NWP SAF

CADS Version 2.3 Aerosol Validation

Version 1.1

28th February 2017

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This documentation was developed within the context of the EUMETSAT Satellite Application Facility on Numerical Weather Prediction (NWP SAF), under the Cooperation Agreement dated 29 June 2011, between EUMETSAT and the Met Office, UK, by one or more partners within the NWP SAF. The partners in the NWP SAF are the Met Office, ECMWF, KNMI and Météo France.

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Version	**Date**	**Author**	**Approved**	**Remarks**
1.0	24.2.17	Jerome Vidot		
1.1	28.2.17	Jerome Vidot		Corrections from Reima Eresmaa added

Table of Contents

1. INTRODUCTION

The cloud and aerosol detection software (CADS) of the NWPSAF have been evaluated for the detection of aerosol with IASI on METOP-A. For that, the IASI observations on the 24th April 2015 of IASI have been processed by the ECMWF and compared with the ESA/CCI Aerosol products from ULB. During this day two types of aerosols are expected to be detected. Firstly, a large plume of desert dust is often observed at this time over the middle Atlantic as well as aerosols over African desert, Middle East and over Asia. Secondly, a strong eruption of the Calbuco volcano (Chile) started on 22nd April 2015 and produced a large ash cloud that rose 15 kilometers above the volcano. During the week after, aerosols from the volcanic eruption have crossed the South Atlantic towards South Africa.

Starting from the best confident AOD retrievals from ULB, we matched ULB and CADS pixels to evaluate the aerosol detection from CADS. The questions we tried to answer are:

- How many pixels with AODs greater than zero are detected by CADS?
- If CADS do not detect aerosol-contaminated pixels, are they flagged as clouds by CADS?
- If they are not flagged as clouds what are the values of AOD of such pixels?

2. AEROSOL DATASET

2.1 CADS product

The Cloud and Aerosol Detection Software (CADS) version 2.3 [Eresmaa, 2016] of the NWP SAF have been processed by ECMWF on IASI-A during daytime and night-time of the 24th April 2015. The total number of processed pixels is more than 1.2 millions. Based on the cloud and aerosol binary flags, the distribution of the classification is 22204 clear-sky pixels, 1095993 cloud-sky pixels only, 95655 cloudy and aerosol-flagged pixels and 794 aerosol-flagged pixels only, which correspond to 1.9%, 90%, 8% and 0.1% of the total number of observations, respectively. The Fig. 1 shows the global distribution of CADS aerosol-flagged pixels during daytime (top) and night-time (bottom).

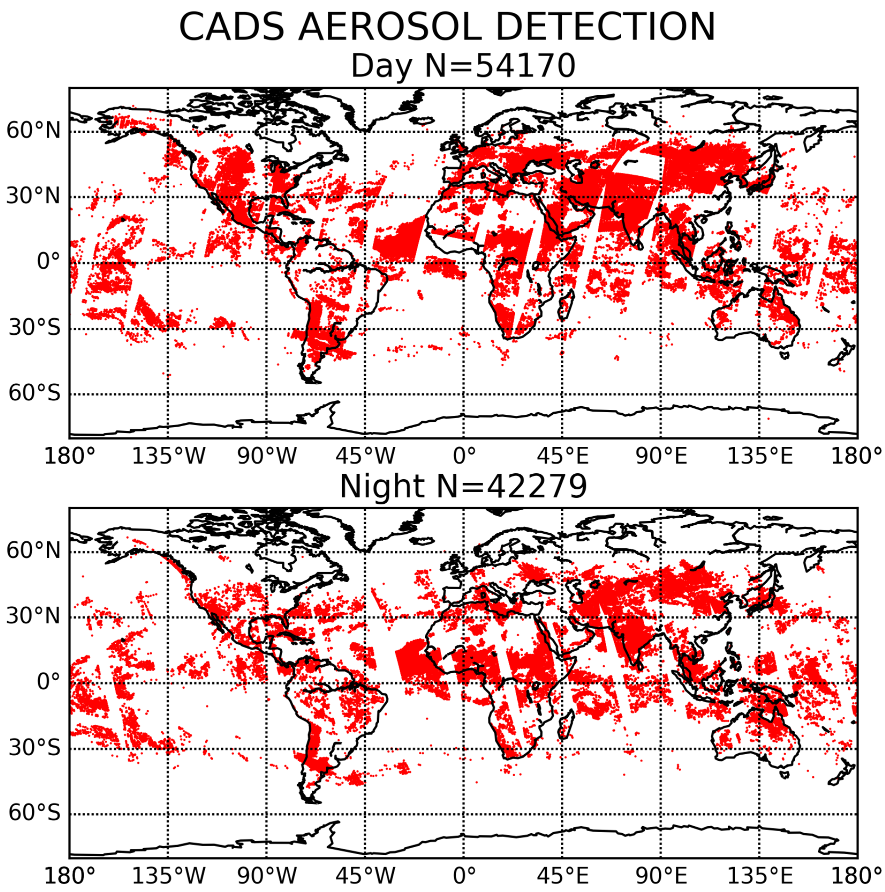

Figure 1: Global distribution of the CADS aerosol-flagged IASI A pixels on the 24th April 2015 at daytime (top) and night-time (bottom).

2.2 ULB aerosol product

Many groups are developing aerosol retrieval product from IASI and four of their products are available through the ESA/CCI aerosol project (http://www.esa-aerosol-cci.org/). We used the IASI aerosol product from the Université Libre de Bruxelles (ULB, Clarrise et al., 2013) which have been found to provide the best performances amongst the four ESA/CCI aerosol retrieval algorithms when comparing to ground-based measurements (Popp et al., 2016). The ULB products use in this study consist in the retrieved aerosol optical depth (AOD) at 10 microns, the cloud flag (based on the EUMETSAT L2 product) and in binary quality indices (named pre- and post-processing). The panel of Fig. 2 represents the global distribution of the ULB retrieved AOD at 10 microns for daytime (top) and night-time (bottom). The cloud flag and the binary quality indices of both pre- and post-processing have been switched on. During daytime ULB retrieved AOD are found for 89248 pixels and during night-time for 63437 pixels. The total number of pixels is 152685 aerosol-flagged pixels. As expected higher AODs are retrieved over middle Atlantic, African deserts, Middle East, India and Asia. Additionally, high AODs over Chile and Argentinia are also retrieved due to the Calbuco eruption.

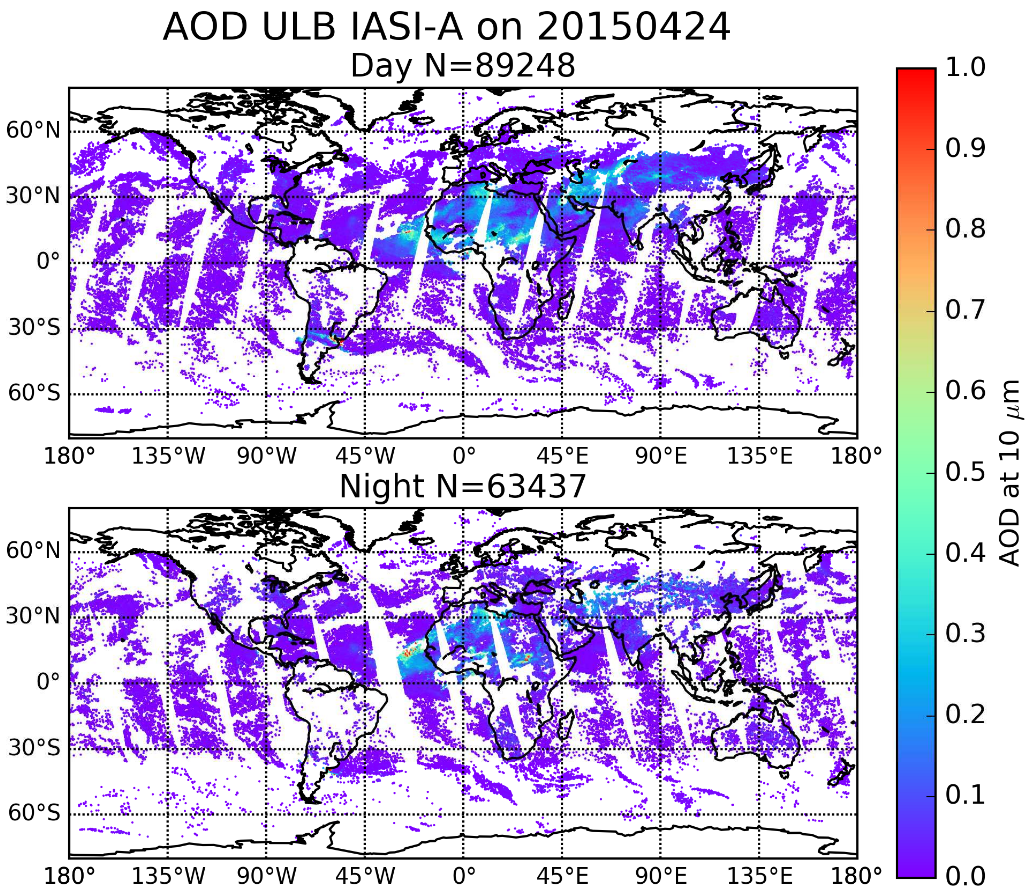

Figure 2. Aerosol Optical Depth from ULB for IASI-A on the 24th April 2015 at daytime (up) and night-time (bottom)

3. VALIDATION RESULTS

3.1 ULB/CADS match-ups

The Fig. 3 shows the ULB AOD for the pixels classified as aerosols by CADS. The percentage of detection is 27.5 % for daytime and 19.2 % for night-time. CADS is able to detect the aerosol plume above middle Atlantic in daytime and night-time. CADS is also able to detect the volcanic aerosol plume when ULB show it at daytime. Over African desert, CADS detect partially desert dust as compared with ULB. Over Middle East, India and Asia, the CADS is also able to detect aerosol as observed by ULB. It is worth mentioning here that CADS seems to also detect volcanic ash during night-time (See bottom of Fig. 1) but it is not verified by ULB. It would be interesting to discuss this point with the ULB groups. On the Fig. 4 is represented the histograms of the number of pixels in function of AOD for daytime (in red) and for night-time (in blue). Most of detected pixels have AOD lower than 0.3.

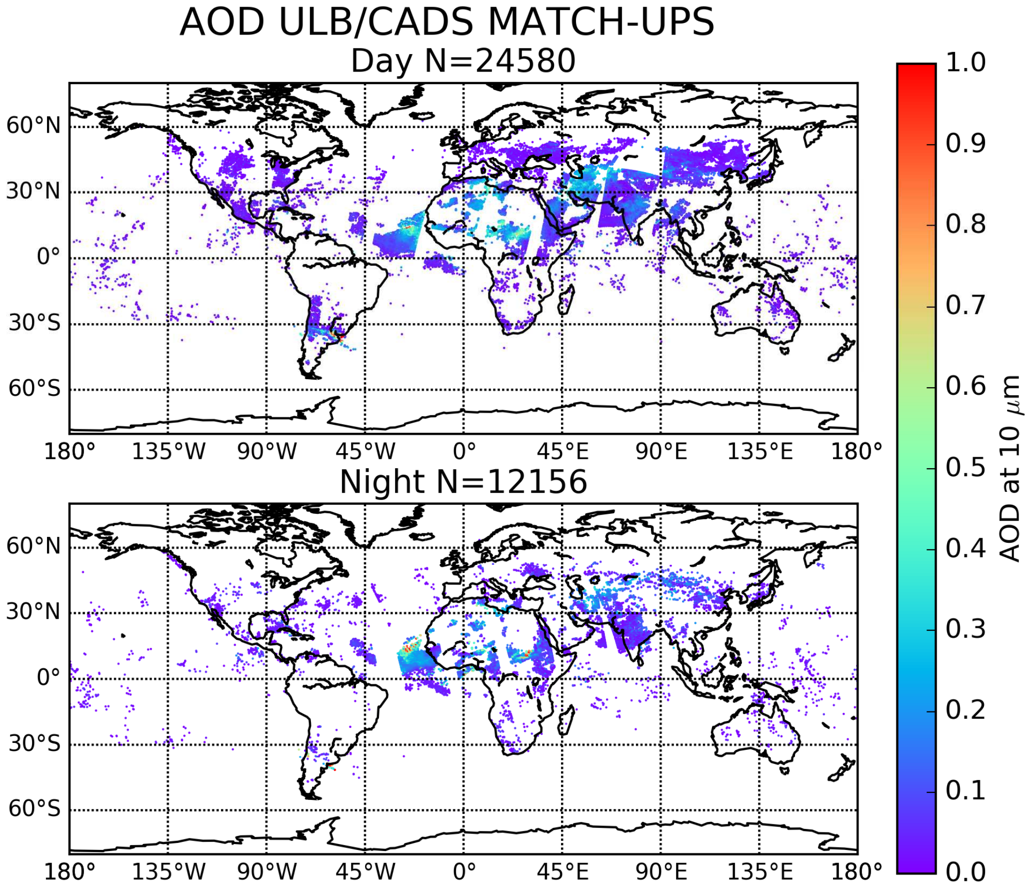

Figure 3. ULB AOD for ULB/CADS match-ups.

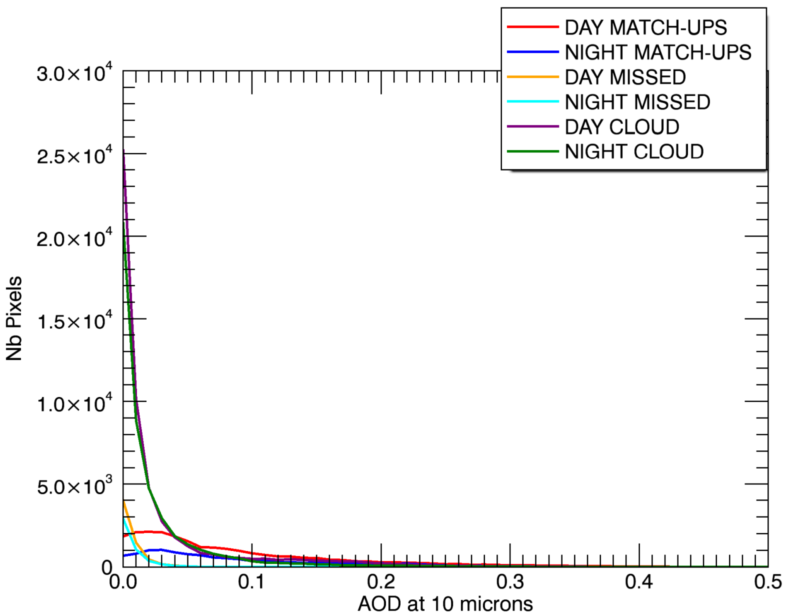

Figure 4. Histograms of the number of pixels in function of AOD for match-ups at daytime (red line) and night-time (blue line), for missed CADS aerosols pixels (orange and cyan lines, respectively) and for CADS cloud-flagged (in purple and grenn lines, respectively).

3.2 ULB AOD classified as cloud by CADS

The Fig. 5 shows the ULB AOD for pixels classified as cloud by CADS. The percentage of CADS cloud-flagged as compared to Fig. 2 is 60.1% for daytime and 72.9 % for night-time. Most of the cloud-flagged pixels have low optical depth over ocean and the CADS missing aerosol-flagged pixels with high ULB AOD over African desert are classified as clouds by CADS.

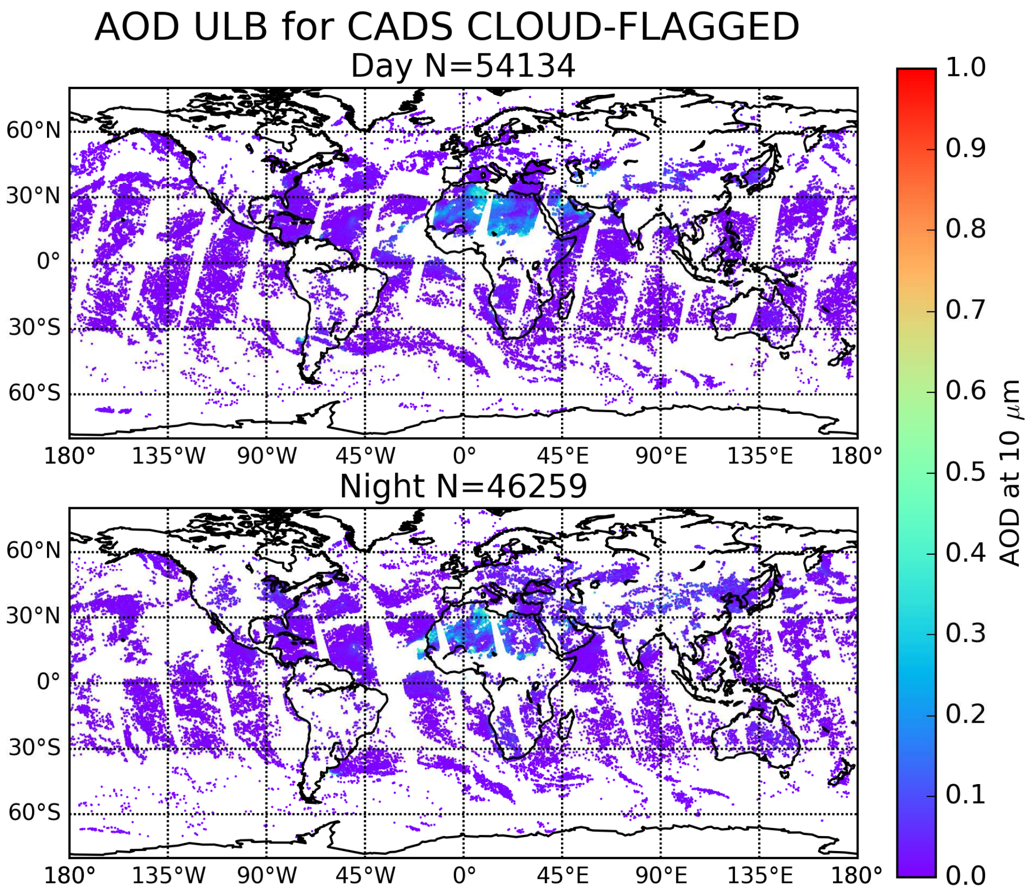

Figure 5. ULB AOD for cloud-flagged pixels by CADS.

3.3 ULB AOD undetected by CADS

The Fig. 6 shows the ULB AOD for pixels classified as clear-sky by CADS. The percentage of CADS clear-sky as compared to Fig. 2 is 7% for daytime and for night-time. It is interesting to notice that all CADS undetected aerosol pixels are above ocean with values below 0.05 (see Fig. 3 in cyan and orange lines). There are still few pixels with higher optical depth above ocean at the coast of Senegal during night-time.

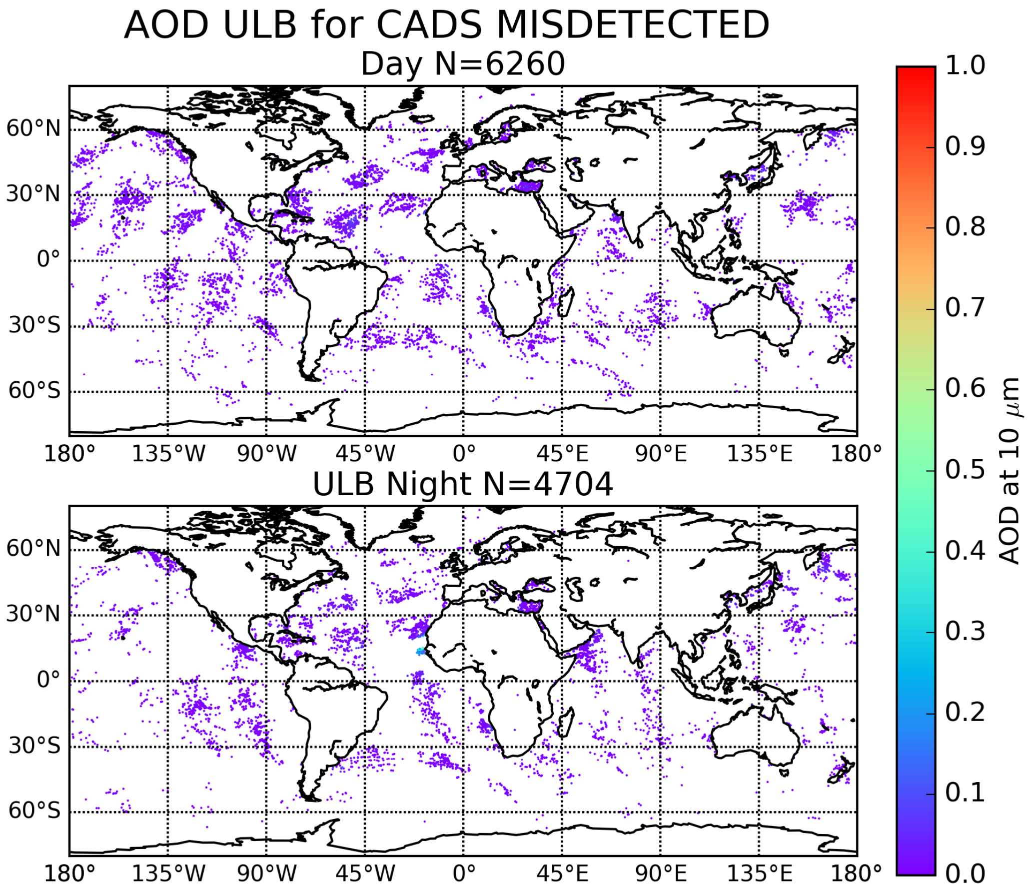

Figure 6.ULB AOD of the clear-sky CADS pixels.

4. CONCLUSION

The CADS version 2.3 aerosol detection algorithm have been evaluated on one day of IASI-A by comparing the CADS aerosol-flagged pixels with the retrieved AOD from ULB. Over this day the numbers of aerosol contaminated pixels are different: 96449 for CADS and 152685 for ULB. This difference might be explained by the cloud detection methods of the two products. CADS have his own cloud detection scheme whereas ULB uses the EUMETSAT L2 cloud product. Nevertheless, we showed that the NWPSAF CADS is able to detect the two types of aerosol (desert dust and volcanic ash). By doing a collocation of ULB and CADS pixels, we also found that on a daily basis 26% of ULB aerosol contaminated pixels are detected by CADS, 67 % are classified as clouds by CADS and the remaining 7% classified as clear-sky by CADS have optical depth below 0.05. We also found that some pixels classified as aerosol by CADS are not retrieved by ULB and very few clear-sky CADS pixels have optical depth around 0.2.

5. REFERENCE

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