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

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INTRODUCTION

The water reflectance, ρ_w, derived from in-situ measurements represents a key element in the validation of MERIS (MEdium Resolution Imaging Spectrometer) atmospheric corrections over ocean. The ESA/MERMAID (MERis MAtchup In situ Database) supports this validation effort with concurrent MERIS/in-situ ρ_w matchups (> 30 sites). The water-leaving radiance, L_w, needs to be corrected for the *Fresnel* reflection of the sky dome by the sea surface. In the standard protocol, the neglect of polarization induces an error on ρ_w.

An alternative correction, fully accounting for polarization processes (*i.e.*, sea surface reflection and atmospheric scattering) has been developed to be implemented into two new sky dome correction processors; the latters have been verified with the MERMAID in-situ processing chain for the AERONET-OC ***SeaPRISM*** sensor at 8 centre wavelengths (412-1020 *nm*) and the MUMM* hyperspectral ***TriOS*** instrument convoluted to the 13 MERIS band filters.

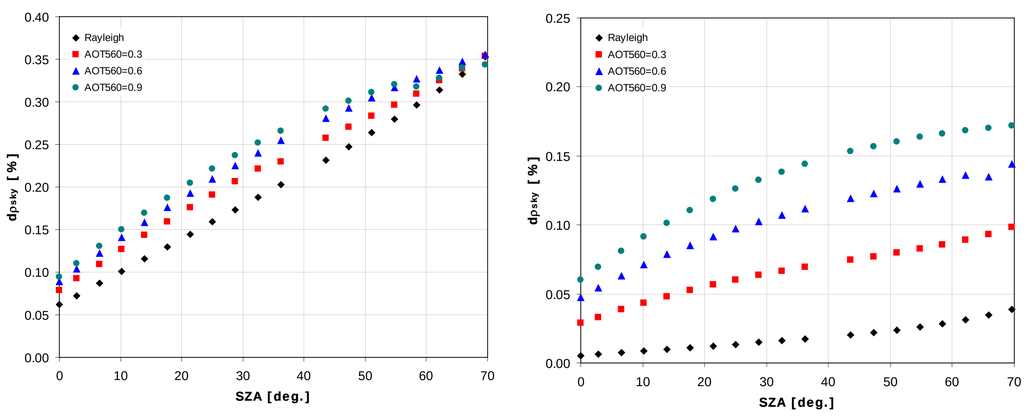
The impact of this new correction on the MERIS level-2 product over ocean has been evaluated by validating the ρ_w retrieval in MERMAID.

SKYDOME CORRECTION FOR SEAPRISM & TriOS

In-situ L_w measurements are collected under geometric conditions favourable to the appearance of a significant polarization effect. Neglecting the polarization may induce a bias of several percents in relative error on the marine ρ_w, depending on the illumination geometry, the state of sea surface and the atmosphere.

Rayleigh scattering in the blue is a major source of impact, due to its high polarization. In the near-infrared (NIR) region, the polarization effect is less important because of reduced light scattering. Aerosols may also impact the polarization process.

The impact of neglecting polarization the polarization is well illustrated in *Santer et al., 2012*, and a simulator, namely, POLREF (*Zagolski et al., 2012*), has then been developed to produce this new *Fresnel* reflection coefficient.



Example of bias on the reflected sky radiance by a wind-roughened black sea surface (5 *m/s*) induced by a standard protocol ignoring polarization. Computations have been completed at 442.5 *nm* (left side) and 753.75 *nm* (right side) for 4 atmospheres: AOT550=0, 0.3, 0.6 and 0.9 (α=-1.5).

- **Bias increasing with SZA**
- **Stronger bias in visible than in NIR, and not strongly aerosol dependent.**

The recommendation to ESA:

→ To include the polarization in the correction of above water measurements for the skydome reflection.

Two skydome correction processors have been developed to perform operational sky dome correction in MERMAID for SeaPRISM and TriOS/ MUMM in-situ L_w, accounting for the polarized nature of:

(i) the incident atmospheric light
(ii) the *Fresnel reflection* of a wind-roughened sea surface.

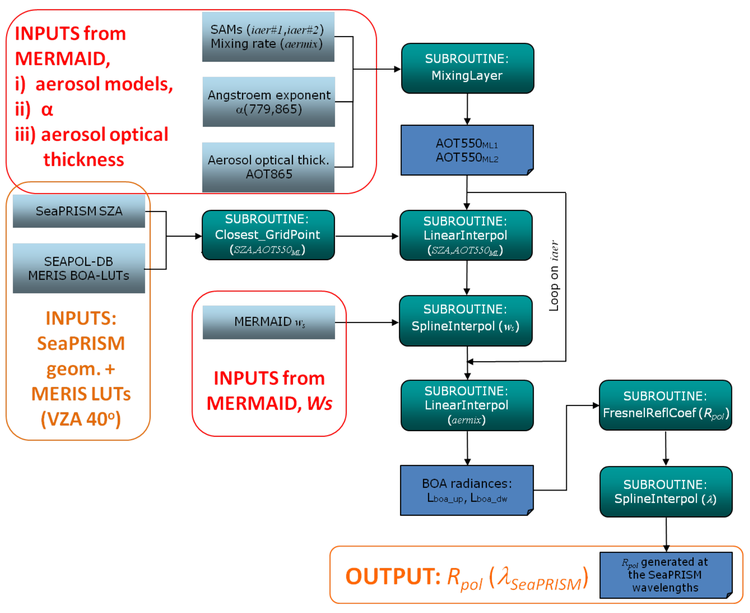
SKYDOME CORRECTION PROCESSORS FOR MERMAID

Objectives:

1. Produce new *Fresnel* reflection coefficients (R_{pol}) accounting for polarization (surface reflection + atmospheric scattering) at the 8 (SeaPRISM) and 13 (TriOS) λ
2. Compute new water-leaving radiances at the 8 (SeaPRISM) and 13 (TriOS) λ, corrected for: (i) BOA reflected Sun glint radiance and (ii) Sky dome reflection

MERIS LUTs of upward/downward radiances pre-computed at bottom of atmosphere (BOA) have been extracted from SEAPOL-DB (*Zagolski et al., 2012*) for the SeaPRISM and TriOS/MUMM view geometries (VZA=40 *deg.*, RAA=90 and 135 *deg.*, respectively)

SEAPRISM PROCESSOR

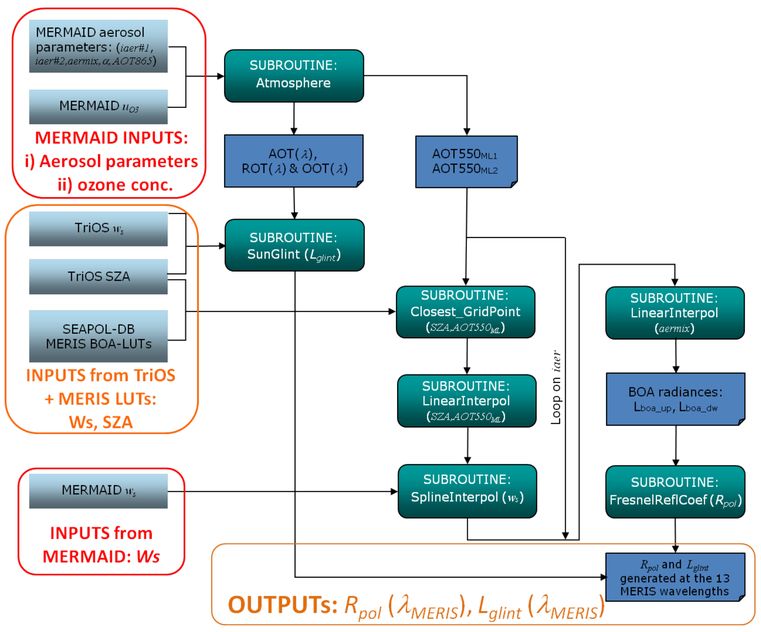


The processors derive, for each SeaPRISM/TriOS-MUMM matchup data sequence, R_{pol} *f*rom:

- the ECMWF wind-speed
- the atmospheric model observed with MERIS (2 bracketing models)
- the aerosol optical thickness at 865 *nm*,
- *the Angstroem* exponent
- the aerosol mixing rate

All these quantities are extracted from MERIS level-2 product

TRIOS PROCESSOR

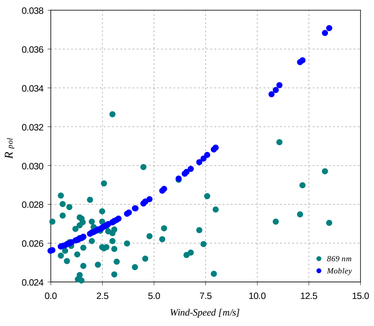


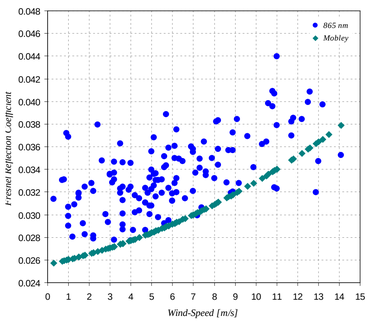
Then, for each pixel within a MERIS-RR (5 x 5) pixels window, the mean $R_{pol}(\lambda_{SeaPRISM})$ and $R_{pol}(\lambda_{TriOS})$ are output by the processors to be used for the skydome correction of above water radiometric measurements.

Comparisons have been made between the standard method (*Mobley, 1999*) and this new correction with in-situ data acquired over AAOT (Venice) with SeaPRISM, and over the Northern sea with TriOS.

RESULTS OF MERMAID IMPLEMENTATION

SeaPRISM

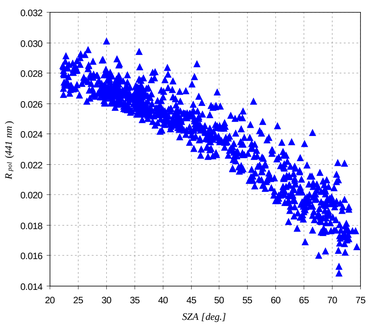


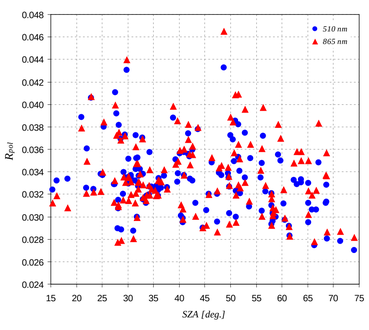


IMPACT OF WIND SPEED ON R_{pol}

R_{mobley} is driven by SZA & w_s. Assumed to include Sun glint

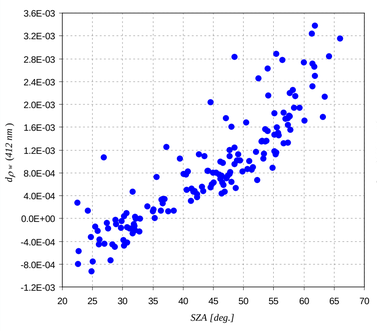
R_{mobley} is overestimated compared to R_{pol} (SeaPRISM processor) and underestimated compared to R_{pol} (TriOS processor)

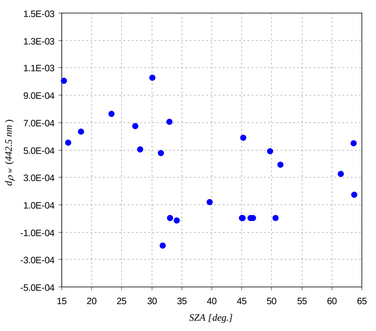




IMPACT OF SZA ON R_{pol}

Increasing SZA decreases the effect of roughness on the Fresnel reflection; therefore at the particular geometry of the SeaPRISM (RAA=90 *deg.*) R_{pol} decreases as SZA increases.

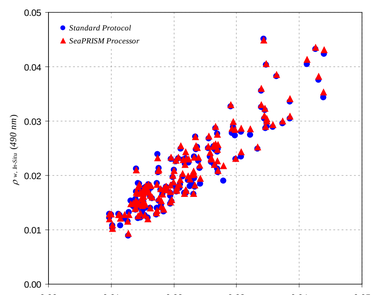


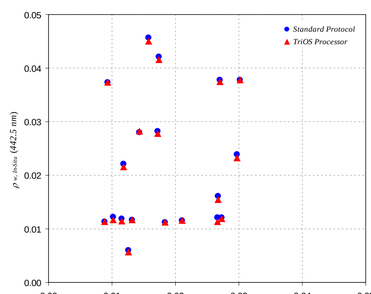


$\Delta\rho_w$: STANDARD (POLREF) vs. NEW

SeaPRISM: $R_{pol} < R_{mobley}$ Larger values of new in-situ ρ_w are expected. Effect increases with SZA in the SeaPRISM geometry.

TriOS: $R_{pol} > R_{mobley}$ Smaller values of new in-situ ρ_w are expected.





ρ_w(412): NEW IN-SITU vs MERIS

As expected, the new sky dome correction slightly improve the water reflectances when they are compared with the MERIS matchups.

CONCLUSIONS

- This work is essential for the MERIS CalVal activities and for quality assurance of both in-situ data and the MERIS derived products over ocean.
- R_{pol} for AAOT has been validated using the POLREF simulator, and analyses show that the sky dome correction tools implemented in MERMAID processing could be operationally applied to other in-situ databases.
- Reprocessed MERIS matchups for SeaPRISM and TriOS/MUMM will be soon available.

ACKNOWLEDGEMENTS

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