CERTO
Copernicus Evolution – Research for harmonised and Transitional water Observation

Adjacency correction

Water Quality Continuum Atmospheric Correction Workshop
20/10/2022

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Image courtesy of NERC Airborne Research Facility

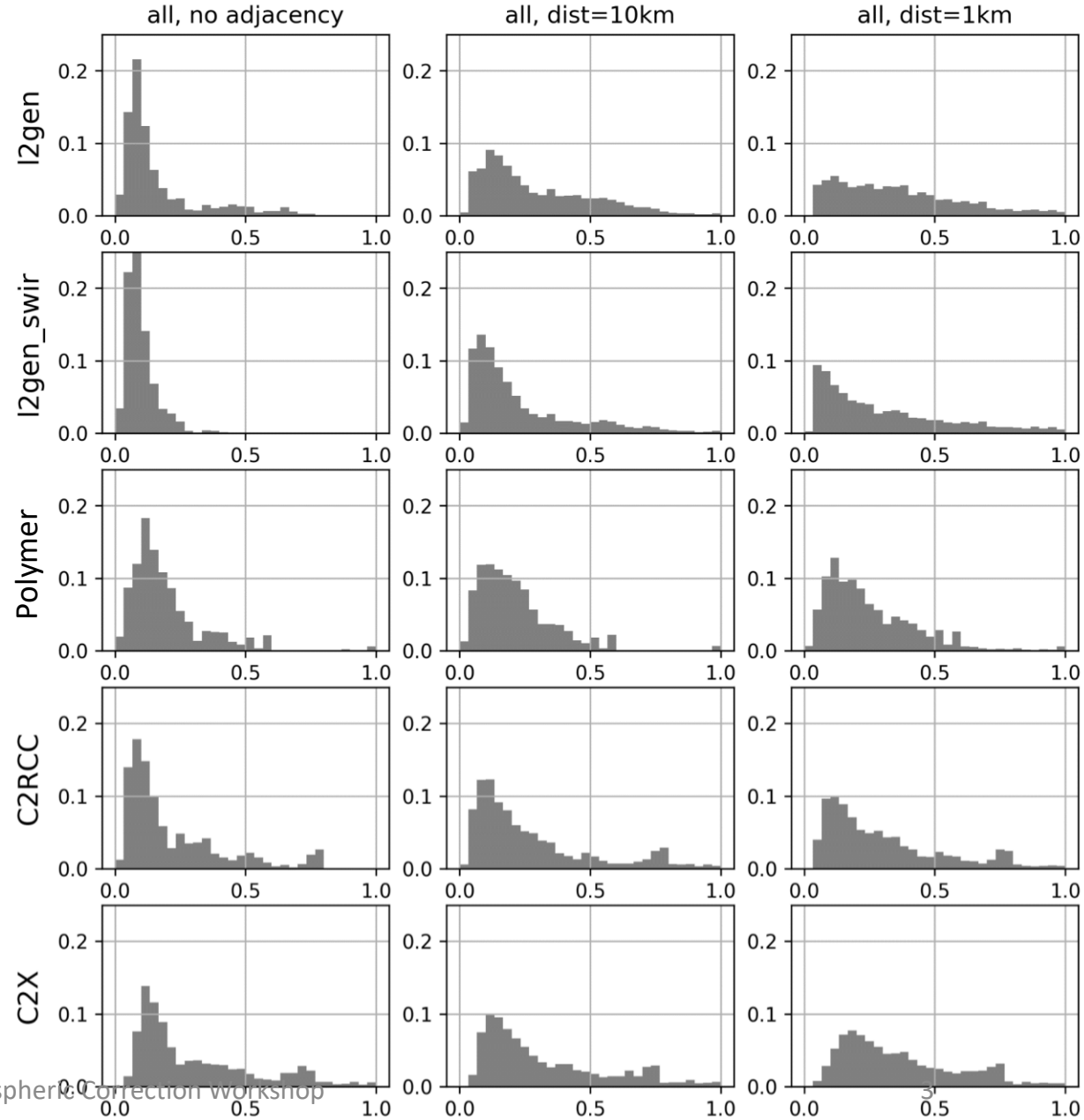
Atmospheric correction: impact and mitigation of adjacency effects

- Evaluation of the impact of adjacency effects on atmospheric correction, based on images and radiative transfer simulations
  - → Highly important for the observation of transitional waters
  - → Evaluation without in-situ data is difficult: natural variations of water reflectance near the coast, can not be discriminated from variations due to adjacency effects
  - → Can still identify some issues due to adjacency, for example negative reflectances
- Implementation of a mitigation method in Polymer
- Work in the frame of H2020 CERTO

AC sensitivity to Adjacency effects

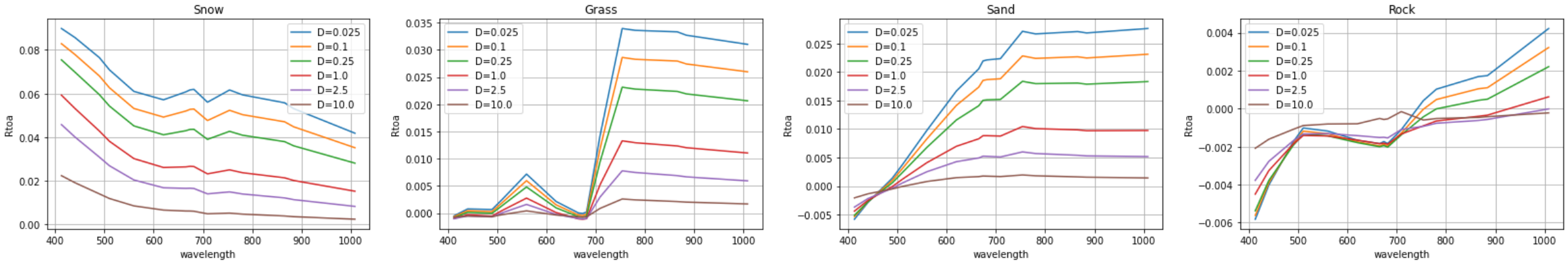
Study performed in the ESA C2X project (2015-2017)

- Simulations using HYGEOS SMART-G radiative transfer code, including various types of waters, aerosols and adjacency effects (snow, grass, aridisol)
- Process with various AC algorithms
- Histograms of integrated spectral difference wrt. simulation
- l2gen is very sensitive to adjacency effects ; Polymer very robust



Simulation of adjacency signal

- Additional TOA signal due to adjacency from **RT simulations**, compared to simulation without adjacency (averaged: geometries, aerosols, water spectra)
- Increasing distance to the linear coastline
- Polymer's atmospheric reflectance model can correct for spectrally smooth contamination ; vegetation (grass) has the strongest spectral features

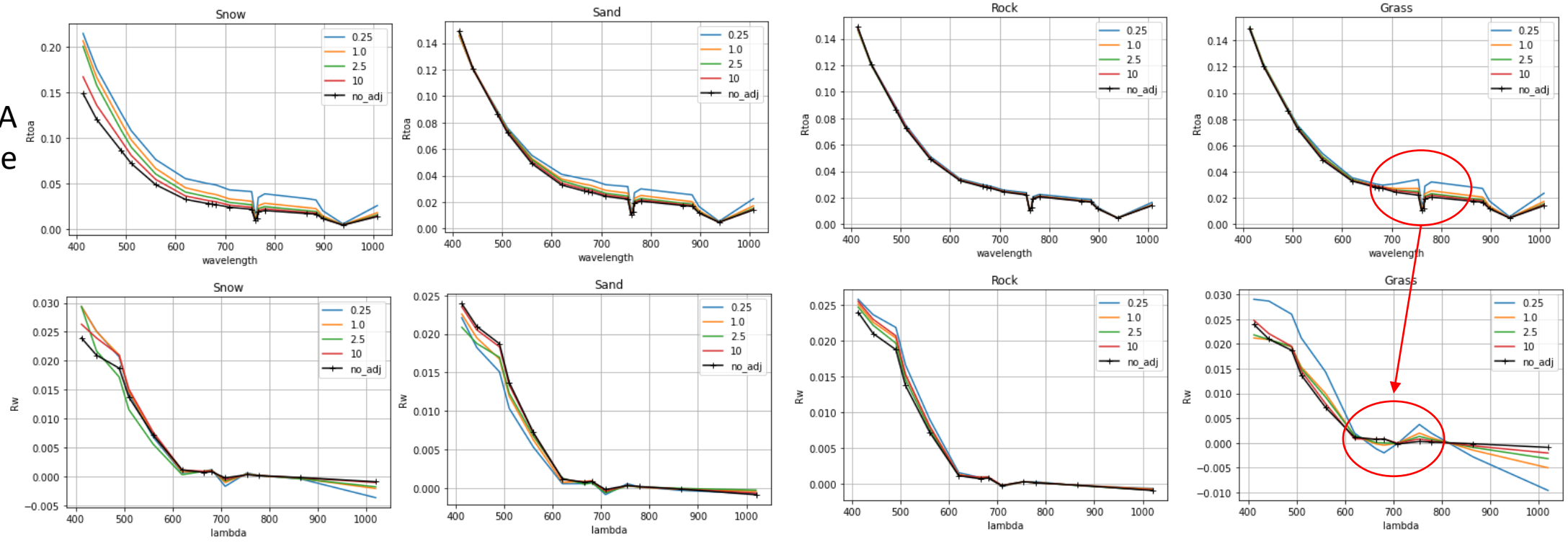


Adjacency: impact on Polymer

- Inversion of simulated spectra with Polymer, with different albedo models and increasing distance to the coastline

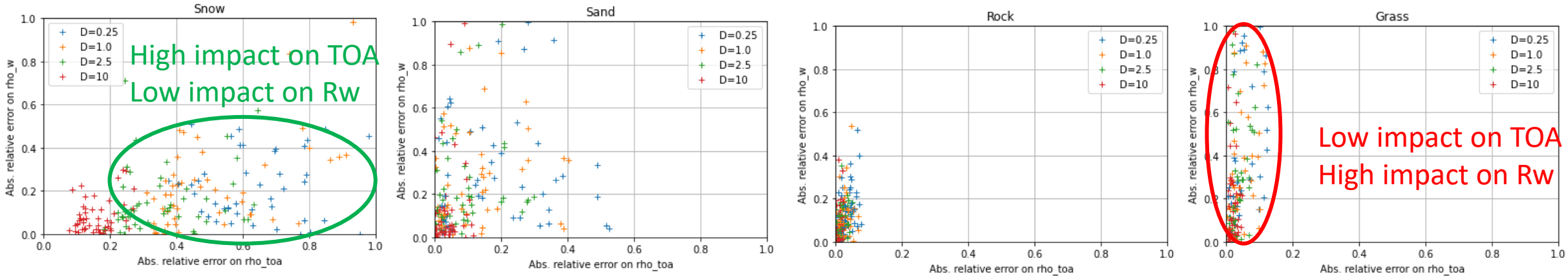
TOA reflectance

water reflectance (Polymer)



Adjacency: impact on Polymer

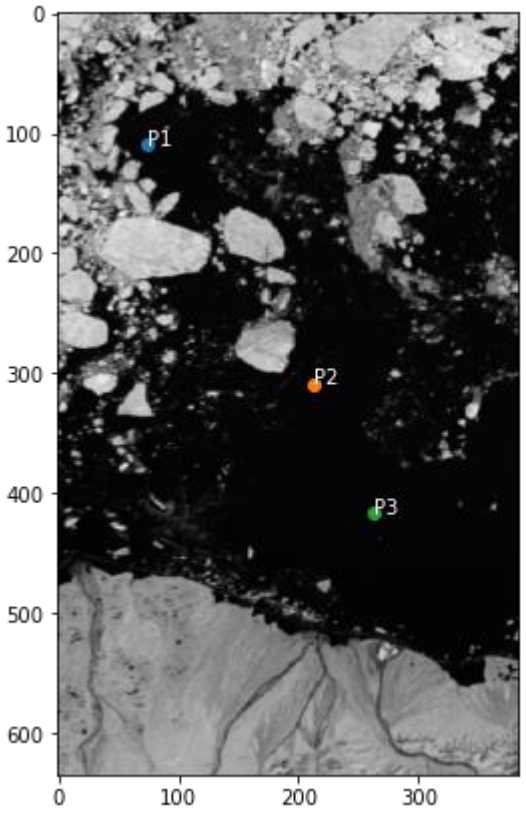
- Overview: relative error on water reflectance due to adjacency, as a function of relative amplitude of adjacency signal on TOA reflectance
- Different aerosol models, different water reflectance spectra, different wavelengths

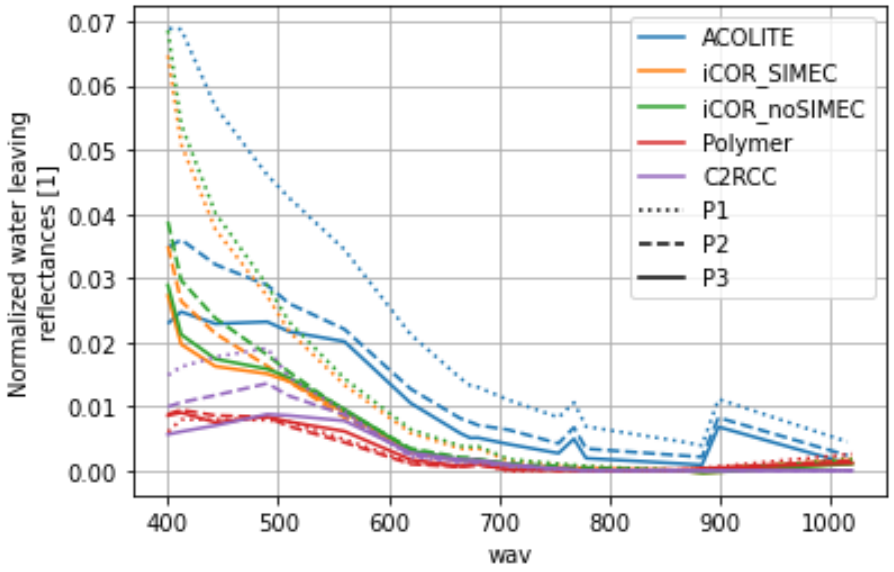


→ Polymer better corrects for snow adjacency than grass adjacency

Impact of snow adjacency on various algorithms

- Example Beaufort Sea (S3B_OL_1_EFR____20210715T202609...)

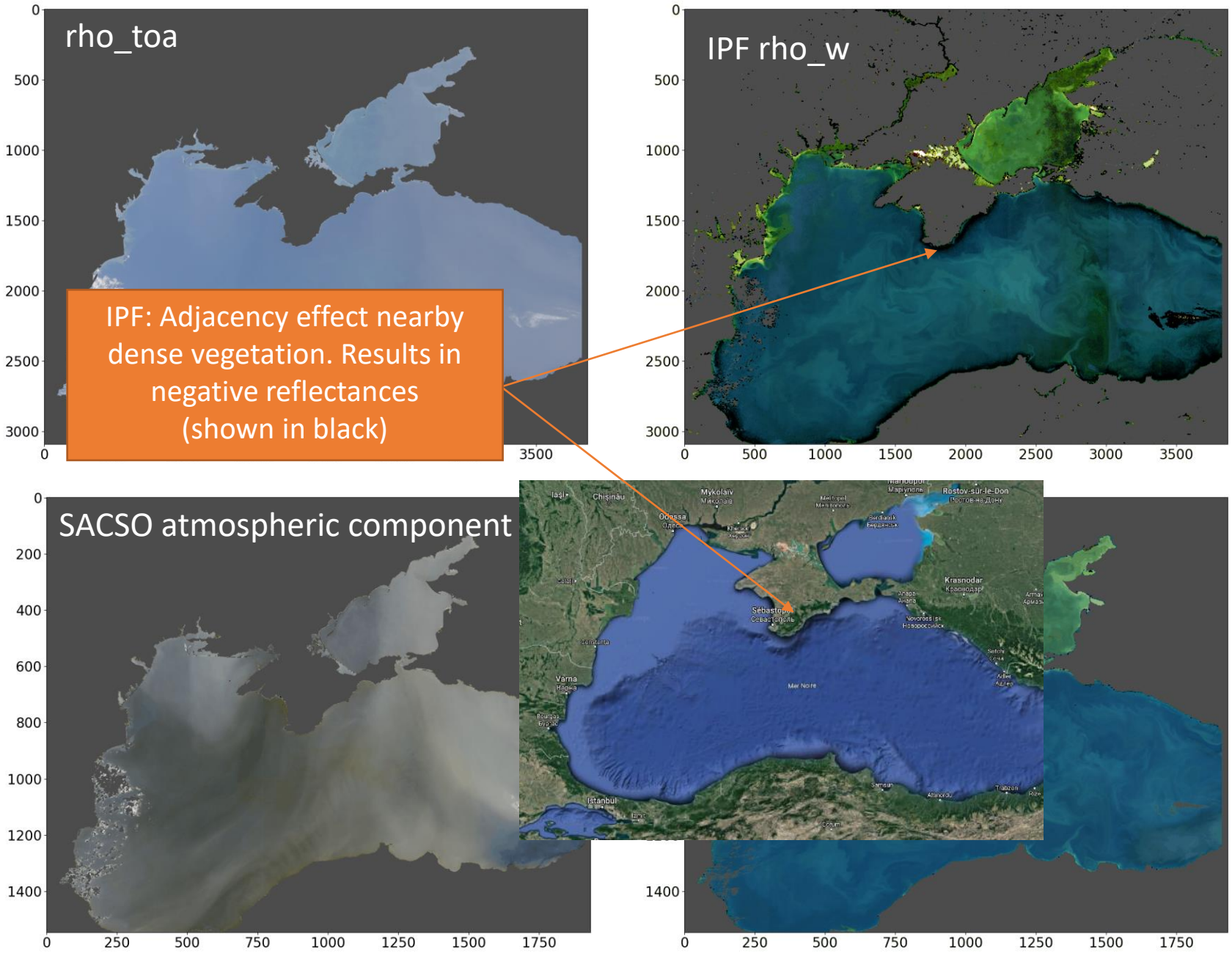




Polymer provides the most consistent spectra in presence of intense snow/ice adjacency

Vegetation adjacency
Example of the Black Sea from the EUMETSAT SACSO project

- RGB composites
- SACSO is an evolution of Polymer ; similar behaviour w.r.t. adjacency effects
- Very strong impact on standard OLCI product (IPF) in presence of vegetation adjacency

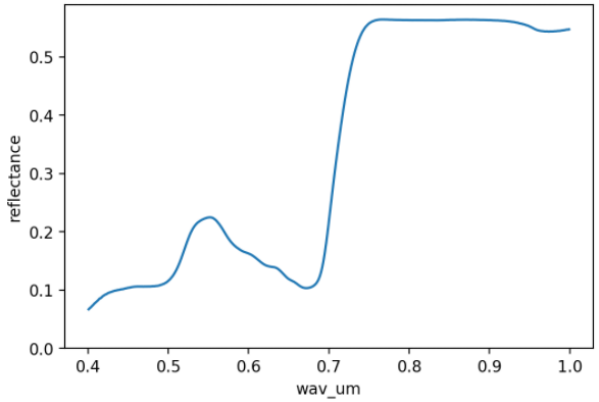


Adjacency effects mitigation in Polymer

- Mitigation method: added a fourth component to Polymer atmospheric model

$$\rho_{atm}(\lambda) = T_0(\lambda)c_0 + c_1\lambda^{-1} + c_2\rho_{mol}(\lambda) + c_3\rho_{veg}(\lambda)\lambda^{-4}$$

- Testing algorithm stability with an additional free parameter



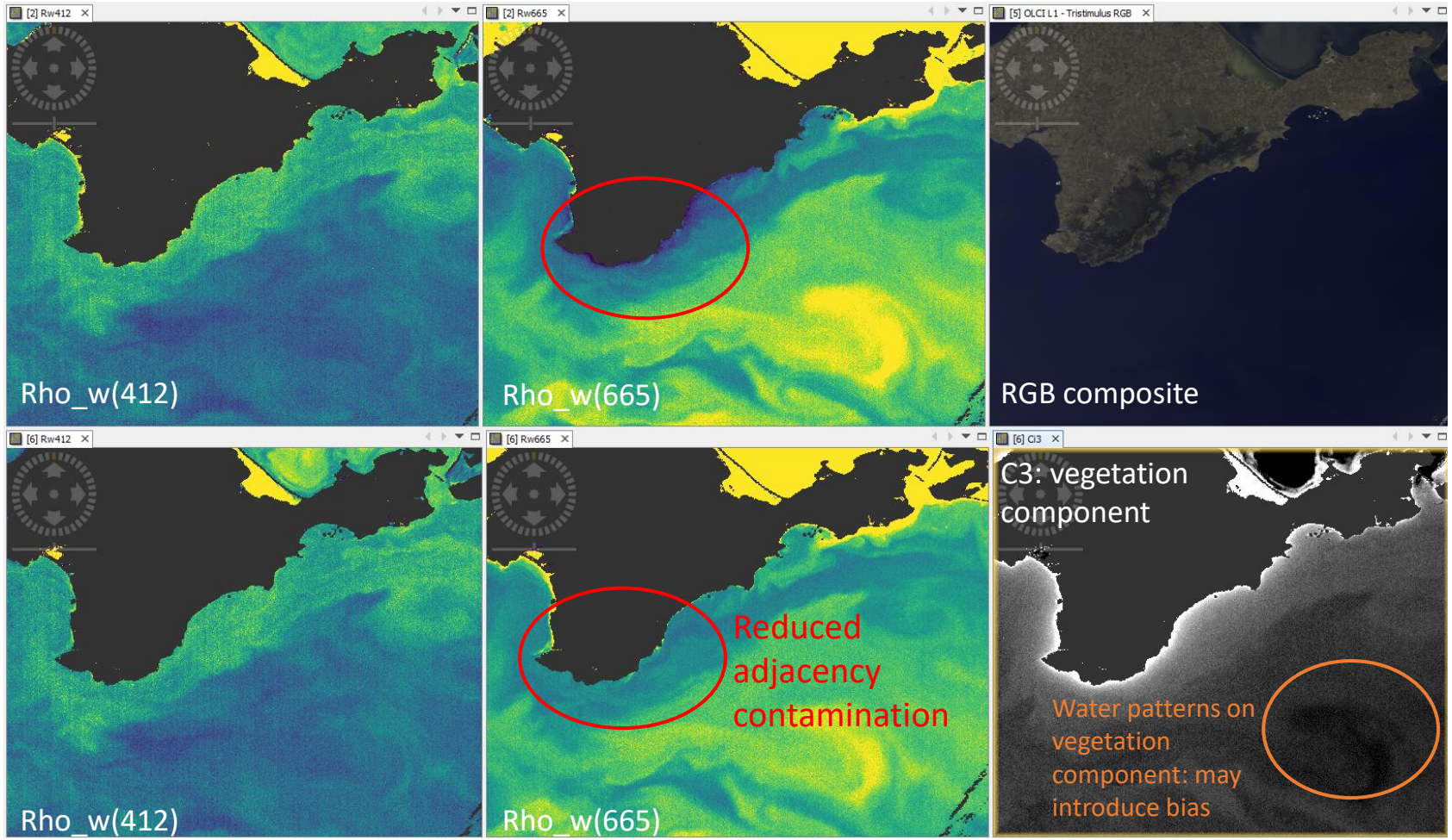
Vegetation reflectance (grass) from ECOSTRESS spectral library

Mitigation of vegetation adjacency in Polymer

- Polymer works with an additional atmospheric parameter (stable inversion!)
- Anomalous reflectances near the coast in the NIR are improved
- Test more extensively ; evaluate whether this modification introduces bias
- Application to floating vegetation ?

Standard Polymer

Polymer with vegetation adjacency correction



Impact of adjacency effects on various AC

- Image-based AC (iCOR, ACOLITE) : assumption of aerosol spatial homogeneity
  - The adjacency signal is **directly propagated** to the water
  - No mitigation (unless dedicated pre-correction), no amplification
  - Most sensitive to snow Adjacency
  - Vegetation adjacency mostly affects NIR bands only
- "Standard" atmospheric correction (estimation of aerosol properties in the NIR ; extrapolation to the VIS)
  - May **amplify (or compensate) the adjacency contamination** to the VIS bands
  - Very sensitive to snow/ice (because of intensity) and vegetation (because it affects NIR bands)
- "Full-spectrum/coupled" AC (Polymer, C2RCC)
  - **Higher capacity to compensate** the adjacency signal
  - Polymer: robust to spectrally smooth adjacency (Snow, sand, rock) ; vegetation adjacency mostly affects NIR bands

Recommendations

- Evaluate the impact of different types of adjacency effects (snow, sand, vegetation…) on each AC algorithm
  - Using radiative transfer simulations
  - Using image-based analysis

    → Image-based consistency verification of adjacency effects is complex, due to near-short variations of water optical properties ; easier for snow/ice adjacency around icebergs
  - Using validation exercises

    → Develop an indicator of adjacency effect (nearby land spectral albedo), and use it in validation
- Correction of adjacency effects should be seen as coupled with atmospheric correction

  → Different impact of adjacency effects on various AC

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Thank you

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