ESA Ocean Colour Climate Change Initiative+ Phase 2

Product Validation and Inter-comparison Report – In situ v1

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Table of Contents

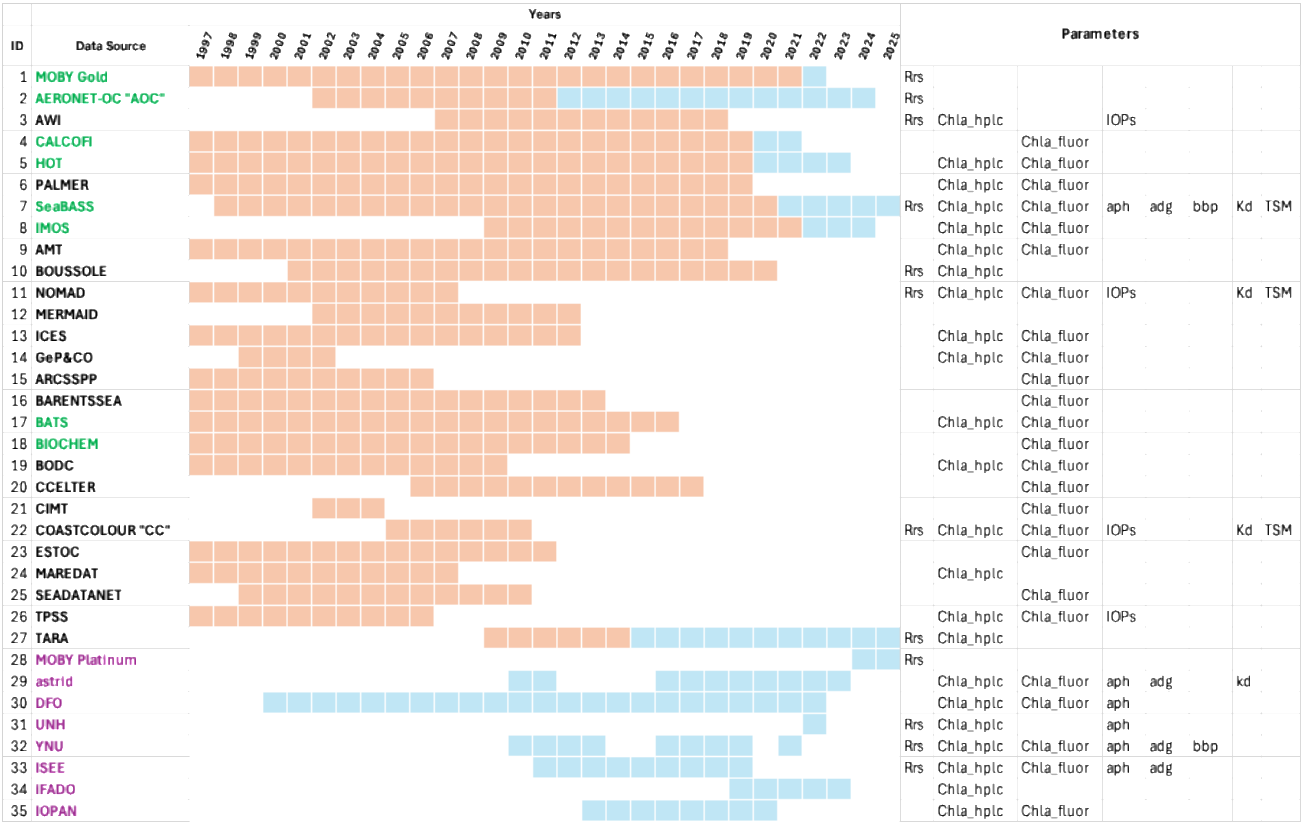
Table of Contents 3
1. Introduction 4
2. OC-CCI Database variables 5
Chlorophyll-a (HPLC and Fluorometric) 5
Remote Sensing Reflectance (R_{rs}) 6
Inherent Optical properties 6
Total Suspended Matter (TSM) 8
3. Conclusions 9
Reference 10

1. Introduction

This release of the *Product Validation and Inter-comparison Report* (PVIR) *In situ* for the ESA Ocean Colour Climate Change Initiative (OC-CCI) project focuses on **Version 7 of the OC-CCI global dataset**. It updates the previous release (PVIR v3.0, 2023) and extends the in-situ database compiled by Valente et al. (2016, 2019, 2022).

The OC-CCI global dataset Version 2025 (hereafter, V25) integrates new datasets to that published by Valente et al (2022) (hereafter, V22) from international monitoring programs, research cruises, and regional datasets, following the same standardized protocols used in V22. The in-situ OC-CCI database includes data from 35 dataset sources (Table 1). Among these, 8 datasets (i.e., MOBY Gold, AERONET-OC, CALCOFI, HOT, SeaBASS, IMOS BATS and BIOCHEM, highlighted in green text at Table 1) had coverage extended with new data, while 8 datasets were newly introduced in V25 (highlighted in magenta text in Table 1), expanding both the temporal and source diversity of the collection.

Table 1: Coverage and parameter mapping of 35 in-situ datasets used in the OC-CCI project. The "Data Source" column text colouring marks data status: black for previously existing sources with no new updates, green indicates already existing datasets that have been updated, and magenta denotes newly added datasets in version 25. Orange highlighting in year cells shows data available in V22, while blue highlighting marks additional data coverage extended in V25.



ID	Data Source	Parameters					
1	MOBY Gold	Rrs					
2	AERONET-OC "AOC"	Rrs					
3	AWI	Rrs	Chla_hplc		IOPs		
4	CALCOFI			Chla_fluor			
5	HOT		Chla_hplc	Chla_fluor			
6	PALMER		Chla_hplc	Chla_fluor			
7	SeaBASS	Rrs	Chla_hplc	Chla_fluor	aph adg bbp	Kd	TSM
8	IMOS		Chla_hplc	Chla_fluor			
9	AMT		Chla_hplc	Chla_fluor			
10	BOUSSOLE	Rrs	Chla_hplc				
11	NOMAD	Rrs	Chla_hplc	Chla_fluor	IOPs	Kd	TSM
12	MERMAID						
13	ICES		Chla_hplc	Chla_fluor			
14	GeP&CO		Chla_hplc	Chla_fluor			
15	ARCSSPP			Chla_fluor			
16	BARENTSSEA			Chla_fluor			
17	BATS		Chla_hplc	Chla_fluor			
18	BIOCHEM			Chla_fluor			
19	BODC		Chla_hplc	Chla_fluor			
20	CCELTER			Chla_fluor			
21	CIMT			Chla_fluor			
22	COASTCOLOUR "CC"	Rrs	Chla_hplc	Chla_fluor	IOPs	Kd	TSM
23	ESTOC			Chla_fluor			
24	MAREDAT		Chla_hplc				
25	SEADATANET			Chla_fluor			
26	TPSS		Chla_hplc	Chla_fluor	IOPs		
27	TARA	Rrs	Chla_hplc				
28	MOBY Platinum	Rrs					
29	astrid		Chla_hplc	Chla_fluor	aph adg	kd	
30	DFO		Chla_hplc	Chla_fluor	aph		
31	UNH	Rrs	Chla_hplc		aph		
32	YNU	Rrs	Chla_hplc	Chla_fluor	aph adg bbp		
33	ISEE	Rrs	Chla_hplc	Chla_fluor	aph adg		
34	IFADO		Chla_hplc				
35	IOPAN		Chla_hplc	Chla_fluor			

The OC-CCI in-situ dataset provides high-quality measurements of key ocean-optical variables used for satellite validation and algorithm development. The target variables include:

- Remote sensing reflectance ($R_{rs}(\lambda)$)
- Chlorophyll-a (*Chl-a*) measured by high-performance liquid chromatography (HPLC) and fluorometric methods

- Total suspended matter (*TSM*)
- Diffuse attenuation coefficient ($K_d(\lambda)$)
- Particulate backscattering coefficient ($b_{bp}(\lambda)$)
- Coloured dissolved organic matter absorption ($a_{dg}(\lambda)$)
- Phytoplankton absorption coefficient ($a_{ph}(\lambda)$)

The OC-CCI project prioritizes quality-controlled observations, ensuring consistent, traceable data across temporal and spatial scales, suitable for long-term climate applications.

2. OC-CCI Database variables

Chlorophyll-a (HPLC and Fluorometric)

A total of 35,281 *Chl-a* HPLC and 78,113 *Chl-a* fluorometric measurements are now included.

- HPLC data increased from 26,268 (V22) → 35,281 (V25), adding 9,013 new records.
- Fluorometric data increased from 48,952 (V22) → 78,113 (V25), adding 29,161 new records. Figure 1 shows the spatial distribution of both HPLC and fluorometric Chla. The histograms of Figure 2 confirm that the new data follow similar log-normal distributions, ensuring compatibility with the existing dataset.

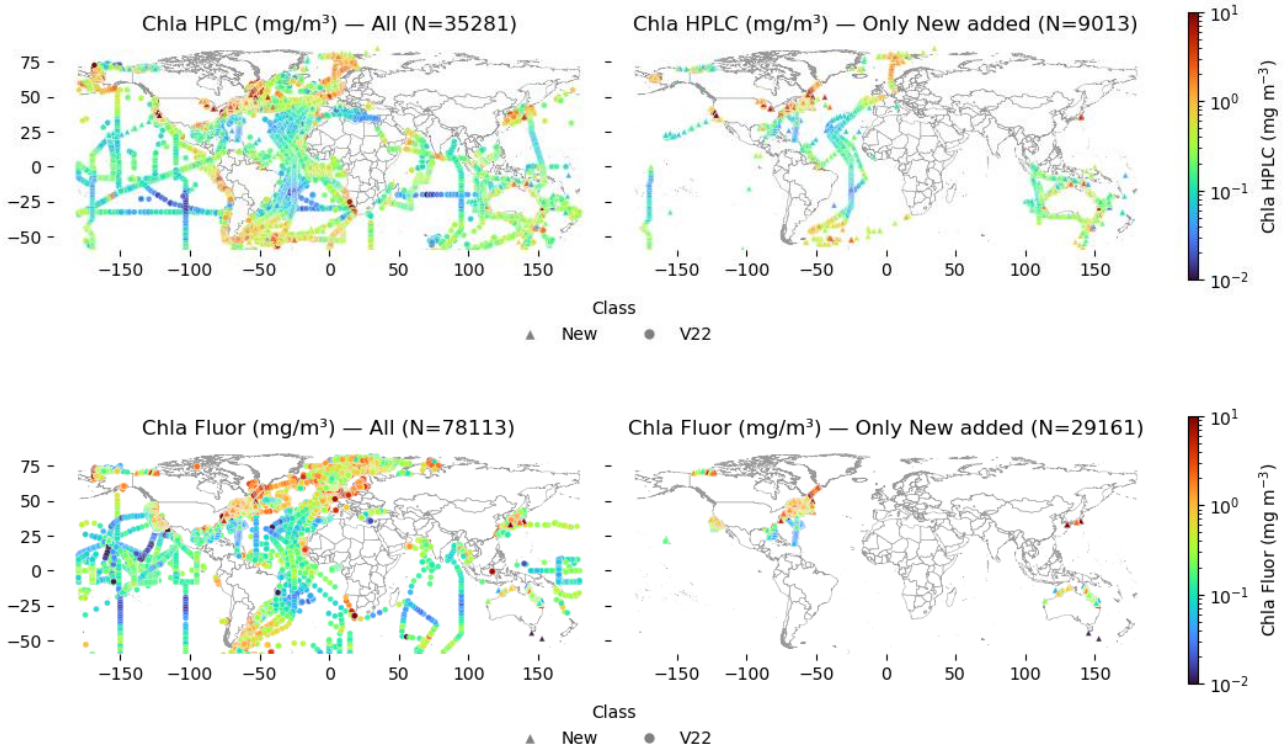


Figure 1: Global spatial distribution of in situ chlorophyll-a (Chla, mg m^{-3}) concentrations from the OC-CCI dataset. Top row: HPLC Chla for all OC-CCI records (left, N=35,281) and for newly added records in V25 (right, N=9,013). Bottom row: Fluorometric Chla for all OC-CCI records (left, N=78,113) and for newly added records in V25 (right, N=29,161). Marker symbols denote data version: triangles for V25, circles for V22.).

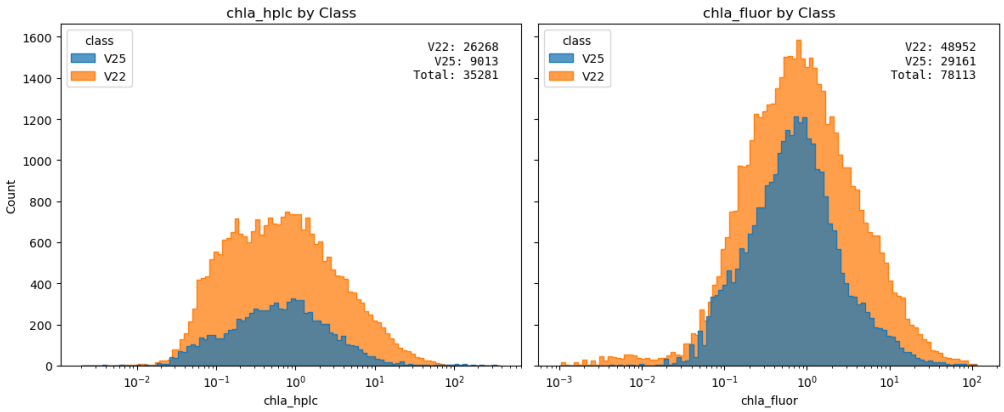


Figure 2: Histogram distribution of Chlorophyll-a (Chla, mg m-3) measured by HPLC: (left, N = 35,281) and by fluorometric methods (right, N = 78,113). Orange and blue colours represent the Chla records from the OC-CCI in situ database V22 and newly added records in V25, respectively.

Remote Sensing Reflectance (R_{rs})

Rrs data show a significant increase from 68,641 (V22) to 135,525 (V25). The newly added data of 66,884 records nearly doubles the number of available *Rrs* spectra, providing a stronger base for satellite algorithm validation and uncertainty assessments.

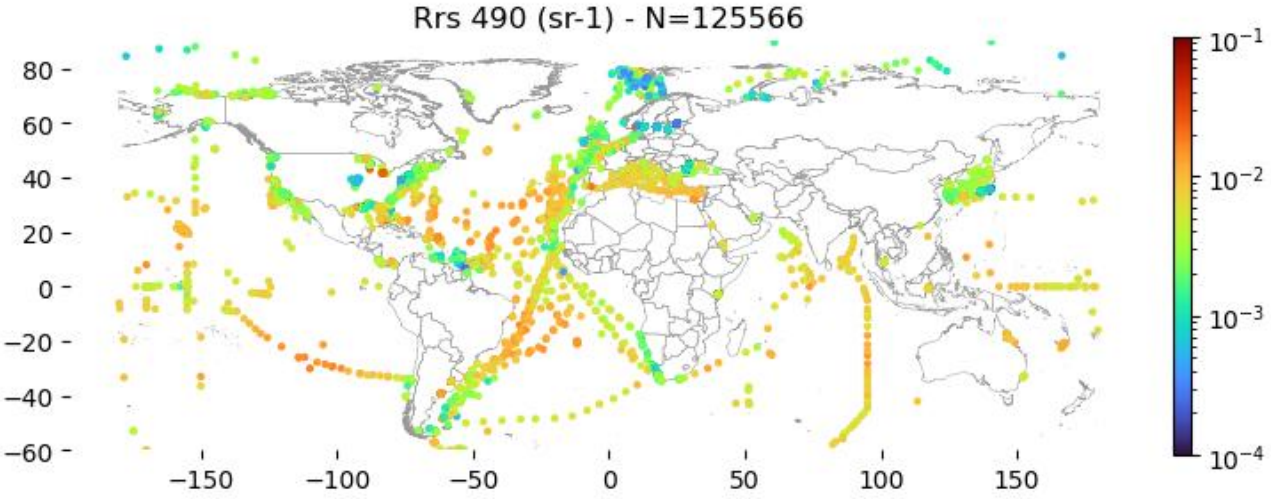


Figure 3: Global spatial distribution of in situ remote sensing reflectance (Rrs, sr -1) at 490 nm for all data points(N = 125,566).

Inherent Optical properties

New additions notably enhance bio-optical coverage:

- a_{ph}: 4,265 (V22) → 10,411 (V25) (+6,146 new)
- a_{dg}: 1,654 (V22) → 2,903 (V25) (+1,249 new)
- b_{bp}: 792 (V22) → 82,139 (V25) (+81,347 new)

The b_{bp} increase is particularly significant, reflecting, notably, new data integration from European and coastal monitoring programs (Figure 6) including from the ESA supported TREC programme.

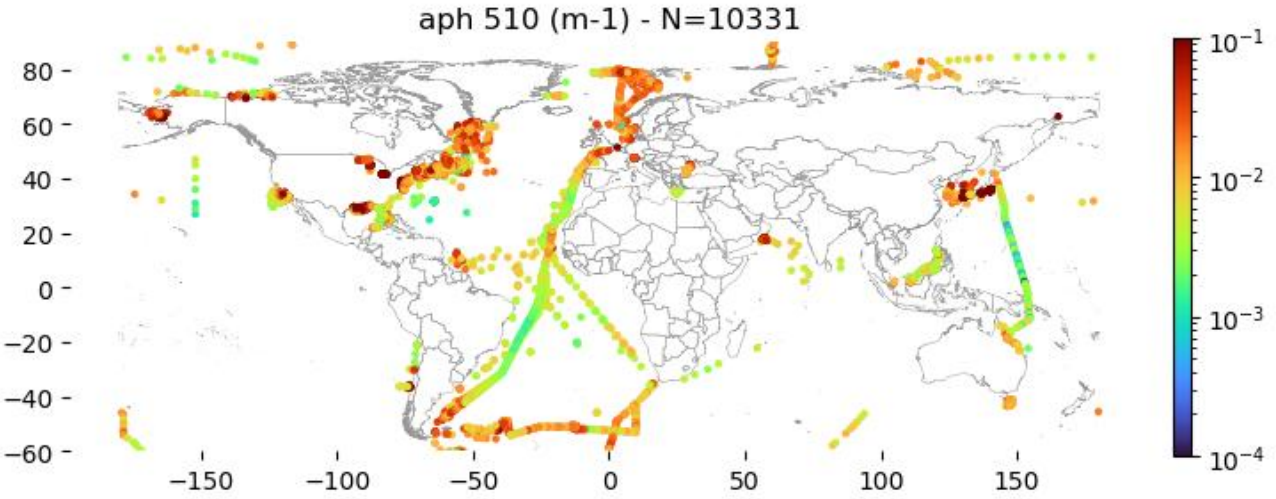


Figure 4: Global spatial distribution of the phytoplankton absorption coefficient (aph 510, m^{-1}) for all records (N = 10,331).

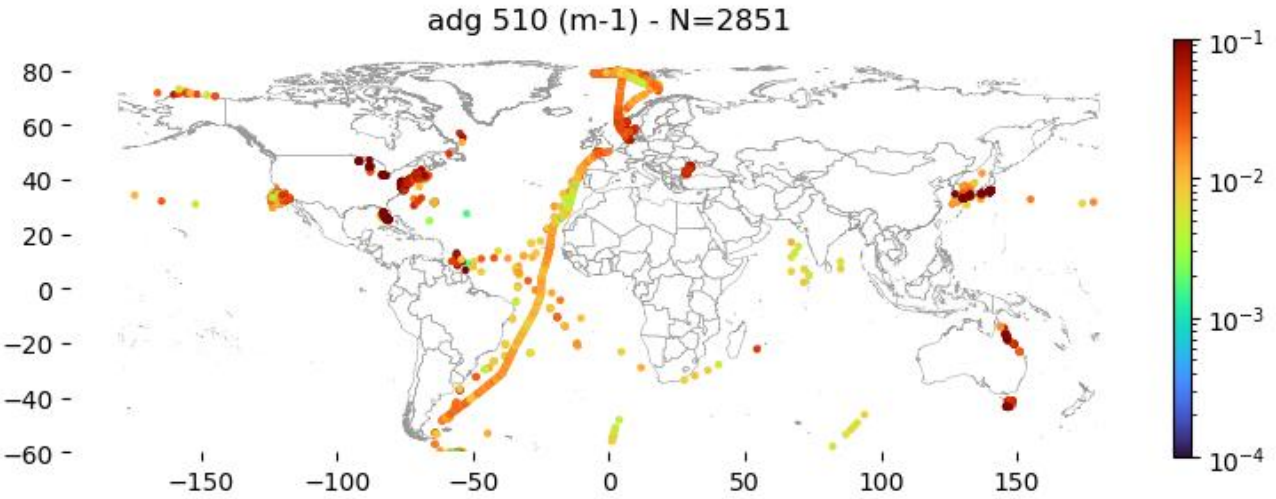


Figure 5: Global spatial distribution of the coloured dissolved and detrital material absorption (adg 510, m^{-1}) for number of records (N) of 10,331.

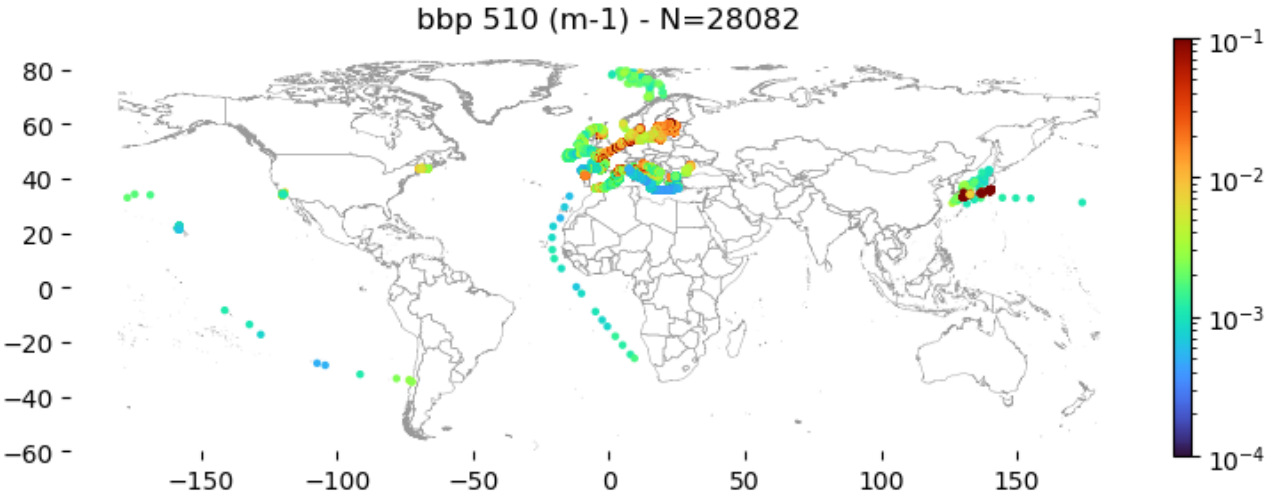


Figure 6: Global spatial distribution of particle backscattering coefficient (bbp 510, m^{-1}) for number of records (N) of 28,082.

Total Suspended Matter (TSM)

TSM data modestly increased from1,546 (V22) to 1,841 (V25). Although the number of new samples is relatively small, they provide important additional coverage in under-sampled regions such as the Southern Ocean and coastal Australia. It is worth noting that TSM is not an official OC-CCI standard product, but it has been included to support a broader range of scientific applications.

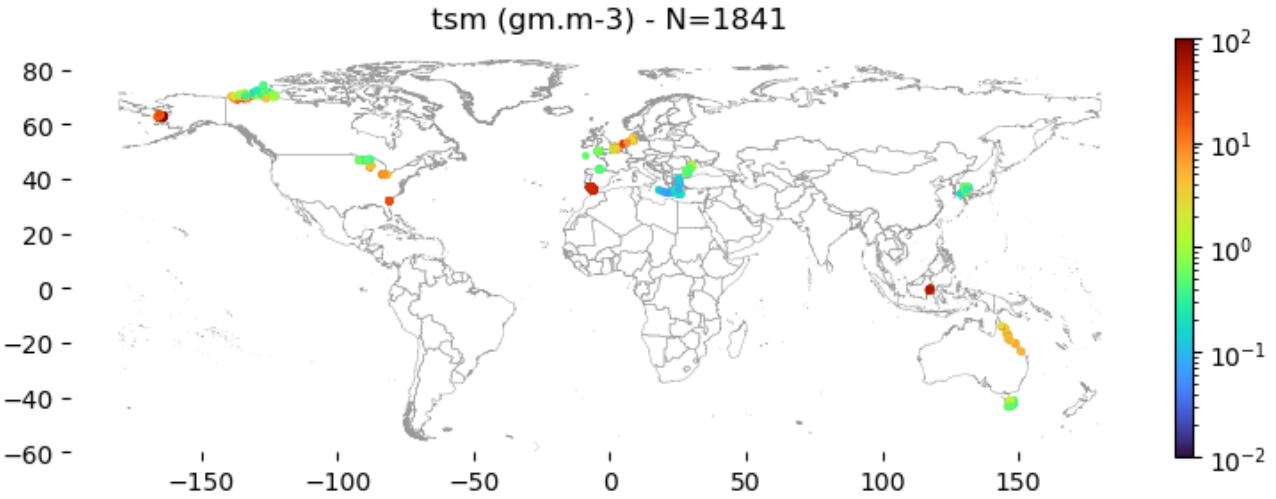


Figure 7: Global spatial distribution of total suspended matter (tsm, g m^{-3}) for number of records (N) of 1,841.

Table 2: Summary of the OC-CCI in-situ dataset expansion from Version 2022 (V22) to Version 2025 (V25), and the number of newly added data points, and the corresponding percentage increase, where N is the number of samples.

Variable	N (V22)	N (V25)	N (Newly added data)	% Increase
Chl-a HPLC	26,268	35,281	9,013	+34%
Chl-a Fluor	48,952	78,113	29,161	+60%
Rrs	68,641	135,525	66,884	+97%
aph 510	4,265	10,411	6,146	+144%
adg 510	1,654	2,903	1,249	+76%
bbp 510	792	82,139	81,347	>10,000%
TSM	1,546	1,841	295	+19%

3. Conclusions

The OC-CCI in-situ database Version 2025 (V25) marks a major step forward in data volume, coverage, and diversity. Improvements are most evident for R_{rs} and b_{bp}, both critical for the retrieval of inherent optical properties. The addition significantly strengthens the representativeness of global and regional validation datasets, ensuring robust evaluation of ocean-colour satellite products for climate applications. Preparations for a 4th publication in the series (Salem et al.) are well underway with submission planned for 2026.

Reference

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