Atmospheric Correction for Coastal and Inland Waters – Current Capabilities and Challenges

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Outline

• In situ validations
• Challenges and issues
  • Aerosols
  • Absorbing waters
  • Extremely turbid waters
  • Calibration errors
  • Trace gases
  • Adjacency effects
  • Sunglint
  • Cloud shadows & wave facets
Validations using AERONET-OC data


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By adopting heritage A/C method, **on average**, we are doing great!
Validations using AERONET-OC data

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But

How well do we do retrievals per-pixel? (maximize number of valid retrievals)
Validations using AERONET-OC data


Validations using AERONET-OC: Necessary but **NOT** sufficient

By adopting heritage A/C method, **on average**, we are doing great!

But

How well do we do over **areas NOT represented within AERONET-OC network**?
Issues with aerosol removal (absorbing waters): representativeness

Landsat-8 derived $R_{rs}(443)$ over Wachusett Reservoir in Massachusetts.
Issues with aerosol removal (absorbing waters): representativeness

Landsat-8 derived $R_{rs}(443)$ over Wachusett Reservoir in Massachusetts

Automated removal of aerosols using existing aerosol LUTs

Manual removal of aerosols using observed AOT spectra
Issues with aerosol removal: representativeness

The standard aerosol models do **NOT** represent aerosols over inland and nearshore coastal areas
Belgian coastal zone / Zeebrugge
Landsat-8/OLI 2015-09-27

TOA
Rayleigh-corrected
water

extremely turbid pixel

Good A/C with
SWIR bands

significant
NIR signal

Credit: Quinten Vanhellemont
Calibration errors

• Use VIIRS NIR/SWIR band combinations to simulate the sensitivity of aerosol removal to calibration errors. The values shown are averaged for > 250 VIIRS observations.

Monitor calibration performances (@low radiances) more frequently to identify any short-term changes in responses within NIR/SWIR
Issues with removal of trace gases: representativeness

1 DU error in NO$_2$ results in large errors in UV and blue

Issues with removal of trace gases: representativeness

Currently, we use climatology or coarse-resolution ancillary data to correct for the effects of trace gases.

Credit: Maria Tzortziou (KORUS –OC field campaign)
Adjacency effects (ice)

Southwest Greenland (June 2\textsuperscript{nd} 2014)

Landsat-8 (OLI) with ~ 30m spatial sampling
Adjacency effects (ice)

Southwest Greenland (June 2\textsuperscript{nd} 2014)

In collaboration with Clémence Goyens & Simon Bélanger
Adjacency effects (ice)

Mackenzie River Delta (June 24\textsuperscript{th} 2016)

Landsat-8 (OLI)
Adjacency effects (ice)
Adjacent effects (land)
Adjacency effects (land)

- Landsat example(s)
  - NDVI calculated using Rayleigh-corrected radiance
  - **Warmer** colors indicate impacts of adjacency effects
Note how adjacency effects vary from time to time. Dependency on environmental conditions & solar angles is clearly observed.
Adjacency effects (man-made structures)

Landsat 8/OLI image of CPower wind farm & OTS platform (AERONET-OC station)

Adjacency effects (man-made structures)

CPower Windfarm

Belgian Coastal Zone 2016-07-18
OLCI TOA radiance 865nm

Ship Anchorage

(presented by Héloïse Lavigne at S3VT)
Sunglint & impact of instrument design

- Examples from Landsat-8/Sentinel-2

![Diagram showing Landsat-8 (OLI) focal plane with track direction and line-of-sight orientations.]

- Track direction
- Line-of-sight (odd: forward looking)
- Line-of-sight (even: backward looking)
- Optical axis (nadir)
- More glint
- Less glint

Notes:
- Track direction
- ~6400 detectors (~185km)
- Optical axis ("nadir viewing")
Sunglint: Near-simultaneous Landsat-8/Sentinel-2 Images
Southern Italy & Malta
Sentinel-2A (MSI)
SZA ~ 22°
Time ~ 10:00

View zenith angle ~ 11°
Landsat-8 (OLI)
SZA ~ 26.2°
Time ~ 9:35 GMT

Sentinel-2A (MSI)
SZA ~ 22°
Time ~ 10:00

View zenith angle ~ 8°

Southern Italy & Malta
Chesapeake Bay
Sentinel-2A (MSI)
SZA ~ 22
Time ~ 16:00 GMT
Chesapeake Bay
Sentinel-2A (MSI)
SZA ~ 22
Time ~ 16:00 GMT

Landsat-8 (OLI)
SZA ~ 25°
Time ~ 15:35 GMT
Cloud shadows & wave facets
Belgian coastal zone / Zeebrugge
Sentinel-2A/MSI 2017-04-19

Wave facets, breaking waves resolved -> SPM product

Credit: Q. Vanhellemont
Bright/dark wave facets: 10-30% difference in $\rho_w$
(+ timing/view differences across bands)

Credit: Q. Vanhellemont
Let’s discuss all these issues...