): The sentences read odd and are difficult to follow. Please revise.

L25-30: This is not an encouraging opening paragraph. The sentences read odd and are difficult to follow. Besides, there is no clear connection between the points. Please revise

L38: please add the specific uncertainties of these methods. Besides, add a

L108: you mean "It should be noted" or "we note"?

Figure 2: I do know that this is an idealized set-up. But is it physically realistic to have the same profiles and emission rates under two different atmospheric conditions (wind shear)?

Figure 4 and 5: I did not find the source of meteorological data in the text.

Figure 8: what happens at 12 hours after the eruption. There is a spike in the error.

Conclusion: Again very hard to follow. Please make it clear and concise.