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Atmospheric Measurement Techniques Discussions

Interactive comment on "Volcanic ash detection and retrievals from MODIS data by means of Neural Networks" *by* M. Picchiani et al.

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Anonymous Referee #1

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This manuscript describes a volcanic ash detection and retrieval approach that makes use of Neural Networks theory applied to MODIS thermal infrared data. The analysis seems methodologically sound and the results clearly presented. The authors present the newly developed approach as a way of quickly detecting and quantifying volcanic ash presence and, therefore, minimizing the potentially large economic losses associated with the disruption of commercial air traffic as recently experienced in the

aftermath of the recent Eyjafjallajokull eruption. In their study, the authors conclude that as a consequence of the need of eliminating false positives in the ash identification process, the usefulness of the suggested NN-based technique is limited to cases when the volcanic emission is continuous allowing the detection and quantification only in the vicinity of the volcano. This limitation reduces the method's capability of ash detection and quantification thousands of kilometers downwind from the source where the volcanic ash may reach commercial air traffic routes. The authors should mention this shortcoming in both the conclusions section and in the abstract of the manuscript. A careful review of the manuscript by a native English speaker is recommended.

To follow the Referee general suggestions, the manuscript has been entirely reviewed by a native speaker. More, the limitations of the segmentation procedure has been mentioned also in the Abstract (the Conclusions already contains the same concepts). The following sentence has been added: "A segmentation procedure has also been tested to avoid the false positive ash pixels detection induced by the presence of high meteorological clouds. The segmentation procedure shows a clear advantage in terms of classification accuracy: the main drawback is the loss of information on ash clouds distal part."

Specific Comments

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Line 3 Use 'ash' instead of 'cloud' The term 'volcanic cloud' implies more than just the ash component.

The term "volcanic cloud" has been substituted with "volcanic ash cloud".

Line 13 The literature review fails to list the UV aerosol index as a well known method of absorbing aerosol detection and characterization including volcanic ash. Papers by Seftor et al, [JGR, 102, 1997] on the Mt. Pinatubo eruption and Krotkov et al, [GRL, 26, 1999] on Mt. Spurr should be included in the review.

In this paper only the ash retrievals from IR sensors have been considered. This is the reason why the UV literature has not been taking into account. To clarify this point, the sentence (Line 13): "The best known approach to detect and retrieve volcanic ash is based on the BTD of two channels centered on 11 and 12 μm." is substituted by: "The most widely approach to detect and retrieve volcanic ash is based on the Brightness Temperature Difference (BTD) procedure applied in the Thermal InfraRed (TIR) spectral range by using two channels centered around 11 and 12 μm."

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Line 7 Provide reference for the assumed ocean emissivity value.

The following reference has been inserted: ASTER spectral emissivity library database (http://speclib.jpl.nasa.gov/)

Line 13 Discuss the choice of Volz 1973 data on refractive index. Haven't we learned more about the optical properties of ash over the last 40 years?

Generally two volcanic ash refractive indexes are used for the ash optical properties retrievals: the first derives from Volz (1973) while the second from Pollack et al., (1973). The two refractive indexes are used in case of basaltic and andesitic ash respectively. Until now, no more recent Etna volcanic ash refractive index measurements, in the TIR spectral range, are available. Being the Etna volcanic ash emission mainly composed by basaltic particles, the Volz (1973) refractive index is generally considered a good approximation. However what is important to emphasize is that the results shown in this work take into account the retrieval errors due to the ash refractive index uncertainty, according to Corradini et al., 2008a.

Line 14 Discuss why the ash density data reported by Neal et al for the 1992 Mount Spurr eruption should be considered representative of the ash density of the 2001, 2002 and 2006 Mount Etna eruptions.

As for the ash refractive index, the Etna volcanic ash density is not known. For the dif-

ferent volcanic eruption, density values around 2.6 106 g/m3 are generally considered a good assumption (see for example: Prata and Grant, 2001; Yu et al., 2002; Corradini et al., 2010; Corradini et al., 2011).

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Line 10 The resulting spatial patterns can be compared to TOMS (2001, 2002) and OMI (2006) Aerosol Index observations as a way of assessing the effectiveness of the detection technique.

Such a comparison would be very useful in order to validate the detection products. But this is not the case. In this work what we want to show is that the NN approach applied to the MODIS measurements can reproduce the results obtained by the standard BTD technique.

Line 13 How persistent is the occurrence of false positives? It can be evaluated using an independent method of volcanic ash detection such as the UV aerosol index. Would it be possible to reduce false positives with the Aerosol Index?

The problem of false positives is one of the main problems of the BTD technique. It is well known (see as example: Prata et al., "Comments on "Failures in detecting volcanic ash from a satellite-based technique"", RSE v. 78, pp. 341– 346, 2001) that this technique produces false positives in some cases, for example over night-time data of clear land surfaces, over soils with a high quartz content (e.g., deserts) and over very cold surfaces (temperatures less than 220 K). We are now working on a new NN approach that will be able to avoid the most of the false positive pixels by using also the UV-VIS MODIS channels. In this sense the experience of the UV aerosol index will be used as reference.

Line 16 The line oriented approach severely limit the usefulness of the method. Only ash near the volcanic vent is detected. The long-range transport ash, which is generally associated with air traffic disruption problems described in the introduction goes undetected. The authors could combine UV and Thermal observations. It would be interesting to try a hybrid approach using UVAI for ash detection and the NN thermal IR for retrieving the volcanic ash mass.

The segmentation technique applied to avoid the false positive pixels is only a possible approach indicated to solve the problem. Clearly such a procedure can be used only if the main interest is to study the volcanic emissions near the vent i.e. to give insights on the volcanic eruptions. As written before, the use of the UV measurements could improve the detection including the long-range transport ash: this work is ongoing and will be described in the next paper.

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Line 10. How can the results of this analysis be validated?

The main aim of this paper is to show that the NN approach is able to reproduce the results obtained by the BTD technique. In this case the 'validation' is limited to the comparison between the NN products and the BTD products. For the validation (cross-comparison) of the MODIS ash products see as examples Corradini et al., 2010 and Corradini et al., 2011.

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