CORRECTION OF THE ABOVE WATER RADIOMETRIC MEASUREMENTS FOR THE SKY DOME REFLECTION, ACCOUNTING FOR POLARIZATION

Richard Santer, Francis Zagolski, Kathryn Barker, Jean-Paul Huot
Context

• In the frame of the validation of the MERIS atmospheric correction above water
• Protocol for water-leaving measurement

\[ L_w^{\uparrow} = L^{\uparrow} - R(\theta_v, w_s) \cdot L^{\downarrow} - L_G(w_s) \cdot \exp(-\tau / \mu_s) \]
Outlines

• Fundamental equations
• Simulator and examples
• Application to MERMAID
Polarization & Intensity

• The polarization is needed to compute the intensity:
  – Nul in average
  – Example: *Rayleigh* polarisation and atmospheric reflectance

• The influence of the polarization on $I$ is by default or by excess
A simple geometry

- Principal plane
- Specular case
Fresnel & Polarization

\[ r_\parallel = -\frac{\tan(\theta_i - \theta_r)}{\tan(\theta_i + \theta_r)} \quad r_\perp = -\frac{\sin(\theta_i - \theta_r)}{\sin(\theta_i + \theta_r)} \]

\[ \sin(\theta_i) = n_w \sin(\theta_r) \]

\[ \begin{align*}
R_1 &= \frac{r_\parallel^2 + r_\perp^2}{2} \\
R_2 &= \frac{r_\parallel^2 - r_\perp^2}{2} \\
R_3 &= r_\parallel \cdot r_\perp
\end{align*} \]
Rayleigh Polarization

Rayleigh, B2

![Graph showing polarization degree vs. VZA (°)]

- Polarization degree on the y-axis
- VZA (°) on the x-axis
- Different symbols and colors for different VZA angles

Legend:
- 30° (diamonds)
- 45° (squares)
- 60° (triangles)
- 75° (crosses)
Scattering & Fresnel

In the principal plane:

\[ Q = -(P \times I) \]
\[ U = 0 \]
\[ I_{ref} = (R_1 \times I) + (R_2 \times Q) \]

\[
R^* = R \cdot \left[ 1 + \frac{R_{pol} \cdot I_{pol}}{R \cdot I} \right] = R \cdot (1 + P_F \cdot P_R)
\]
Outlines

• Fundamental equations
• Simulator and examples

Poster session 1:

"POLREF - A New Simulator for Polarized Reflection Coefficients over Ocean"
Francis Zagolski, Richard Santer, Kathryn Barker, and Jean-Paul Huot

• Application to MERMAID
General flowchart of the POLREF simulator

1. **Extract AOT550 in Mixing Layer**
   - **AOT550ML**

2. **Ozone amount ($u_{O3}$)**
   - **SUBROUTINE: SplineInterpol ($w_z$)**
   - **Wind-speed ($w_z$)**
   - **SUBROUTINE: SplineInterpol ($w_z$)**

3. **Geometrical conditions ($SZA, VZA, SAA, VAA$)**
   - **SUBROUTINE: Closest_GridPoint ($SZA, VZA, RAA, AOT550ML$)**
   - **SUBROUTINE: LinearInterpol ($SZA, VZA, RAA, AOT550ML$)**

4. **Correction for O3 absorption ($SZA, u_{O3}$)**
   - **Correction for O3 absorption ($SZA, u_{O3}$)**
   - **SEAPOL-DB MERIS BOA-LUTs**
   - **SEAPOL-DB MERIS BOA-LUTs**

5. **Outputs generated for 15 MERIS bands:**
   - $L_{boa\_up}$, $L_{boa\_dw}$, $T_{tot\_dw}$
   - $R, R_c$
Reflection Coefficient & Wind-Speed

Reflection coefficient at 520 nm versus the solar zenith angle. Rayleigh (blue diamond), M3 with AOT at 550 nm of 0.3 (red square), 0.6 (green triangle) and 0.9 (blue cross)

510 nm; 1 m/s

510 nm; 5 m/s

510 nm; 10 m/s

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<th>w(m/s)</th>
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<td>1</td>
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<tr>
<td>5</td>
<td>2.84</td>
</tr>
<tr>
<td>10</td>
<td>3.29</td>
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Reflection Coefficient & SZA

M3 with AOT=0.3 at 550 nm: Spectral dependence of the reflection coefficient at 2 SZA for three wind speeds: 1 m/s (blue diamond), 5 m/s (red square) and 10 m/s (green triangle)
Wind speed of 1 m/s. Absolute bias on the water reflectance for two solar zenith angles versus the wavelength: The AOT at 550 nm is for M1 (blue diamond), M2 (red square), M3 (blue cross) and M4 (green triangle).
Influence of the Aerosol Model

Wind speed of 10 m/s. Absolute bias on the water reflectance for two solar zenith angles versus the wavelength: The AOT at 550 nm is for M1 (blue diamond), M2 (red square), M3 (blue cross) and M4 (green triangle).

\[ SZA=29^\circ, \text{ws}=10 \, \text{m/s}, \text{AOT}=0.3 \]

\[ SZA=59^\circ, \text{ws}=10 \, \text{m/s}, \text{AOT}=0.3 \]
Influence of the azimuth (VZA=40°)

412 nm, wind speed of 7.2 m/s.

*Pure molecular atmosphere at SZA=30° (diamond) and 60° (square) M4, AOT560=0.3) at SZA=30° (triangle) and 60° (cross)*

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Outlines

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Poster session 2:

"Sky Dome Correction For SeaPRISM and TriOS Above Water Radiometric Measurements in MERMAID"

Kathryn Barker, Francis Zagolski, Richard Santer, C. Kent, Jean-Paul Huot, Giuseppe Zibordi, Kevin Ruddick.
Flowchart of Fresnel Reflection Coefficient Computation for SeaPRISM

SeaPRISM SZA

SEAPOL-DB MERIS BOA-LUTs

SAMs ($iaer_1,iaer_2$)
Mixing rate ($aermix$)

Angstroem exponent $\alpha(779,865)$

Aerosol optical thick. AOT865

SUBROUTINE: MixingLayer

AOT550$\text{ML}_1$
AOT550$\text{ML}_2$

SUBROUTINE: Closest_GridPoint ($SZA,AOT550_{\text{ML}}$)

MERMAID $w_S$

SUBROUTINE: LinearInterpol ($SZA,AOT550_{\text{ML}}$)

SUBROUTINE: SplineInterpol ($w_S$)

Loop on $iaer$

Angstroem exponent $\alpha(779,865)$

SUBROUTINE: LinearInterpol ($aermix$)

SUBROUTINE: FresnelReflCoef ($R_{pol}$)

BOA radiances: $L_{\text{boa\_up}}, L_{\text{boa\_dw}}$

SUBROUTINE: SplineInterpol ($\lambda$)

$R_{pol}$ generated at the SeaPRISM wavelengths
Comparison with Mobley
Impact on Rhow

Impact on Rhow

Impact on Rhow

Impact on Rhow

Impact on Rhow
Conclusion

• Need to compute I by accounting for the polarization
• Find the best geometry of observation to minimize the impact or take advantage of it (SIMBADA)
• Correct for accounting for the polarization