A First National Seagrass Map of Venezuela

C. Benjamin Lee [1*], Ana Carolina Peralta Brichtova [2], Mar Roca [3*], Tylar Murray [2],
Oswaldo David Bolivar Rodriguez [4], Daniele Cerra [5], Frank E. Muller-Karger [2]

[1*] German Aerospace Centre, Remote Sensing Technology Institute (IMF), Rutherfordstr. 2, 12489 Berlin, Germany
[2] University of South Florida, College of Marine Science, 830 1st St S, St. Petersburg, FL 33701, United States
[3] Spanish National Research Council (CSIC), Department of Ecology and Coastal Management, Institute of Marine Sciences of Andalusia (ICMAN), Cadiz, Spain
[4] Energy and Environment Unit, Institute of Advanced Studies IDEA, Caracas, Venezuela
[5] German Aerospace Centre, Remote Sensing Technology Institute (IMF), 82234 Wessling, Germany

1 Introduction

Background/Situation:

- With a coastline of about 2,800 km, Venezuela supports numerous seagrass meadows (Vera *et al.*, 2008).
- There is currently no nationwide seagrass map for Venezuela, only a collection of polygon and point vector data (UNEP-WCMC & Short, 2021) as well as two mapped islands (Wabnitz *et al.*, 2009; Schweizer *et al.*, 2005).
- It is crucial to establish the presence of Venezuela's native seagrasses, especially given the threat posed by the invasive *Halophila stipulacea*. (Vera *et al.*, 2014; Rodriguez *et al.*, 2018).

Challenge:

- Seagrass data is mostly dispersed across the nation. As such, an established multitemporal approach could be used as an initial stopgap approach to map seagrasses (Traganos *et al.*, 2018; Blume *et al.*, 2023).
- The presence of clouds causes issues with image quality, which cannot be fully mitigated by multitemporal composition alone. To better manage the cloudy pixels, the Cloud Score+ Product was used to identify and mask out cloud pixels (Pasquarella *et al.*, 2023).

Aim:

1. Explore the use of Cloud Score+ to improve the image composites.
2. Produce an initial seagrass map of Venezuela.

2 Methods & Materials

Map of the study site

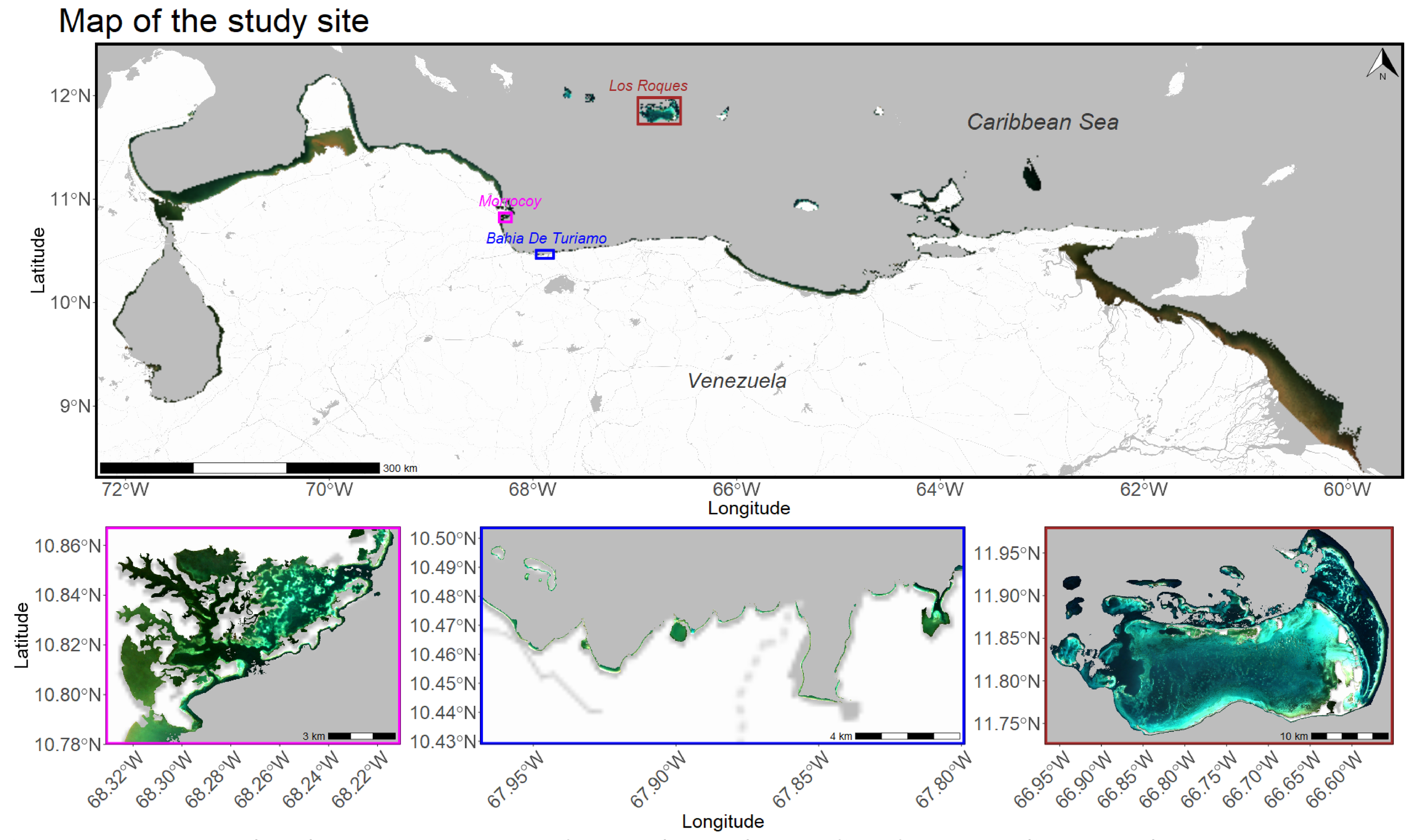

Figure M1: Venezuela. Three sites were used to evaluate the predicted map quality, namely Morrocoy National Park, the Turiamo region, and Los Roques.

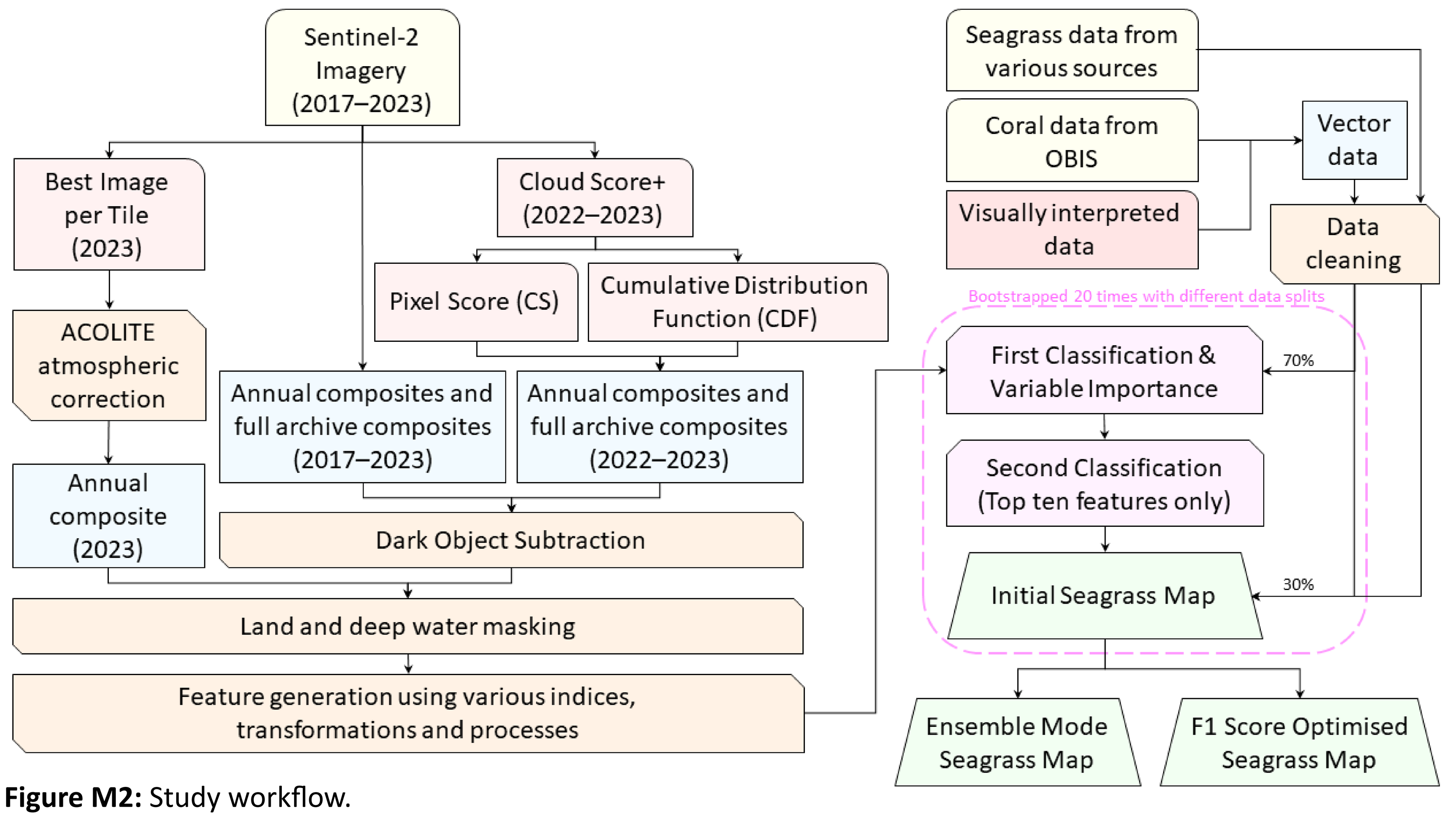

Figure M2: Study workflow.

Image processing:

- Sentinel-2 L1C TOA images with 20% or less cloud cover score.
- The Cloud Score+ CS product uses a pixel quality score, while the Cloud Score+ CDF uses a distribution function value.
- Multitemporal composites composited using the 10th percentile.
- ACOLITE mosaic based on best single tile image.

Vector processing:

- Class: *Sand, Seagrass, Coral, Turbid, Deep Water.*
- Based on publications and photointerpretation.

Classification & Ensemble:

- Bathymetry and slope derivatives added.
- Image composite was split into coastal (Case 2) and open waters (Case 1) for the feature selection (Figure R3) and classification.
- Maps were ensembled (n = 20) by mode or by best F1-Score.

3 Results

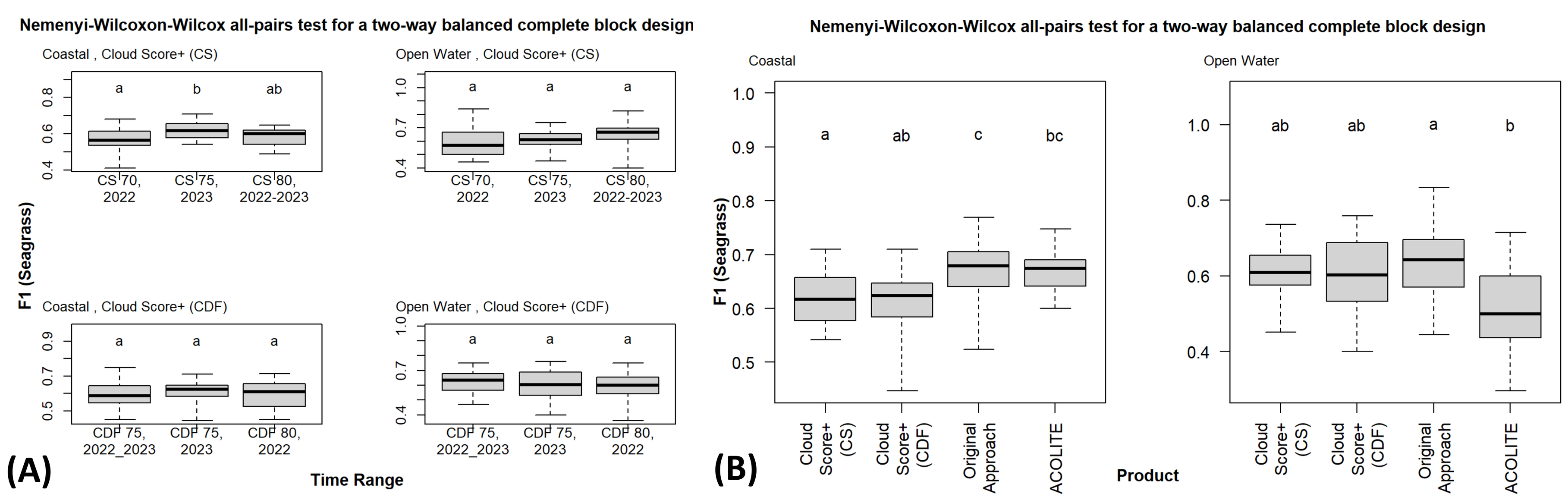

Figure R1: Post-hoc comparison of classification performance of the different product treatments (n = 20) for **(A)** the Cloud Score+ products across different time periods, and **(B)** all the different products/approaches.

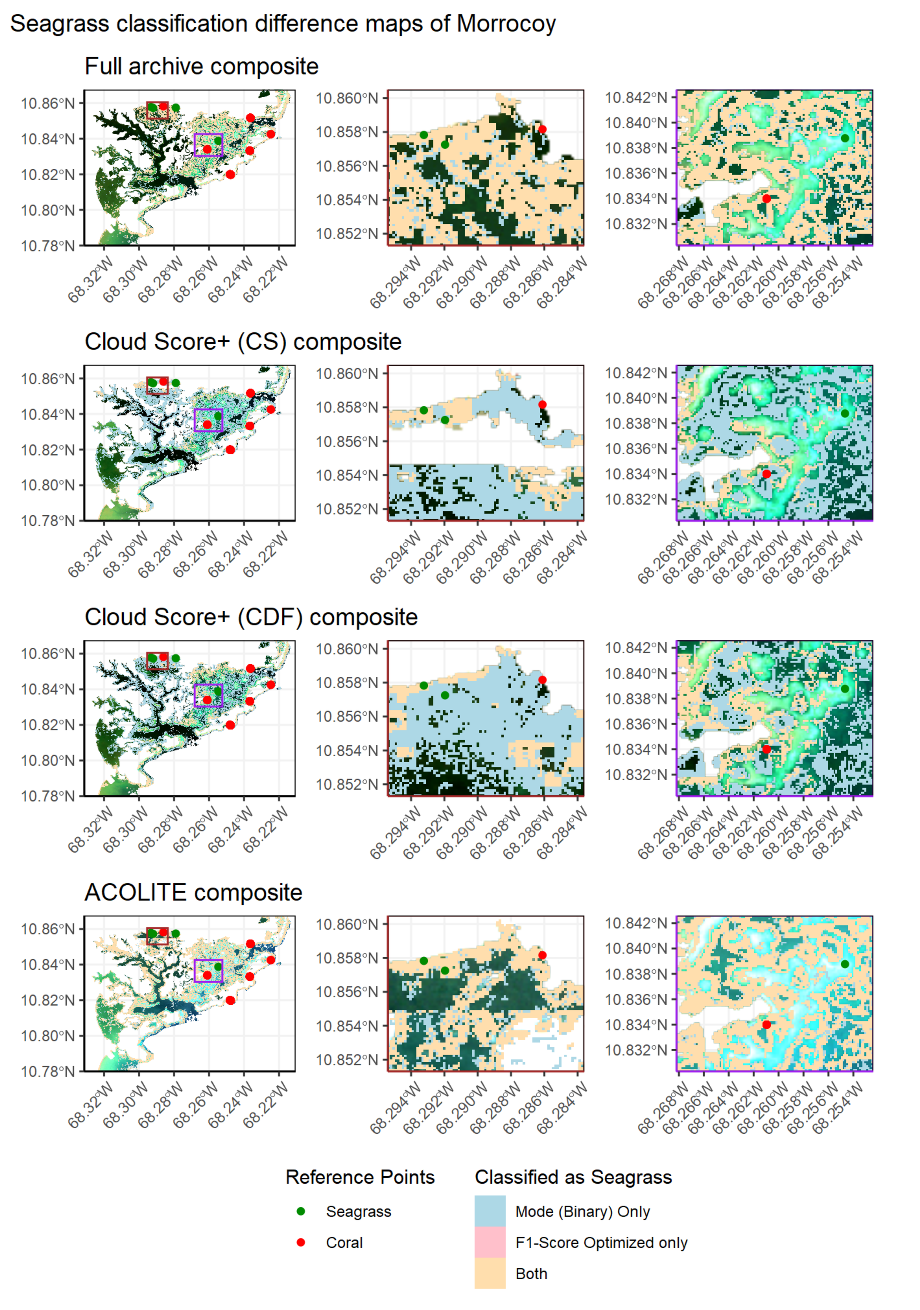

Figure R2: Ensemble classification difference maps at Morrocoy National Park for all four different approaches. Two subsites per site were further examined for their qualitative map performances. For the other sites, readers are referred to the publication (QR code, bottom right).

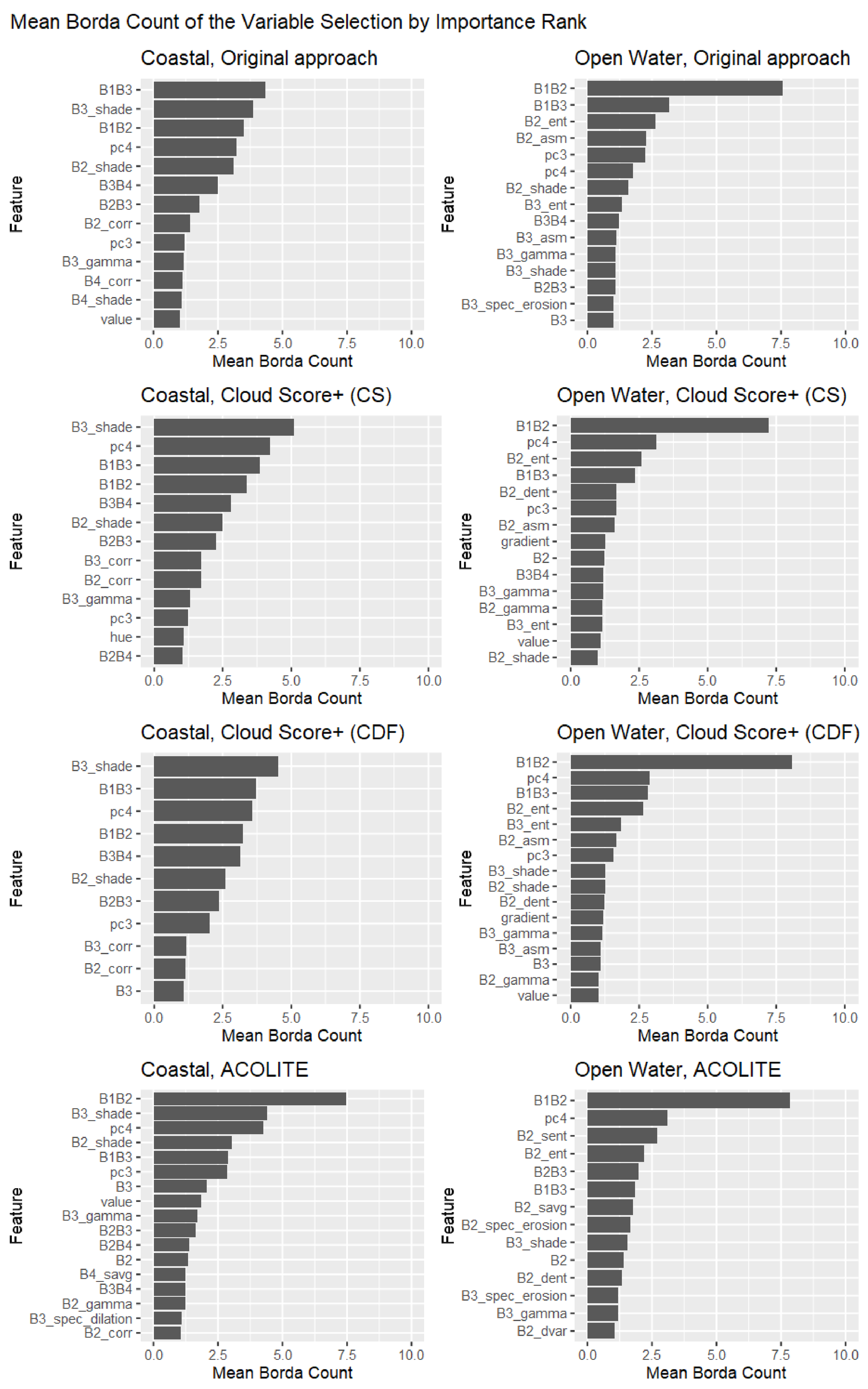

Figure R3: Analysis of the most frequently selected features in variable importance across different approaches and water types.

Predicted seagrass map (Original approach)

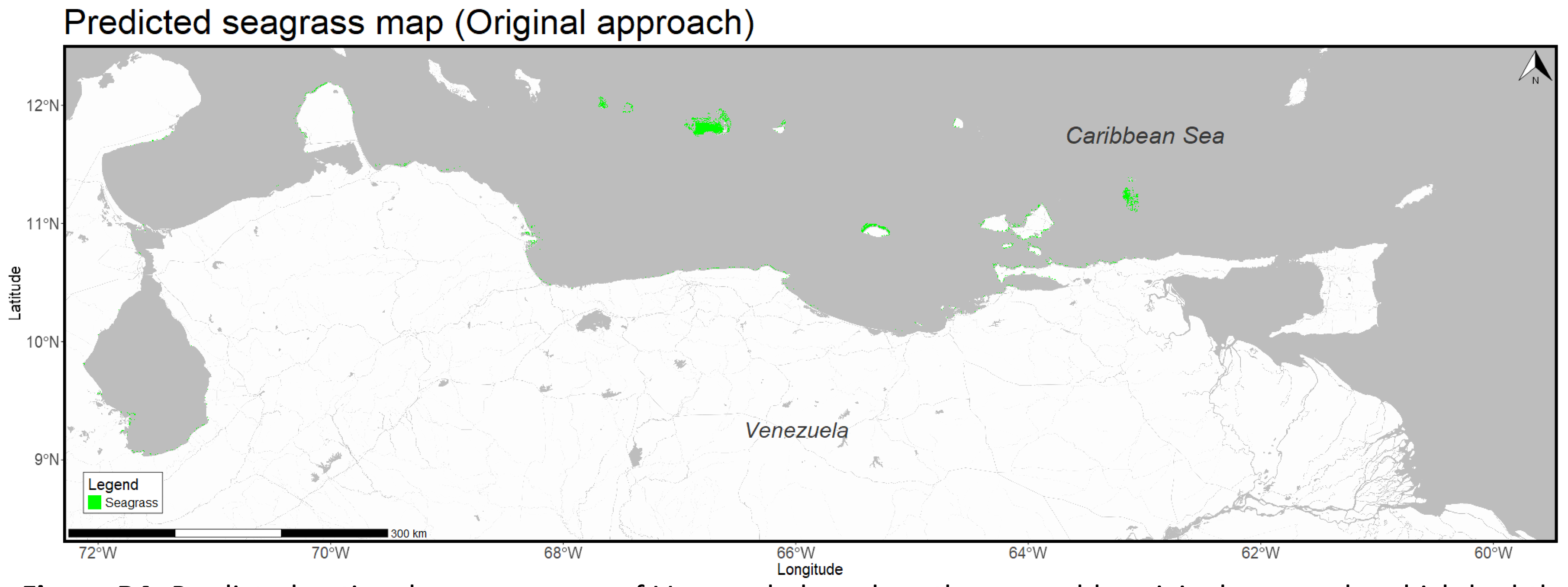

Figure R4: Predicted national seagrass map of Venezuela based on the ensemble original approach, which had the best overall quantitative performance. Map post-processed to exclude the turbid misclassifications in the east.

4 Discussion

Classification performance:

- Statistically similar performances across different CS and CDF scores thresholds and time window (Figure R1A).
- The original approach had the best quantitative results, and statistically better in coastal waters (Figure R1B).
- ACOLITE approach had the best qualitative result (Figure R2).
- Both Cloud Score+ products are comparable to the original approach in open waters while needing a smaller time window (Figure R1B).

Impact:

- Produced a predicted first national seagrass map of Venezuela (Figure R4).
- Cloud Score+ enables temporal analyses and monitoring, trading classification performance for a shorter composition time window.

Take Home Message:

1. Cloud Score+ products are competitive over open waters while needing a shorter time period, thereby enabling temporal analyses.
2. Predicted national seagrass maps of Venezuela are produced nationwide for the first time.

Reference

Blume, A., Pertiwi, A. P., Lee, C. B., & Traganos, D. (2023). Bahamian seagrass extent and blue carbon accounting using Earth observation. *Frontiers in Marine Science*, *10(2023), 1058460*.

Pasquarella, V. J., Brown, C. F., Czerwinski, W., & Rucklidge, W. J. (2023). Comprehensive quality assessment of optical satellite imagery using weakly supervised video learning. In *Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition* (pp. 2124-2134).

Rodríguez-Guia, A., Rodríguez, C., & Rodríguez-Quintal, J. G. (2018). Halophila stipulacea (Hydrocharitaceae) en la Laguna de Yapascua, Parque Nacional San Esteban, Carabobo, Venezuela. *Acta Botanica Venezuelica*, *41*(1), 109-121.

Schweizer, D., Armstrong, R. A., & Posada, J. (2005). Remote sensing characterization of benthic habitats and submerged vegetation biomass in Los Roques Archipelago National Park, Venezuela. *International Journal of Remote Sensing*, *26*(12), 2657-2667.

Traganos, D., Aggarwal, B., Poursanidis, D., Topouzelis, K., Chrysoulakis, N., & Reinartz, P. (2018). Towards global-scale seagrass mapping and monitoring using Sentinel-2 on Google Earth Engine: The case study of the Aegean and Ionian seas. *Remote Sensing*, *10*(8), 1227.

UNEP-WCMC, & Short, F. T. (2021). Global distribution of seagrasses (version 7.1). Seventh update to the data layer used in Green & Short (2003). Cambridge (UK): UN Environmental Programme World Conservation Monitoring Centre. Data DOI: https://doi.org/10.34892/x6r3-d211

Vera, B. (2008). Contribution of Seagrass Ecosystems to the Venezuelan Coastline Vegetation. *Mangroves and Halophytes: Restoration and Utilisation*, 65-75.

Vera, B., Collado-Vides, L., Moreno, C., & van Tussenbroek, B. I. (2014). Halophila stipulacea (Hydrocharitaceae): a recent introduction to the continental waters of Venezuela. *Caribbean Journal of Science*, *48*(1), 66-70.

Wabnitz, C. C., Andréfouët, S., Torres-Pulliza, D., Müller-Karger, F. E., & Kramer, P. A. (2008). Regional-scale seagrass habitat mapping in the Wider Caribbean region using Landsat sensors: Applications to conservation and ecology. *Remote Sensing of Environment*, *112*(8), 3455-3467.

First author's ORCID record

Read this paper

chengfa.lee@dlr.de, mar.roca@csic.es