

Télédétection hyperspectrale des eaux turbides

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Talk outline

- Remote-sensing of turbid nearshore waters: needs and challenges
- Bio-optical algorithms for
 - suspended particulate matter concentration (SPM)
 - chlorophyll *a* concentration (Chl *a*)
- Application of SPM algorithm to MERIS, SPOT and Pléiades
- Application of Chl *a* algorithm to airborne hyperspectral image



Remote-sensing of turbid nearshore waters

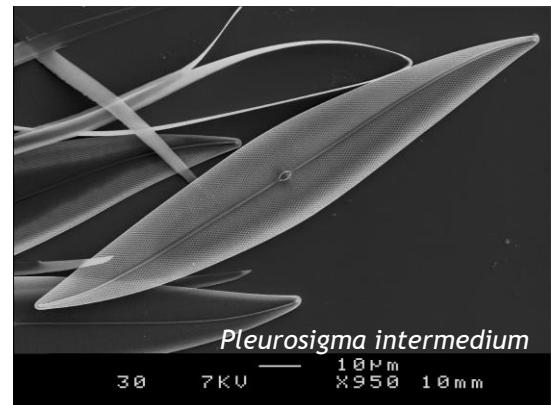
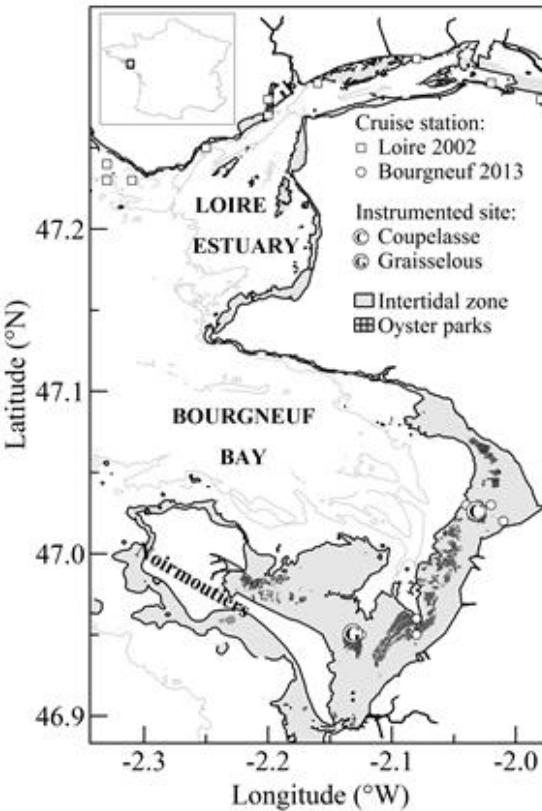
Needs and challenges

- Hyperspectral and high-resolution spatial data
- Atmospheric corrections for turbid waters with non-zero near-infrared (NIR) reflectance values
- Bio-optical algorithms adapted to turbid waters (*i.e.*, when SPM > 50 g m⁻³)

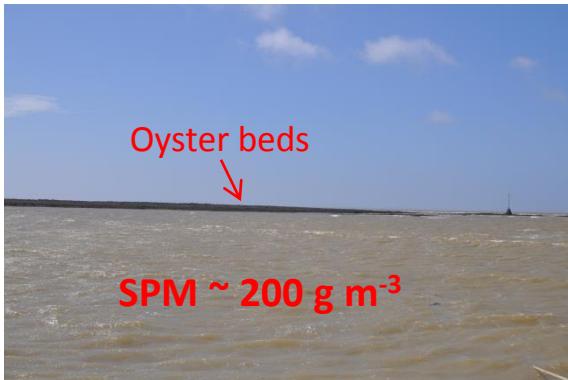
Study site

Bourgneuf Bay and Loire estuary:

- Large intertidal mudflats
- Turbid waters
- Benthic microalgae (microphytobenthos)

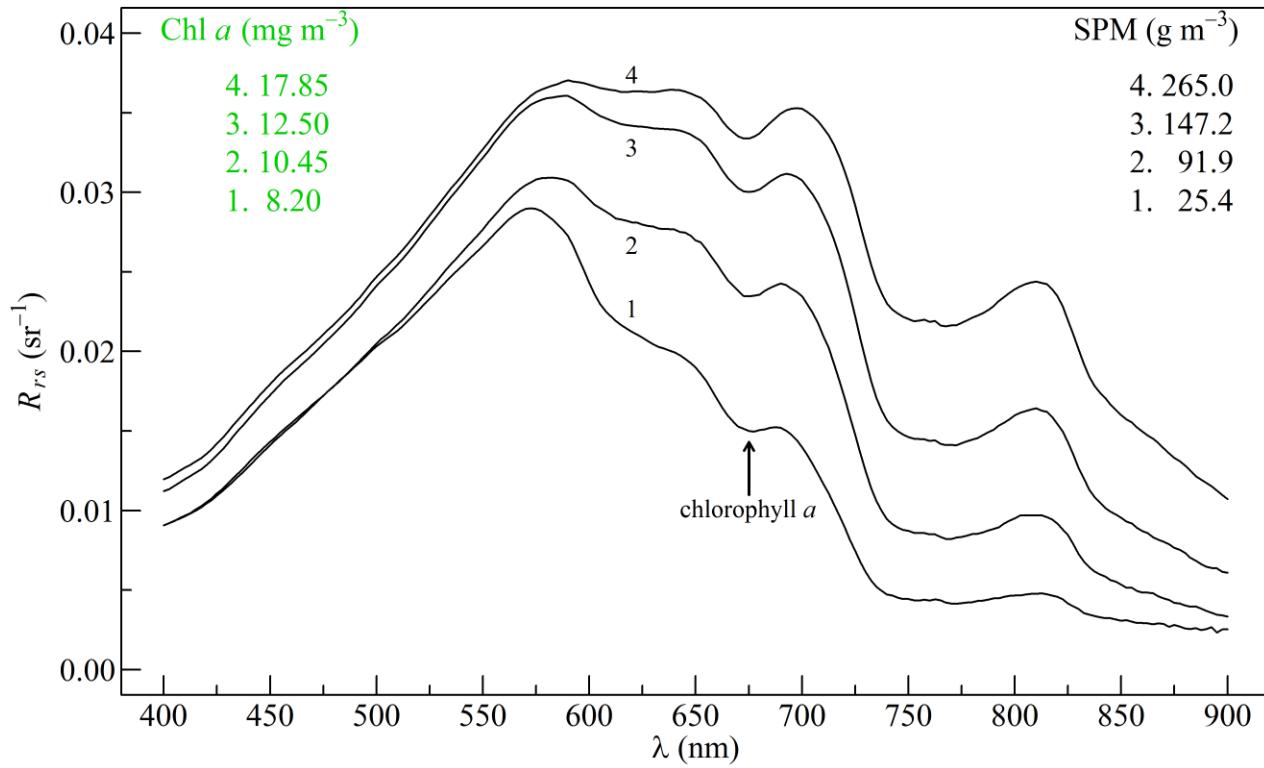


Bio-optical cruise in Bourgneuf Bay, 8 - 12 April 2013



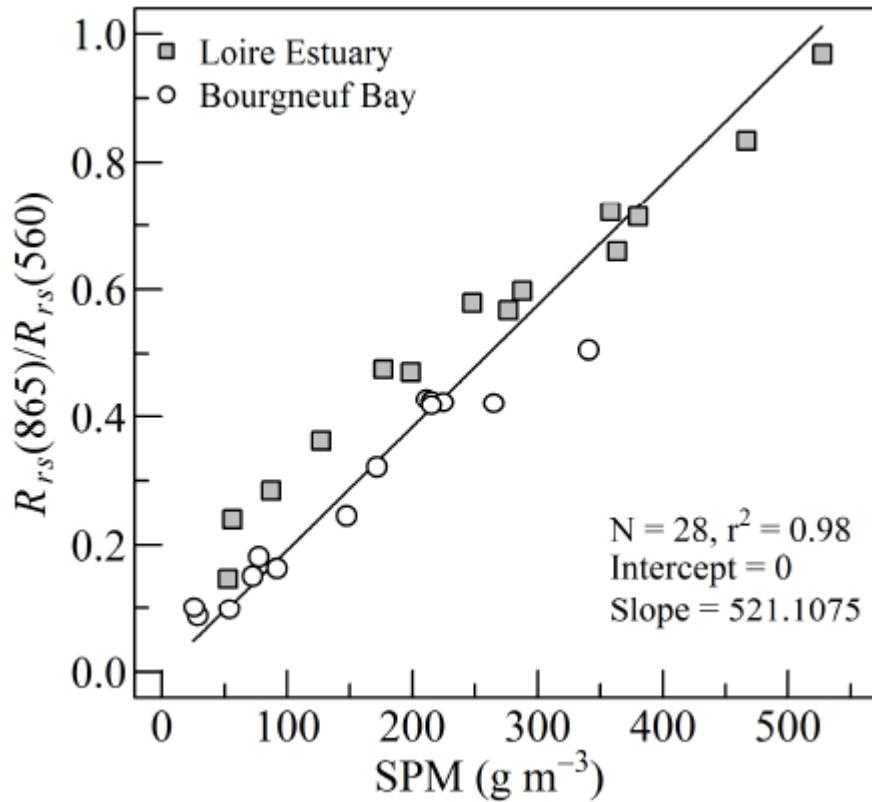
- Acquisition of $R_{rs}(\lambda)$, SPM, and Chl *a* data in shallow turbid waters of the intertidal zone (nearby oyster- and mussel-farming sites)
- IOPs were measured: a , a_p , b_{bp}
- Pigment composition of microalgae determined using HPLC

Example of *in situ* reflectance, SPM and Chl *a* data



SPM Bio-optical algorithm

- Adapted to MERIS bands
- Easily modified for other sensors (*e.g.*, SPOT, Pléiades)

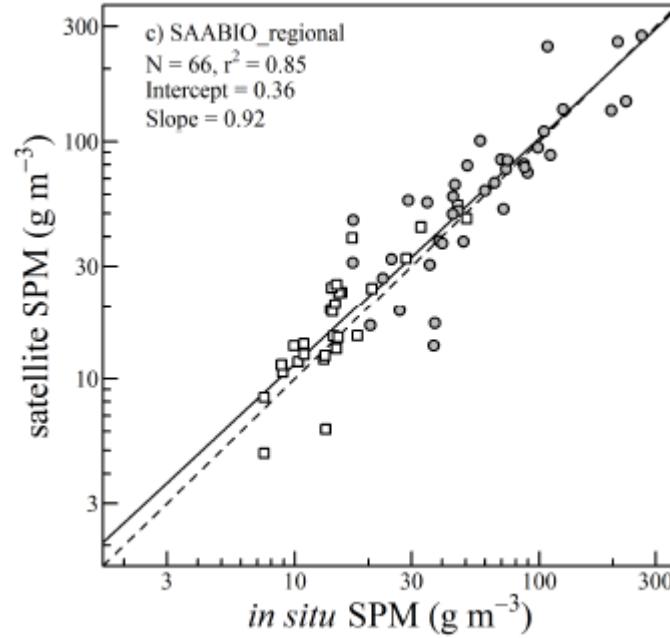
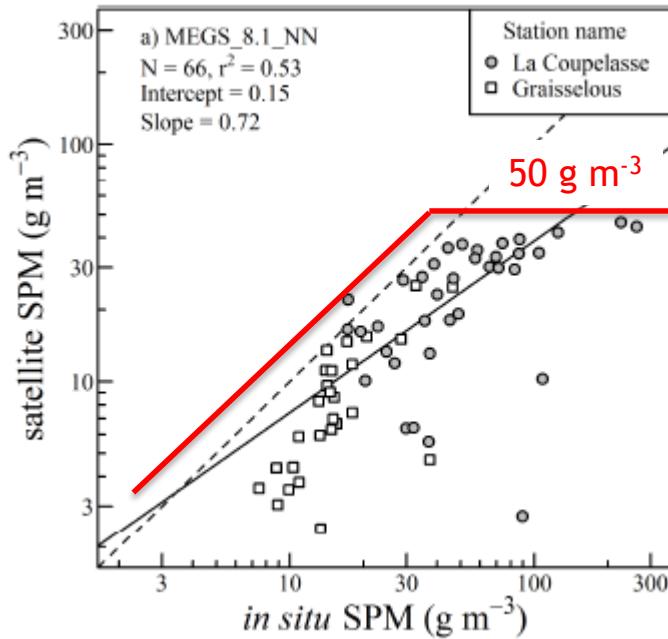


Doxaran, D., J.-M. Froidefond, and P. Castaing (2003). Remote sensing reflectance of turbid sediment-dominated waters. Reduction of sediment type variations and changing illumination conditions effects using reflectance ratios, *Appl. Opt.*, 42, 2623-2634.

Gernez, P., L. Barillé, A. Lerouxel, C. Mazeran, A. Lucas, & D. Doxaran (submitted). Remote sensing of suspended particulate matter in turbid oyster-farming ecosystems.

Application of SPM algorithm to MERIS FR

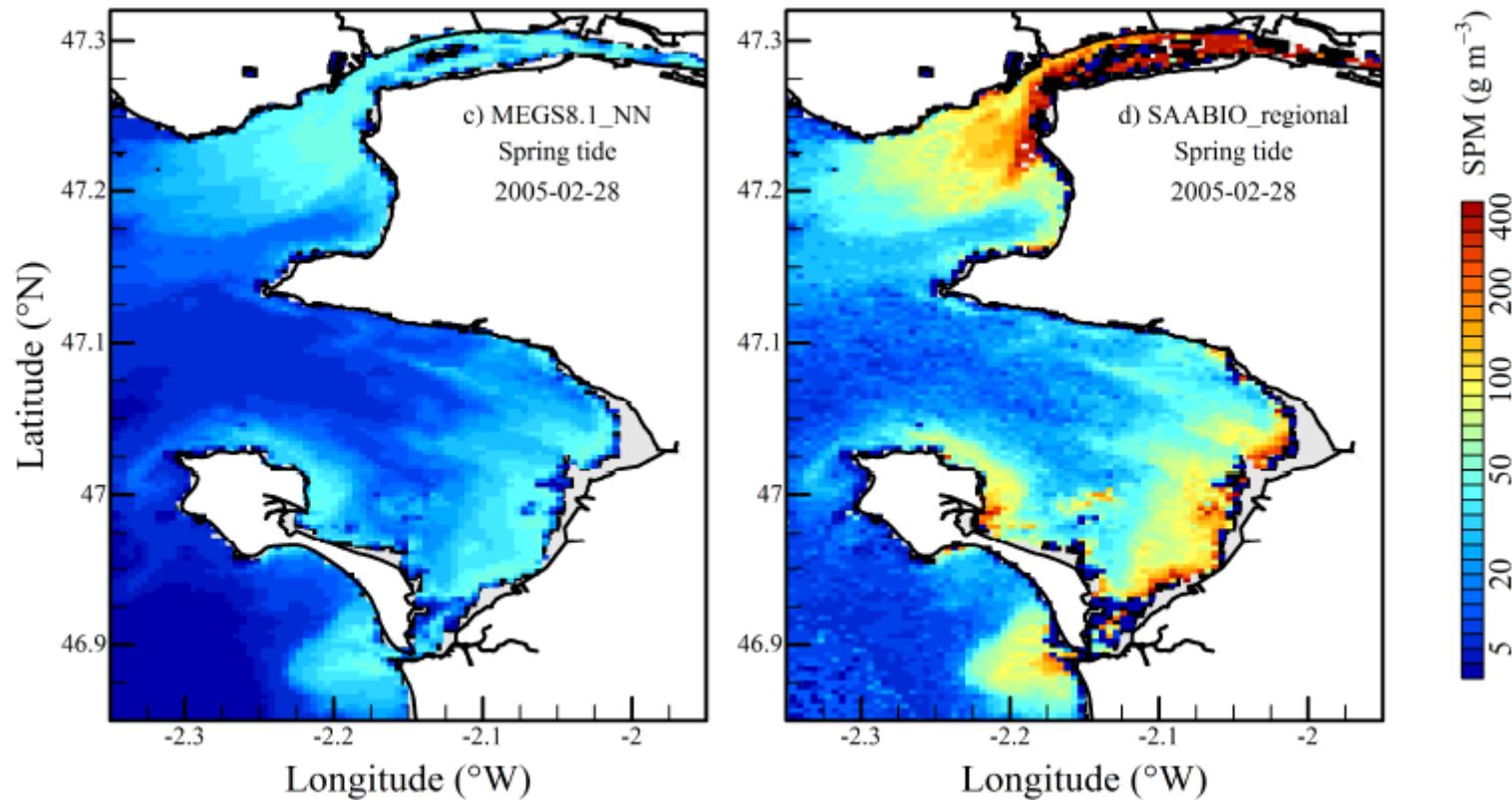
- Standard case 2 SPM saturates at about 50 g m^{-3}
- SAABIO atmospheric correction + regional algorithm is OK



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Application of SPM algorithm to MERIS FR

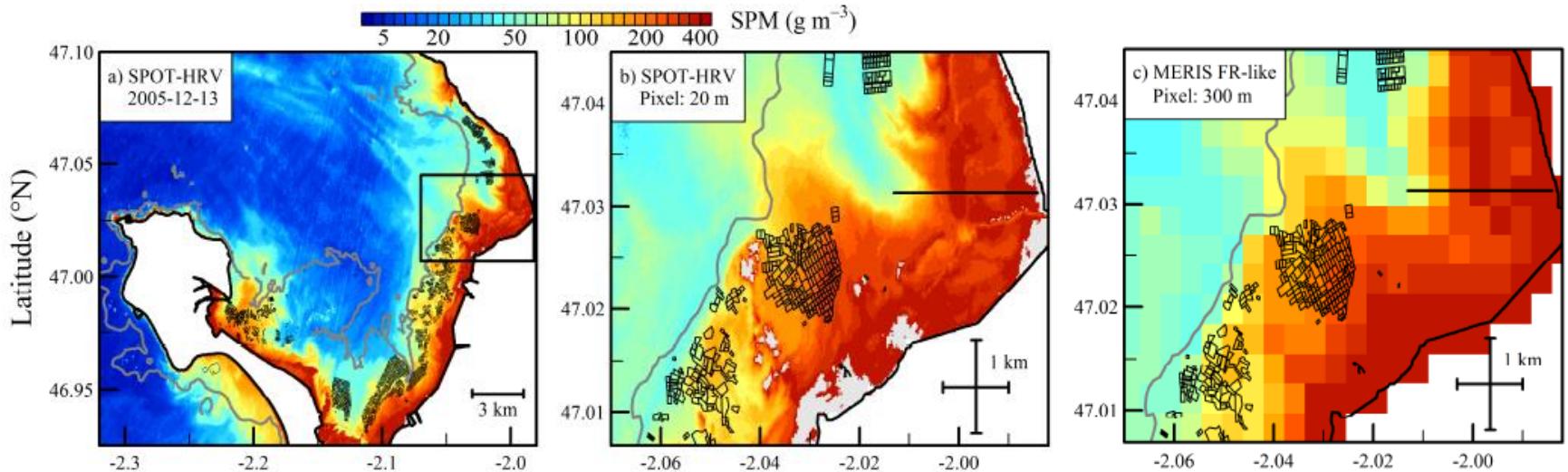
- Same MERIS image processed using case 2 standard vs. algorithm for turbid waters



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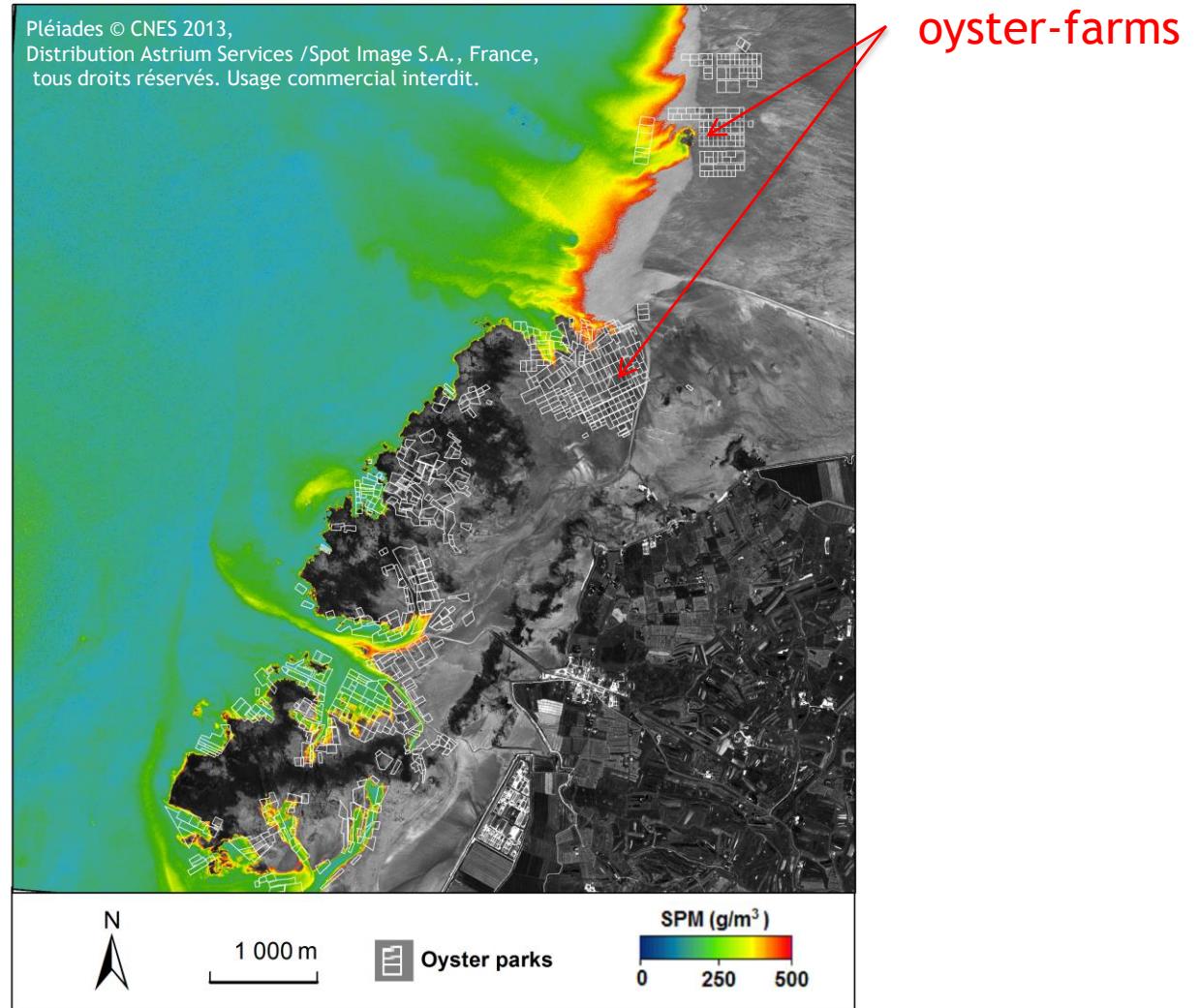
Application of SPM algorithm to SPOT

- Spatial resolution of 300 m is sufficient for bay-scale studies

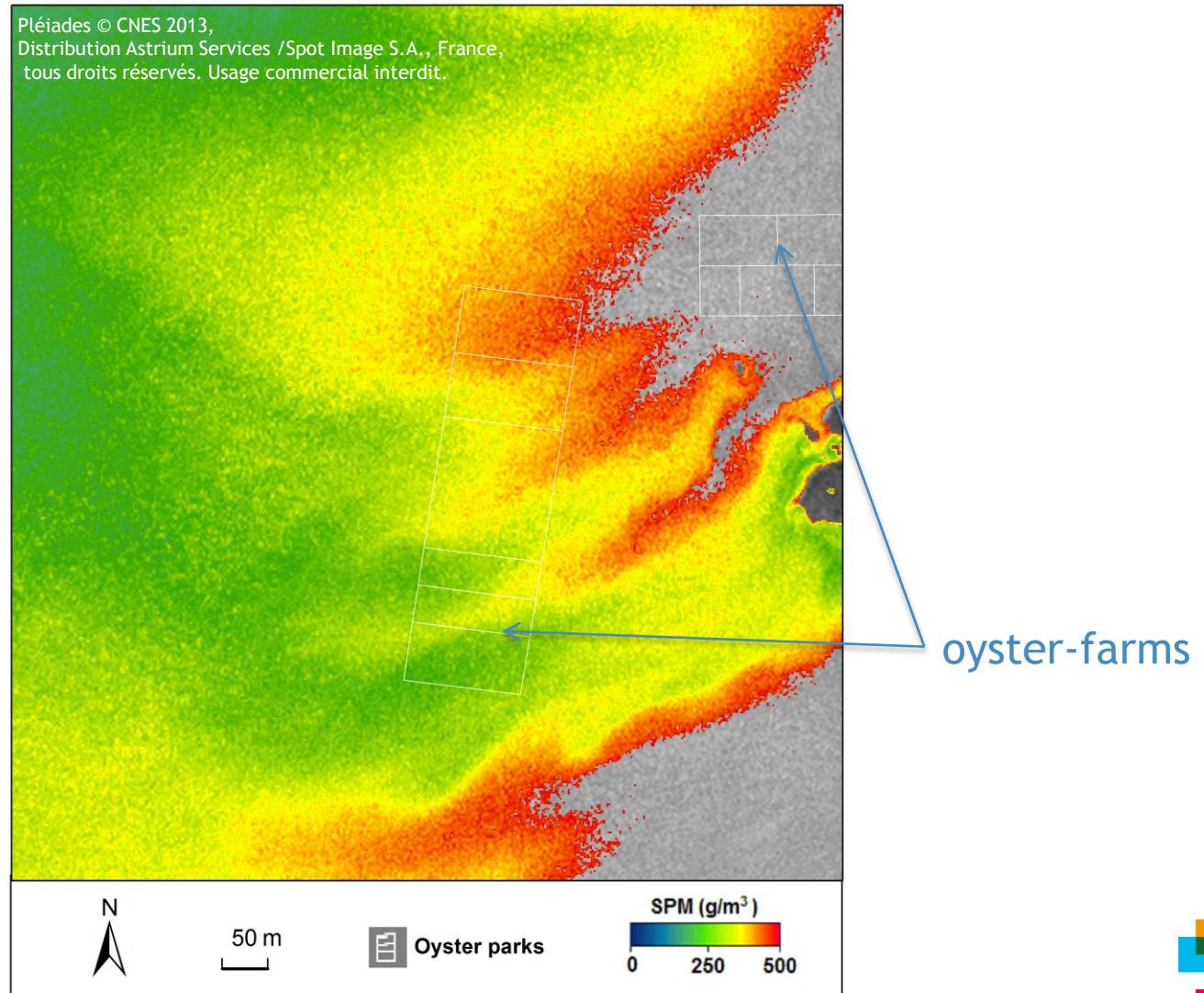


Gernez, P., L. Barillé, A. Lerouxel, C. Mazeran, A. Lucas, & D. Doxaran (submitted).
Remote sensing of suspended particulate matter in turbid oyster-farming ecosystems.

Application of SPM algorithm to Pléiades



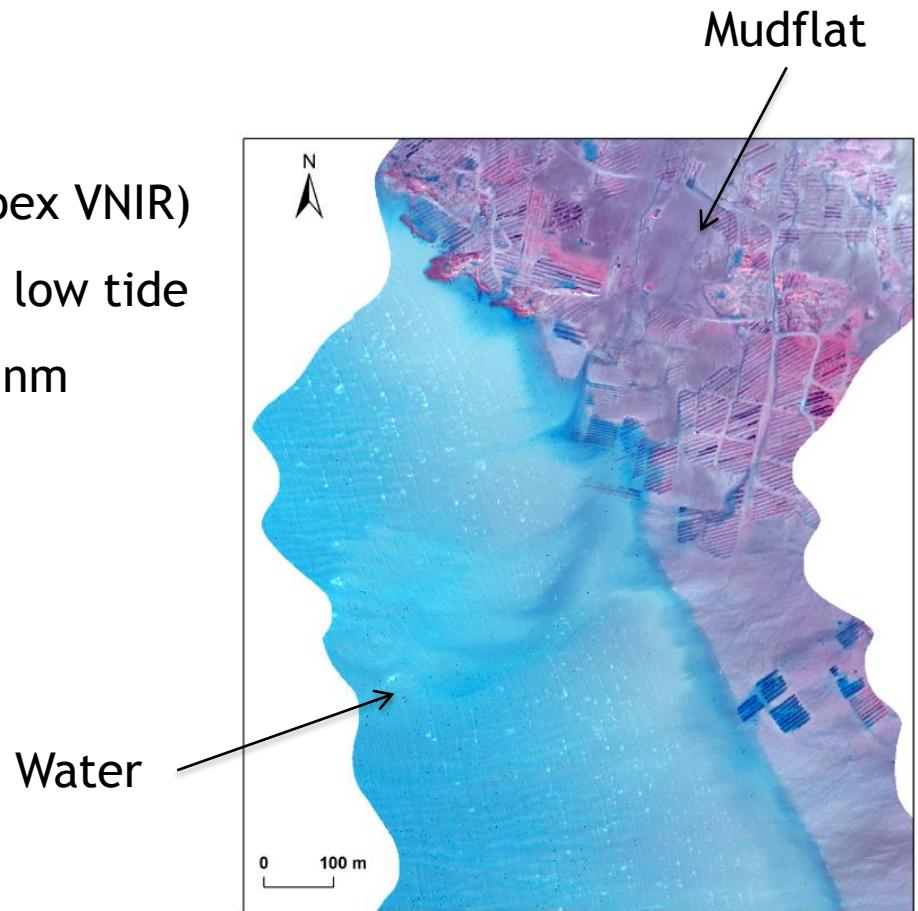
Application of SPM algorithm to Pléiades



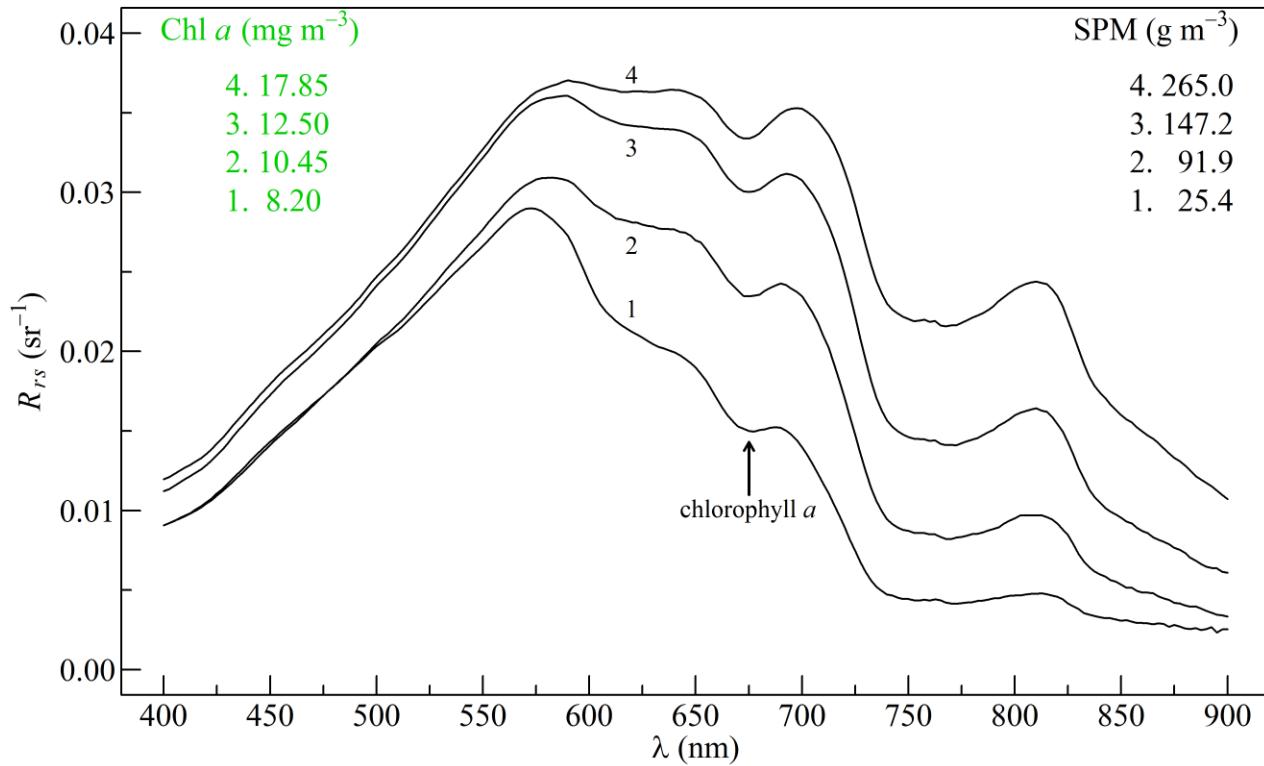
Airborne hyperspectral data

Airborne hyperspectral image (HySpex VNIR)

- 21 September 2009, 1 hour after low tide
- Spectral range from 400 to 1000 nm
- Spectral resolution of 4.5 nm
- Ground resolution of 1 m



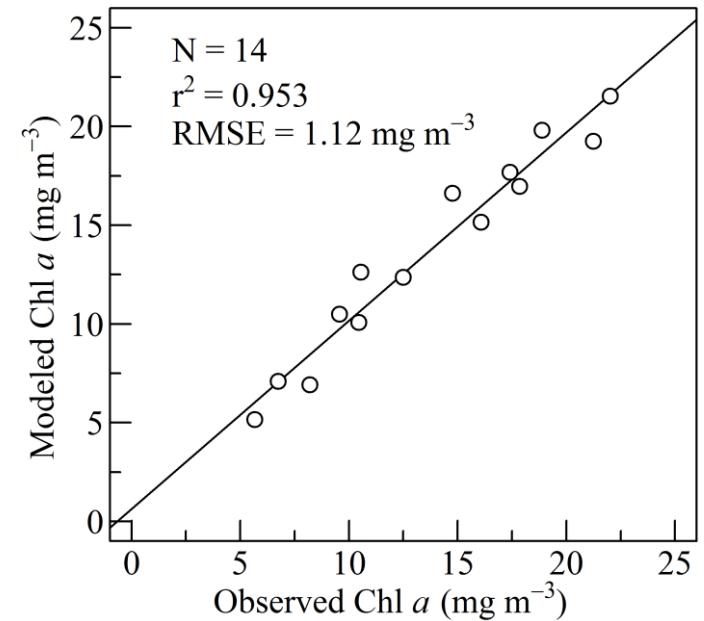
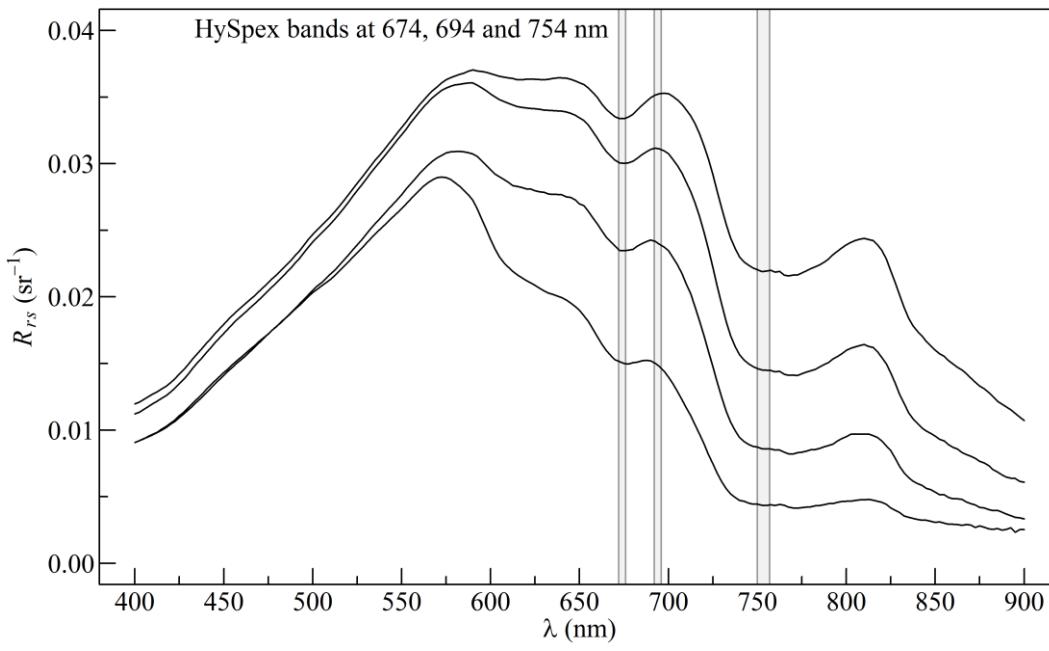
How to detect chlorophyll *a* in turbid waters?



Example of *in situ* reflectance, SPM and Chl *a* data

3-band model (HySpex bands)

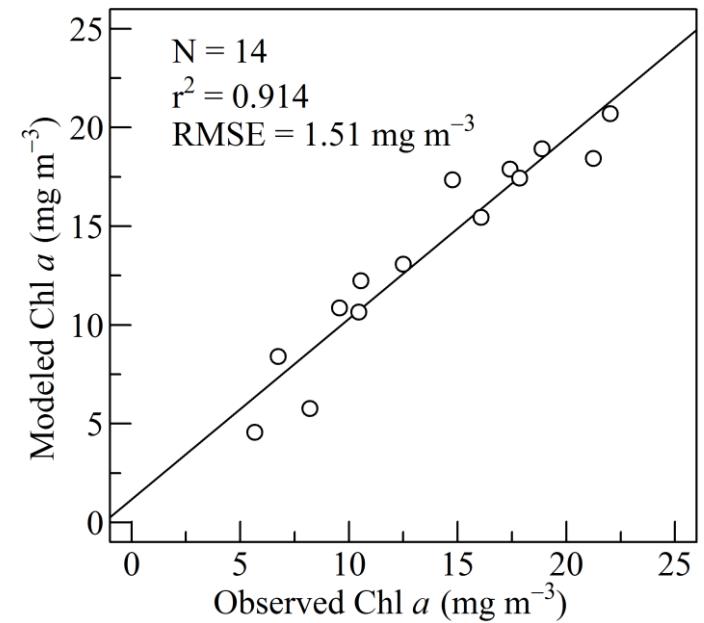
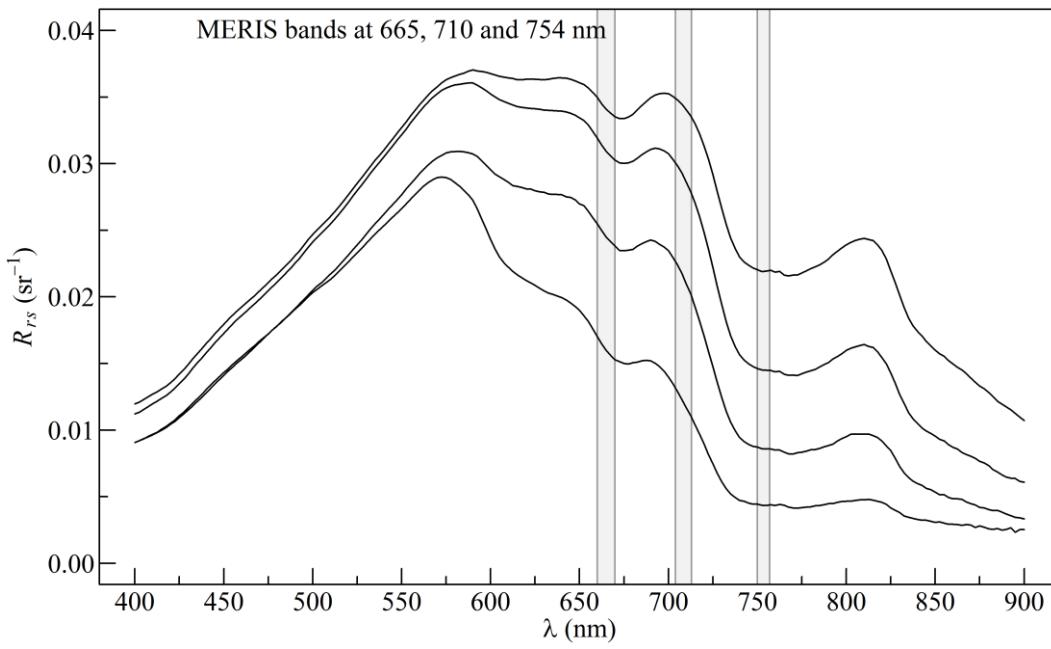
$$\text{Chl } a \sim R_{rs}(754) / [1/R_{rs}(674) - 1/R_{rs}(694)]$$



Adapted from Gitelson et al. (2008) A simple semi-analytical model for remote estimation of chlorophyll *a* in turbid waters: Validation. *Remote Sensing Environment* 112: 3582-3593.

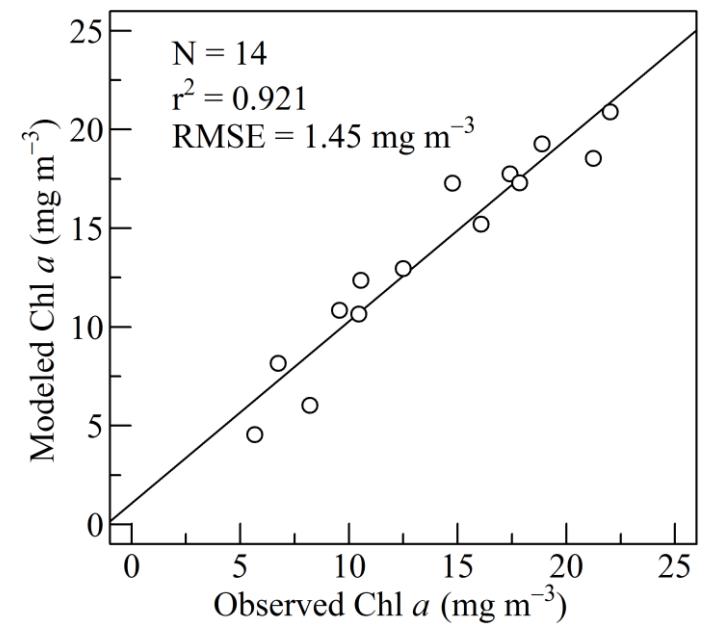
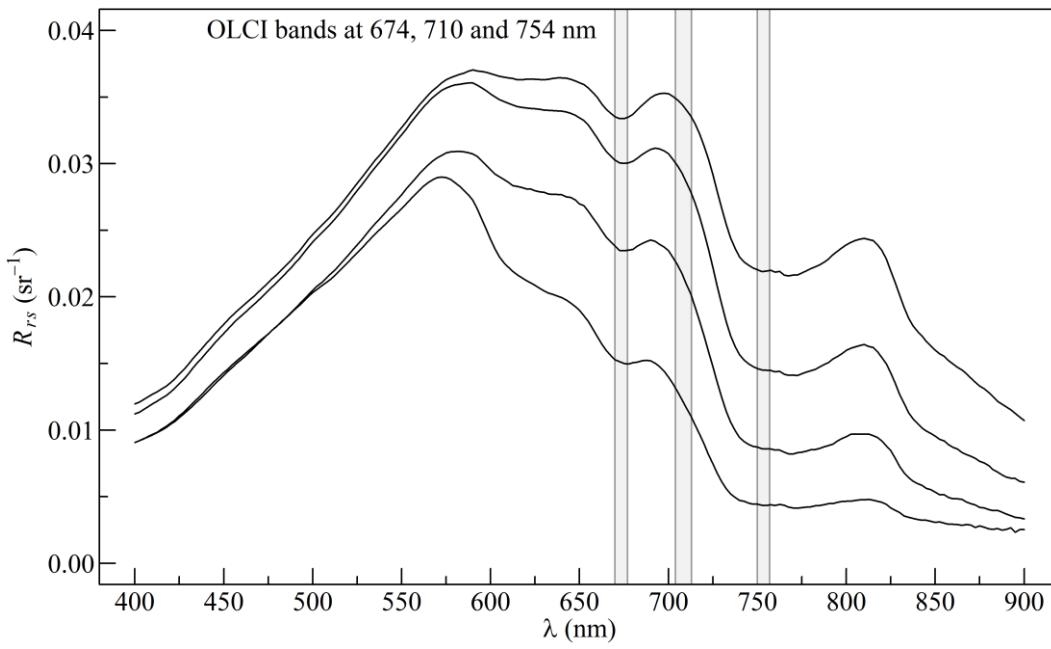
3-band model (MERIS bands)

$$\text{Chl } a \sim R_{rs}(754) / [1/R_{rs}(665) - 1/R_{rs}(710)]$$

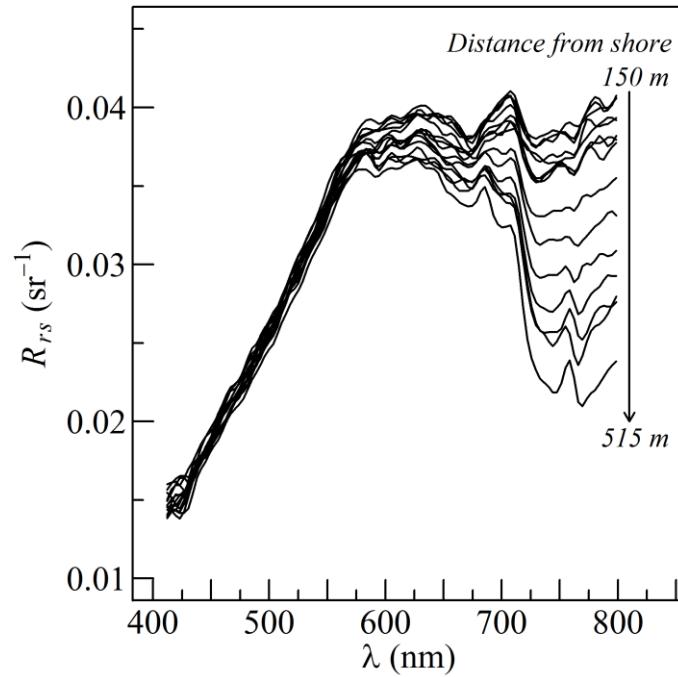
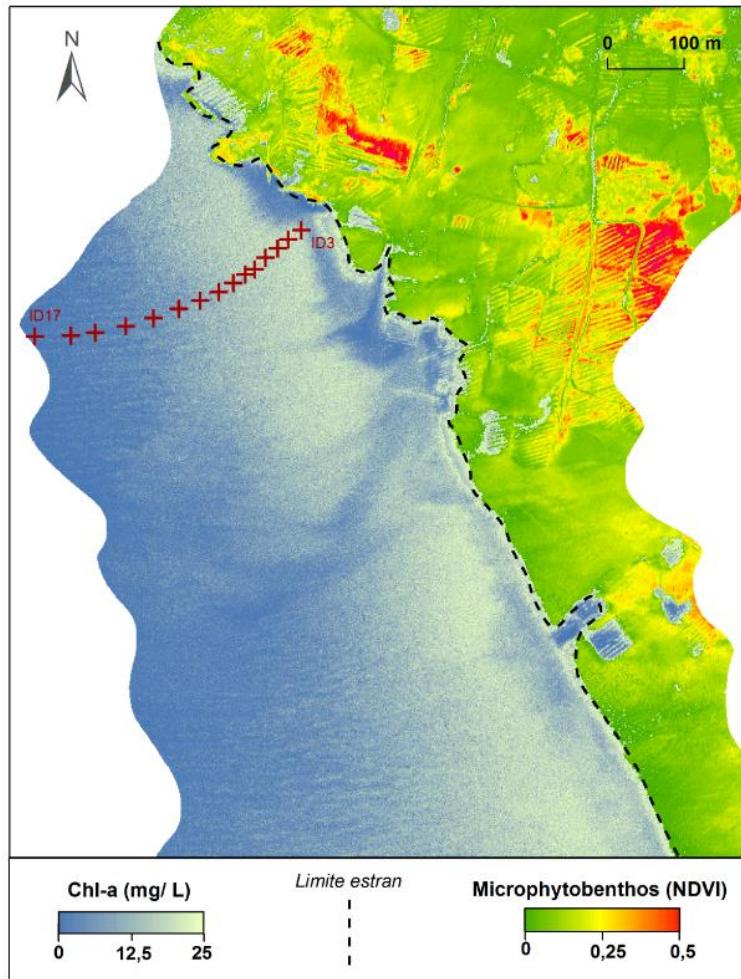


3-band model (OLCI bands)

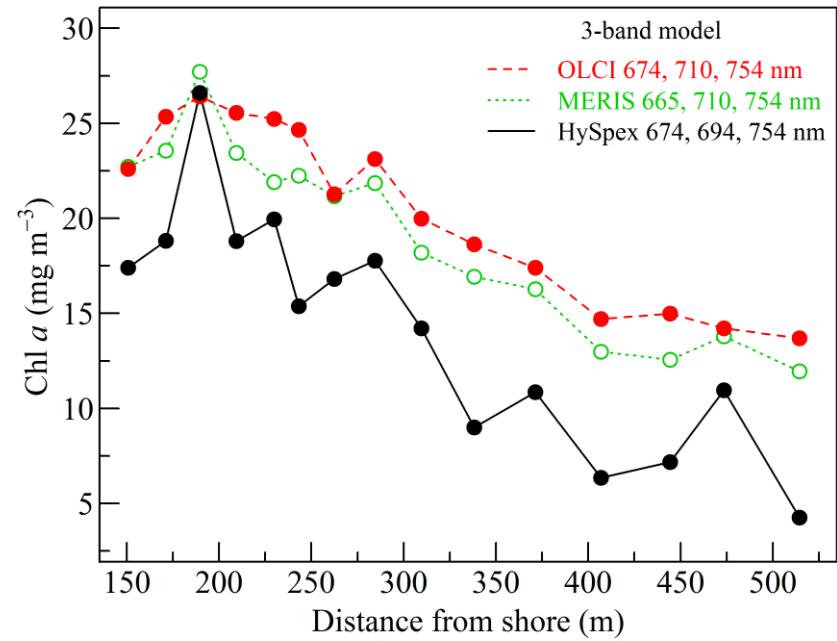
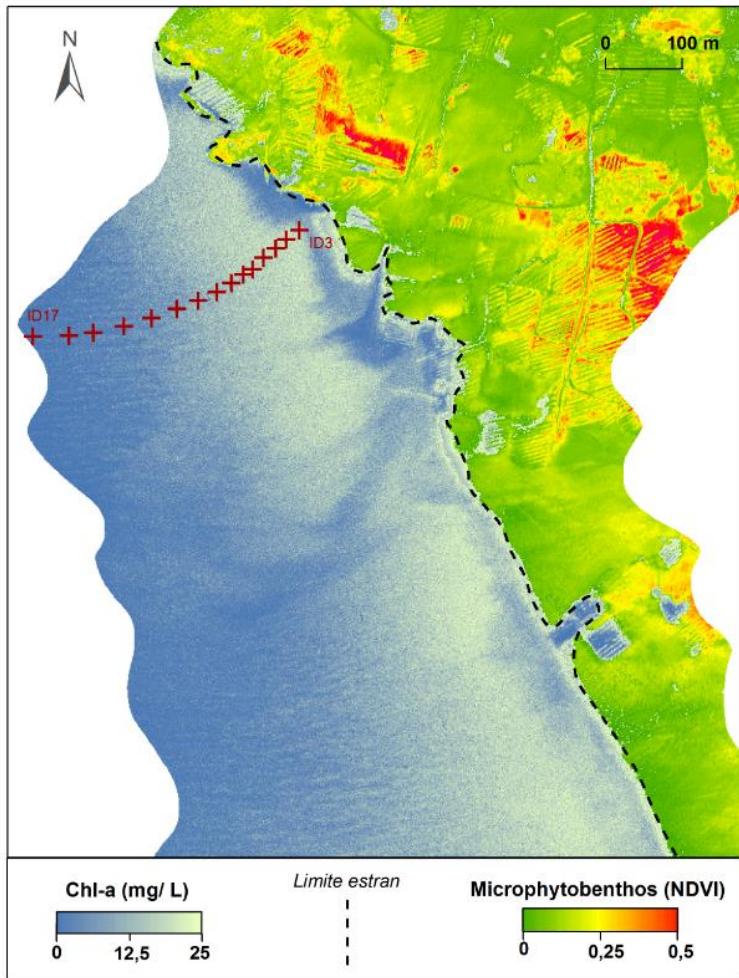
$$\text{Chl } a \sim R_{rs}(754) / [1/R_{rs}(674) - 1/R_{rs}(710)]$$



Application to airborne hyperspectral data



Application to airborne hyperspectral data





Conclusion

- Remote sensing of nearshore waters requires
 - high ground resolution: at least 300 m for bay-scale studies
 - appropriate atmospheric correction
 - SPM algorithm based on 2-band ratio (560 and 865 nm)
 - Chl a algorithm based on 3-band model (674, 694, and 754 nm)
- Hyperspectral data makes it possible to
 - develop multisensor algorithms
 - select the most appropriate wavelengths for Chl- a inversion
 - prepare future missions (*e.g.*, HYPXIM, OLCI)

Acknowledgements

- ANR for the funding of the GIGASSAT project
- GIS-COOC for quick access to MERIS FR data and ACRI-st for SAABIO processing
- CNES, Astrium and Pléiades User Group for Pléiades and SPOT data
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THANK YOU !

