

# Validation of remote sensing reflectance derived with WASI from EnMAP L2A land data using AERONET-OC data

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The WASI<sup>[1]</sup> Rrs tool allows to derive water remote sensing reflectance ( $R_{rs}$ ) from the land product of satellite L2A data. This work presents the  $R_{rs}$  spectra obtained with WASI for eight EnMAP scenes atmospherically corrected using PACO<sup>[2]</sup>. Two scenes each are chosen above four AERONET-OC<sup>[3]</sup> sites, in order to validate the results against in-situ data. The outcome is also compared with EnMAP's water-specific atmospheric correction algorithm MIP<sup>[4]</sup>.

## Workflow

WASI inverts a bio-optical model of the water column to determine, among others, concentrations of water constituents. Its Rrs tool corrects glint through pixelwise quantification of the sky radiance reflected at the water surface as fractions of sun glint (direct solar radiation) and sky glint (Rayleigh and aerosol scattering). For each scene, atmospheric parameters are input into the model and the user optimizes the inversion parameters individually. Based on the inversion results, a glint image  $R_{rs}^{surf}$  is generated and subtracted from the input L2A image, resulting in the glint corrected  $R_{rs}$  image. Figure 1 depicts this workflow for one EnMAP scene of each chosen AERONET-OC site: Acqua Alta Oceanographic Tower (AAOT), Chesapeake Bay, Lucinda Jetty and Bahia Blanca.

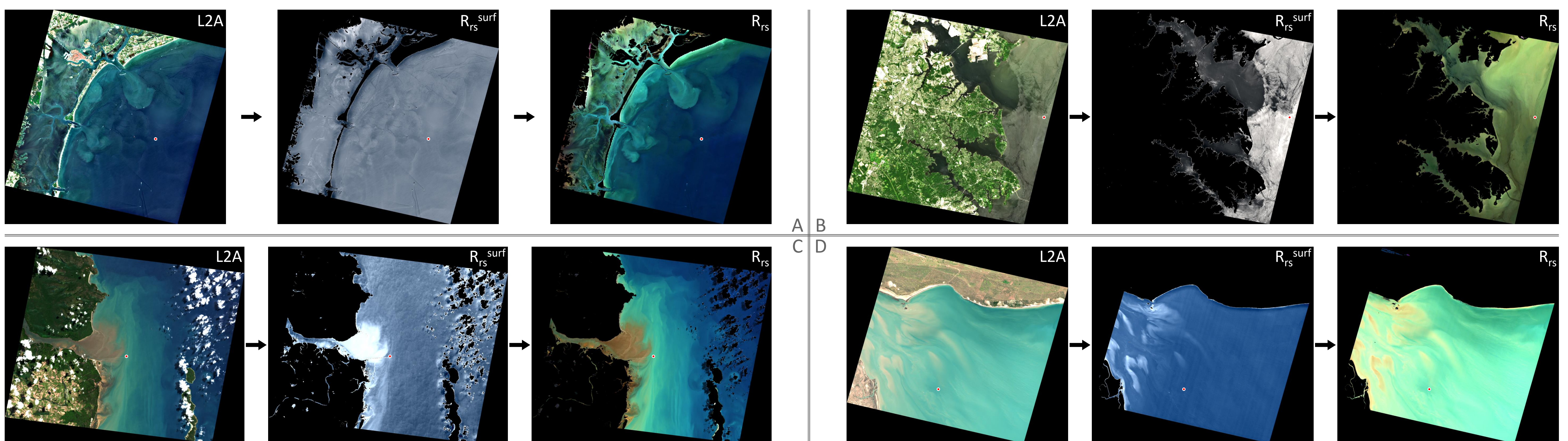


Figure 1: EnMAP images of (A) AAOT, 2022-07-16, (B) Chesapeake Bay, 2022-07-22, (C) Lucinda Jetty, 2023-08-29, and (D) Bahia Blanca, 2022-08-24. For each scene, from left to right, the L2A PACO and the WASI derived  $R_{rs}^{surf}$  (glint) and  $R_{rs}$  images are shown. Land and clouds are masked out in the  $R_{rs}^{surf}$  and  $R_{rs}$  images. The red dot shows the AERONET-OC site.

## Results

The average spectrum of a 3x3 pixels window, shifted 100m north and east to avoid influences from the infrastructure, is used to validate the aquatic remote sensing reflectance against in-situ data. The AERONET-OC measurement closest to the time of the EnMAP overpass is adopted as a coincident matchup. Figure 2 shows the spectral comparisons for the eight analyzed scenes.

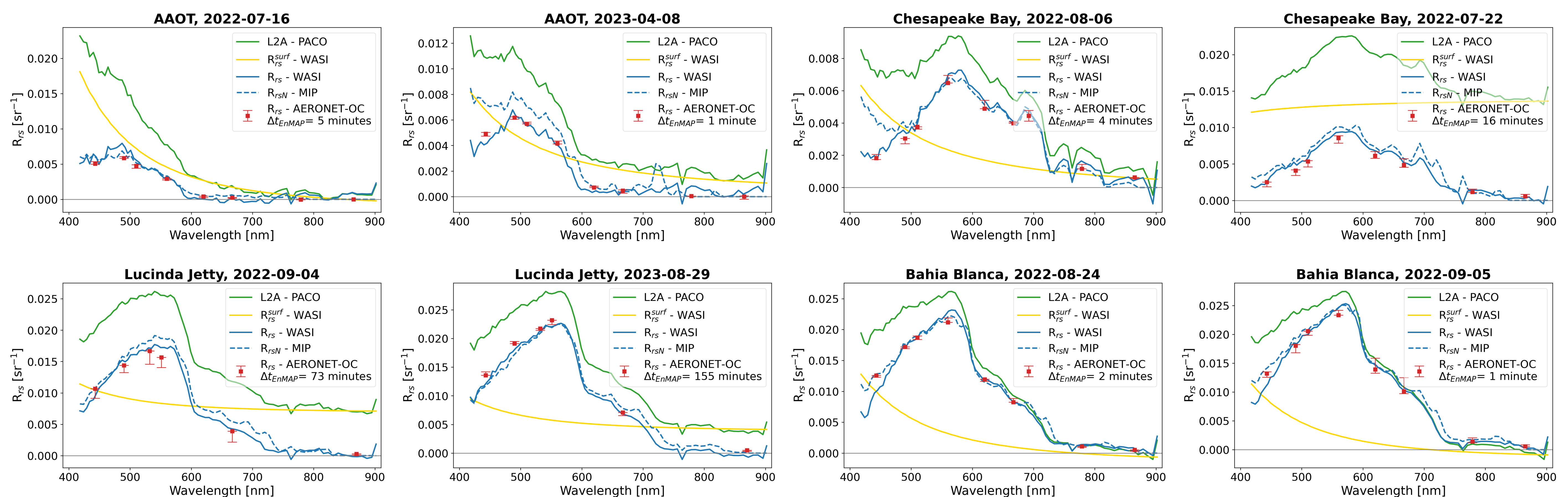


Figure 2: L2A (PACO),  $R_{rs}^{surf}$  (WASI),  $R_{rs}$  (WASI) and  $R_{rsN}$  (MIP) spectra from EnMAP images compared to in-situ AERONET-OC data. The error bars represent the in-situ variability within  $\pm 1$  hour ( $\pm 4$  hours for Lucinda Jetty) of the satellite overpass, with the exact matchup time difference indicated by  $\Delta t_{EMAP}$ .

A very good correspondence between the WASI derived  $R_{rs}$  and AERONET-OC is achieved for all scenes and sites, with an average difference (unit:  $sr^{-1}$ ) of  $0.0012 \pm 0.0008$ ,  $0.0007 \pm 0.0005$  and  $0.0002 \pm 0.0001$  for the wavelengths 443, 490 and 667 nm (common channels for all analyzed sites). Relative to each in-situ measurement, these average differences are of  $12.3 \pm 7.3$ ,  $10.4 \pm 9.8$  and  $8.4 \pm 11.7$  %. The obtained  $R_{rs}$  spectra resemble generally the MIP results ( $R_{rsN}$ ), outperforming it for AAOT (2023-04-08) up to 600 nm and Chesapeake Bay (2022-08-06) up to 500 nm. In the case of Bahia Blanca, the presence of TSM distribution patterns in the resulting glint image indicates a possible glint overestimation for water bodies with high TSM concentrations.

The aquatic  $R_{rs}$  spectra obtained with the WASI Rrs tool from the EnMAP land product are in close agreement with those from the coincident in-situ measurements as well as the standard water product. Ongoing work focuses on the automatization of the parameters setup of this tool, in order to make it integrable into operational remote sensing processors for water applications.

## References

- [1] P. Gege, "WASI-2D: A software tool for regionally optimized analysis of imaging spectrometer data from deep and shallow waters", Computers & Geosciences, 62, 208-215, <https://doi.org/10.1016/j.cageo.2013.07.022>, (2014).
- [2] R. de los Reyes, et al., "PACO: Python-Based Atmospheric Correction", Sensors, 20, 1428. <https://doi.org/10.3390/s20051428>, (2020).
- [3] G. Zibordi, et al., "AERONET-OC: A Network for the Validation of Ocean Color Primary Products", J. Atmos. Oceanic Technol., 26, 1634-1651, <https://doi.org/10.1175/2009JTECH0654.1>, (2009).
- [4] T. Heege, et al., "Mapping of Water Constituents in Lake Constance Using Multispectral Airborne Scanner Data and a Physically Based Processing Scheme." Canadian Journal of Remote Sensing, 30(1), 77-86. <https://doi.org/10.5589/m03-056>, (2004).

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