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# DEVELOPMENT/ENHANCEMENTS OF AEROSOL PRODUCTS FROM MSG SEVIRI

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# DEVELOPMENT/ENHANCEMENTS OF AEROSOL PRODUCTS FROM MSG SEVIRI

## 1 INTRODUCTION

This paper describes the current work at EUMETSAT with the goal to derive operational aerosol products over land and over the ocean from SEVIRI on Meteosat Second Generation. Currently two different approaches are adopted over land (optimum estimation technique) and over the ocean (threshold technique). The paper responds to Action 33.06.

Various studies have demonstrated the importance of adequate aerosol information. For instance, Tompkins et al. (2005) have shown that an improved aerosol climatology improves the ECMWF 5-day forecast of the African Easterly Jet due to the direct radiative heating. It could be concluded that actual aerosol information would lead to even better impact. Concerning climate simulations we just recall the work of Cusack et al. (1998) who demonstrated that a simple aerosol climatology in the Hadley Centre general-circulation model is the only plausible means of reducing significant short-wave biases at the top of the atmosphere compared with earth radiation budget measurements from satellites and solar irradiance measurements at the surface.

## 2 Aerosol over Ocean Surfaces

The adopted Meteosat Second Generation (MSG) approach to derive the aerosol optical depth over ocean essentially follows the single-channel retrieval method described by Ignatov and Stowe (2002). This method was originally developed for the Advanced Very High Resolution Radiometer measurements (AVHRR) onboard the NOAA polar orbiters and is also successfully applied to the Moderate Resolution Imaging Spectroradiometer (MODIS) onboard the TERRA and AQUA spacecraft.

The MSG channels VIS0.6, VIS0.8, and NIR1.6, which measure reflected solar radiation, are all useful for aerosol retrievals. These retrievals are made in cloud-free conditions and outside the sun glint area. The algorithm for each reflectance channel uses appropriate single-channel lookup tables, the tables being calculated for the same aerosol model, non-aerosol atmospheric parameters like Rayleigh scattering, gaseous absorption and oceanic reflectance.

Comparisons of initial MSG results with collocated polar orbiter data – using the same algorithm – show good agreement. Figure 1 is an example for the single channel VIS0.6 aerosol optical depth. Minor problem areas involve the derivation of a reliable cloud-free mask and an appropriate application of the MSG land-sea mask. The example in the Figure shows the obvious problem areas near coasts where pixels with some land fraction result in unrealistic high aerosol optical depth.

An operational implementation of this aerosol retrieval within the MSG central meteorological processing at EUMETSAT is envisaged for 2007.

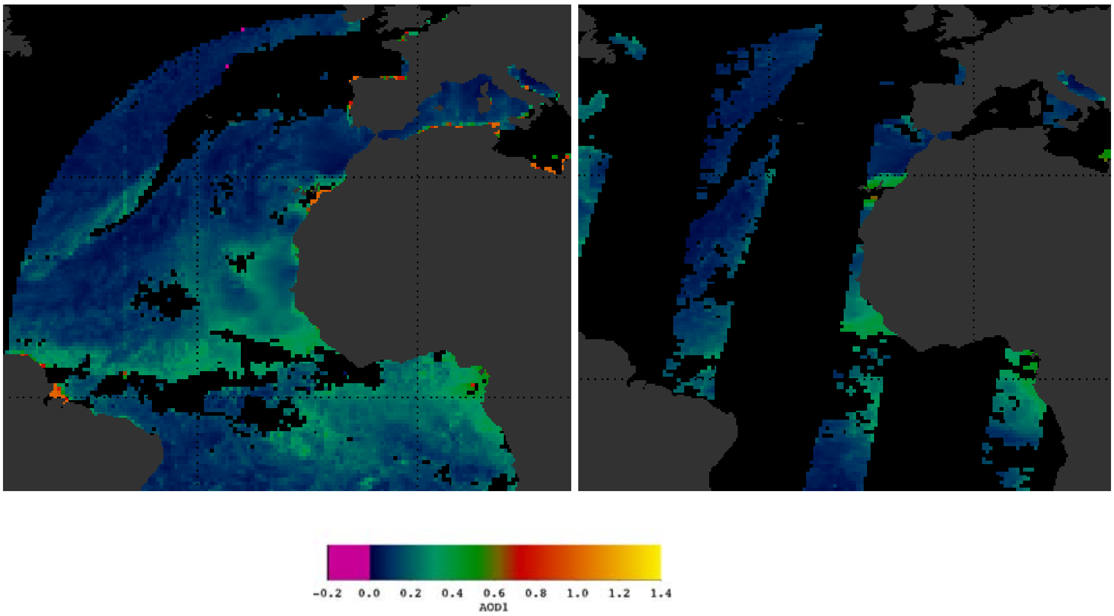


Figure 1: Example of retrieved optical depth using the single-channel approach for MSG VIS0.6 (left), compared to the corresponding collocated MODIS/TERRA result (right).

It should also be noted that a different retrieval approach is under development and testing at EUMETSAT which is based on an optimal estimation technique (see CGMS 34 – WP 20 for details). This technique will make combined use of the three reflectance channels, i.e. the result will be a single final aerosol optical depth over the ocean. The optimal estimation version will serve as an independent algorithm validation and will be considered for the operational retrieval at a later stage.

## 3 Estimation of tropospheric aerosol properties from SEVIRI observations with an optimal estimation technique

An aerosol product over land is currently prototyped on the Optimal Estimation (OE) technique. OE is an advanced technique for the retrieval of quantitative information from space observations. An algorithm relying on this method is currently prototyped at EUMETSAT for the retrieval of tropospheric aerosol load for MSG/SEVIRI observations. The characterisation of the lower boundary conditions, i.e., the surface reflectance and/or emissivity and temperature, is critical for an accurate estimation of aerosol optical thickness from space observations. The proposed approach relies on the possibility to recognise the different temporal rates of change of the various radiative components (*i.e.*, emissivity, temperature, aerosols) in order to extract maximum information from the signal. This mechanism is used to define a priori knowledge on the surface properties which in turn is used to derive aerosol properties.

Prototyping activities are divided into two phases. In the first phase, only SEVIRI solar channels are used and both surface and aerosol properties are assumed to be stable during the course of one day. The objective of this algorithm is to derive a mean daily aerosol optical depth at 0.55 μm for various types of aerosol classes. The algorithm

relies on the inversion of a coupled surface-atmosphere model which accounts for anisotropic surface reflectance. Observations are composed of daily sequentially accumulated reflectance in the VIS0.6, VIS0.8 and NIR1.6 bands. A priori information on the surface reflectance is gradually collected, assuming the temporal stability of these properties over a period of 5 to 10 days. This algorithm will deliver daily mean aerosol optical thickness at 0.55 µm over land surfaces with an expected root mean square error of about 0.15. This aerosol product could be used for atmospheric correction (e.g., for surface flux estimation), aerosol transportation, and general air quality diagnostics. The main expected outcome of this first version is to demonstrate the possibility to reliably separate the surface contribution from the one coming from the atmosphere in the absence a channel in the blue spectral region.
In the version of this algorithm that will be developed in a second phase, the strong constraint of the daily stability of the aerosol load will be relaxed and MSG/SEVIRI thermal infrared observations will be added. The use of the thermal infrared bands requires to also infer surface emissivity properties. This latter quantity could potentially be derived from SEVIRI observations within the same framework as the aerosol, essentially making use of the higher temporal stability of emissivity than surface temperature. Using this constraint, it is hoped that surface emissivity might be derived from SEVIRI observations. Infrared channels should provide useful information in case of very high optical thickness as in the case of dust storm over bright surfaces, a situation where aerosol retrieval from solar channels is particularly difficult. A by-product of the inclusion of the thermal channels will be an accurate land surface temperature estimate.

## 4 CONCLUSIONS

This paper describes the current work at EUMETSAT with the goal to derive operational aerosol products over land and over the ocean, respectively, from SEVIRI on Meteosat Second Generation. Currently two different approaches are adopted over land (optimum estimation technique) and over the ocean (threshold technique).

The products are planned to be available toward end of 2006 (over ocean) and in the first half of 2007 (over land), respectively. Following the evaluation phase the aerosol over ocean product is expected to become fully operational by 2007, for the aerosol over land product the operational availability is expected for 2008/2009.

### Reference

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