

# Variability of temperature and chlorophyll in the Sado Estuary: integration of *in situ* observations and satellite data

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## Introduction and Objectives

Studying estuaries can present numerous challenges.

Estuaries are subjected to:

- anthropogenic pressure
- strong interactions with the atmosphere
- daily mixing of fresh water with salt-water

Promotes a constant variation of the estuarine physicochemical and biological parameters.

Solutions? Integrate *in situ* observations with satellite data

Study the Sado estuary as to its temperature and chlorophyll-*a* variability integrating *in situ* observations with satellite data, allowing an extended temporal and spatial analysis.

## Data and Methodology

### In Situ Observations

May 2018 – September 2019

#### Temperature

- CTD - stns. #6, #7 and #8;
- EXO2 Multiparameter Sonde - 8 stns.;
- Doppler Current Sensor - stns. #6, #7 and #8.

#### Chlorophyll-*a*

- Water samples collection for HPLC quantification.

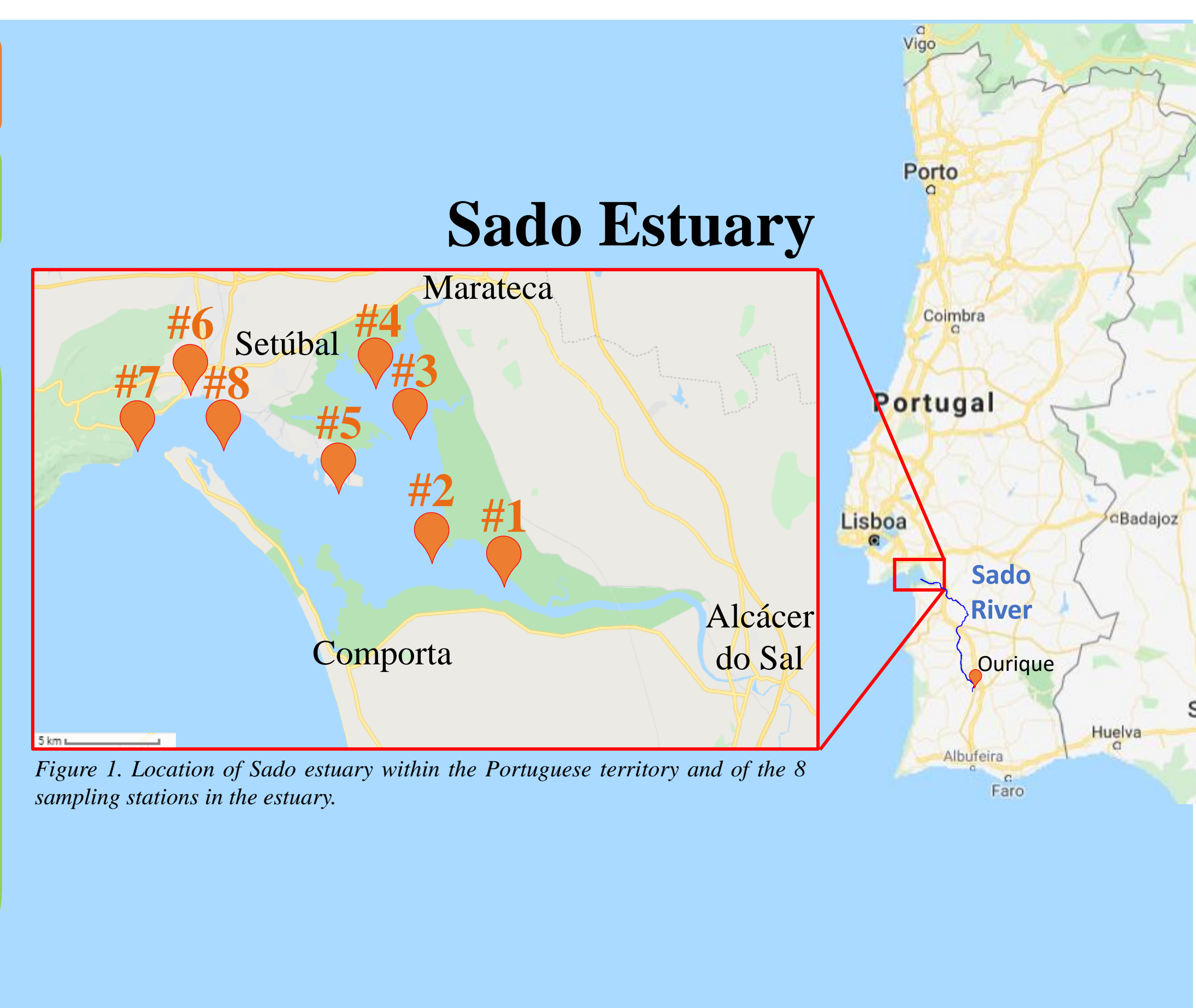
### Satellite data

#### Sea Surface Temperature

- Group for High Resolution Sea Surface Temperature (GHRSSST):
- Version 4.1 of the Multiscale Ultrahigh Resolution (MUR);
  - 1 km spatial resolution;
  - 1 day temporal resolution;
  - Data set: 01JU2002–30SEP 2019;
  - 8 sampling stns.

#### Chlorophyll-*a*

- OLCI – Sentinel-3**
- 300 m spatial resolution;
  - 2/3 days temporal resolution;
  - Neural Net algorithm (NN);
  - Data set: 2018 and days of *in situ* campaigns;
  - 8 sampling stns.
- MERIS - ENVISAT**
- 300 m spatial resolution;
  - 3 days temporal resolution
  - OC5 algorithm (Gohin *et al.*, 2002)
  - Data set: 2002-2012
  - 8 sampling stns.



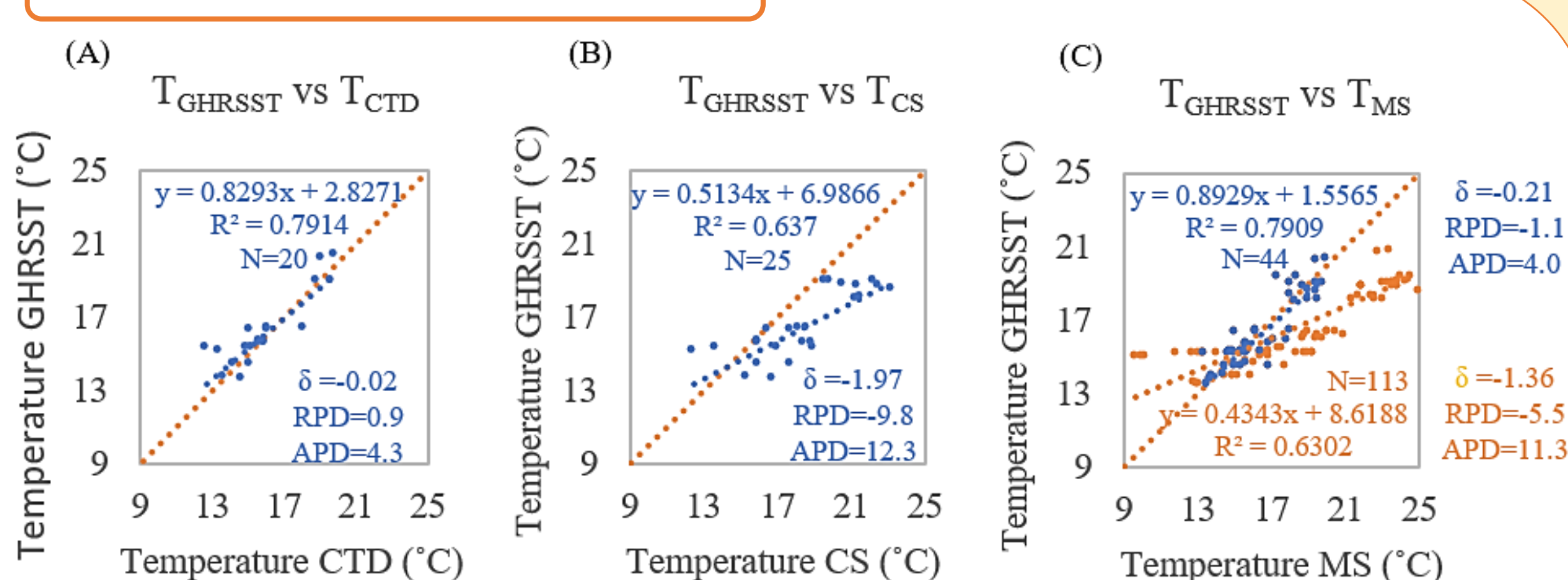
## Results

### Sea Surface Temperature

#### In Situ CTD Observations

- Clear seasonal behavior: Summer -  $\approx 19.0^\circ\text{C}$ ; Winter -  $\approx 13.8^\circ\text{C}$ .
- Water column well mixed, no relevant variations with the tidal cycle.

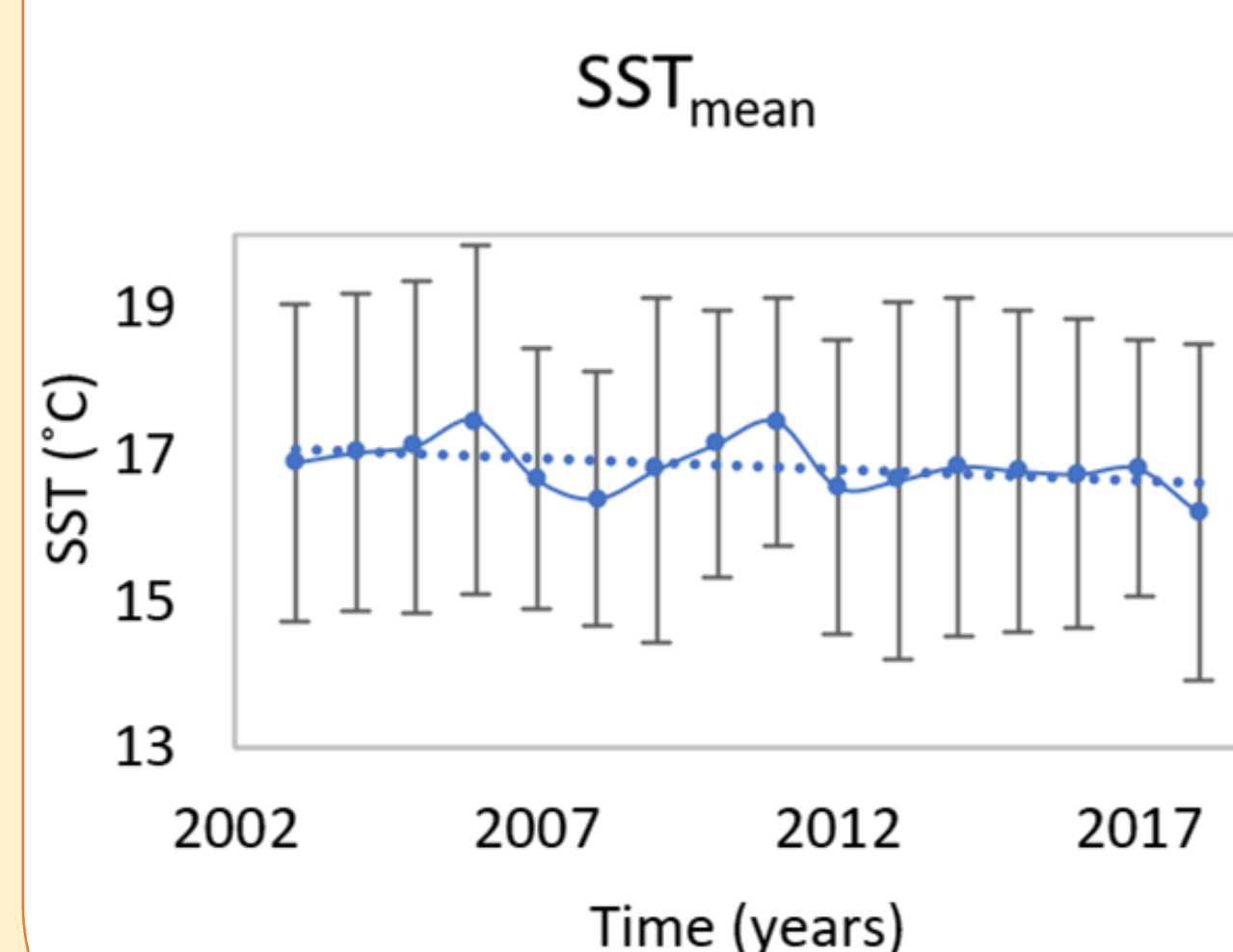
#### In Situ vs Satellite-derived SST



- Best correlations: satellite-derived SST data with the CTD data ( $R^2=0.7914$ ) and the MS data ( $R^2=0.7909$ ), for stns. #6, #7 and #8 (in blue in Figure 2).

#### Satellite-derived SST

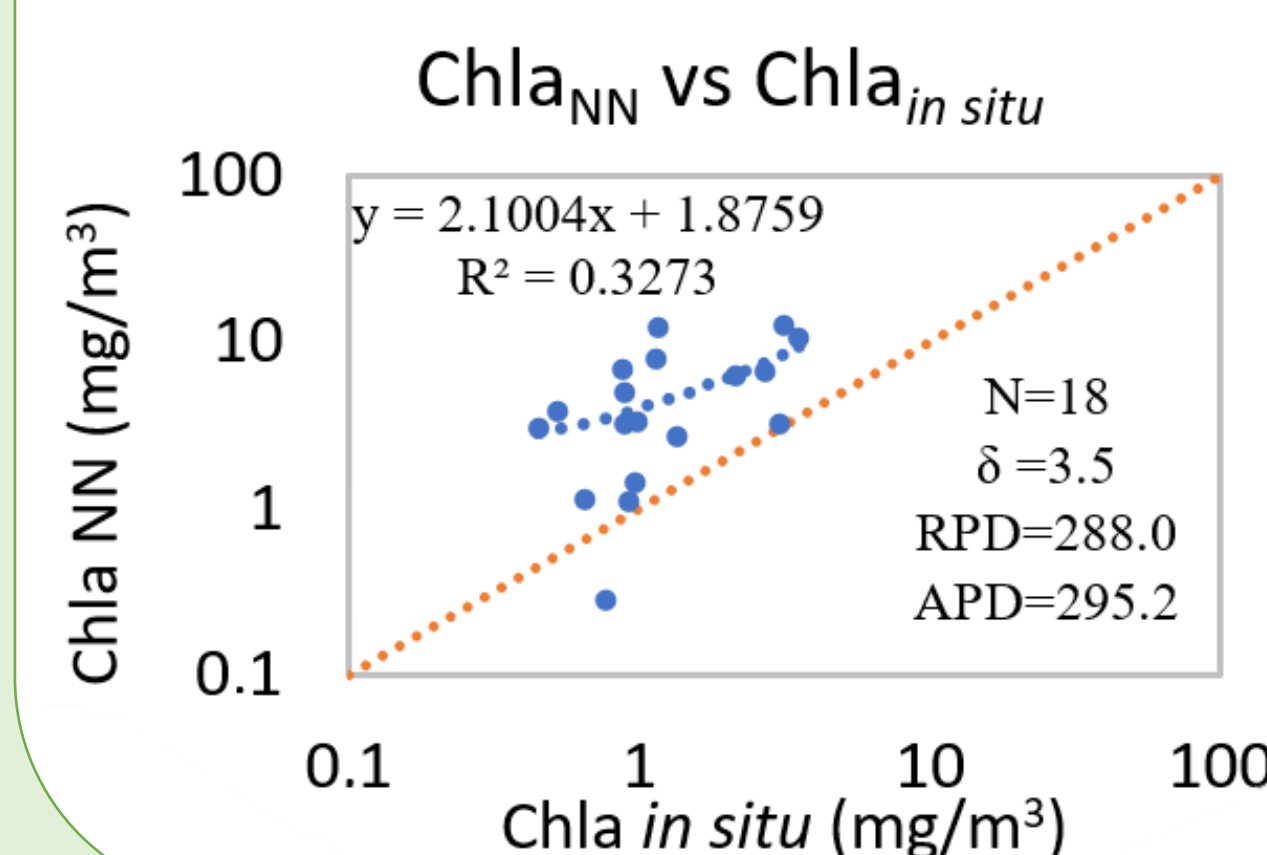
- GHRSSST 2003-2018:
- Average of the estuary:  $\approx 17.0^\circ\text{C}$ .
  - Higher values: 2006, 2010 and 2011.
  - Lower values: 2008 and 2012



### Chlorophyll-*a*

#### In Situ vs Satellite-derived Chla

- Low relationship ( $R^2=0.3274$ ) between the two datasets (Figure 4).
- Overestimation of the concentrations derived from the satellite.



- Relation between the satellite-derived Chla and *in situ* SPM was observed (data not shown).

#### OLCI 2018:

- higher Chla values in spring and in the inner channels.

#### MERIS 2002-2012:

- no reliable results - different from previous studies and from the seasonal analysis made with OLCI data.

#### Satellite-derived Chla

## Conclusions

- The outermost area of the estuary is spatially homogeneous based on temperature data. The estuary is spatially heterogeneous as to its chlorophyll-*a* concentration.
- The GHRSSST dataset seems to be acceptable for a thorough temporal analysis of the temperature distribution in the estuary, especially in its outermost part.
- On the other hand, the quantification of chlorophyll-*a* in shallow and coastal waters using satellite remote sensing is still a challenge.
- However, the seasonal analysis made with OLCI showed an improvement in the quality and accuracy of the data when compared with MERIS.
- No relation was found between the temperature and the chlorophyll-*a* variability in the past years.

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