CERTO
Copernicus Evolution – Research for harmonised and Transitional water Observation

Atmospheric correction in the CERTO project

Water Quality Continuum Atmospheric Correction Workshop
20/10/2022

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This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 870349.

Image courtesy of NERC Airborne Research Facility

Introduction: the CERTO project

Copernicus Evolution: Research for harmonised Transitional water Observation

- Study and develop harmonized water quality products in transitional waters
- Develop a prototype system designed to be applicable across Copernicus services (Copernicus Marine, Copernicus Climate Change, and Copernicus Land)
- Focus on six case study sites across Europe →
- Main components of the project:
  - In-situ data gathering
  - Water optical classification
  - Atmospheric correction study and improvement
  - Develop indicators that are useful to end-users and stakeholders
  - Demonstration to end users
- https://certo-project.org/

Venice lagoon, Italy

Razelm-Sinoe Lagoon, Romania

Tamar Estuary, UK

Curonian lagoon, Russia/Lithuania

Elbe Estuary, Germany

Tagus Estuary, Portugal

The CERTO case study sites

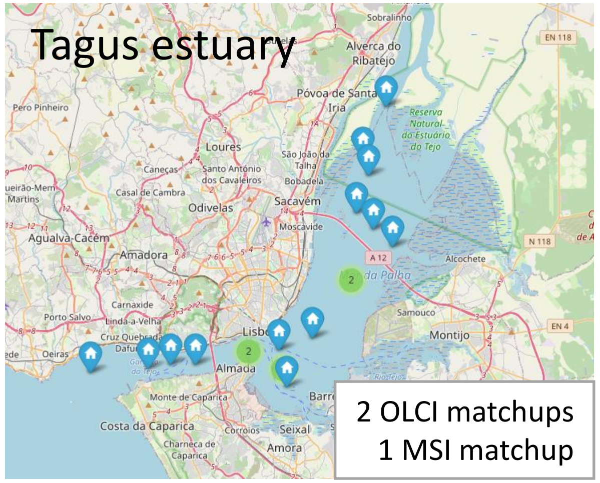
The Atmospheric Correction WP in CERTO: overview

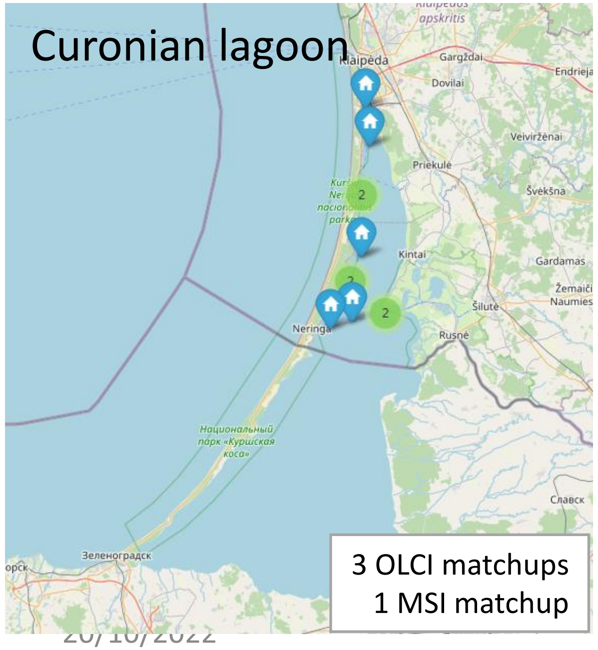
<u>Objective</u>: evaluate and optimize atmospheric correction in transitional waters, in view of harmonizing the methods from inland to coastal waters (Use of Sentinel-2 MSI and Sentinel-3 OLCI data)

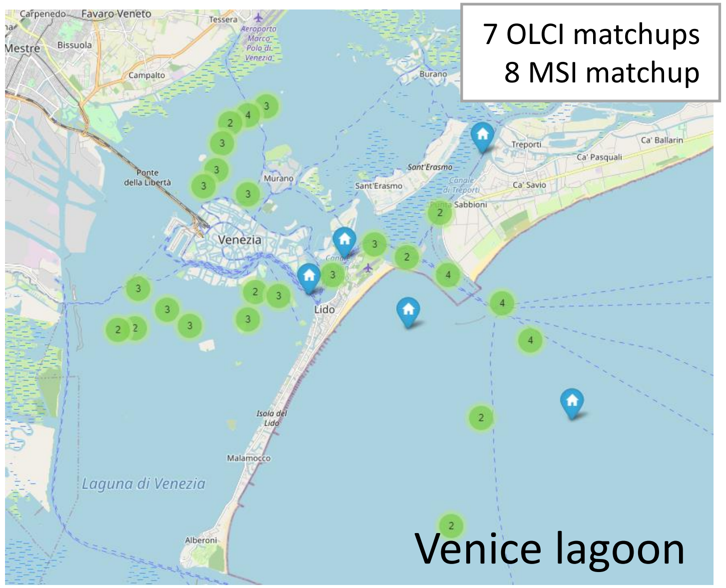
- Evaluation of various atmospheric correction schemes in transitional waters ; selection for prototype development
- Improving atmospheric correction
    - Bathymetry effect detection and correction
    - Improve adjacency effect correction
    - Focus on Polymer improvements

  → Involve radiative transfer simulations and in-situ data

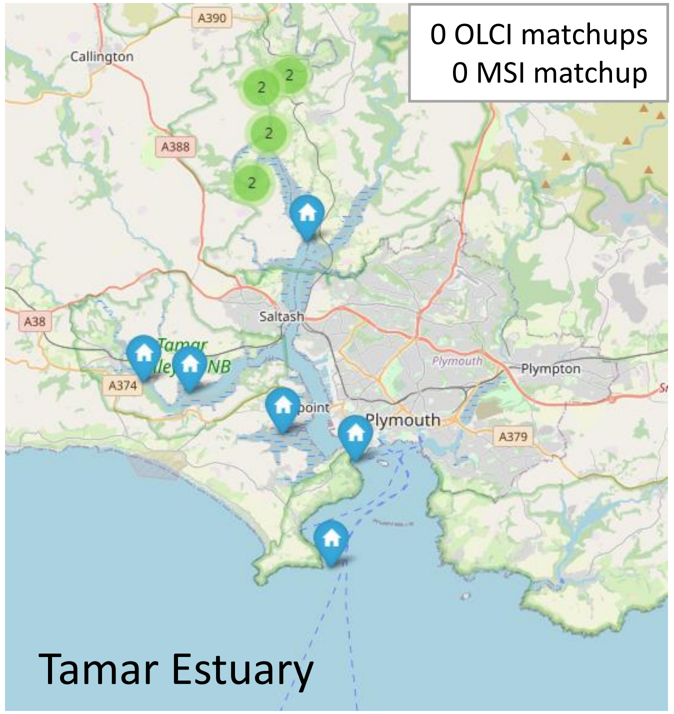
In-situ data from CERTO campaigns







+ matchups from the Solar tracking radiometry platform being integrated (automated So-Rad data, PML)

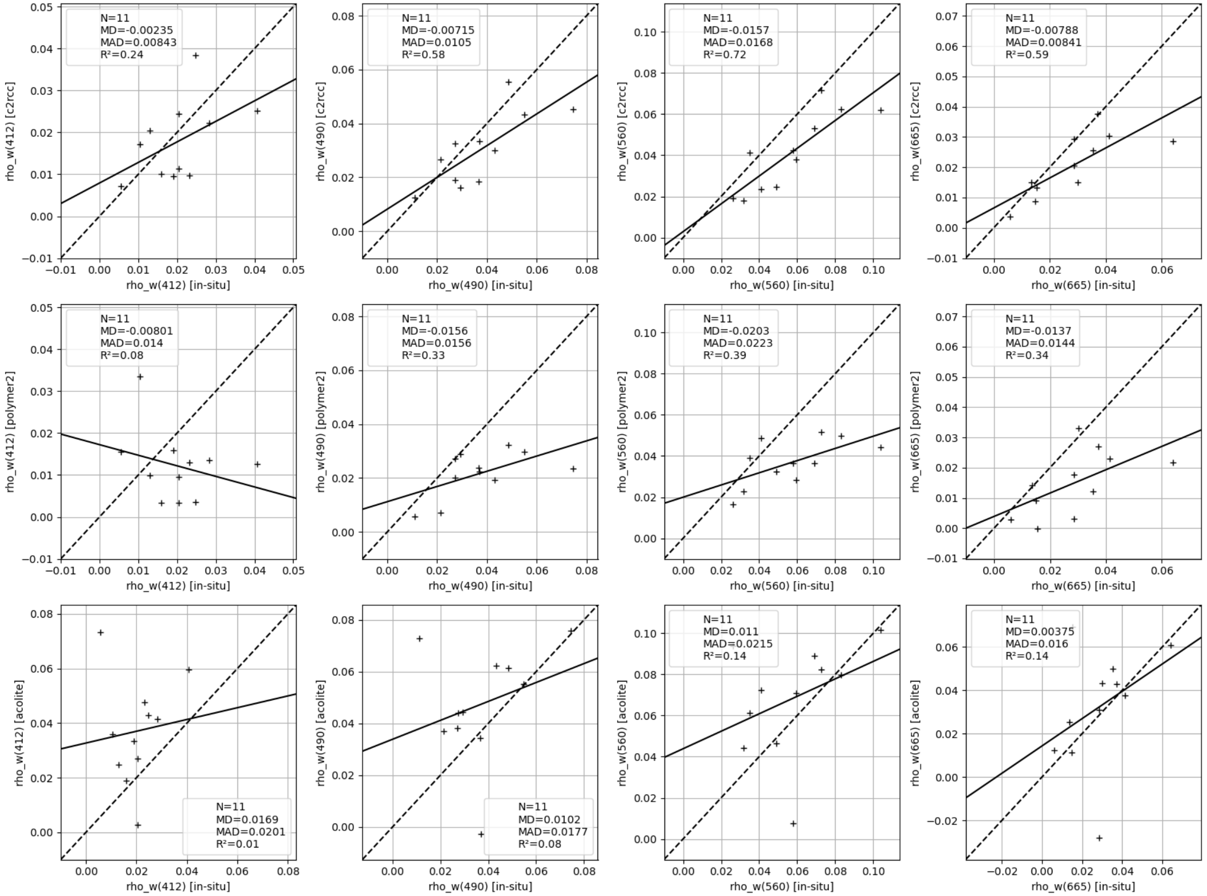


Validation exercise

- First validation conducted in 2020 using Aeronet-OC data from Venise AAOT which showed best performance by Polymer
- Now updated with CERTO campaigns data and PML So-Rad data
- Algorithms:
  - C2RCC
  - Polymer with current CERTO modifications (modifications presented later)
  - ACOLITE
  - iCOR not included in this presentation, to be added for final evaluation
- Insufficient matchups for conclusive results ; historical data are being added to the analysis

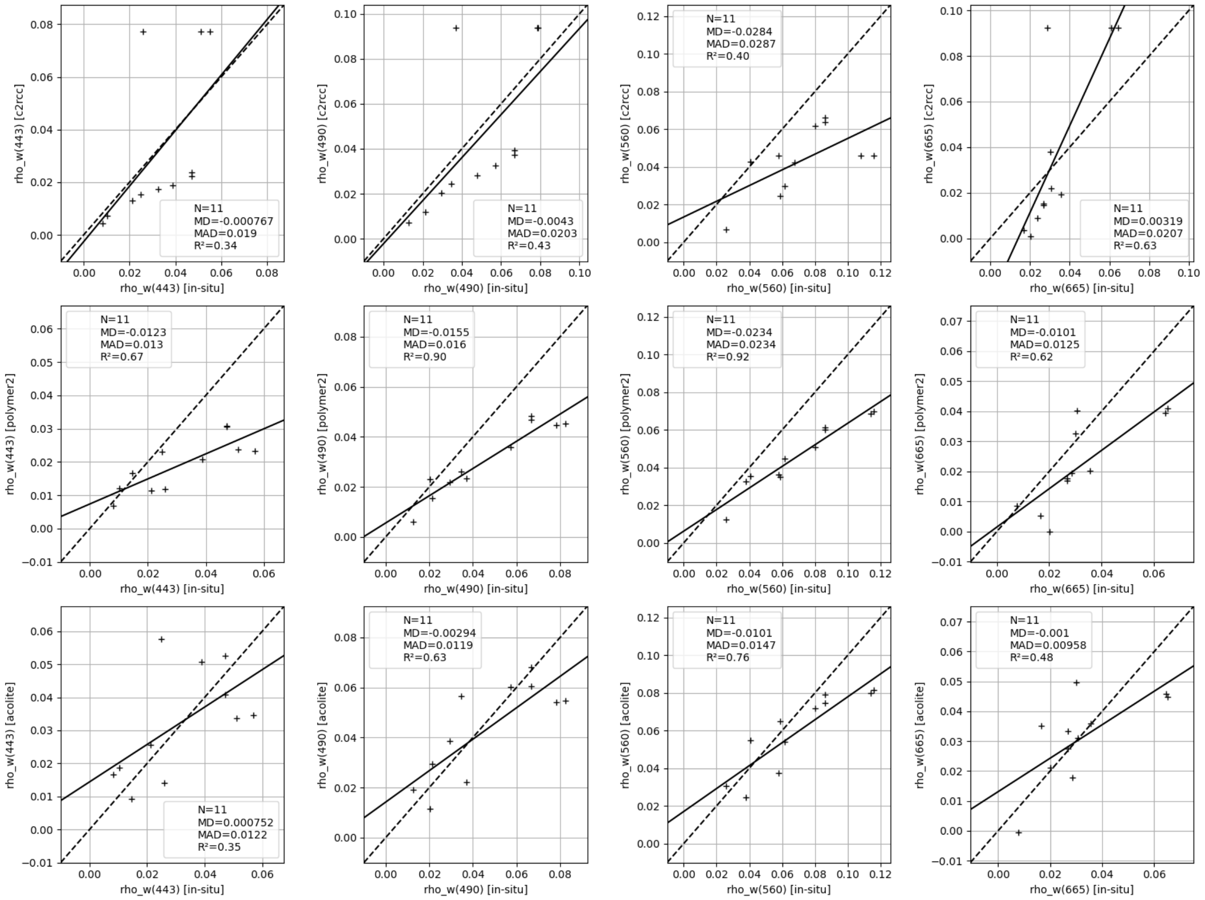
OLCI - CERTO campaigns

- Matchups dominated by Venice lagoon
- Best quality by C2RCC
- Underestimation by Polymer



MSI – CERTO campaigns

- Matchups dominated by Venice lagoon
- Best accuracy by ACOLITE
- Best correlation by Polymer



Polymer updates

- Added an uncertainties propagation mechanism:
  - TOA uncertainties, propagated to water reflectance (equivalent to Monte Carlo uncertainties)
  - Uncertainties induced by model inversion
- Water model update: better account for highly turbid waters
  - → Switch to increase of mineral particles when chl > 10mg/m3
  - → Avoids introducing a third parameter to the water reflectance model
- Added a new first guess: test several points of the cost function instead of a single fixed point
  - → impact on stability, eg in Curonian lagoon
- Added band 1020 for atmospheric correction (OLCI)

(these updates are not yet publicly released)

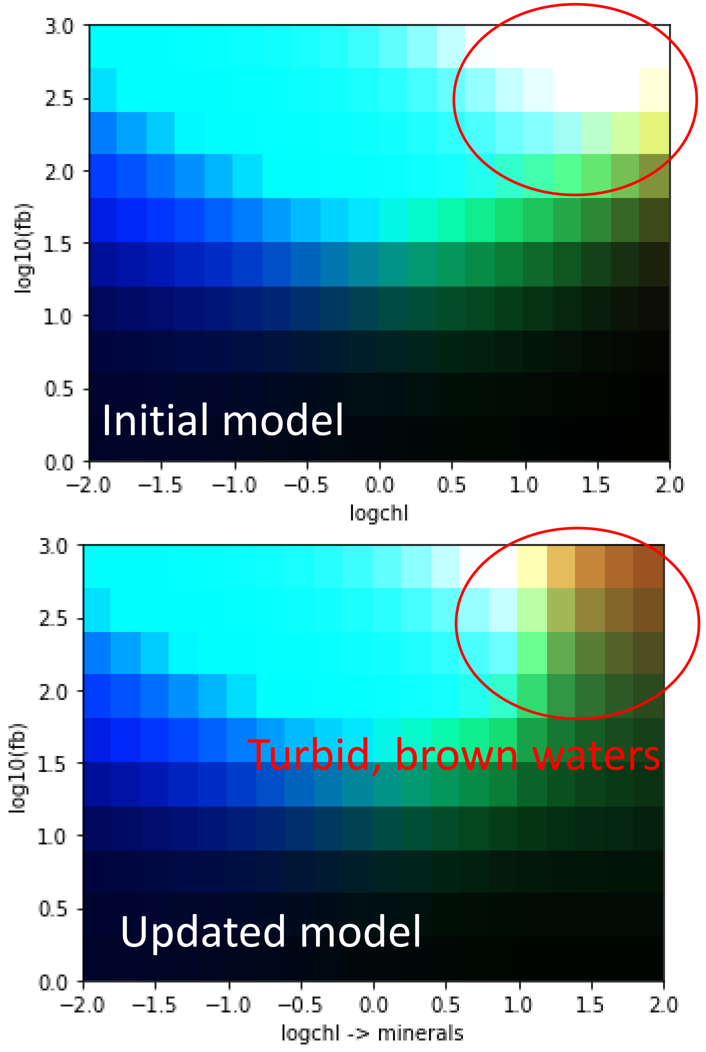
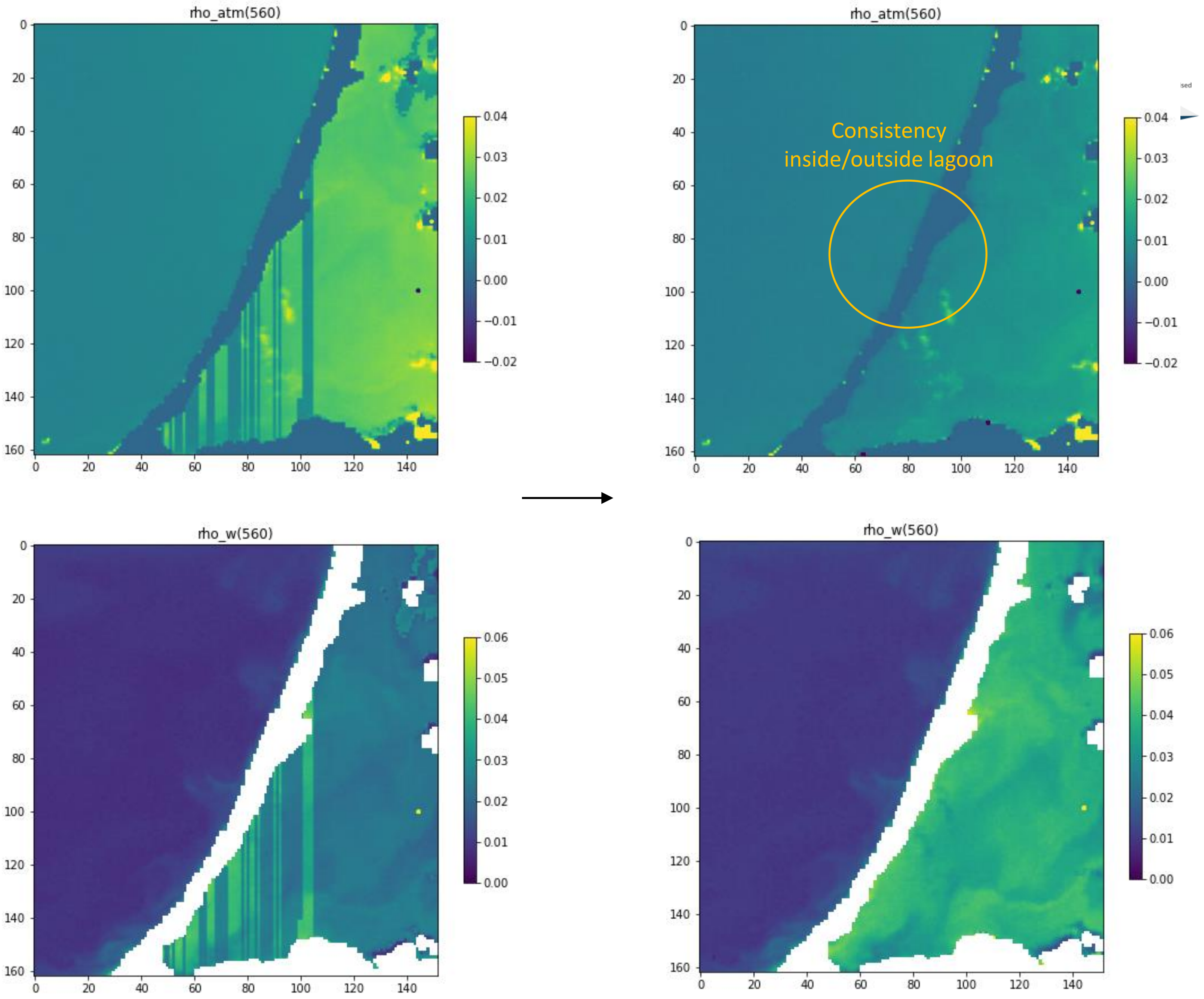


Illustration of the Polymer model of water reflectance in « natural colour »

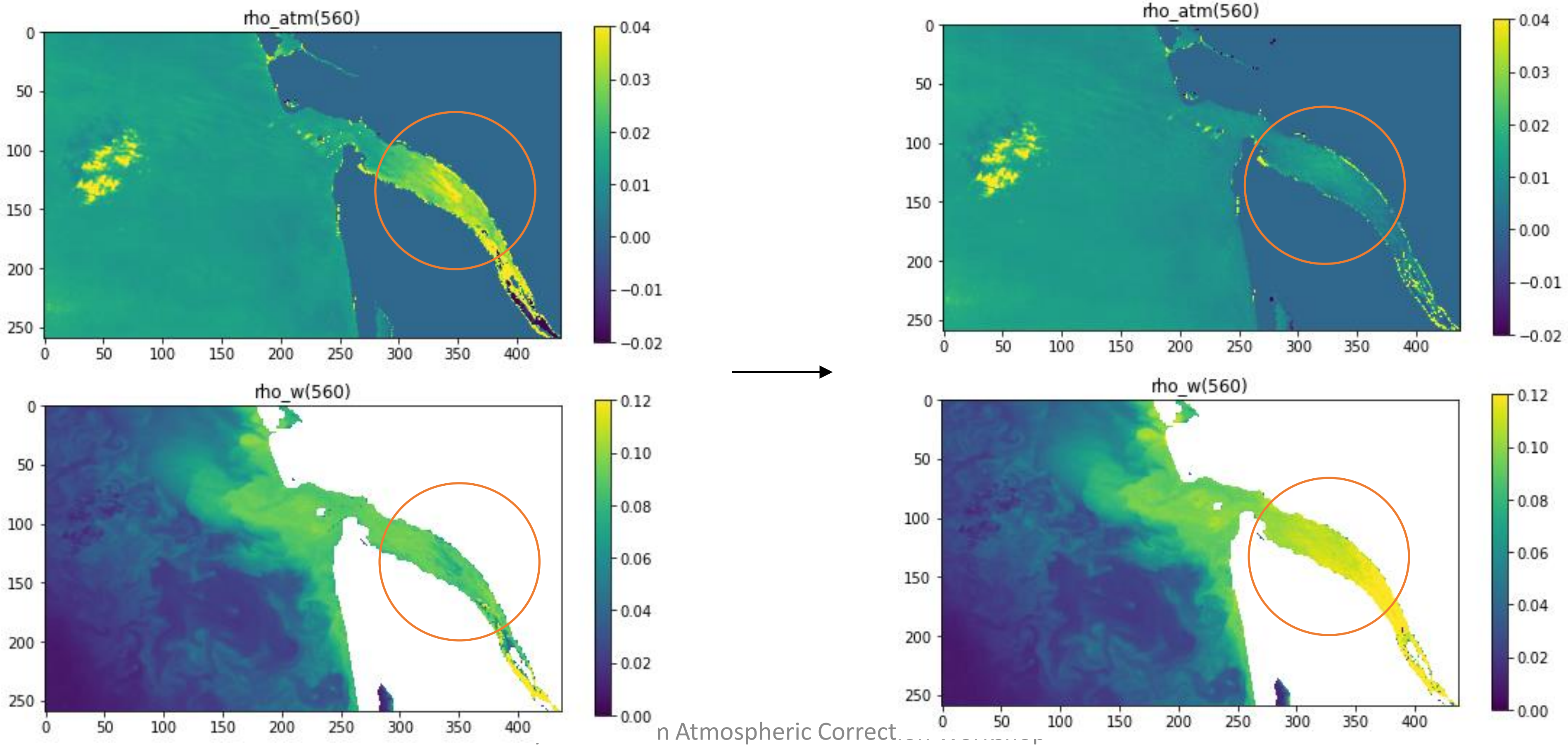
Impact of Polymer modifications on Curonian lagoon (S3B_OL_1_EFR____20200604T090813)

Improved stability



Impact of Polymer modifications on Gironde estuary (S3A_OL_1_EFR____20170123T102913)

Reduced the underestimation of (very turbid) water reflectance



Bathymetry effects (bottom visibility)

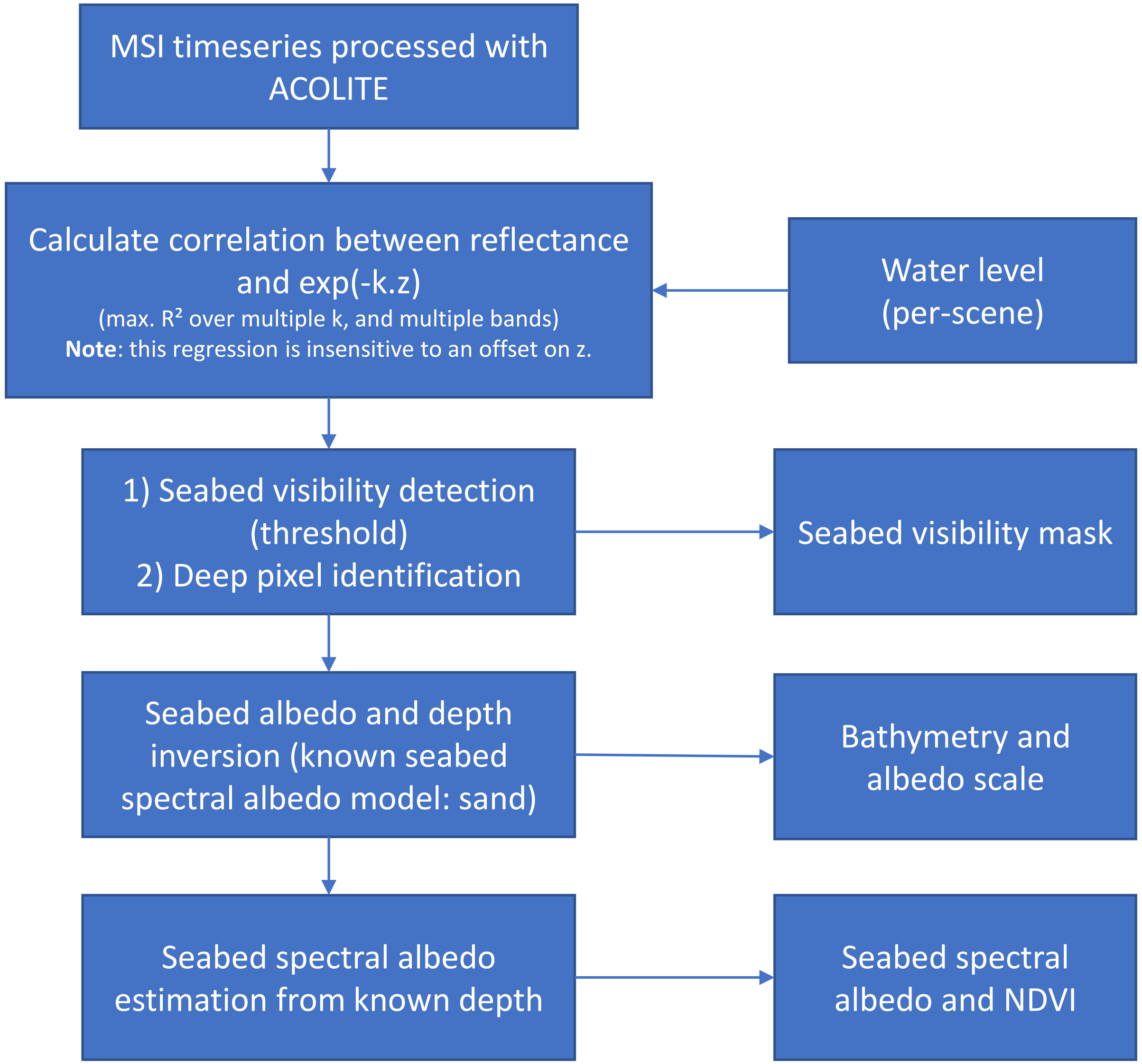
- Bottom visibility impacts the observation of water colour
- Depends on the bathymetry, on the tide height, and on the water optical properties
- Can be estimated using multi-temporal and multi-spectral measurements, for clear waters (Wei et al, 2020). Can it be applied to transitional waters as well ?
- Objectives:
  1. Detect and mask out pixels affected by bottom visibility, first in the inter-tidal zone, then in the sub-tidal zone
  2. If possible, provide bathymetry and seabed albedo

Bathymetry effects visible in the Venice Lagoon

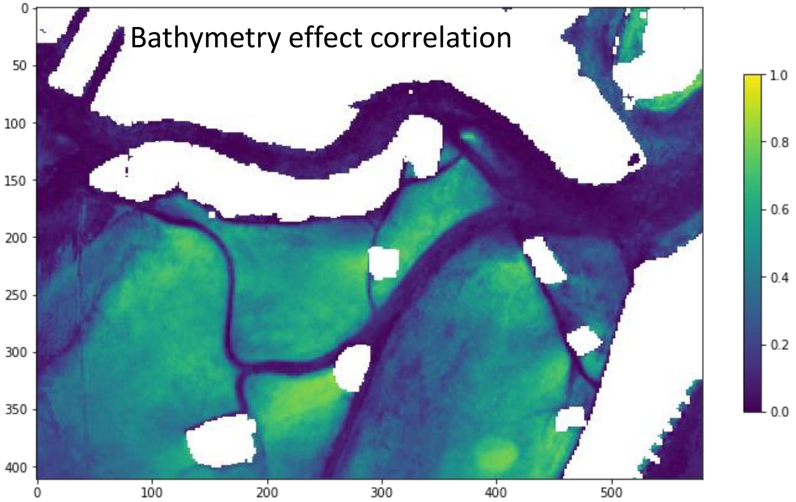
Bathymetry effects

- Generic method for estimating bathymetry effects from Sentinel-2 timeseries. Requires sufficient tidal amplitude and external water level information
- **Bathymetry effect detection** (correlation of reflectance with water level)
- Bathymetry and seabed albedo inversion, assuming spatial homogeneity of water IOPs
- Inversion of spectral seabed albedo and NDVI

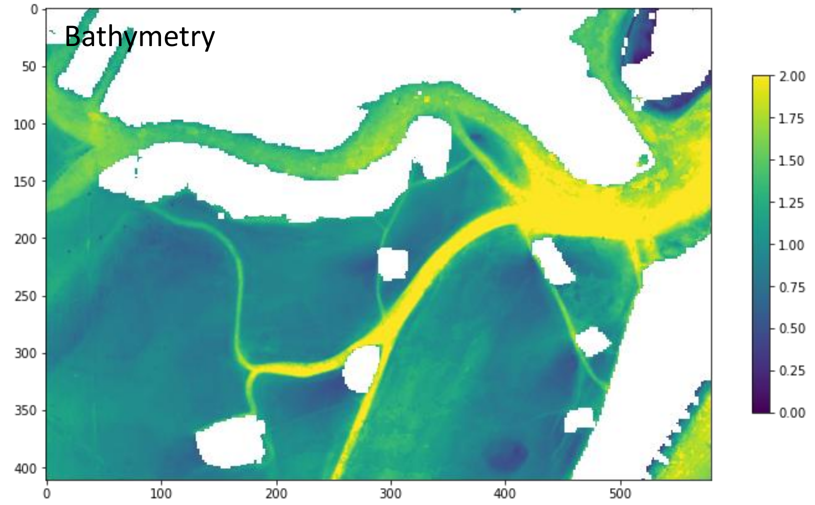
Site	Applicability
Curonian lagoon	✗
Elbe estuary	✓
Razelm-Sinoe lagoon	✗
Tagus estuary	✓
Tamar estuary	✓
Venice lagoon	✓

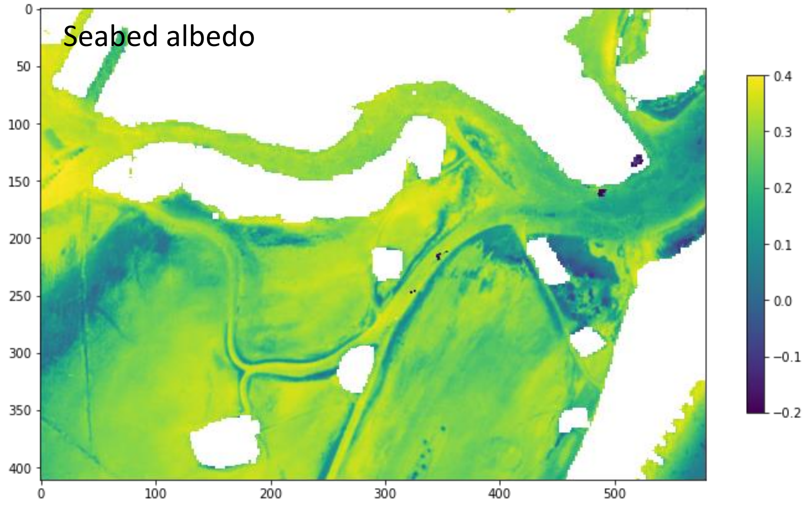


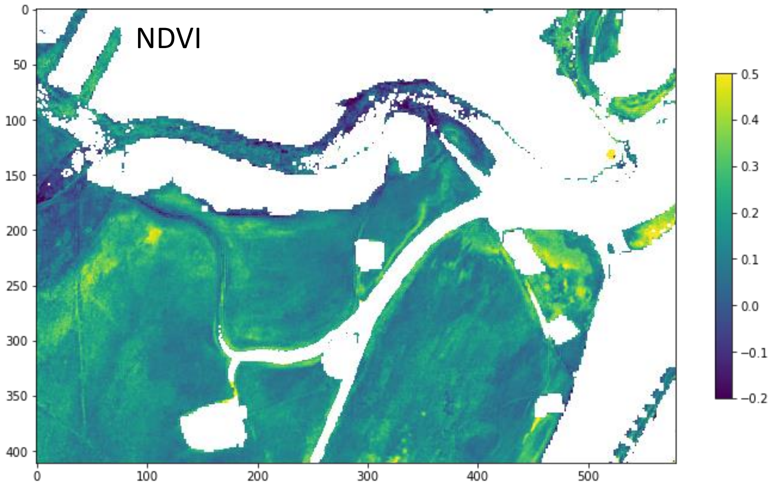
Bathymetry effects: Venise Lagoon



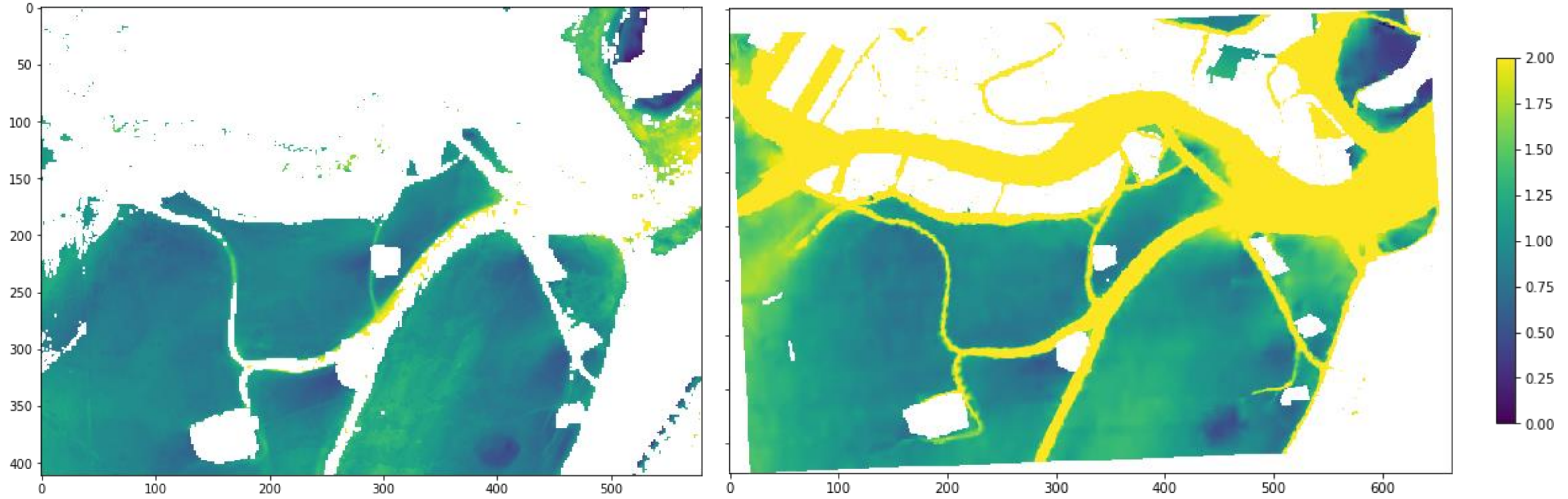
Consistent decoupling between bathymetry and seabed albedo







Bathymetry effects: Venise Lagoon (validation)



Our bathymetry from S2 timeseries

Venice lagoon bathymetry from Zaggia et al 2017

Recommendations: AC for transitional waters

- Good to have consistent methods and open source tools for validation exercises. Support EUMETSAT initiative in this regard.
- Importance of in-situ data in complex waters
- Additionally consider consistency verifications (spatial or temporal features) which do not require in-situ data, in addition to traditional validation:
  - Impact of sun glint
  - Impact of observation geometry
  - Water/atmosphere decoupling

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Thank you

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