Deriving water quality from APEX imagery

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Our test sites

<table>
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<th>Scheldt</th>
<th>Lake Constance</th>
<th>Wadden Sea</th>
<th>Gironde</th>
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</table>

- Scheldt:
  - A strong tidal influence.
  - TSM: several to several hundreds mg L\(^{-1}\).
  - CHL: 0 - 30 g L\(^{-1}\).
  - Fluvioglacial origin.
  - CHL: 30 (spring bloom) - 0.5 g L\(^{-1}\) (winter).
  - TSM: 0.3 - 10 mg L\(^{-1}\).
  - Shallow sea with tidal flats, connected with the North Sea by a series of islands.
  - TSM: 1 - 1225 mg L\(^{-1}\).
  - CHL: 1 - 90 g L\(^{-1}\) (Hommerson et al., 2009).

- Lake Constance:
  - Macrotidal estuary with suspended sediments delivered by the Garonne and Dordogne rivers and trapped within the maximum turbidity zone of the estuary.
  - TSM from ten to four thousands mg L\(^{-1}\) (Doxaran et al. 2002a, 2002b, 2006, 2009).

- Wadden Sea:

- Gironde:
Challenges - Complex waters

- Water Quality Estimations for CASE-II water systems
  - Algae [CHL]
  - Total Suspended Material [TSM]
  - Colored Dissolved Organic material [CDOM]
Challenges - A low signal
Absorption and backscattering of light by particles and water

Sky glint

Adjacency effects

Sun glint

Atm. path radiance

Phytoplankton
Suspended sediment
Dissolved carbon

Absorption and backscattering of light by particles and water

Bottom reflectance

Air/water interface
Challenges - Dynamic environment

Match up difficulties
Need for detailed campaign planning
A typical water spectrum – simulation
Simulated Hydrolight spectra

Effect of concentration on the simulated spectra

Variation in TSM concentration
Left: Scheldt
Right: Lake Constance
Simulated Hydrolight spectra

Effect of concentration on the simulated spectra

Variation in CHL concentration
Left: Scheldt
Right: Lake Constance
Water quality algorithm: Curve fitting

**Objective:** develop algorithm less sensitive to noise in atmospheric correction and sensor noise.

\[
R(0-, \lambda) = p_1 (1 + p_2 x + p_3 x^2 + p_4 x^3)(1 + p_5 \frac{1}{\cos \theta_s})(1 + p_6 u) x
\]

\[
x = \frac{b_b(\lambda)}{a(\lambda) + b_b(\lambda)}
\]
Simulated Hydrolight spectra

Effect of noise on the simulated spectra
Wavelet based curve fitting algorithm

Look at the shape of the spectra and those features which are **Sensitive** to change in the WQP and **Insensitive** to Noise.
Wavelet based curve fitting algorithm

Objective: develop algorithm less sensitive to noise in atmospheric correction and sensor noise

\[ R(0-, \lambda) = p_1 (1 + p_2 x + p_3 x^2 + p_4 x^3)(1 + p_5 \frac{1}{\cos \theta_s})(1 + p_6 u)x \]

\[ x = \frac{b_b(\lambda)}{a(\lambda) + b_b(\lambda)} \]

Study area: Scheldt
Reference = Hydrolight with known concentrations, resampled to APEX wavelengths
Noise: adjacency, with wavelets
APEX campaign: 06/2011 - Wadden Sea

- Cooperation with INPLACE project
- Logistics (boat, lab, ..)

Zeevonk

TESO (ferry)

NIOZ - pontoon

INPLACE pole
APEX campaign: 06/2011 - Wadden Sea

ASD spectra

APEX
Wavelet based curve fitting algorithm

TSM concentrations in the Wadden Sea (in mg L\(^{-1}\)), mosaic of flight line 1, 2 and 3

CHL concentrations in the Wadden Sea (in µg L\(^{-1}\)), mosaic of flight line 1, 2 and 3

RMSE of 2.9 µg L\(^{-1}\) or 32% for the CHL concentration and 2.7 mg L\(^{-1}\) or 36% for the TSM concentration.
Life after MICAS?

» Looking at the SWIR part of the spectrum (SEASWIR - BELSPO)
» BELAIR Validation site in Zeebrugge (BELAIR – BELSPO)
» Water quality mapping from a UAV (Chameleon – IWT)
» WAVESIM – wavelet enhanced semi-analytical inversion model (PHD Eva Ampe)
» Remote sensing and in-situ data fusion for water applications (Phd Sivee Chawla)
» Processing of new satellite imagery –sentinel 2 (HIROC - FP7)
» Improvement of algorithm for new sensors (INFORM –FP7)
WAVESIM – wavelet enhanced semi-analytical inversion model
(PhD Eva Ampe)

Legend
CHL (µg/L)
- 0-3
- 3-5
- 5-8
- 8-15
- 15-25
- 25-60
- >60

Legend
TSM (mg/L)
- 0-2
- 2-4
- 4-6
- 6-8
- 8-10
- 10-12
- >12

Legend
aCDOM(440) (1/m)
- 0-0.3
- 0.3-0.5
- 0.5-0.7
- 0.7-0.9
- 0.9-1.1
- 1.1-1.5
- >1.5

0 0.5 1 2 3 Kilometers
Remote sensing and in-situ data fusion for water applications (Phd Sivee Chawla)

Better calibration of RS data to develop Chl-a/ SPM concentration maps. Which needs in situ data having better spatial coverage (covering the entire range).

Define a sampling strategy for collecting in situ data.

Resultant Chl-a concentration map

Remote Sensing data as *priori* information

Chl-a concentration maps
Life after MICAS?

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THANK YOU

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