AEROSOL RETRIEVAL FROM OMI: APPLICATIONS TO THE AMAZON BASSIN

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ABSTRACT

We present the aerosol optical depth retrieved from OMI measurements using the multi-wavelength algorithm for two different environments: over Western Europe where the aerosols are weakly absorbing and over the Amazon basin where aerosol optical properties are governed by biomass burning. The results are evaluated by comparison with MODIS data. Over Western Europe OMI and MODIS aerosol optical depth are well-correlated, although the multi-wavelength algorithm appears to overestimate the aerosol optical depth values with respect to MODIS . Over the Amazon Basin the datasets are poorly correlated. Ongoing work to constrain the height and improve the retrieval of AOD over the Amazon basin is expected to be finalize by fall 2007.

Key words: OMI, Aerosols.

1. INTRODUCTION

It is well known that aerosols affect the Earth's radiative balance, therefore it is of primary importance to monitor them. It is hard to make an estimation of the radiative forcing due to aerosols - because of the large variety of sources and precursors and the high variability of their concentrations and optical properties in both time and space - but necessary for a better understanding and modeling of the terrestrial climate. Satellite observations provide information on aerosol properties over a large area and can be used for monitoring on regional and global scales.

The aerosol optical depth (AOD) is one of the aerosol optical properties which can be derived from satellite data. The AOD provides information on the total concentration of particles and its spectral variation gives indications the size distribution. Current techniques allow for their retrieval over both ocean and land. The Ozone Monitoring Instrument (OMI, [1, 2]) is a Dutch-Finnish contribution to the Aura mission. OMI is a nadir viewing spectrometer, which measures reflected and backscattered solar light in a part of the UV-Visible domain (270-500 nm). The near-UV part of the spectrum observed by OMI enables the detection of absorbing aerosols such as minerals and carbonaceous aerosols. To derive aerosol optical properties from the reflectance at the top of the atmosphere measured by OMI, a new multi-wavelength algorithm was developed, [3]. In this study, OMI is used to retrieve the AOD for two different aerosol populations: weakly absorbing aerosols, over Western Europe for May to July 2005 and biomass burning aerosols, over the Amazon basin for november 2006 to February 2007.

The main goal of this study is to validate the consistency of the OMI aerosol properties derived by means of the multi-wavelength algorithm. The derived properties will be compared to their counterparts, i.e. ground-based measurements or derived from other space borne based instrument like MODIS. Results from an application of this algorithm over Western Europe and the Amazon basin are presented.

2. THE MULTI-WAVELENGTH ALGORITHM

The multi-wavelength algorithm [3] has been developed to retrieve AOD using OMI measured reflectance at the top of the atmosphere (OMAERO product). Improved retrievals have been achieved by using surface reflectance data from a field campaign in Cabauw (The Netherlands), a new cloud screening method and a global aerosol database derived from the aerosol transport model TM5, [4]. Up to 20 wavelength bands between 350 and 500 nm are used. For cloud-free pixels, the OMI measured reflectance at the top of the atmosphere (TOA) at these wavelengths is fitted for in total 50 aerosol models. The surface reflectance is obtain from either a surface reflectivity database, or an ocean color model.

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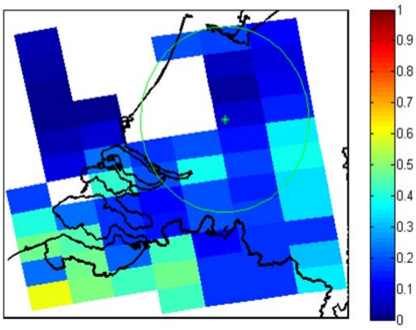
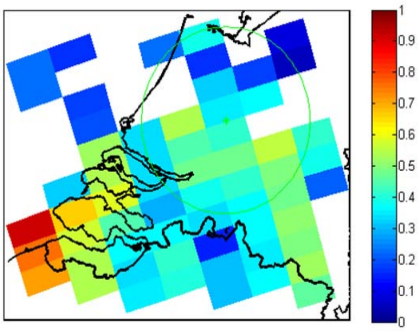


(a) June 19, 2005



(b) June 23, 2005

Figure 1. Composite map of the AOD derived at 442 nm over Western Europe for two different airmasses. Clean airmass, June 19th, 2005 and a polluted one, June 23rd, 2005

3. RESULT AND DISCUSSION

In the following section we discuss the AOD derived by the multi-wavelength algorithm to the aerosol optical depth derived by MODIS. The MODIS instrument is often used as a reference for comparison with other data. Because MODIS and OMI view the same area within 15 minutes, the AOD distribution should be very similar. MODIS aerosol data (collection 4) have been meshed into the OMI grid for Western Europe and the Amazon Basin. The results are separately presented for land and ocean as MODIS and OMI use different algorithm for dark and bright surfaces.

3.1. Urban Industrialized Aerosols : Western Europe

The retrievals were made over Western Europe for May to July 2005 for wavelengths of 342.5, 367.0, 388.0, 406.0, 425.5, 442.0, 463.0, and 471.0 nm. The observed area is located between latitude 60°N 35°N and longitude 25°E and 15°W.

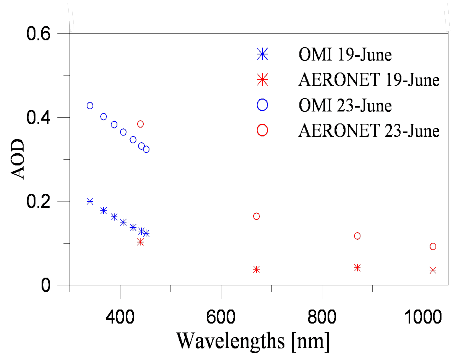


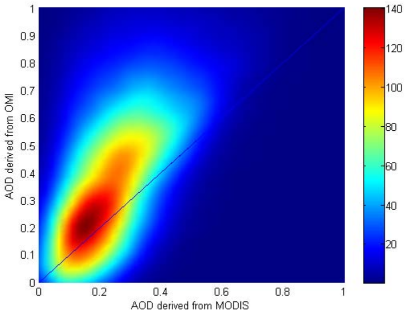
Figure 2. Comparison of the mean AOD retrieved using the multi-wavelength algorithm(blue) and AOD measured by sun photometers (red)

Table 1. Correlation between OMI and MODIS for Western Europe for dark surface

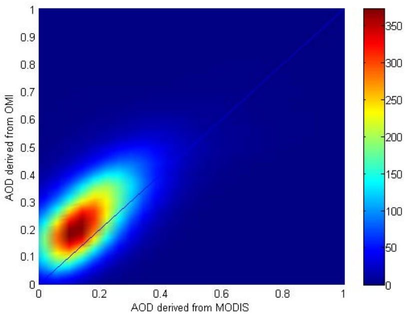
Month	correlation(%)	slope	offset
May	77.27	1.165	0.0445
June	76.44	0.9945	0.0711
July	81.42	0.7717	0.1238

Figure 1 shows composite maps of the AOD retrieved from the multi-wavelength algorithm for two case study: clean air on June 19th, figure 1(a) and polluted air on June 23rd, figure 1(b), for the south west of The Netherlands. Despites the size of the pixels, the multi-wavelength algorithm shows the AOD gradient with the high AOD values associated with strongly industrialized area like for example Amsterdam and Rotterdam. The satellite derived AOD were compared to ground based sun photometer data from Cabauw, figure 2. The measured, in red, and derived, in blue, AOD compare favorably.

Figure 3 is a scatter density plot of the AOD derived from OMI at 471 nm as a function of the AOD derived by MODIS at 470 nm. Figure 3(a) as well as figure 3(b) show a clear correlation between both dataset. However, the multiwavelength algorithm appears to overestimate the AOD values with respect to MODIS. Table 1 presents the correlation coefficient between the OMI dataset and the MODIS dataset over dark surfaces for May to July 2005 over Western Europe. Table 2 presents the correlation coefficient for bright surfaces. The multi-wavelength algorithm seems to perform better over sea than over land. The lower correlation over land is also explained by the fact that MODIS is over land less reliable than over sea, [5, 6].



(a) land



(b) sea

Figure 3. Scatter density plot of the AOD at 471 nm derived from OMI data as a function of the AOD at 470 nm derived from MODIS data over Western Europe for May to July 2005. a) represents sea pixels and the right panel and b) shows land pixels.

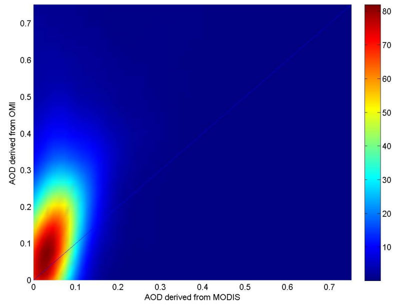
3.2. Biomass Burning Aerosols : Amazon Basin

The retrievals were made over the Amazon Basin for November 2006 to February 2007 for 14 wavelengths. The results are here presented at 477 nm. The observed area is located between latitude 5°N 25°S and longitude 35°W and 75°W. As we consider the Amazon Basin, results are presented only for land pixels.

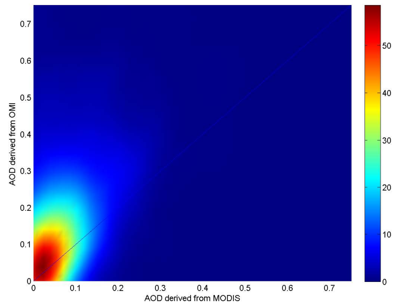
Figure 4 shows scatter density plots of the AOD derived from OMI and the AOD provided by MODIS for each month of the considered period. Over the Amazon basin, the AOD dataset the correlation between MODIS and OMI is less than over Western Europe. The correlation decrease by about 20% during the rainy season The OMI values are considerably larger. Part of this over estimation may due to undetected clouds. A preliminary study done over the Atlantic ocean for desert dust aerosols suggests that the multi-wavelength algorithm overestimates the AOD where the aerosol layer heights are underestimated. This may also cause the relatively high OMI AOD values. Therefore, to improve the AOD retrieved by OMI, lidar (CALIOP) data will be introduced to constrain the aerosol retrievals.

Table 2. Correlation between OMI and MODIS for Western Europe for bright surface

Month	correlation(%)	slope	offset
May	69.66	1.244	0.0559
June	60.42	1.091	0.1144
July	58.74	1.049	0.1618



(a) november



(b) february

Figure 4. Scatter density plot of the AOD at 477 nm derived from OMI data as a function of the AOD at 470 nm derived from MODIS data over Amazon Basin for November 2006 and February 2007.

Table 3. Correlation between OMI and MODIS for Amazon Basin

Month	correlation(%)	slope	offset
November	63.16	1.7461	0.0927
December	41.18	1.0645	0.2188
February	44.40	1.0122	0.1125

4. CONCLUDING REMARKS

The spatial variation of the AOD over Europe for May to July 2005 was derived from OMI data. The first results from OMI multi-wavelength algorithm are promising. The direct comparison between the AOD derived from the multi-wavelength algorithm and the values derived from MODIS show a correlation for both areas, although OMI has a tendency to overestimate the AOD value with respect to MODIS. Ongoing work to introduce lidar height and constrain aerosol retrieval, is expected to be finalize by fall 2007.

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