living planet symposium | BONN 23–27 May 2022

TAKING THE PULSE OF OUR PLANET FROM SPACE

The CMEMS High-Resolution Coastal Service

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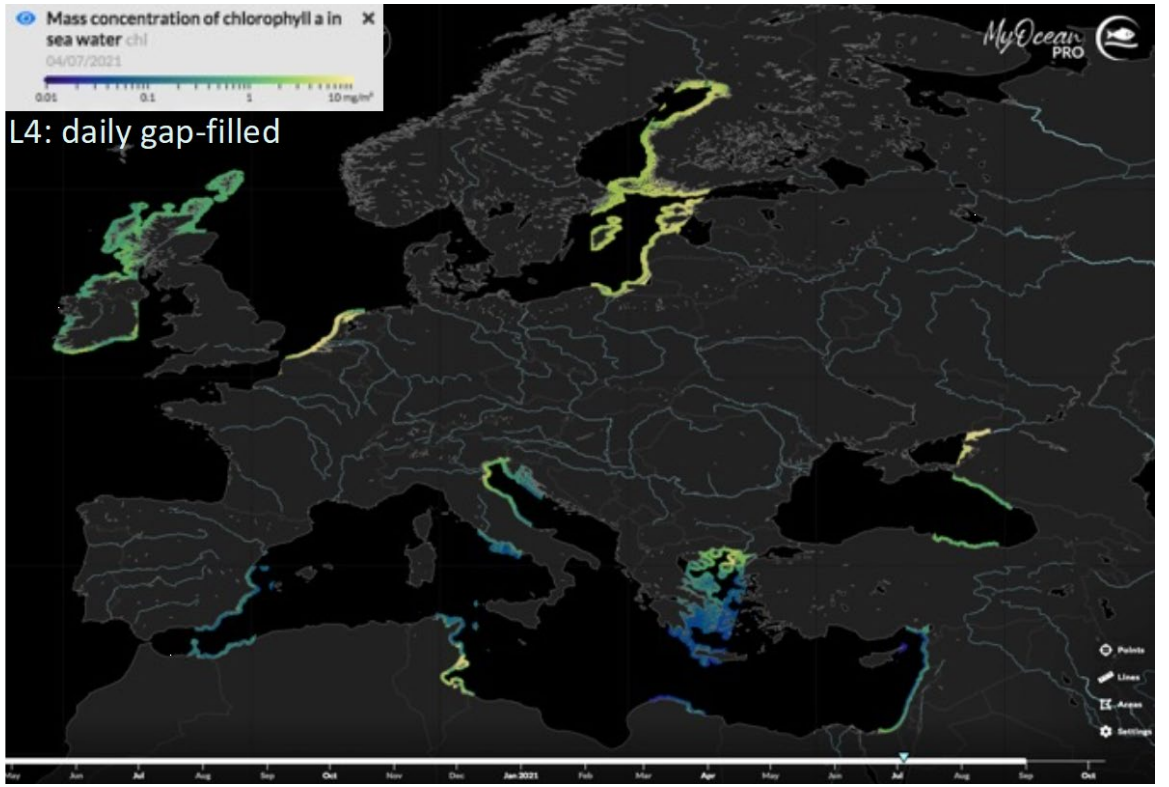
Fact Sheet High Resolution Coastal Service

- **Sensor:** Sentinel-2/MSI (A&B)
- Covering **coastal strips of 20km** for all European Seas
- **Spatial resolution**: 100m
- **Gridding:** Geographic lat/lon grid WGS84 / polar Lambertian Azimuthal Equal Area
- **Period:** 1/1/2020 to current day
- **Temporal:**
  - Daily NRT
  - Monthly NRT
  - Daily DINEOF gap-filled
- **Parameters**
  - Remote Sensing Reflectances - RRS(l)
  - Turbidity - TUR
  - Suspended particulate matter – SPM
  - Particulate Backscatter - BBP(l)
  - Chlorophyll Concentration – CHL
- **Production:** Cloud-based processing system running on CreoDias

https://cmems.lobelia.earth/

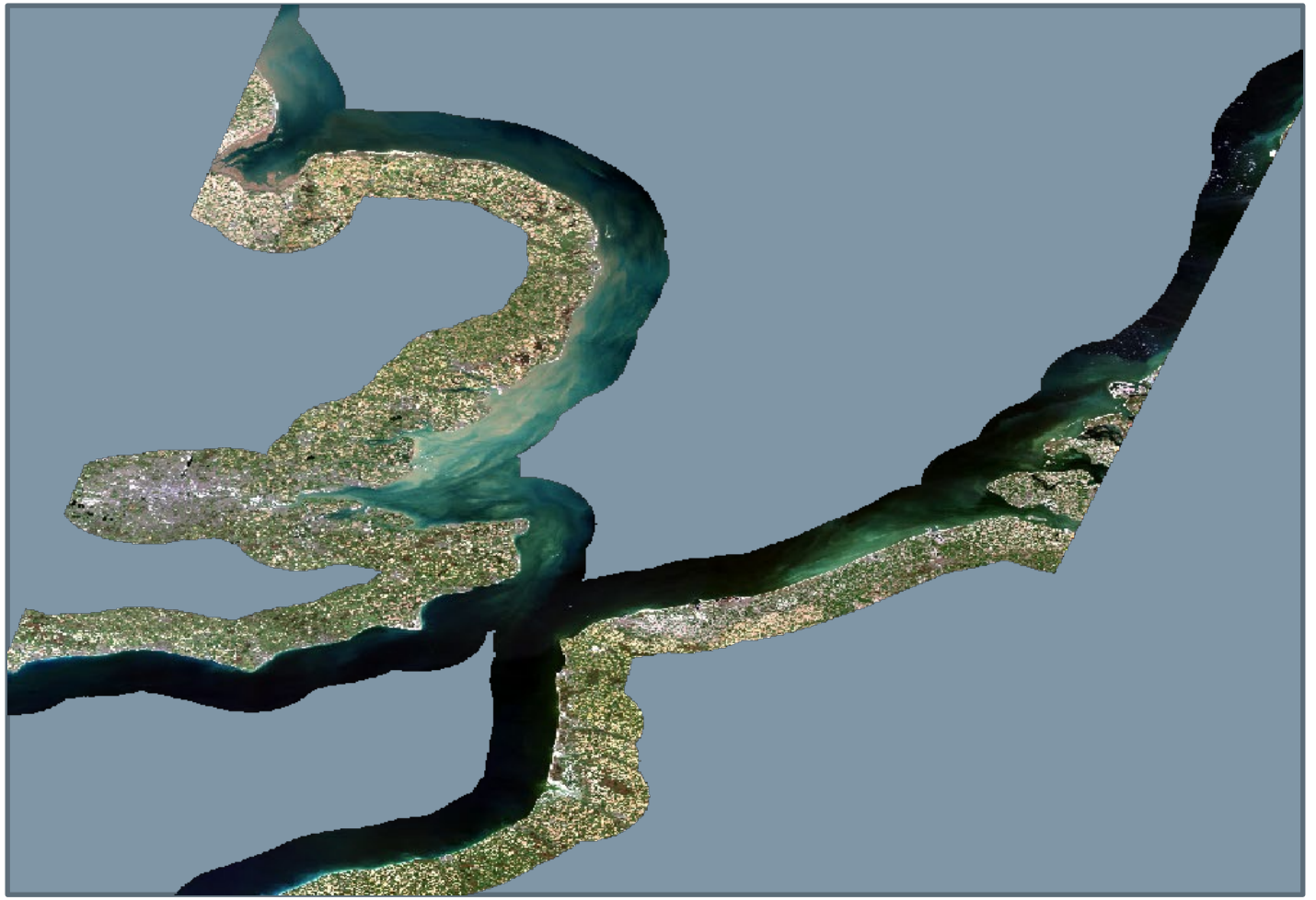


Chlorophyll-a concentration on 4/7/2021

High-Resolution Ocean Colour Products examples

Daily NRT products

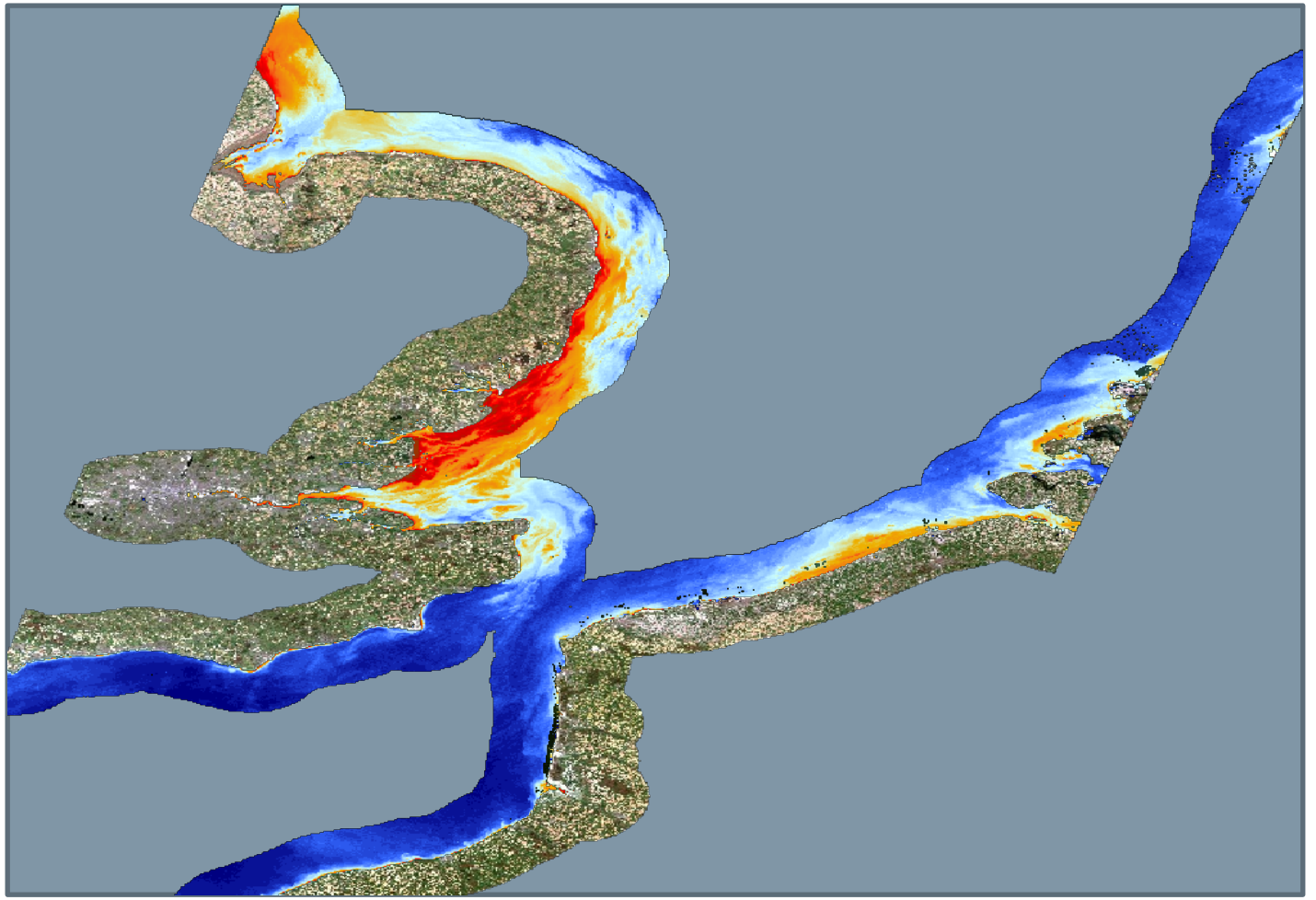
- NWS (Thames Estuary, Scheldt Estuary
- 20210423
- RGB



High-Resolution Ocean Colour Products examples

Daily NRT products

- NWS (Thames Estuary, Scheldt Estuary
- 20210423
- Turbidity (TUR)



High-Resolution Ocean Colour Products examples

Daily NRT products

- NWS (Thames Estuary, Scheldt Estuary
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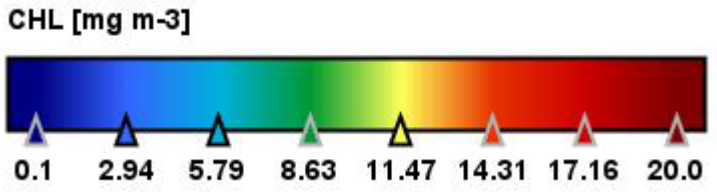
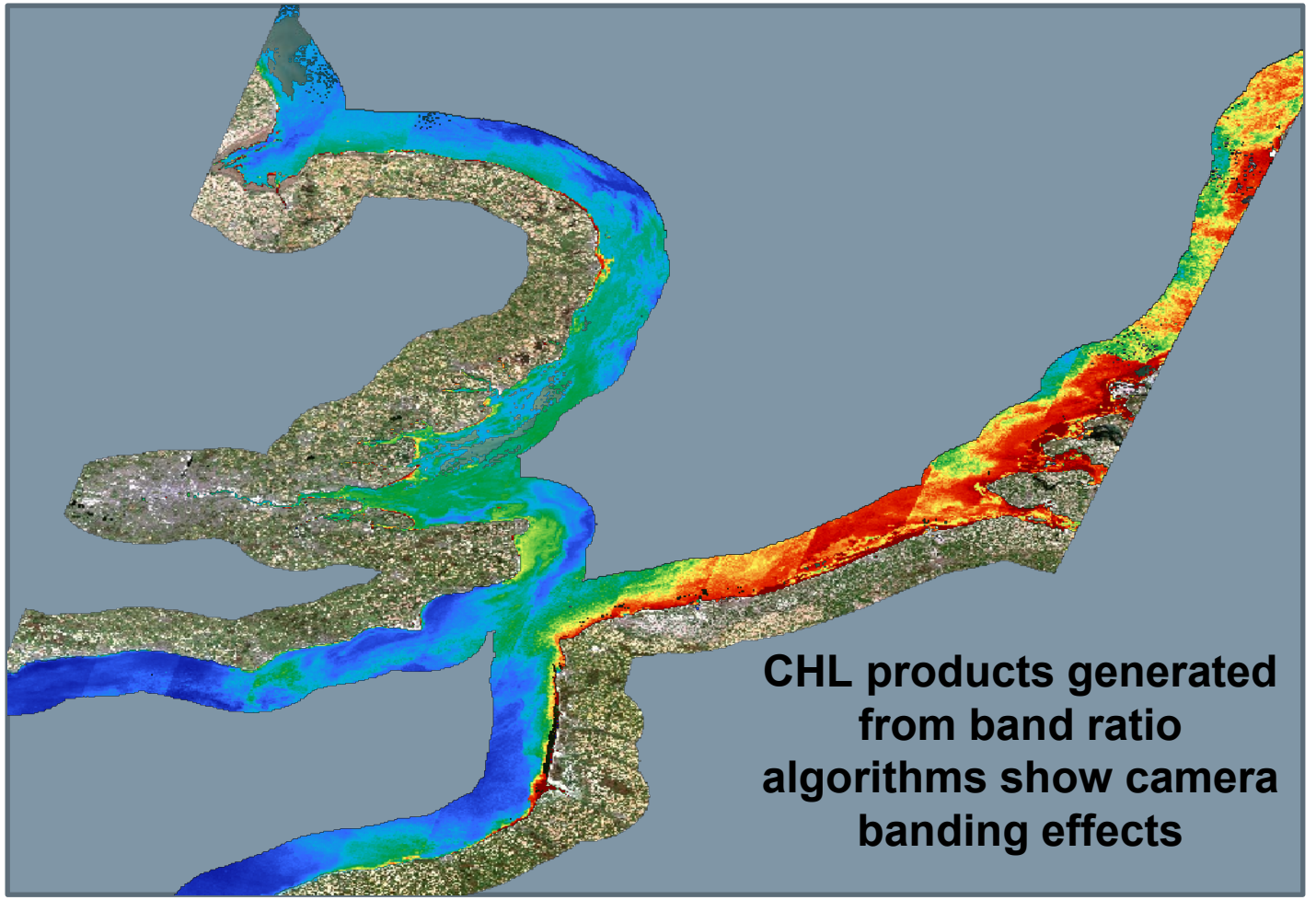
- Chlorophyll (CHL)





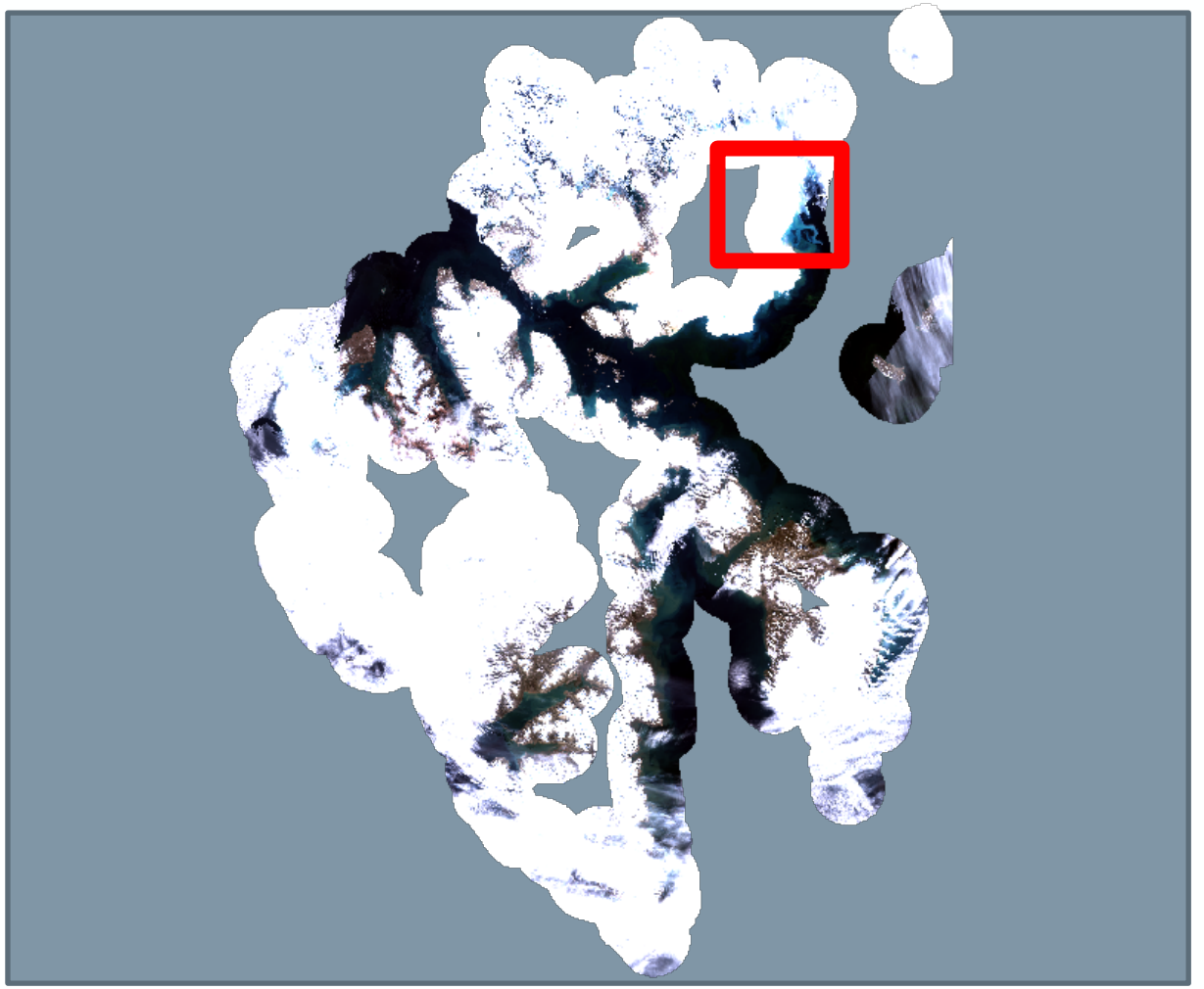
High-Resolution Ocean Colour Products examples

Daily NRT products

ARC (Svalbard)

20210715

RGB



High-Resolution Ocean Colour Products examples

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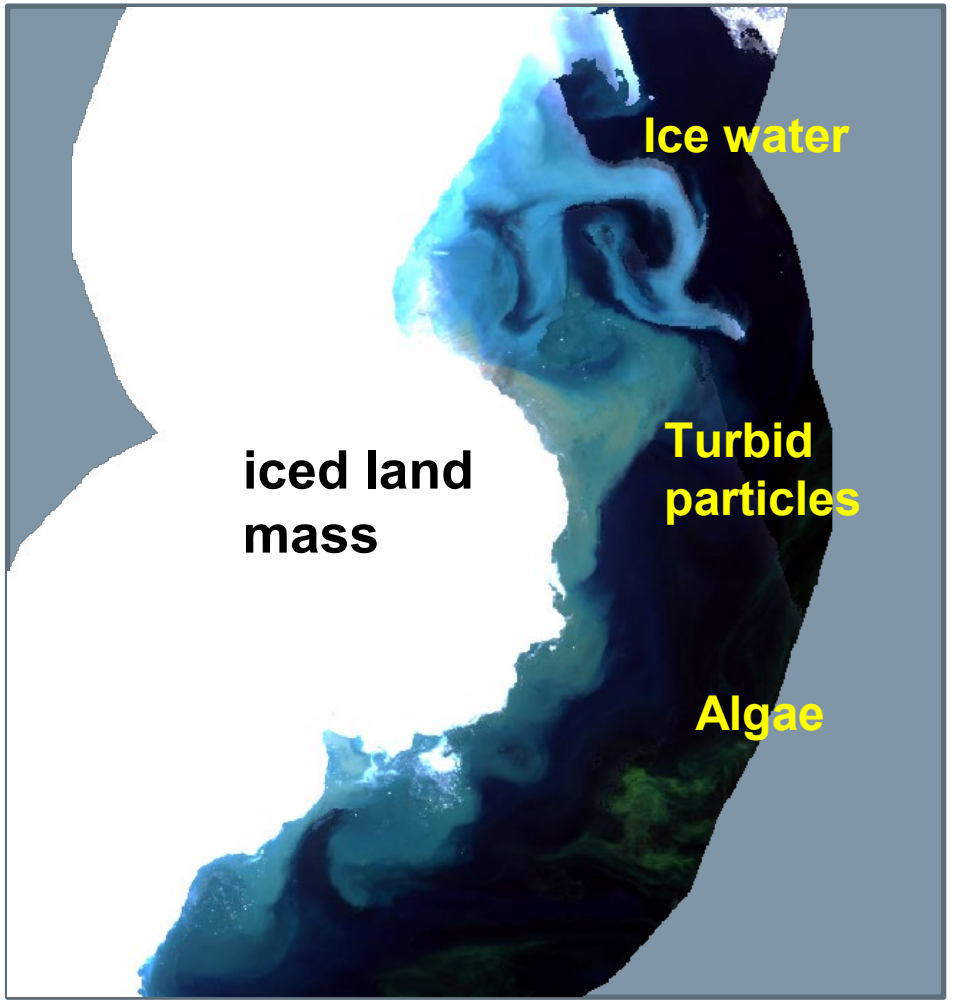


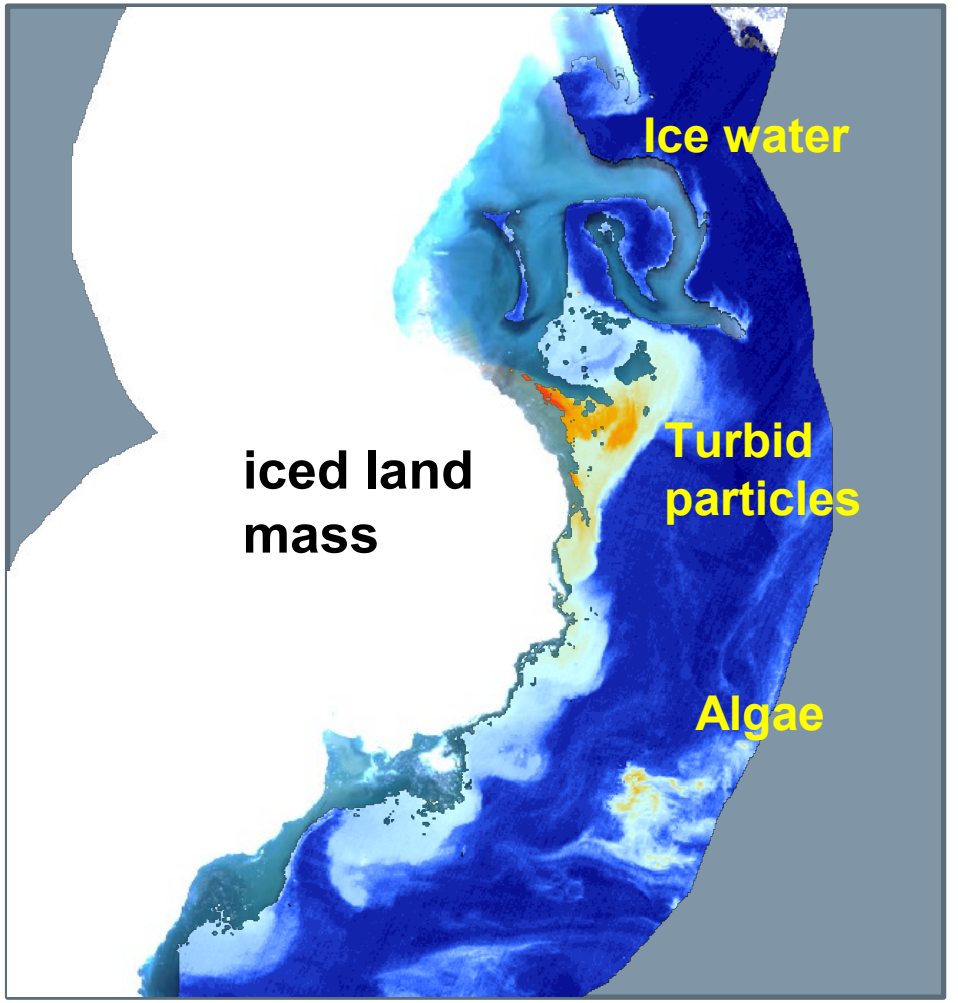
High-Resolution Ocean Colour Products examples

Daily NRT products

ARC (Svalbard)

20210715

Turbidity



High-Resolution Ocean Colour Products examples

Daily NRT products

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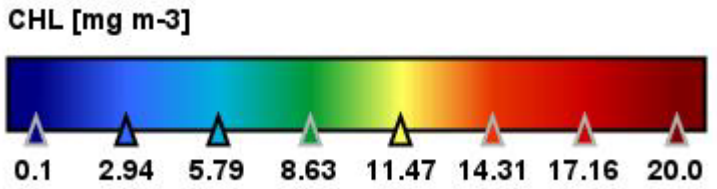
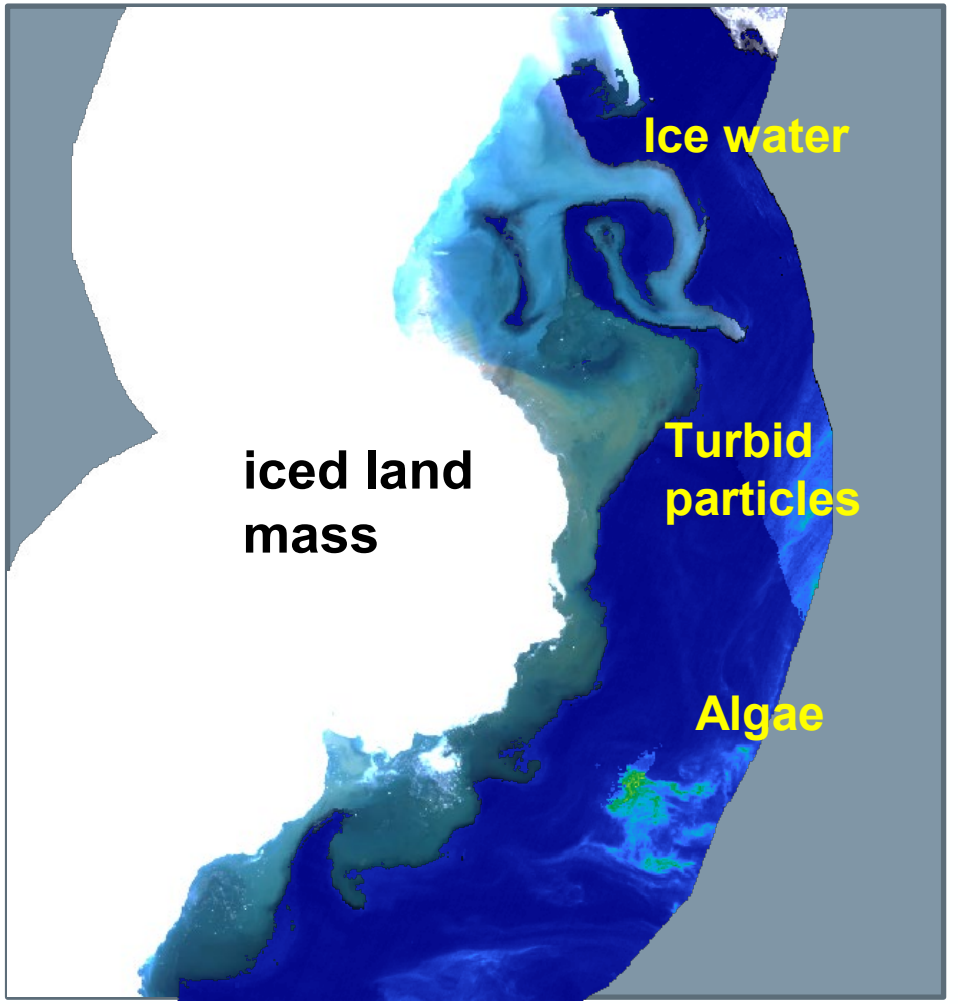
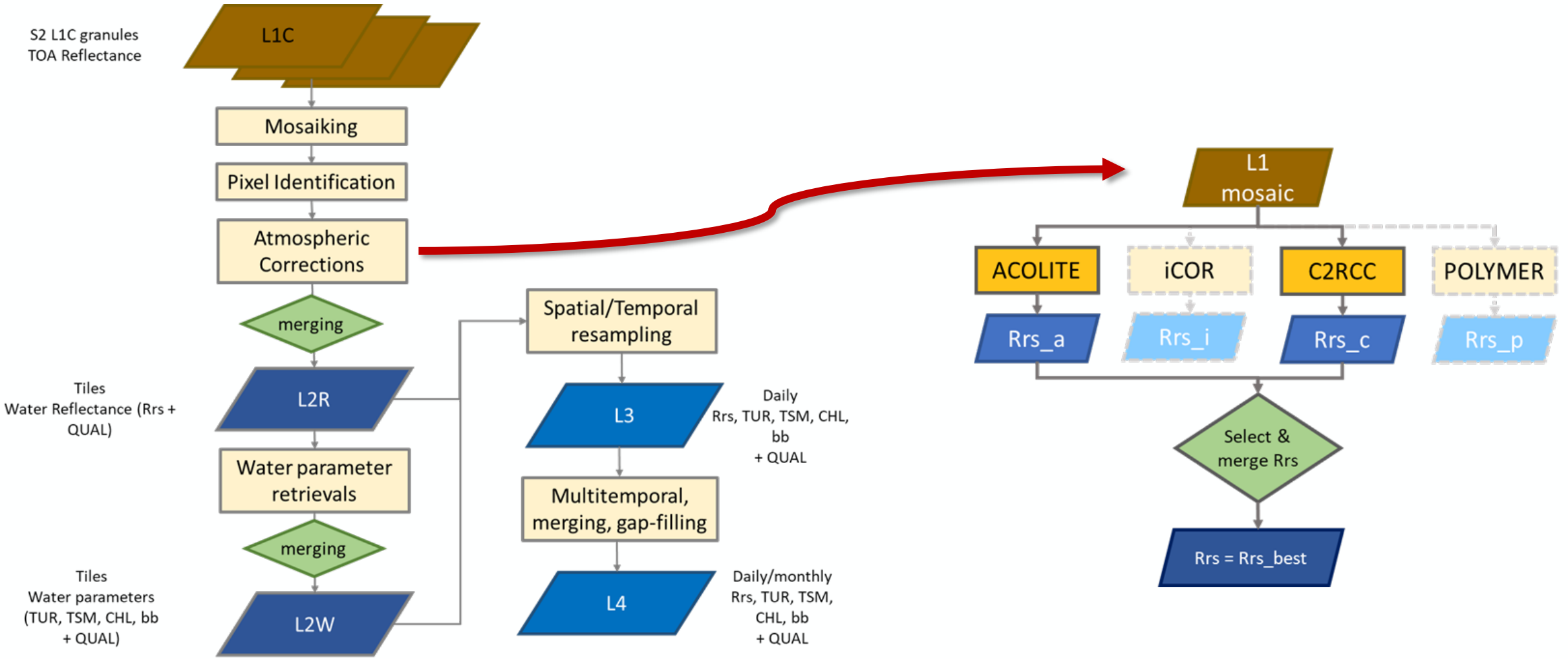
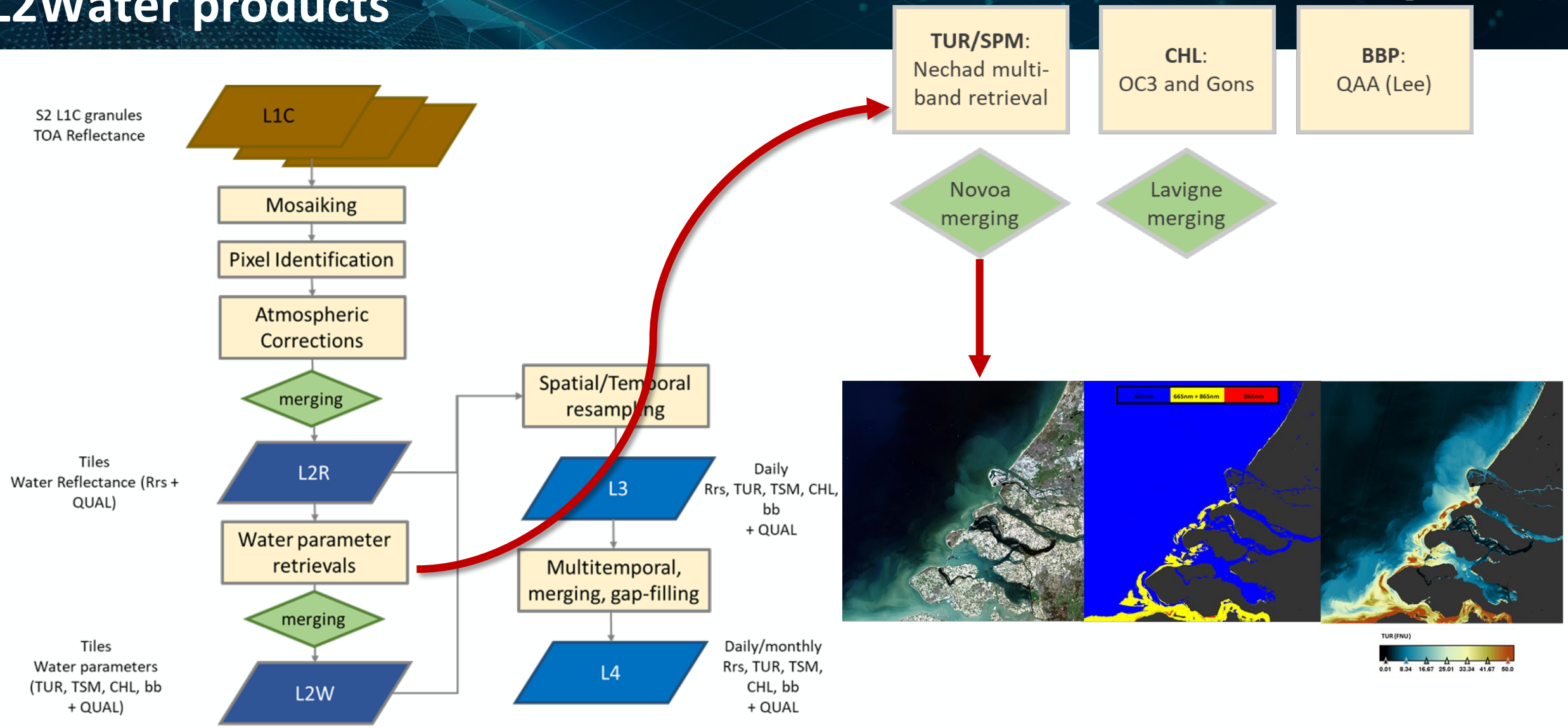




High-Resolution Ocean Colour Processor



High-Resolution Ocean Colour Processor
L2Water products



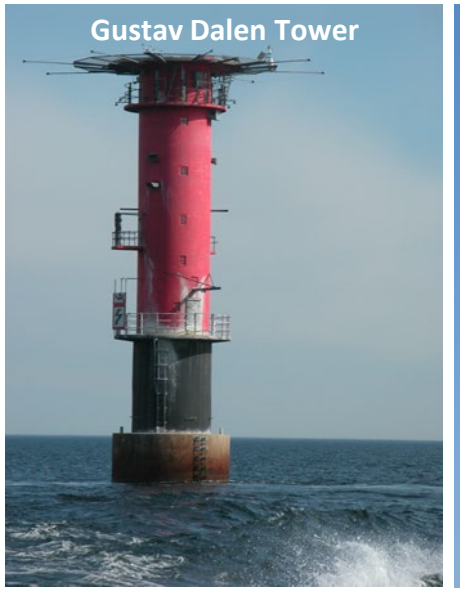
- Novoa et al. (2017). Atmospheric corrections and multi-conditional algorithm for multi-sensor remote sensing of suspended particulate matter in low-to-high turbidity levels coastal waters. Remote Sensing
- Lavigne et al.(2021). Quality-control tests for OC4, OC5 and NIR-red satellite chlorophyll-a algorithms applied to coastal waters. Remote Sensing of Environment

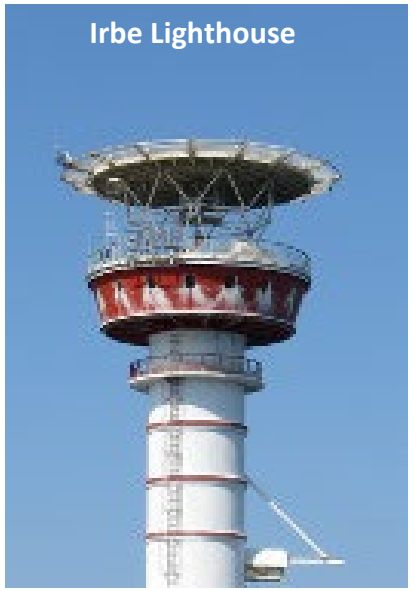
Rrs Validation using AERONET-OC

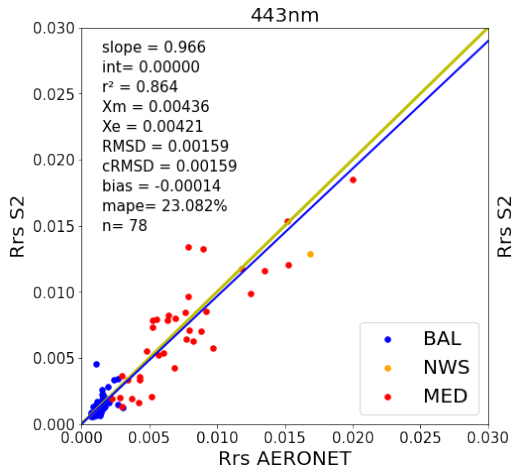
- AERONET-OC

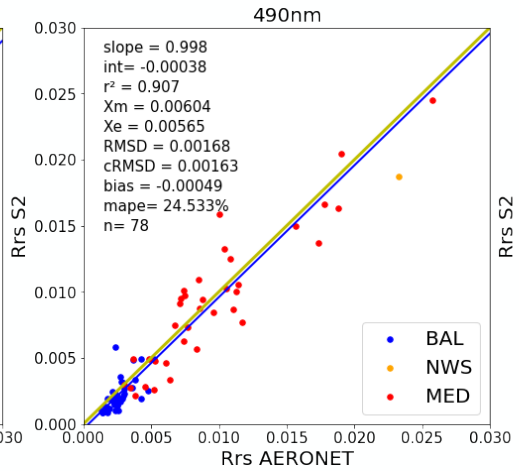
Dataset	PI	ID	REGION	Latitude-N	Longitude-E
Gustav Dalen Tower	Giuseppe Zibordi	3	Baltic	58.594	17.467
Irbe_Lighthouse	Giuseppe Zibordi	3	Baltic	57.751	21.723
Zeebrugge-MOW1	Vanderzande	4	NWS	51.362	3.120
Venice	Giuseppe Zibordi	6	Med Sea	45.314	12.508

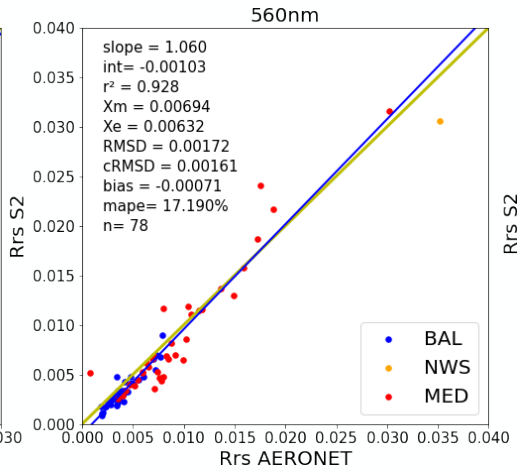
2021 operational product validation

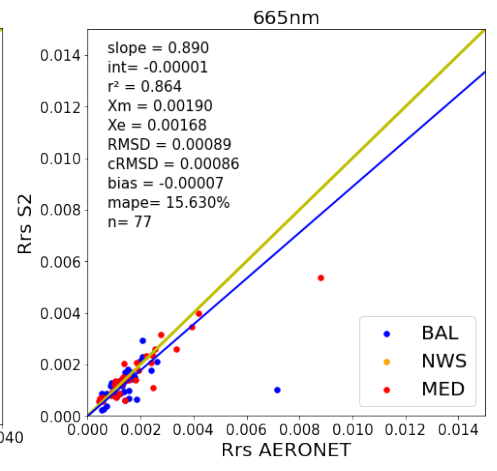


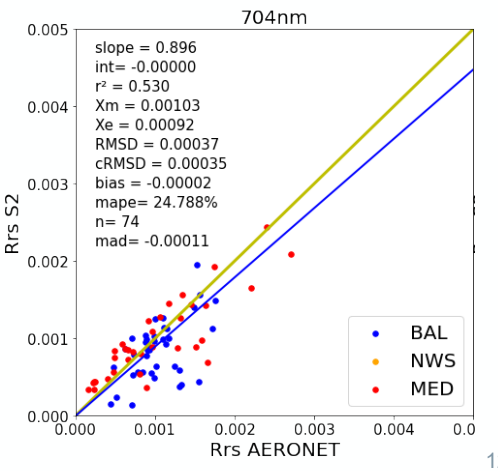








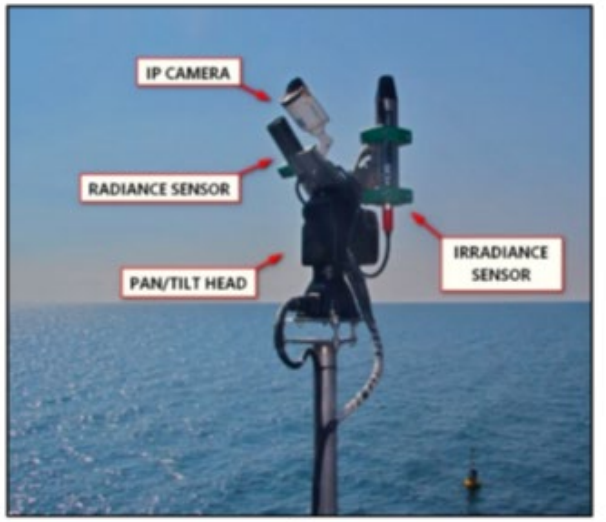




Rrs Validation using PANTHYR (Waterhypernets)

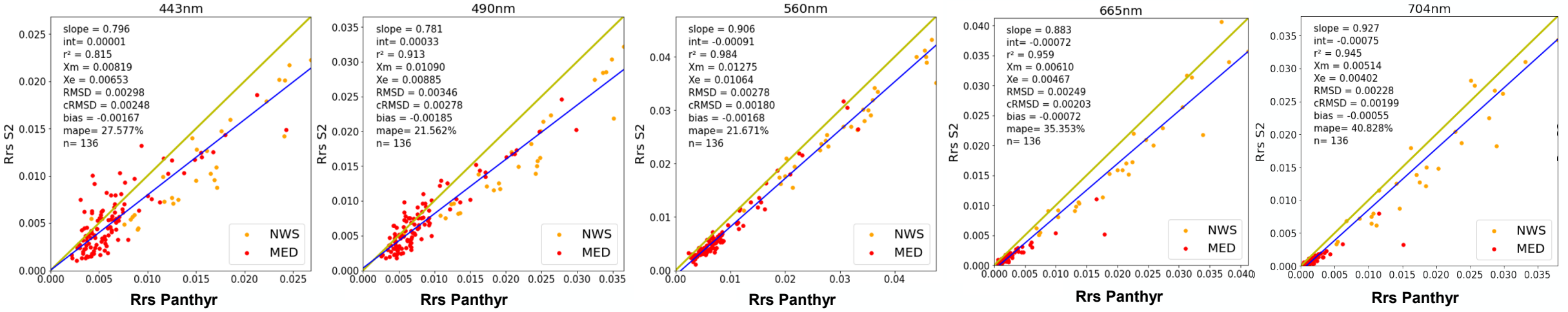
- Waterhypernet (2 PANTHYR stations)
  - Autonomous measurement of hyperspectral water reflectance
  - Pan-and-tilt system + Trios

Oostende (BEL; PI: VLIZ)
Aqua-Alta (IT, PI: CNR)
2020-2022 operational product validation



(a)

(b)

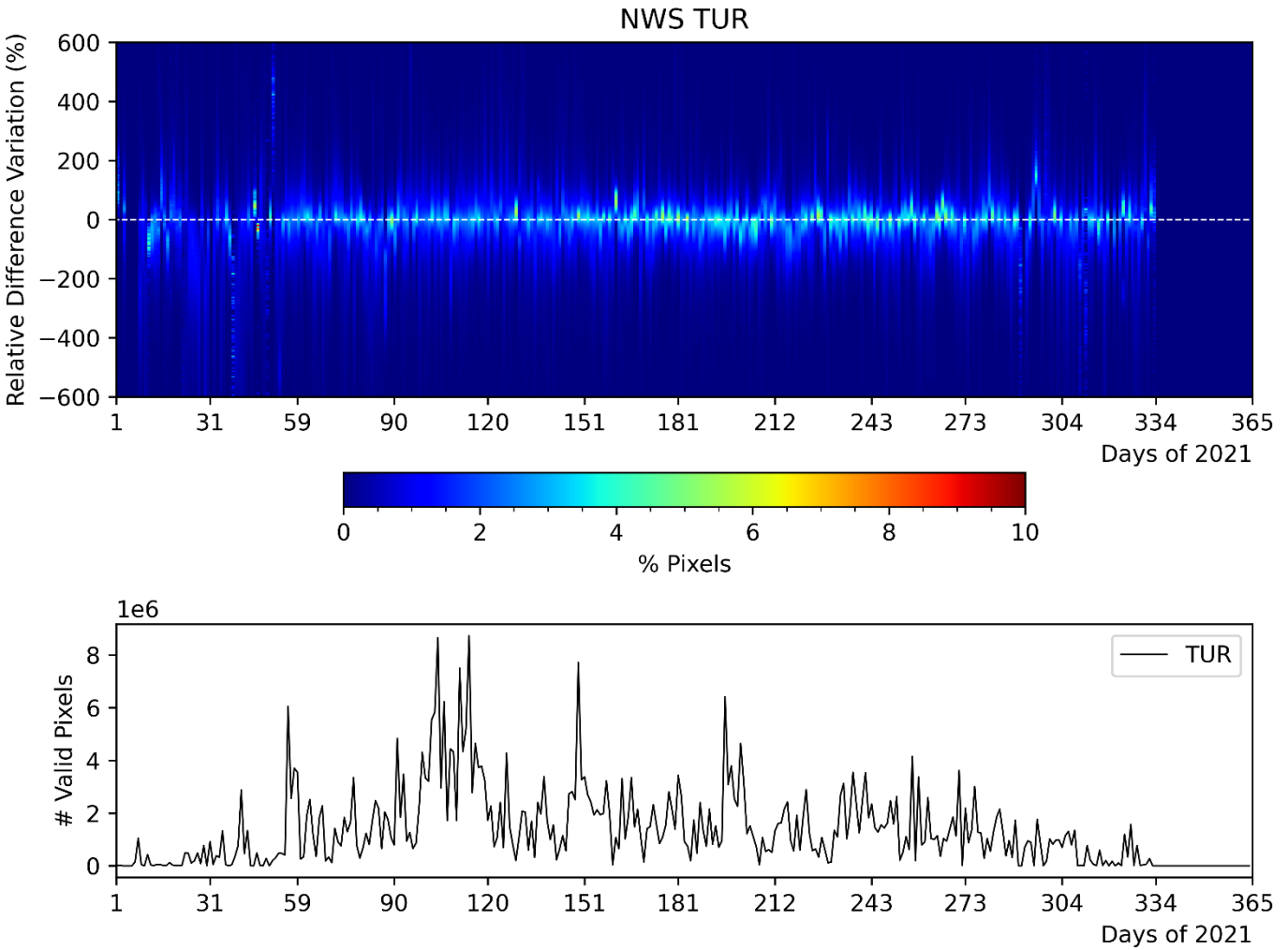


Vansteenwegen D. & Ruddick K. & Cattrijsse A. & Vanhellemont Q. & Beck M. **The Pan-and-Tilt Hyperspectral Radiometer System (PANTHYR) for Autonomous Satellite Validation Measurements—Prototype Design and Testing** (2019) *Remote Sensing* , Vol. 11(11) p. 1360

Quality Indicator (QI) graphs: monitoring operational products in NRT

- **QI graphs** indicate the consistency to previous year(s)
- The base year is currently 2020/2021
- Intention to identify trends of discrepancies

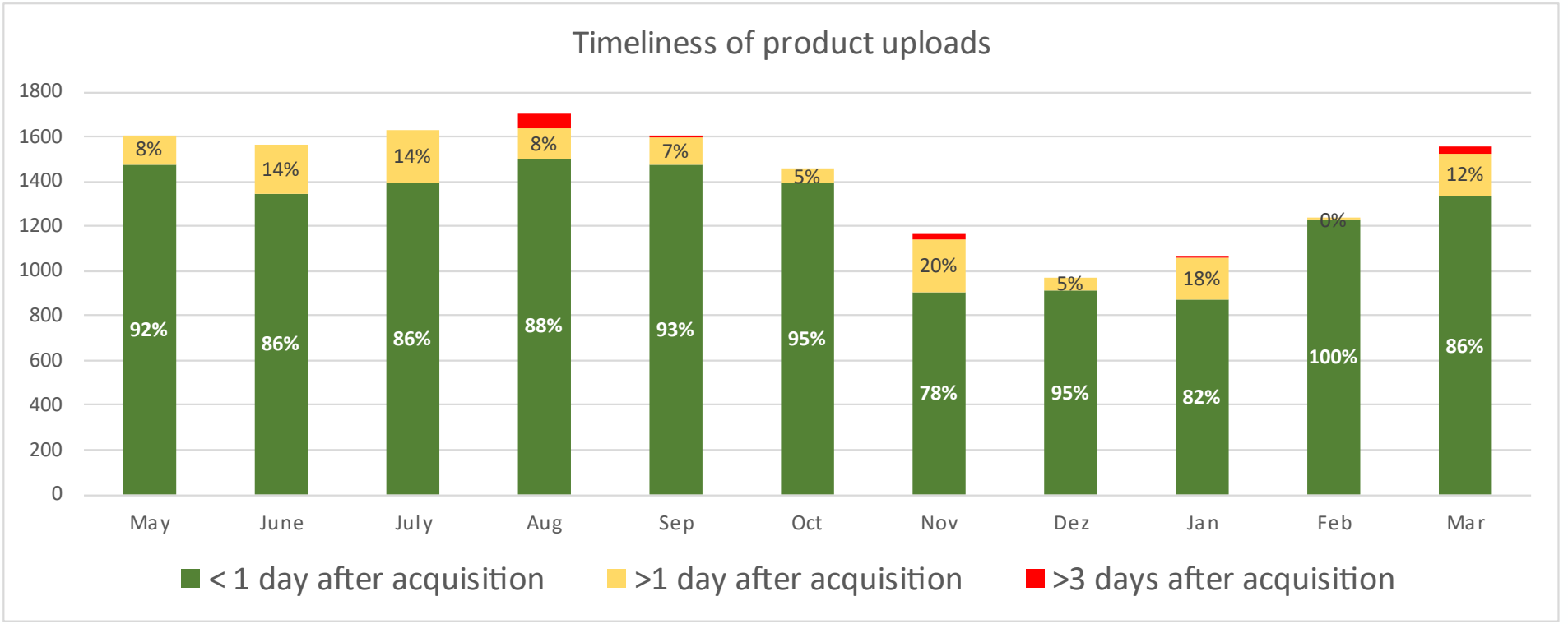
$$QI = \frac{CurretDataPixel - PreviousYearsAvgL4DataPixel}{PreviousYearsAvgL4DataPixel}$$



Production monitoring - timelines

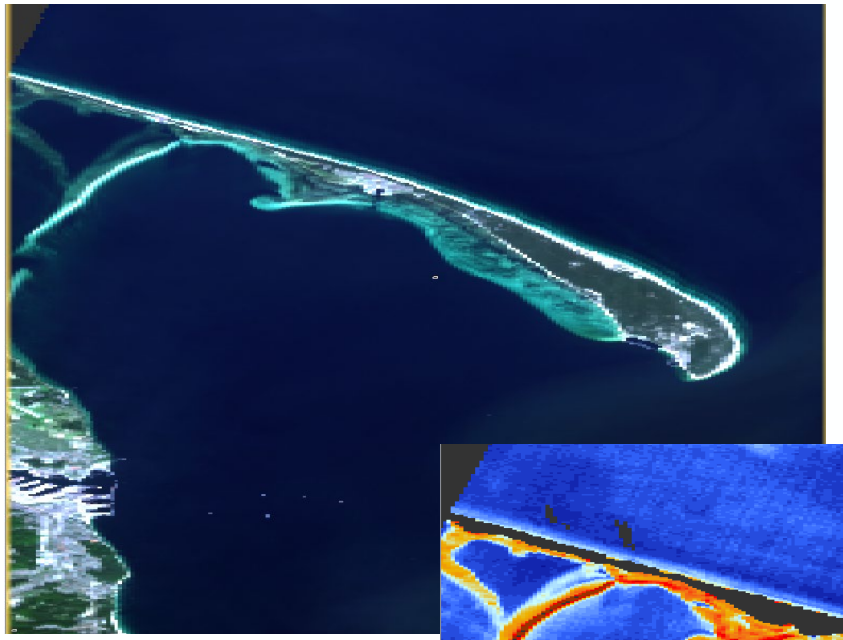
Entry of service → May 2021 (+/- 1 year of operational production)

- Originally, the products needed to be delivered the day after the acquisition
- Due to late delivery of Sentinel-2 tiles → relaxed to **3 days after acquisition**
- This enables us to deliver **99% of all products in time**
- The day after acquisition only 88% of all products could be delivered in time



Ongoing evolutions (2022)

Improvement of flagging



Gulf of Gdansk (Baltic Sea)

Bottom reflection flagging

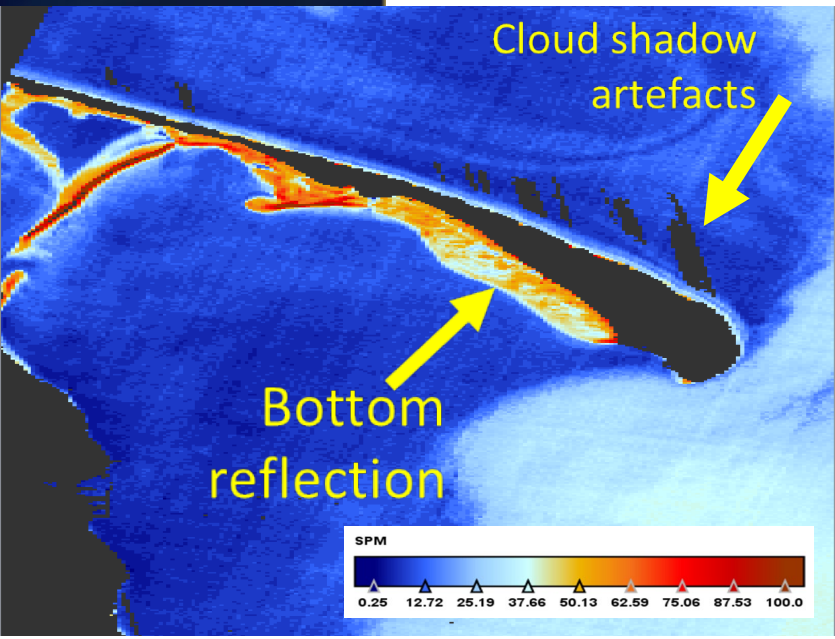
- HROC products cover intertidal flats impacted by bottom reflection
- They are insufficiently flagged with current approach

→**Improve flagging of pixels impacted by bottom reflection** (2022/05)

Cloud shadow artefact flagging

- Cloud shadow flagging performed by IDEPIX
- Some bright coastline features are detected as 'cloud' and activate the cloud shadow generation resulting in persistent artefacts

→**Improvement of cloud shadow detection** in IDEPIX by eliminating erroneous cloud detection from e.g. bright beaches (2022/07)

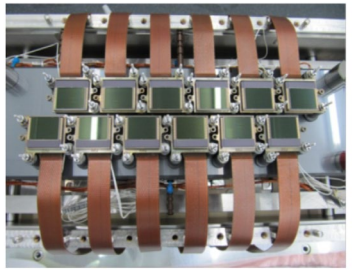


Planned evolutions (2023)

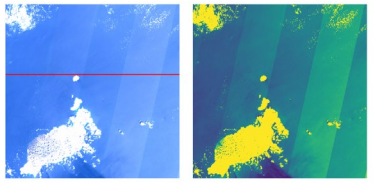
Reduce striping in products (especially CHL)

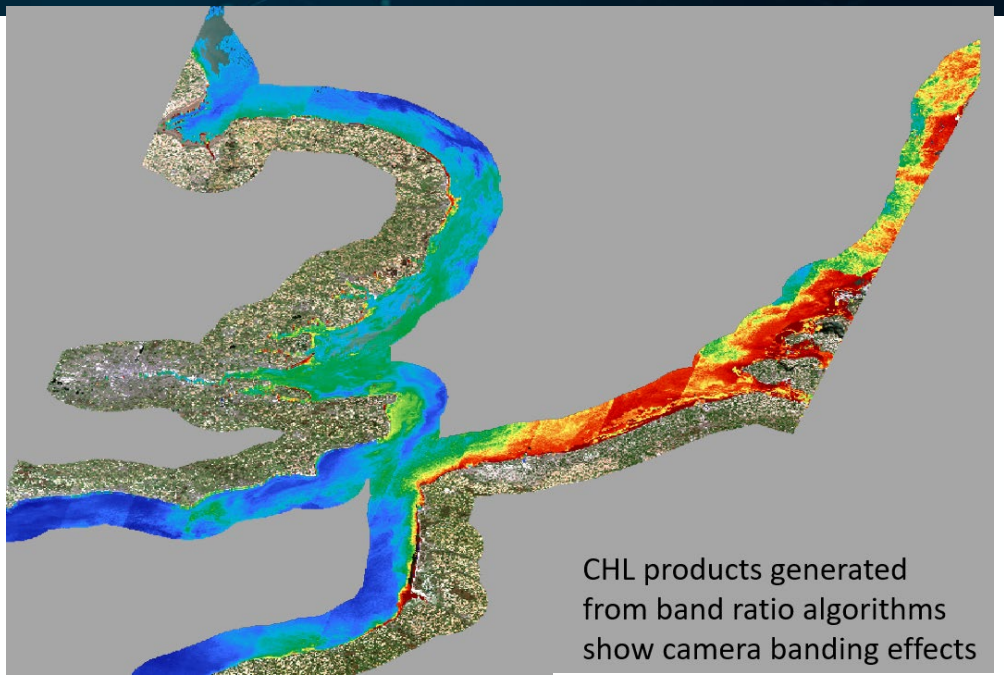
- Sentinel-2 sensor construction leads to sharp changes in relative viewing azimuth angle between adjacent detectors causing **visible artefacts**
- influences not only the values of parameters but also the flagging

→Improvement of the products through adaptation of atmospheric correction algorithms (i.e. C2RCC and ACOLITE) (2023/07)

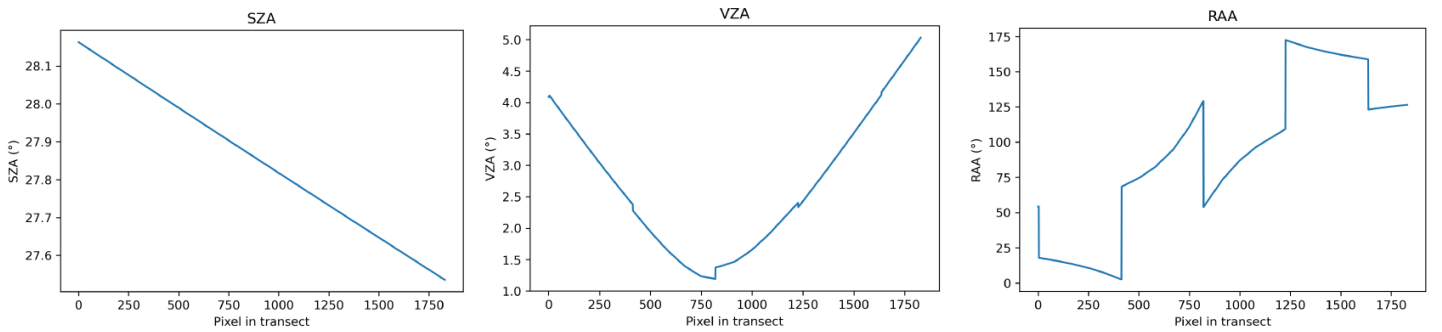


12 detectors of the MSI VNIR focal plane



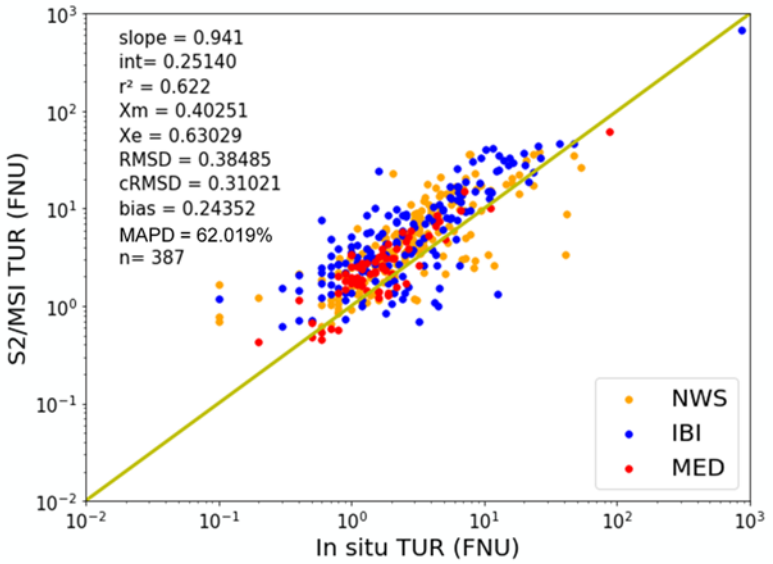


Sharp changes in relative viewing azimuth angle between adjacent detectors

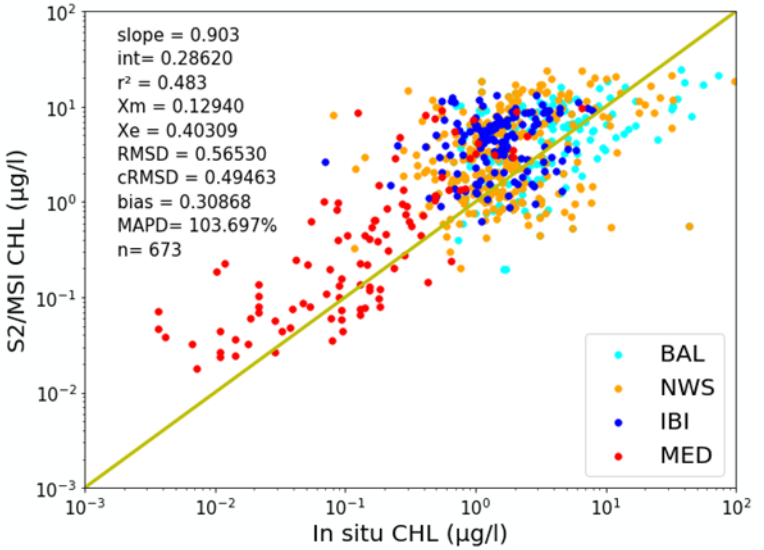


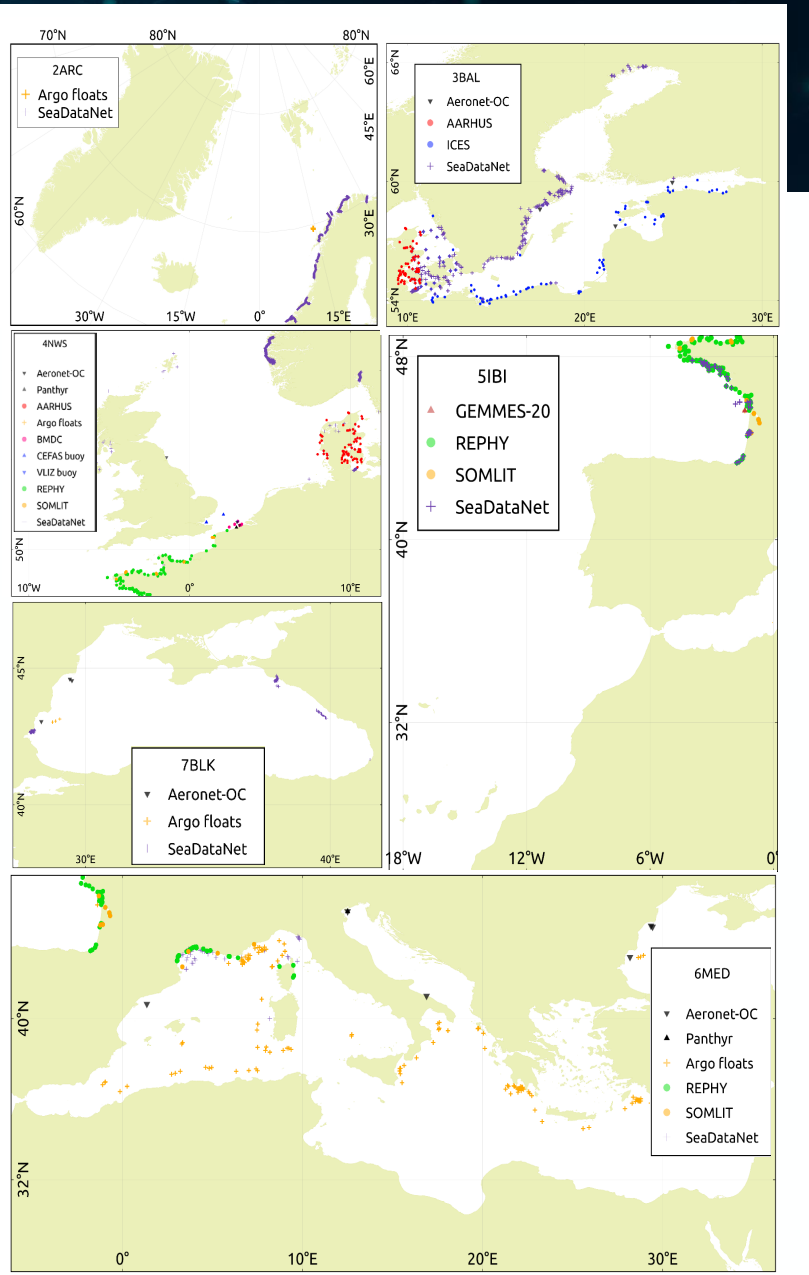
Planned evolutions

Turbidity



Chlorophyll-a





- Investigation of **basin specific ocean colour algorithms** for SPM, TUR and CHL and assess potential improvements in product quality (2023/07)
- Extension of **coastal zones validation dataset for all regions**

Take home messages

Atmospheric Correction:

- **good water leaving reflectances** products by **combining 2 different ACs**
- **modular** and **flexible HROC production chain** able to adapt to new developments (e.g. improved glint correction)

Reference data:

- **AERONET-OC** stations very helpful for **validation of ACs**; hyperspectral **PANTHYR data** very valuable → need to further investigate **differences** between AERONET/PANTHYR
- Need for **more diverse validation sites** – most stations located in relatively **clear waters** (no reference data for IBI or ARCTIC)
- Data for **in-water validation** (chlorophyll concentrations, suspended matter, etc.) of **diverse origin** (e.g. HPLC, Fluo)

Requirements for improvements:

- **MSI banding artefacts** not properly addressed by any AC yet
- Improved **flagging** (e.g., bottom reflection, cloud shadow, etc.)
- Address **sun glint effect** – constant observation geometry in S2 tiles -> sun glint permanent for zones affected
- The SNR is problematic for clear (dark) water -> noisy images and derived product

CMEMS High Resolution Service

- **Covered timeframe**: 01.01.2020 – ongoing
- **Service frequencies and timings**
  - NRT daily service: Daily products are available end of next day after acquisition (but allow 3 days)
  - NRT monthly products are available 3 days after each month, delivered 1/month
  - DINEOF Gap-filled daily products are available 1/quarter
- **Access via CMEMS catalogue**
  https://resources.marine.copernicus.eu/products
- **Feedback is much appreciated**
  https://marine.copernicus.eu/contact