Optimizing Water Quality Parameters Retrieval from PRISMA data: A Comparative Study of Atmospheric Correction Algorithms

Panizza L.[1], Fabbretto A.[1,2], Pellegrino A.[1,3], Bresciani M.[1], Gianinetto M.[4], Giardino C.[1,5]

[1]Institute for Electromagnetic Sensing of the Environment, National Research Council, 20133 Milan, Italy, panizza.l@irea.cnr.it; fabbretto.a@irea.cnr.it; pellegrino.a@irea.cnr.it; bresciani.m@irea.cnr.it; giardino.c@irea.cnr.it
[2] Tartu Observatory, Department of Remote Sensing, University of Tartu, 61602 Tõravere, Estonia
[3] University of Sapienza, Department of Engineering, 00185 Rome, Italy
[4] Department of Architecture, Built Environment and Construction Engineering, Politecnico di Milano, 20133 Milano, Italy, marco.gianinetto@polimi.it
[5] NBFC, National Biodiversity Future Center, 90133 Palermo, Italy

Hyperspectral remote sensing provides relevant information for monitoring biophysical water parameters [1]; an appropriate atmospheric correction (AC) is crucial, especially considering its impact on the estimation of the composition of phytoplankton functional types. In this context, for this preliminary study, 31 match-ups have been considered, using data from the hyperspectral Italian mission PRISMA over three Italian lakes: Trasimeno (meso-eutrophic), Varese (eutrophic) and Garda (meso-oligotrophic). The first aim was to validate PRISMA L2C standard reflectance products and PRISMA L1 data atmospherically corrected using ACOLITE, ACOLITE-T-Mart, iCOR, MIP, hGRS, POLYMER, 6SV processors, with *in situ* measurements, provided by the WISPStation and ad-hoc field campaigns. In accordance with the uncertainties assessed through statistical analysis, the second aim was to provide the most accurate water quality maps in terms of Chlorophyll-a (Chl-a), Total Suspended Matter and Phycocyanin, and bottom substrate characterization maps, using the bio-optical model BOMBER [2], the Semi-empirical band ratio [3], and a machine learning algorithm (MDN) [4]. Overall, results identified different performances of AC algorithms across the study areas and each spectral region (R^2 greater than 0.80 for Lake Trasimeno, R^2 below 0.75 for Lake Varese, and higher accordance in Lake Garda's shallow waters compared to deep waters). Figure 1 reports the analysis of the image acquired over Lake Trasimeno on 12/08/2022 as an example. Comparing the AC processors, PRISMA L2C shows a Spectral Angle (SA) of 8° and an R^2 of 0.95, while other algorithms, like MIP, shows better performance with SA equal to 3° and 0.98 as R^2. When generating Chl-a maps, PRISMA L2C shows a 16% bias, whereas MIP shows only 1% with *in situ* data, indicating that more performant AC improves the accuracy of biophysical parameter retrieval, and that PRISMA L2C may not always provide the most accurate results. Although a more comprehensive dataset and further analysis are recommended to

improve PRISMA's performance across different optical water types and atmospheric and geometric conditions, this study demonstrates the importance of AC for biophysical parameters estimation, and highlights hyperspectral sensors as a suitable technology for water quality mapping.

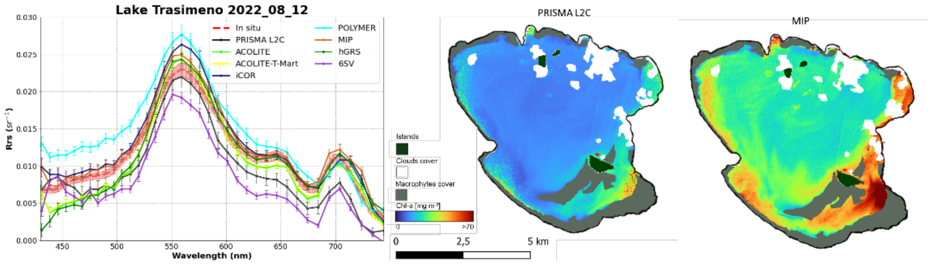

Figure 1 - AC processors comparison for 12/08/2022 for Lake Trasimeno on the left in terms of Remote Sensing Reflectance (Rrs), and Chl-a maps generated from PRISMA L2C and MIP data. The red star in the south east part of the lake shows the position of the WISP Station.

Acknowledgements: This study was part of PRISCAV (grant nr. 2019-5- HH.0) and PANDA-WATER projects (Contract ASI N. 2022-15-U.0), both funded by Italian Space Agency. We acknowledge the support of the National Biodiversity Future Centre (NBFC) funded by the Italian Ministry of University and Research, National Recovery and Resilience Plan (NRRP), Mission 4 Component 2 Investment 1.4—Call for tender No. 3138 of 16 December 2021, rectified by Decree n.3175 of 18 December 2021 of the Italian Ministry of University and Research funded by the European Union—NextGenerationEU. Award Number: CN_00000033, Concession Decree No. 1034 of 17 June 2022 adopted by the Italian Ministry of University and Research, Project title "National Biodiversity Future Center—NBFC". This research was supported by the fund "NextGenerationEU" of the European Union (D.M. 737/2021—CUP B79J21038330001). We also want to acknowledge the investigators of ACIX-III Aqua project for providing PRISMA products of Rrs, and Nima Pahlevan for the project coordination.

References

1. Giardino, C., Brando, V. E., Gege, P., Pinnel, N., Hochberg, E., Knaeps, E., ... & Dekker, A.: Imaging spectrometry of inland and coastal waters: state of the art, achievements and perspectives. Surveys in Geophysics, 40, 401-429 (2019).
2. Giardino, C., Candiani, G., Bresciani, M., Lee, Z., Gagliano, S., & Pepe, M.: BOMBER: A tool for estimating water quality and bottom properties from remote sensing images. Computers & Geosciences, 45, 313-318 (2012).
3. Hunter, P., Neil, C., Knaeps, E., Sterckx, S., D e Keukelaere, L., Reusen, I., …, Van Der Zande, D.: D5. 15 INFORM protoype/algorithms validation report. CNR ExploRA (2017).
4. O'Shea, R. E., Pahlevan, N., Smith, B., Bresciani, M., Egerton, T., Giardino, C., ... & Vaičiūtė, D.: Advancing cyanobacteria biomass estimation from hyperspectral observations: Demonstrations with HICO and PRISMA imagery. Remote Sensing of Environment, 266, 112693 (2021).