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Atmospheric Measurement Techniques Discussions

Interactive comment on "Simulation of SEVIRI infrared channels: a case study from the Eyjafjallajökull April/May 2010 eruption" *by* A. Kylling et al.

A. Kylling et al.

arve.kylling@nilu.no

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Overall response to interactive comments from the Referees

We thank the referees for constructive comments to our manuscript. While revising the manuscript, an error in the calculation of the optical properties of the ash particles surfaced. This error led to a factor 3 too large ash absorption optical depth. The correction of this error has drastically improved the agreement between the simulated and measured brightness temperature differences (Figs. 6 and 7). In addition to this

correction, numerous changes have been made as suggested by the referees. Some of these changes were suggested by two or more of the referees. They are addressed first and referred to in the individual answers to the referees.

1. All three referees have questioned the use of a constant water vapour profile over the whole domain. As mentioned in the manuscript this was done for technical reasons. While revising the manuscript simulations were made with a one-dimensional code that allow the variation of water vapour to be included. Simulations with a fixed water vapour profile and one with water vapour from the ECMWF were compared. Brightness temperature differences in the $\pm$1.5 K range were found between the two simulations. The 10.8-12.0 μm brightness temperature difference is on average overestiamted by 0.2 K using a constant water vapour profile. The impact of using a constant water vapour profile is discussed in the revised manuscript.

2. Referees #2 and #3 questions the use of constant liquid and ice water cloud radii. In the revised manuscript we have adopted the parameterisations used by Bugliaro et al. (2011). The effect of including liquid and ice water cloud parameterisations for the effective radii is readily seen in the revised left panel of Fig. 6. The impact is largest for high ice clouds where a fixed effective radii may overestimate the brightness temperature by up to about 15 K. For brightness temperature differences used for ash discrimination, bottom panel Fig. 7, the difference between using fixed effective radii and the above mentioned parameterisation is small. The paragraph describing the choice of effective radii has been rewritten to reflect the changes in the approach. In addition, the description of the optical properties of ice clouds have been clarified, including the citation of the correct Yang et al. (2005) paper.

3. Emissivity was set to a fixed value of 1 in the original manuscript. In the revised manuscript the emissivity has been taken from Borbas and Ruston (2010). The use of this emissivity atlas resulted in a decrease of the brightness temperature of about 0.5 K over ocean regions. The largest decrease of 4 K was seen over the Sahara. The use of the emissivity atlas is mentioned in the revised manuscript.

4. Table 1, the text where appropriate, and all relevant figures have been updated to reflect the changes due to the points mentioned above.

Response to interactive comments from Referee #3

General comments:

The differences between measurements and simulations in Figs. 6 and 7 was largely caused by an error in the calculation of the ash particle optical properties. Please see overall response above.

Concerning the use of fixed liquid and ice water cloud effective radii and a fixed water vapour profile, and no variation in the surface emissivity, please see overall response above.

The idea of degrading the simulations and measurements to the same spatial resolution may be promising. We believe, however, that a thorough comparison of measurements and simulations should be based on more than one scene. Therefore, calculations for the whole Eyjafjallaökull episode are presently being made and a full comparison of simulations and measurements at the same spatial resolution will be made with those results in a future study.

Specific comments:

1. The reason why molecular cross sections may not vary horizontally is highly technical. Take water vapour as an example: The ECMWF fields provides the density of water vapour for each voxel. Based on the density, the temperature and the cross section, the optical depth must be calculated for each voxel. However, in the IR, line-by-line calculations are too time-consuming, thus parameterizations must be used for the absorption of trace gases. We use the LOWTRAN band model. For each wavelength band several calls must be made to the MYSTIC radiation solver, each call with different input optical parameters for the trace gases. For the ash, liquid and ice water clouds this is simpler to implement in the code than for the trace gases.

2. The real and imaginary part of the refractive index for andesite (Pollack et al., 1973) has been added to Fig. 2.

3. The discussion has been rephrased and clarified so that only the area detected as ash is discussed.

4. The locations A, B, C, and D are know reported in Fig. 7 as well.

5. Over the scene the particle size distribution varies as the age of the ash increases. A fixed particle size distribution can not encompass all this change even if the effective radius is allowed to vary. There will always be one size dsitribution that will fit part of the domain, but not one that will fit all of the domain. As such, adding a synthetical ash size distribution to Fig. 9 will add little value in

our opinion.

6. The word “shadow” has been removed and the corresponding sentences rephrased.

7. The work “approximation” has been corrected and Varnai and Davies (1999) has been added as a reference for the TIPA.

8. Typo fixed.

9. The panels of Fig. 4 are correctly identified in the revised manuscript.

Interactive comment on Atmos. Meas. Tech. Discuss., 5, 7783, 2012.