EUMETSAT

PROGRAMME OF THE EUROPEAN UNION

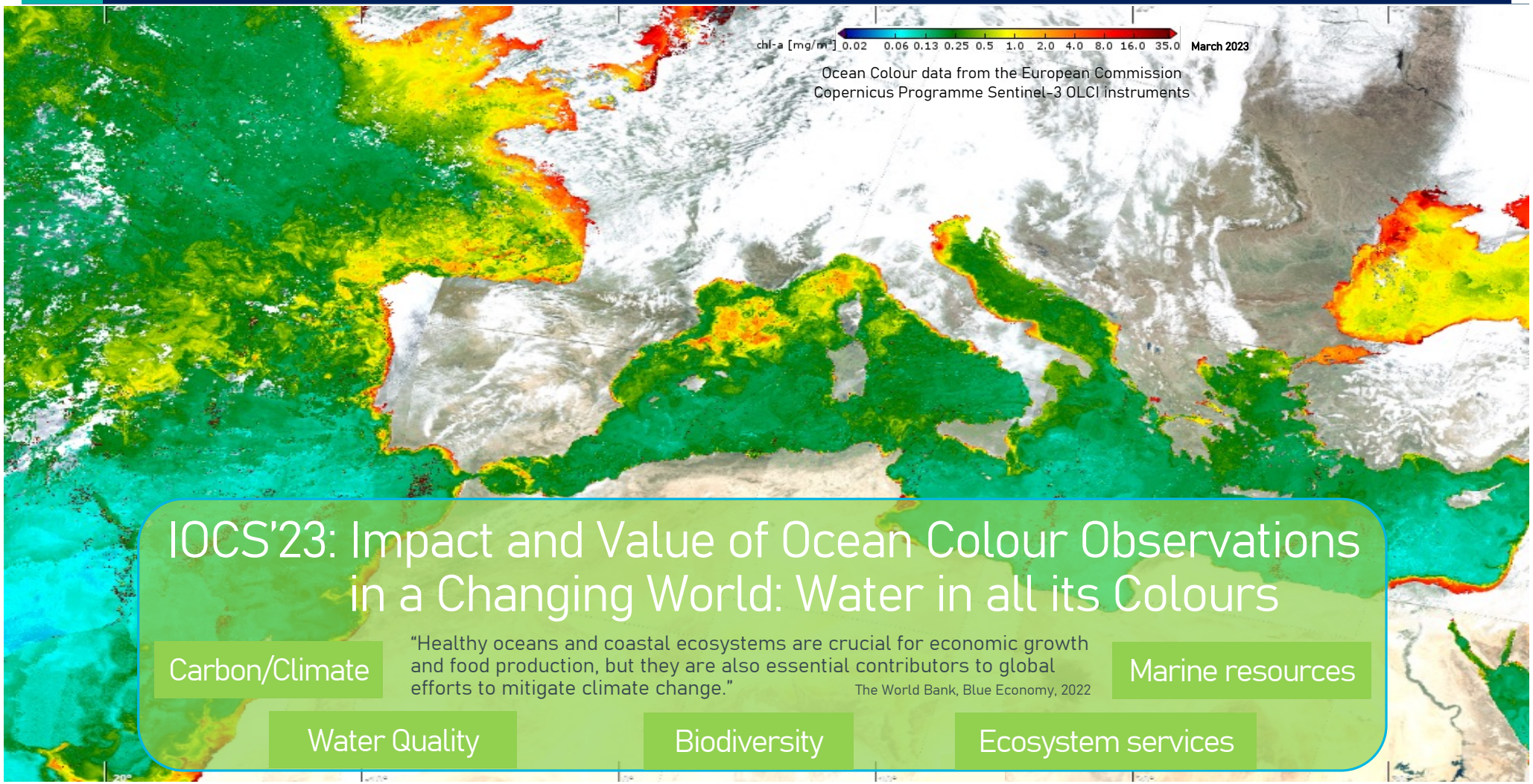
Copernicus
Europe's eyes on Earth

EUMETSAT Ocean Colour products and services: status and outlook

Juan Ignacio Gossn
EUMETSAT

IOCS meeting, 16 November 2023

Ocean Colour: observing the living aquatic ecosystems



IOCS'23: Impact and Value of Ocean Colour Observations in a Changing World: Water in all its Colours

"Healthy oceans and coastal ecosystems are crucial for economic growth and food production, but they are also essential contributors to global efforts to mitigate climate change."

The World Bank, Blue Economy, 2022

Carbon/Climate

Marine resources

Water Quality

Biodiversity

Ecosystem services

EUMETSAT: delivering quality Ocean Colour data services to users

copernicus.eumetsat.int

https://www.eumetsat.int/ocean-colour-services

Sentinel-3 OLCI Collection-3 currently in operations

- v. 3.00 since **16 Feb 2021**
- v. 3.01 since **28 Apr 2021** two minor updates
- v. 3.02 since **19 Apr 2022** new processor naming

Collection-3 summary

- **High consistency between OLCI-A and OLCI-B**
- Open water chlorophyll within mission requirements
- Improved product retrievals over turbid waters
- Reduced «salt and pepper» noise in products

Collection-3 documentation online

- Collection-3 Report:
  https://www.eumetsat.int/media/47794
- Ocean Colour Services page:
  https://www.eumetsat.int/ocean-colour-services

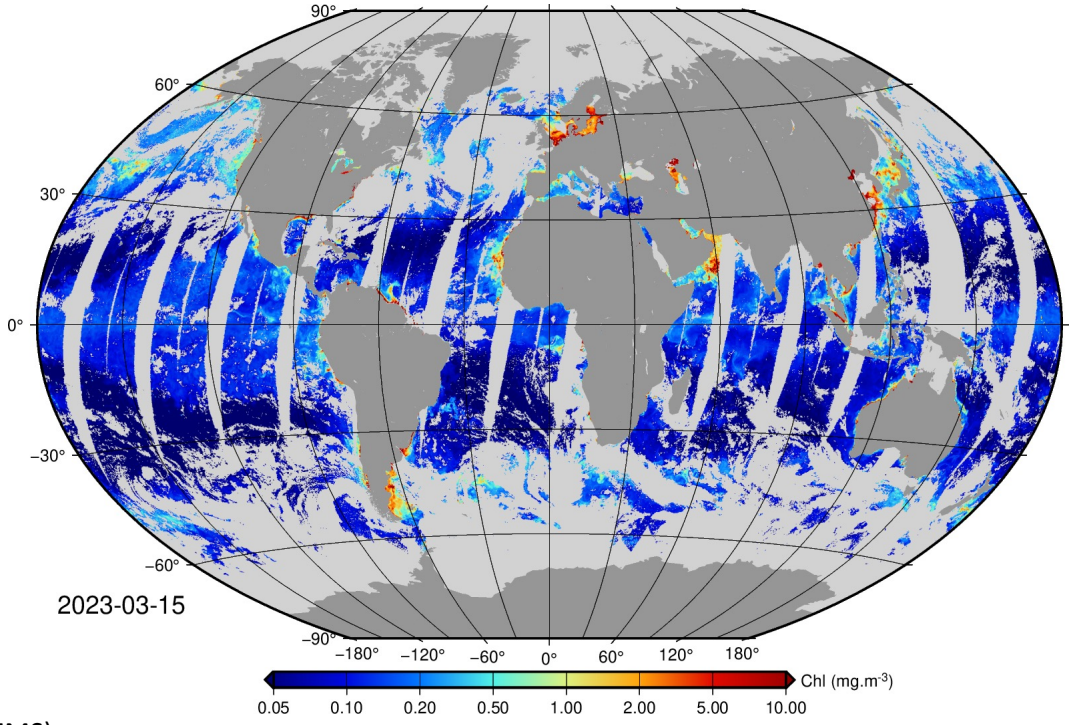
Collection-3 user validation and recommendations

- Many validation collaborations and peer-reviewed publications
  - Sentinel-3 Validation Team-OC (S3VT-OC)
  - OC-TAC Copernicus Marine Environment Monitoring Service (CMEMS)
  - Sentinel-3 OLCI/SYNERGY Quality Working Group

Data access via EUMETSAT Data Store

- *https://data.eumetsat.int*

Sentinel-3A and Sentinel-3B OLCI constellation daily coverage at 300m resolution



New OLCI IOP products in operations from January 2024, v. 3.04

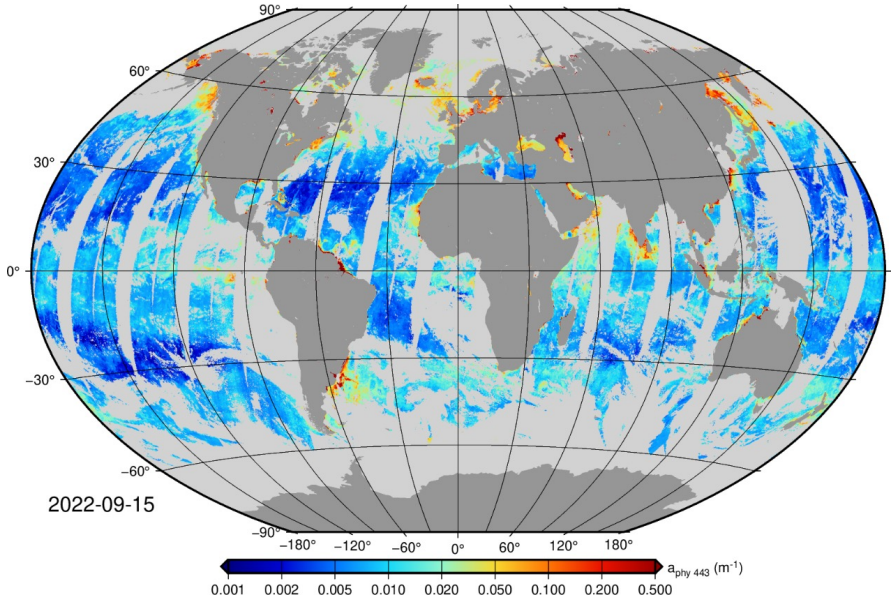
copernicus.eumetsat.int

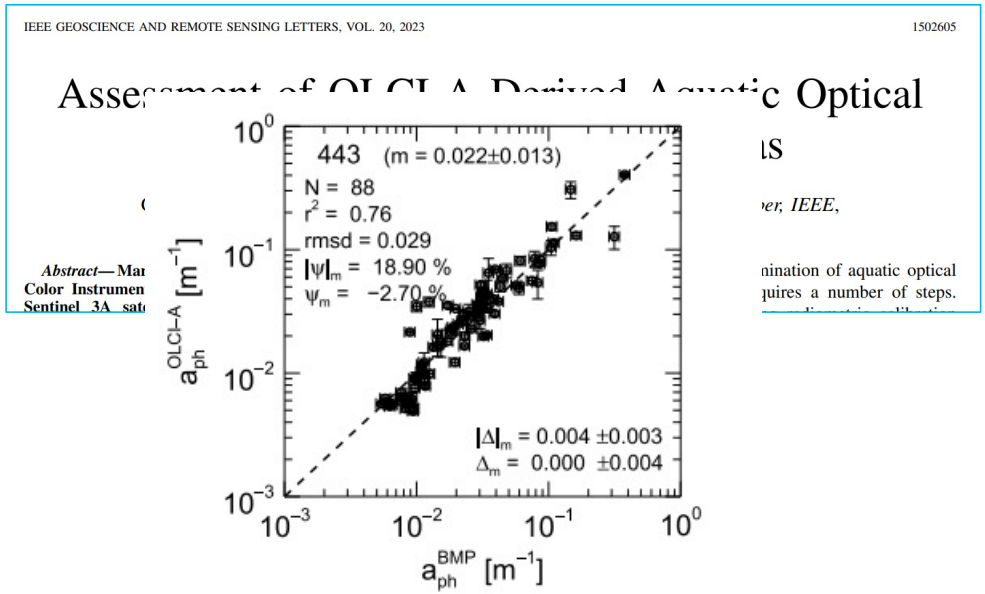
https://www.eumetsat.int/S3-OLCI-IOP

New OLCI IOP products

- $a_{nw}(\lambda)$, $b_{bp}(\lambda)$, $a_{phy}(\lambda)$, $a_{cdm}(\lambda)$, $a_{cdom}(\lambda)$, $K_d(\lambda)$, b_{bp} spectral slope, optical water class
- a and b_{bp} are at 442.5 nm and K_d is at 490 nm
- Description*: https://www.eumetsat.int/S3-OLCI-IOP*
- SNAP toolbox: *http://s3vt.skytek.com/group/s3vt-oc/home*
- Gitlab source code available to produce IOPs at all OLCI spectral bands: *https://gitlab.eumetsat.int/eumetlab/oceans/ocean-science-studies/olci-iop-processor*

Jorge *et al.*, 2021 RSE IOP
Bonelli *et al.*, 2021 RSE CDOM





Redevelopment of the Atmospheric Correction

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Redevelopment of Standard Atmospheric Correction (OC-SAC)

https://www.eumetsat.int/oc-sac

- Atmosphere Spherical Shell modelling of the molecular Rayleigh scattering
- Aerosol standard models from Ahmad *et al.*, 2010, with continuous discretization
- Extension of standard aerosol models to stronger absorbing models with increased refractive index
- Radiative Transfer Modelling at detector wavelength, no smile correction
- Aerosol detection with 6 NIR bands (instead of 2), and uncertainty estimates
- Aerosol vertical profile, through a rough estimate of aerosol layer height with O_2-absorption bands

See poster **n° 150** by Constant Mazeran

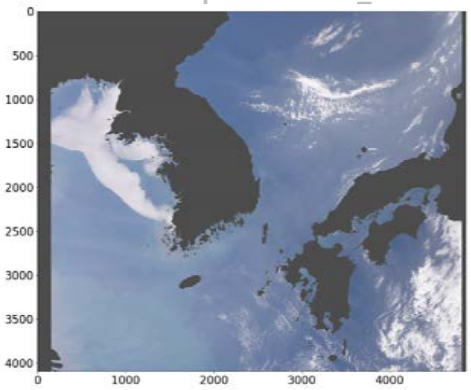
Development of Alternative Spectral-Matching Atmospheric Correction (SACSO)

https://www.eumetsat.int/SACSO

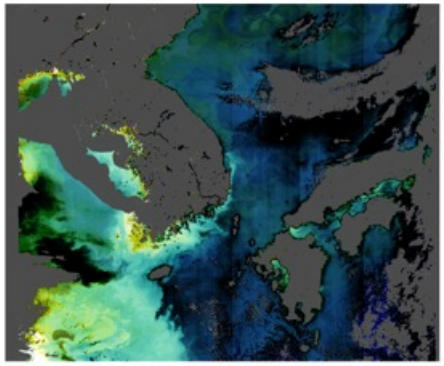
- Development based on the POLYMER iterative spectral optimisation using the full solar spectrum
- Multiple scattering approximation to model the aerosol reflectance
- New inversion method to improve the stability of the algorithm

solVo HYGEOS

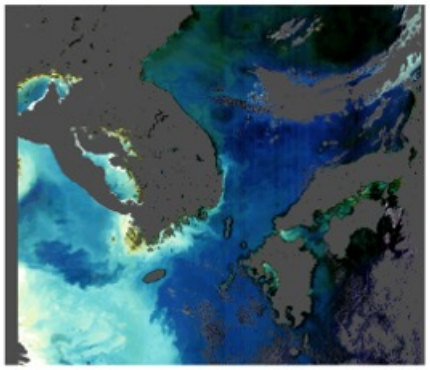
RGB composite of rho_toa



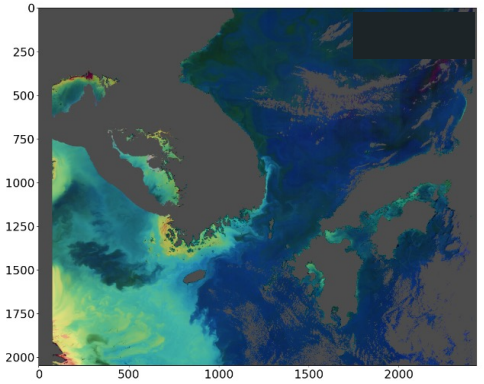
RGB composite of rho_w Collection-3



RGB composite of rho_w OC-SAC



RGB composite of rho_w SACSO



Validations and development of the BRDF correction

copernicus.eumetsat.int

https://www.eumetsat.int/brdf-correction-s3-olci-water-reflectance-products

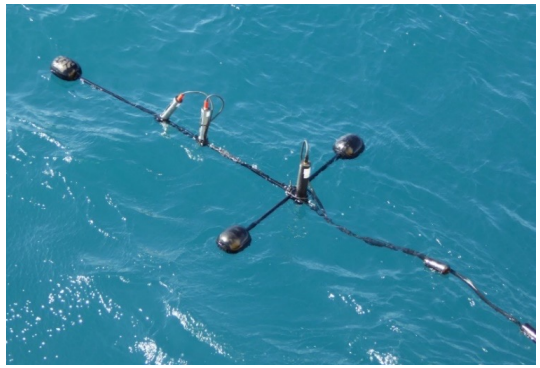
BRDF corrections tested and validated

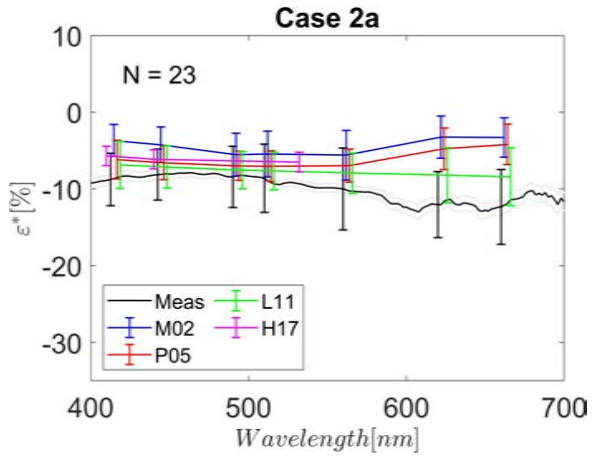
- Morel *et al.*, 2002 → M02
- Park and Ruddick, 2005 → P05
- Lee *et al.*, 2011 → L11
- He *et al.*, 2017 → H17
- Twardowski and Tonizzo, 2018 → T18

See poster by Vittorio Brando

BRDF extension to improve the accuracy and expand the validity range

- RT simulations for realistic water combinations using a dataset especially developed for the study
- IOPs retrieval based on QAA V6 reference design
- BRDF correction LUT based on L11 reference design
- Reversibility of the BRDF correction scheme and provision of uncertainties





Æquora consulting

Consiglio Nazionale delle Ricerche

Institut de Ciències del Mar

solVo

Development of OLCI Fluorescence product

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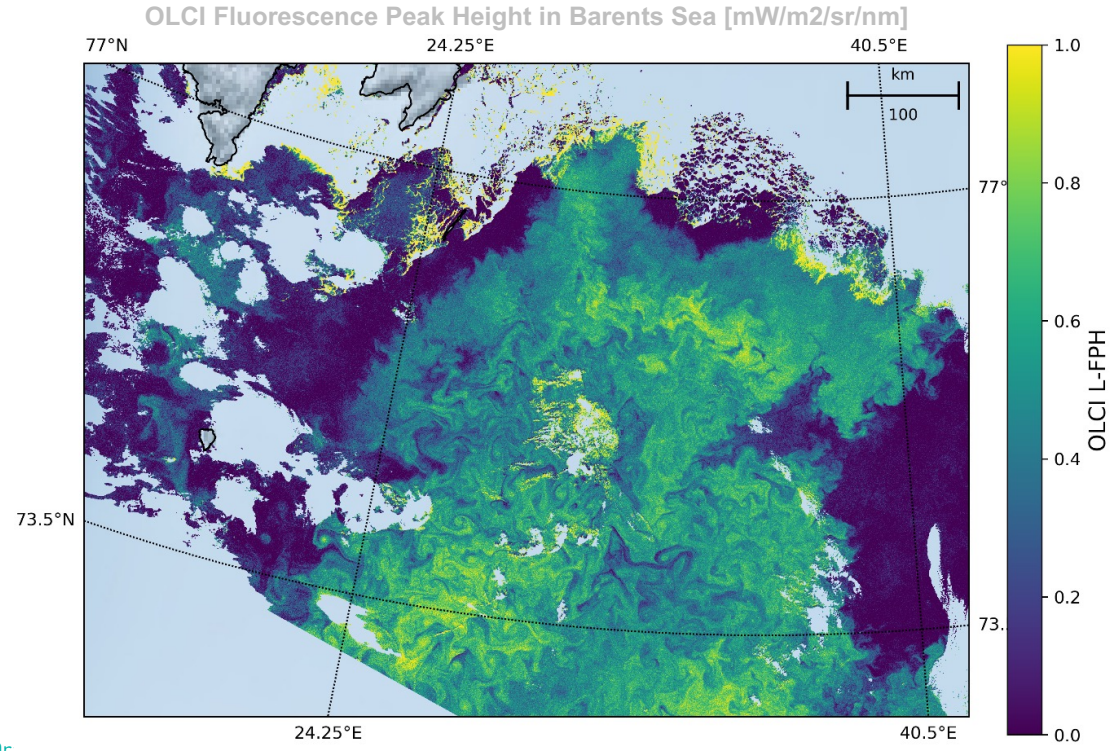
https://www.eumetsat.int/S3-OLCI-FLUO

OLCI Fluorescence product

- TOA-radiance Fluorescence Peak Height
- Description: *https://www.eumetsat.int/S3-OLCI-FLUO*
- SNAP plugin: *http://s3vt.skytek.com/group/s3vt-oc/home*

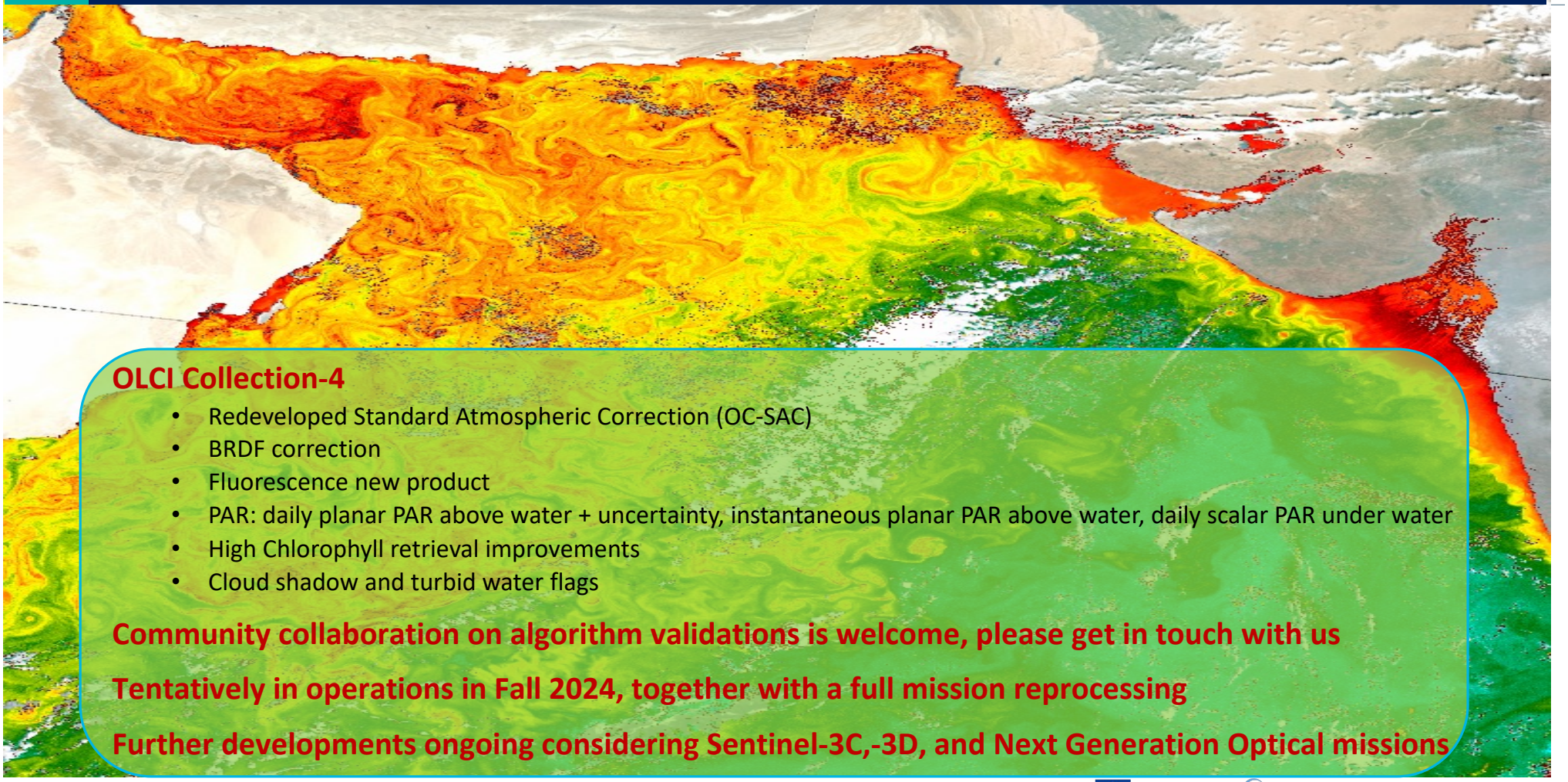


Spectral Earth GmbH

Kritten *et al.*, 2020 RS MDPI Fluo

Meeting registration now closed but new teams welcome to join S3VT

Developments towards OLCI Collection-4 and beyond



OLCI Collection-4

- Redeveloped Standard Atmospheric Correction (OC-SAC)
- BRDF correction
- Fluorescence new product
- PAR: daily planar PAR above water + uncertainty, instantaneous planar PAR above water, daily scalar PAR under water
- High Chlorophyll retrieval improvements
- Cloud shadow and turbid water flags

Community collaboration on algorithm validations is welcome, please get in touch with us

Tentatively in operations in Fall 2024, together with a full mission reprocessing

Further developments ongoing considering Sentinel-3C,-3D, and Next Generation Optical missions

Towards Copernicus System Vicarious Calibration infrastructure

copernicus.eumetsat.int
https://www.eumetsat.int/OC-SVC

Copernicus Ocean Colour System Vicarious Calibration (OC-SVC)

- Activities managed by EUMETSAT for the Copernicus Programme on behalf of the European Commission
- Multi-phase Copernicus OC-SVC roadmap
- Independent Copernicus studies via Invitations To Tender
- International Expert Review Board at each Phase

To achieve the best OC-SVC infrastructure for the upcoming 20+ years of the Copernicus Programme and in support of international missions

Phase 1
Requirements
(completed)

Phase 2
Preliminary design, project plan, costing
(completed)

Phase 3
Infrastructure location
(completed)

Phase 4
Engineering design, technical definition, specs

Phase 5
Development, testing, and demonstration

Phase 6
Operations

Fiducial Reference Measurements for validation – FRM4SOC2

copernicus.eumetsat.int
https://frm4soc2.eumetsat.int

Fiducial Reference Measurements for Satellite Ocean Colour

- Phase 1 coordinated by ESA, https://frm4soc.org
- Phase 2 funded by the EC Copernicus Programme and coordinated by EUMETSAT, https://frm4soc2.eumetsat.int

To provide to the Community easy procedures, guidelines and tools for collecting FRM-quality radiometric measurements

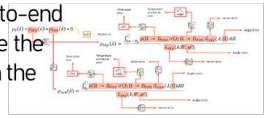
A. Bialek's poster on uncertainty assessment of AWR

HyperCP training was on Monday

9. Review and test the developed procedures, guidelines and tools: a field experiment, an international workshop, Expert Review Board

8. Maintain Ocean Colour In-Situ Database OCDB

7. Develop a complete end-to-end uncertainty budget, include the uncertainty calculations in the community processor

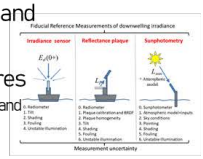


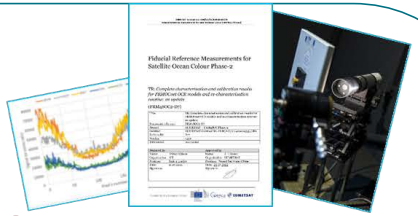
6. Develop a community processor for in situ radiometric measurements, cooperate with NASA *et al.* on HyperCP

HyperCP

1. Initially focus on the two most common Ocean Colour hyperspectral radiometer classes

5. Provide prescriptive and detailed FRM in situ measurement procedures (following from the IOCCG protocols and FRM4SOC-1 experience)



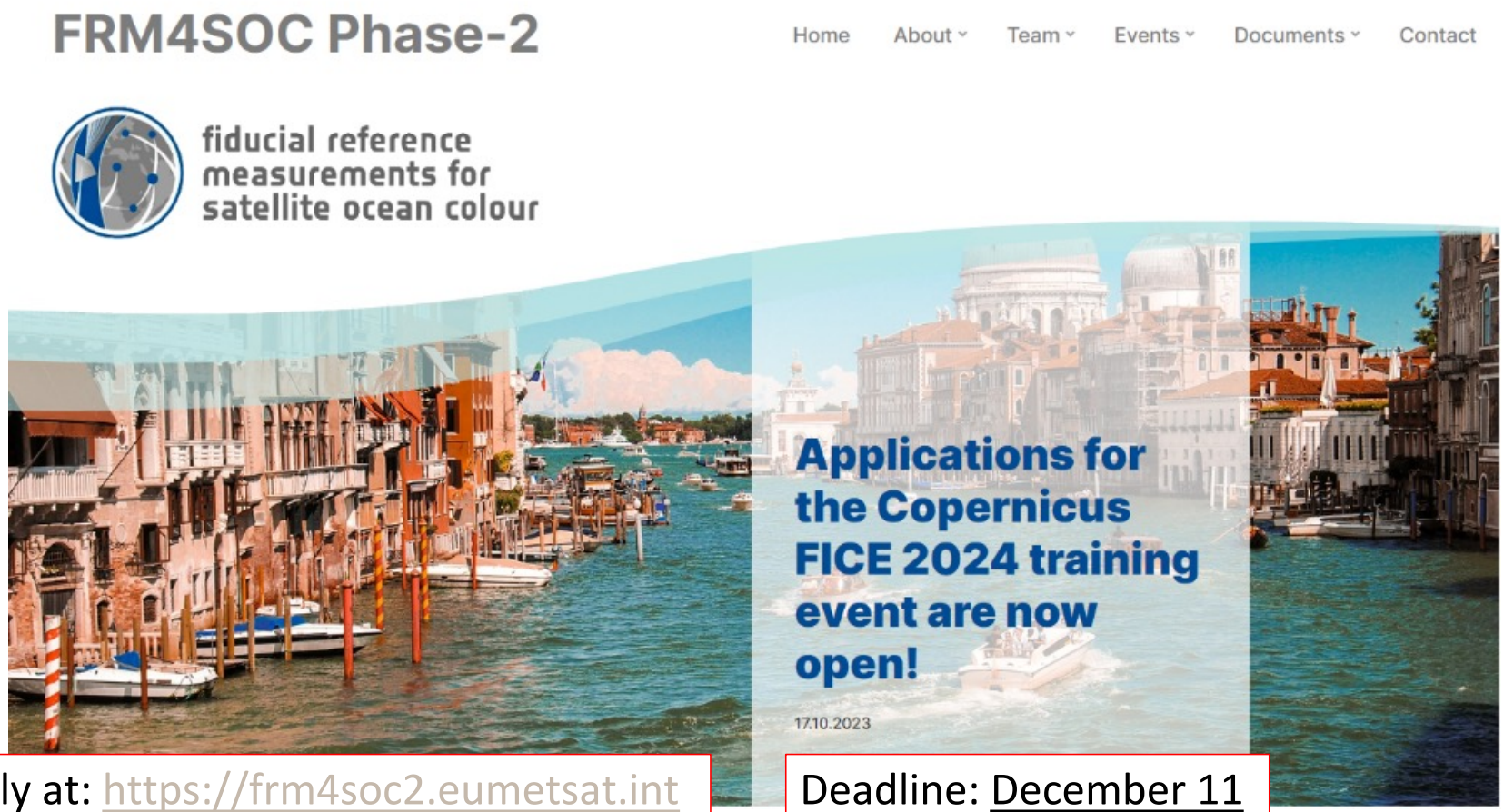


2. Fully characterise the two Ocean Colour radiometer classes (issue recommendations to instrument manufacturers)

3. Provide community guidelines on radiometer cal/char schedules

4. Develop radiometer cal/char guidelines for laboratories, include an international lab inter-comparison exercise

Training on above-water radiometry at Acqua Alta Oceanographic Tower



Apply at: https://frm4soc2.eumetsat.int

Deadline: December 11

Geostationary Ocean Colour developments

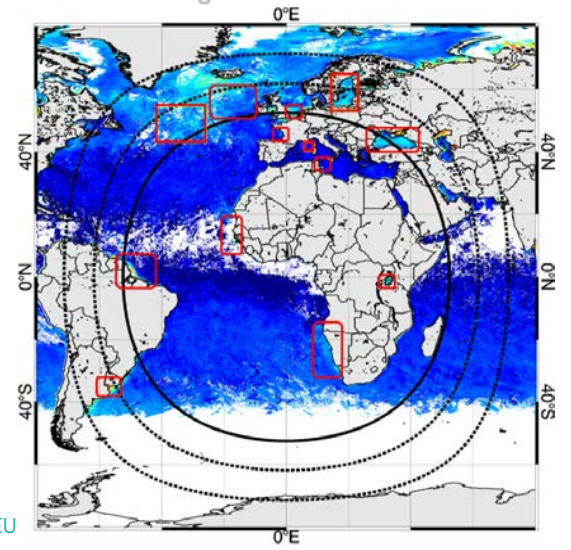
copernicus.eumetsat.int
https://www.eumetsat.int/OC-GEO

Development of Ocean Colour demonstration products from geostationary Meteosat SEVIRI and FCI instruments

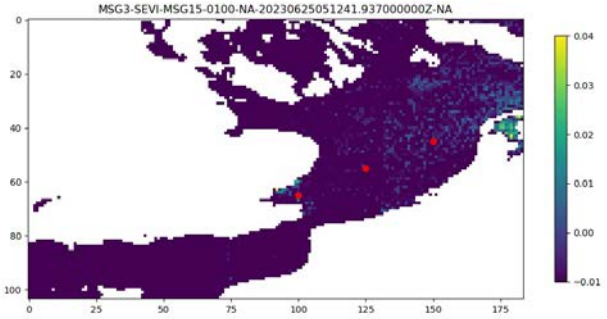
- Prototyping of water quality products such as Turbidity, Suspended Particulate Matter, Secchi Depth, and Chlorophyll (from FCI only)
- Investigating different Atmospheric Correction approaches: Standard, Alternative spectral-matching (for FCI only), and Neukermans *et al*., 2012, 2009

GEO-OC Project User Consultation Workshop, 7 – 8 December, 2023 at EUMETSAT headquarters and online, open for registration

Locations of diagnostic datasets for validation



Meteosat Second Generation SEVIRI rho_w(600nm)



Meteosat Third Generation FCI disk coverage every 10 min at 1 km resolution