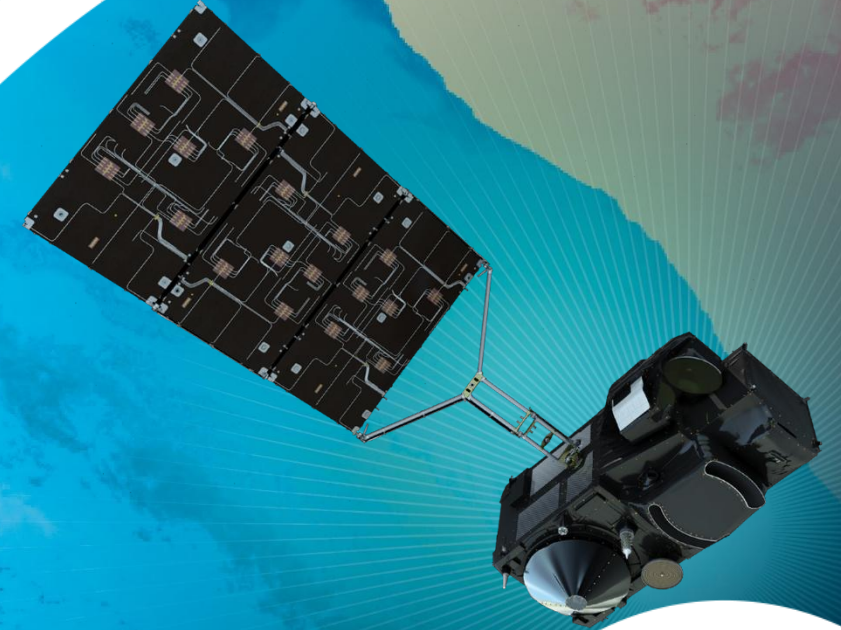


# Sentinel-3 Validation Team Meeting

Presenter Name = Kevin Ruddick

*Ocean Colour session DAY2 (31 Mar 2026) 11:30-  
11:45*



## Radiometric Validation of **Sentinel-3AB/OLCI** by the WATERHYPERNET, including new 2025 data

Kevin Ruddick (RBINS)

Quinten Vanhellemont, Dieter Vansteenwegen

Agnieszka Bialek, Vittorio Brando, Pieter de Vis, Ana Dogliotti, David Doxaran, Joel Kuusk,

Matthew Beck, Ivan Farace, Ken Flight, Anabel Gammaru, Philippe Goryl, Luis Gonzales Vilas, Kaspars Laizans, Francesca Ortenzio, Denis Paillier, Pablo Perna, Estefania Piegari, Lucas Rubinstein, Morven Sinclair, Kevin Turpie, Dimitry Van Der Zande

(c) HYPERNETS Consortium, 2026 (RBINS, TARTU, RSWARE, SU, CNR, NPL, CONICET, VLIZ)

# HYPERNETS in a single slide

## INSTRUMENTS

Automated hyperspectral measurements



PANTHYR system  
[Vansteenwegen et al, 2019]  
400-900nm, 10nm FWHM



HYPSTAR® system  
[https://hypstar.eu/]  
380-1700nm, 3-10nm FWHM

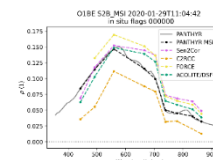
## NETWORK

RBINS (BE, coordinator)  
+ VLIZ (BE), CNR (IT), LOV (FR),  
NPL (UK), TARTU (ES),  
CONICET (ARG), UMBC (USA)  
+ UST21 (SKOR)

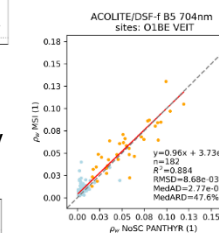


11 water and 7 land sites currently operating  
Expanding slowly in 2026 ...

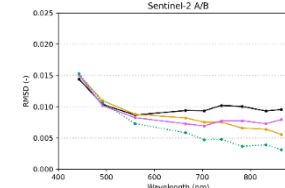
## DATA PROCESSING and ANALYSIS



e.g. one matchup



one band (S2/704nm), many matchups



spectral stats, many matchups

Prototype network has provided validation data and information to:

Sentinel-2A&B, Sentinel-3A&B/OLCI, Landsat-8&9, Planetscope Doves and Superdoves, PACE, PRISMA, Pléiades, EMIT, ENMAP, MODIS-A&T, VIIRS-1&2, ACIX, ...

**OBJECTIVE:** To validate **all** VIS/NIR spectral bands (400-1700nm, @3-10nm FWHM) for **all** satellite missions measuring water or land surface reflectance

and preparing for:

DESI, MTG and SEVIRI, CHIME, LSTM, GLIMR, SBG, GOCI, SABIAMAR, various Newspace, ...  
(national hyperspectral imagers from Canada, Norway, Australia, ...)

# WATERHYPERNET network

- WATERHYPERNET **hyperspectral water (400-900 nm) reflectance** for sat validation

**diverse waters (11):** blue/green/brown/dark, coastal/inland, latitudes 35°S-52°N

=> useful for determining **fitness-for-purpose** and **identifying where improvements** can be made esp Atmospheric Correction, Cloud and Cloud shadow masking, sunglint, adjacency, ...

- **Demonstration validation studies** for Sentinel-3/OLCI include:

- Dogliotti et al. 2024. "Using the Automated HYPERNETS Hyperspectral System for Multi-Mission Satellite Ocean Colour Validation in the Río de La Plata, Accounting for Different Spatial Resolutions." *Frontiers in Remote Sensing* 5. <https://doi.org/10.3389/frsen.2024.1354662>. [includes quantification of uncertainty from spatial variability]
- Doxaran et al. 2024. "Validation of Satellite-Derived Water-Leaving Reflectance in Contrasted French Coastal Waters Based on HYPERNETS Field Measurements." *Frontiers in Remote Sensing* 4. <https://doi.org/10.3389/frsen.2023.1290110>. [includes quantification of spatial variability]
- González Vilas et al. 2024. "Validation of Satellite Water Products Based on HYPERNETS in Situ Data Using a Match-up Database (MDB) File Structure." *Frontiers in Remote Sensing* 5. <https://doi.org/10.3389/frsen.2024.1330317>.
- Ruddick et al. 2024. "WATERHYPERNET: A Prototype Network of Automated in Situ Measurements of Hyperspectral Water Reflectance for Satellite Validation and Water Quality Monitoring." *Frontiers in Remote Sensing* 5. <https://doi.org/10.3389/frsen.2024.1347520>.
- Vanhellemont and Ruddick 2021. "Atmospheric correction of Sentinel-3/OLCI data for mapping of suspended particulate matter and chlorophyll-a concentration in Belgian turbid coastal waters." *Remote Sensing of Environment*, 256, 112284. <https://doi.org/10.1016/j.rse.2021.112284>.

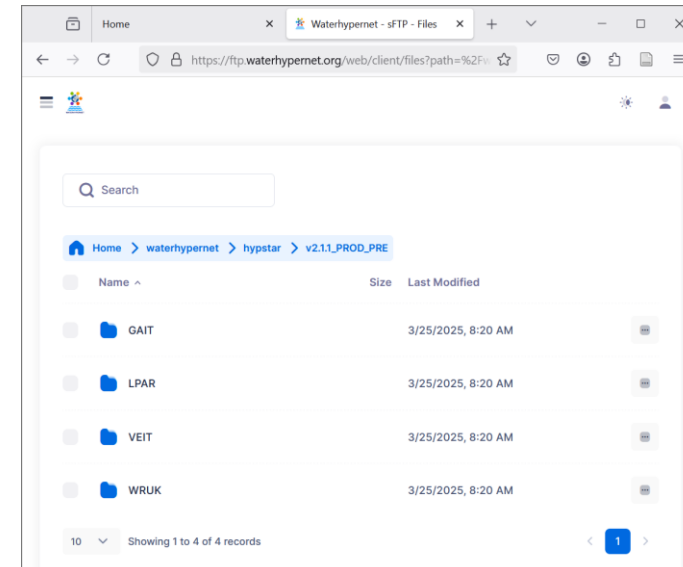
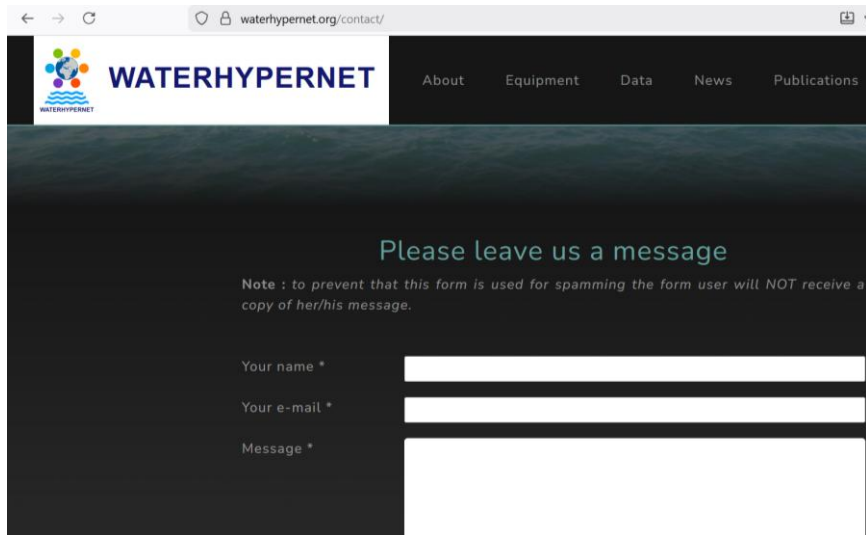
See also:

- **S3VT2026 poster** by K. Kangro et al, "Spectral possibilities for phytoplankton assessment in a shallow, eutrophic lake"
- **S3VT2026 next talk** by *Luis González Vilas*, "Assessing changes in the processing chain of Sentinel-3/OLCI using reference measurements from fixed autonomous hyperspectral radiometers in four Italian sites"

# WATERHYPERNET Data Distribution

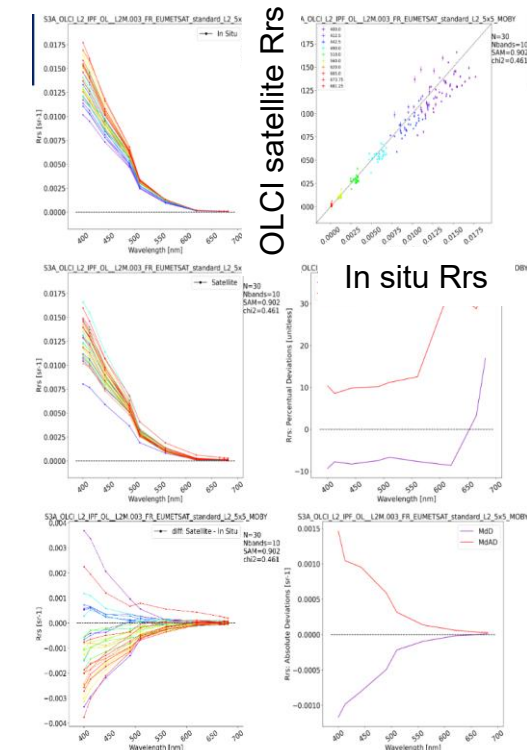
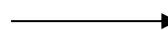
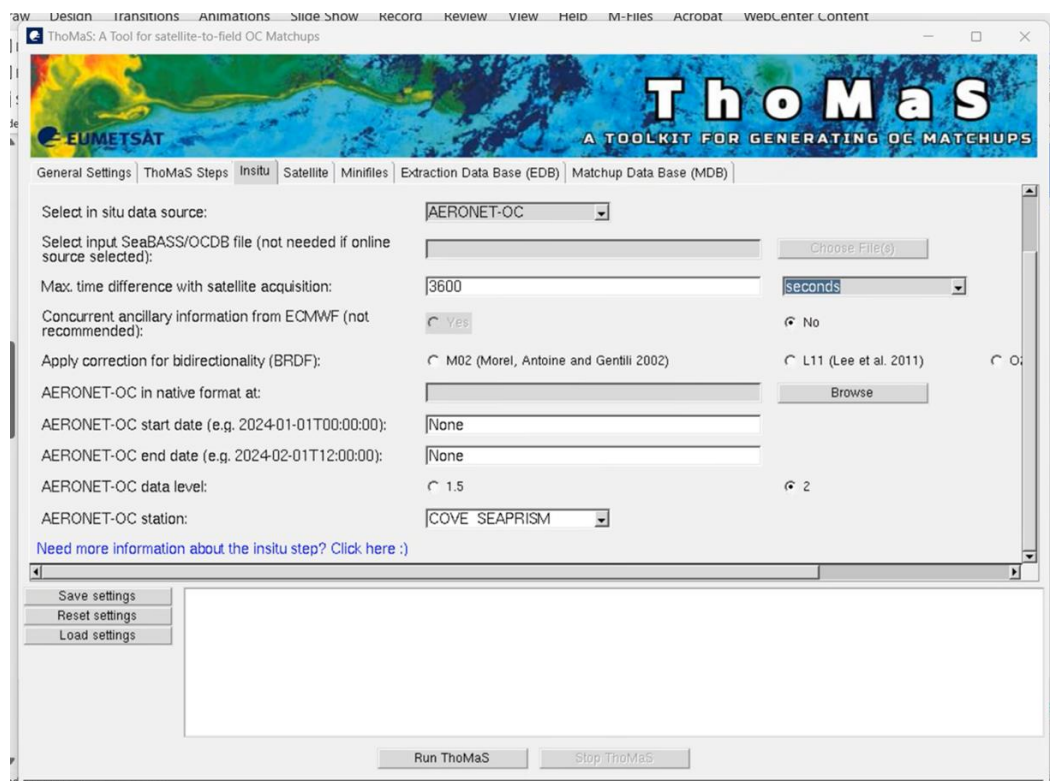
- **WATERHYPERNET** major public release in Dec 2025
  - QC-approved 2023 and 2024 data from 7 sites (1.1GB, <2 mins download, 19 295 high quality measurements)
  - **Apr2026 new data release: reprocessed** (inc feedback recommendations), **expanded** to 4 more sites and **updated** to Dec 2025 with ~25 000 new high quality measurements
  - **Register** at <https://waterhypernet.org/contact/> (just provide email and prove you are not a robot)
  - **Access** via <https://waterhypernet.org/data/>
  - **Data policy** copied from AERONET-OC: [https://waterhypernet.org/documents/20/HYPERNETS\\_DataPolicy\\_2025-04-24.pdf](https://waterhypernet.org/documents/20/HYPERNETS_DataPolicy_2025-04-24.pdf)

(Please do not use data released on zenodo in 2023, data quality and QC has greatly improved since then)



# IOCS2025/WATERHYPERNET Data Users meeting

- Exploitation tools requested/contributed:
  - EUMETSAT/**THOMAS matchup tool** development, using WATERHYPERNET (and AERONET-OC) as standard in situ data archives for match-up scatterplots and statistics for OLCI data (BRDF option)
  - Hereon (Martin Hieronymi) presented the **GALAXY/OWT tool** development, which can be used to classify WATERHYPERNET data according to Optical Water Types and thus stratify validation analyses and conclusions as function of OWT.



## Example OLCI validation study

Processing and analysis: Q. Vanhellemont

Oostende site PI: D. Vansteenwegen

## Conclusions (S3VT2023 and [Vanhellemont and Ruddick, 2021, RSE])

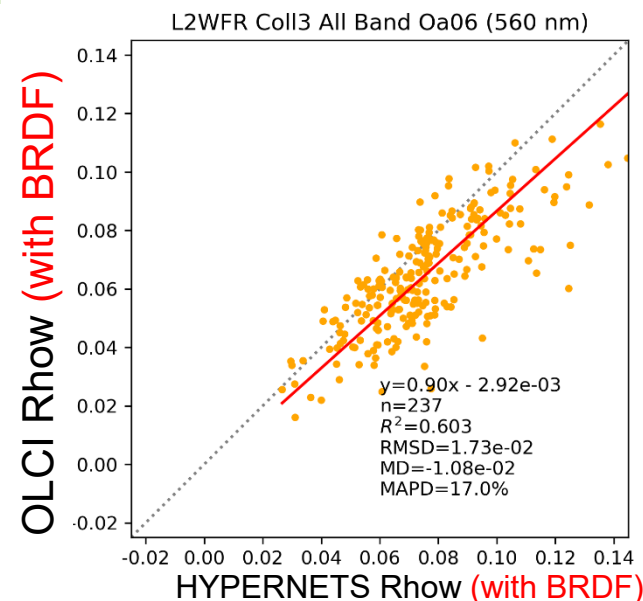
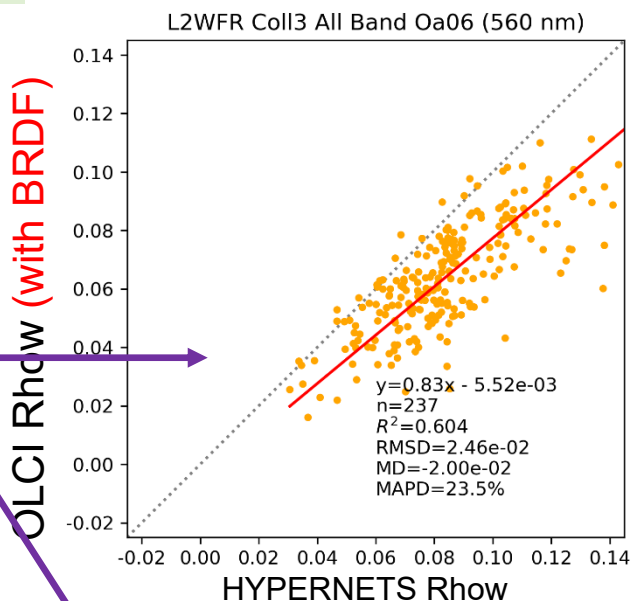
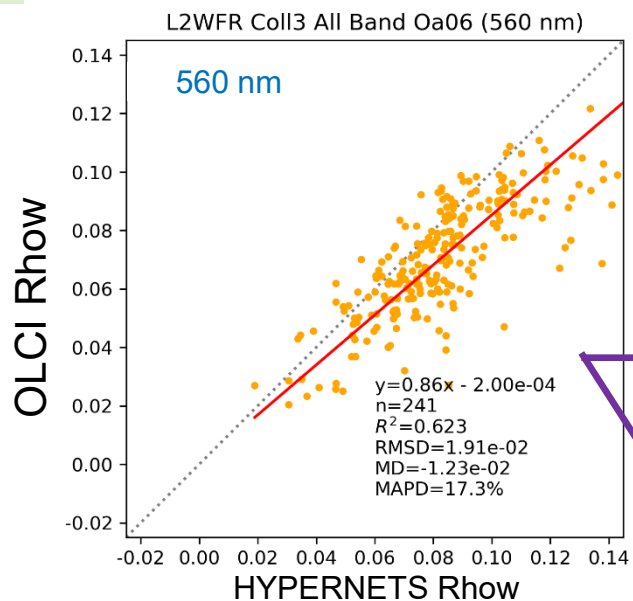
- ✓ HYPERNETS useful for OLCI validation, esp 400 nm and 754-884 nm
- ✓ Very interesting individual image (outliers) Validation Data Sheets
  - Oostende site 100s matchups over ~5 years):
    - ✓ Most ACOLITE\_DSIF outliers are thin clouds, scattered clouds, cloud edge, cloud shadow
    - ✓ Some turbid water artefacts seen in L2WFR aerosol epsilon [Ruddick et al, 2002; MAVT]
    - ✓ L2WFR biased low in turbid waters esp 400-412 nm
    - ✓ Bizarre coastal staircase artefact in L1 (most visible in NIR)
  - La Plata site (53-74 matchups over ~1 year):
    - RMSD ~ atmospheric path reflectance for 400-412 nm, water reflectance for 490-778 nm
- ✓ S3VT\_2020, 2021 paper and S3VT\_2022:
  - L2WFR reduces TOA noise at 884 nm BUT amplifies noise at short wavelengths e.g. 490 nm

## Any big changes in Collection 4? ...

Acknowledgements: Copernicus/EUMETSAT/ESA and contractors for OLCI data

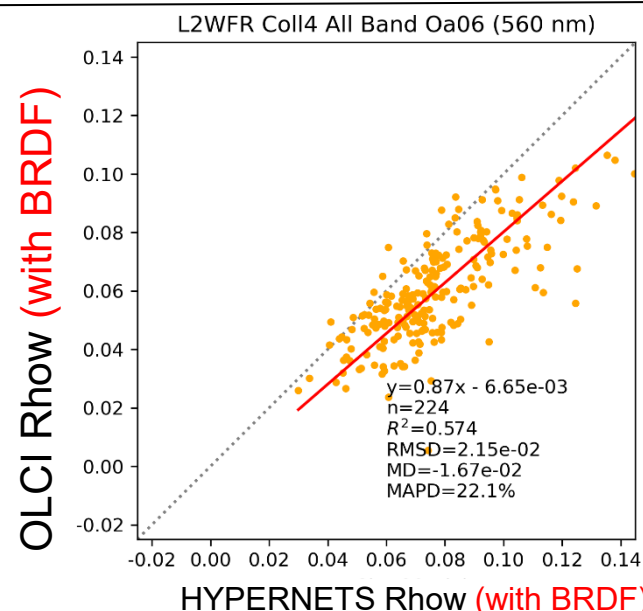
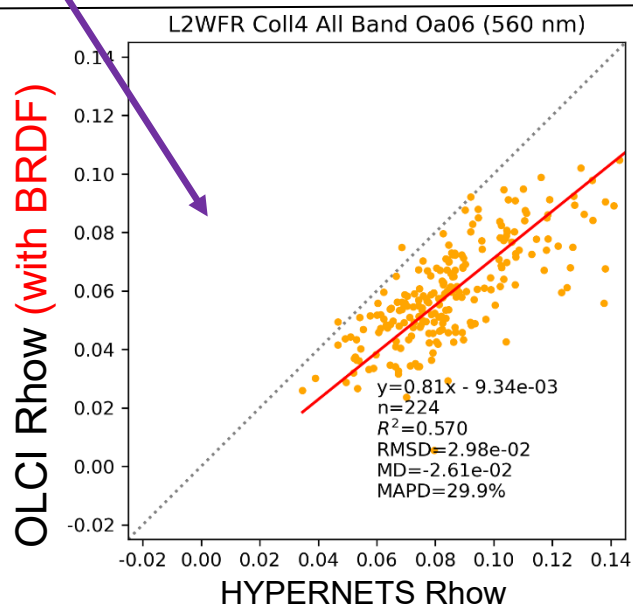
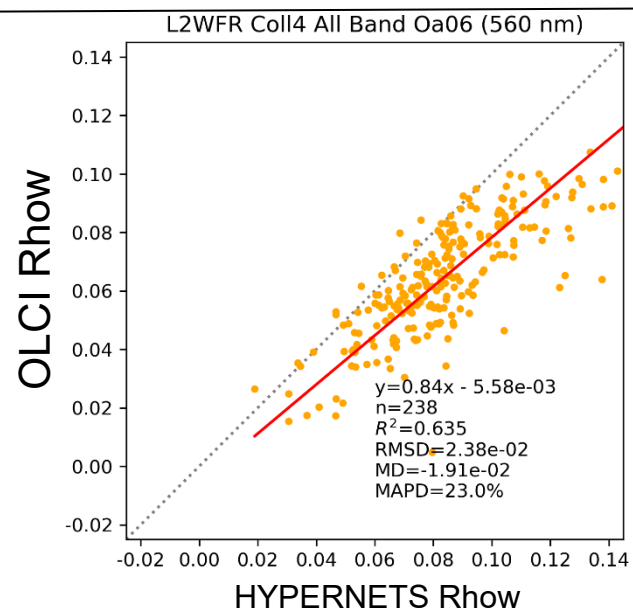
## Main Collection 4 change for reflectances is from BRDF (small impact on validation metrics)

Collection 3



Oostende  
PI: D. Vansteenwegen

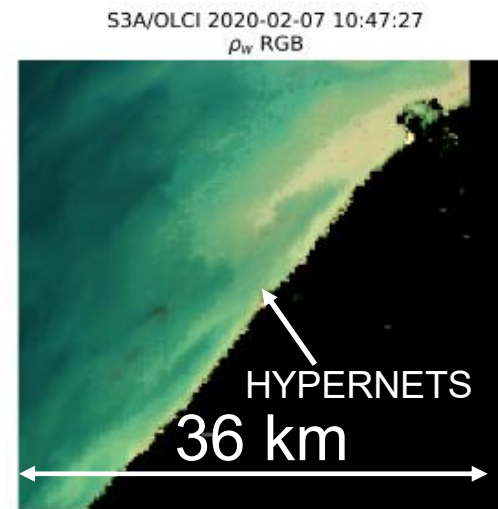
Collection 4



# Atmospheric correction issues in turbid waters

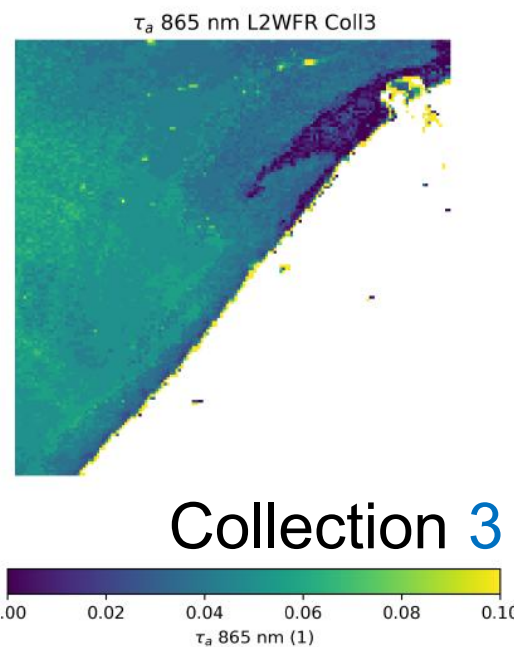
Example 2020-02-07

R<sub>h</sub>w  
RGB



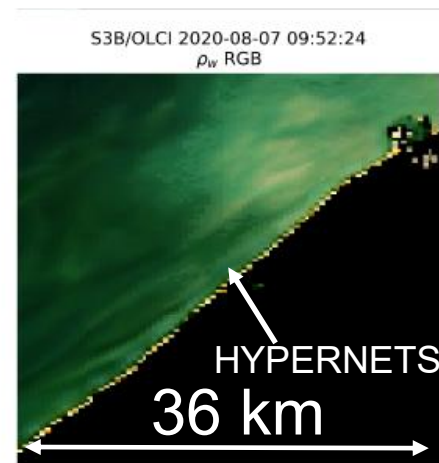
Aerosol products show turbid water artefacts that propagate to R<sub>rs</sub>  
[MAVT2002 ... S3VT2023]

AOT<sub>865</sub>



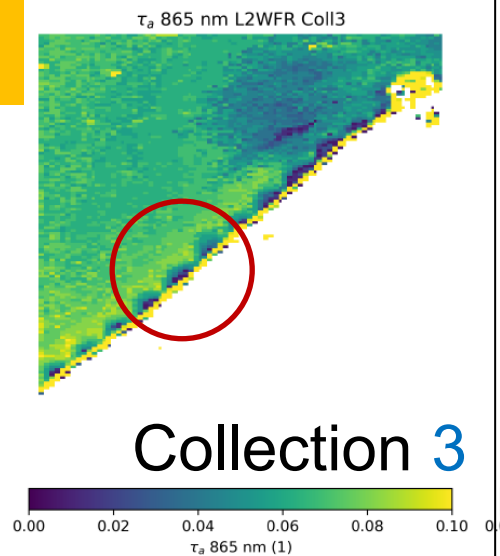
## L1 coastal staircase artefact

R<sub>h</sub>w  
RGB



L1 coastal staircase artefact propagates to L2 products (R<sub>rs</sub>, CHL) [S3VT2023]

AOT<sub>865</sub>

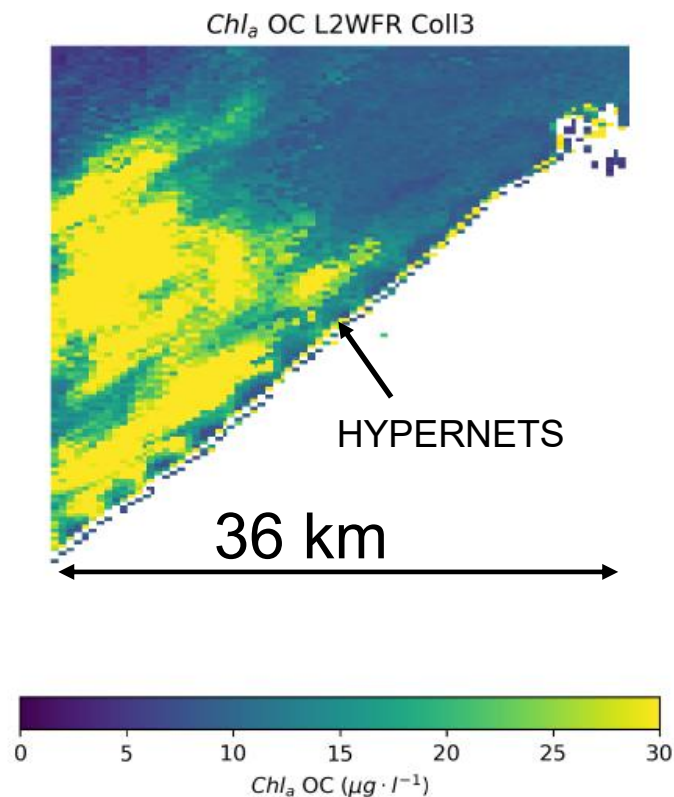


# Huge change in standard CHLa in turbid waters

Example 2020-08-07

Coll4 standard chlor\_a very different from Coll3  
(this diff is not from SVC, A/C, BRDF, etc.)

RBINS does not use this product in BE waters

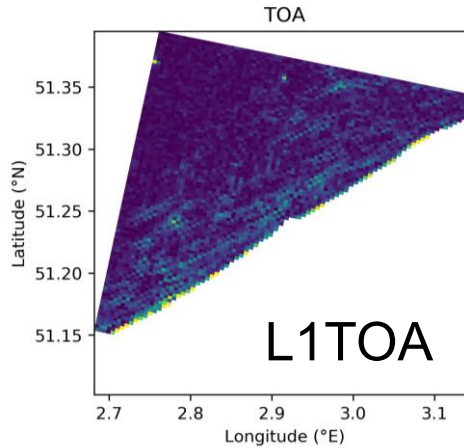


Collection 3

# Noise evaluated by Laplacian operator $\nabla^2$ (sum of x and y horizontal 2nd derivatives)

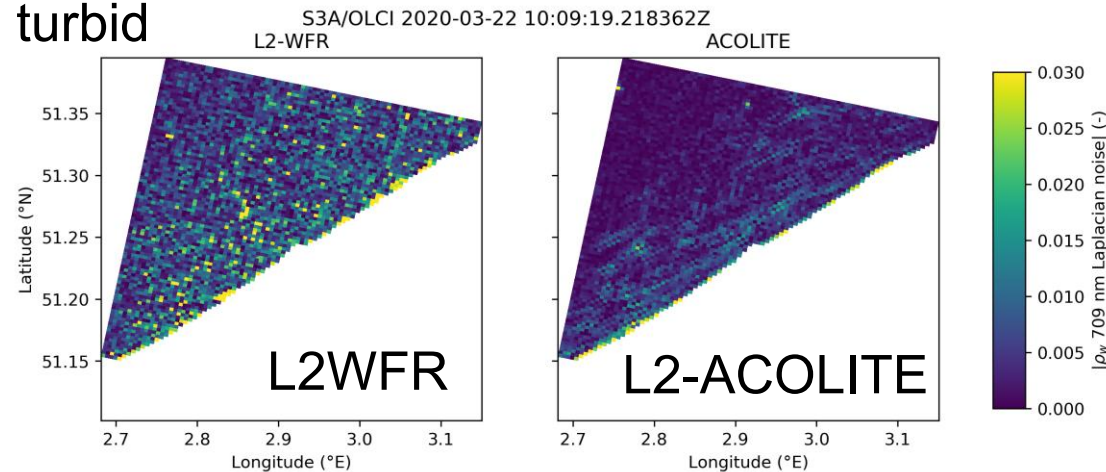
e.g.  
709nm

L2WFR/IPF6.13  
Processing adds lot of  
pixel noise  
(also IPF07.0 but  
only/mainly in turbid  
waters?)



**OLD  
SLIDE**  
(S3VT, Dec2020)

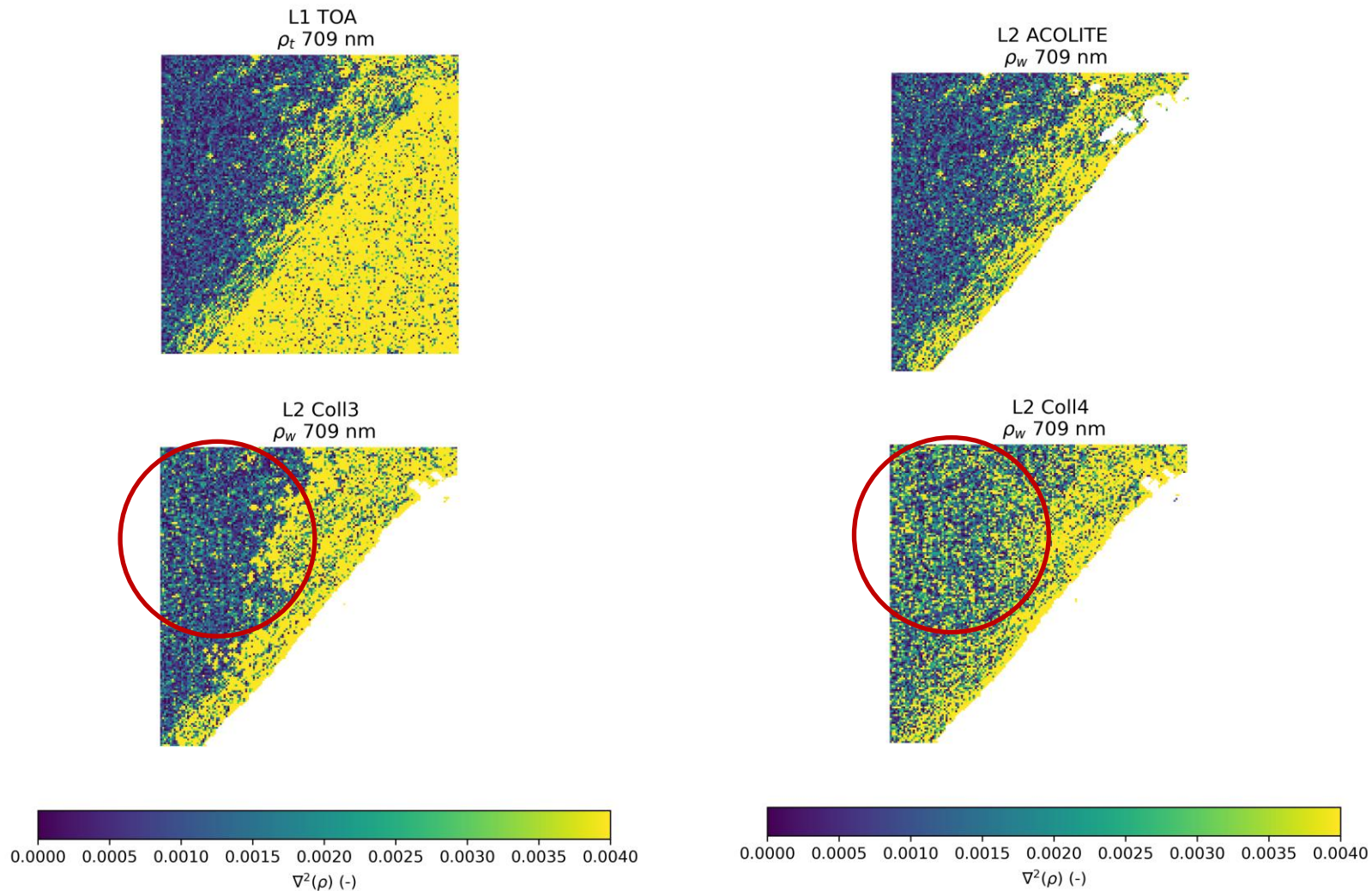
L2ACOLITE Processing  
noise at BOA similar to  
TOA



[Vanhellemont and Ruddick, "Atmospheric correction of Sentinel-3/OLCI data for mapping of Suspended Particulate Matter and Chlorophyll a concentration in Belgian turbid coastal waters, Rem. Sens. Env., 2021  
<https://doi.org/10.1016/j.rse.2021.112284>]

# Laplacian noise (pixel-pixel spatial variability)

[Vanhellemont and Ruddick, 2021, RSE]



# Conclusions (S3VT2026)

- HYPERNETS useful for OLCI validation, esp 400 nm and 754-884 nm
- Very interesting individual image (outliers) Validation Data Sheets
- Oostende site (100s matchups over 5 years):
  - Most ACOLITE\_DSF outliers are thin clouds, scattered clouds, cloud edge, cloud shadow
  - Some turbid water artefacts seen in L2WFR aerosol epsilon [Ruddick et al, 2002; MAVT]
  - L2WFR biased low in turbid waters esp 400-412 nm
  - Bizarre coastal staircase artefact in L1 (most visible in NIR)
  - L2WFR reduces TOA noise at 884 nm BUT amplifies noise at short wavelengths e.g. 490 nm
  - Collection 4 (BE coastal water study):
    - Abovementioned problems persist
    - Reflectance change is mainly from BRDF extrapolation, but has little impact on satellite - in situ difference
    - Standard chlor\_a very different in BE waters from Collection 3
- WATERHYPERNET data distribution:
  - Currently available for 7 sites, 2023-24 (19 295 high quality measurements)
  - Release of 2025 data for 11 sites (~25 000 measurements) in April 2026
  - Register at <https://waterhypernet.org/contact/> for news and updates (just provide email and prove you are not a robot)
  - Looking forward to EUM/THOMAS multi-site validation study ...