Assessment of EnMAP atmospheric correction in both oligotrophic and hypertrophic inland waters using 6S and in situ spectroscopy data

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

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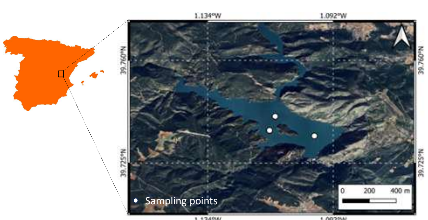
Challenge

This research aimed to accurately correct the inherent atmospheric effects of two EnMAP Level 1C hyperspectral images acquired on April 22 and July 24, 2024, over two oligotrophic and hypertrophic inland water bodies. This was achieved by applying a radiative transfer modelling (RTM) approach based on the Second Simulation of the Satellite Signal in the Solar Spectrum (6S) (Deuzé, 1997). This methodology enables the simulation of atmospheric parameters, which are then incorporated into the radiative transfer equation to facilitate the conversion of top-of-atmosphere (TOA) radiances to surface reflectance. The performance discrepancy between the above water remote sensing reflectance (Rrs) in situ measured and the Rrs derived from EnMAP L2A and 6S atmospherically corrected images is assessed regarding uncertainty, imprecision, and inaccuracy across the visible through near-infrared (VNIR) wavelength range.

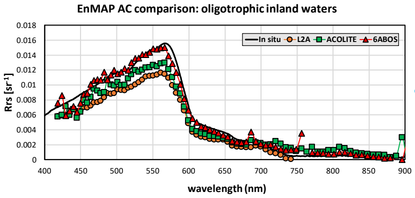
Materials & Methods

On April 22 and July 24, 2024, we measured the Rrs at three points in the Benagéber (oligotrophic) and Bellús (hypertrophic) inland water reservoirs in Valencia, Spain. Using a portable spectroradiometer (ASD Field Spec® HandHeld 2), we collected radiometry data at a 1 nm spectral resolution from 400-900 nm. These campaigns coincided with the EnMAP sensor passing over the study sites at around 11:30 a.m. local time. We constructed the spectral response functions for the VNIR and the short-wave infrared (SWIR) wavelength ranges using EnMAP's spectral configuration and a Gaussian probability density distribution. Utilising the 6S radiative transfer model, we conducted simulations of the atmospheric parameters essential for computing the relationship between the at-sensor radiance captured by the EnMAP hyperspectral instrument and the water-leaving radiance across each spectral band. Furthermore, we employed the ACOLITE atmospheric correction framework as a benchmark to facilitate a comparative analysis of our findings.

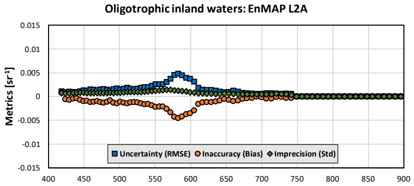
Oligotrophic inland waters: Benagéber inland reservoir



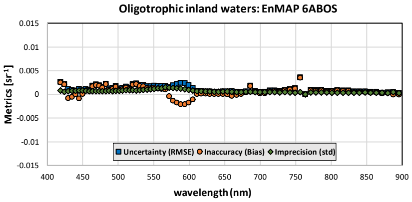
EnMAP AC comparison: oligotrophic inland waters



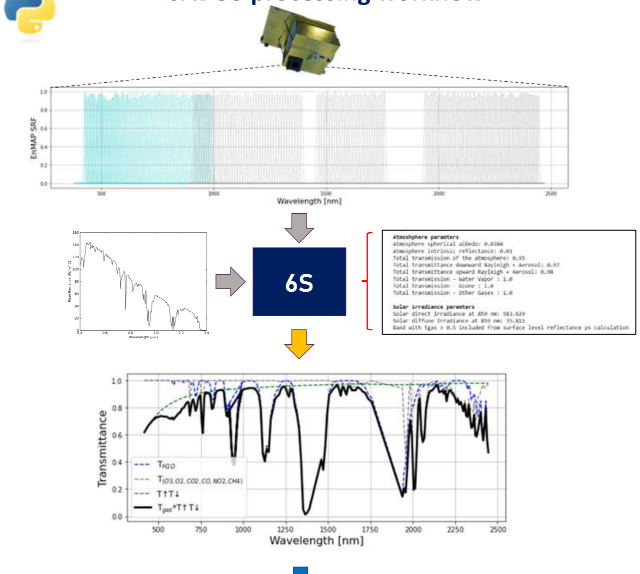
Oligotrophic inland waters: EnMAP L2A



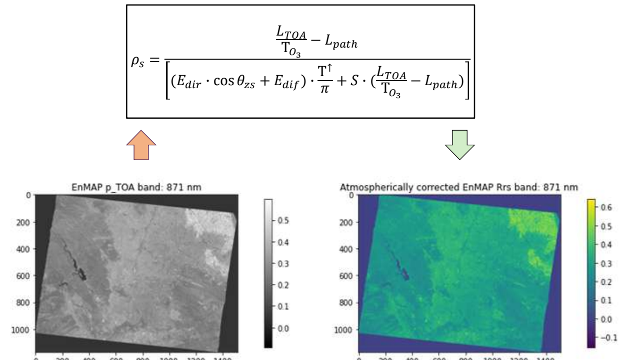
Oligotrophic inland waters: EnMAP 6ABOS



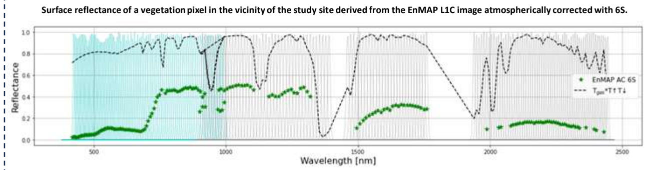
6ABOS processing workflow



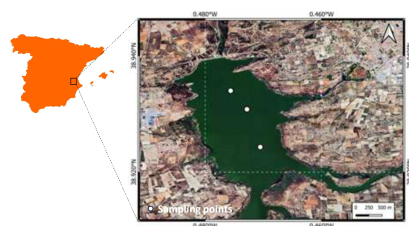
$$\rho_s = \frac{\frac{L_{TOA}}{T_{O_3}} - L_{path}}{\left[(E_{dir}\cdot\cos\theta_{zs}+E_{dif})\cdot\frac{T^{\uparrow}}{\pi} + S\cdot\left(\frac{L_{TOA}}{T_{O_3}} - L_{path}\right)\right]}$$



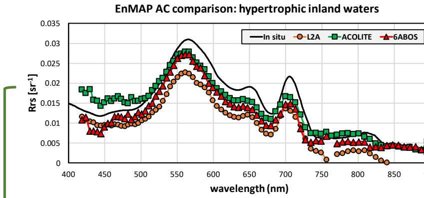
Surface reflectance of a vegetation pixel in the vicinity of the study site derived from the EnMAP L1C image atmospherically corrected with 6S.



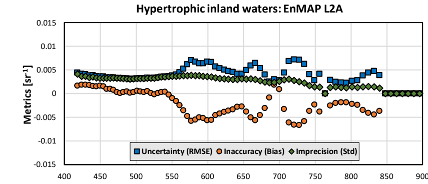
Hypertrophic inland waters: Bellús inland reservoir



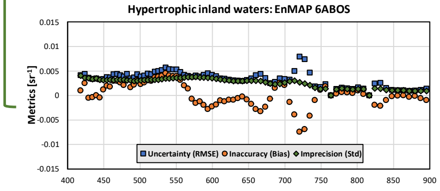
EnMAP AC comparison: hypertrophic inland waters



Hypertrophic inland waters: EnMAP L2A



Hypertrophic inland waters: EnMAP 6ABOS



Conclusions

The research conducted has conclusively demonstrated the reliability and precision of a 6S-based atmospheric correction scheme. This correction scheme was implemented to effectively conduct atmospheric correction of EnMAP L1 hyperspectral TOA radiance data over 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.

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