BATHYSAT:
Feedback on the deployment of the first services

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From light to Earth information

Develop the uses of spectral imagery for mapping

Created in 2016

A team of 12 people + temp / trainees

3 Technical Units

SENSING / MAPPING

ANALYTICS

SOFTWARE

Operational Services

Data acquisition Aircrafts and UAVs	Image analysis and processing	Dev of processing and viz infrastructures
FlySpec	Hypip	Bathysat
STORMM	SWIM	Littoviz
...	...	...

Apps : maritime & agronomy

Hydrography and costal moprhodynamics,
Coastal biodiversity, dynamics of habitats, macrofaune,
Turbidity monitoring, coastal archeology, phenotyping

Use case: Saint-Pierre-et-Miquelon, North Atlantic

PRÉFET DE SAINT-PIERRE ET MIQUELON
Liberté
Égalité
Fraternité

Direction des Territoires, de l'Alimentation et de la Mer de Saint-Pierre et Miquelon

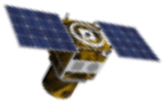
- 0-10m Bathymetric DEM requested by DTAM, the public office in charge of the administration of the coastal domain
- Exail / Hytech : **What about using SDB in shallow waters and DriX MBES in higher depths ?**

  → Increse safety of the DriX navigation by avoiding shallow waters

  → Enable full coverage using MBES where SDB can not (turbid area)

  → Save (a large amount of) money by reducing DriX costs !!

Bathysat



Bathysat : based on RTM inverion

SWIM© :
Shallow water mapping using optical remote sensor(s)

INVERSION MODEL : MODULE SWIM©

Remote-sensing reflectance under the water surface	=	Water column reflectance	+	Bottom reflectance

$$R_{rs}^{-} = R_{rs}^{\infty}(1 - A_1 e^{-(K_d + k_{uW})Z}) + A_2 R_{rs}^{B} e^{-(K_d + k_{uB})Z}$$

PARAMETERS ESTIMATION BY INVERSION OF THE RADIATIVE TRANSFER MODEL

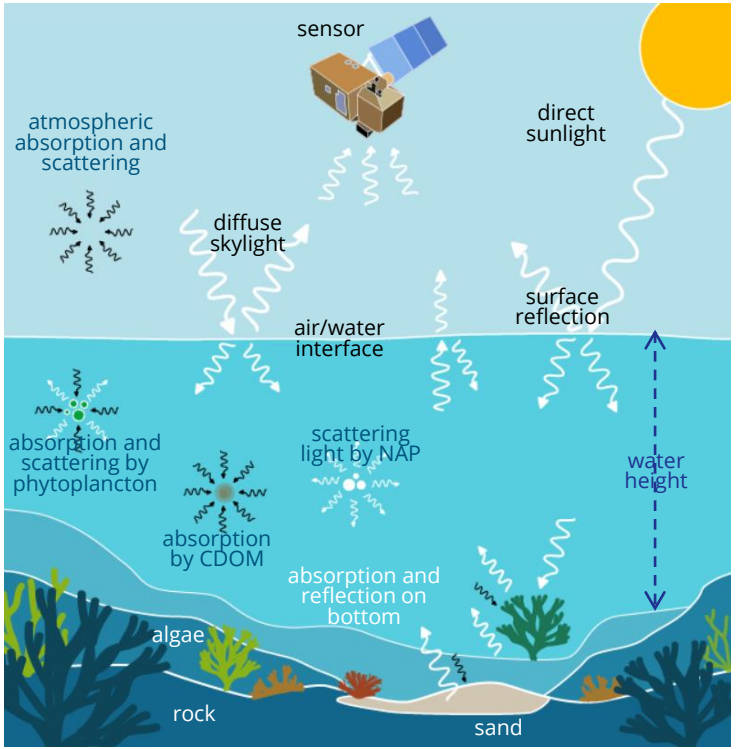
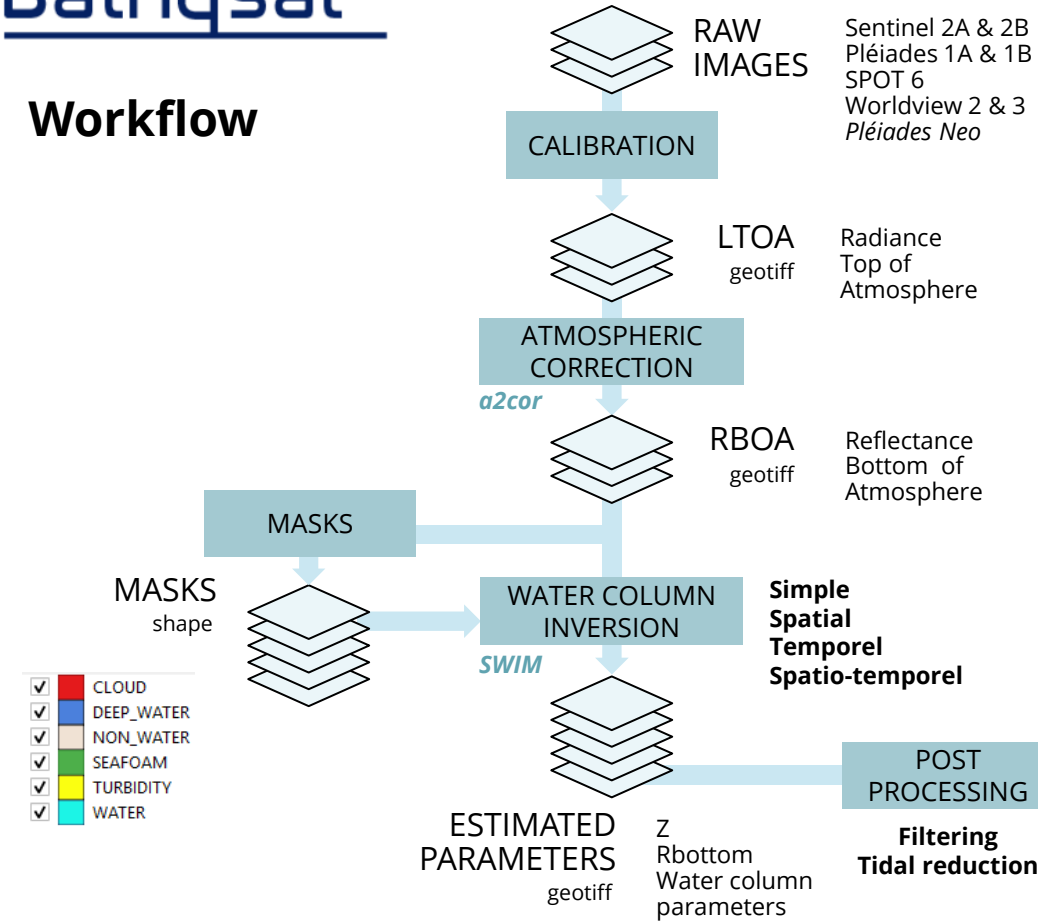


Illustration ©Hytech imaging d'après Guyot (2021)

Bathysat

Workflow



UNCERTAINTIES PROPAGATION

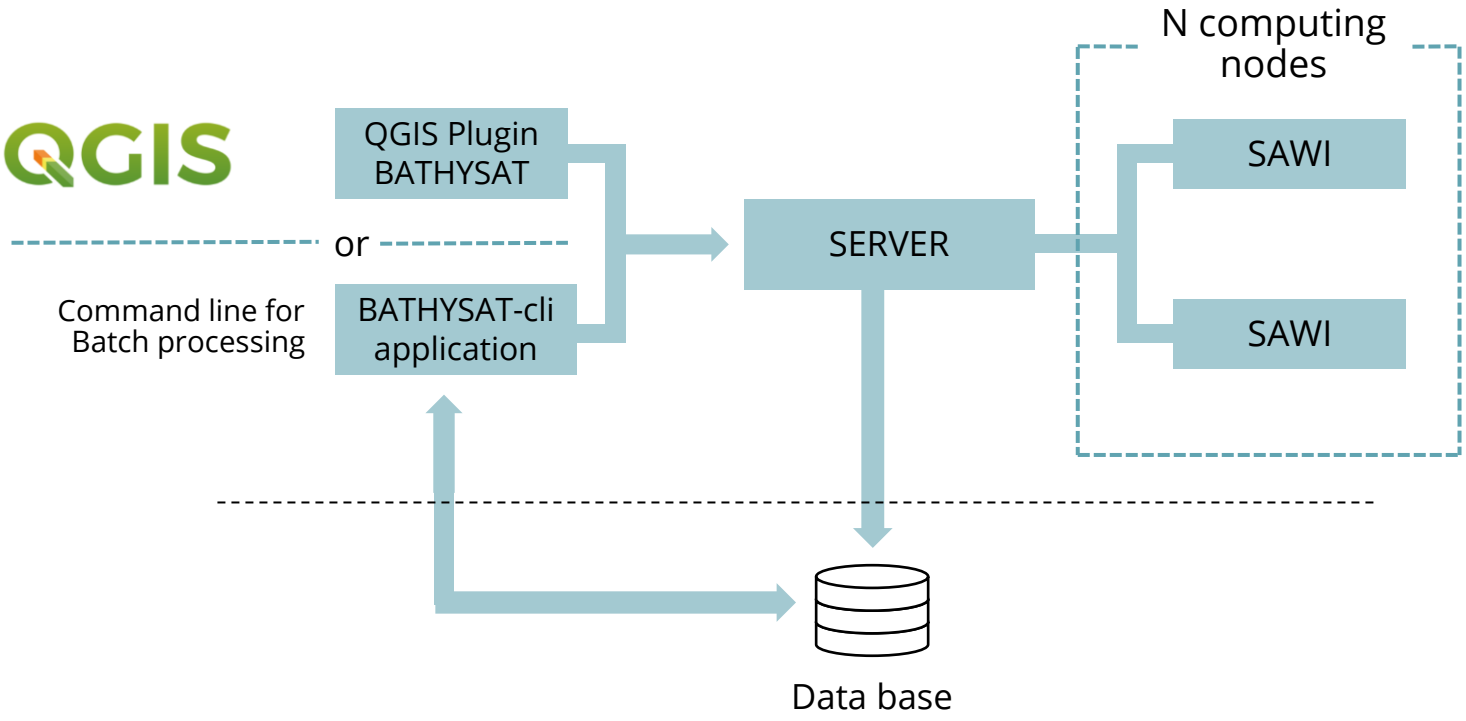
PARALLELIZED COMPUTATIONS

PYTHON AND COMPILED LANGUAGE

ON DEMAND DEPLOYMENT ON CLUSTER / CLOUD

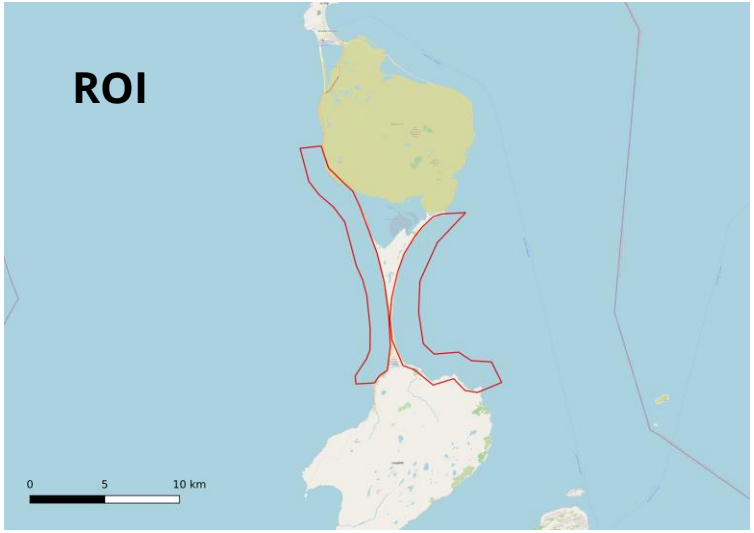
Performances ++

General architecture



Implementation on a local server or on the AWS cloud

Area of interest : usually turbid, especially in the West

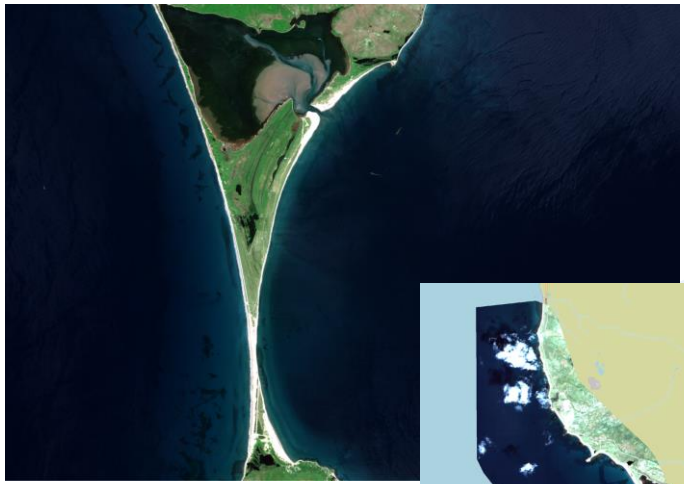


Typical S2 imagery

See plumes on the western part

Step 1: Get satellite data ⇒ Sentinel-2 + Pleiades

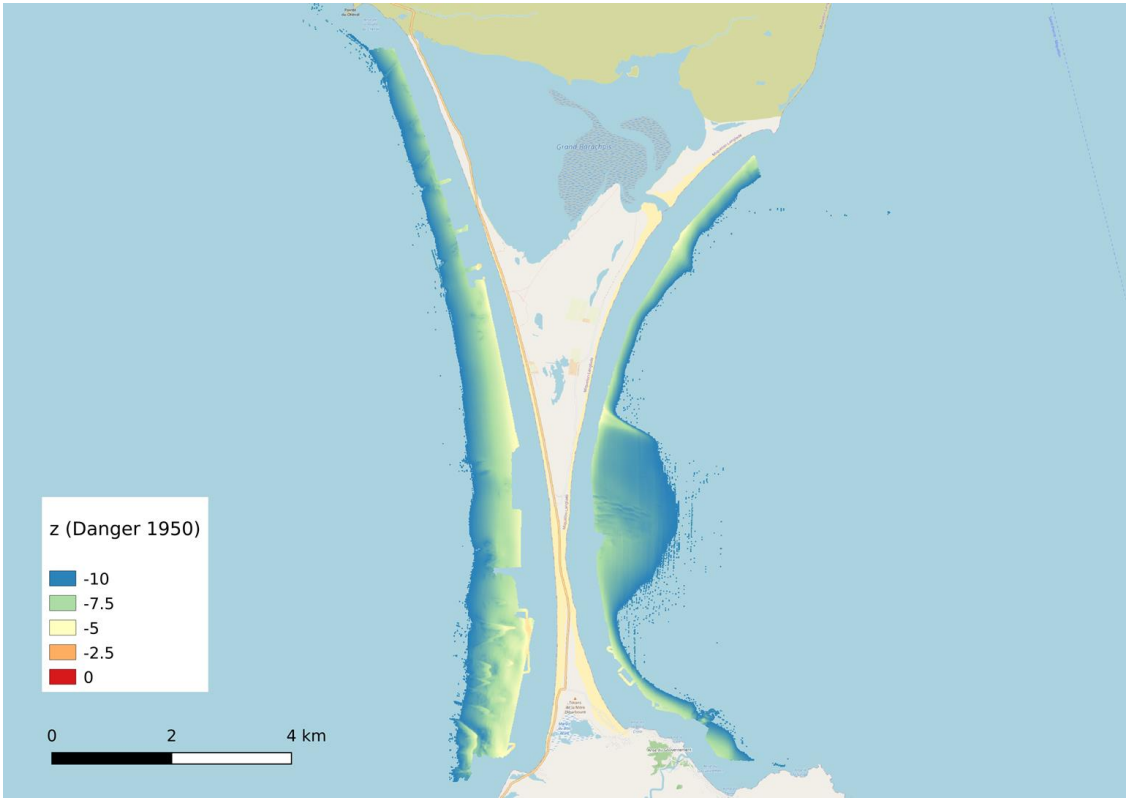
S2 - 08/06/2022



S2 - 08/07/2020

Pléiades - 08/09/2022

Step 2 : Get MBES DriX data (~5 to ~10m deep)

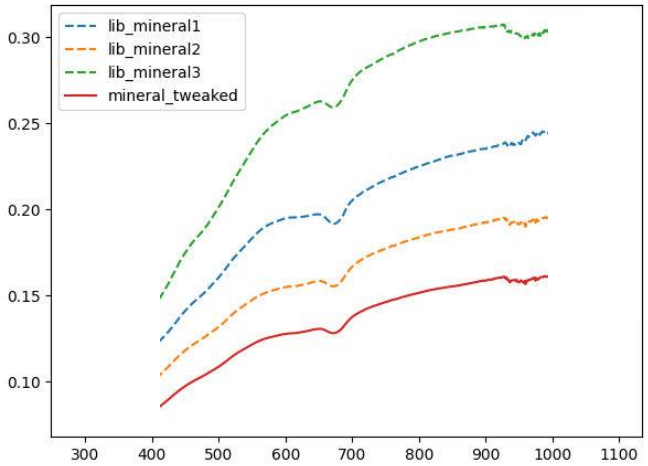


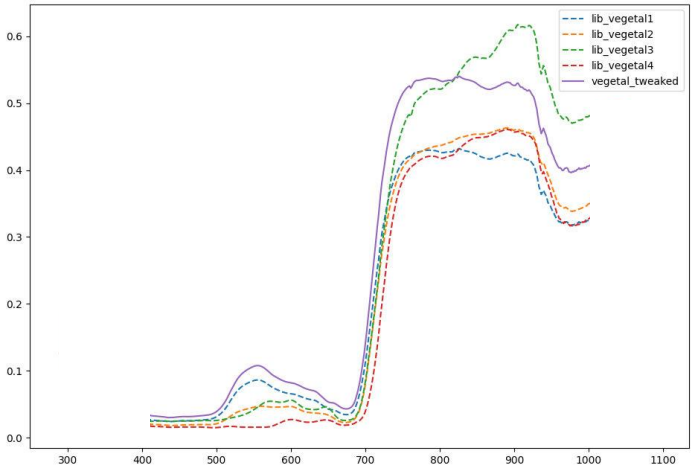
Step 3 : Find MBES / SDB overlapping areas and adjust the bottom model in the RTM

Bathysat

Operation modes

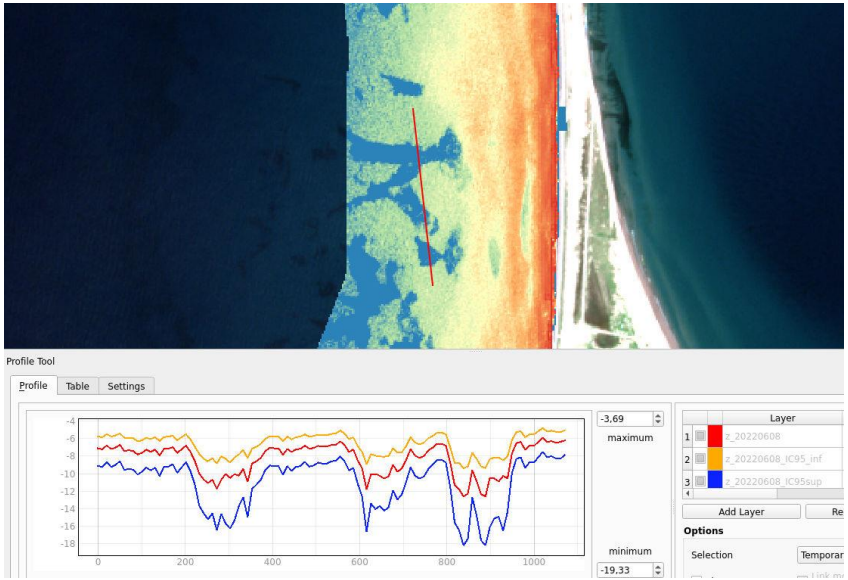
- ❑ Auto / semi-auto modes
- ❑ With / without in situ data
- ❑ Simple / spatial / temporel modes
- ❑ Analytical estimation of uncertainties

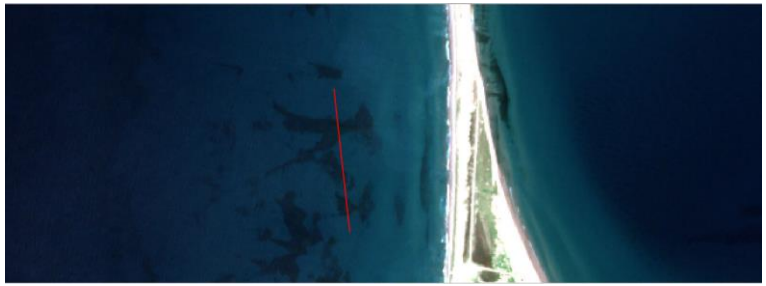


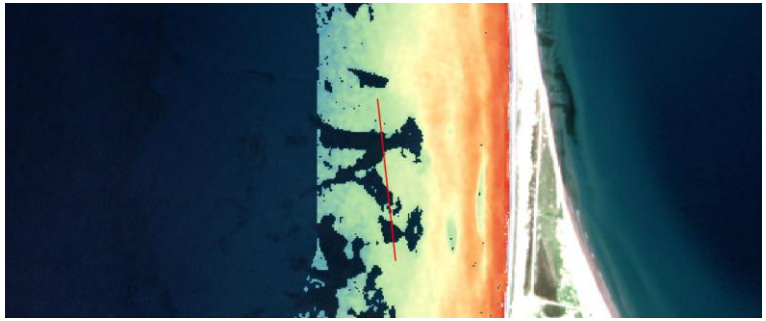


St-Pierre : bottom model adjusted over the DriX MBES / SDB overlap areas

Step 4: Compute SDB + uncertainties, then filter

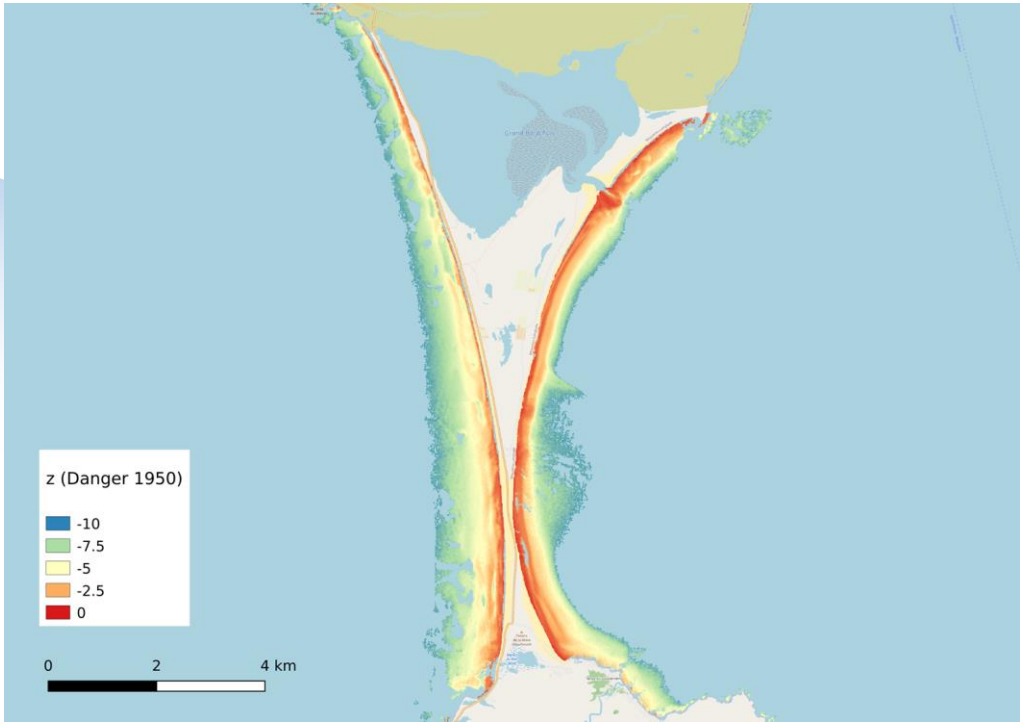




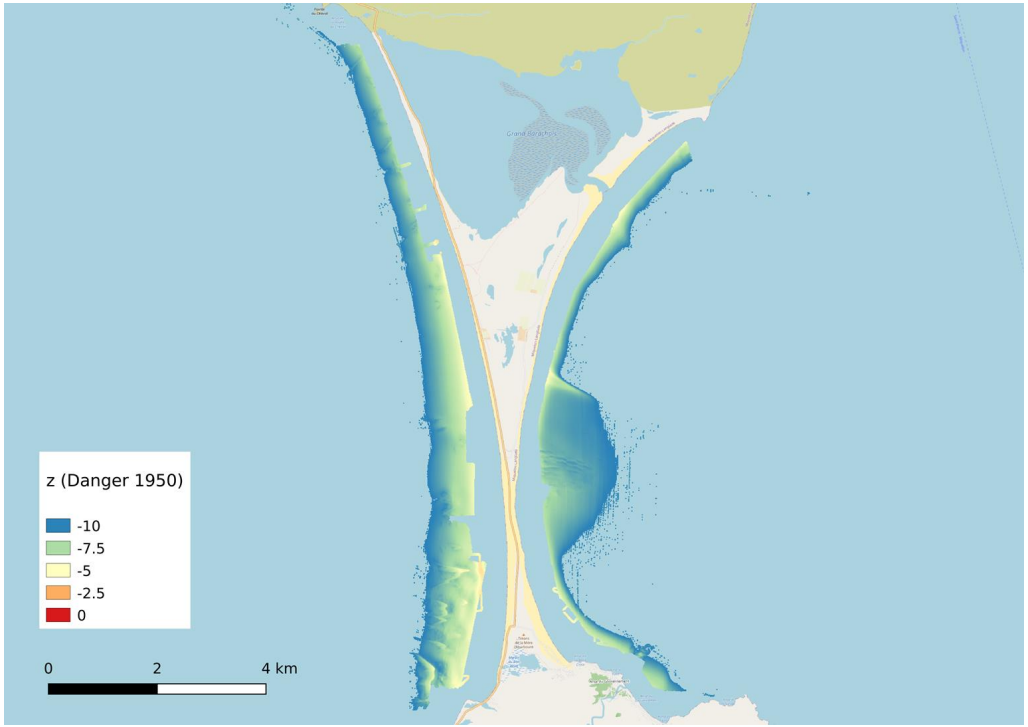


Dark bottoms filtered due to high uncertainty

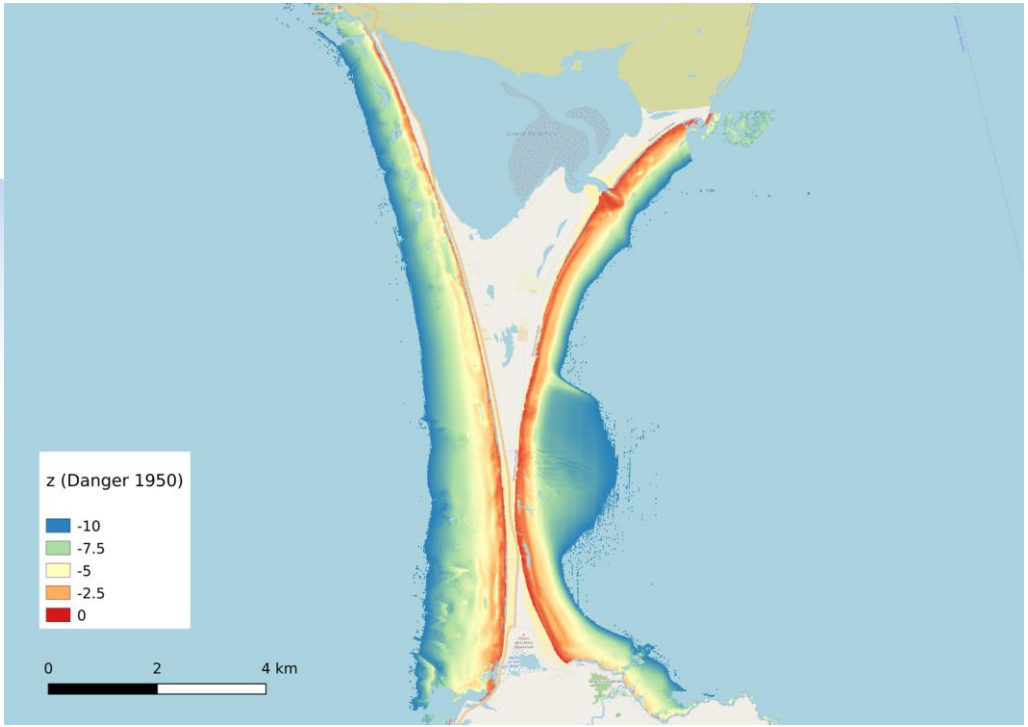
Then compute SDB on the full area 0 to ~7m



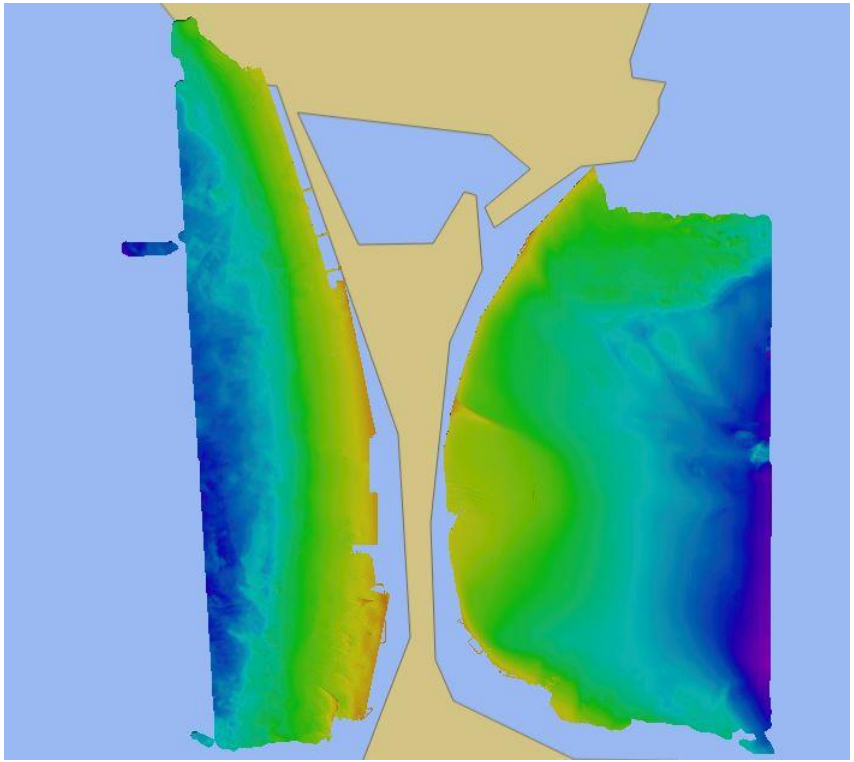
Get Back MBES DriX data ~5 to ~10m

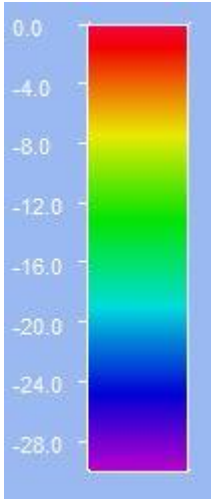


And then fuse SDB + MBES DriX ⇒ 0 to 10m

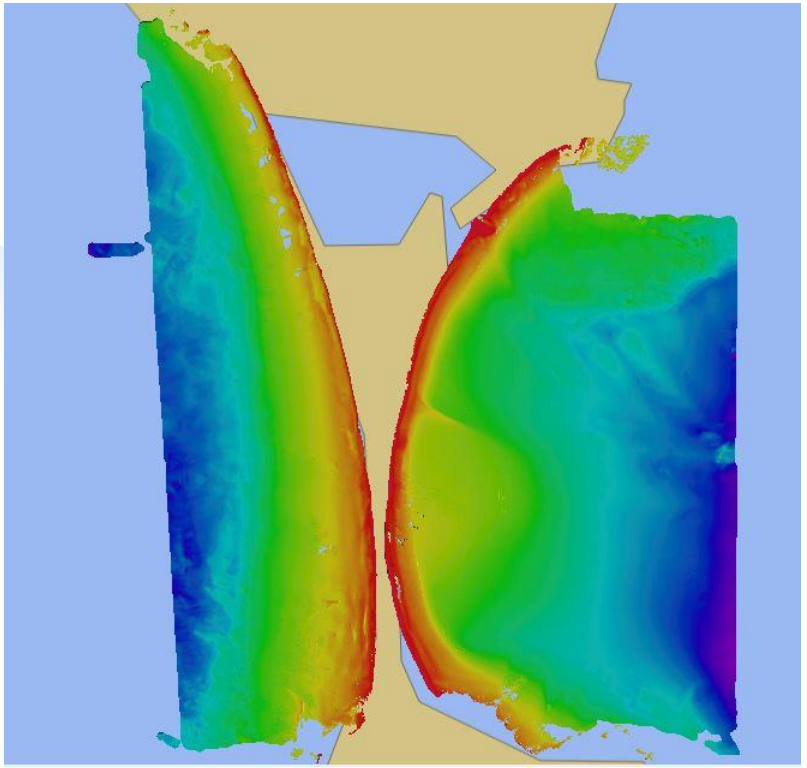


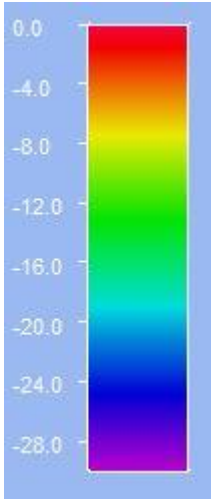
Then extend DriX to 30m



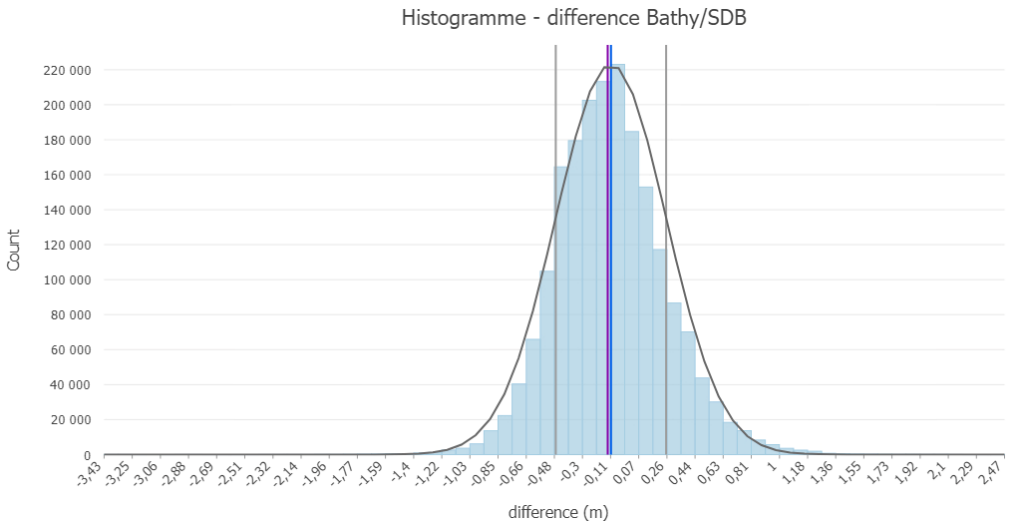


And then fuse SDB + MBES DriX ⇒ 0 to 30m





Precision / accuracy reached



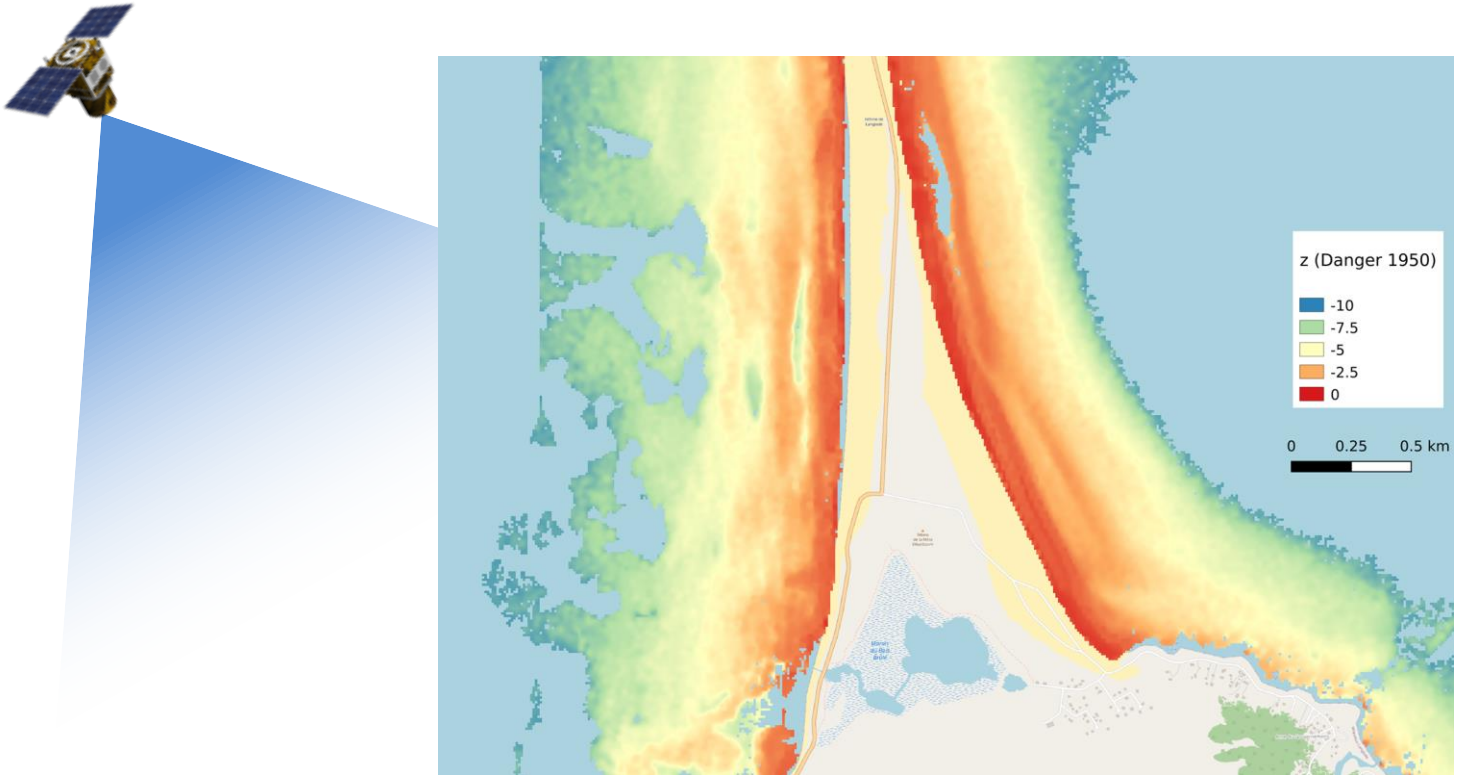
Accuracy / Precision evaluated in the overlapping MBES / SDB area :

Bias : **10.9 cm**
σ : **36.2 cm**

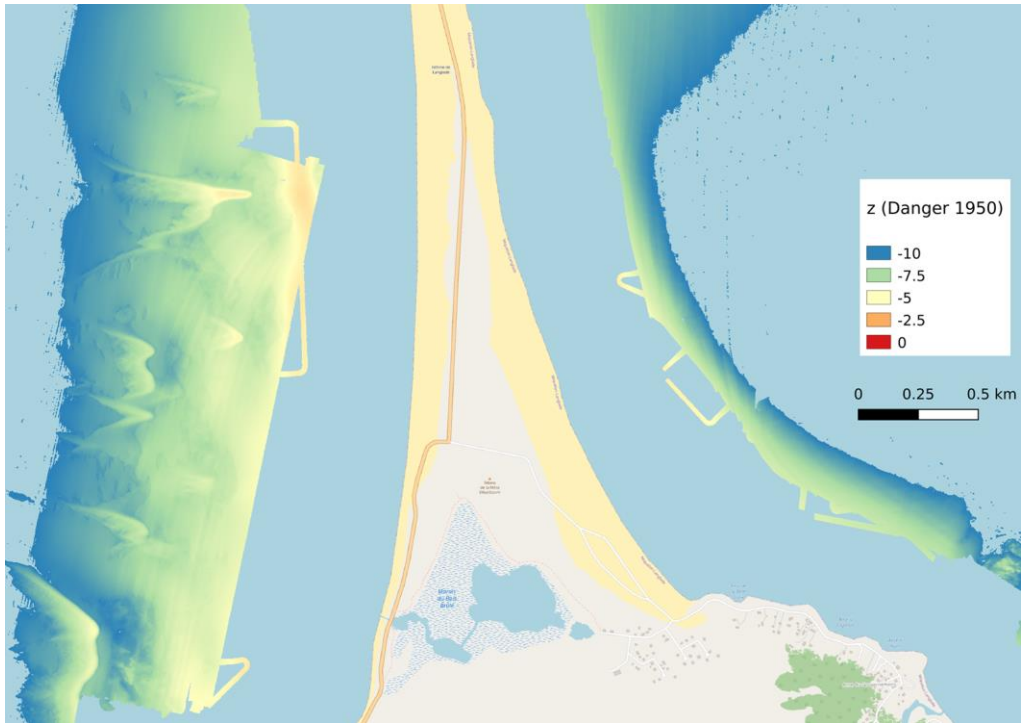
Overlapping area being mostly in the highest SDB depths (~5 to 7m)

⇒ precision / accuracy even quite better in shallower areas (< 5m)

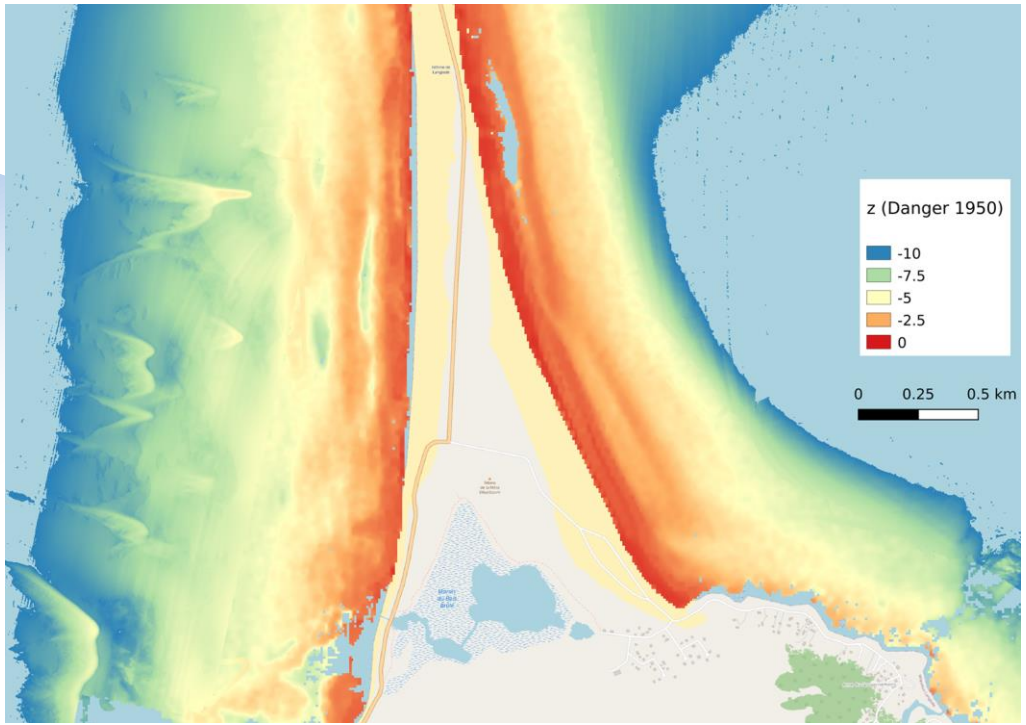
Zoom on SDB 0 to ~7m



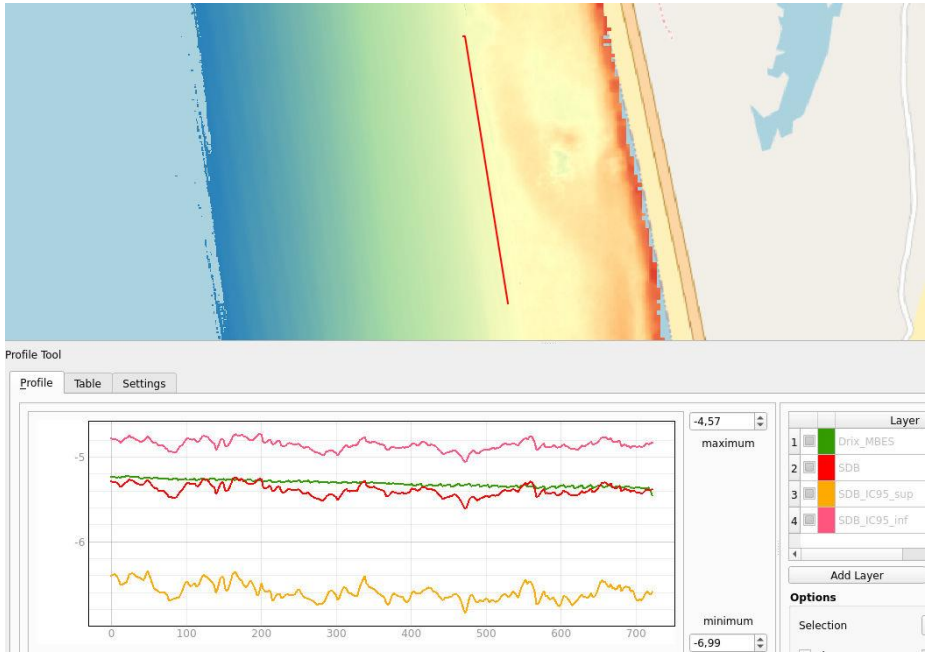
Zoom on MBES Drix ~5 to ~10m

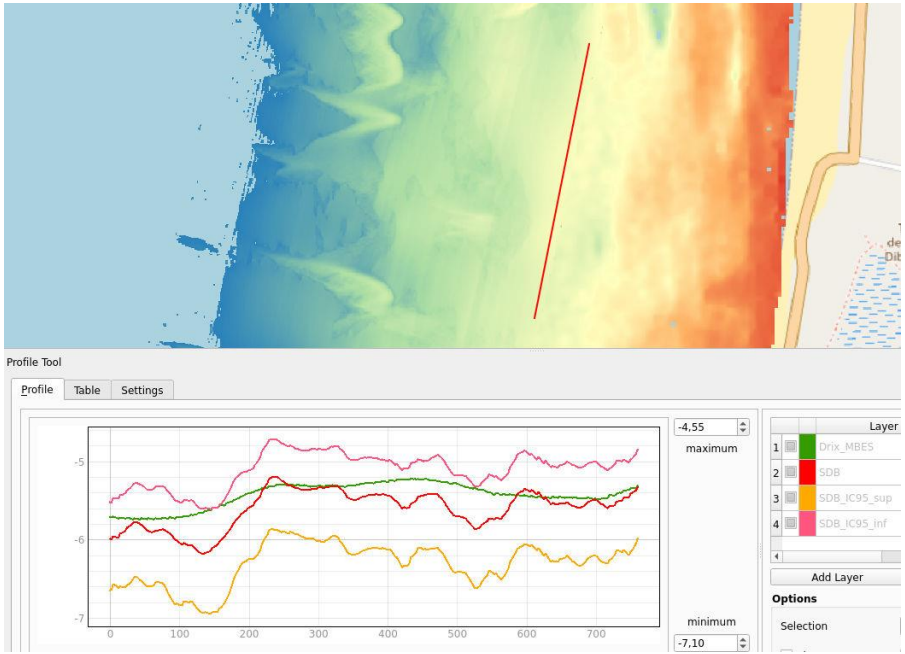


Zoom on fused SDB + MBES Drix ⇒ 0 to 10m



SDB / DriX MBES / Uncertainties





Lessons learned

- RT models usually need local adjustments
  $\Rightarrow$ can be done without any ground truth, but easier when z data available

- MBES data can be collected only up the depth that can be reached with SDB
  (MBES data very long and costly in shallow areas)

- Then SDB can fill the gap in shallow water areas

$\Rightarrow$ **Drix + SDB can be used to make seamless precise coastal DEMs at costs much lower than using MBES data alone**

Thank you

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