Inland and coastal water quality retrieval

Some challenges and new opportunities

Els Knaeps, Dries Raymaekers, Sindy Sterckx (VITO, Belgium)
Kevin Ruddick, Bouchra Nechad (MUMM, Belgium)
Ana Dogliotti (IAFE, Argentina)
David Doxaran (LOV, France)
Susanne Kratzer (Stockholm University, Sweden)

GloboLakes Scientific Workshop , 10-12 December, Stirling

SeaSWIR belspo

2 Mers Seas Zeeën INTERREG IV A

Scheldt (Belgium)
up to 400 mg l^{-1}

APEX 2009

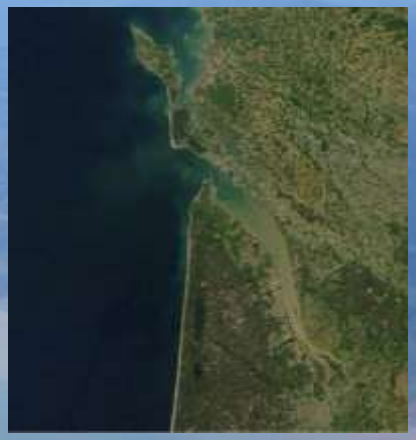
Yangtze (China)
up to several g l^{-1}

MODIS-Aqua 2003

La Plata (Argentina)
up to 400 mg l^{-1}

MODIS-Aqua

Gironde (France)
up to several g l^{-1}



Landsat 2000

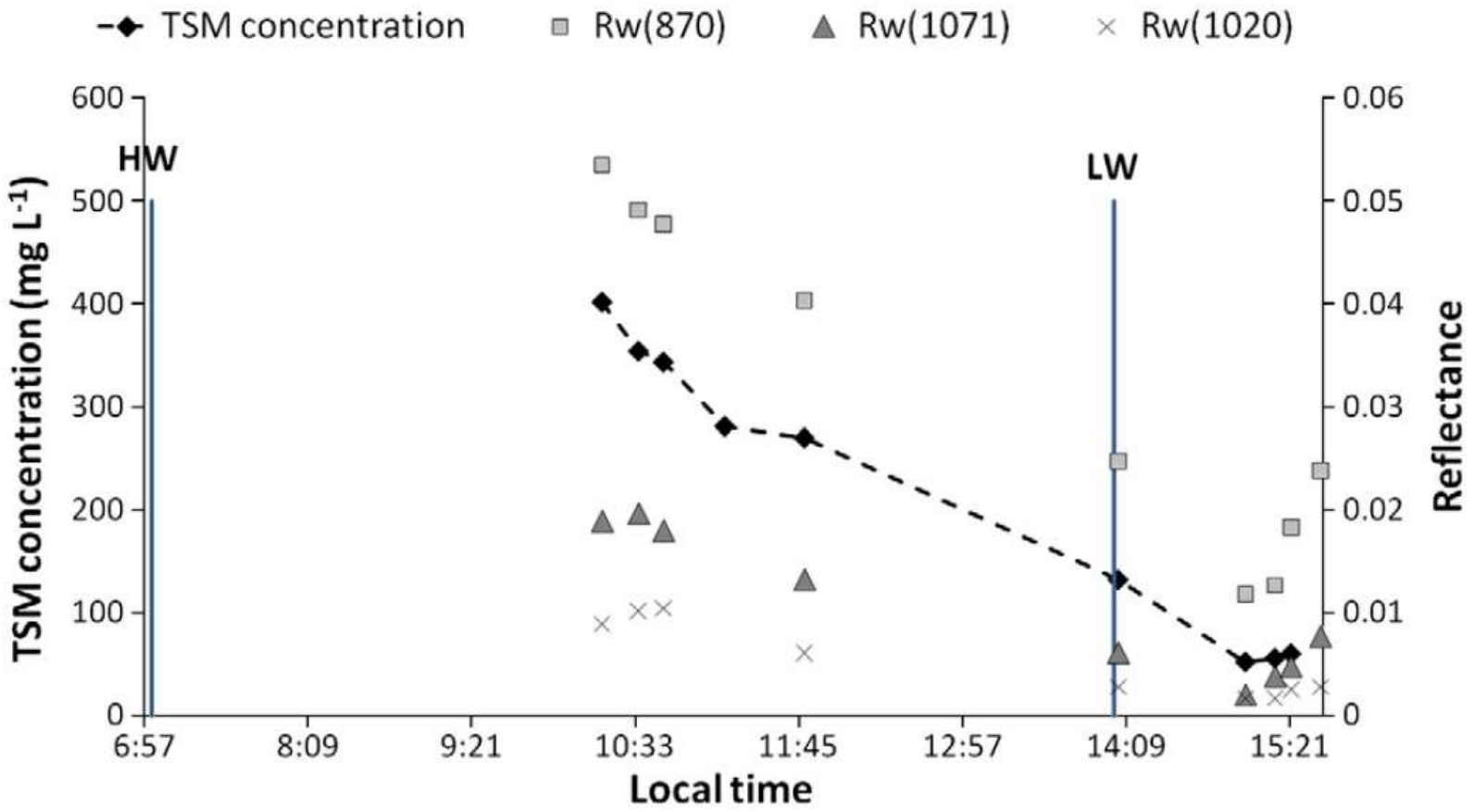
Wadden Sea (The Netherlands)

APEX 2010

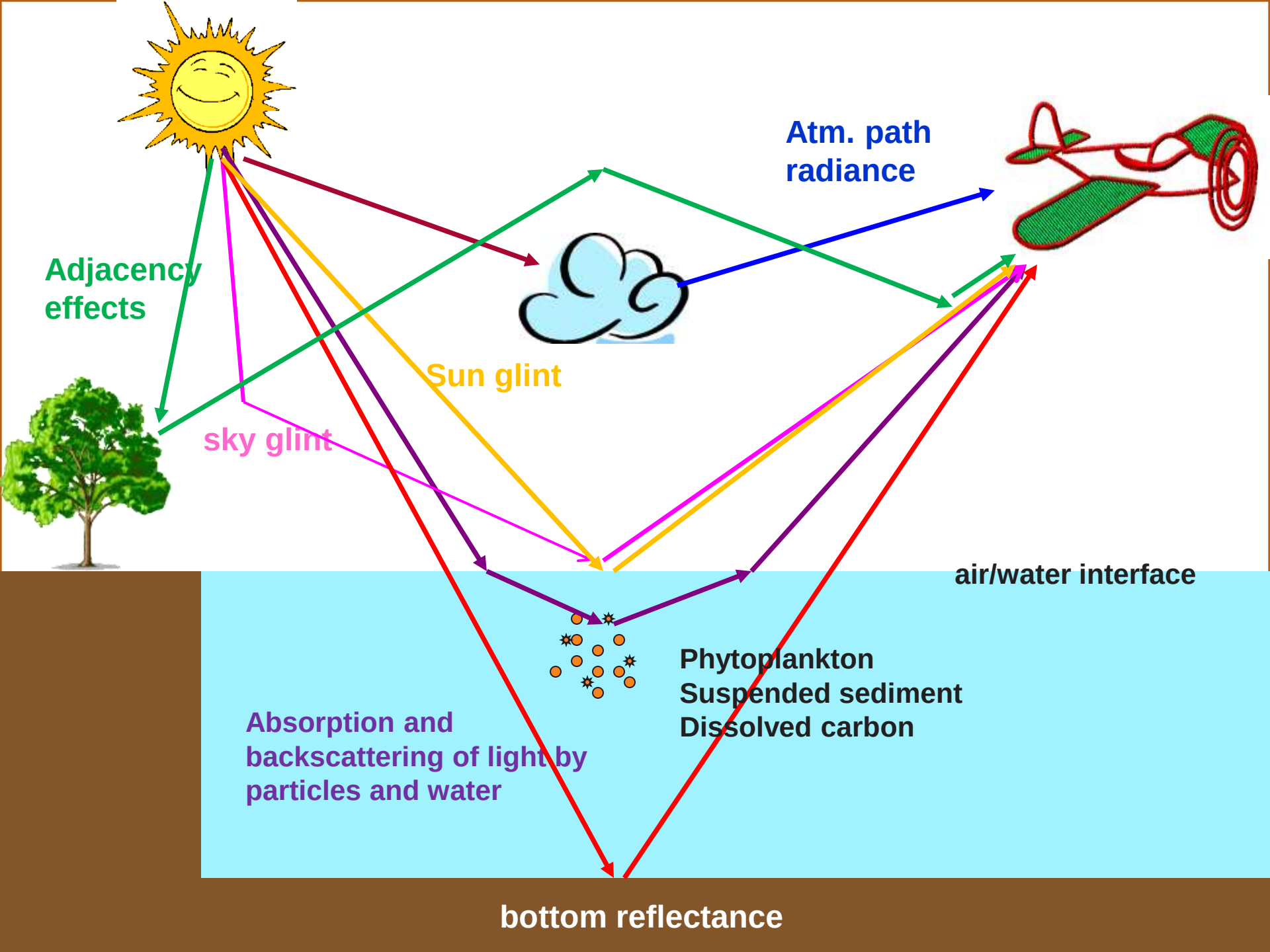
Molse meren (Belgium)

AHS/CASI 2007

Our test sites – Dynamic environments

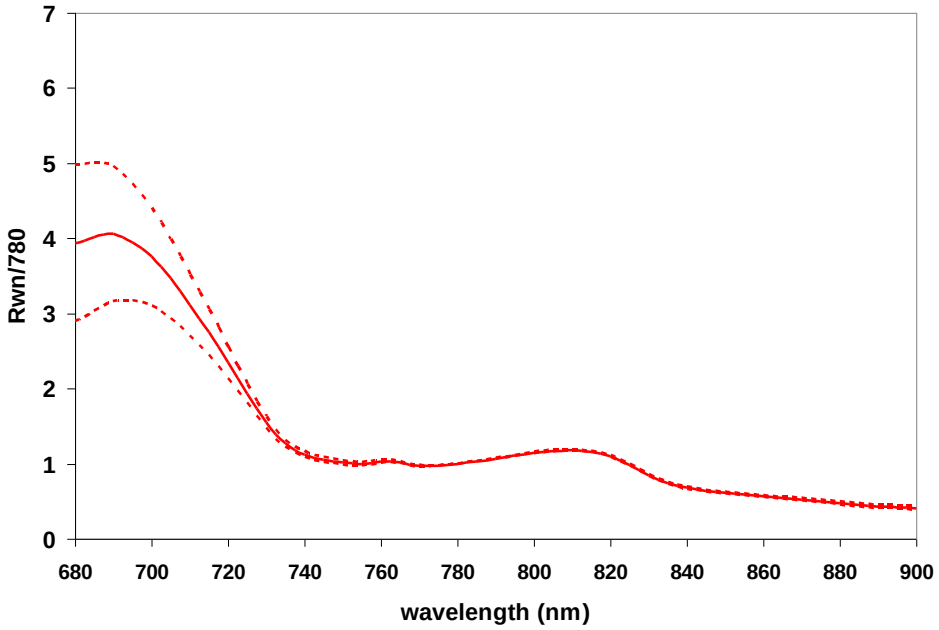


→ **Match up difficulties**
Need for detailed campaign planning


Atm. path radiance
Adjacency effects
Sun glint
sky glint
air/water interface
Phytoplankton
Suspended sediment
Dissolved carbon
Absorption and backscattering of light by particles and water
bottom reflectance

Adjacency correction - SIMEC

A “similarity” NIR reflectance spectrum is defined by normalization at 780 nm (Ruddick *et al.,* 2006).



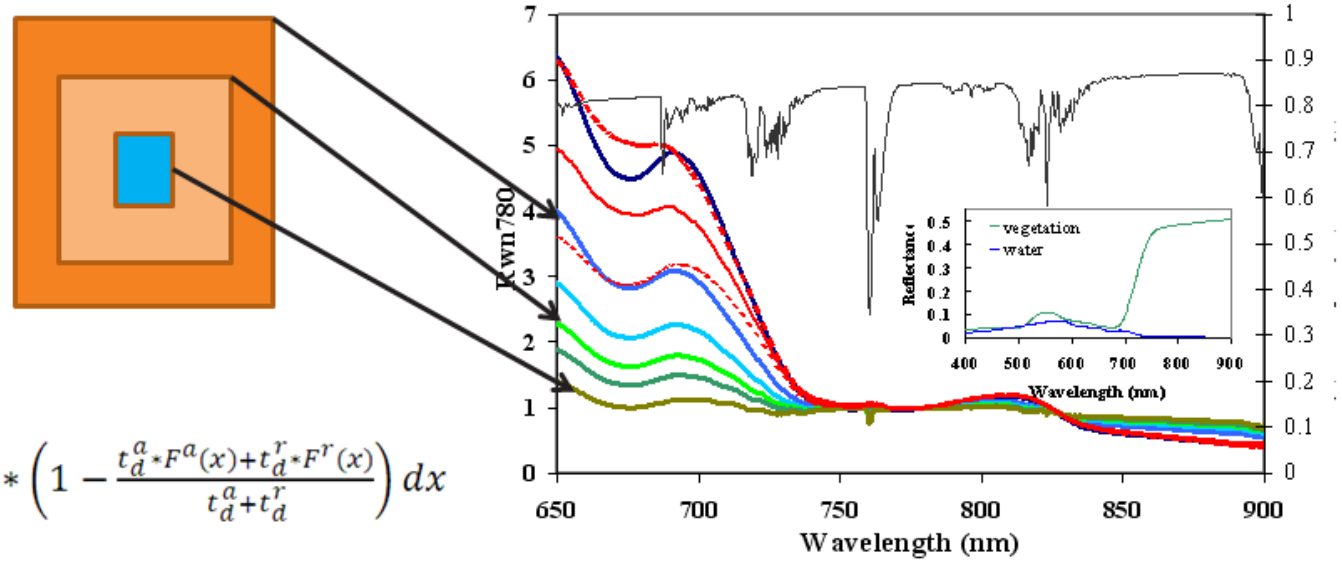
Sterckx, S., E. Knaeps, K. Ruddick, 2011, Detection and Correction of Adjacency Effects in Hyperspectral Airborne Data of Coastal and Inland Waters: the Use of the Near Infrared Similarity Spectrum, *International Journal of REMOTE SENSING*, 32(21): 6479–6505

Knaeps, E., S. Sterckx, K. Ruddick, C. Giardino, B. Mariano, SIMEC, An Environment Correction For MERIS Based On The NIR Similarity Spectrum, proceedings Ocean Optics

-> can be used to **detect** and **correct** adjacency effects

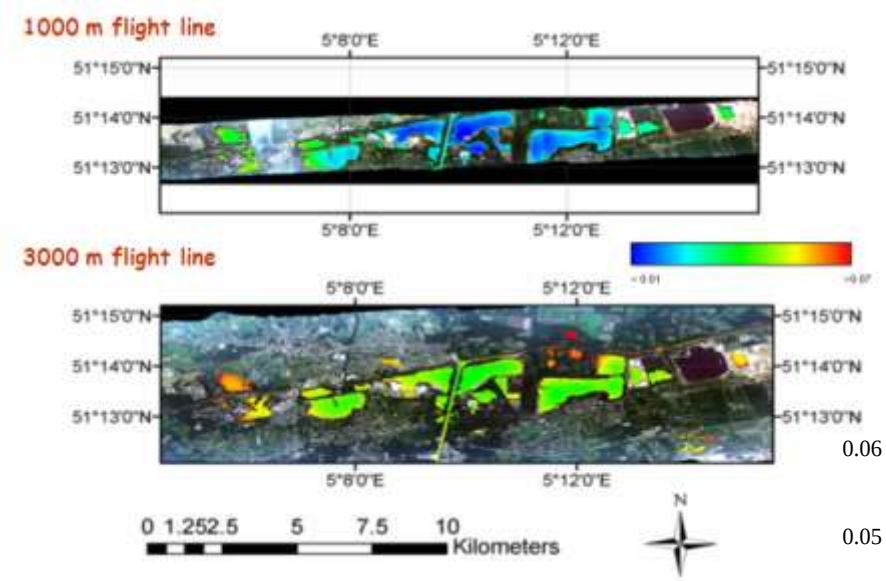
SIMEC Background: Workflow

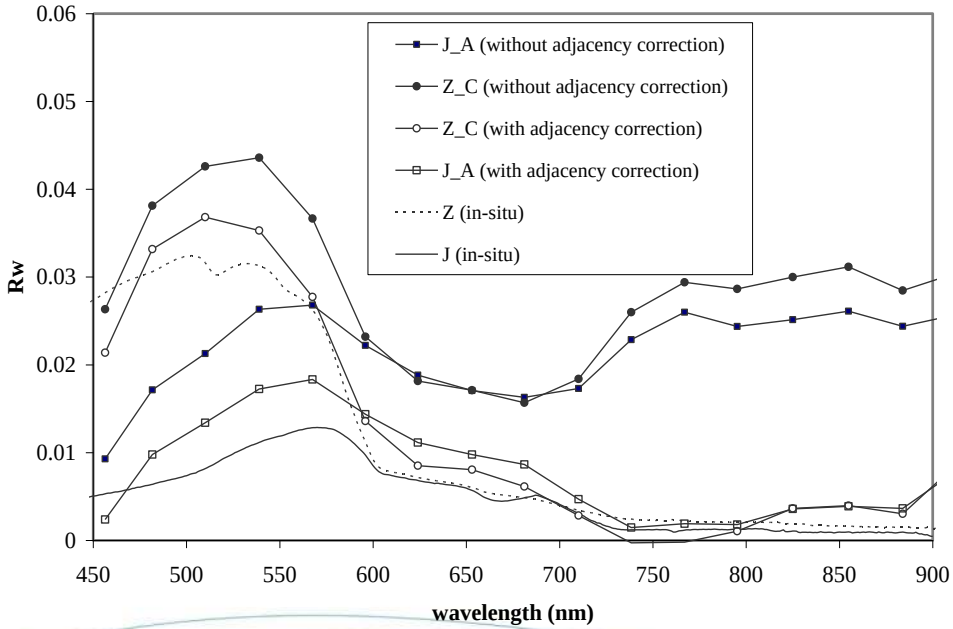
- Atmospheric correction (Modtran based)
  - AOT from land targets or sun photometer readings
  - ignoring adjacency effects
- Normalization at 780 nm
- Deviations from the NIR similarity spectrum = measure of the magnitude of the adjacency effect.
- Iteratively calculate contributing background until agreement with NIR similarity spectrum



$$\omega_i = \int_{x_{i-1}}^{x_i} A_x * \left(1 - \frac{t_d^a * F^a(x) + t_d^r * F^r(x)}{t_d^a + t_d^r}\right) dx$$

SIMEC application to airborne data





Sterckx S., Knaeps E., Ruddick K. International Journal of Remote Sensing
Vol. 32, Iss. 21, 2011

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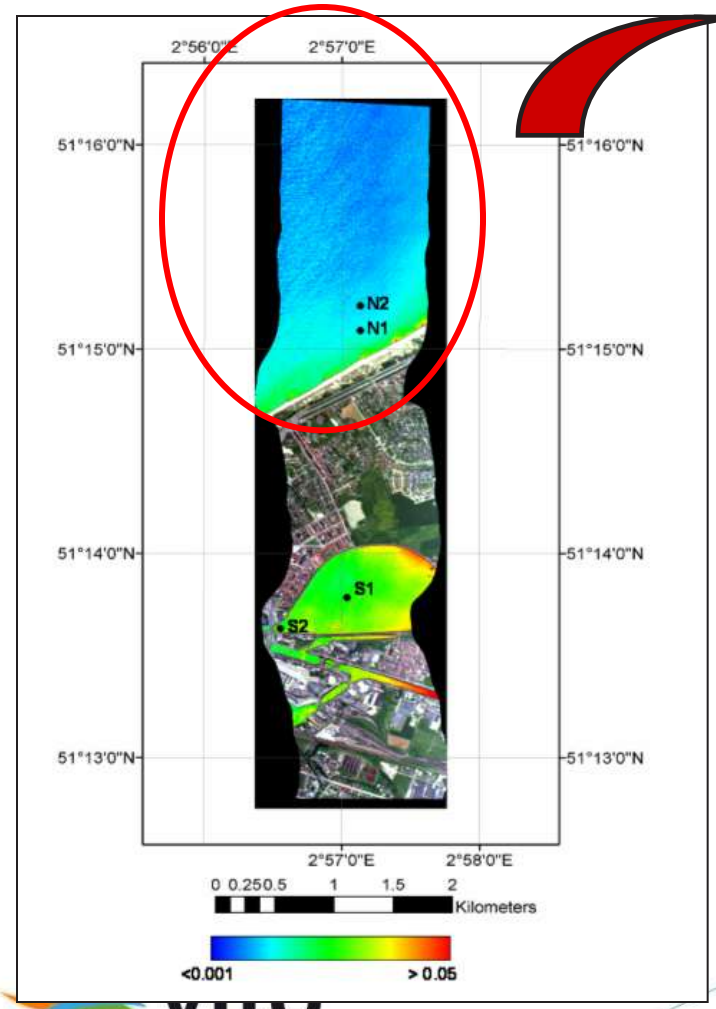
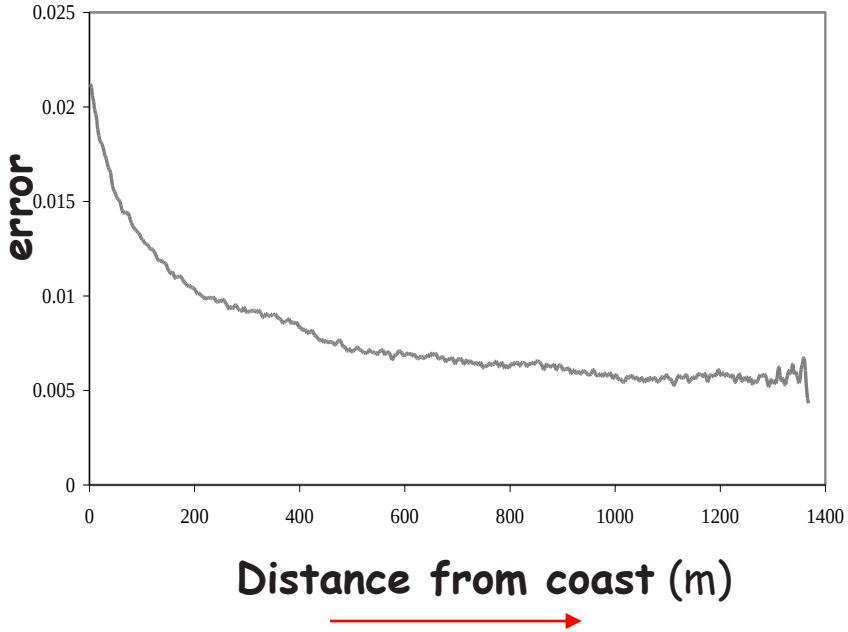
SIMEC application to airborne data

Example : Airborne CASI North Sea + Spuikom



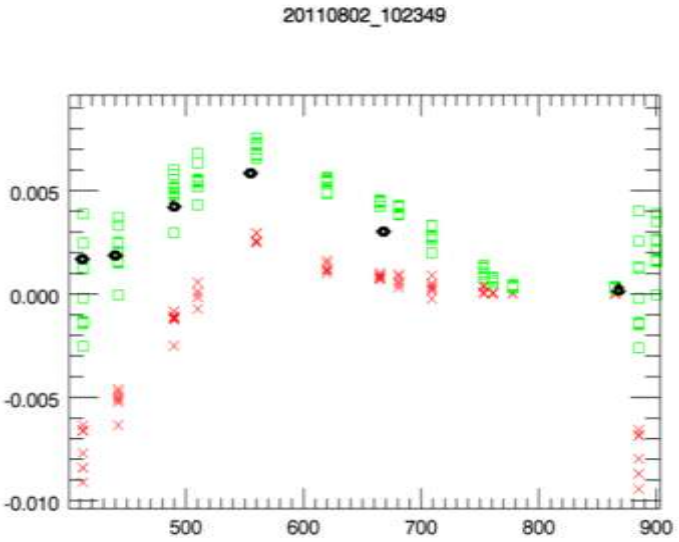


SIMEC application to MERIS : Palgrunden

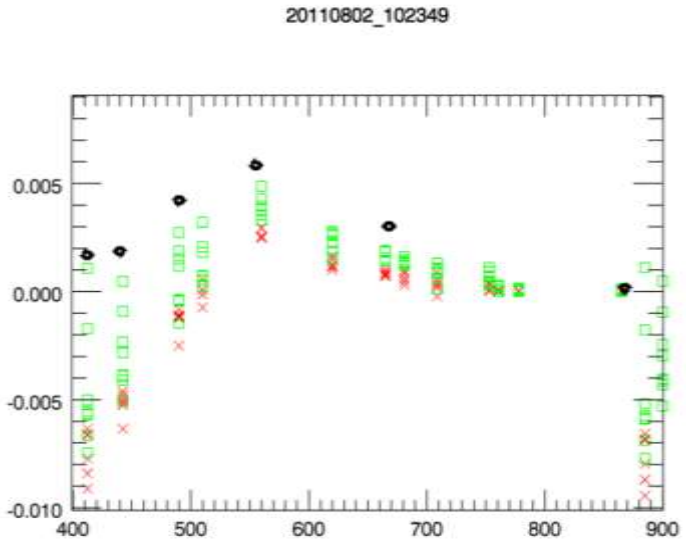
Green squares : SIMEC/ICOL + ODESA

Black diamonts : in-situ

Red crosses : ODESA without SIMEC/ICOL



SIMEC



ICOL

SIMEC application to MERIS : Palgrunden

Green squares : SIMEC/ICOL + ODESA

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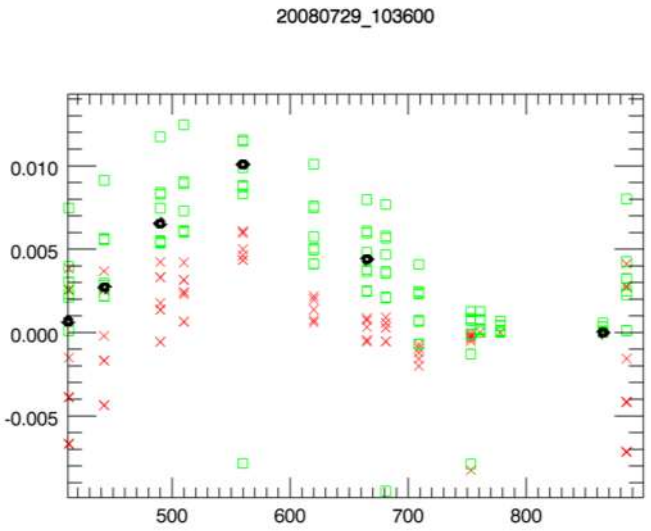
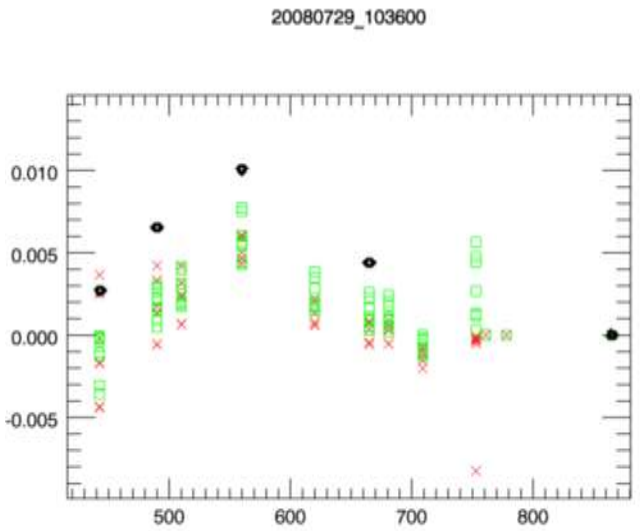


SIMEC



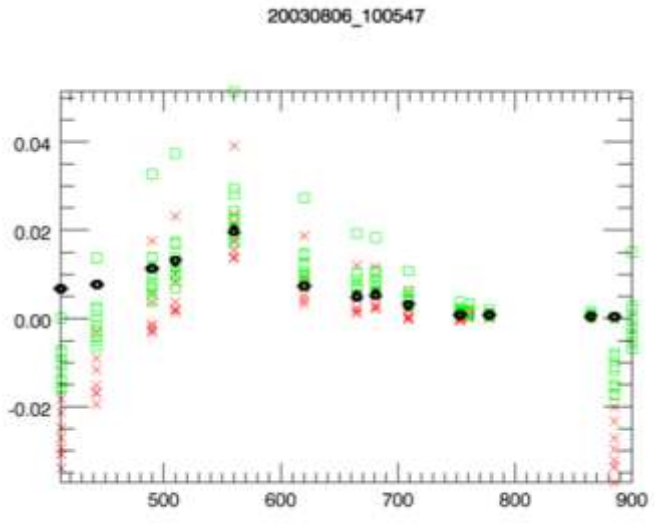
ICOL

SIMEC application to MERIS : North Sea

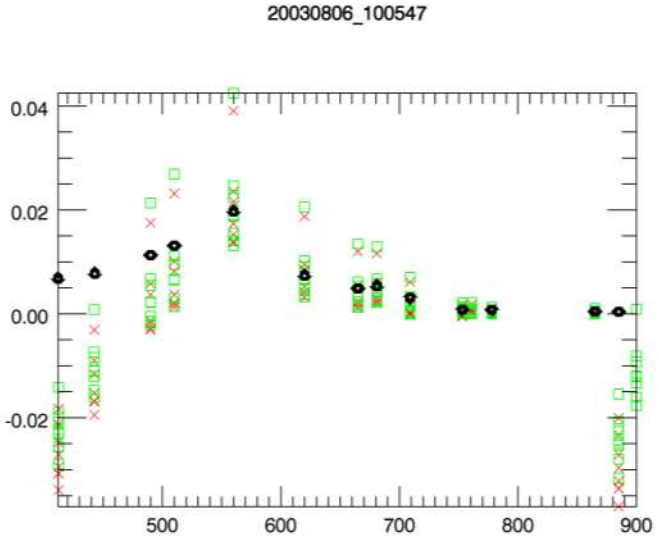
Green squares : SIMEC/ICOL + ODESA

Black diamonts : in-situ

Red crosses : ODESA without SIMEC/ICOL



SIMEC



ICOL

CONCLUSIONS AND FUTURE WORK (1)

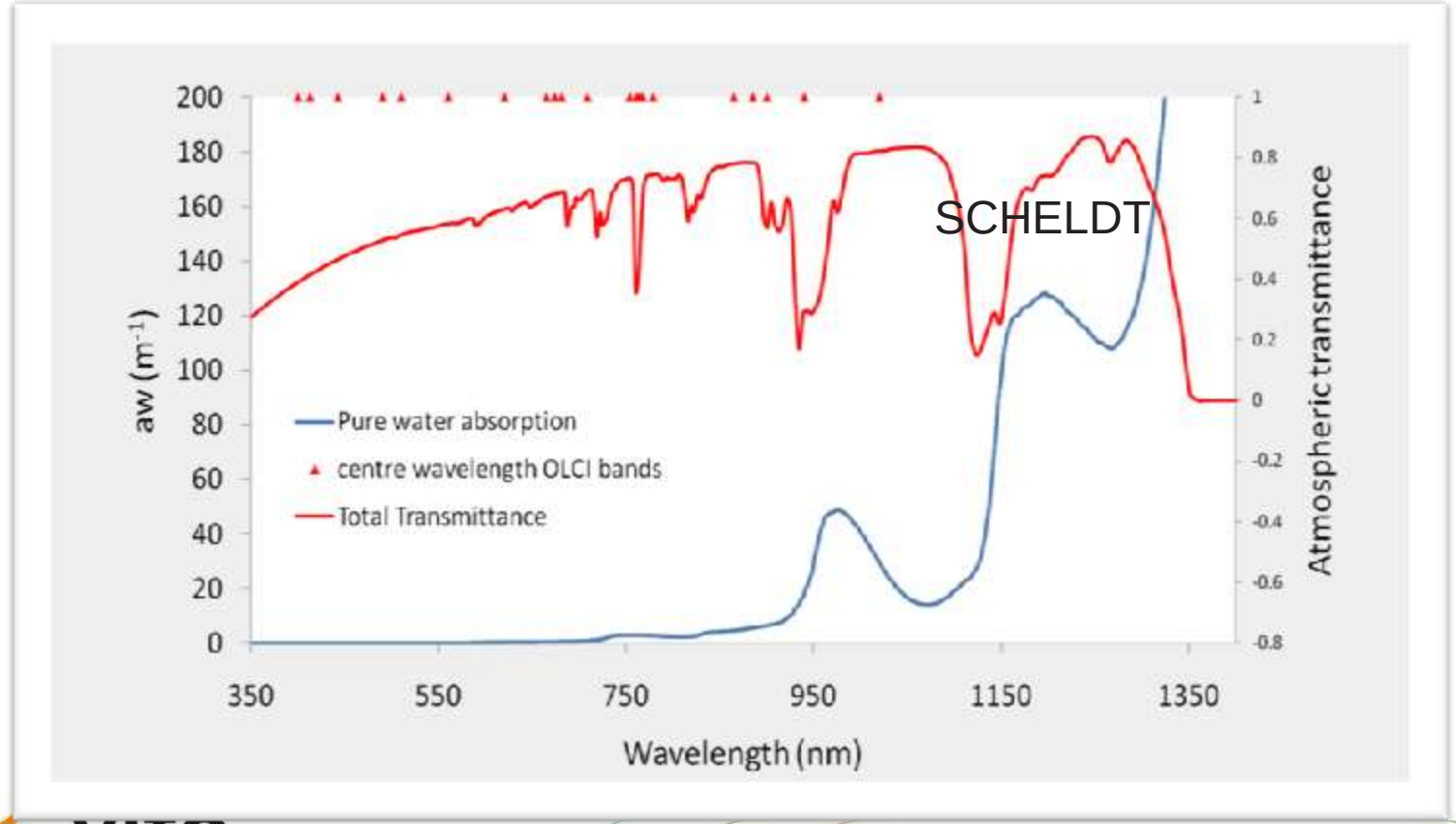
- SIMEC = sensor generic
- Complementary to the ICOL adjacency correction implemented in BEAM.
- focus on the further operationalisation of the algorithm by incorporation of SIMEC in a complete processing chain and linking it with automatic modules to derive AOT from land targets.

Water leaving reflectance – SWIR?

SeaSWIR

SWIR is potentially interesting:

- Atmospheric transmission windows
- SWIR spectral bands available in future spaceborne sensors (e.g. Hyspiri, OLCI)
- Local decrease in pure water absorption



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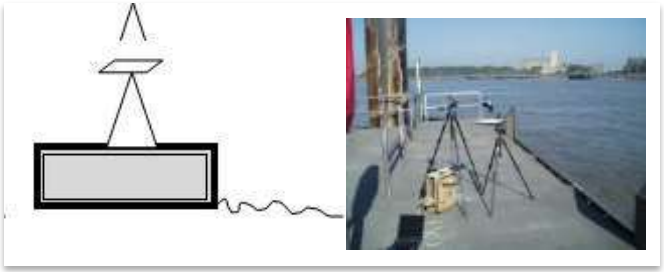
Knaeps, E. et al., Remote Sensing of Environment 120 (2012) 133-144

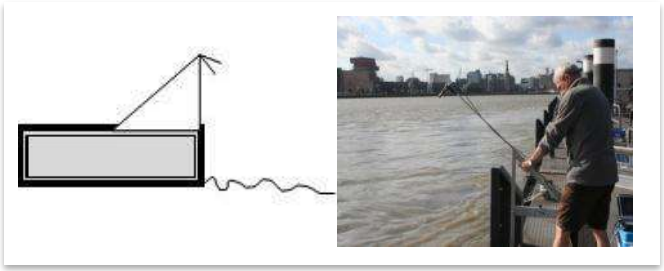
water leaving reflectance – SWIR?

But: little knowledge available, no suitable instrumentation
-> ASD spectrometer and Hydroscat with SWIR wavelengths

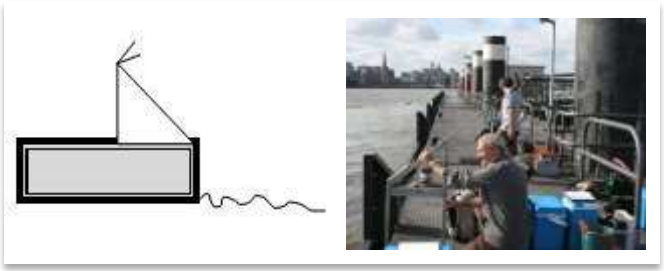
$E_d(0+)$:
downwelling irradiance
above the surface.



$L_u(a)$
total upwelling radiance
from the water



$L_{sky}(a)$
Downwelling sky radiance



The water-leaving reflectance (Rw) was calculated using the following equation (Mobley, 1999):

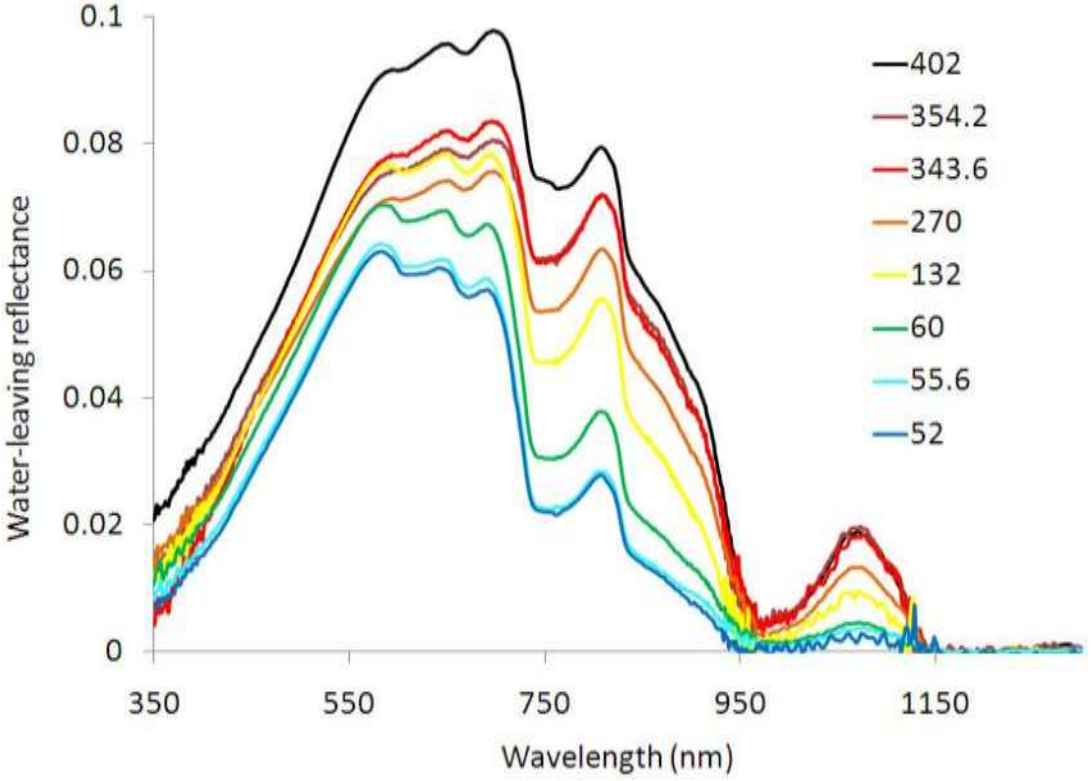
$$Rw = (Lw(a) - \rho as * Lsky(a)) / Ed(a)$$


Scheldt river
SeaSWIR
ASD
TRIOS

Scheldt river: Belcolour – MICAS heritage

Knaeps, E., Raymaekers, D., Sterckx, S, Ruddick, K., Dogliotti, A.I.. 2012. In situ evidence of non-zero reflectance in the OLCI 1020nm band for a turbid estuary, *Remote Sensing of Environment, Sentinel special issue*, 112

Pure water absorption coefficient (Pope & Fry, 1997: Kou *et al*., 1993)



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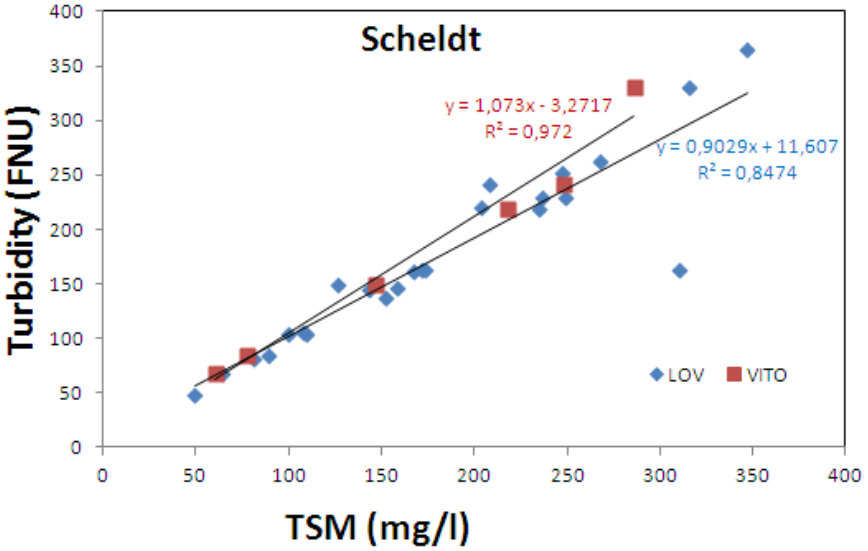
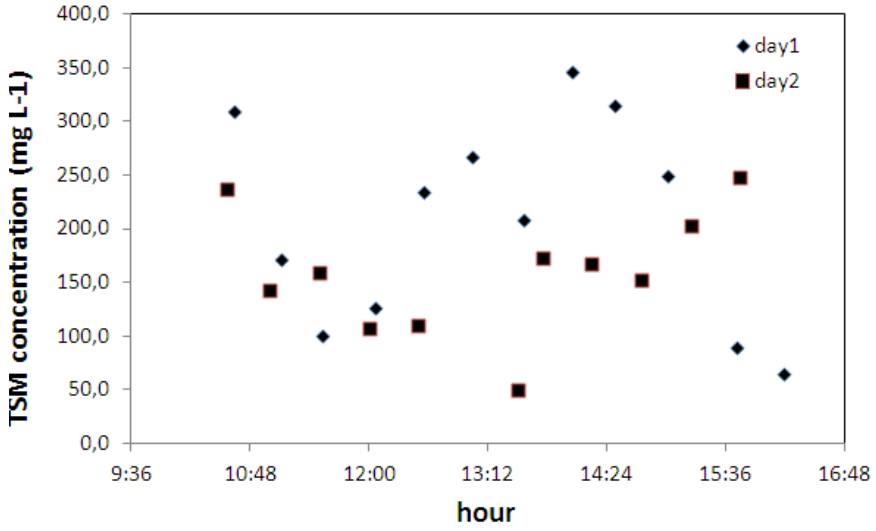
MUMM

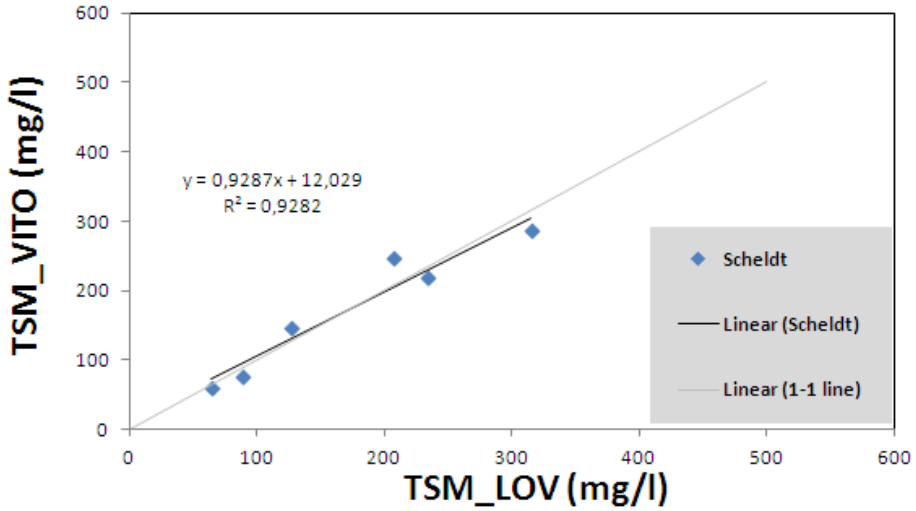
I A F E CONICET U B A

OBSERVATOIRE OCEANOLOGIQUE VILLEFRANCHE/MER

Scheldt river: new data collection







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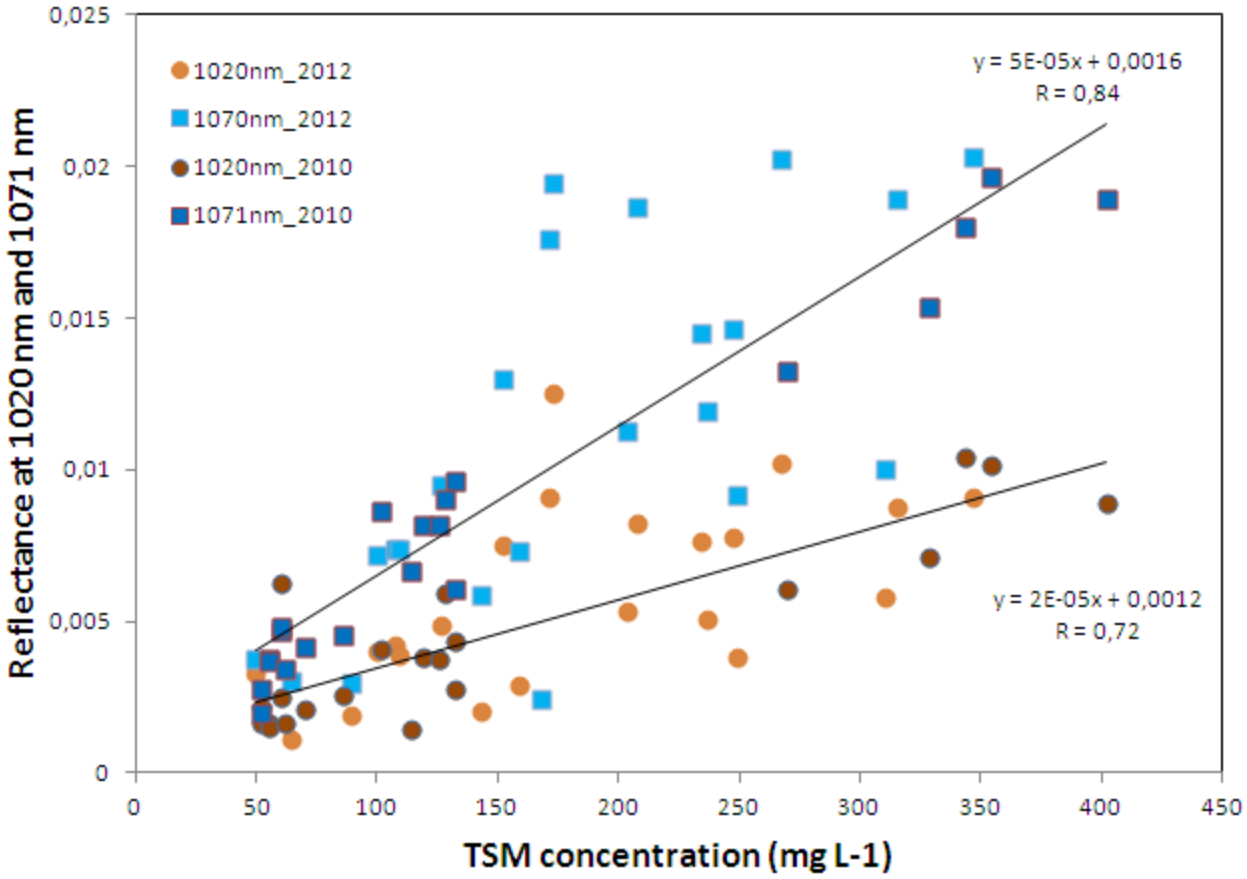
Scheldt river: new data collection



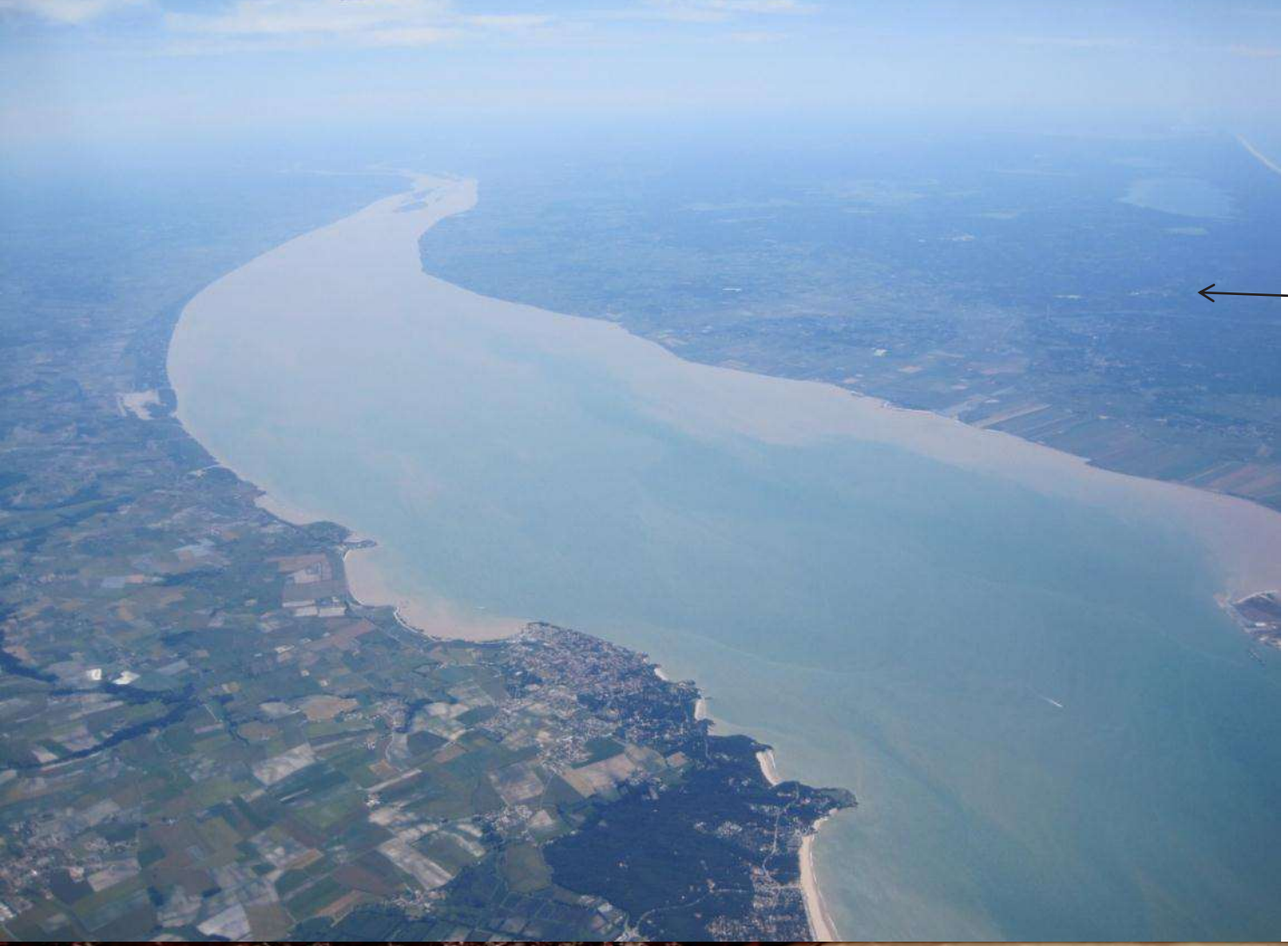

Gironde river
Côte de la Manche


SeaSWIR
Blaye


Paulliac


Blaye

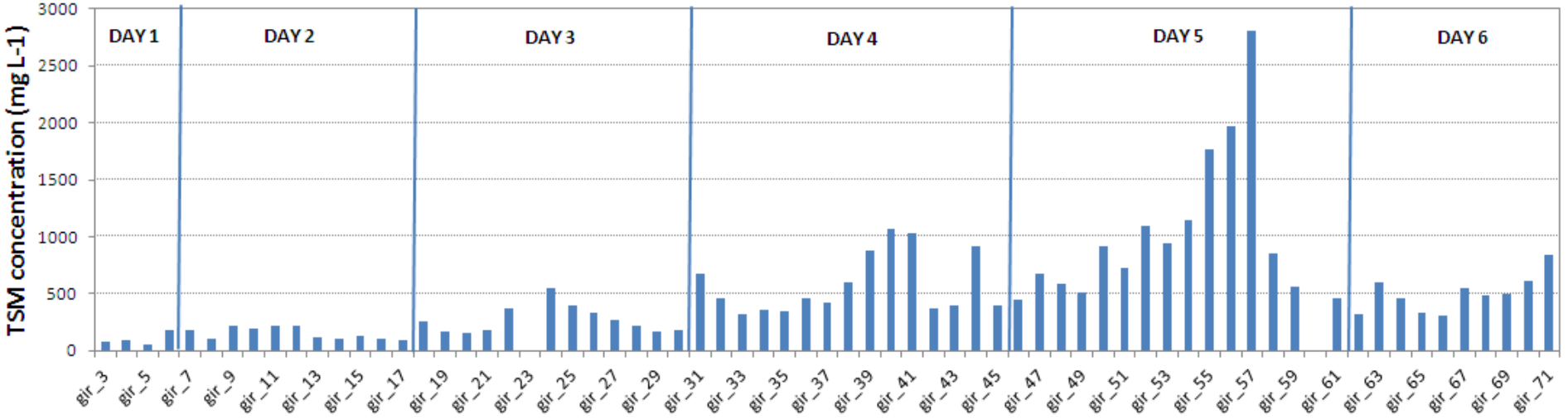
SeaSWIR

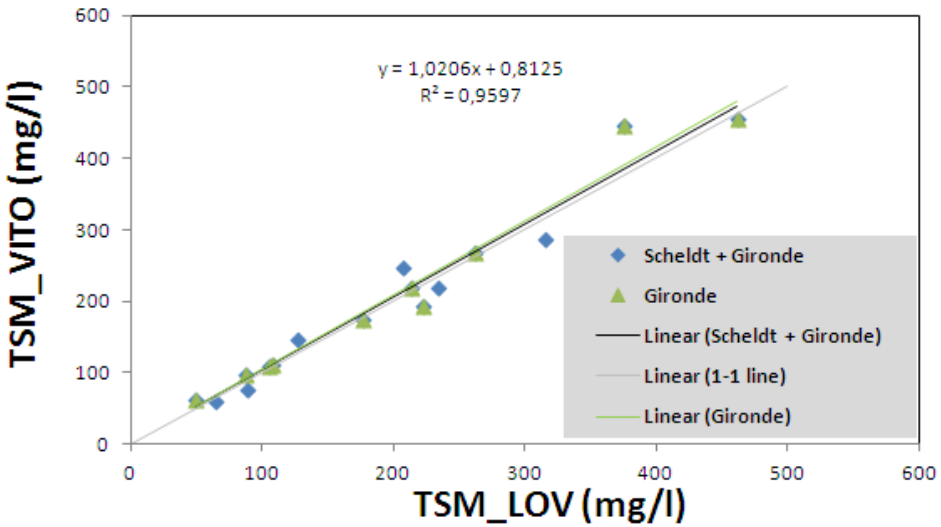


Picture taken by
APEX operator

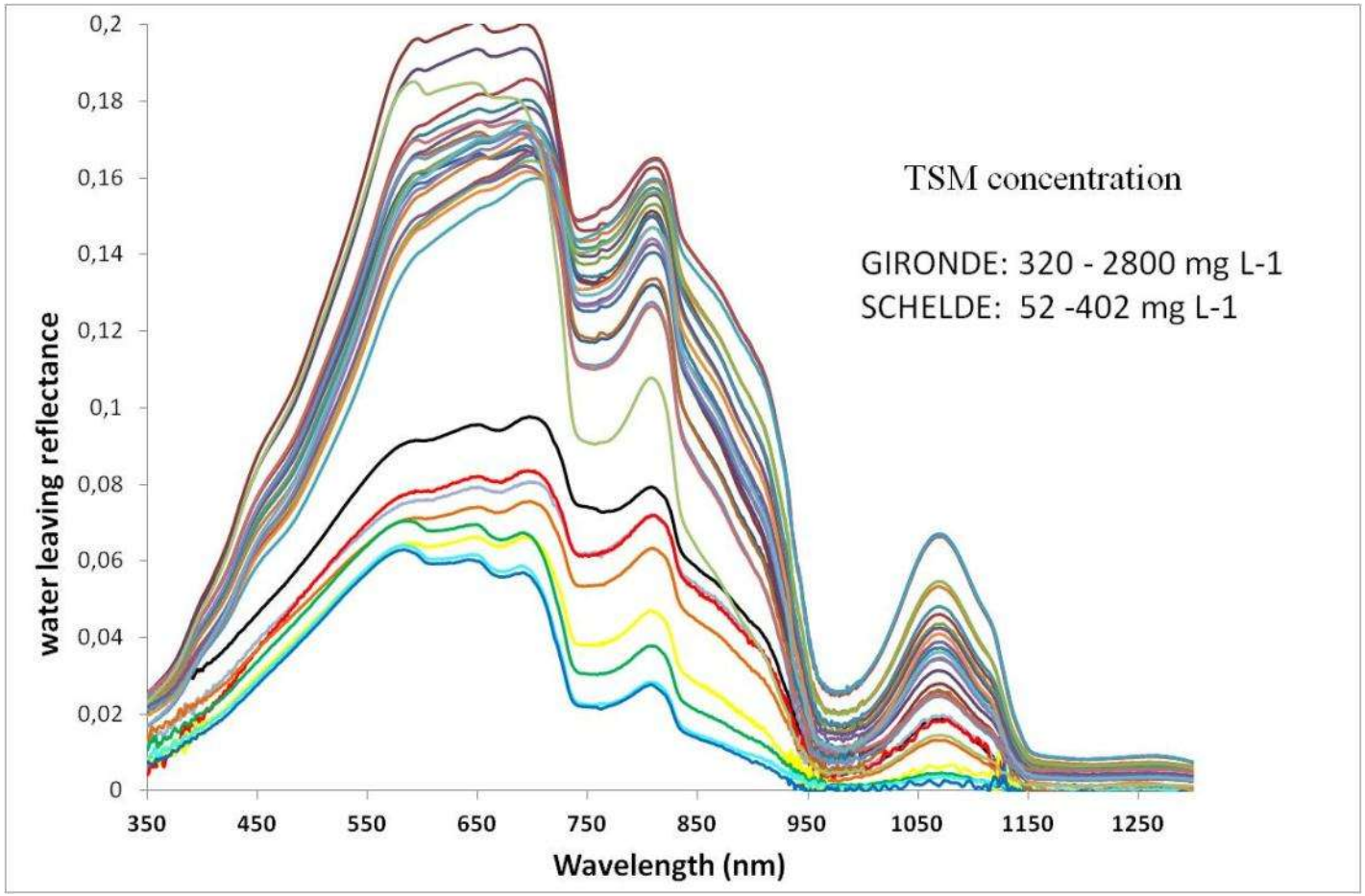
APEX quicklook

Gironde river

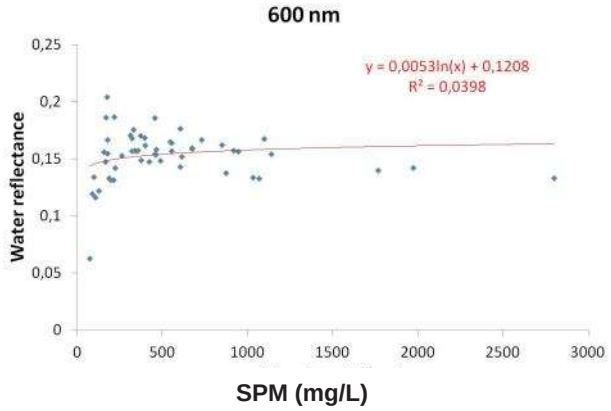


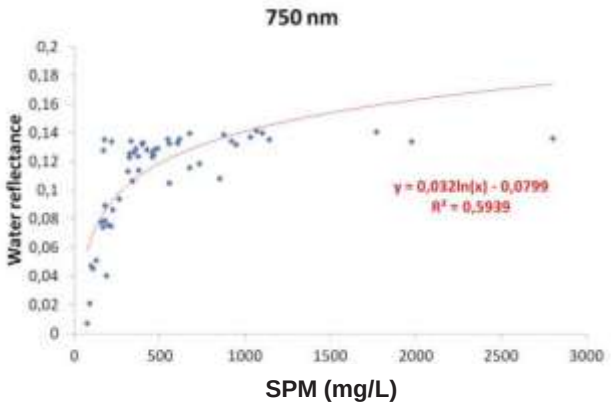


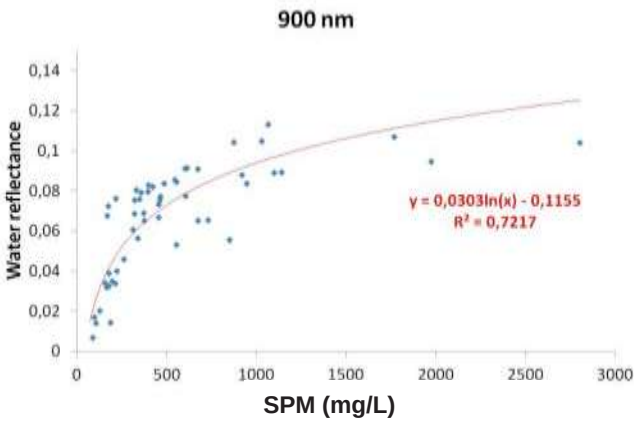
Gironde river – ASD water reflectance

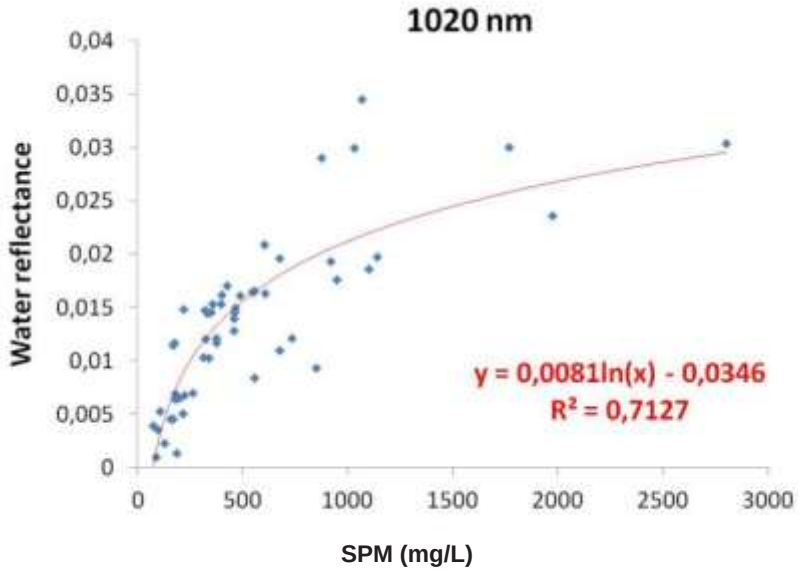


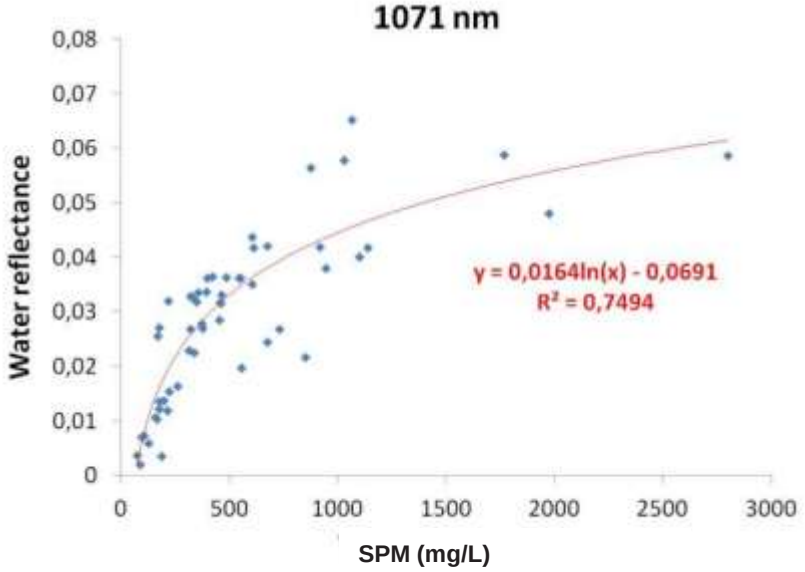
Gironde river – ASD water reflectance



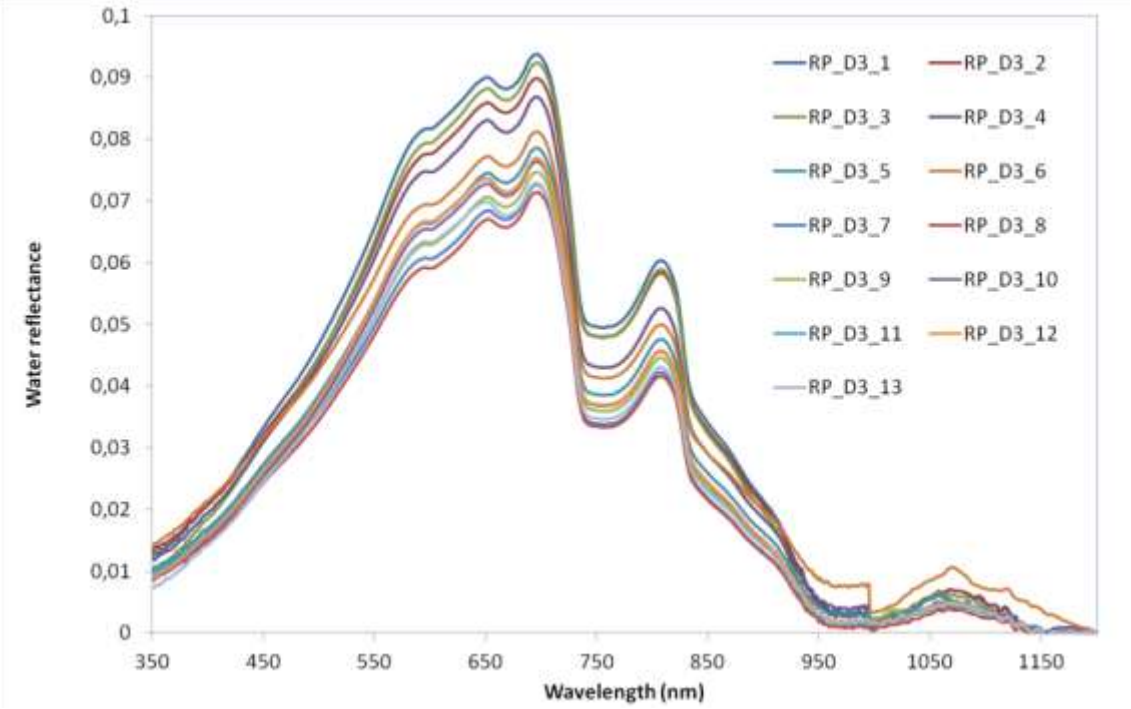








La Plata river – ASD water reflectance



Scheldt – APEX flight

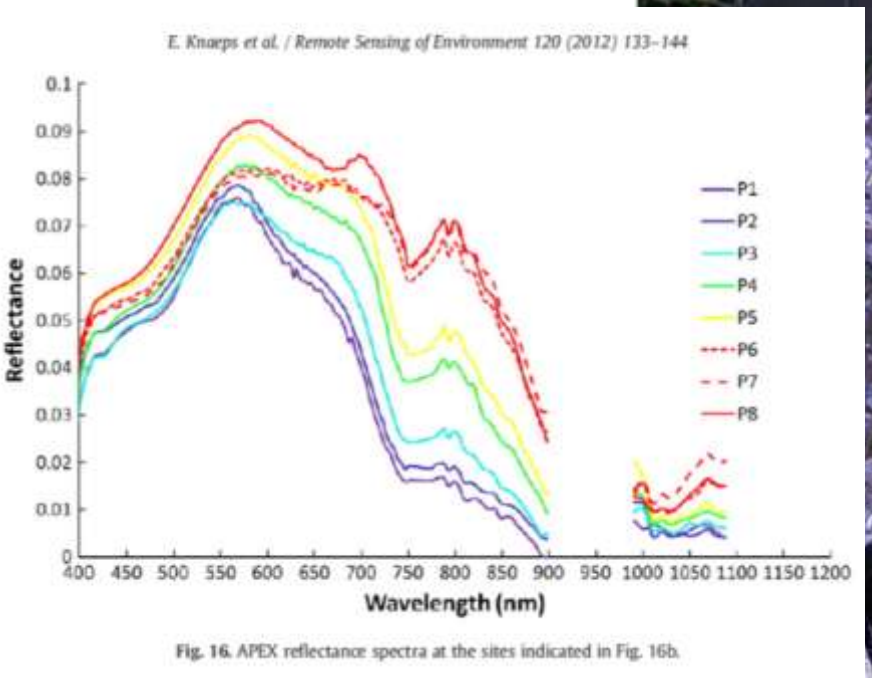
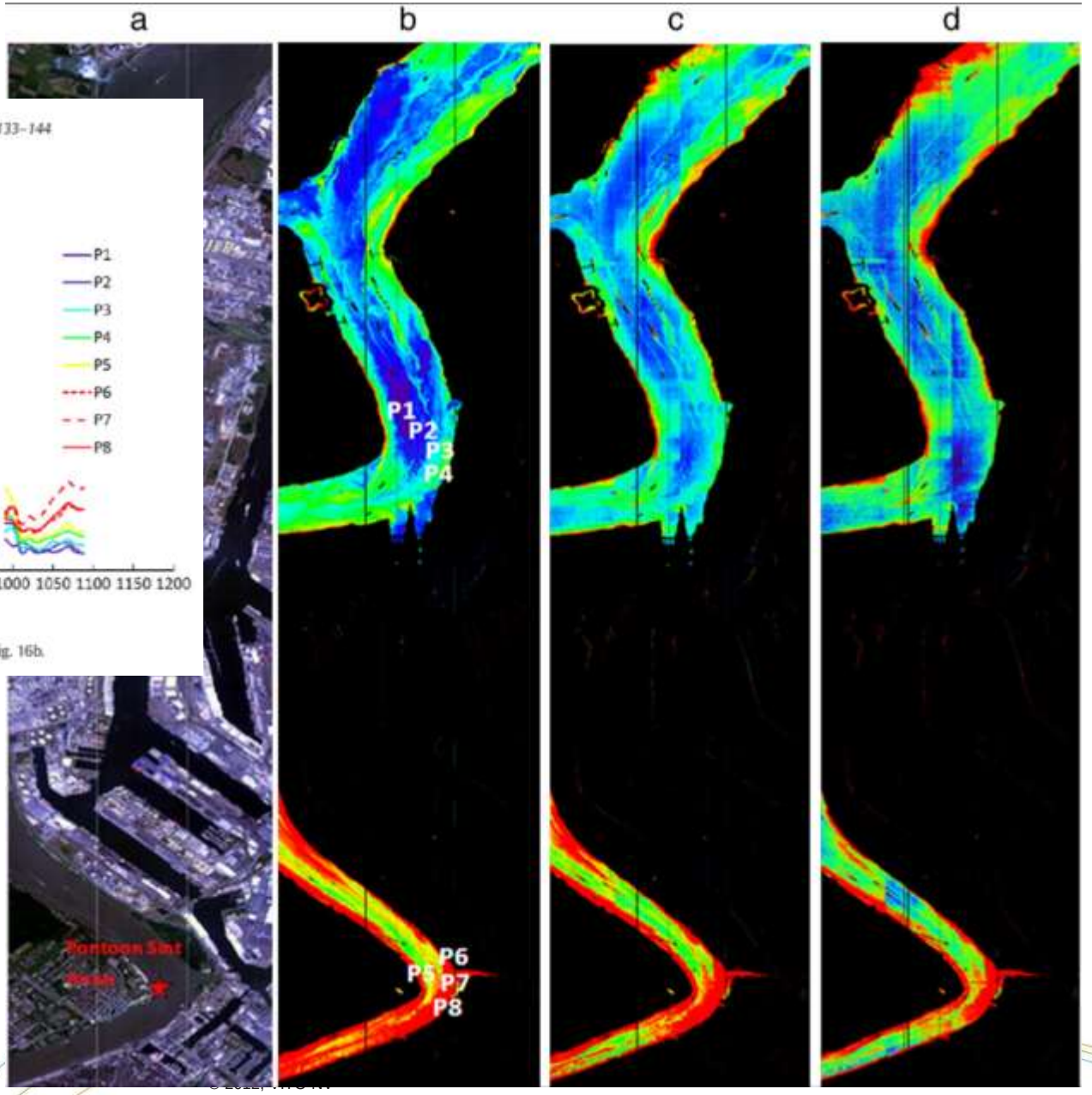


Fig. 16. APEX reflectance spectra at the sites indicated in Fig. 16b.



(a) RBG APEX image of the Scheldt
(b) map of Rw711/Rw597
(c) map of Rw1069
(d) map of Rw1020.

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CONCLUSIONS AND FUTURE WORK (2)

- black pixel assumption invalid for Scheldt ,Gironde and la Plata estuary. A significant increase in reflectance was observed between 950 and 1150 nm where pure water absorption has a local minimum.

- SNR and atmospheric influences does not seem to alter these findings.

WARNING when using the SWIR black pixel assumption for atmospheric correction

need for an **adjusted atmospheric correction for highly turbid waters**. (Incorrect use of the black pixel assumption in atmospheric correction can lead to an overestimation of the aerosol contribution and a significant underestimation of the derived water reflectance!)

- correlation of water reflectance with TSM concentration.

Suggest that spectral bands beyond 1000 **nm contain information on the concentrations of optical constituents.**

CONCLUSIONS AND FUTURE WORK (2)

Future work includes:

- TRIOS analysis and intercomparison
- IOP analysis (including Hydroscat!)
- Hydrolight simulations
- Image analysis (MODIS, HICO, APEX)
- Are there systematic differences between sites or is a single algo appropriate for all 3 sites?

Thank you

http://hyperspectral.vgt.vito.be/

els.knaeps@vito.be