Using supervised learning for modeling biogeochemical parameters in New Caledonia with MODIS ocean color

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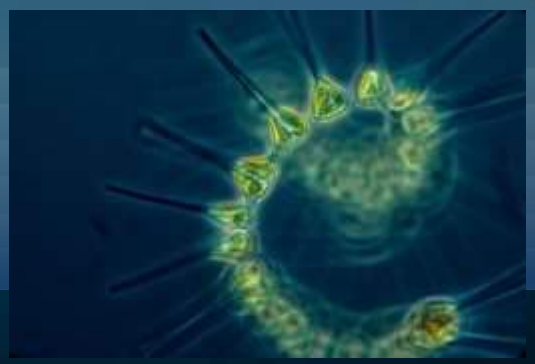
CNRT NICKEL & son environnement

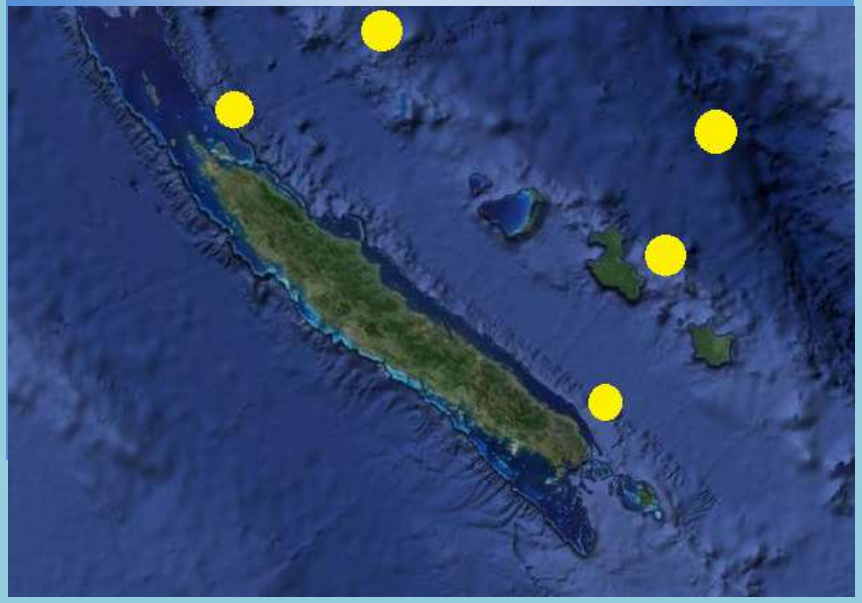
Introduction: ocean color

- Remote sensing widely used in assessing biogeochemical parameters in oceans
  - Chlorophyll-a concentration
  - Turbidity
  - Colored Dissolved Organic Matter

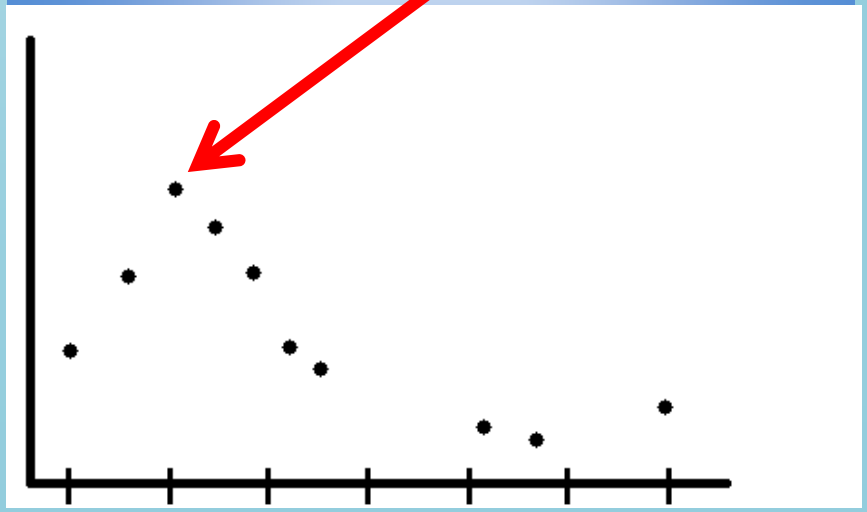


Remote sensing interests

- Global spatial view
  - Study of big areas is possible (low cost)
  - Study at each point of the area

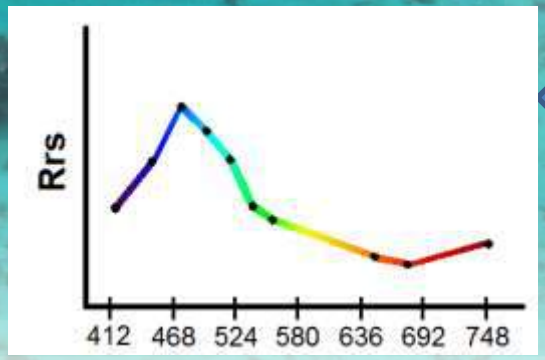


- Global time view
  - Time series (daily)
  - Transient and unusual events



Problems

- Algorithms conception
  - Convert ocean color to tangible figures
- Clouds
  - No data
- Shallow waters
  - Spectral signal includes
    - Water column signal
    - Bottom signal

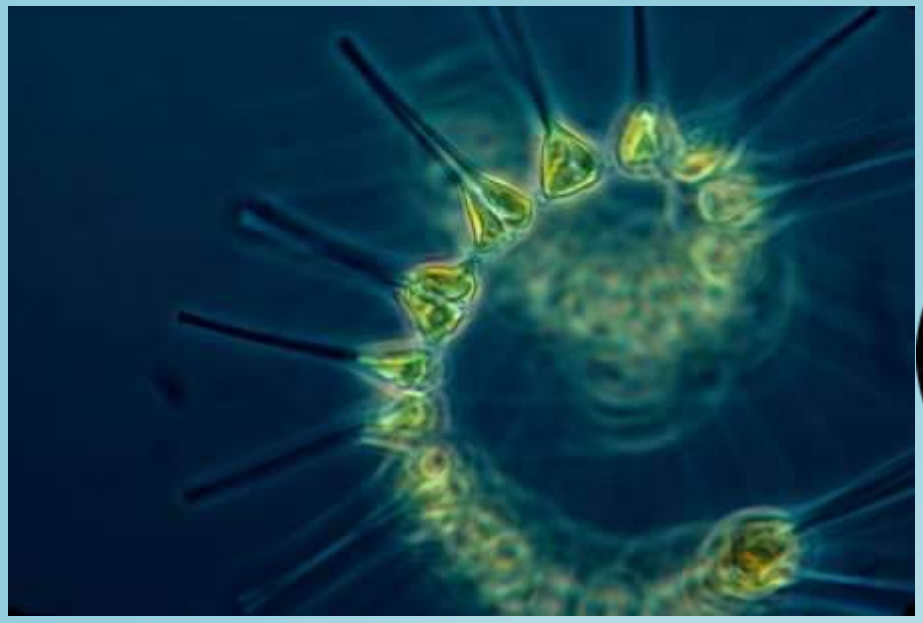


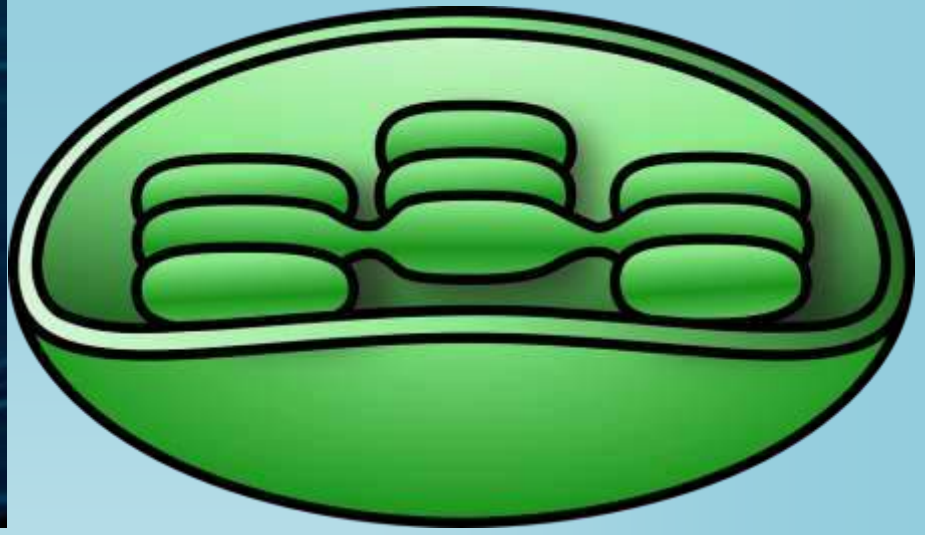
How to get only water column signal?

- Signal inversion
  - Lyzenga's method for assessing bathymetry
  - Bottom color assessment [Minghelli-Roman, Dupouy 2013]
- Using supervised learning
  - Learning how the spectral signal is impacted by specific bottom types
  - Implementing the learning
  - Assessing the learning quality and reliability

Application of the supervised learning on the lagoon of New Caledonia

- Get match-ups [Bailey and Werdell 2006]
  - In situ measurements
  - MODIS Satellite images
- Learning with a Support Vector Regression (SVR) [Drucker et al., 1996] model
  - Selection of the more representative spectral reflectances for assessment
  - Test different models to use the best one!



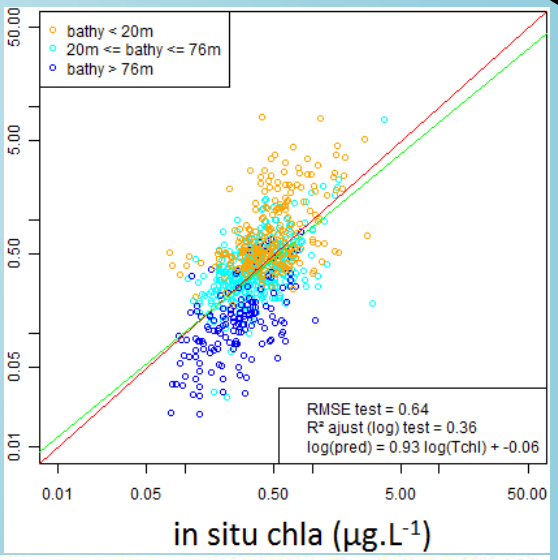


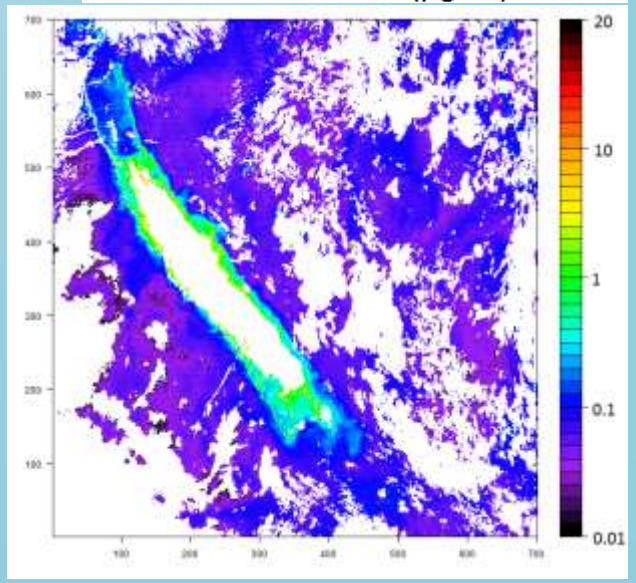
Example of application

CHLOROPHYLL-A CONCENTRATION ASSESSMENT

Context

- Existing algorithms for [chl-a] assessment are not well-suited for oligotrophic waters of New Caledonia
  - Underestimation in open ocean
  - Overestimation in shallow waters of the lagoon

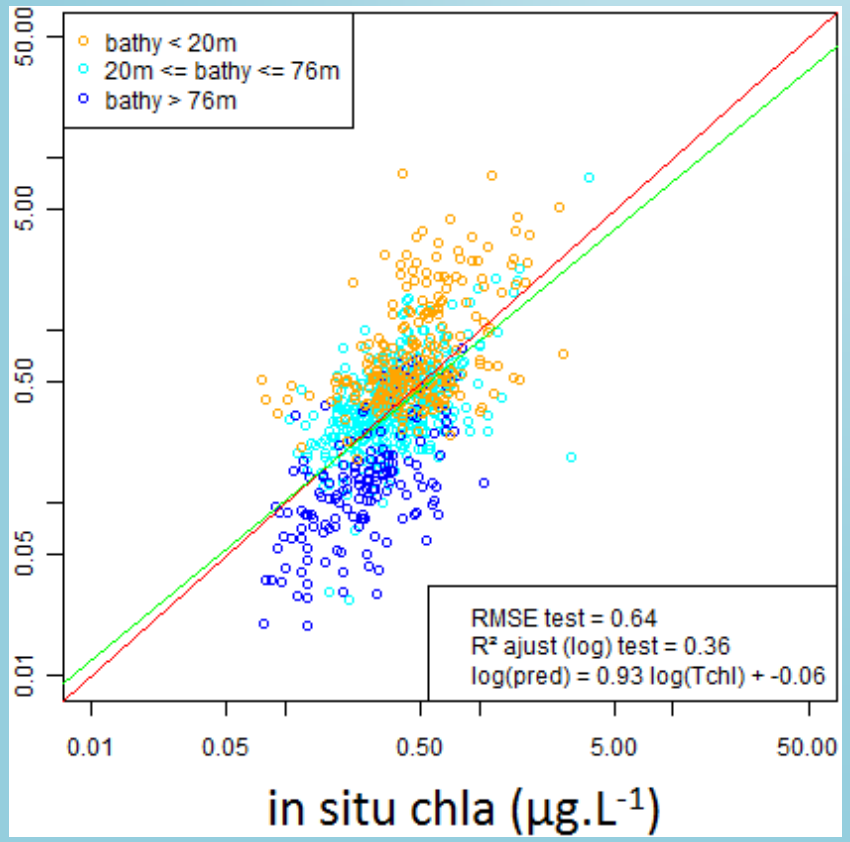




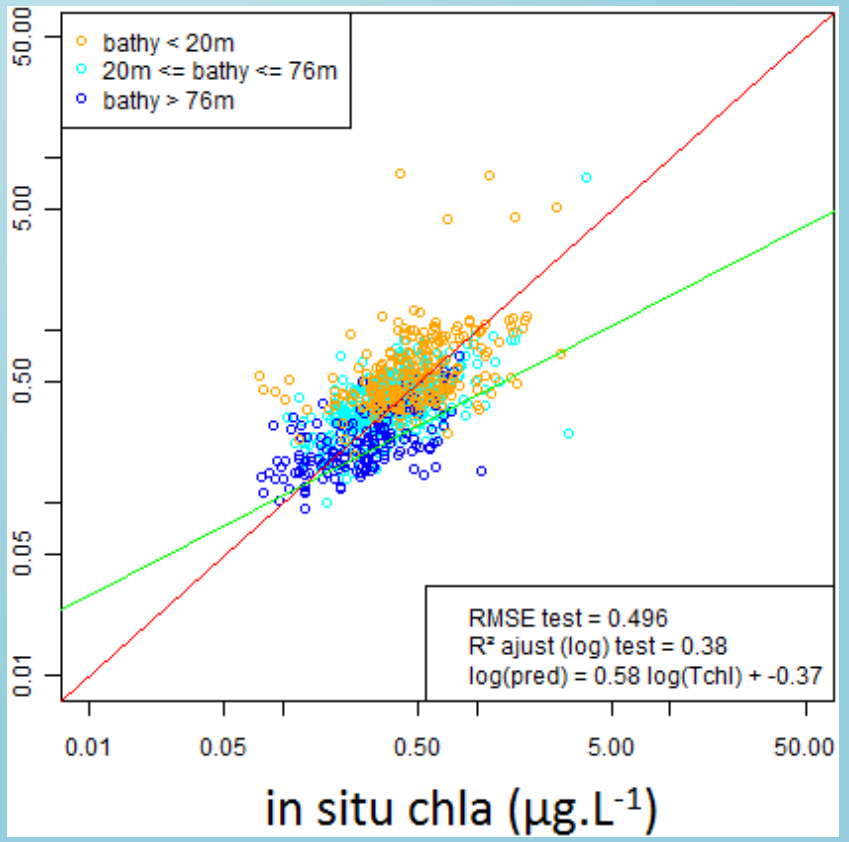
Dupouy et al., 2010

Measure the improvement

OC3



New algorithm based on supervised learning



Wattelez et al., 2016

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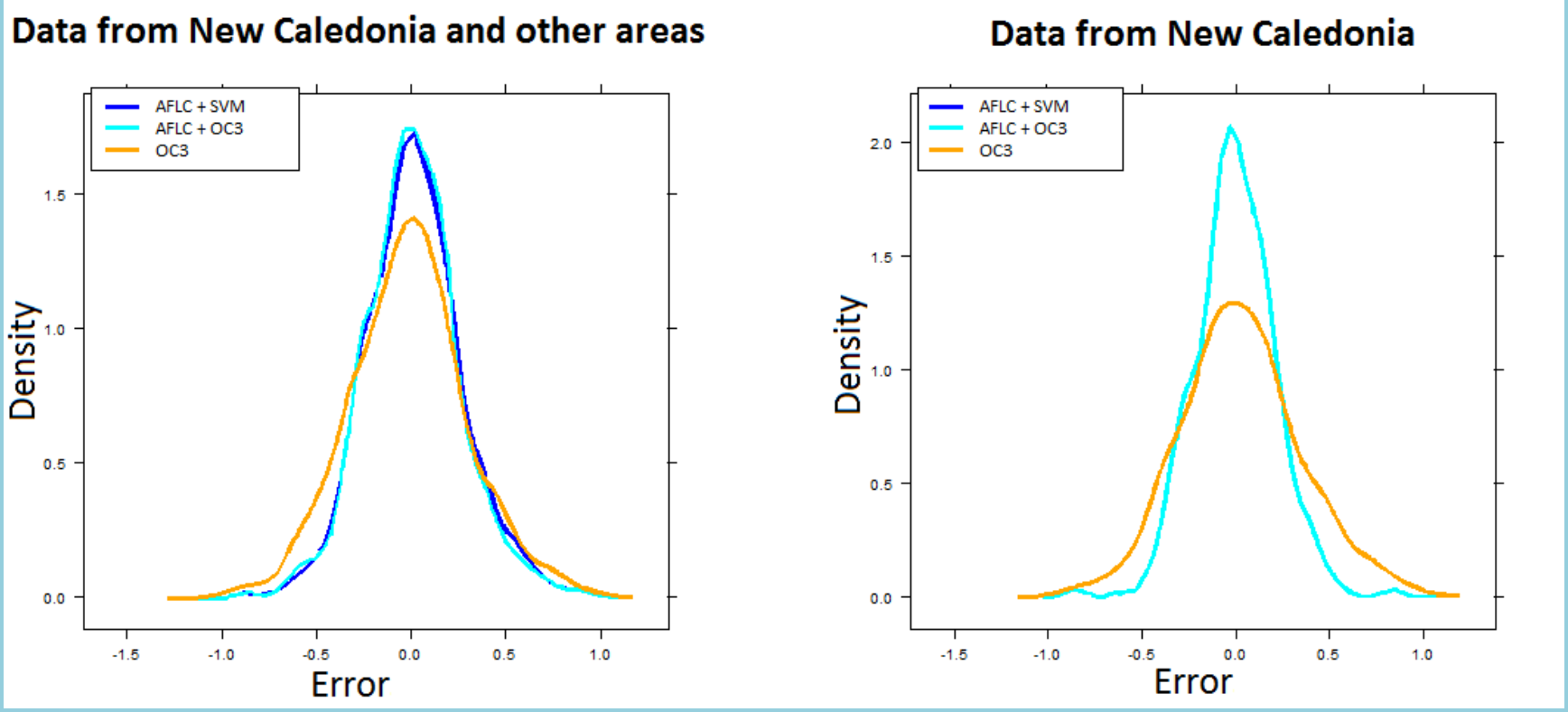
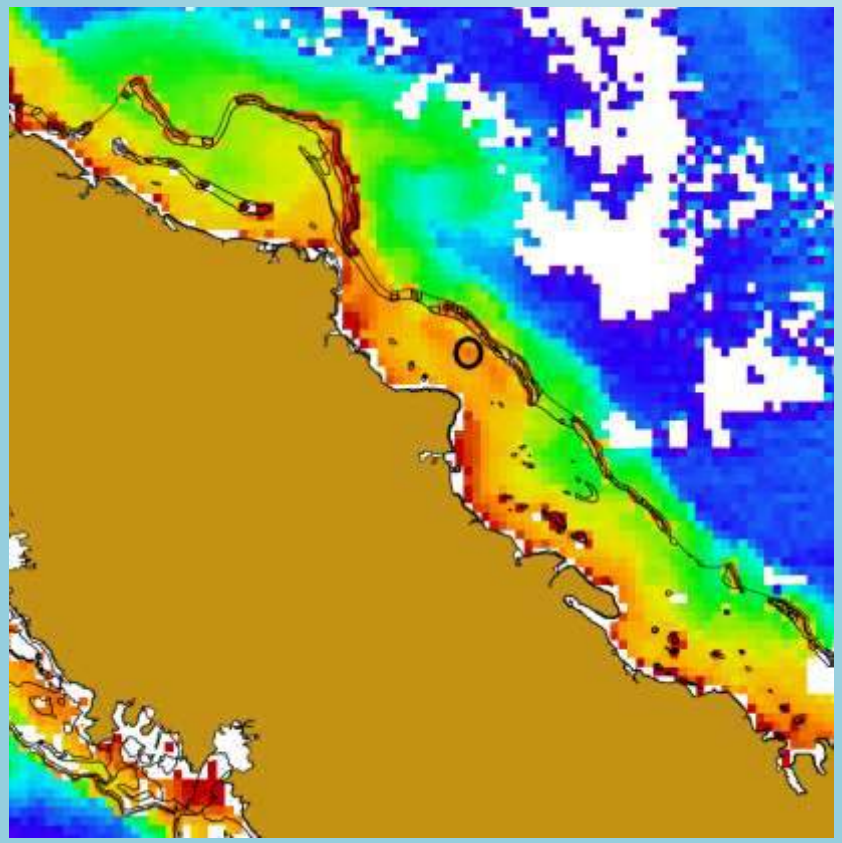


Wattelez et al., 2016

Mapping

OC3



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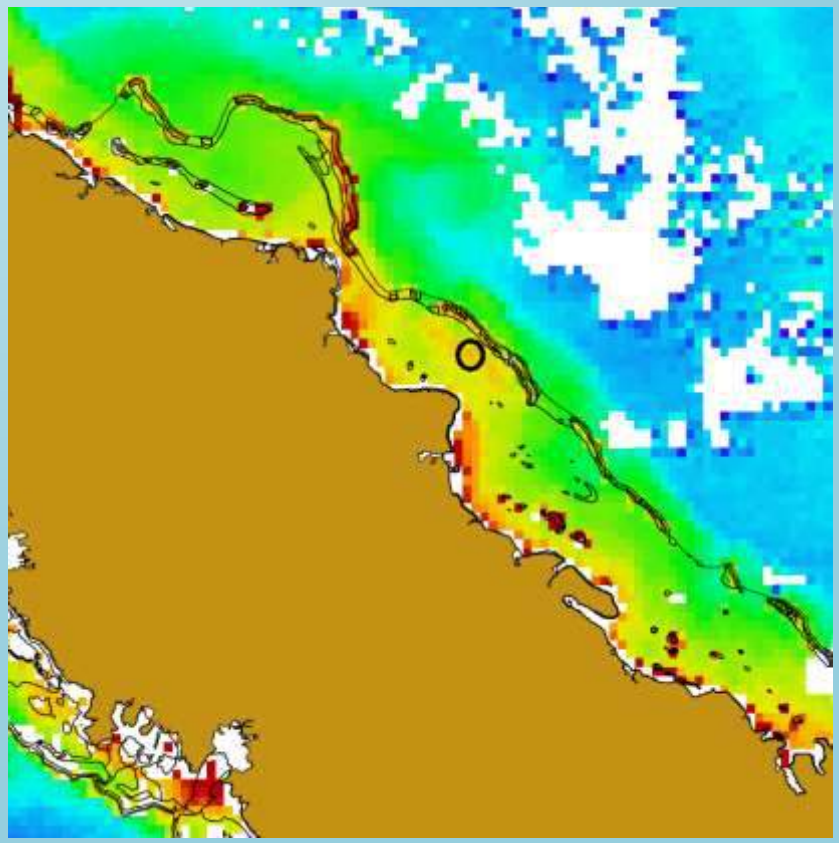


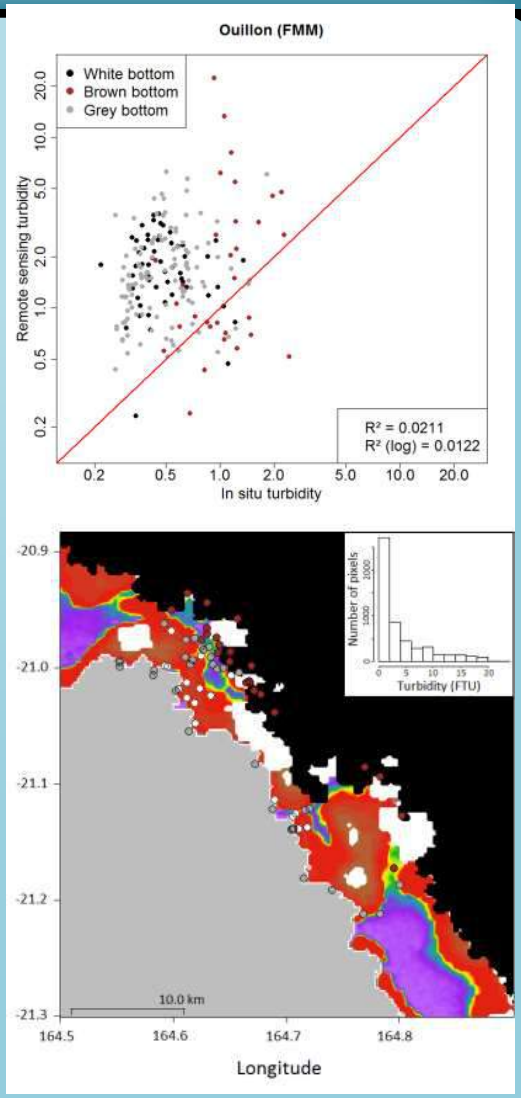
Wattelez et al., 2016

Example of application

TURBIDITY ASSESSMENT

Context

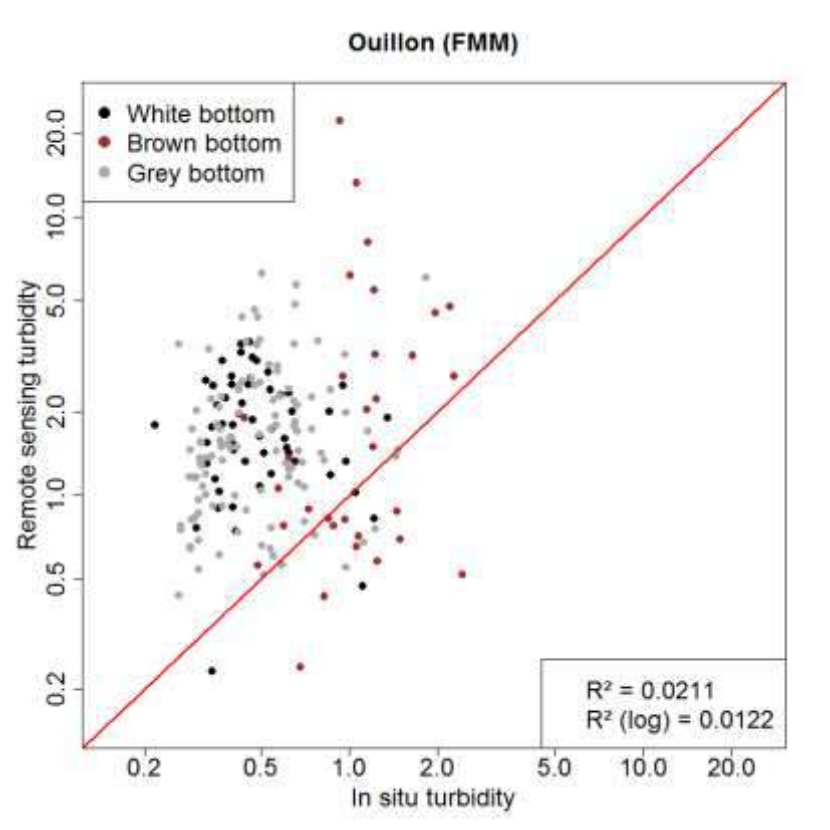
- Mining project at Koniambo (Northern Province of New Caledonia)
  - How mining activities do impact environment?
  - Study water quality: turbidity mapping
- Waters especially shallow in this lagoon
  - Remote sensed algorithms not reliable in this context



Juillot 2015 (DYNAMINE project, CNRT)

Measure the improvement

Ouillon et al. 2008



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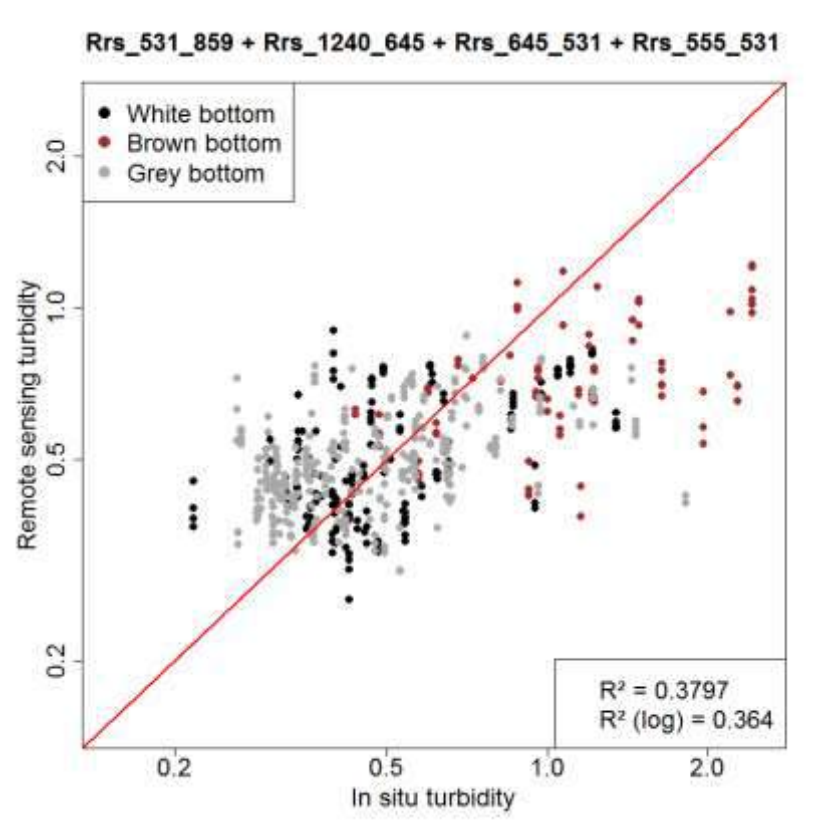

Wattelez et al., 2017

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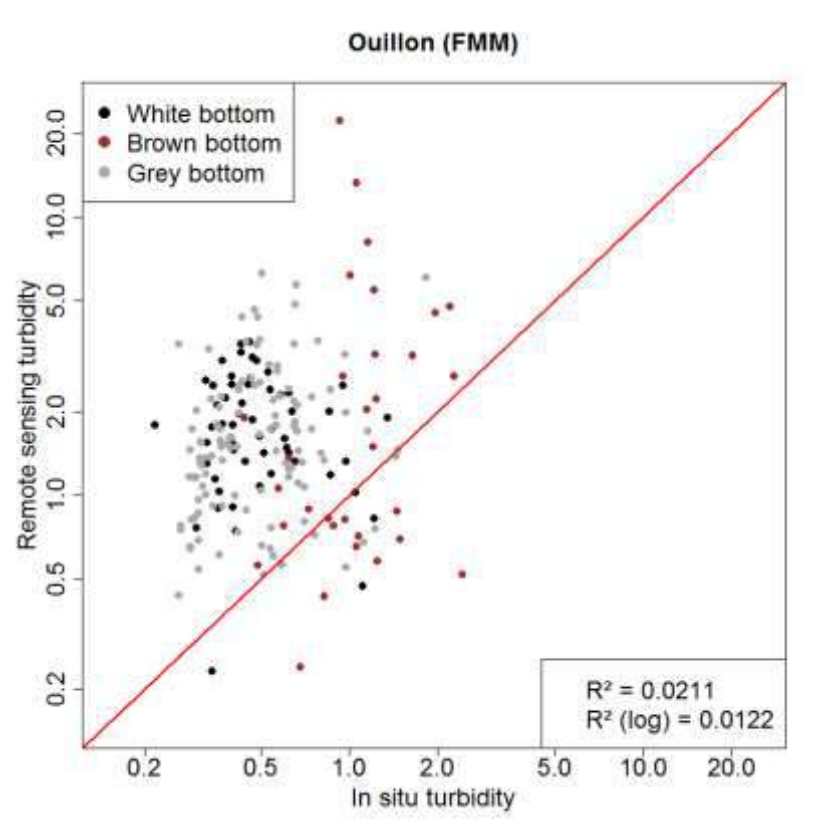

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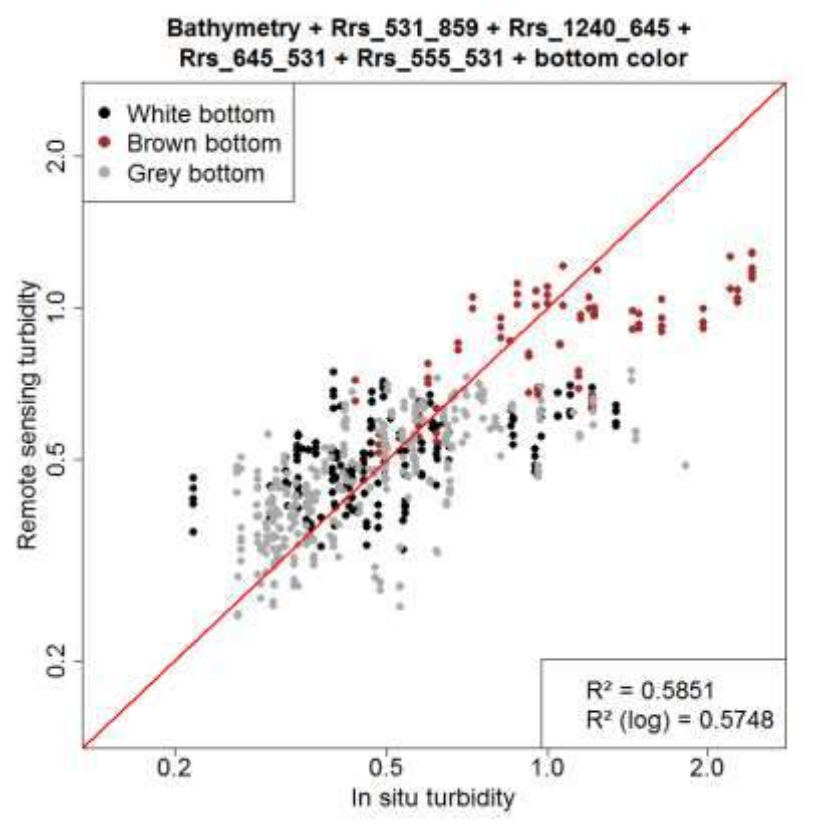

Wattelez et al., 2017

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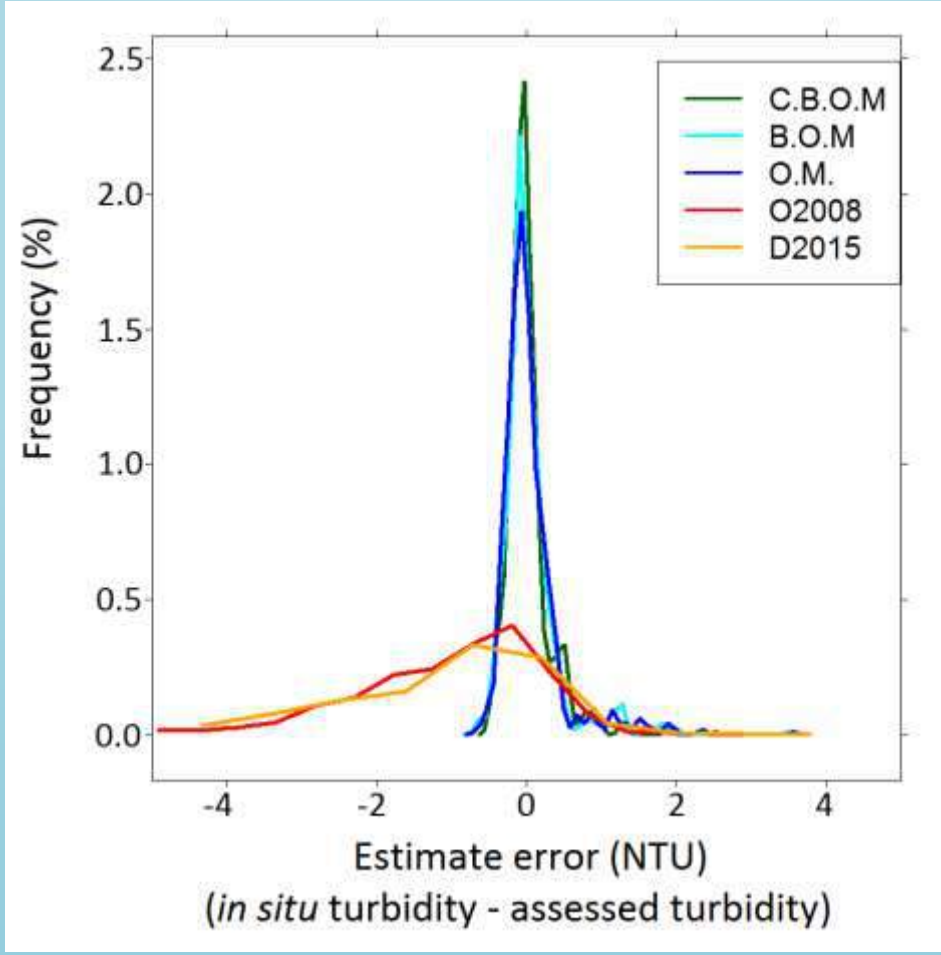

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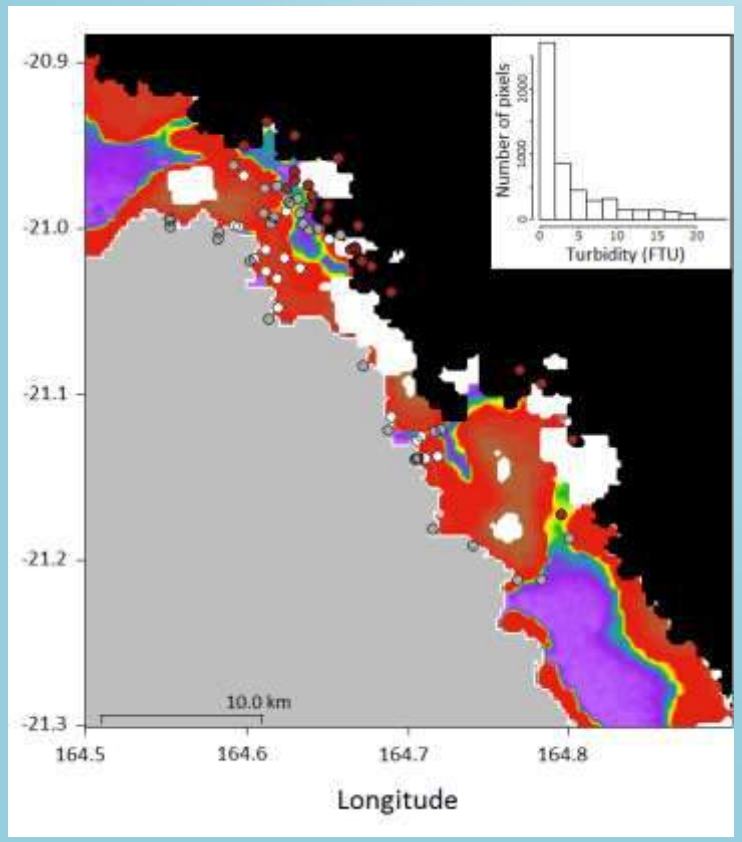
Mapping

Ouillon et al., 2008



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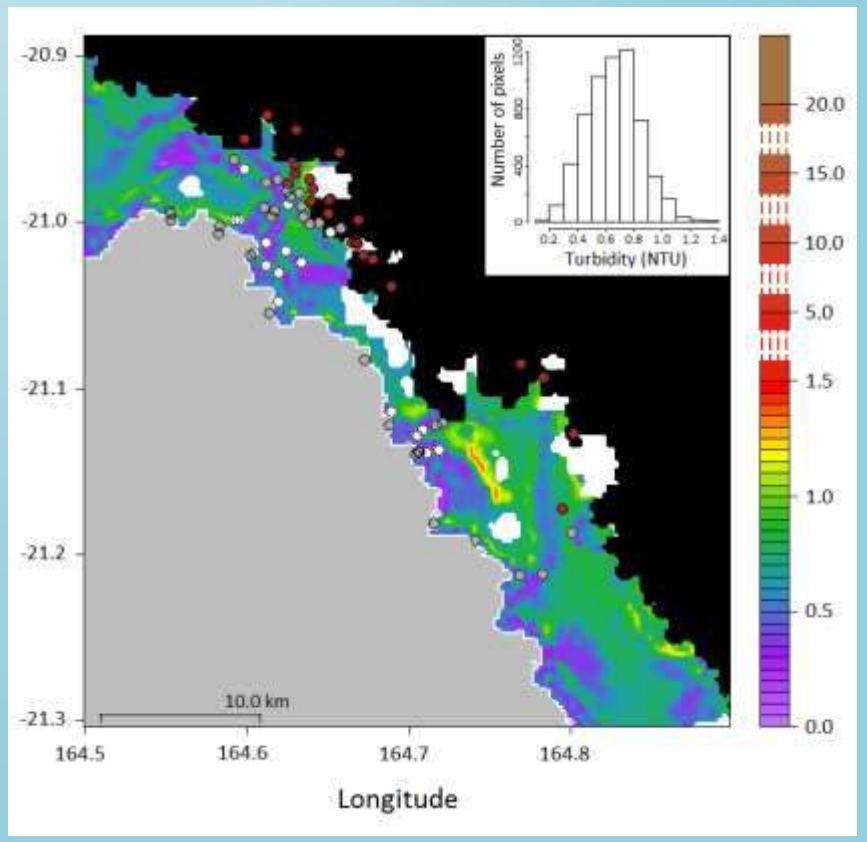

Wattelez et al., 2017

Conclusion

- Limitations
  - Good assessments only for similar learning cases
    - Hard to correctly assess special events
- Benefits
  - Wide application (many study fields in many areas)
  - Using many factors and many kinds of factors
    - Optical factors (reflectance, backscattering, …)
    - Environmental factors (bathymetry, bottom colors, …)
  - Getting more reliable assessments of biogeochemical parameters enables better understanding and monitoring of our living environment. That helps for its preservation in a sustainable development context
- Special thanks to:
  - CNRT Nickel et son environnement (DYNAMINE)
  - TREMOLO (INSU EC2CO)
  - VALHYSAT (SPIRALES) / VALHYBIO (INSU PNTS)

Vinaka vakalevu!

Thank you for your attention!