Validation of Absorbing Aerosol Height product from GOME-2 using CALIOP data

De Bock, V.[1], Pardo Cantos, I. [2], Laffineur, Q. [1], Mangold, A. [1], Tilstra, G. [3], Tuinder, O. [3], and Delcloo, A.[1,4]

[1] Royal Meteorological Institute of Belgium, Uccle, Belgium
[2] Université de Liège, Liège, Belgium
[3] Royal Netherlands Meteorological Institute, De Bilt, The Netherlands
[4] Ghent University, Ghent, Belgium

1 Introduction

The Absorbing Aerosol Height (AAH) is a new GOME-2 product for aerosol detection developed within the Atmospheric Composition Satellite Application Facility (AC-SAF). It uses the Absorbing Aerosol Index (AAI) and derives the actual height of the absorbing aerosol layer in the O2-A band using the Fast Retrieval Scheme for Cloud Observables (FRESCO) algorithm (Tilstra et al. 2010). This AAH product could be used to monitor volcanic eruptions globally and to provide the height of the ash layers (e.g. within the framework of aviation safety).
To determine the quality of the AAH, a new quantitative validation exercise has been done, using the extracted height of the different aerosol layers from CALIOP and comparing this to the AAH from GOME-2. The results from different case studies will be presented.

2 Method

- Download CALIOP Vertical Feature Mask data (version 4.20) from NASA Langley Research Center Atmospheric Science Data Center
- Retrieve aerosol type(s) and layer height from CALIOP
- Retrieve AAH from GOME-2 for AAI>4 cases
- Compare CALIOP layer height with AAH for points located within 100km distance

3 Some validation results

3.1 Case 1: Calbuco eruption

- On 23/04/2015, the ash plume rose higher than 15 km and drifted N, NE, and E.

Fig. 1 shows the aerosol layers detected by CALIOP and GOME-2 for 23/04/2015 (left) and 24/04/2015 (right).

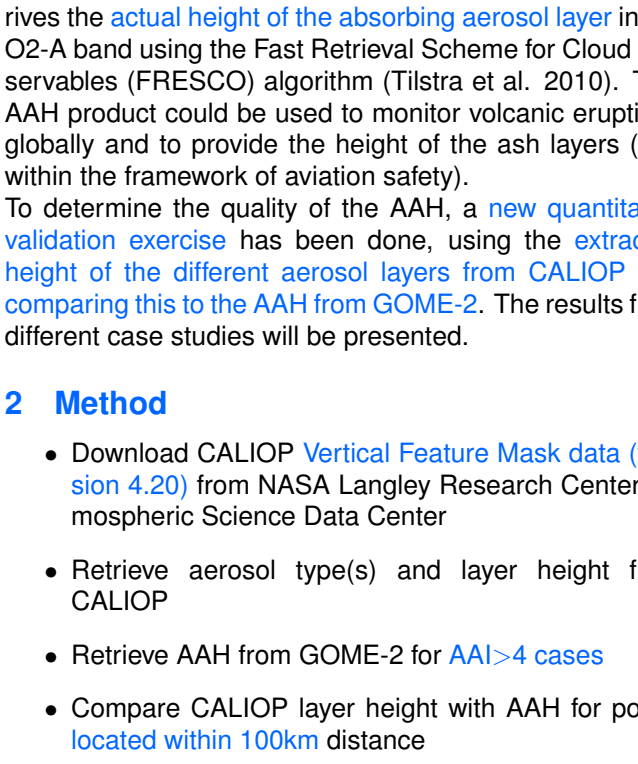

Figure 1. The figures on top show the location of the volcano (in red) and the GOME-2 (in green) and CALIOP (in blue) overpasses for 23/04/2015 (left) and 24/04/2015 (right). The figures in the middle show the differences between the aerosol layer height observed by CALIOP and the corresponding AAH observed by GOME-2 for different aerosol types as observed by CALIOP in function of the distance between GOME-2 and CALIOP. The bottom figures show the minimum and maximum aerosol layer height detected by CALIOP and the AAH from GOME-2.

On 23/04/2015, CALIOP detected volcanic ash between 13-18.5 km altitude and stratospheric elevated smoke between 15.5-17 km altitude. The AAH of GOME-2 was lower (between 10.5-14.5 km) and thus underestimated the altitude of the volcanic layers. It needs to be mentioned that the AAH can never be higher than 15 km as a result of using the FRESCO algorithm.

On 24/04/2015, CALIOP detected several aerosol species: dust and polluted dust between 0.2-5.5 km; volcanic ash between 13-17.5 km; sulfate and stratospheric elevated smoke between 14.5-15 km. The AAH of GOME-2 was between 1.8-4.8 km.

3.2 Case 2: Puyehue eruption

- On 05/06/2011, the ash plume rose to 10.7-12.2 km and drifted ESE over the coast of Argentina and into the Atlantic Ocean.

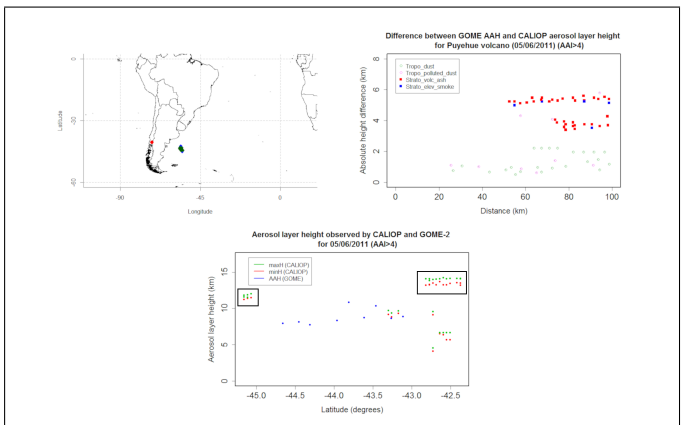

Figure 2. The figure shows the location of the volcano (in red) and the GOME-2 (in green) and CALIOP (in blue) overpasses for 05/06/2011 (top left). The top right plot shows the differences between the aerosol layer height observed by CALIOP and the corresponding AAH observed by GOME-2 for different aerosol types as observed by CALIOP in function of the distance between GOME-2 and CALIOP. The bottom plot shows the minimum and maximum aerosol layer height detected by CALIOP and the AAH from GOME-2. The volcanic ash layer is indicated by the boxes.

On 05/06/2011, CALIOP detected volcanic ash between 11-14 km, stratospheric elevated smoke between 13.5-14 km, dust between 5.5-9.5 km and polluted dust between 4-9.5 km. GOME-2 AAH was between 4-11 km.

3.3 Case 3: Grimsvotn eruption

- On 23/05/2011, the ash plume rose to 5-10 km and drifted S at lower altitudes and W at altitudes over 8 km.

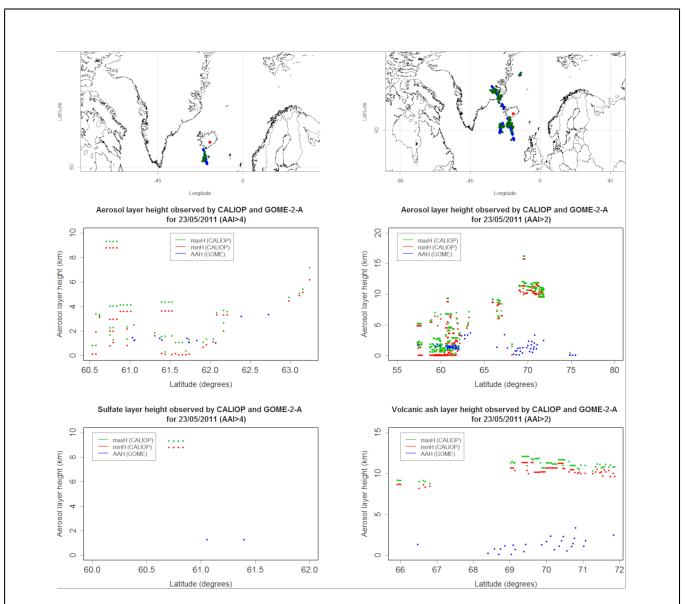

Figure 3. The top plots show the location of the volcano (in red) and the GOME-2 (in green) and CALIOP (in blue) overpasses for 23/05/2011 for AAI>4 (left) and AAI>2 (right). The middle plots show the minimum and maximum aerosol layer height detected by CALIOP and the AAH from GOME-2 for the AAI>4 (left) and the AAI>2 (right) case. The bottom plots show the minimum and maximum height of the sulfate (left) and volcanic ash (right) layer detected by CALIOP and the AAH from GOME-2 for the AAI>4 (left) and the AAI>2 (right) case.

When only taking the AAI>4 GOME points into consideration, there are only CALIOP observations of dust, polluted dust and sulfate located within 100 km. The height of the sulfate layer is between 8.8-9.3 km and the corresponding AAH is 1.2-1.3 km. However, when we would also look at AAI>2, there are much more points in the comparison. CALIOP data now also include observations of volcanic ash (at 8.2-12.1 km), sulfate (at 8.8-16.3 km) and elevated smoke (8.4-10.9 km). The corresponding AAH is lower than 3.4 km.

3.4 Case 4: Mount Kelud eruption

- On 13/02/2014, ash plumes rose to an altitude of 17 km and caused ashfall in areas NE, NW and W of the volcano.

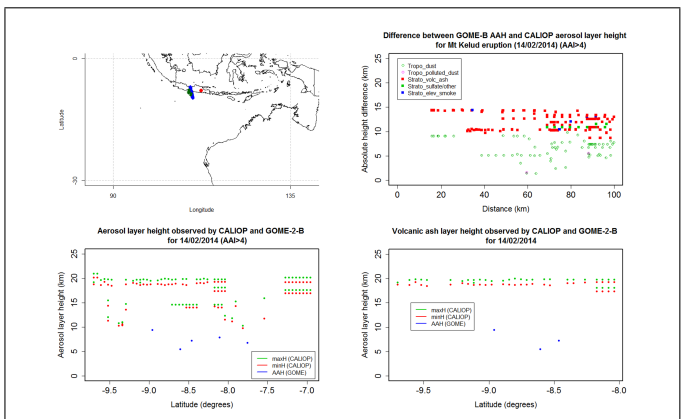

Figure 4. The figure shows the location of the volcano (in red) and the GOME-2 (in green) and CALIOP (in blue) overpasses for 14/02/2014 (top left). The top right plot shows the differences between the aerosol layer height observed by CALIOP and the corresponding AAH observed by GOME-2 for all aerosol types as observed by CALIOP in function of the distance between GOME-2 and CALIOP. The bottom plots show the minimum and maximum height of the aerosol layer (left) and the volcanic ash layer (right) detected by CALIOP and the AAH from GOME-2.

It can be seen that the AAH does not agree with the height of the volcanic layer observed by CALIOP.

4 Conclusions/Outlook

The amount of data for comparison is often highly limited when only using AAH calculated under conditions with AAI>4.

Finding perfect collocations both in space and time between GOME-2 and CALIOP overpasses is challenging.

For the volcanic case studies, the AAH clearly underestimated the height of the volcanic aerosol layers detected by CALIOP. The fact that GOME-2 AAH is limited at 15km plays a role.

Dispersion modelling will be used in the future to study the bin size of the aerosol layer and to determine the representative type.

5 References and acknowledgements

- Tilstra et al. (2010), GOME-2 Absorbing Aerosol Index: statistical analysis, comparison to GOME-1 and impact of instrument degradation, in Proceedings of the 2010 EUMETSAT Meteorological Satellite Conference, EUMETSAT P.57, ISBN 978-92-9110-089-7, Cordoba, Spain.

- Information on the studied volcanos was found at: https://volcano.si.edu/
- The CALIOP data were obtained from the NASA Langley Research Center Atmospheric Science Data Center.

De Bock V. et al., Royal Met. Inst., Ringlaan 3, B-1180 Brussels, Belgium.
Veerle.DeBock@meteo.be