Synergy between optical and acoustic remote sensing

for shallow-water benthic ecosystems cartography

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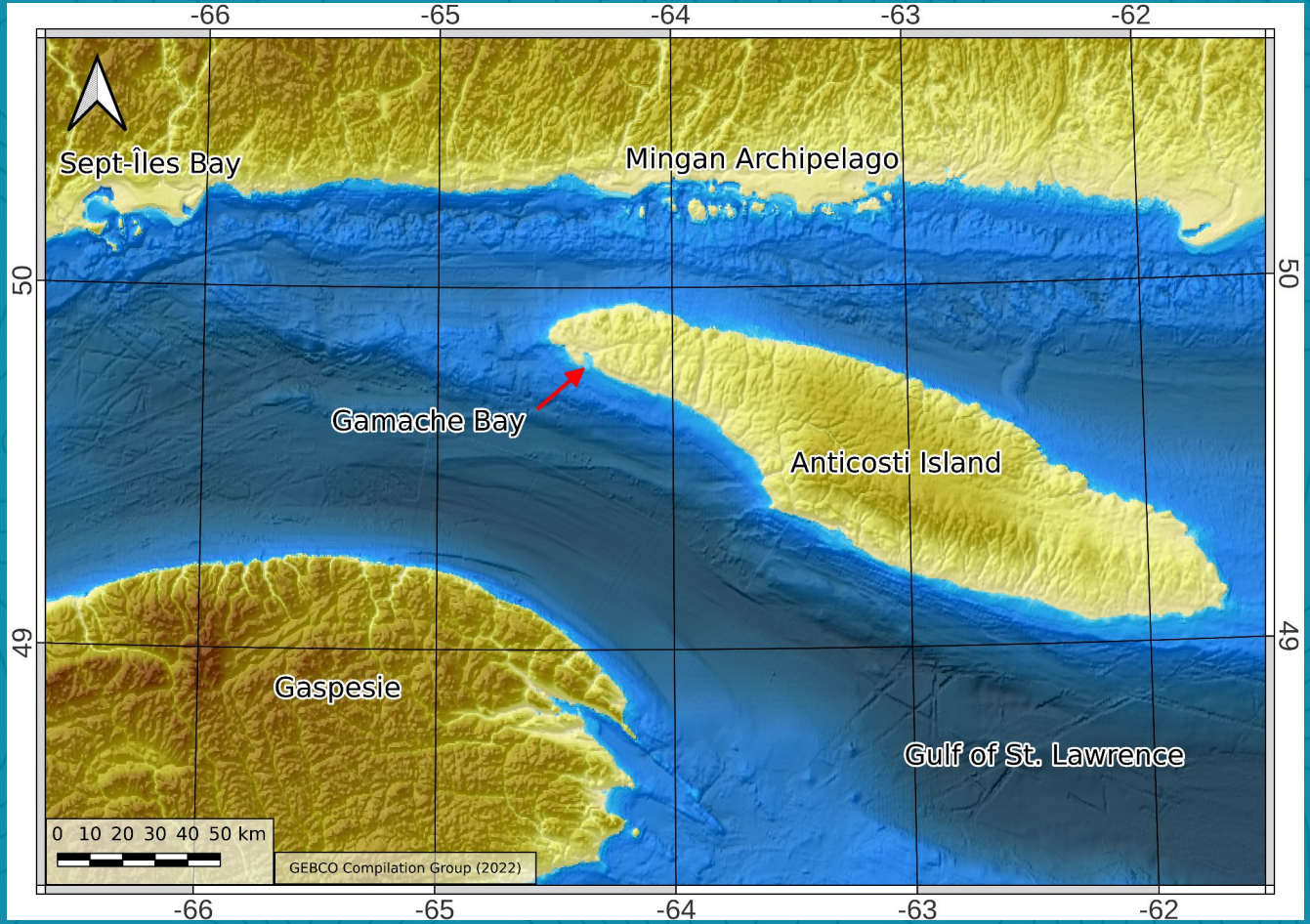
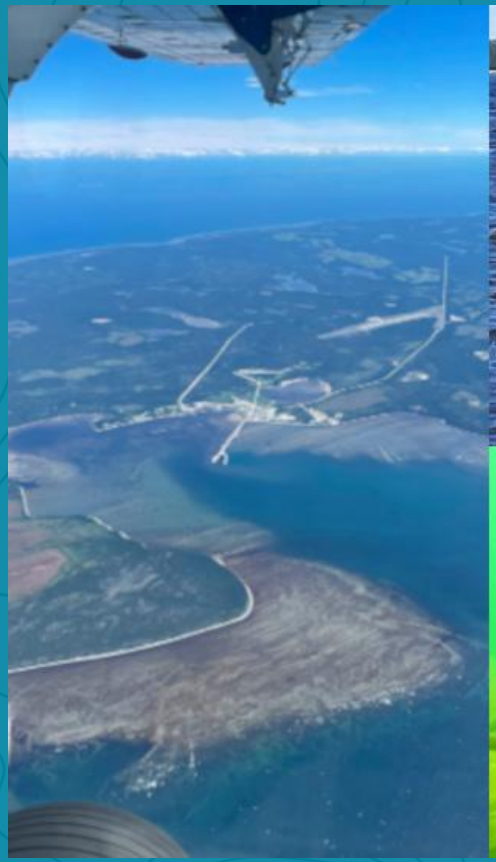
Mitacs

The Algae-WISE project



Mobilisation

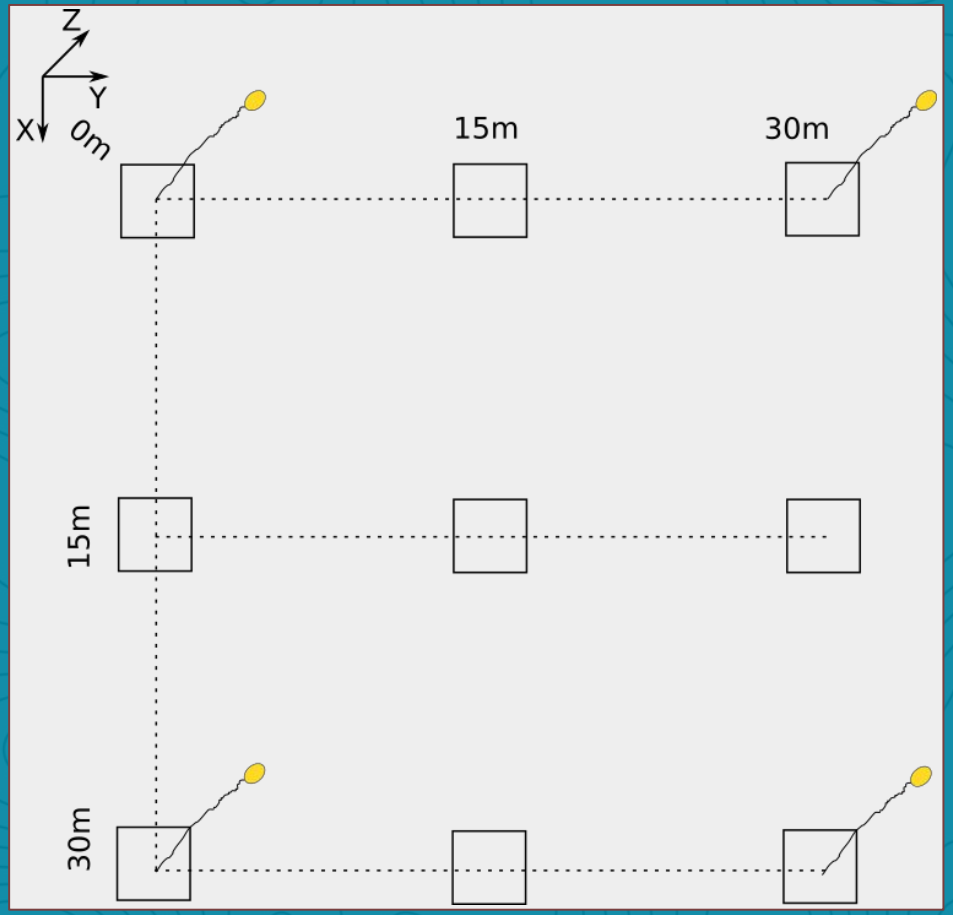
- NRC FLR Plane
- Coriolis 2
- Diving team
- Jet-ski



BARE
BARE

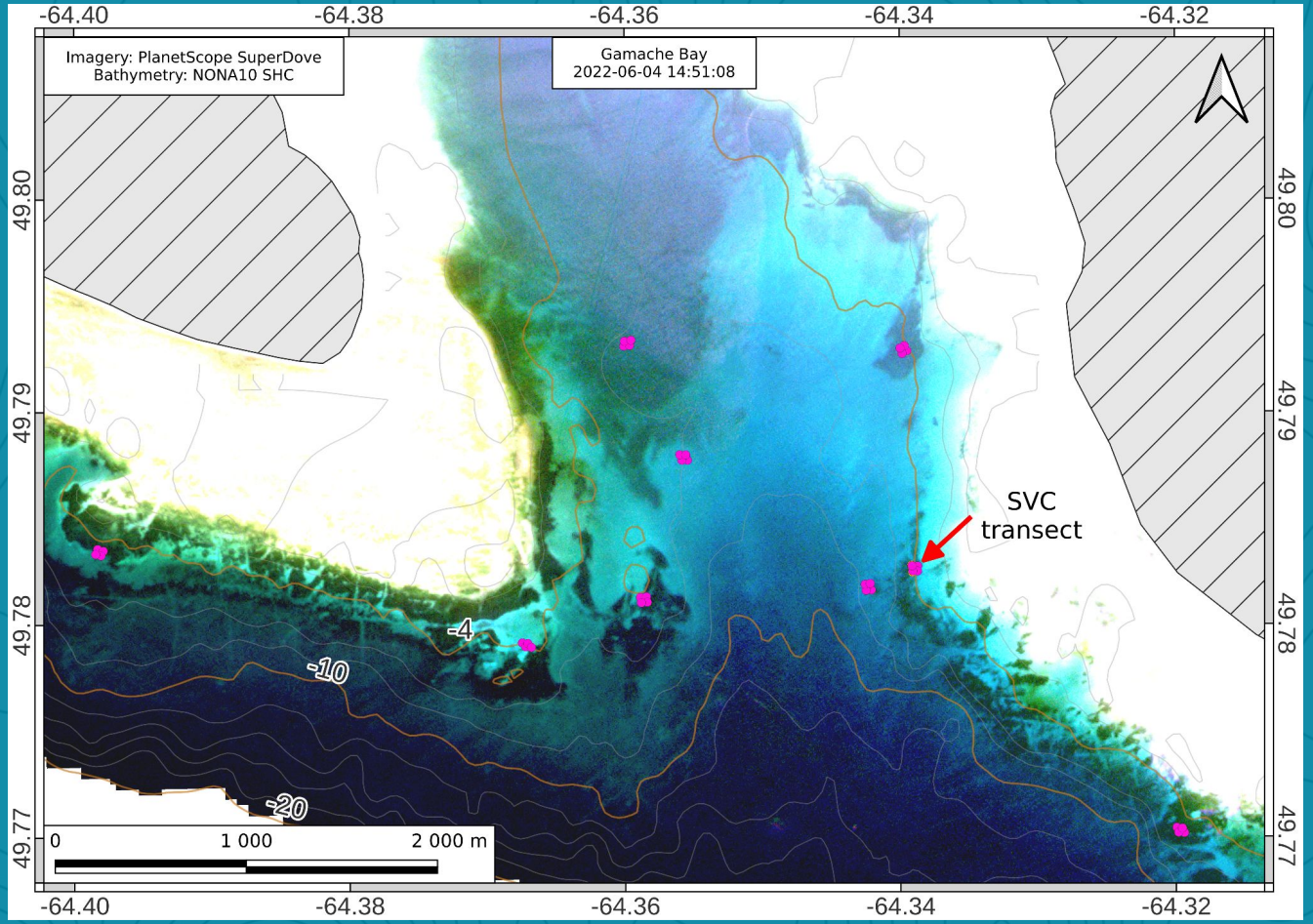
Ground-truth sampling plan

- Macroalgal cover harvested in 9 quadrats
- 0.25 m^2 quadrat
- Surface buoy deployed in corner for georeferencing



Ground-truth diving sites

- Purple point: corner of sampling grid
- 9 diving sites
- Measurement:
  - Species
  - Density
  - Biomas
- 1 underwater hyperspectral radiometry transect



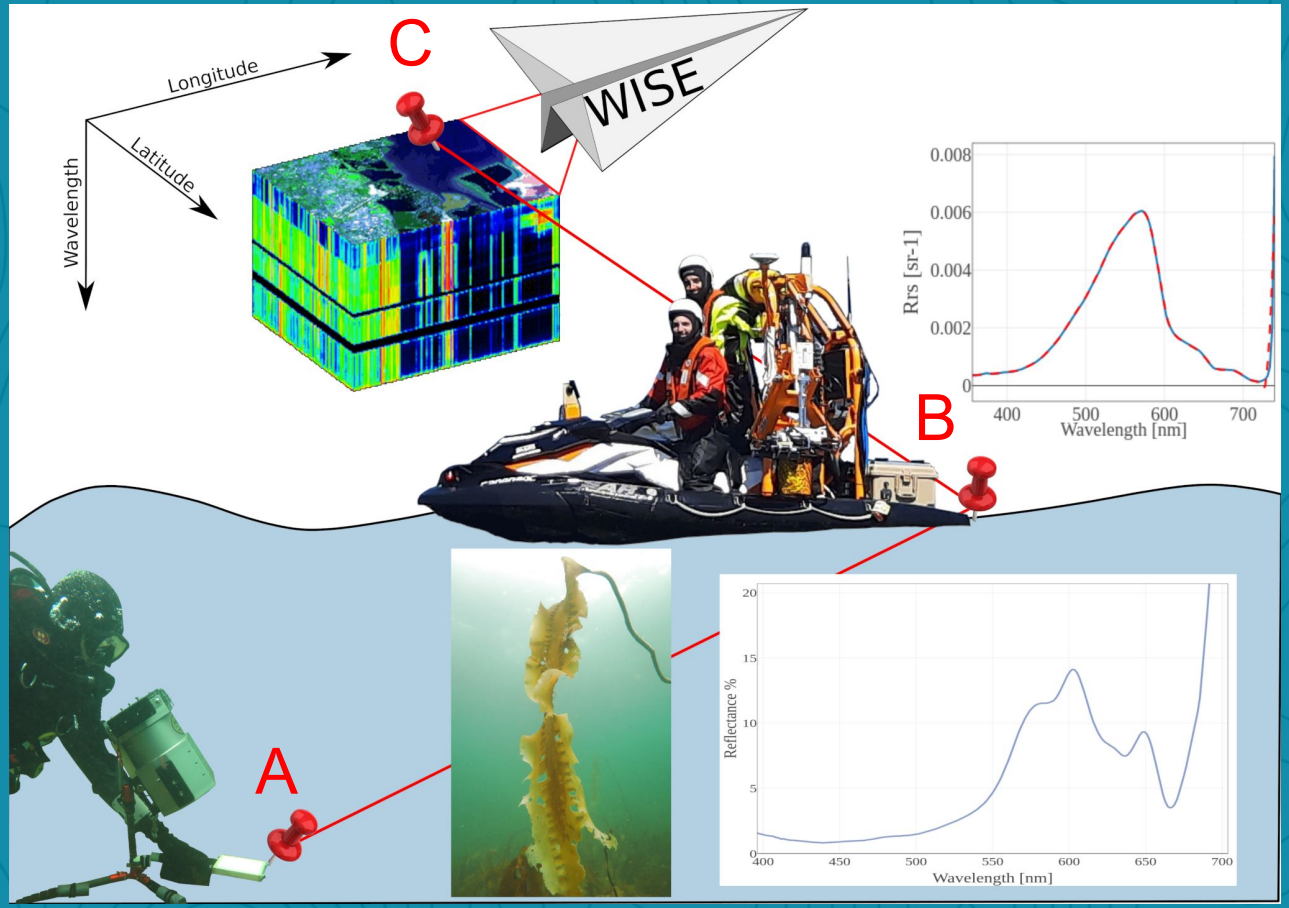
Concept

- Three hyperspectral acquisitions

A. Bottom reflectance

B. Water reflectance

C. Airborne WISE 144 bands



A jet-ski as an acquisition platform

Acquire data up to ~ two meters depth

Combine acoustic and optical instruments

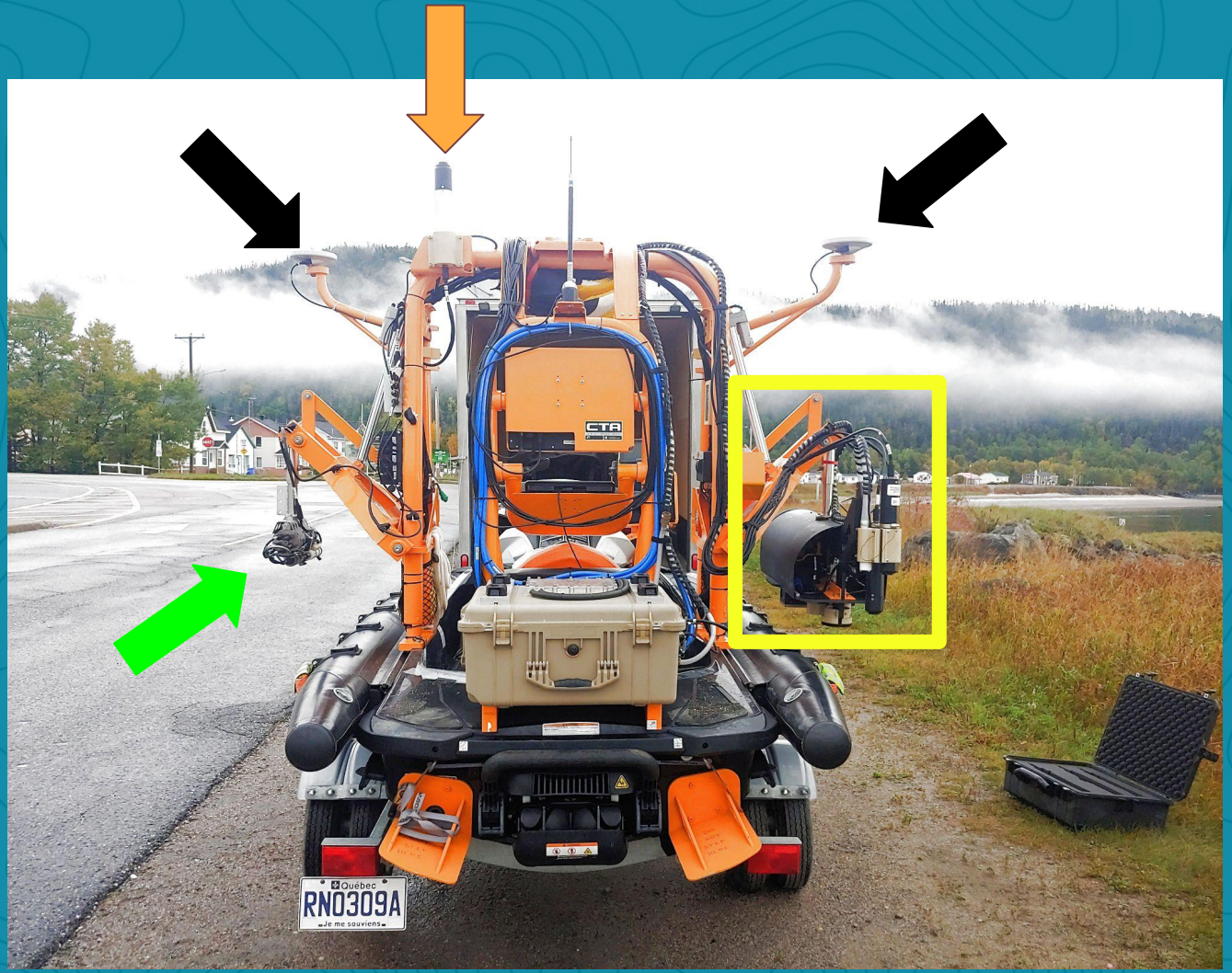
Continuous acquisition

Instruments

GPS RTK
Lat, Lon,
Altitude, DateTime

HOCR
Incident light
above water

CTD, pH, DO



Instruments

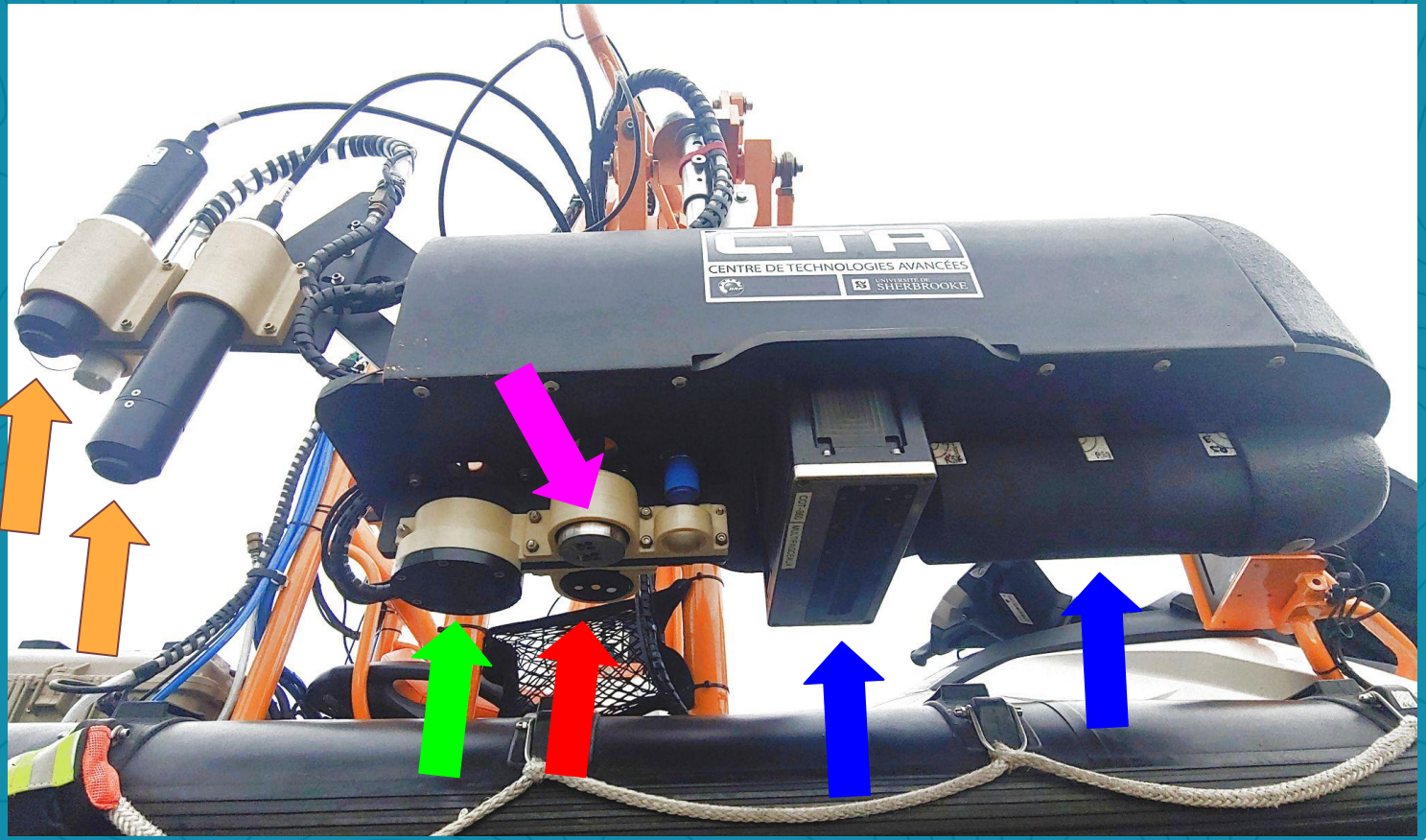
HOCR
Upwelling light at two differents depths

Depth, Canopy Height

Backscattering, Chl-a, FDOM

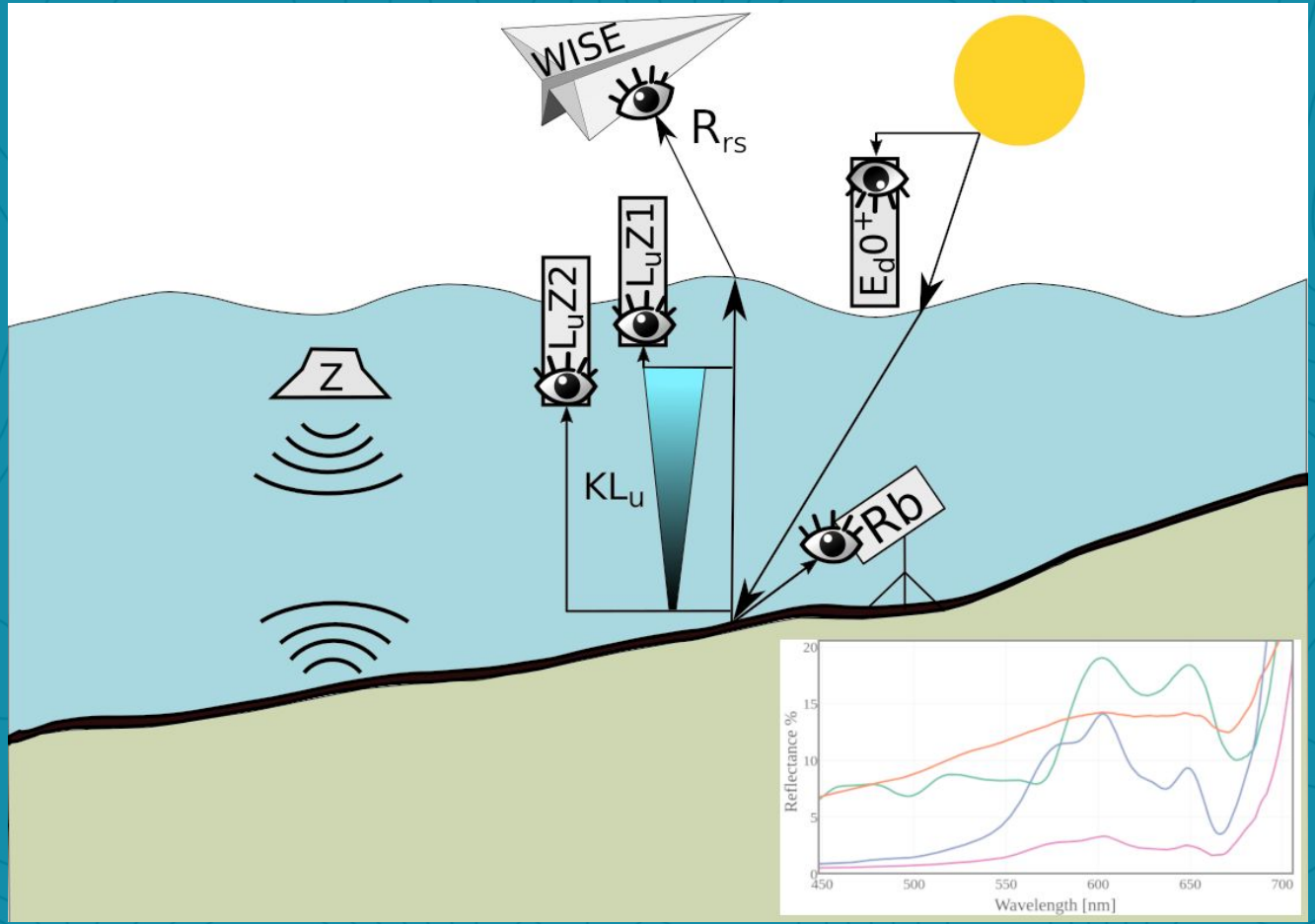
Turbidity, Pigments

Depth



Objectives

1. Retrieve aquatic reflectance (Rrs)
2. Combine optical and acoustic sensors (Z, KLu)
3. Retrieve benthic reflectance (Rb)



Overview

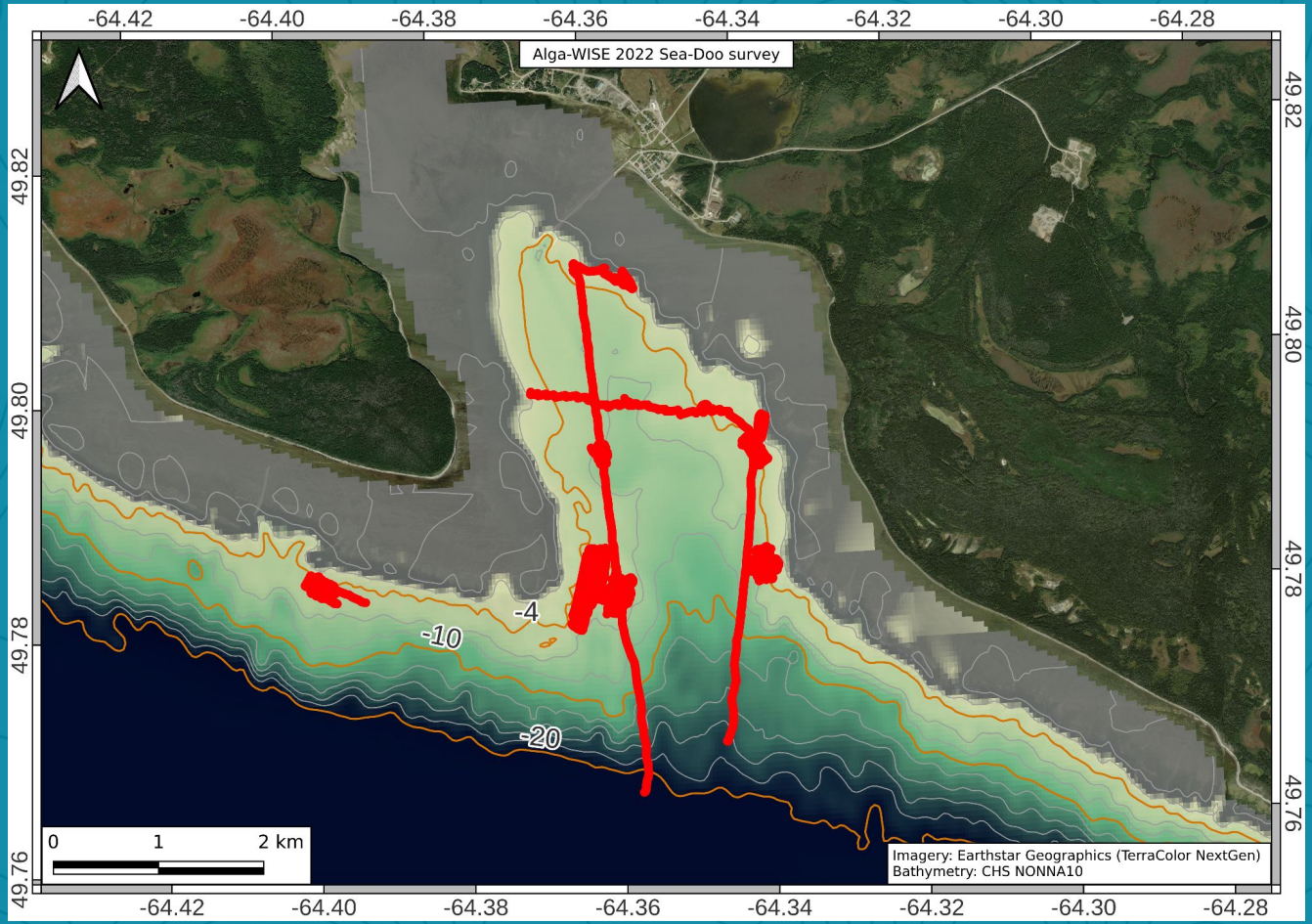
51 514 seconds
~ 14.31
survey hours

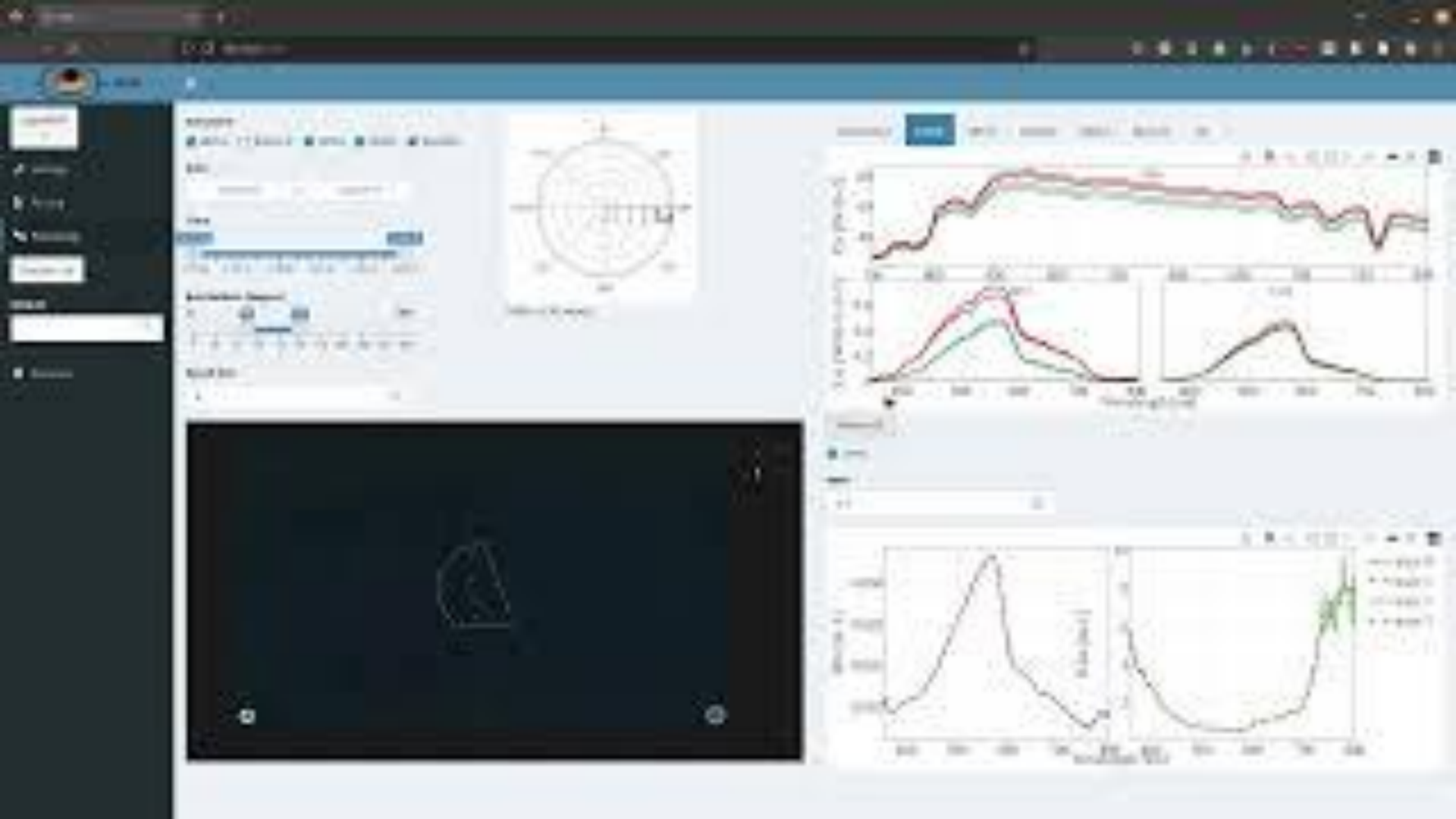
~ 5 seconds to discretize an observation

~ 10 302 discretes observations

~ 5 minutes to process one observation

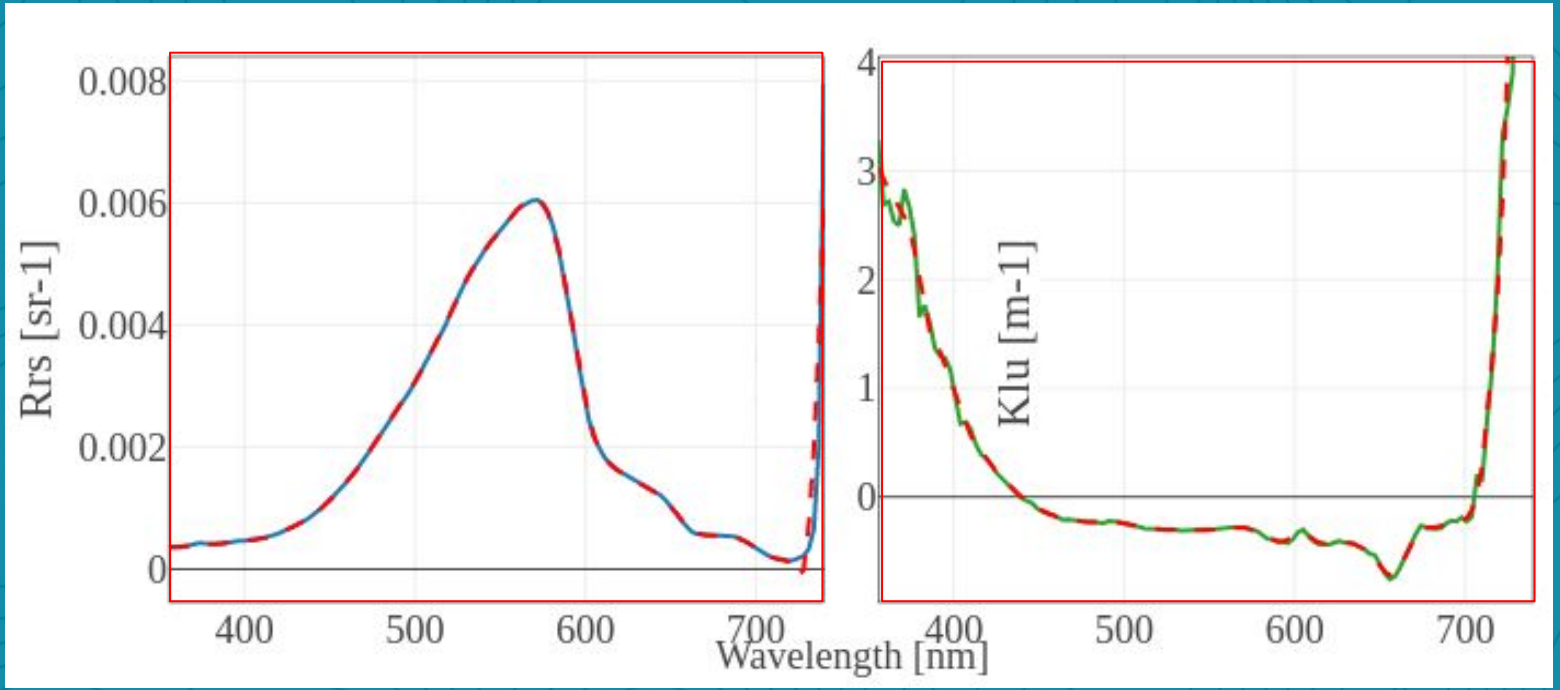
~ 858 hours of processing





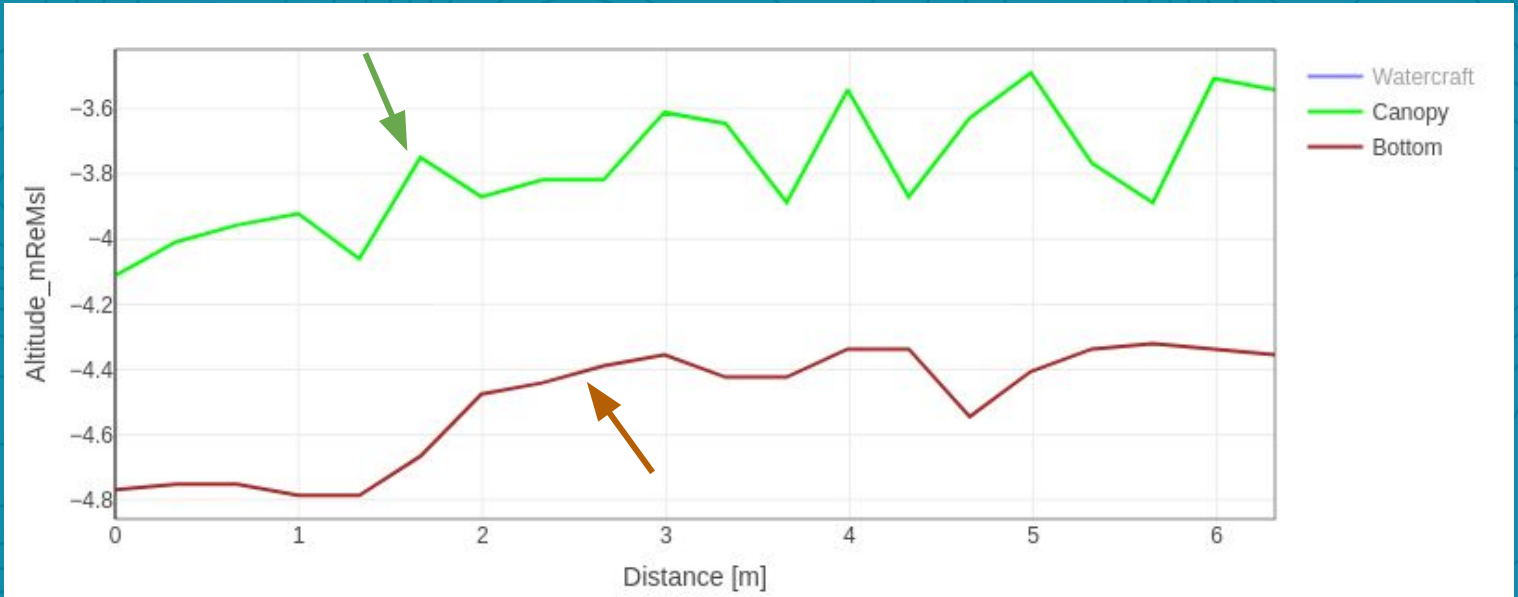
Optic and acoustic combination

1. Aquatic reflectance: R_{rs}
2. Attenuation coefficient : KL_u



Optic and acoustic combination

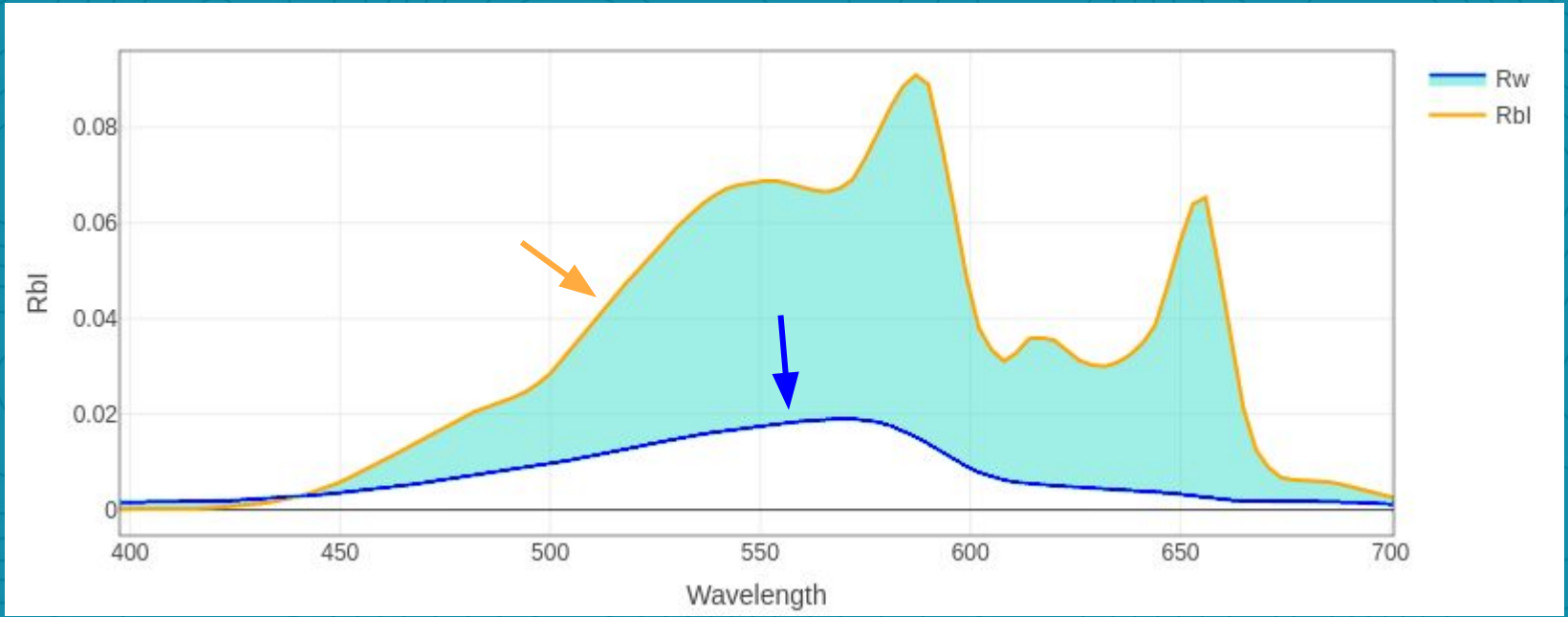
3. Water depth above bottom (-4.50 m) or algal canopy (0.71 m) : Z



4. We can estimate the bottom reflectance by removing the water column contribution from the total signal :

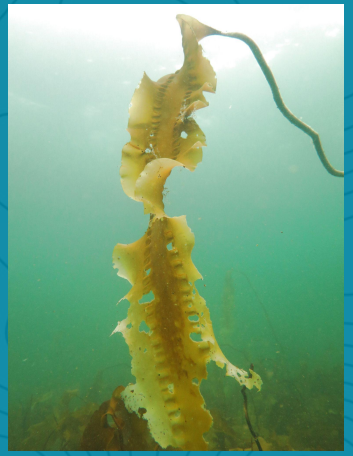
$$\rho_b = \rho_w - \rho_{wc}$$

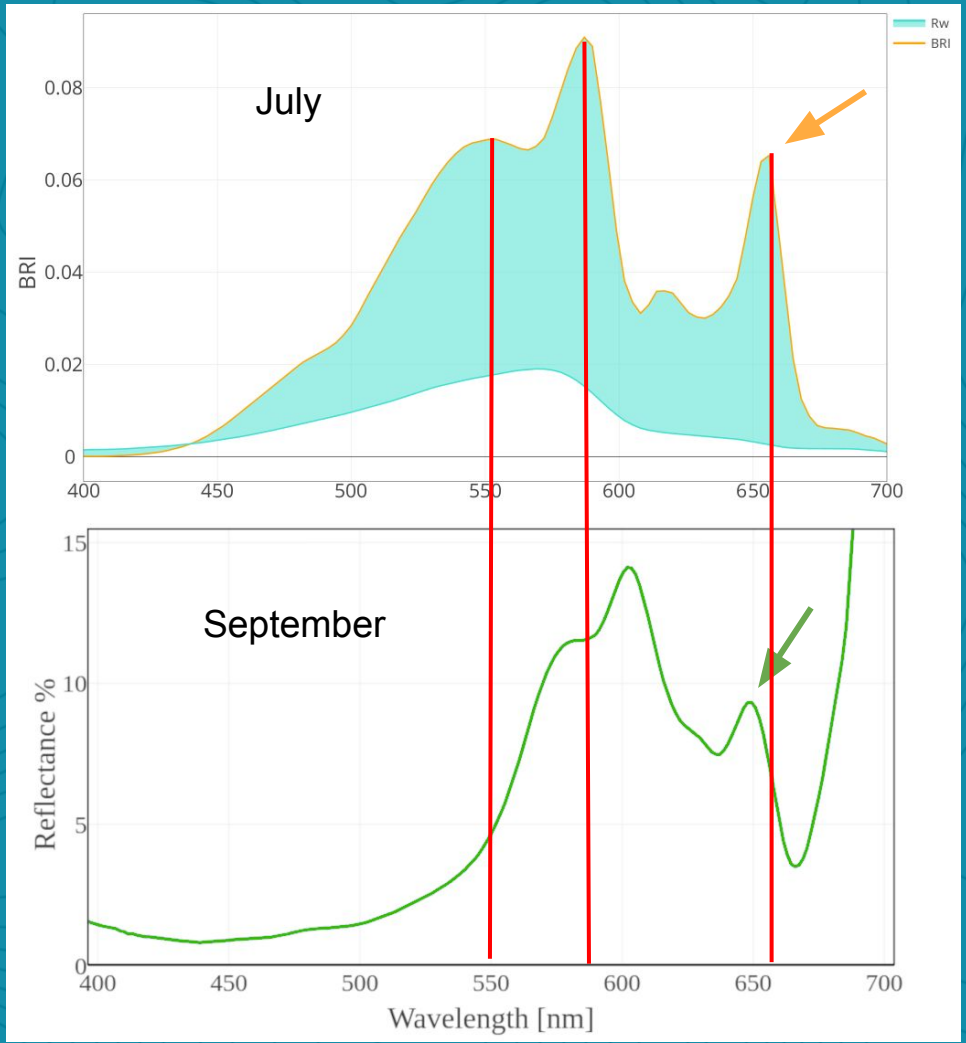
$$\rho_b = \pi . R_{rs} / e^{(-KL_u . Z)}$$



Spectral signature

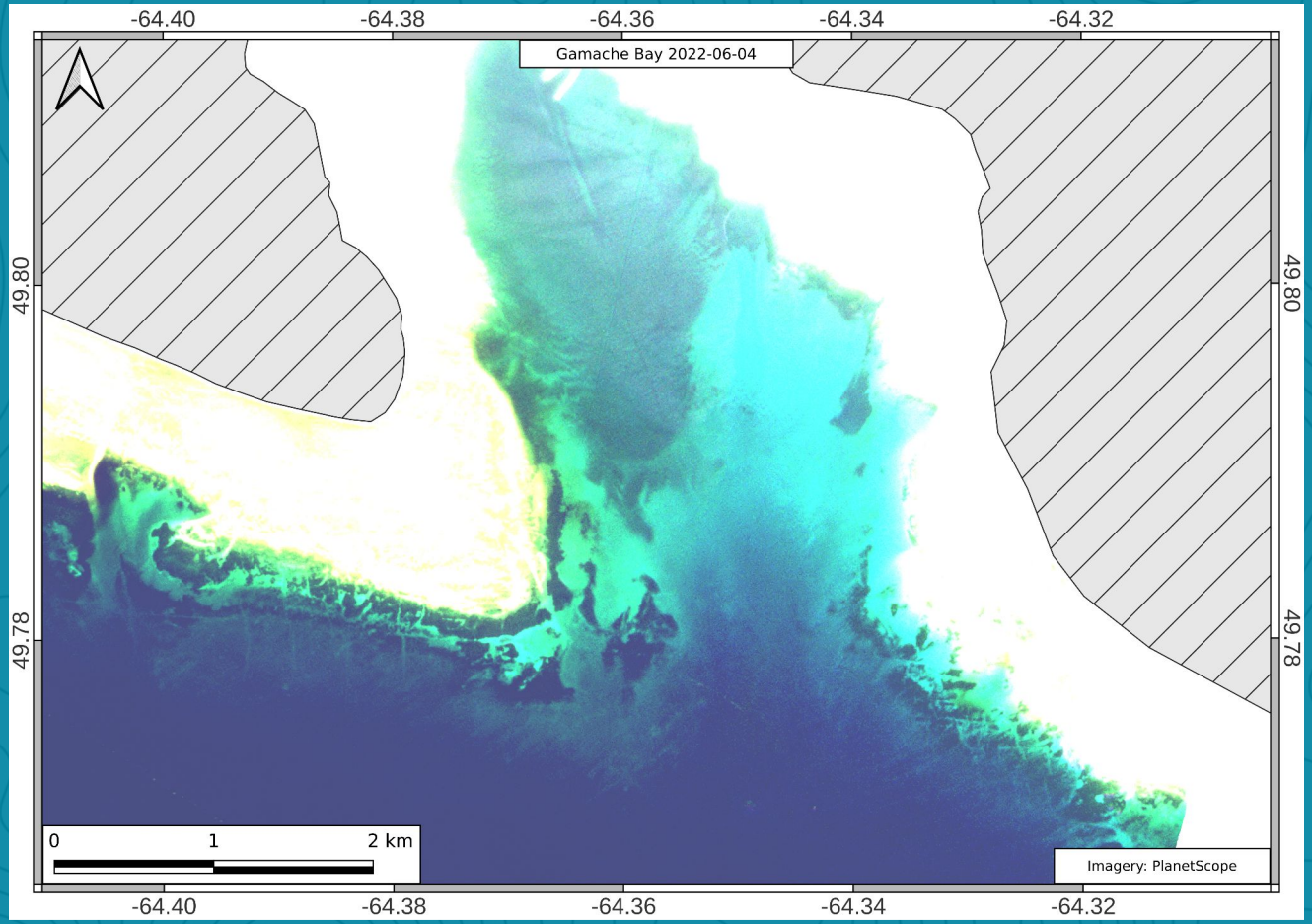
- Estimated benthic reflectance closely match the spectral shape of kelp
- Difference in peak reflectance related to seasonality ?





Hydrospatial perspectives

- "Big data" for AI algorithm development
- Automated detection of macroalgae
- Worldwide daily imagery at ~4m resolution
- Study spatio temporal change



Thank You !

Questions ?

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