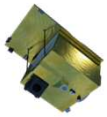
Optimising 6S-based atmospheric correction for PRISMA and EnMAP hyperspectral imagery over inland waters

Gabriel Rodrigo Caballero[1], Xavier Sòria-Perpinyà[1], Barbara Alvado[1], Antonio Ruiz-Verdú[1], Jesús Delegido[1] and José Moreno[1]

[1]Laboratory for Earth Observation (LEO), Universitat de València, c/Catedrático José Beltrán 2, Paterna, 46980, València, Spain.



Gabriel Caballero: gabriel.caballero@uv.es

Keywords: atmospheric background offset subtraction, oligotrophic and hypertrophic water reservoirs.

Challenge & Objective

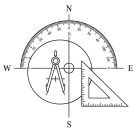
In aquatic remote sensing, accurately retrieving water quality parameters from hyperspectral data is a significant challenge due to the complex interaction of light with both the atmosphere and the water column. Our objective was to develop an efficient, generic and simple atmospheric correction method using a radiative transfer modelling (RTM) approach scheme based on the Second Simulation of the Satellite Signal in the Solar Spectrum (6S) model. This study presents 6ABOS (6S-based Atmospheric Background Offset Subtraction), a novel atmospheric correction framework applied to Level 1 PRISMA and EnMAP hyperspectral imagery over inland water bodies.

Materials & Methods

Rrs was measured at three sampling points in the Benagéber (oligotrophic) and Bellús (hypertrophic) inland water reservoirs in Valencia, Spain, using a portable spectroradiometer (ASD Field Spec® HandHeld 2). The field measurements were conducted during four campaigns: February 28 and September 20, 2023, coinciding with PRISMA acquisitions, and April 22 and July 24, 2024, coinciding with EnMAP acquisitions. Atmospheric parameters were simulated using the 6S radiative transfer model to compute the relationship between at-sensor and water-leaving radiance, with the ACOLITE atmospheric correction framework employed as a comparative benchmark.

STAGE-1: DATA ACQUISITION & ATMOSPHERIC PARAMETERS RETRIEVAL

PRISMA & EnMAP L1 satellite imagery (LTOA)



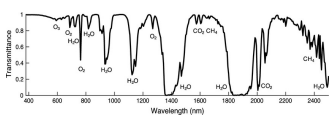
Acquisition Geometry (Viewing and Sun Zenith & Azimuth angles)

Atmospheric parameters (AOT@550 nm, O_3 and H_2O)

STAGE-2: 6S EXECUTION & GAS TRANSMITTANCE MODELING

6ABOS PROCESSING FRAMEWORK

- Gas Transmittance (*Tgas*)
- Spherical Albedo (*Satm*)
- Atmospheric Path Radiance (*Lpath*)
- Total Atmospheric Transmittances (*T↑ and T↓*)



STAGE-3: SURFACE & REMOTE SENSING REFLECTANCES RETRIEVAL

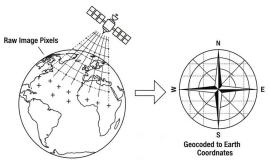
$$\rho_s = \frac{\frac{L_{TOA}}{T_{O_3}} - L_{path}}{\left[(E_{dir} \cdot \cos\theta_{zs} + E_{dif}) \cdot \frac{T^{\uparrow}}{\pi} + S_{atm} \cdot \left(\frac{L_{TOA}}{T_{O_3}} - L_{path}\right)\right]}$$

Above water surface reflectance (ρ_s)

$$Rrs = \frac{\rho_s}{\pi}$$

Above water remote sensing reflectance (*Rrs*)

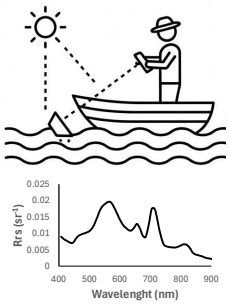
3.1: GEOMETRY CORRECTION AND GEOCODING (PRISMA ONLY)



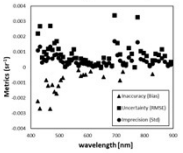
STAGE-4: VALIDATION ASSESSMENT AGAINST IN-SITU SPECTROSCOPY DATA

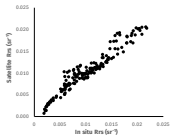
QUANTIFICATION OF THE LACK OF PERFORMANCE

4.1: IN-SITU MEASURED SPECTROSCOPY DATA



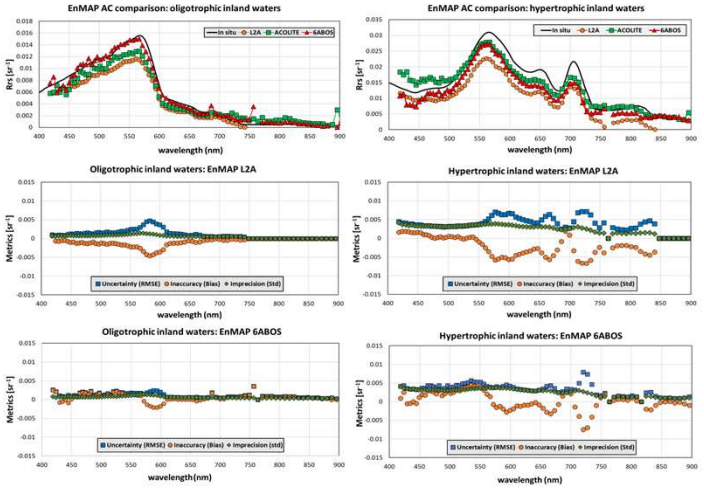
Assessment metrics (Inaccuracy, Uncertainty, and Imprecision)

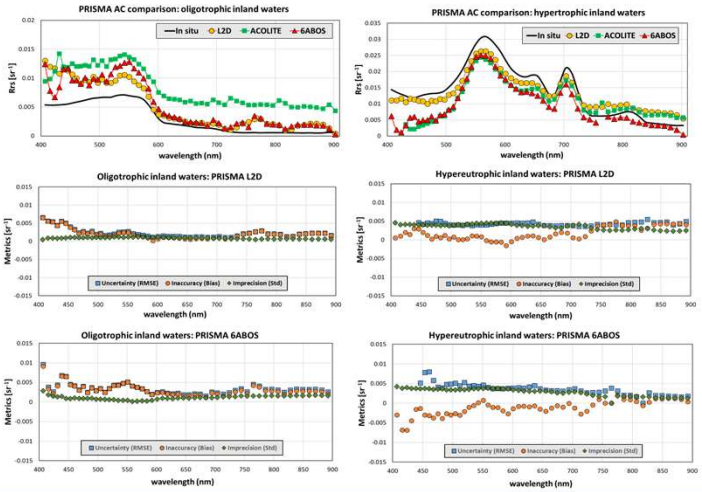




EnMAP Atmospheric Correction Results

PRISMA Atmospheric Correction Results





Discussion & Conclusions

This study presents the first evidence of the reliability and precision of 6ABOS. In our dataset, 6ABOS outperformed EnMAP L2A and showed validation results comparable to those of PRISMA L2D. Furthermore, 6ABOS was successfully implemented for both PRISMA and EnMAP data, demonstrating its robustness across different sensors and in both oligotrophic and hypertrophic inland water reservoirs.

References

- Jean-Luc Deuzé. Second Simulation of the Satellite Signal in the Solar Spectrum, 6S: an overview. IEEE Trans. Geosci. Remote Sens., January 1997.