Aerosol Inherent Optical Properties

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- Université du Littoral
Outline

- Validation of the aerosol product
- Alternative aerosol IOPS
- Perspectives
The test sites equipped with CIMEL

Venice
Lampedusa
El Arenosillo
Lanai
San Nicolas
## Validation days

<table>
<thead>
<tr>
<th>site</th>
<th>date</th>
<th>time</th>
<th>°s</th>
<th>°</th>
</tr>
</thead>
<tbody>
<tr>
<td>Venise</td>
<td>10/08/2003</td>
<td>09:34:42</td>
<td>35.085</td>
<td>145.077</td>
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<td>09:40:18</td>
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<td>Lampedusa</td>
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<td>31.701</td>
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<td>Gotland</td>
<td>07/09/2003</td>
<td>09:56:36</td>
<td>55.535</td>
<td>136.752</td>
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<td>Gotland</td>
<td>08/09/2003</td>
<td>09:20:35</td>
<td>52.325</td>
<td>120.935</td>
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<td>Helgoland</td>
<td>16/09/2003</td>
<td>10:10:26</td>
<td>53.468</td>
<td>129.268</td>
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<td>Lampedusa</td>
<td>21/09/2003</td>
<td>09:13:33</td>
<td>38.969</td>
<td>131.549</td>
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<td>65.247</td>
<td>121.479</td>
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</table>
\[ y = 0.3236x - 0.5081 \quad R^2 = 0.1357 \]
\[ y = 0.9965x + 0.0266 \quad R^2 = 0.6663 \]
y = 0.5486x + 0.0873  
R² = 0.6708  
y = 0.4564x + 0.0612  
R² = 0.5727
Conclusion 1

- A good retrieval of $\alpha$
- MERIS overestimates AOT_865
The atmospheric correction

Formulation of the signal

\[ L_{\text{toa}} = (L_{\text{atm}} + T \cdot L_g + t \cdot (L_w)) T_g \]

What do we need?

Compute the atmospheric functions:
- with a radiative transfer code
- and standard values for aerosol IOPs:
  Phase function, extinction and scattering coefficients
Derive P from sky radiance measurements

1- Correct from multiple scattering:

\[ f = \left( \frac{L(1)}{L} \right)_{\text{theo}} \approx \left( \frac{L(1)}{L} \right)_{\text{mes}} \]

2- Primary scattering approximation:

\[
P(\Theta) = 4L_{\text{mes}}^{(1)} \exp\left(\frac{\tau}{\mu}\right) \left[1 - \exp\left(-\tau\left(\frac{1}{\mu_o} - \frac{1}{\mu}\right)\right)\right]^{-1} \left[\frac{\mu_o}{\mu - \mu_o}\right]^{-1}
\]

Devaux et al., 1989
Multiple scattering correction

**Successive Order of Scattering**

**Inputs:**

- total optical thickness $\tau$
- single scattering albedo $\omega$ time phase matrix $M$

**Hypothesis:**

- Cox and Munk for wave slope distribution
- inhomogeneous atmosphere $\Rightarrow H_a = 3 \text{ km} \; H_r = 8 \text{ km}$
More to know

- Derive aerosol phase functions from sky radiance measurements in the frame of MERIS aerosol remote sensing validation
  Zagolsky François and Richard Santer (Université du Littoral)

- A new aerosol climatology for MERIS atmospheric correction over water using ground based measurements of the solar extinction and of the sky radiances
  Richard Santer and Zagolsky François (Université du Littoral)
The Aeronet data base
Data filtering

Expected range of:
Alpha
Single scattering albedo

<table>
<thead>
<tr>
<th>case</th>
<th>(i)</th>
<th>$\alpha_1$</th>
<th>$\omega_1$</th>
<th>$\omega_2$</th>
<th>$\omega_1 + \omega_2$</th>
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<tr>
<td>N</td>
<td>3157</td>
<td>2685</td>
<td>2388</td>
<td>2268</td>
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Spectral dependancy
Single scattering albedo ($\omega_a$) versus $\alpha$
Phase function versus $\alpha$

(a) $\Theta = 90^\circ$

(b) $\Theta = 130^\circ$
aerosol phase function for mean value of $\alpha$, 

- 25 classes in $\alpha$ with $\Delta \alpha = 0.2$
- Between 100 to 200 phase functions per class
- Filtering at 1 sigma
aerosol phase function: $\alpha = -0.08$
We know from $\alpha$ the 2 SAMs used in MERIS GS

- We then know the phase functions used
- We assume than the aerosol path radiance in primary scattering is correctly retrieved
- We then get

$$\tau a \sigma_0^a P_a$$

- We correct the initial AOT_865 by $P\text{cimel}/ P\text{meris}$

$$\tau_{a IOP} = \frac{(\tau a \sigma_0^a P_a)_{SAM}}{(\sigma_0^a P_a)_{IOP}}$$
Readjust AOT_865

AOT at 865 nm

MERIS

CIMEL

Série1

Série2
Perpectives

- Generate a significant IOPs data base at 865 nm, 670 nm and 440 nm
- Classify by alpha
- Generate LUTs
- Process level 2 with this new LUTs
- Evaluate improvements