VALIDATION OF OLCI SUSPENDED PARTICULATE MATTER CONCENTRATION PRODUCT AND VARIABILITY OF EUROPEAN COASTAL WATERS QUALITY

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Objectives and study area

Region of interest

European coastal waters: monitoring of the coastal water quality mandatory in the frame of the EU « Marine Strategy »

Objectives

- **Estimation of SPM** over diverse water types
- **Validation of estimated SPM** using an extensive in-situ dataset
- Characterization of the **European coastal waters SPM spatio-temporal variability**

Data

Satellite data

Sentinel-3/OLCI Remote Sensing Reflectance (Rrs) at 300 m resolution coastal product from **CMEMS** (Copernicus Marine Service) : daily Rrs fields from April 2016 to March 2023. L2 OLCI data from EUMETSAT used as an upstream product.

Copernicus Marine Service

In-situ data

GLORIA dataset [1]: compilation of 7572 hyperspectral Rrs measurements, co-located with at least one water quality parameter measurement (SPM, Chla …), in coastal and inland waters all over the world

Validation

SPM model validation

- **478 quality controlled data points**
- Comparison with Nechad10 [4]
- Good performance of Han16 [2]
- **Great Dynamic range** : retrieval of SPM concentrations < 2 $g.m^{-3}$

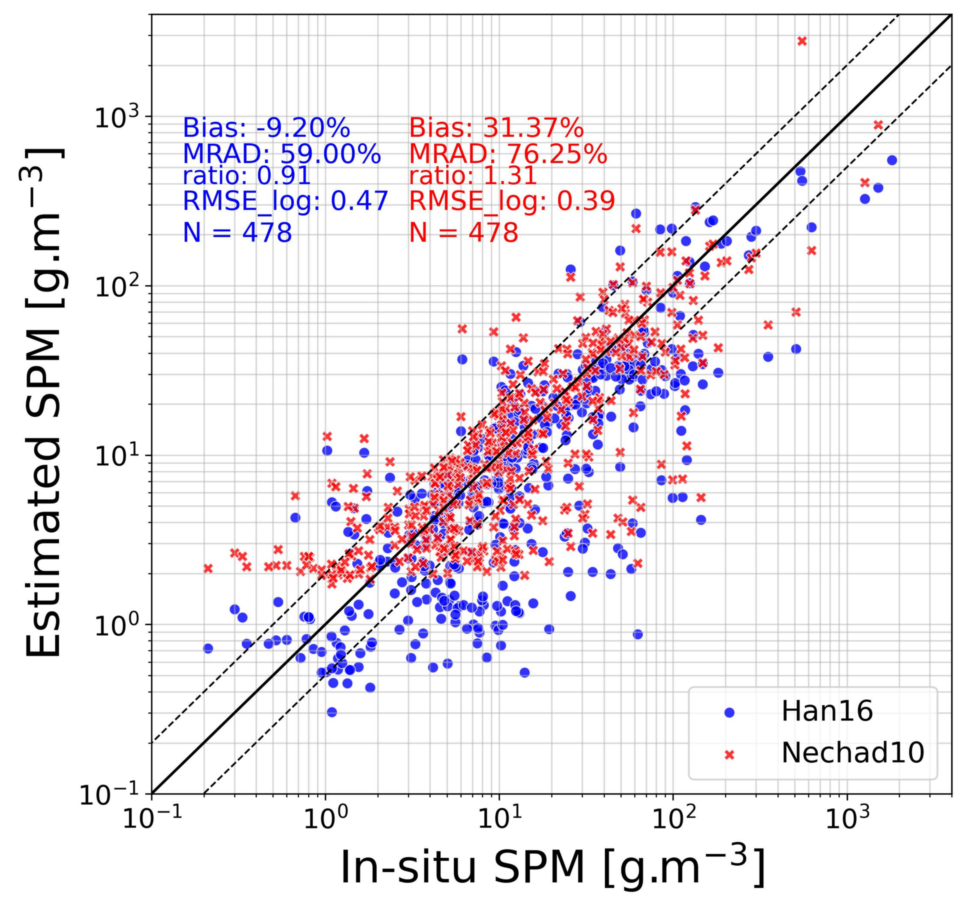

Figure 1 : Comparison of measured SPM, and estimated SPM from in-situ Rrs with methods from [2] (blue) and [4] (red)

Matchup of Rrs and SPM

Matchup method: at least 5 valid pixels in the 3x3 window, variation coefficient within the window < 30 %, time difference < 3 h

- **19 matchups** with OLCI in European coastal waters
- **Rrs at 665 nm well estimated**
- Retrieval of **SPM inaccurate** (possible quality issues with SPM measurements)

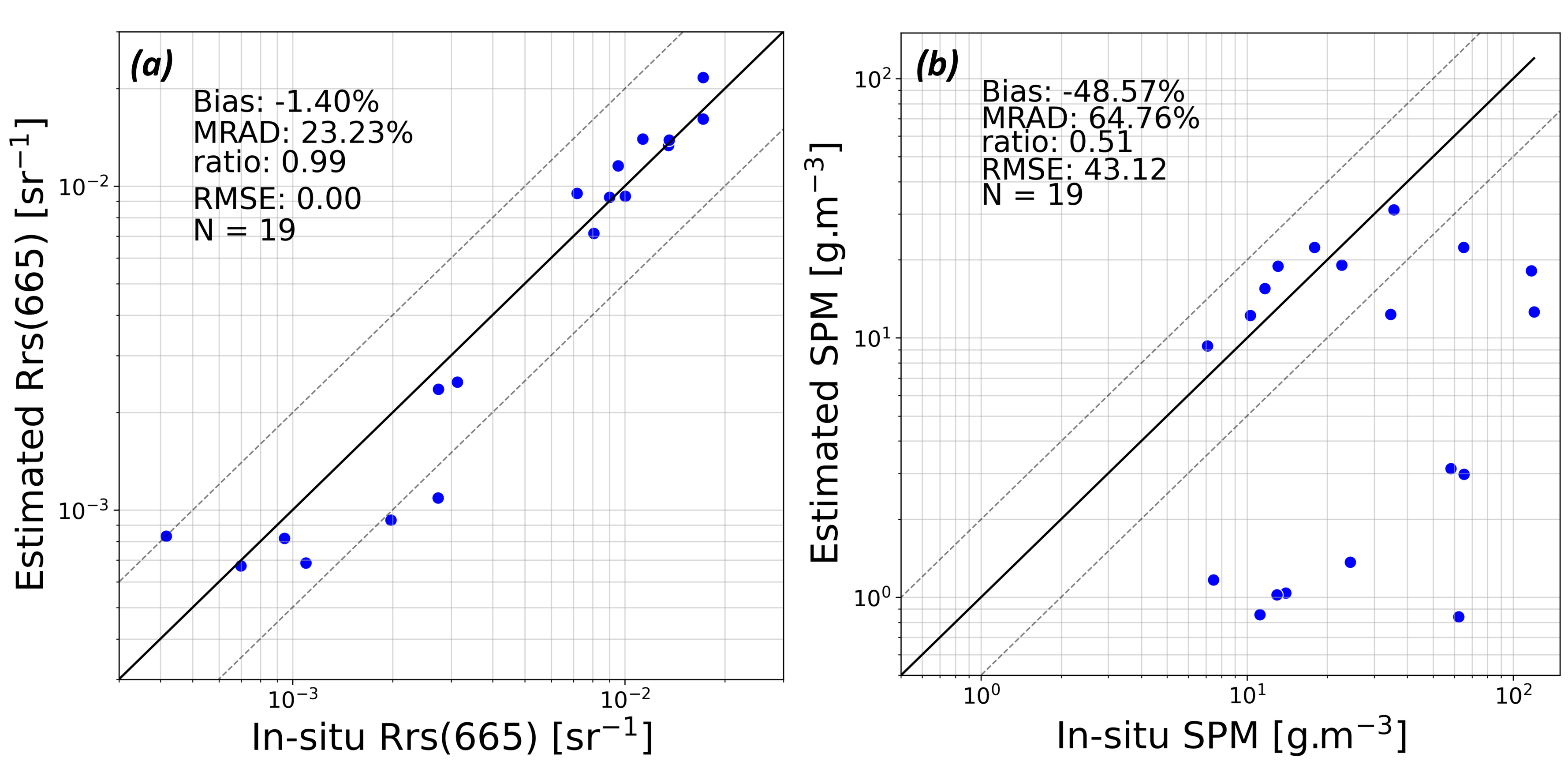

*Figure 2 : Matchup comparison of Rrs(665) **(a)** and SPM **(b)** estimated from OLCI and measured and compiled in GLORIA*

Conclusions and perspectives

Conclusions

- SPM model presents a **great dynamic range** and is **suited for a large scale study**
- SPM variance dependence to seasonal and trend variances changes spatially
- **Significant rate of change in SPM** detected in Europe over the OLCI period

Perspectives

- **Comparison of SPM OLCI time series** with other periods (GlobCoast, OC-CCI, GlobColour)
- Investigation of the **environmental and anthropogenic forcings** driving SPM trends
- Study of **other bio-optical parameters** over the same period of time (Chla and Kd)
- Investigation of **Chinese coastal** waters quality using **Haiyang 1-C**

Methods

SPM inversion model

SPM concentration is estimated from **semi-analytical** SPM model in [2]. It is tuned for Low (L) and High (H) turbidity conditions, allowing a **large dynamic range**

$$SPM_{L/H} = A^{\rho}{}_{L/H} + \rho_w(\lambda_0)/(1-\rho_w(665)/C^{\rho}{}_{L/H}) + B^{\rho}{}_{L/H} \qquad SPM = \frac{W_L.SPM_L + W_H.SPM_H}{W_L + W_H}$$

$W_{L/H}$: weights

Time series decomposition

X(t) = S(t) + T(t) + I(t)

Census X-11 [3]: based on an iterative bandpass filter algorithm. It decomposes a time series in a seasonal, a trend, and an irregular term. Monotonic changes in SPM time series are detected through a seasonal Kendall test and a Sen slope estimator

SPM variability in European coastal waters

- **Seasonal term variance** dominates the SPM variance signal in the **North Sea**, and in the **south of the Baltic Sea**
- **Trend variance** contributes significantly to the SPM variance in the **English Channel and in the North of the Baltic Sea**
- The Irregular term contribution needs to be compared with those results

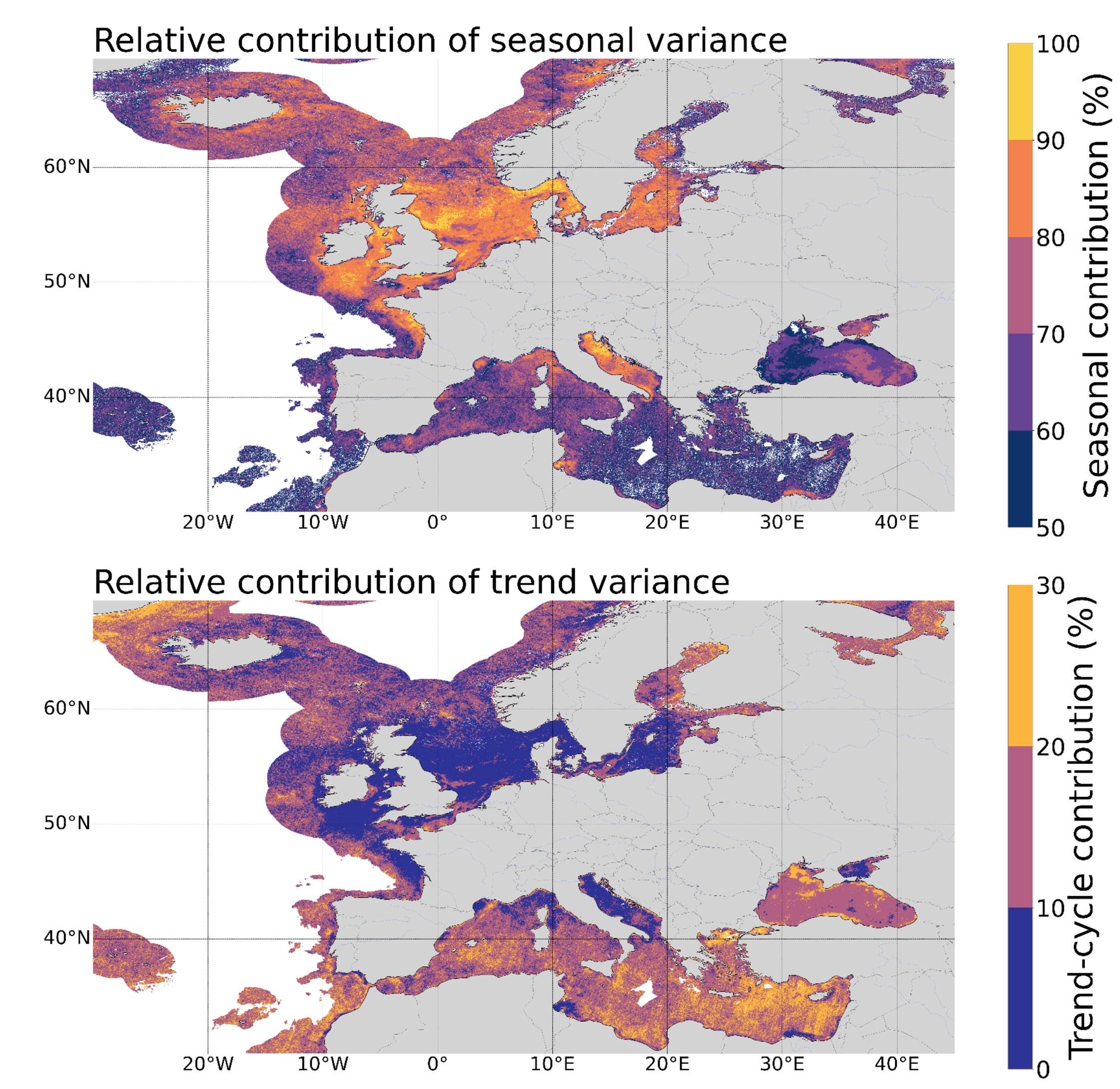

Figure 3 : Relative contribution of seasonal and trend variances to total SPM variance

- **SPM decreased significantly** in the **English Channel** over the OLCI period
- **SPM increased** in the **North Sea**, in the **North of the Baltic Sea**, and in the **Black Sea**
- Monotonic changes in SPM over time could be linked to **environmental** (winds, climate indices …) and **anthropogenic** (dam construction, increasing port activities …) **forcings**

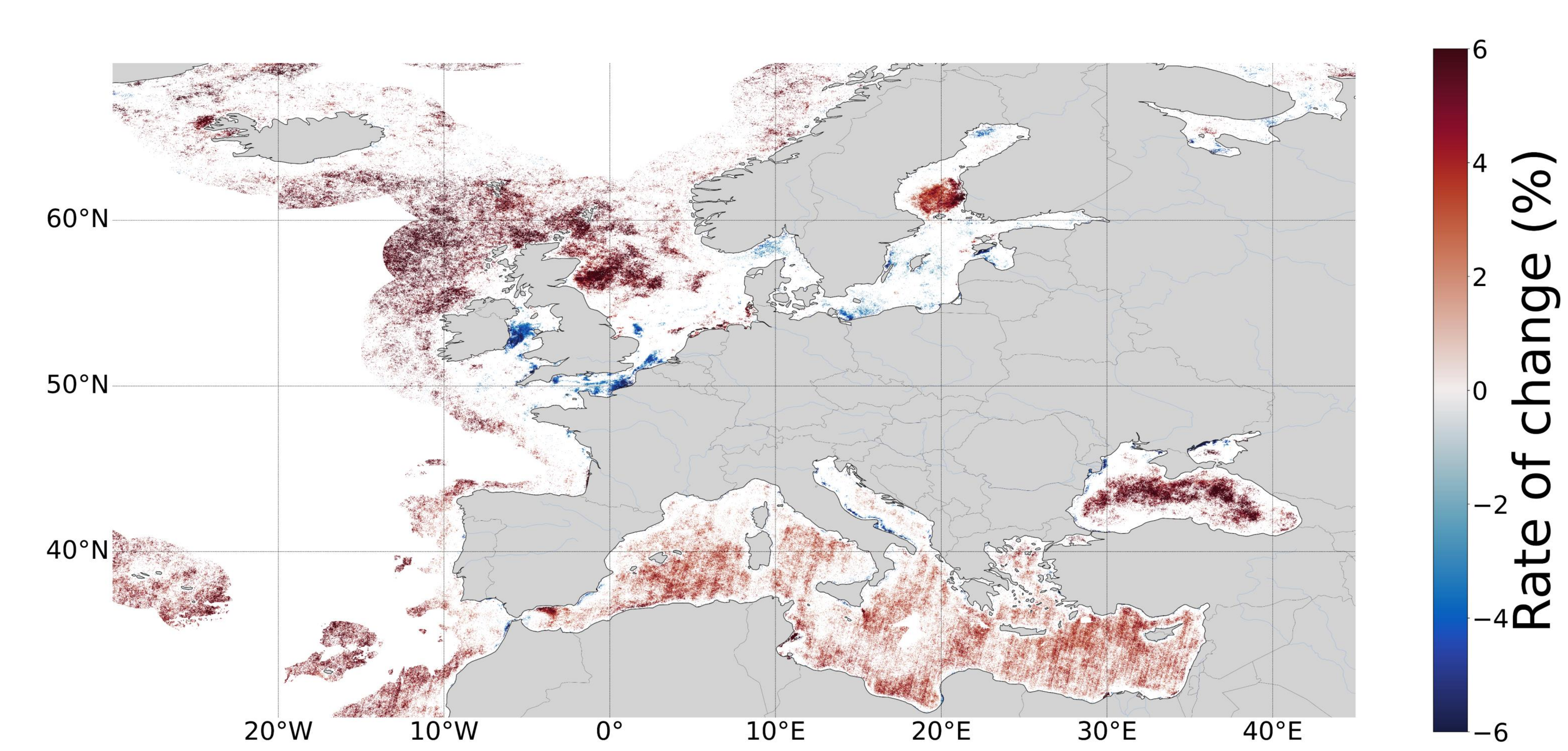

Figure 4 : Significant (p < 0.05) rate of change of SPM (%/year)

References :
[1] Lehmann et al., Scientific Data, 2023
[2] Han et al., Remote Sensing., 2016
[3] Vantrepotte and Melin, Deep Sea Research, 2011
[4] Nechad et al., Remote Sensing of Environment, 2010

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