

Response to Anonymous Referee #2

Ash plume top height estimate using AATSR

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This is a very good manuscript, well done! The structure is good, as well as the use of English language and the science is sound! But I would suggest some small corrections/additions.

We thank the Referee for the positive feedback and constructive comments. The comments are addressed below and the changes to the manuscript are listed at the end of this document.

- *First, it would be fair to mention at least some other operational cloud height monitoring methods (BT and CO2). And then you can say that these methods cannot offer the same accuracy as the photogrammetric methods.*

We have added a short chapter on other methods to the introduction.

- *What I would suggest to the authors is to add 2-3 sentences to explain how specifically is their work different from study described in the paper of Prata and Turner (1997).*

The main difference between the present work and the previous work of Prata and Turner is the use of different definitions for the cross correlation coefficient C , as already shown in equations (1) and (3). We have now emphasized this difference more in the discussion before Eq. (3) on page 3871. In addition, there are some other differences such as the automated ash detection, which are already discussed in the manuscript.

- *As the first reviewer also noticed, you are describing not the operational MISR product but the results obtained by the Minx software, so add reference to: <http://www.mdpi.com/2072-4292/5/9/4593>*

We agree that the suggested reference (Nelson et al., 2013) is more appropriate, and have added it to the text.

- *In addition, it would be nice to know, how fast is your implementation, because this is important information for real time volcano monitoring. Furthermore, what kind of software / programming language did you use? Is the code available...?*

The ACM height retrieval code was written in Fortran and implemented as a part of the larger ADV/ASV aerosol optical depth retrieval algorithm. It is a research algorithm still under development, and as such not available as a stand-alone tool. Any researcher interested in the code are encouraged to contact the authors for collaboration.

The code was run on a regular table-top PC. The time consumption of the code depends naturally on the retrieval parameters and the number of ash flagged pixels. A typical run on an AATSR scene of 10.000 ash-flagged pixels takes about five minutes with the standard parameters (Table 1). A full scene height estimate takes much longer, so the automated ash detection is crucial for NRT volcano monitoring, as discussed in the introduction (page 3866, lines 19-21).

We have added a short description of the implementation to the end of section 2.4.

- *You mentioned that semi-transparent plumes are not as easy to detect in visible data, but what about the correlation? Is it of the same order in VIS as in TIR? The shades provide extra contrast which is probably not the case in the TIR data so I would assume that if clouds/plume has 'rough' topography, then is image matching robuster in the VIS data. A short discussion...*

The initial tests with different wavelengths show similar cross correlation coefficients on average (slightly lower C for VIS), but large differences in pixel-by-pixel comparison. A more detailed comparison between VIS and TIR detection is needed, and will be addressed later. This is now indicated in the text.

- *3887/15 KM, not HM*

Corrected.

Change log

The changes made to the manuscript are listed below.

- Page 3865, line 18. Added chapter: 'Other methods for plume top height estimate include satellite based lidars, brightness temperatures (BT) methods, and CO₂ absorption techniques. The Cloud-Aerosol Lidar with Orthogonal Polarization (CALIOP) has a vertical resolution up to 30 m, but a very limited coverage. BT methods are based on comparing the measured plume BT to atmospheric temperature profiles, and the absorption technique uses the wavelength dependence of CO₂, but these methods generally do not provide the same accuracy as the purely geometric stereo matching methods. These alternative methods are recently discussed e.g. by Zakšek et al. (2013) and Ekstrand et al. (2013).'
- Page 3872, line 25. Added chapter: 'The ACM height retrieval algorithm was written in Fortran and implemented as a part of the larger ADV/ASV aerosol retrieval algorithm. A typical run on an AATSR scene of 10.000 ash-flagged pixels takes about five minutes on a regular table-top computer. A full scene height estimate takes much longer, so the automated ash detection is crucial for NRT volcano monitoring, as discussed in the introduction.'
- Page 3871, line 9. Replaced
'The approach adopted here is to consider the deviation of the measured values from the local average, instead of the measured values themselves (Muller et al., 2007; Zakšek et al., 2013; Fisher et al., 2013).'
- by
'Instead of following the method of Prata and Turner (1997) as such, the approach adopted here is to consider the deviation of the measured values from the local average, instead of the measured values themselves (Muller et al., 2007; Zakšek et al., 2013; Fisher et al., 2013).'
- Page 3887, line 12. Replaced '3-5 hm' by '3-5 km'.

Note that other changes are made based on the comments of Referee #1 (not listed here).