EUMETSAT

PROGRAMME OF THE EUROPEAN UNION

Copernicus
Europe's eyes on Earth

# Satellite Ocean Colour: What does colour really tell us about our seas?

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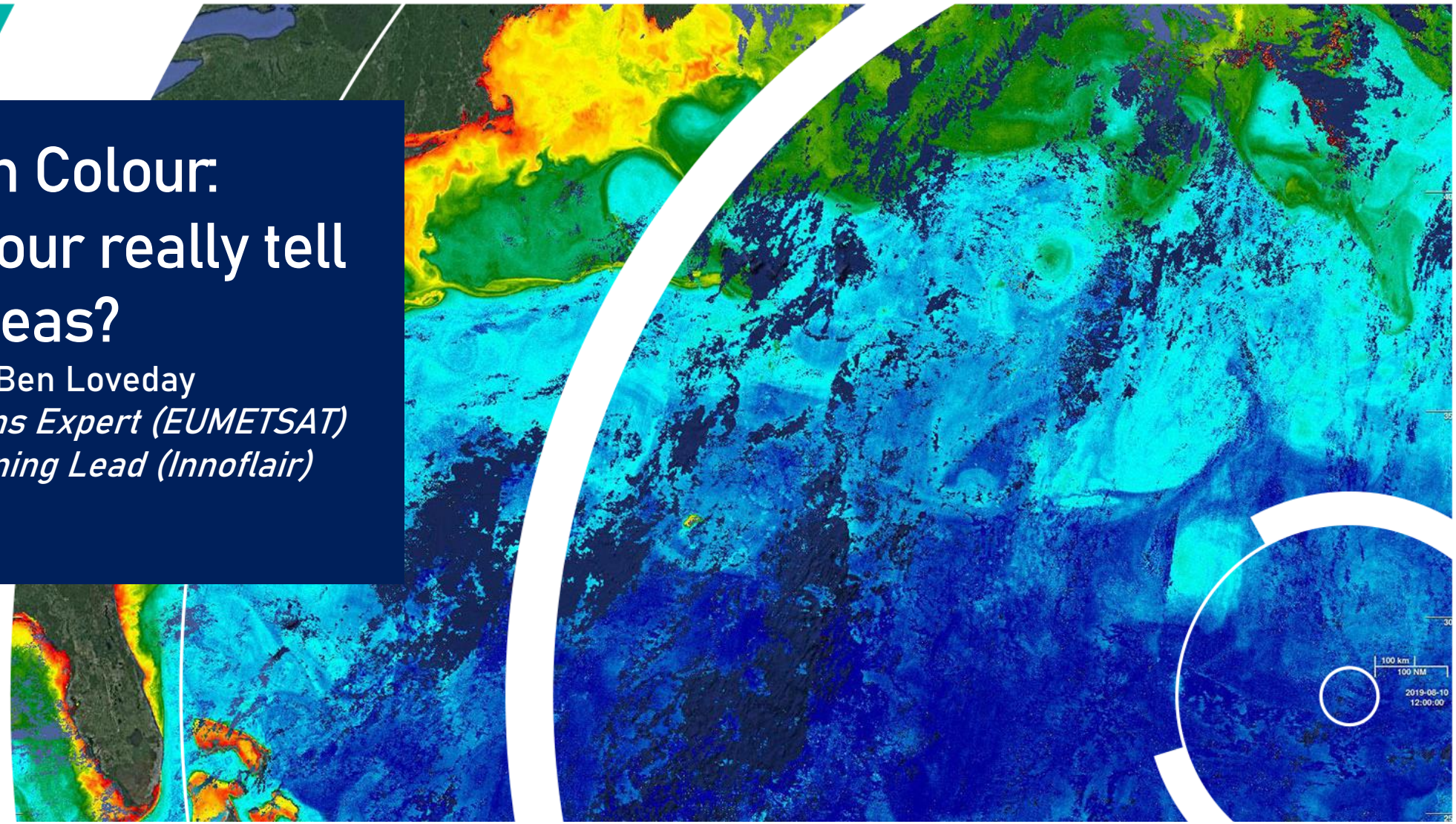
*EUMeTrain Event week 2025*

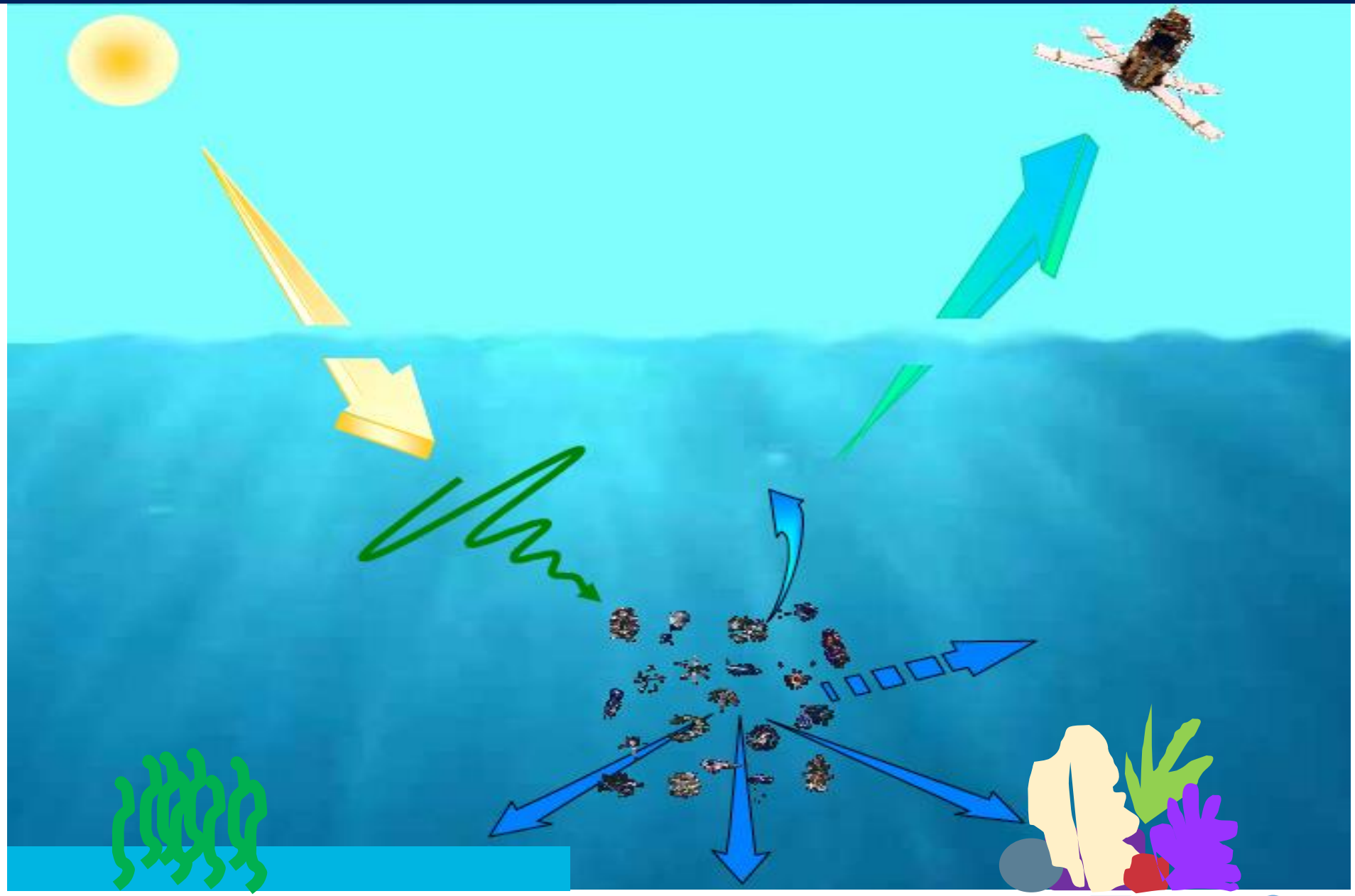


# What colour is the ocean?

# Let's visit https://ismy.blue/ ....

# Ocean Colour theory





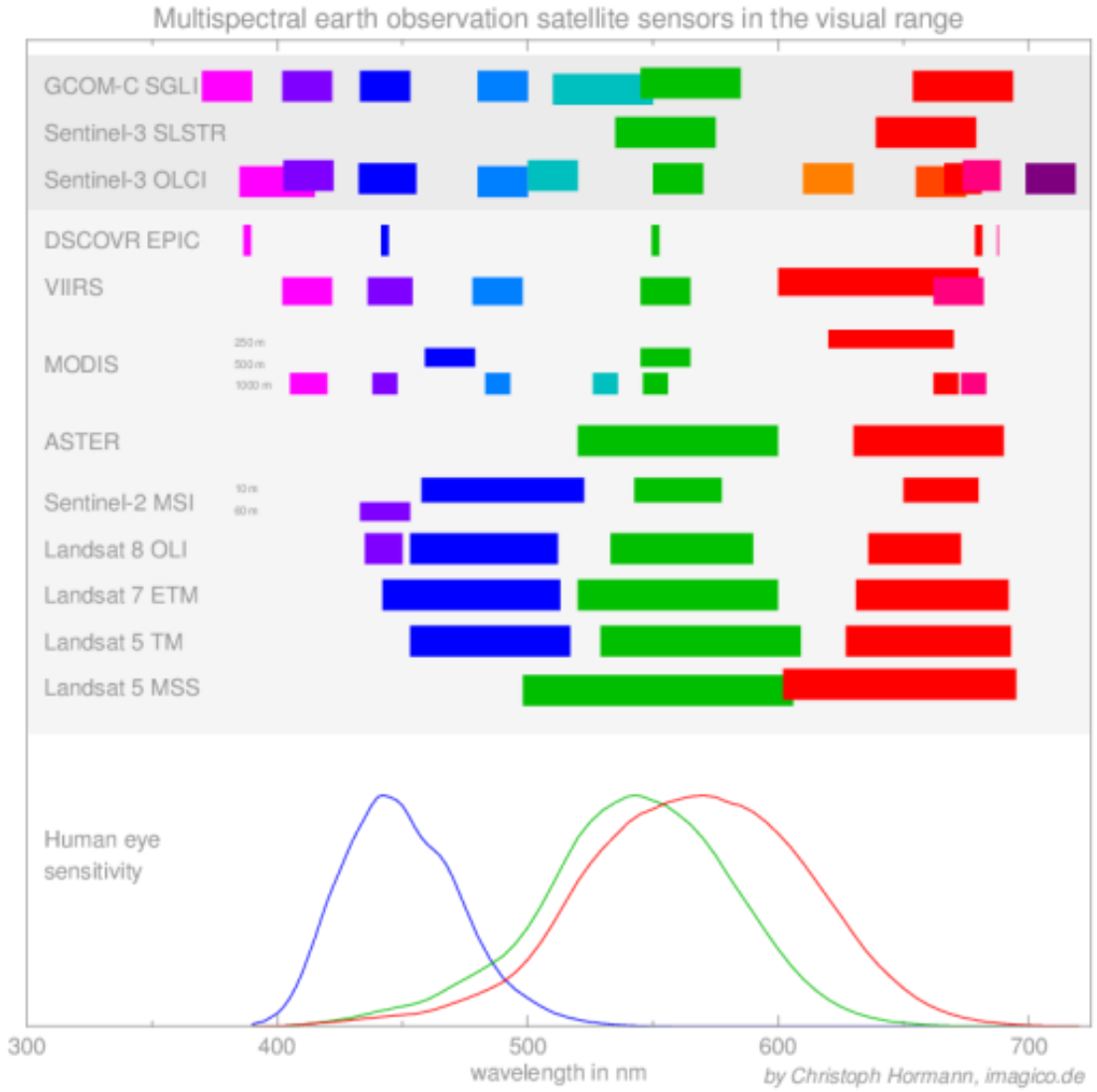
# Why Ocean Colour?

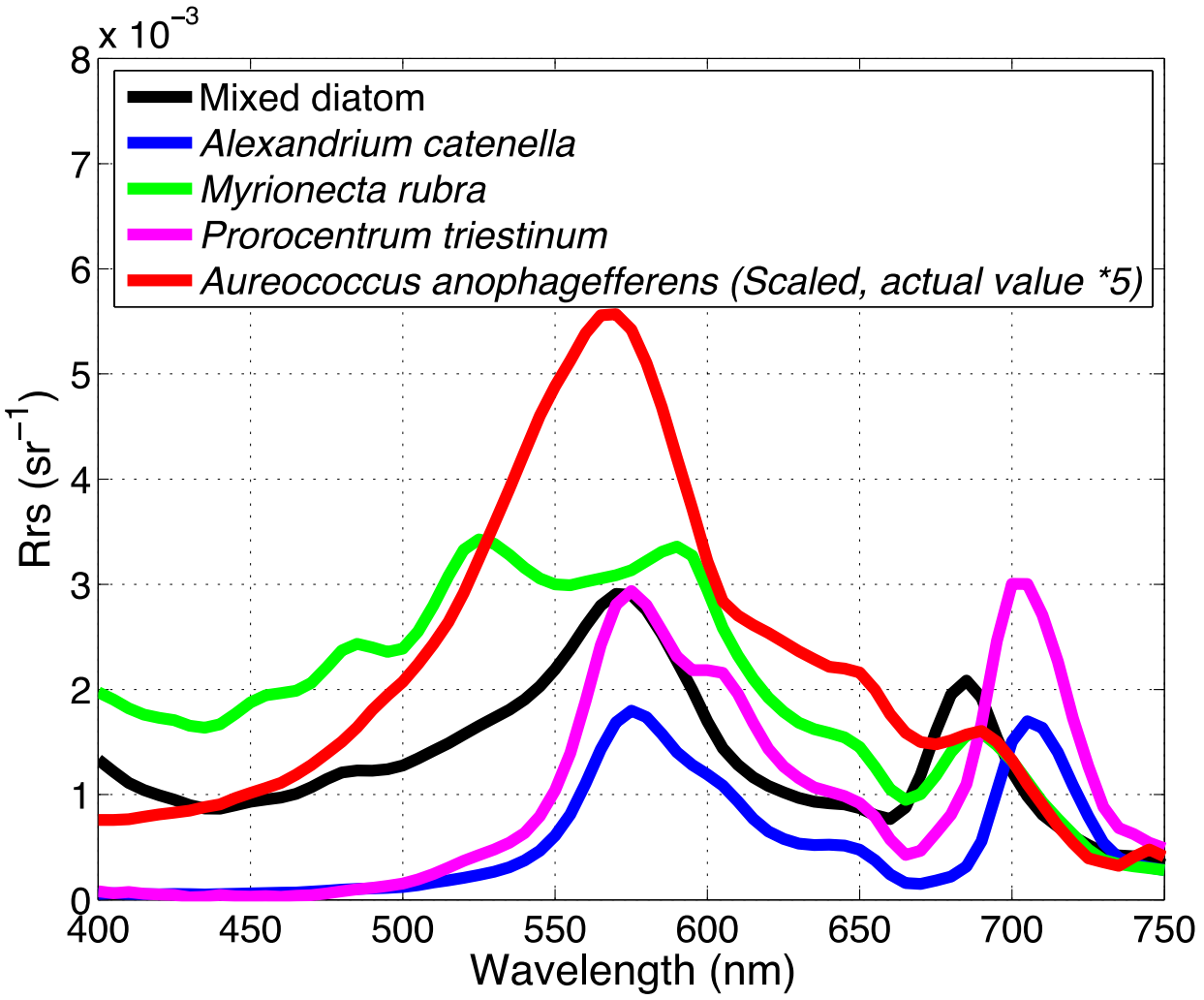


- Tells us about what's in ocean waters:
  - Phytoplankton
    - Carbon
    - Food chain
  - Sediments
  - Ice
  - Other things:
    - Pollution
    - Infrastructure
    - Debris
    - The ocean floor!

# Ocean Colour satellites





# Ocean Colour satellites

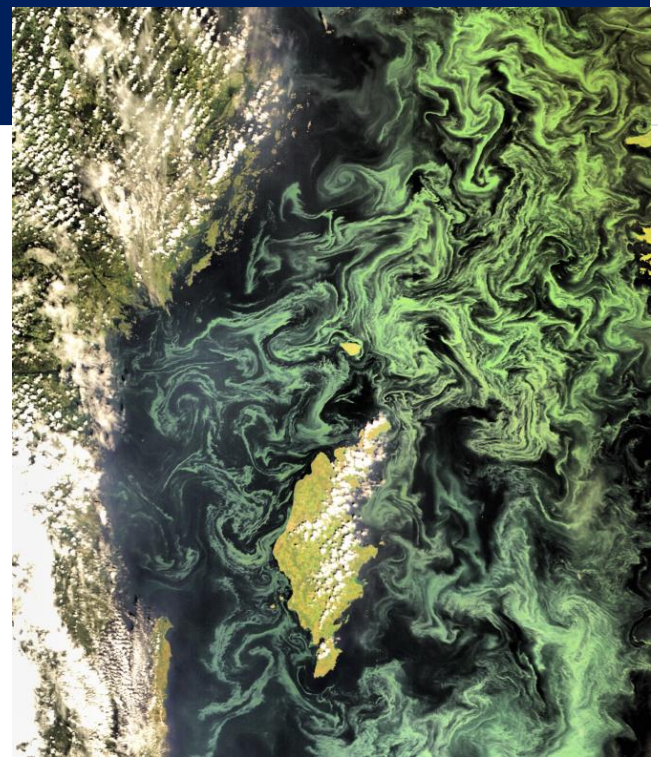


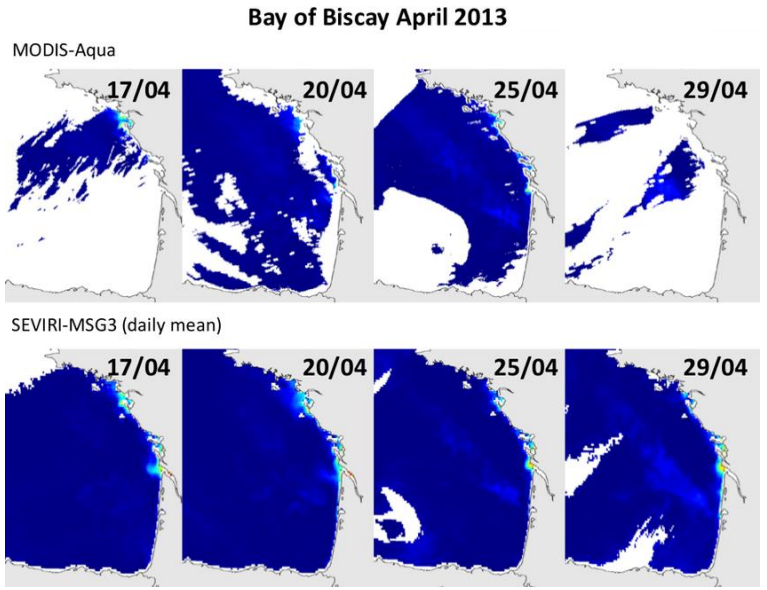
| Status | Sensor type | Platform | Sensor | Spatial Resolution= Pixel size | Spectral bands (400–1000 nm) | Revisit frequency (at equator) | Launch (end) | Water quality variables | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Chl | CYP | TSM | CDOM | Kd | Turb/ SD |
| Defunct | Sun-sync | SeaStar | SeaWiFS | 4 and 1 km | 8 | 2 days | 1997-(2010) | | S | | | | |
| | | Envisat | MERIS | 1.2 km and 0.3 km | 15 | 2 days | 2002-(2012) | | | | | | |
| Current | Sun-sync | Terra/Aqua | MODIS-A&T | 1 km | 9 | daily | 1999/2000 | | S | | | | |
| | | Oceansat 2 | OCM-2 | 300 m | 8 | 2–3 days | 2009 | | | | | | |
| | | Suomi/NOAA-20 | VIIRS | 750 m | 7 | daily | 2011/2017 | | S | | | | |
| | | Sentinel 3 A/B | OLCI | 300 m | 21 | Daily (with 2 satellites) | 2016/18 | | | | | | |
| | | GCOM-C | SGLI-2 | 250 m | 9 | 2–4 days | 2017 | | S | | | | |
| | GEO | KOMPSAT | GOCI | 500 m | 8 | Half hourly | 2010 | | | | | | |
| | | Himawari-8&9, GOES-R | AHI | 500 m–2 km | 4 | 10 min | 2014 | | | | | | |
| Future | Sun-sync | JPSS-2, JPSS-3 | VIIRS. | 750 m | 7 | daily | 2017, 2022, | | S | | | | |
| | | Sentinel 3 C/D | OLCI | 300 m | 21 | Daily (with 2 satellites) | >2022 | | | | | | |
| | | Oceansat-3 | OCM-3 | 300 m | 13 | 2–3 days | 2020 | | | | | | |
| | | Sabia-MAR | MUS | 200/800 m | 13 | 1–2 days global | | | | | | | |
| | | PACE | OCI | 1 km | Hyperspectral; 5 nm (340–890 nm) | Daily | 2022 | | | | | | |
| | GEO | KOMPSAT-3B | GOCI | 500 m | 8s | Half hourly | 2019 | | | | | | |

*■: highly suitable, ■: suitable, ■: potential, ■: not suitable, Chl, Chlorophyll; CYP, cyanobacterial pigments (S denotes surface blooms); TSM, total suspended matter; CDOM, coloured dissolved organic matter; Kd, diffuse attenuation coefficient (or attenuation coefficient of diffuse light); Turb, Turbidity / SD, Secchi Disk Depth.*

# EUMETSAT and Ocean Colour

- Traditional (multispectral, narrow bands, high spatial resolution) Ocean Colour is relatively new – Sentinel-3 OLCI.
- Potential for some OC applications from existing (SEVIRI) and upcoming (FCI) imaging sensors.
  - Challenges: wide bands, poor SNR for dark targets, angular dependency, lower spatial resolution
  - Benefits: More data, daily cycles, cloud avoidance, good for large signals and patterns.

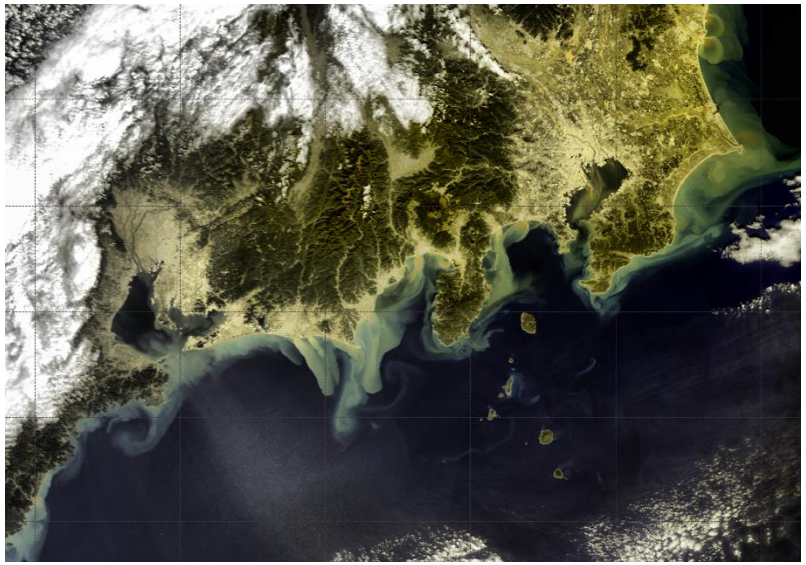


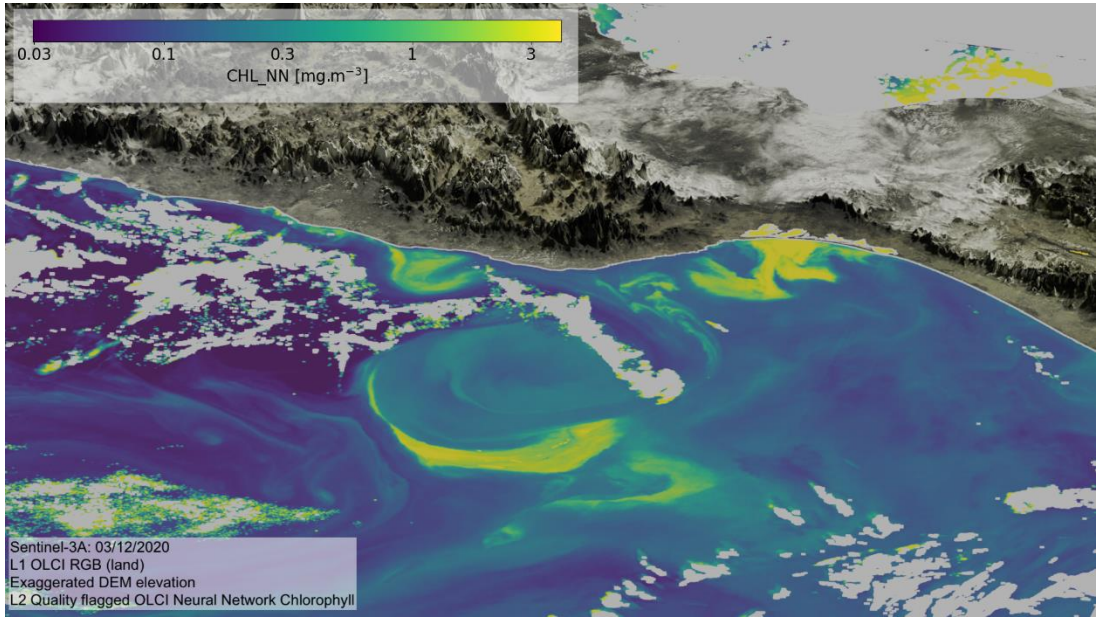


# Current Sentinel-3 OLCI products



- 300m level-1 and level-2 available at NRT (3 hours) and NTC (30 days).
- Level-2 geophysical products:
  - Reflectance at each band
  - Chlorophyll-a (x 2)
  - Total Suspended Matter
  - Absorption of gelbstoff and detritus
  - Kd(490)
  - iPAR
  - IOPs
- Included in downstream L3 and L4 from Copernicus Services
- Further products can be derived with open/custom algorithms.



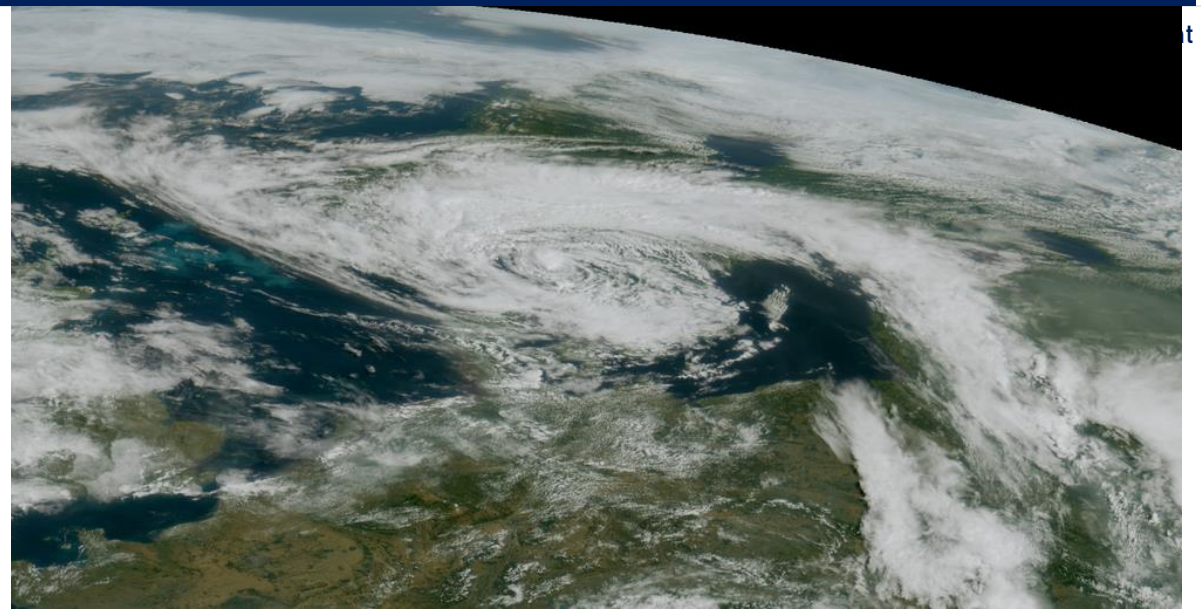


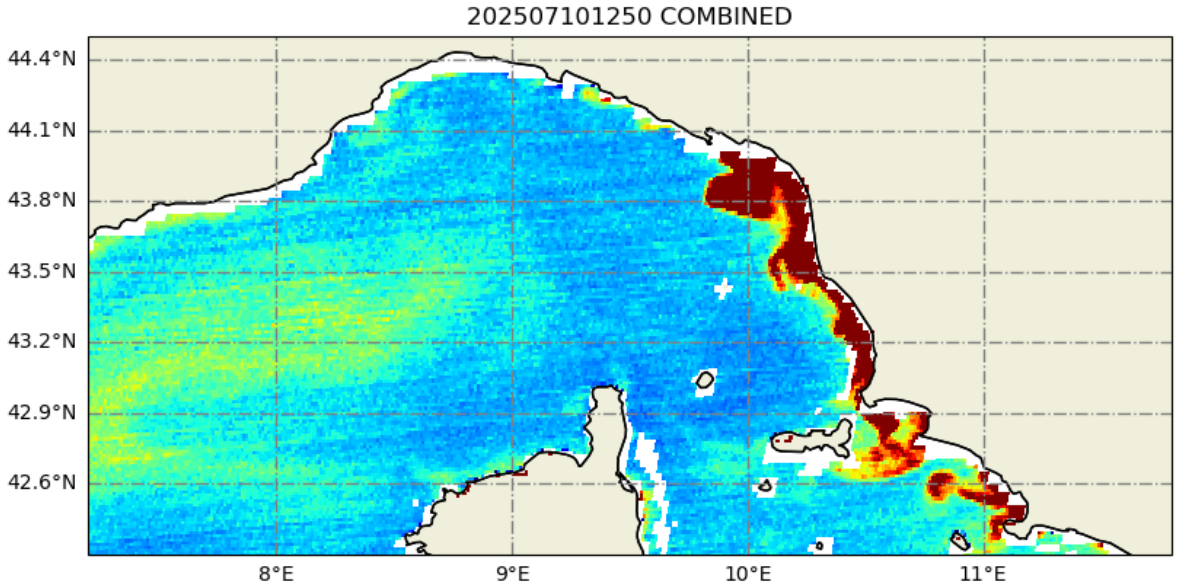
# Pushing Geospatial imagers to their limits…

- Geostationary Meteosat SEVIRI and FCI instruments are NOT developed with Ocean Colour requirements
- Meteosat demonstration products to showcase the value of GEO-OC
- Prototyping of products such as Turbidity, SPM, Chlorophyll (FCI only), cocco index
- Investigating different Atmospheric Correction approaches: standard, spectral-matching (POLYMER, FCI only), and Neukermans *et al.*, 2012, 2009

Documentation, resources

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

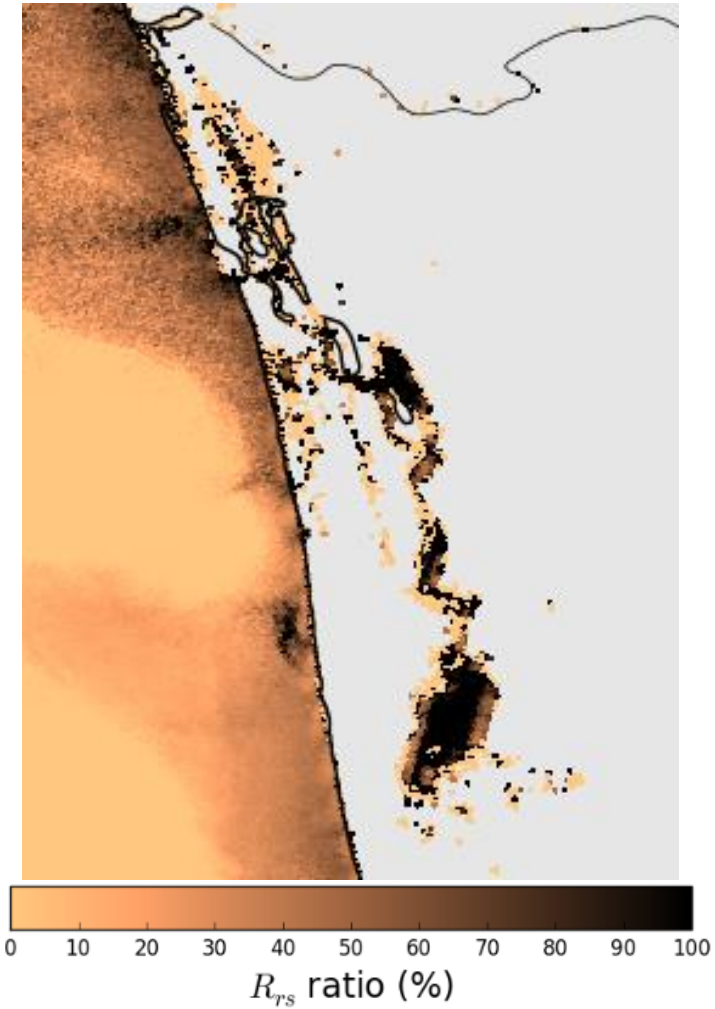




# Example applications with Sentinel-3

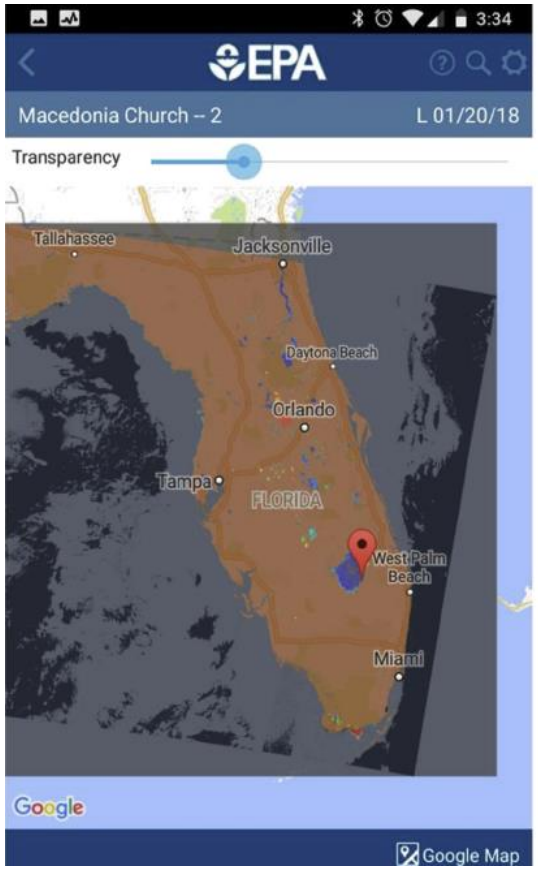


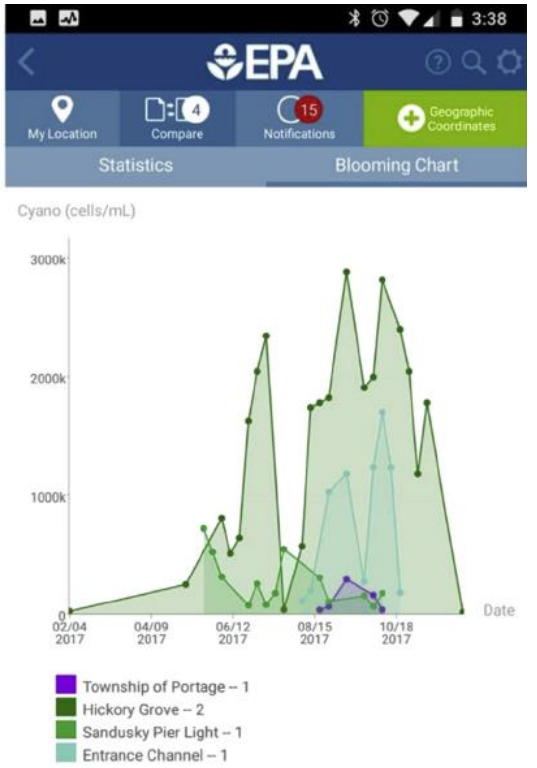
**OLCI data used to develop cholera potential indicators, Kerala, India (Hayley Evers-King, Marie-Fanny Racault, Shubha Sathyendranath)**



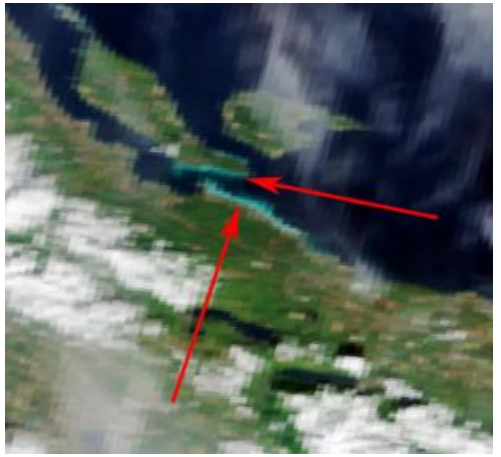

CYAN

EPA United States Environmental Protection Agency



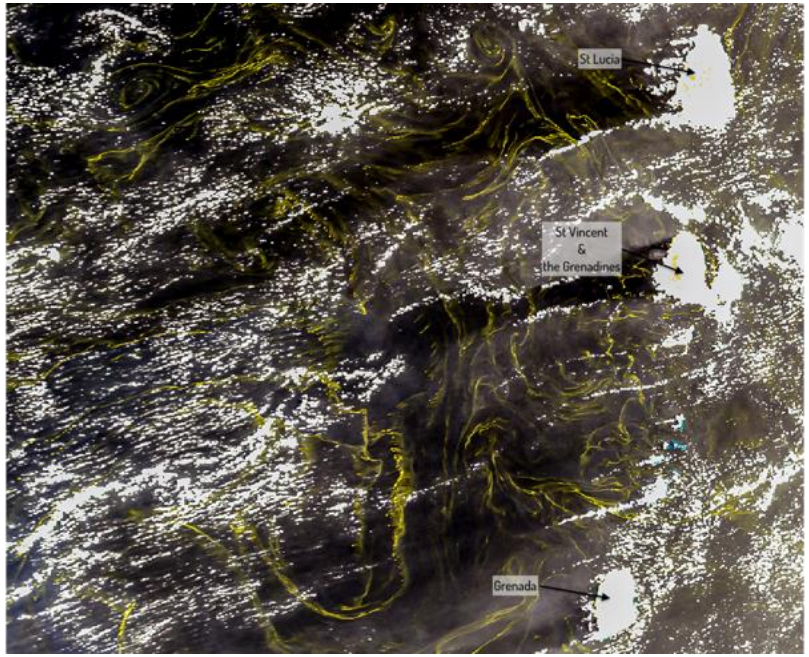

**OLCI: A mobile application providing information about cyanobacterial blooms (Schaeffer et al., 2018)**

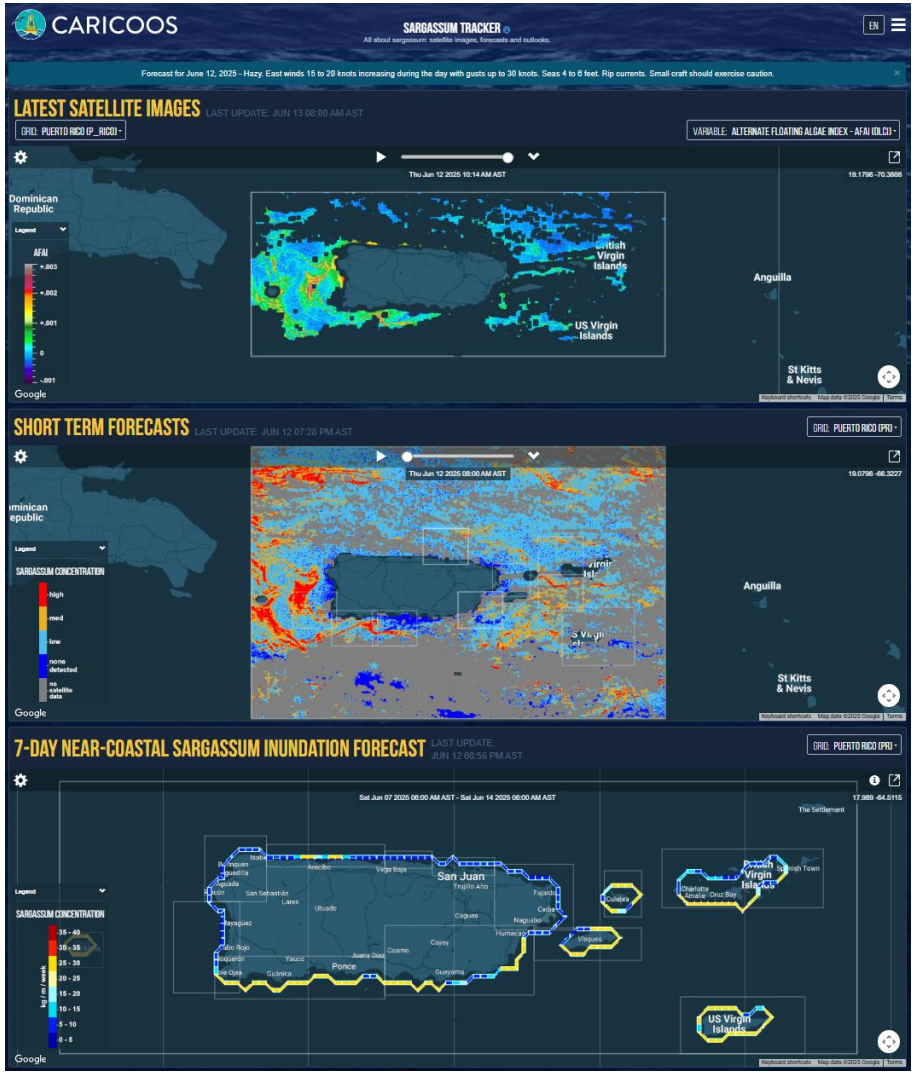


**OLCI: Herring Spawn off Vancouver Island (Maycira Costa), synergy with Sentinel-2.**

# Example applications with Sentinel-3 (and 2)

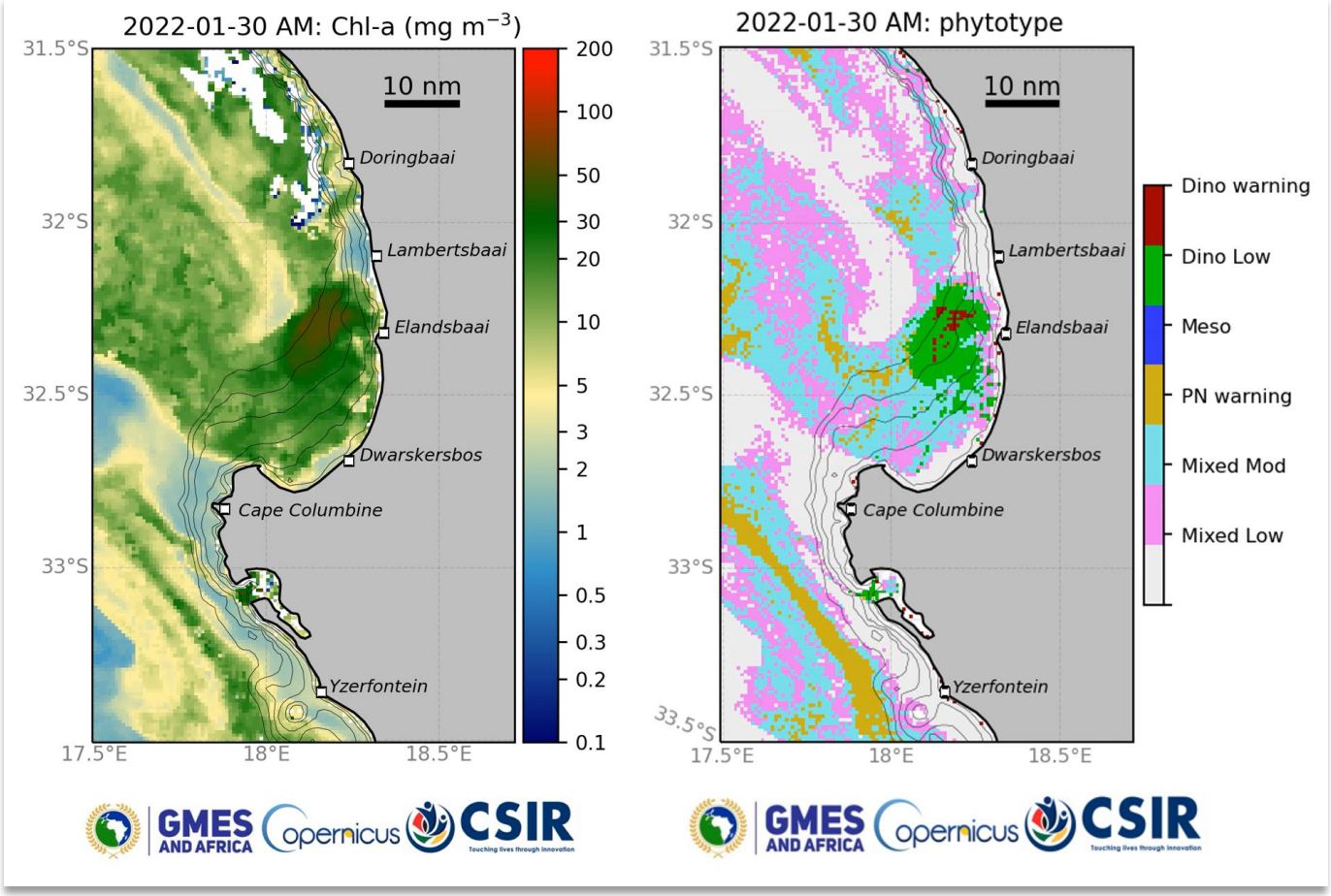


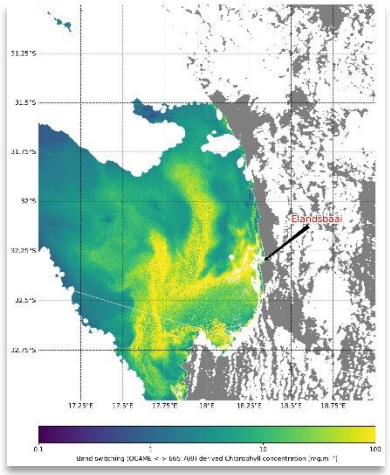


# Challenge 3 – Sustainably feed the global population

- **Showing the utility of Sentinel-3 for water quality monitoring in support of sustainable aquaculture.**

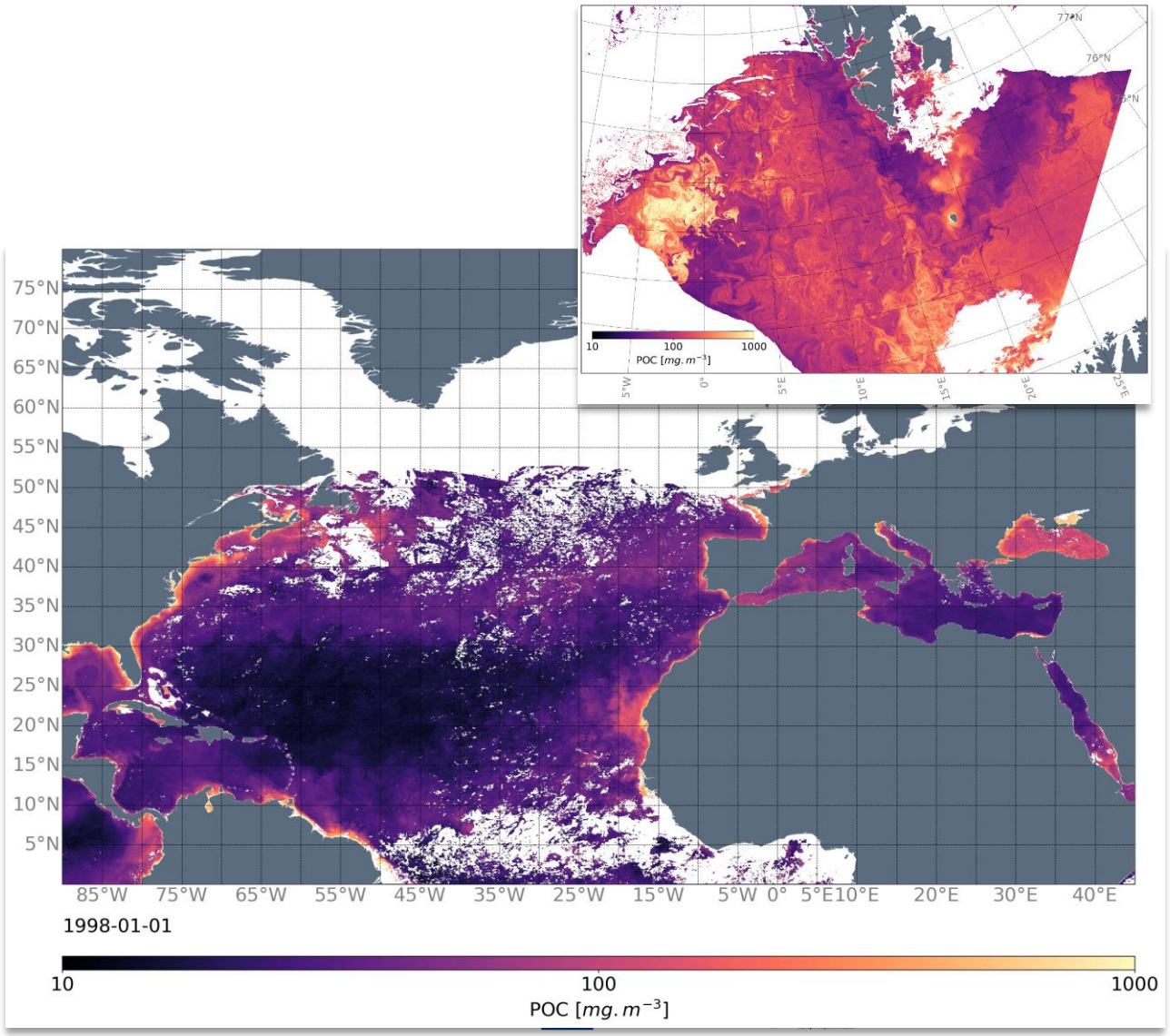



- Sustainable aquaculture is intimately linked to water quality.
- Monitoring HABs allows for adaptation of operations.
- Ocean colour provides a view on situation at regional, event scale, and through time series.
- Notebook shows how to access OC data and apply algorithms suitable for high biomass blooms linked to deoxygenation.
- Case study in partnership with GMES&Africa marine consortia who deliver this as a service towards national blue economy initiatives.

# Challenge 5 – Ocean solution to climate change

- **Satellite data contributing to monitoring ocean carbon uptake:**
  - Ocean colour data can be used to derive information about carbon pools e.g. POC, PIC
  - Other data can be used towards studies of carbonate system (ocean acidification).
  - Data offers insight in to event scale dynamics and long-term trends.
  - Notebook shows access to ocean colour data and applications of a simple, published algorithm for POC.



# EUMETSAT Helpdesk

OPS@eumetsat.int

Contact the EUMETSAT helpdesk with any questions about EUMETSAT data products or services

## EUMETSAT User Support Resources

### User portal

Copernicus & mandatory missions Data access

### Courses

moodle


### Code distribution

CONDA

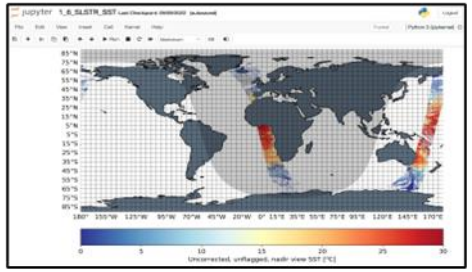
GitLab

### Video tutorials

YouTube


### Jupyter Notebooks

jupyter



### Cloud services

binder

WEKEO

### Case studies