COLOUR ME OPTICALLY SHALLOW

A Simple and Adaptive Method for Standardised Analysis Ready Data for Coastal Ecosystem Assessments

Chengfa Benjamin Lee[1*], Dimosthenis Traganos[1], Peter Reinartz[2]

[1]German Aerospace Center (DLR), Remote Sensing Technology Institute (IMF), Rutherfordstr. 2, 12489 Berlin, Germany
[2]German Aerospace Center (DLR), Remote Sensing Technology Institute (IMF), 82234 Wessling, Germany
*Corresponding author: chengfa.lee@dlr.de

Introduction

Situation:

- Remote sensing provide useful information on the valuable seascape ecosystems such as seagrasses
- Challenges introduced by the water column, in particular light attenuation

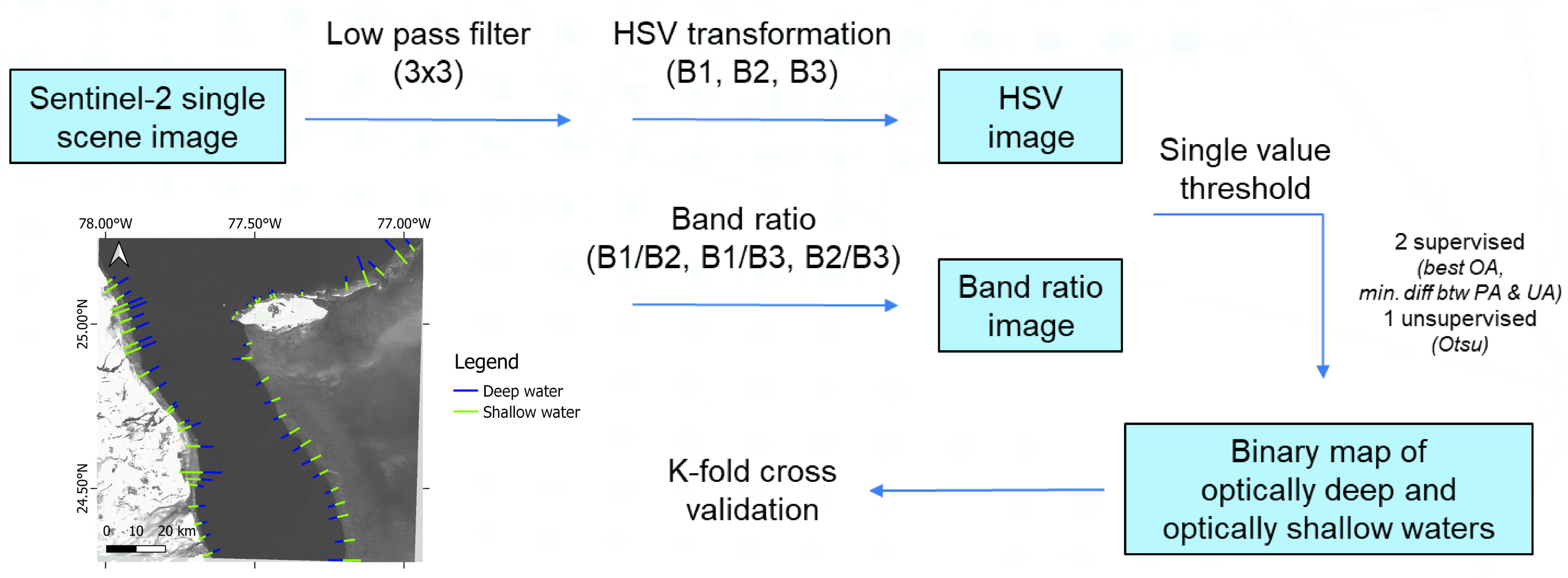
Problem:

- Light is unequally attenuated across its wavelength , which has a greater effect on the spectral signals of a seabed cover as depth increases
- Darker seabed covers such as seagrass are easily confused with optically deep waters at greater depths
- Optically deep waters pixels do not contain any information on the seabed and can be removed (Brando *et al.*, 2009)

Proposed solution:

- By using a HSV-transformed B1-B2-B3 false-colour composite of the Sentinel-2 image archive within the Google Earth Engine
- Tested with single images across different sites with differing water qualities — showcasing Tanzania and the Bahamas
- Showcased benefit for mapping and national coastal ecosystem assessments in the Bahamas.

Methods



Results

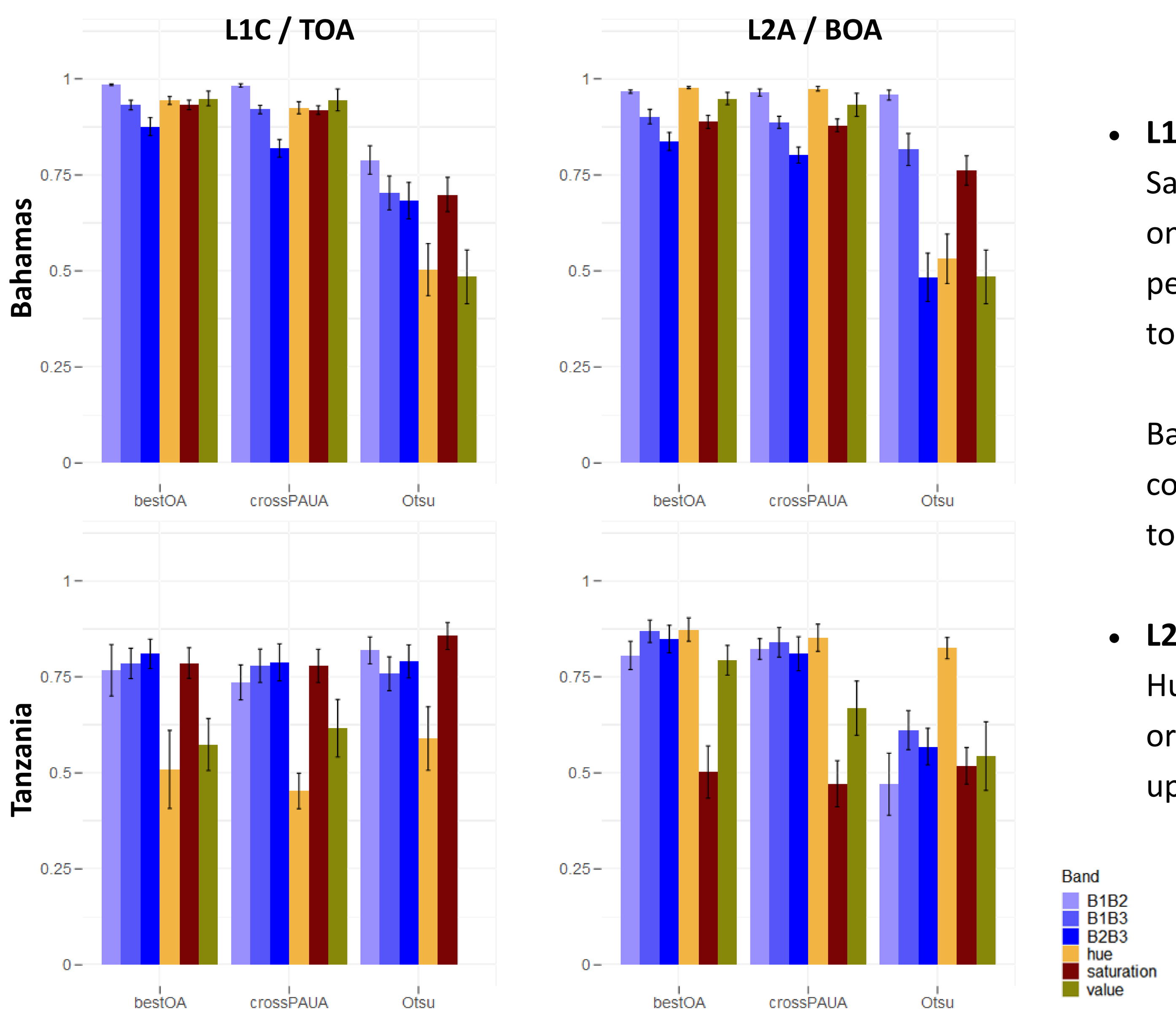


Figure 1. Overall accuracy of the various spectral methods to differentiate the optically shallow water class from the optically deep water class for Sentinel-2 L1C and L2A single images.

- **L1C images:**
  Saturation consistently one of the best performers, with OA up to 0.93

  Band ratios were competitive, but specific to site
- **L2A images:**
  Hue consistently the best or second-best, with OA up to 0.98

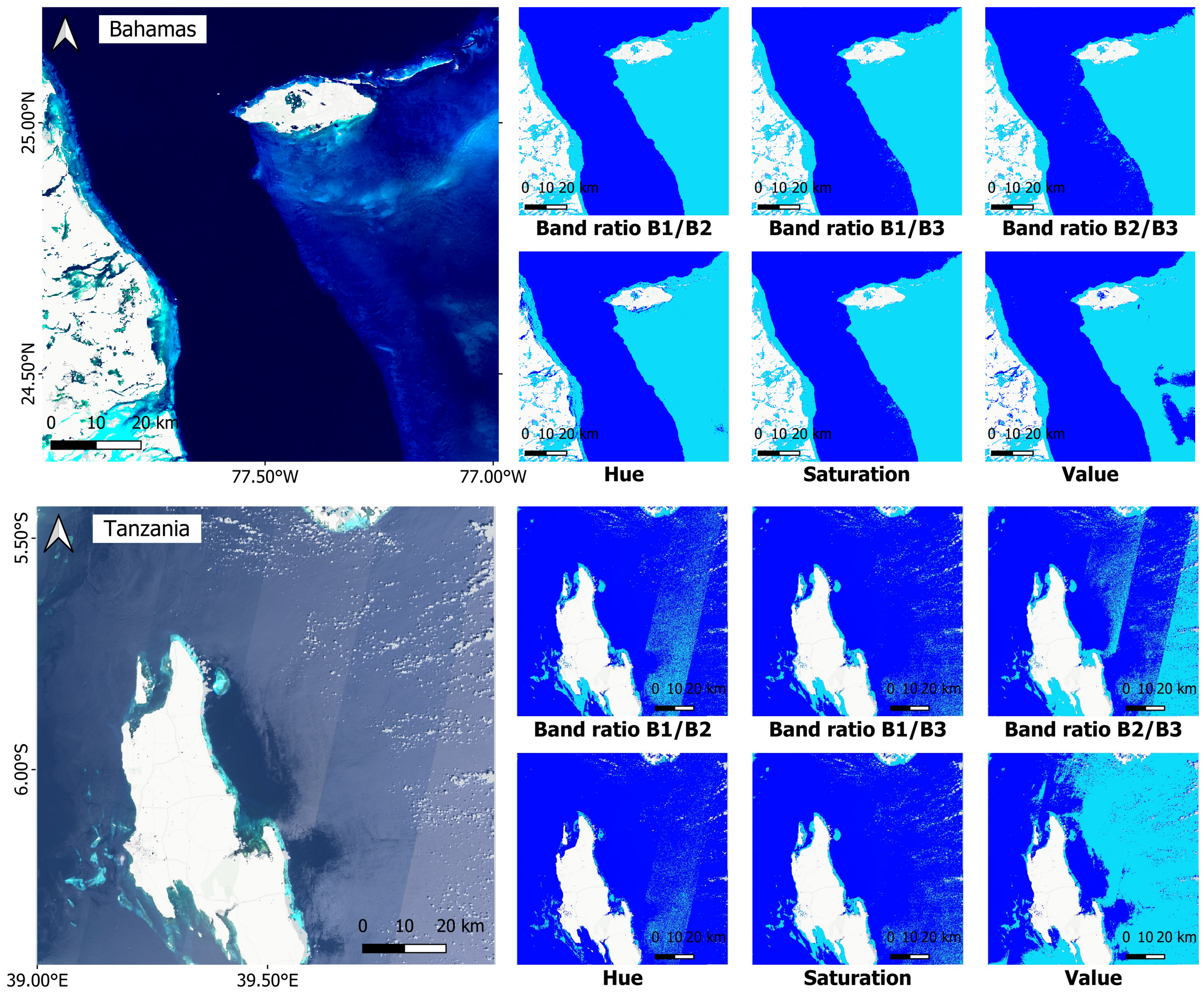


Figure 2. Map assessment of the various spectral methods to differentiate the optically shallow water class from the optically deep water class for the Sentinel-2 L1C images, with the RGB image on the left. Light blue represents the optically shallow waters while dark blue represents the optically deep waters.

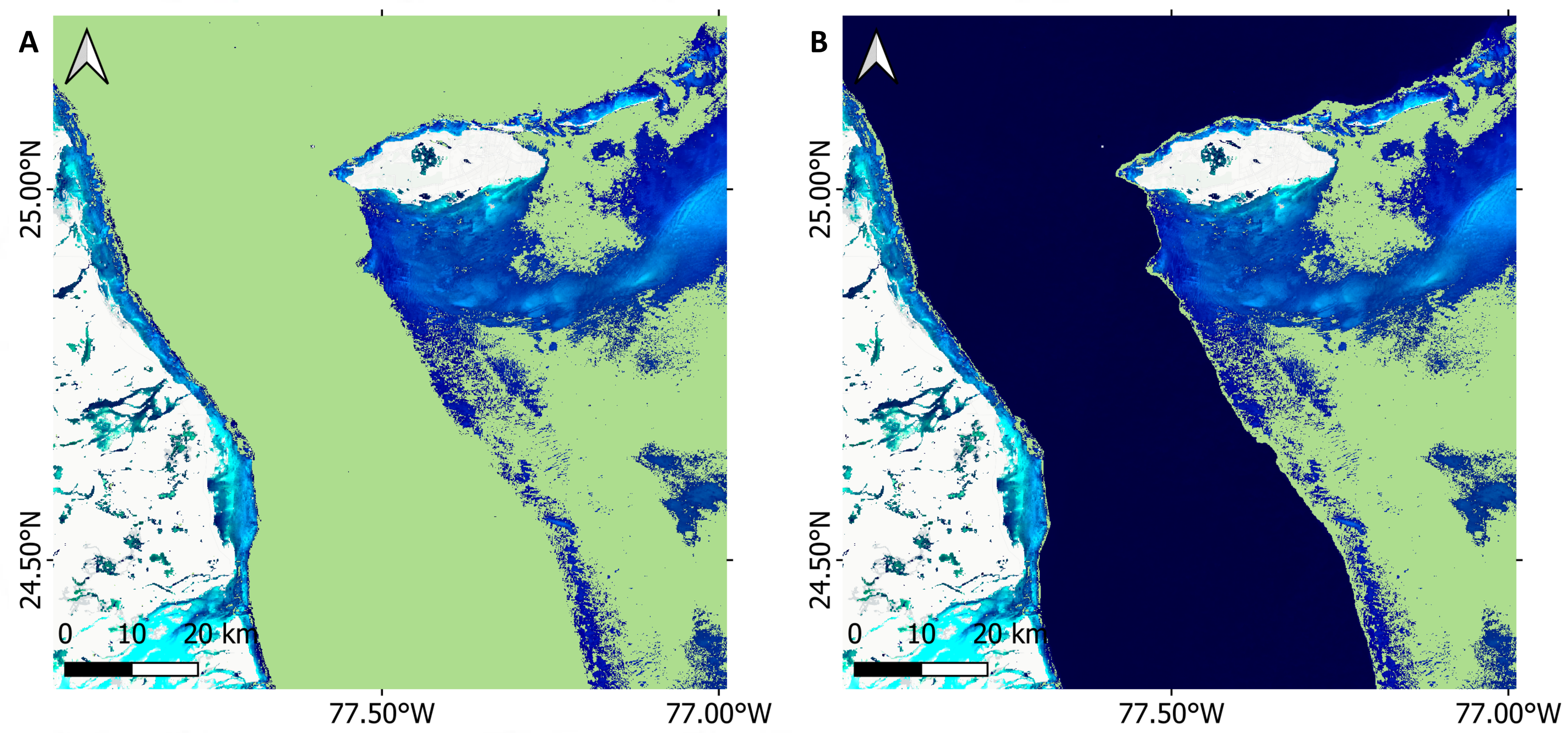


Figure 3. Classification of seagrass in the Bahamas with deep water masking (A) and without deep water masking (B). The final classification was done using seagrass points sampled from the ALLEN Coral Atlas benthic classification map. The RGB image used is the same as in Figure 2.

Discussion & Conclusion

- Although no atmospheric correction is required, the different optimal HSV variable for L1C and L2A images is reflective of the relationship of hue to oceanic colour. (Lee *et al.*, 2021)
- Potential stepping stone to an automated approach to mask out deep water on a large scale
  ⇒ Reduce benthic cover confusion at deeper depth & produce better maps
  ⇒ More computationally friendly than optimisation (within the user quota of GEE).
  ⇒ Suitable automated and dynamic thresholding method still required.
- B1-B2-B3 false-colour Saturation & Hue can mask out optically deep waters for Sentinel-2 L1C & L2A, respectively.

Reference

Brando, V. E., Anstee, J. M., Wettle, M., Dekker, A. G., Phinn, S. R., & Roelfsema, C. (2009). A physics based retrieval and quality assessment of bathymetry from suboptimal hyperspectral data. Remote sensing of Environment, 113(4), 755-770.

Lee, C. B., Traganos, D., & Reinartz, P. (2022). A Simple Cloud-Native Spectral Transformation Method to Disentangle Optically Shallow and Deep Waters in Sentinel-2 Images. *Remote Sensing*, *14*(3), 590.

Lee, Z., Shang, S., Li, Y., Luis, K., Dai, M., & Wang, Y. (2021). Three-Dimensional Variation in Light Quality in the Upper Water Column Revealed With a Single Parameter. IEEE Transactions on Geoscience and Remote Sensing, 60, 1-10.

Read my paper