

COPERNICUS MARINE 8th GENERAL ASSEMBLY

● MultiRes

Generation of multi-resolution, daily and gap-free ocean colour satellite products for coastal applications

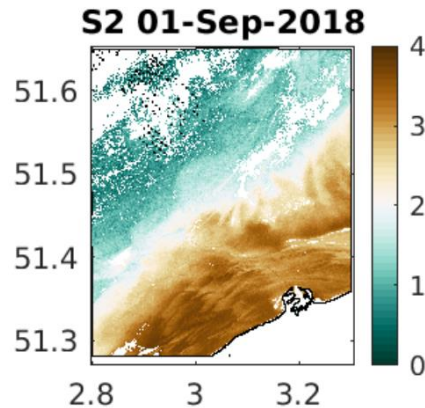
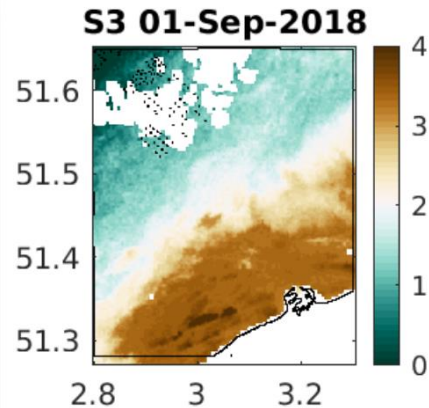
Aida Alvera-Azcárate, Dimitry Van der Zande, Alexander Barth, Joppe Massant, Antoine Dille, Juan Manuel López Contreras, Jean-Marie Beckers

Objectives of MultiRes

Coastal regions need appropriate monitoring datasets, but no single product provides this.

Objective: use Sentinel-2 & Sentinel-3 data streams in synergy → Super-resolution products

→ Data harmonization



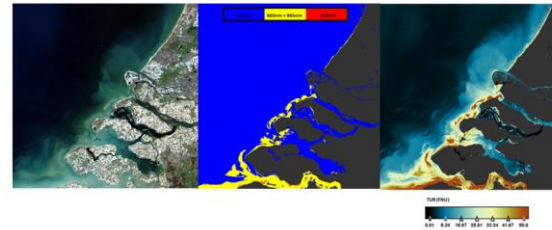
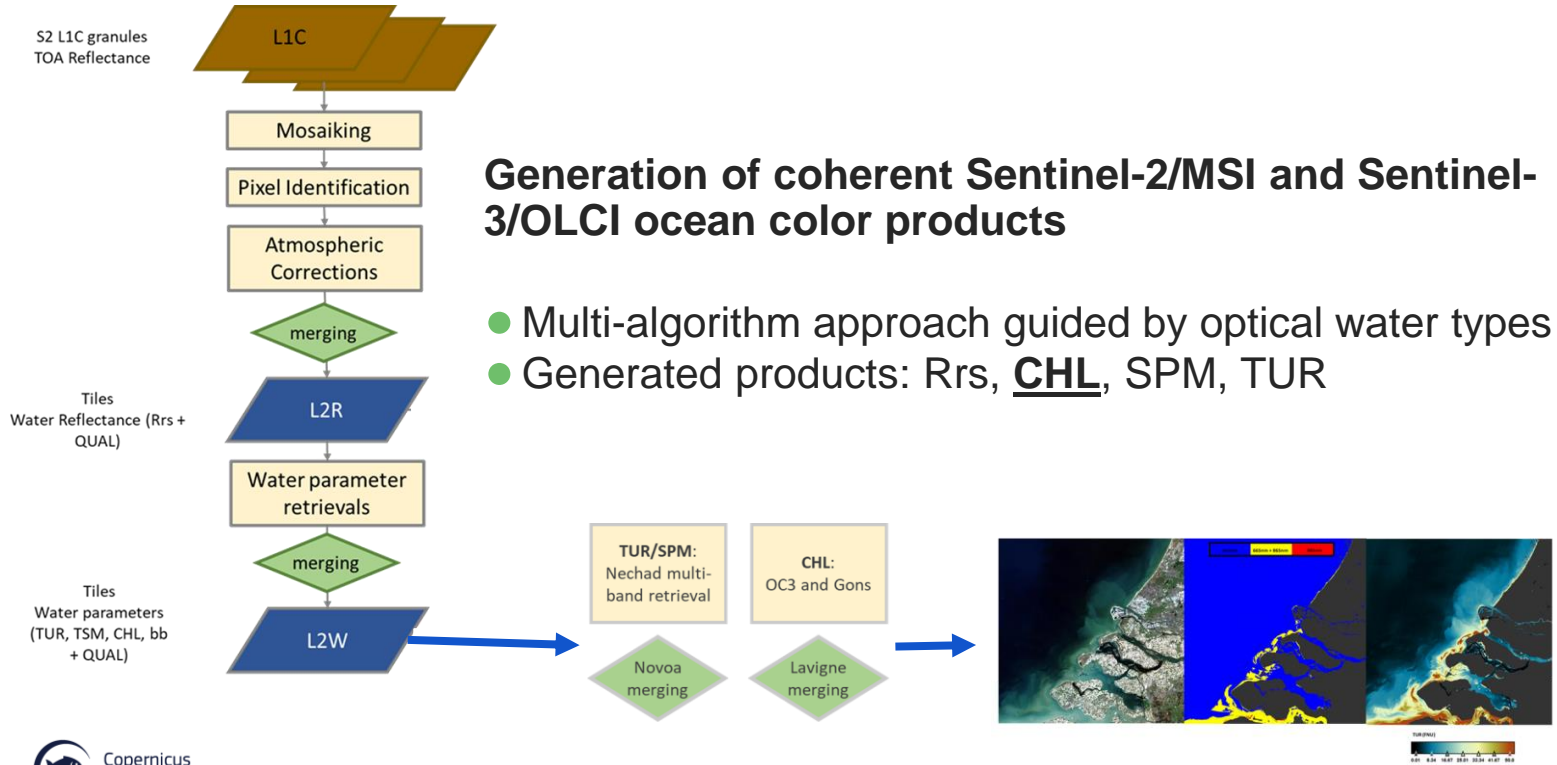


Copernicus
Marine Service

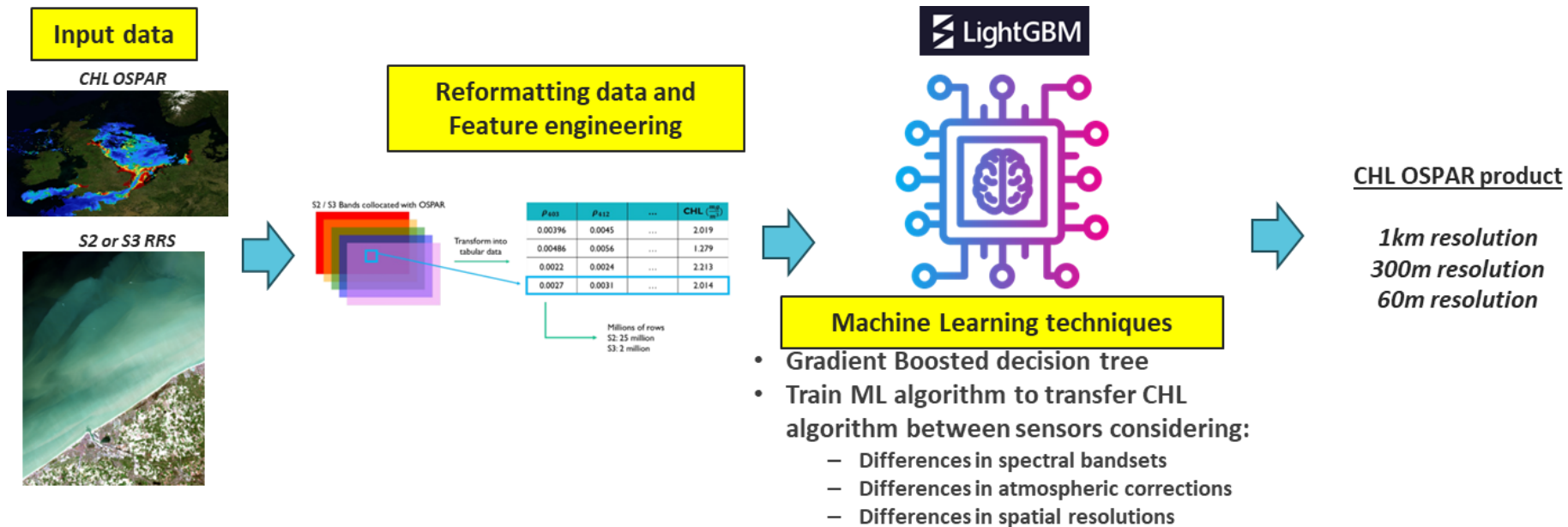


● **Data preparation**

Copernicus Marine High-Res Processing Chain

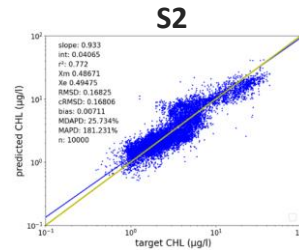
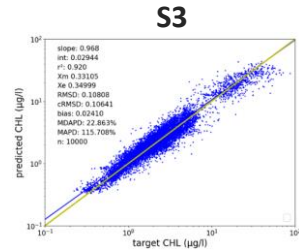
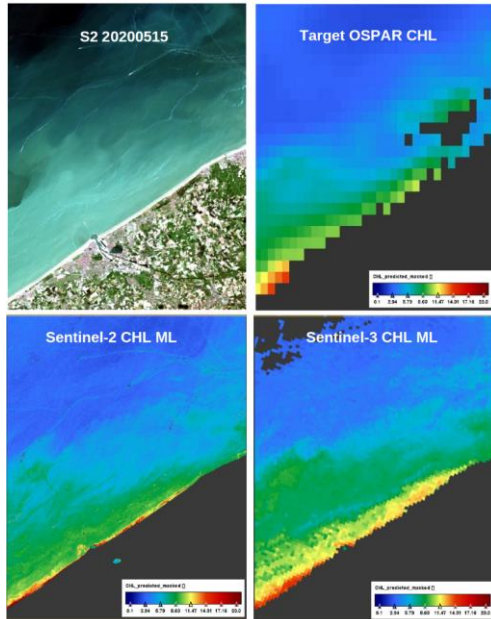


Use of Machine Learning to increase coherency between Sentinel-2 and Sentinel-3 (example for CHL)

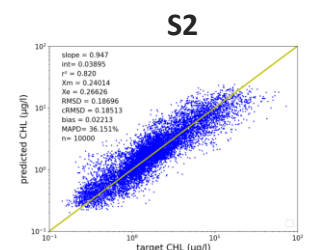
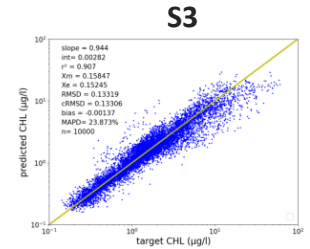
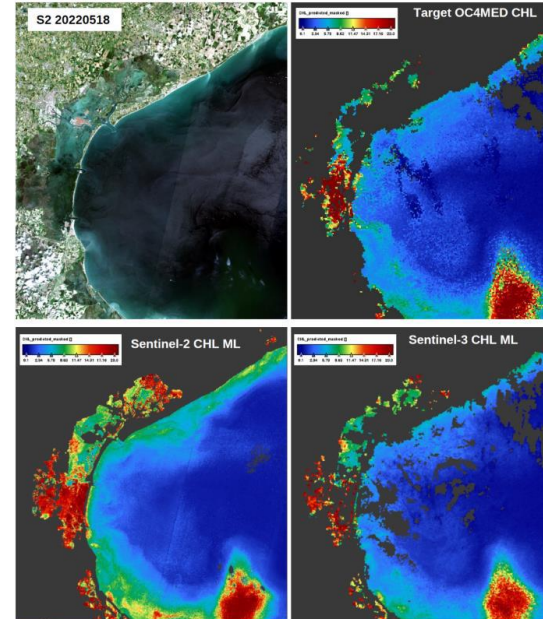


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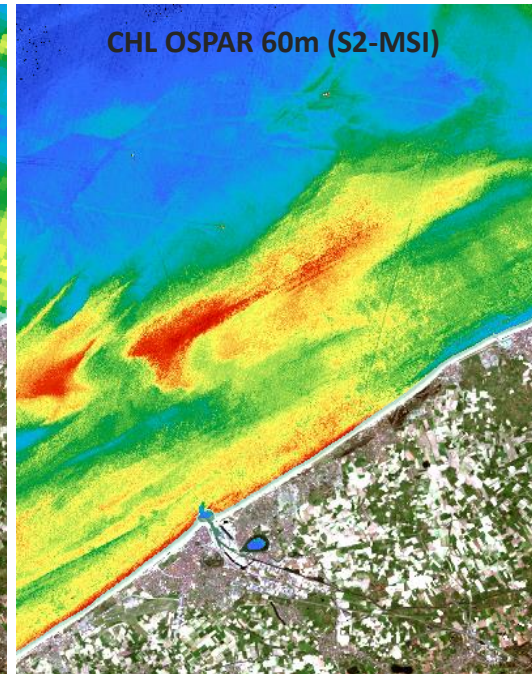
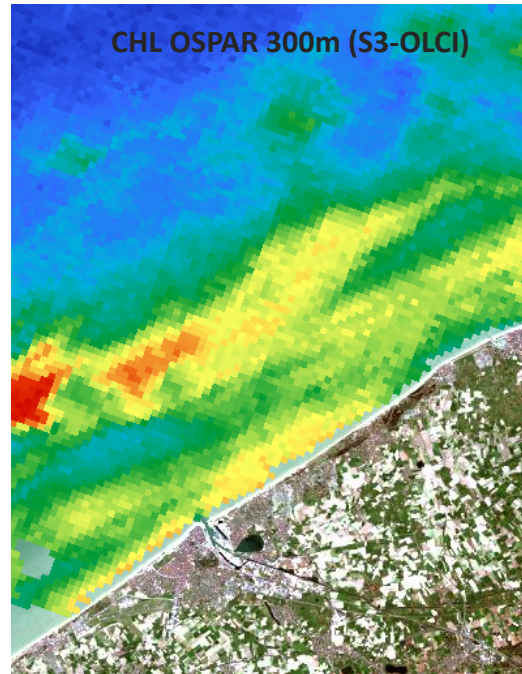
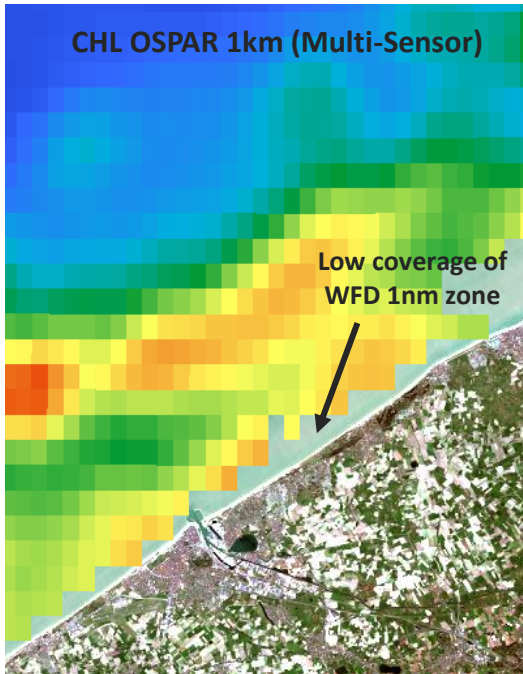
Belgian Coastal Zone



Venice Lagoon

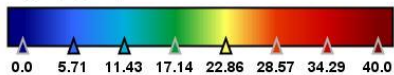


Use of Machine Learning to increase coherency between Sentinel-2 and Sentinel-3 (example for CHL)



Sentinel-2 RGB 20200405 (Oostende, BE)

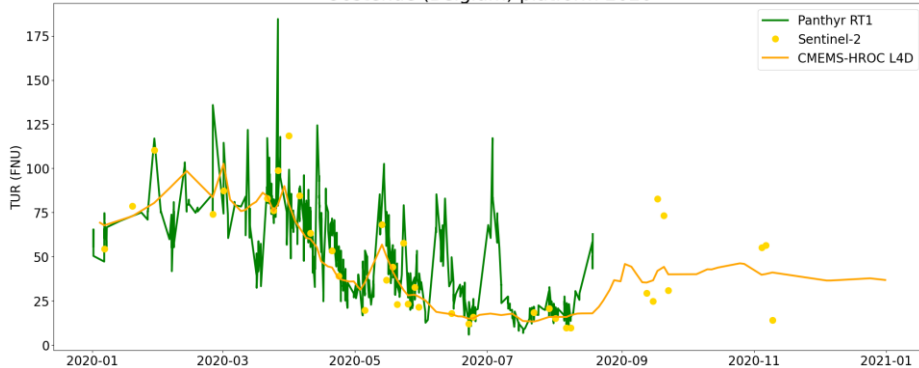
chl_mi [mg m⁻³]





Validation of super-resolution products

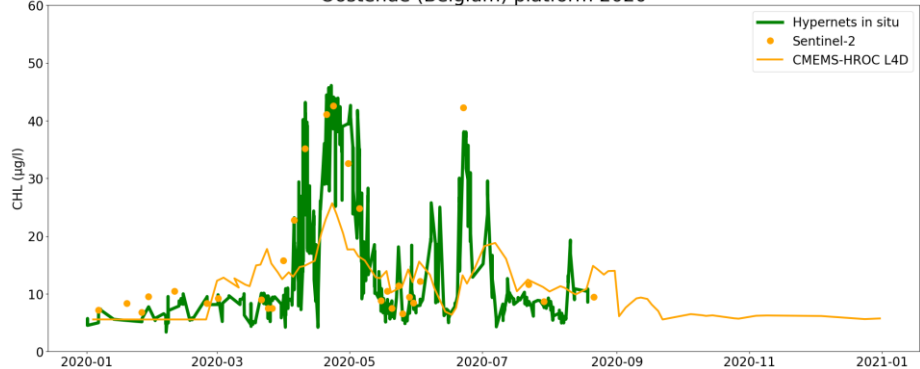
Oostende (Belgium) platform 2020



- The CMEMS L4D HROC product based on S2 only capture the seasonal CHL dynamics (Spring Bloom in April and late summer bloom in July)
- It underestimates the intensity of the blooms due to low temporal coverage

- The CMEMS L4D HROC product based on S2 only capture the seasonal TUR dynamics (↑ winter and ↓ summer)
- By only using S2 data the tidal variability is not described

Oostende (Belgium) platform 2020





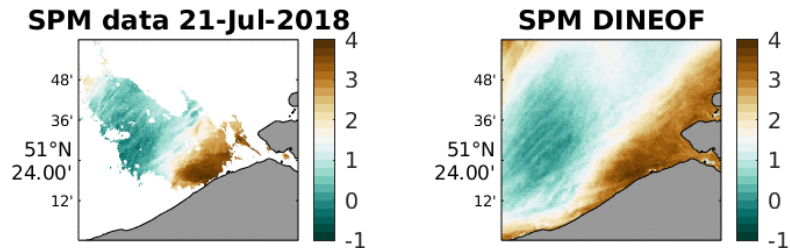
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- **Super-resolution data**

DINEOF

Technique to **fill in missing data** in geophysical data sets, based on a EOF decomposition

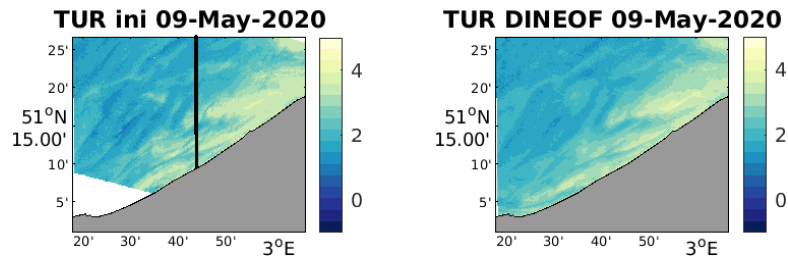
- **Truncated EOF basis** to calculate missing data (iterative method)
EOFs extract main patterns of variability
Reduced noise
- Optimal number of EOFs?: reconstruction error by cross-validation
- Uses EOF basis to infer missing data: **non-parametric**
- No need of a priori information (correlation length, covariance function...)
- Spatio-temporal coherence exploited to calculate missing values



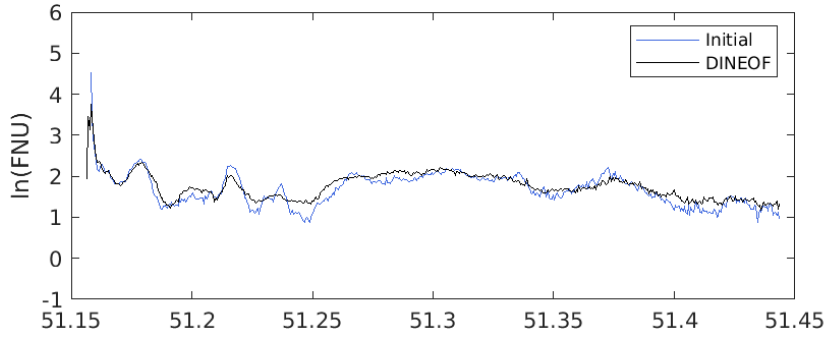
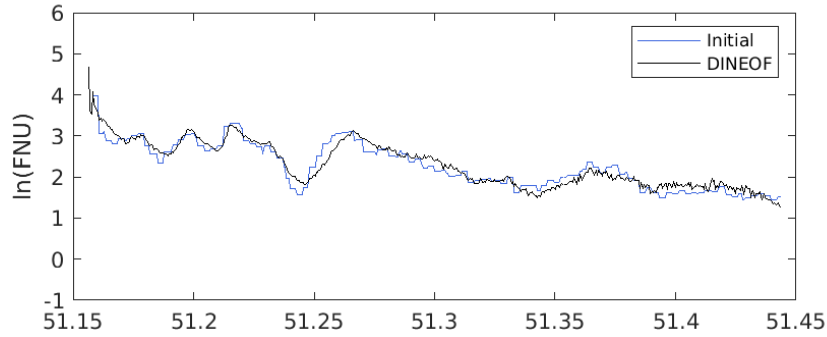
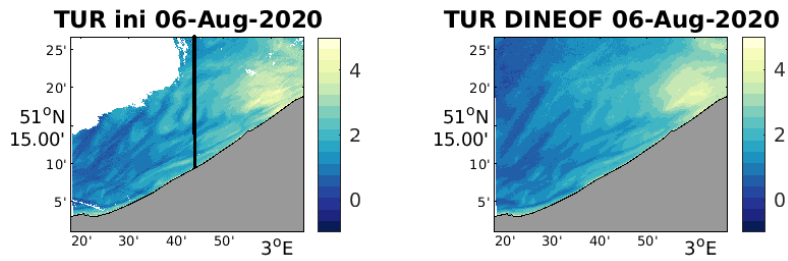
MultiRes -> Merge Sentinel-2 & Sentinel-3 using DINEOF

Results

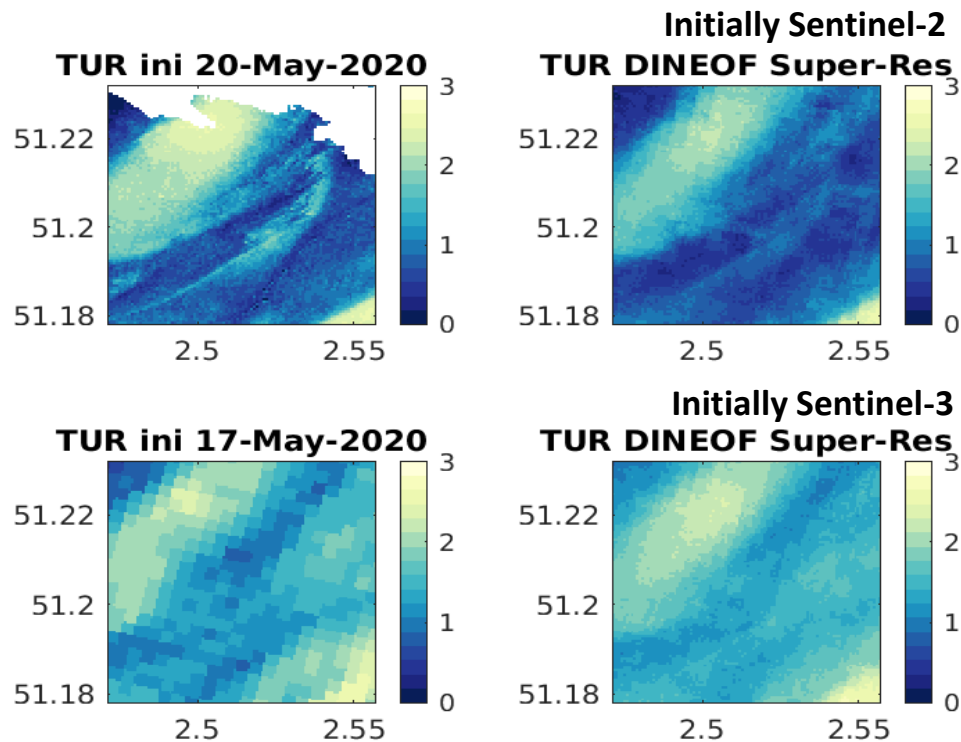
Initially Sentinel-2



Initially Sentinel-3

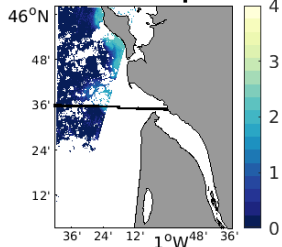


Super-resolution data

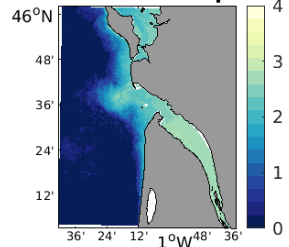


Study sites

CHL ini 08-Sep-2022

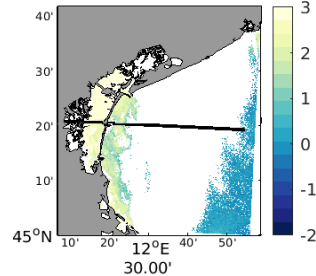


CHL DINEOF 08-Sep-2022



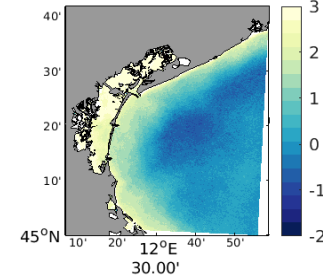
Gironde

TUR ini 15-Mar-2021



Venice

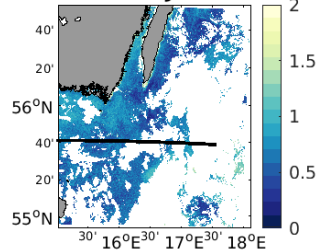
TUR DINEOF 15-Mar-2021



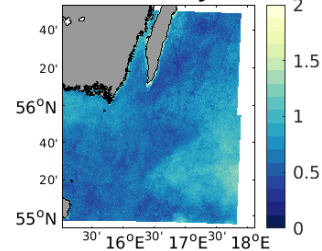
Baltic Sea

Oostende

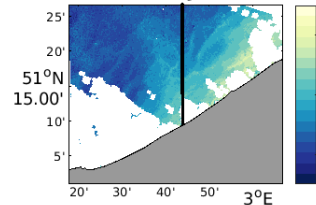
CHL ini 08-Jun-2021



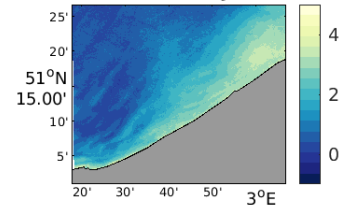
CHL DINEOF 08-Jun-2021



TUR ini 16-Jun-2020



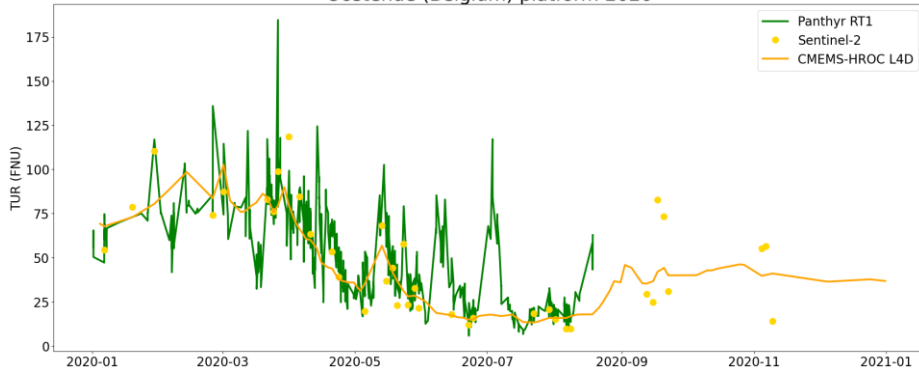
TUR DINEOF 16-Jun-2020





Validation of super-resolution products

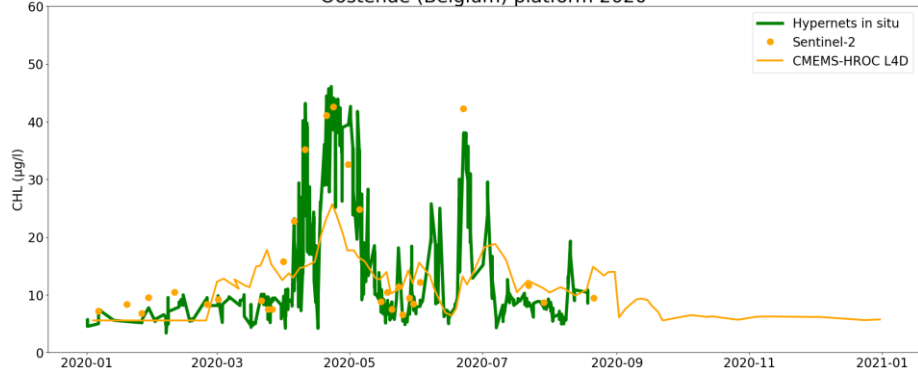
Oostende (Belgium) platform 2020



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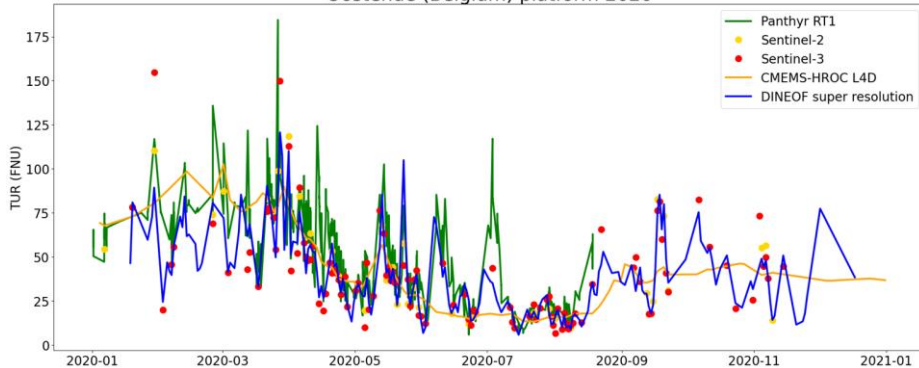
Oostende (Belgium) platform 2020





Validation of super-resolution products

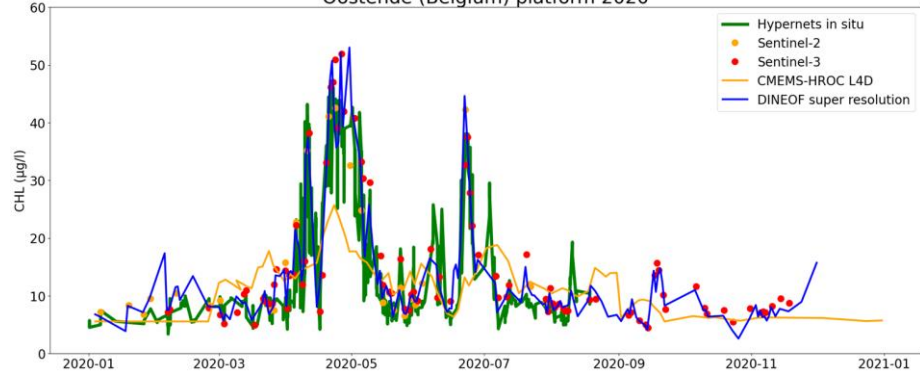
Oostende (Belgium) platform 2020



- The seasonal phytoplankton bloom dynamics are captured more correctly in terms of its timing and intensity by the DINEOF super-resolution products by incorporating the daily and coherent S3 products

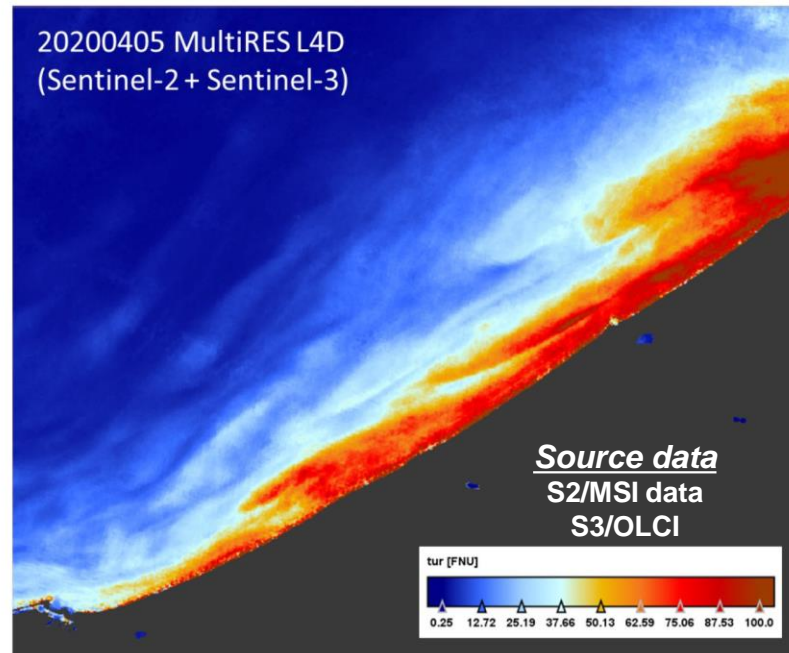
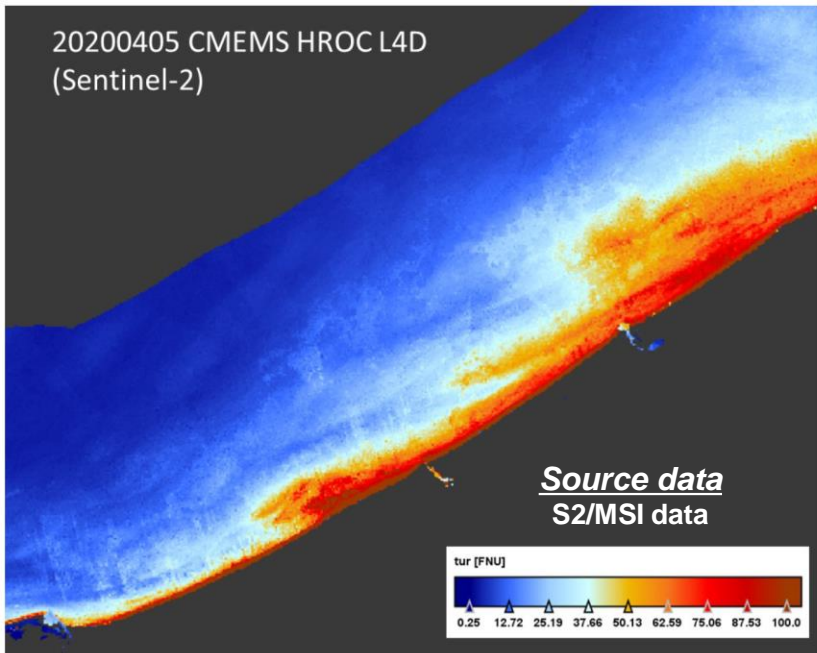
- The tidal TUR variability is captured by the DINEOF super-resolution product by incorporating the daily S3 TUR products

Oostende (Belgium) platform 2020



● Improvement of Copernicus Marine HROC L4D products

Gap filled TUR products for 20200405 for the Belgian Coastal Zone region



Conclusions

- Data processing chain provides high quality datasets with a large degree of complementarity
- DINEOF can provide super-resolution products for monitoring coastal waters

Van der Zande et al., Improving operational ocean color coverage using a merged atmospheric correction approach. Proc. SPIE 12728, Remote Sensing of the Ocean, Sea Ice, Coastal Waters, and Large Water Regions 2023.

Alvera-Azcárate, A., Van der Zande, D., Barth, A., Dille, A., Massant, J., and Beckers, J.-M.: Generation of super-resolution gap-free ocean colour satellite products using DINEOF, EGUsphere [preprint], <https://doi.org/10.5194/egusphere-2024-1268>, 2024.