Adjacency correction

Water Quality Continuum Atmospheric Correction Workshop
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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

[Graphs showing TOA reflectance and 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

**IPF: Adjacency effect nearby dense vegetation. Results in negative reflectances (shown in black)**
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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