Breakout Workshop # 10

Merged Long-Term Ocean Colour Products: Challenges, Strategies, and Community Priorities

Chairs: Robert Frouin, Elizabeth Atwood

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Breakout Workshop Overview

Goals

- Encourage and support an inclusive, international dialogue on the challenges and requirements for producing long-term, multi-sensor ocean-colour datasets, with relevance to climate research, operational monitoring, and ecosystem applications.
- Gather community input that will directly inform the IOCCG Long-Term Time Series Task Force's future recommendations and work plan.

Structure

-Framing presentation

-Overview of LTTS Task Force plans and deliverables

-Lightning talks from invited experts

-Open discussion with all participants

Key questions

1. Most pressing user needs for products?
2. Critical gaps in current products in terms of spatial/temporal resolution, uncertainty quantification, sensor continuity, or product accessibility?
3. Criteria to define "climate-quality" or "application-ready"?
4. Key methodological challenges in harmonizing and blending across sensors?
5. Community support to sustain and improve merged data records?
6. User vision of essential future capabilities or product features?

Participants

What is your
field of research?

What LTTS products
do you already use?

Short presentations

ZhongPing Lee: *Introduction of GLOSS (Global, Long-term, Ocean-color Synthesis Series)*

- Novel merging of multi-satellite ocean color data by implementing cross-satellite atmospheric correction (CSAC) and AI-based calibration.

Jing Tan: *Achieving Radiometric Consistency Across Missions: Polar-Orbit Cross-Calibration and Bayesian Multi-Site SVC*

- Cross-calibrating polar-orbiting sensors and harmonizing vicarious calibration gains from multiple in situ sites. Uses geostationary data as intermediaries; Applies hierarchical Bayesian modeling to combine multi-site SVC data.

Salem Salem: *OC-CCI: An Integrated Ocean Colour Product for Climate Research*

- Overview of OC-CCI processing, updates coming in version 7 and future directions.

Short presentations (contd.)

Lionel Arteaga Quintero: *Overview of the NASA Ocean Biogeochemical Model (NOBM)*

- Data assimilation of NASA's Ocean Biogeochemical Model (NOBM) together with MODIS data to fill observational gaps and generate Level-4 products. Tools applied to assess climate impacts on ocean ecology, inform satellite mission design, and detect long-term trends in key variables like chl and net primary production.

Thomas Jackson: *EUMETSAT Climate Team*

- EUMETSAT's role in creating long-term, climate data records. Highlighted need for inter-agency collaboration, harmonized processing, and robust uncertainty characterization to support climate monitoring, trend detection, and application-ready products for diverse user needs.

Myung-Sook Park: *Using Long-Term Ocean Color Records to Uncover Climate-Driven Changes*

- Widespread ocean color shifts toward bluer waters in tropical/subtropical regions and greener waters at high latitudes, suggesting ocean desertification in low-latitude regions and increased productivity in polar areas, with significant implications for global carbon cycles and fisheries.

Review of Existing Recommendations

2023.04.1	The community should develop an open-access database of POC and DOC for inland and coastal waters	Community	Actioned*
2023.08.1	The community needs to conduct more research to identify all sources of discrepancies in merged datasets (beyond time and space, including geometry and other factors) and to quantify and correct them.	Community	OPEN
2023.08.2	The community needs to improve description of continuity metrics including reporting of possible extremes (tails), possibly using Probability Density Functions.	Community	OPEN
2023.08.3	Space agencies and distribution services (in collaboration with the ocean colour and metrology communities) need to prioritise calculating and distributing uncertainties associated with all products (pixel-based and composite), and including propagation through AC and algorithms following metrological practices.	Agency	OPEN
2023.08.4	The community and IOCCG need to consider revising/updating the 2006 IOCCG report on data merging.	IOCCG	OPEN
2023.08.5	Space agencies should advocate for mission design to ensure backwards compatibility to improve confidence in derived trends and ensure overlap between missions.	Agency	OPEN

* Open-access databases already exist. IOCCG suggests collating and adding POC and DOC data for inland and coastal waters to existing community databases, such as SeaBASS.

Task Force Governance

Co-Chairs (2): Provide overall leadership, represent TF within IOCCG, and oversee progress toward deliverables.

Secretariat (1): Provides logistical and administrative support, including meeting coordination, documentation of discussions and actions, progress tracking, and maintaining communication with the IOCCG Project Office.

Robert Frouin

Frederic Melin

EUROPEAN COMMISSION

Elizabeth Atwood

Four subgroups, structured around reports

- *Status Assessment* – Products, datasets, gaps
- *Blending Strategies* – Harmonization methods.
- *Calibration & Infrastructure* – Link to SVC Task Force.
- *Policy & Interagency Coordination* – Governance and sustainability.

Subgroup Leads/Co-Leads: Organize work, assign writing tasks, report progress.

Editorial Team: Ensure consistency, manage timelines, integrate final outputs.

Regular plenary meetings for coordination and milestone review.

Emerging Recommendations

1. Develop Regionalized LTTS Products Without Fragmenting the Record

Create regionally informed LTTS datasets where appropriate but avoid multiple competing products; Aim for one unified blended long-term record with optional regional adjustments where physics and optics differ; Ensure regional tuning does not override true physical differences ("do not force sensors or regions to look the same when they are not").

2. Establish Clear Climate-Quality Requirements and Uncertainty Baselines

Define climate-quality uncertainty thresholds such that uncertainties are smaller than the trends being investigated; Recognize that different applications require different uncertainty tolerances; Provide flexibility so users can adapt to their needs; Establish variable-specific minimum record lengths (e.g., ~35 years for chlorophyll; shorter for some other variables).

3. Strengthen Community Collaboration and Shared Infrastructure

Emphasize that no single agency, mission, or group can deliver a complete LTTS product; Promote coordinated local–regional–global networks that build on one another; Support shared investments in calibration sites, matchup databases, and processing tools.

Emerging Recommendations (contd.)

4. Improve and Expand In Situ Observations and Validation
Address gaps in global in situ coverage, especially in underserved regions; Ensure in situ quality is high enough to validate satellite products, recognizing that in some regions (e.g., Baltic cyanobacteria blooms) in situ uncertainty exceeds satellite uncertainty; Develop approaches that explicitly account for regional limitations in in situ data.

5. Advance Cross-Calibration and SVC Approaches
Evaluate whether current cross-calibration methods (including GEO-mediated approaches) are sufficient or require improvement; Ensure traceable cross-calibration chains, noting gaps in current geostationary sensors and mission coverage; Recognize that SVC yields different results across sites; merged products should account for site-to-site variability rather than averaging indiscriminately.

6. Develop Robust Merging Frameworks
Ensure merging algorithms can accommodate differences between merging two sensors vs. merging five or more sensors; Annotate merged products with metadata describing which missions contribute at each time step; Recognize and avoid regional artifacts (e.g., aggressive gap-filling under aerosols or dust that creates unrealistic boundaries); Provide guidance on acceptable gap durations (daily vs. 7-day composites) depending on the application.

Emerging Recommendations (contd.)

7. Integrate New Methods with Caution (Especially AI/ML)

Encourage innovation but apply caution: AI-generated data must avoid unrealistic features or false continuity; ML models must be traceable, physics-aware, and uncertainty-quantified; Ensure AI/ML approaches do not mask real variability or introduce artificial trends.

8. Provide Multi-Scale Uncertainty Options

Offer pixel-level uncertainties but also recognize that regional aggregation reduces uncertainty; For some applications, regional or ensemble uncertainty may be more appropriate than per-pixel estimates; Provide uncertainty PDFs or ensembles to capture extreme behavior (tails).

These recommendations emphasize the need for robust uncertainty characterization, improved calibration and validation, regional awareness, cautious integration of new technologies, and sustained community cooperation.

Thank you!