Aerosol retrieval algorithm for MERIS

Miriam Kosmale¹, Pekka Kolmonen², Thomas Popp¹
¹German Aerospace Center (DLR), German Remote Sensing Data Center (DFD)
²Finnish Meteorological Institute (FMI)
contact: Miriam.Kosmale@dlr.de

Introduction
The Aerosol_cci project aims to provide aerosol climate data records consisting of aerosol data sets retrieved from various European satellites. Within the project also an aerosol retrieval for MERIS was developed.

The Medium Resolution Imaging Spectrometer (MERIS) has been launched in 2002 onboard the ESA Envisat satellite and was providing data until Envisat’s end in 2012. The MERIS spectrometer was designed primarily for surface and land scientific applications and measured reflected solar radiation in 15 channels from 400-900nm. An aerosol retrieval for MERIS was developed as part of the ESA Aerosol_cci project, where the basic scheme follows the algorithm by NASA (Sayer, 2012 and Hsu, 2012) for applications and measured reflected solar radiation in 15 channels from 400-900nm. An aerosol retrieval for MERIS was developed providing data until Envisat’s end in 2012. The MERIS spectrometer was designed primarily for surface and land scientific

Radiative Transfer
The Look-Up-Tables (LUT) are calculated using the radiative transfer code LIStRadTran. The implementation within the creation of the MERIS-LUT is a user-specific, in order to solve the radiative transfer equation.

• Plane parallel
• Mid-latitude standard atmosphere
• Fix NO2, O3 content
• 36 aerosol mixtures with varying AOD loading
• 6 different Albedi
• Varying viewing geometry

Aerosol model
The aerosol model on which the forward calculations are based, consists of 36 external mixtures of 4 aerosol components. The microphysical properties for these aerosol types are shown in the table below. The 36 mixtures should reflect a realistic range of aerosol compositions, from weak to strong absorbing, fine to coarse particles, as well as varying salt or dust fractions.

<table>
<thead>
<tr>
<th>aerosol component</th>
<th>refractive index real part @550nm</th>
<th>refractive index imaginary part @550nm</th>
<th>effective radius [µm]</th>
<th>mode radius [µm]</th>
<th>comments</th>
<th>aerosol layer height</th>
</tr>
</thead>
<tbody>
<tr>
<td>dust</td>
<td>1.56</td>
<td>0.0018</td>
<td>1.94</td>
<td>0.788</td>
<td>non-spherical</td>
<td>2-4 km</td>
</tr>
<tr>
<td>sea salt</td>
<td>1.4</td>
<td>0</td>
<td>1.94</td>
<td>0.788</td>
<td>0-1 km</td>
<td></td>
</tr>
<tr>
<td>fine-mode weak-absorbing</td>
<td>1.4</td>
<td>0.001</td>
<td>0.14</td>
<td>0.07</td>
<td>SSA=0.56</td>
<td>0.2 km</td>
</tr>
<tr>
<td>fine-mode strong-absorbing</td>
<td>1.5</td>
<td>0.040</td>
<td>0.14</td>
<td>0.07</td>
<td>SSA=0.032</td>
<td>0.2-1 km</td>
</tr>
</tbody>
</table>

Table 1: definitions for aerosol model

Algorithm concept
The aerosol properties retrieved are the aerosol optical depth (AOD) at the wavelength 550nm; in best case also information on the aerosol type can be inverted, but its accuracy is dependent on the degrees of freedom within the measurement. Reflectance spectra at TOA computed by the forward radiative transfer model LibRadtran are fitted with Levenberg-Marquardt to the MERIS reflectance measurements. The cost-function over all 36 predefined aerosol models defines a probability density function to retrieve the most plausible AOD.

BRDF effects
As the surface database includes Lambertian albedo only, a BRDF correction is added within the retrieval scheme. Two different surface types are included: Savannah for bright surface and coniferous forest for dark surface. Based on the BRDF definition (Rahman, 1993) an indicatrix corrects the given surface albedo for selected pixel and viewing geometry.

Surface database
level 1 orbits are projected to a regular grid with a resolution of 0.05 degree. Includes cloud screened pixels. 16 day window around each day of the year is selected for each land gridbox. minimum reflectance within this time window. Lambertian Equivalent Reflectance (LER) applied to aerosol-free LUT and retrieve then the corresponding surface albedo for the selected grid box. 

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References:
Hsu, C.; Goddert, P.; Skary, A.; Bettenhausen, C.; Li, C.; Jörg, M.-J.; Tsay, S.-C. & Holben, B. Global and regional trends of aerosol optical depth over land and ocean using SeaWIFS measurements from 1997-2010, Atmospheric and Oceanic Physics, 2012, 12, 8037-8053