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Atmospheric Measurement Techniques Discussions

Interactive comment on "Retrieval of ash properties from IASI measurements" *by* Lucy J. Ventress et al.

Anonymous Referee #2

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The manuscript describes a method for ash property retrievals using IASI measurements. The manuscript is well-written, but more details of the methodology and analysis are desirable and should be included before publication. Suggestions for improvements are given below.

- **Surface temperature retrieval**: In the abstract and elsewhere it is mentioned that the surface temperature is retrieved. However, in the manuscript no surface temperature retrievals are described. This should be one of the retrieved quantities that is easiest to compare with independent measurements or weather forecast models. Hence, please include a discussion and presentation of the surface temperature retrievals and comparison with relevant data.
- **Introduction, general comment:** A majority of earlier works on satellite ash

detection and retrieval use broad band instruments such as SEVIRI, MODIS, AVHRR etc. Please include a paragraph about what are the advantages and disadvantages with hyperspectral instruments. For example: hyperspectral instruments provide more spectral information and may thus potentially retrieve parameters that otherwise have to be assumed in retrievals using broad band instruments. On the other side, hyperspectral instruments typically have larger footprints than the broadband instruments. For example compare AVHRR and IASI which are on the same satellite. It should also be emphasized that you are retrieving the altitude of the plume height. The lack of plume height information is a major limitation in most split-window and similar techniques.

- **Page 2, lines 5-6**: Of the papers mentioned here, only the paper by Clarisse et al. (2010) use hyperspectral data, while the rest use broad band data. As this paper use IASI data it should be clearly stated that the other papers use the mentioned techniques on broad band data with limited spectral information. You may also want to mention that hyperspectral data may be used to retrieve the ash refractive index, see Ishimoto et al. (2016).
- **Page 2, line 20**: fr → für.
- **Page 3, line 9**: To make the manuscript self-contained, please include one or two sentences describing how the ash detection is done and IASI pixels flagged.
- **Page 16, line 9**: Please state which parameters are not retrieved but assumed and included in b. How does the assumed values of these parameters affect the retrieval error?
- **Page 3, line 23**: the the → the.
- **Page 3, line 24**: Please state your convergence criteria and maximum number of iterations.

- **Page 4, lines 4-5**: It is assumed that "these variables are orthogonal to the ash signal". May you please state what "these variables" are in order of importance? You mention clouds. Can you justify that ash clouds and for example liquid water clouds are orthogonal to each other using the difference in their optical properties?

- **Page 4, lines 20**: Please clarify if the forward model was cloudless also for the cloudy covariance matrix. Would it be possible to make covariance matrices for each effective cloud temperature and would you expect this to improve the retrieval?

- **Page 4, lines 24-26**: You mention clouds above and below the ash cloud. What about clouds at the same altitude as the ash cloud? And what about the presence of ice in the ash cloud itself? The latter is known to be a challenge, see for example Rose et al. (1995), Durant et al. (2008), Kylling (2016). Please discuss.

- **Page 6, line 13**: The ash cloud is assumed to be infinitely thin. Corradini et al. (2008) showed that ash cloud vertical extent have effect on the retrieved ash cloud optical properties. How realistic is the infinitely ash plume assumption and how does it affect your results? Is the error due to this assumption inluded in your error budget? If not, please make this clear in the manuscript.

- **Page 6, line 24**: P_l is not used anywhere in the text. This line may be omitted.

- **Page 6, line 28**: Mention what ash size distribution is used and what parameters and values that describe it. Mention what ash type and refractive index that is used and include reference(s).

- **Page 8, line 1**: Please mention the wavenumber (wavelength) of the optical depths.

- **Page 9, line 4**: Please mention which longitudes are included in the "local" covariance matrix.

- **Page 9, line 11-13**: I do not understand how this explains the decrease in temperature uncertainty. Please clarify. You may also possibly use the simplified model by Prata and Grant (2001) to explain the observed behaviour, see their Eqs. (2)-(5).

- **Page 9, line 24-26**: This behaviour may also possibly be explained by the simplified model of Prata and Grant (2001).

- **Page 10, line 4**: Please specify the threshold value.

- **Page 10, line 8**: Please mention what the average retrieved surface temperature including standard deviation. How does it compare to ECMWF values for the area?

- **Page 11-12, lines 2-8**: Do the MODIS and IASI retrievals use the same ash type and size distributions? If yes, please state so. If not, please state how any differences affect the comparison results.

- **Page 12, line 8**: What are the units of the number 2.6?

- **Page 12, line 12**: Several MODIS pixels cover one IASI pixel. Please mention how the MODIS ash optical propertis vary across the IASI pixels. This variability may be included as vertical error bars in Fig. 6.

- **Page 12, line 19**: Please mention what the "imposed quality controls" are.

- **Page 12, line 27**: Numbers for the "goodness" of the correlation may be obtained if fitting a straight line to the data.

- **Page 12, line 30**: Eyjafjallajköull → Eyjafjallajökull.

- **Page 14, lines 17-18**: You state that "The retrieved effective size distribution from IASI measurements is consistent with the values from the aircraft measurements, although slightly smaller." Here you state that you retrieve the effective size distribution from IASI measurements. Is this really so? Is it not the effective radius you retrieve based on an assumed size distribution? Please clarify.
- **Page 14, lines 15-20**: When comparing effective radii, please provide numbers for the IASI effective radius. This you may obtain by fitting a curve to the histogram in Fig. 7 and thus obtain an estimate of the IASI effective radius.
- **Page 16, lines 19**: Under **Results** also discuss Fig. 8. Also mention in the Introduction and Abstract that you include Grimsvotn data.
- **Page 16, lines 23**: What is implied by "The colocation for this scene is good"? Please quantify time and spatial differences.
- **Page 16, line 25**: 10 → Fig. 10.
- **Page 16, line 26**: Please quantify "good agreement".
- **Page 16, line 30**: Please beaware that the altitudes in Stohl et al. (2010) are derived from IASI and SEVIRI measurements using an inversion procedure. They only include the altitude of the fine ash that may be dispersed. Thus their use as a reference here is dubious. For the altitude of the plume above the volcanic vent the Arason et al. (2011) reference is maybe more appropriate.
- **Page 16, line 32**: It is not a big surprise that "the latitudinal location of the plume is correct". This statement may be omitted.
- **Page 17, Fig. 8**: What is shown by the solid line in the Figure?
- **Page 18, lines 14-15**: This could be due to the ash cloud being above an optically thick low altitude cloud, case b in Fig. 2. If the below cloud is optically thick

the retrieved surface temperature should represent that of the cloud and not the Earth's surface. Thus it would be interesting to know the retrieved surface temperatureds for these pixels and how they compare with the surface temperatures from for example ECMWF.

- **Page 20, lines 16**: You state "skewing towards slightly smaller particles due to viewing a larger area of the plume." However, I can not see that you have given evidence anywhere that the larger area is the reason. Yes, you speculate that this is the reason, but hard facts are needed to be able to firmly state this. Please clarify.

References

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