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Arctus

Télédétection des environnements aquatiques
& veille environnementale

CIDCO 2023 SYMPOSIUM, Rimouski

New development in Satellite-Derived Bathymetry in optically complex waters

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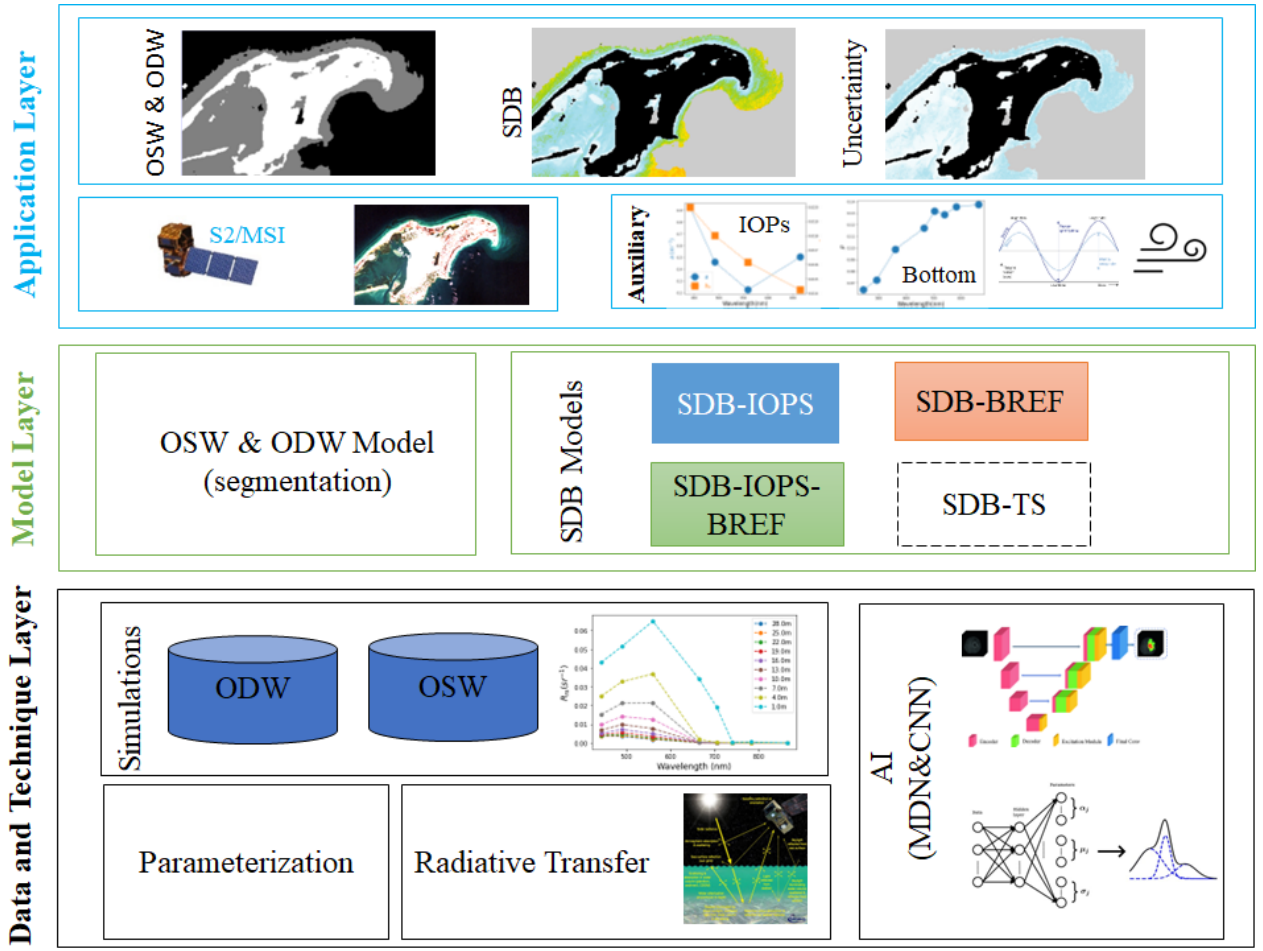
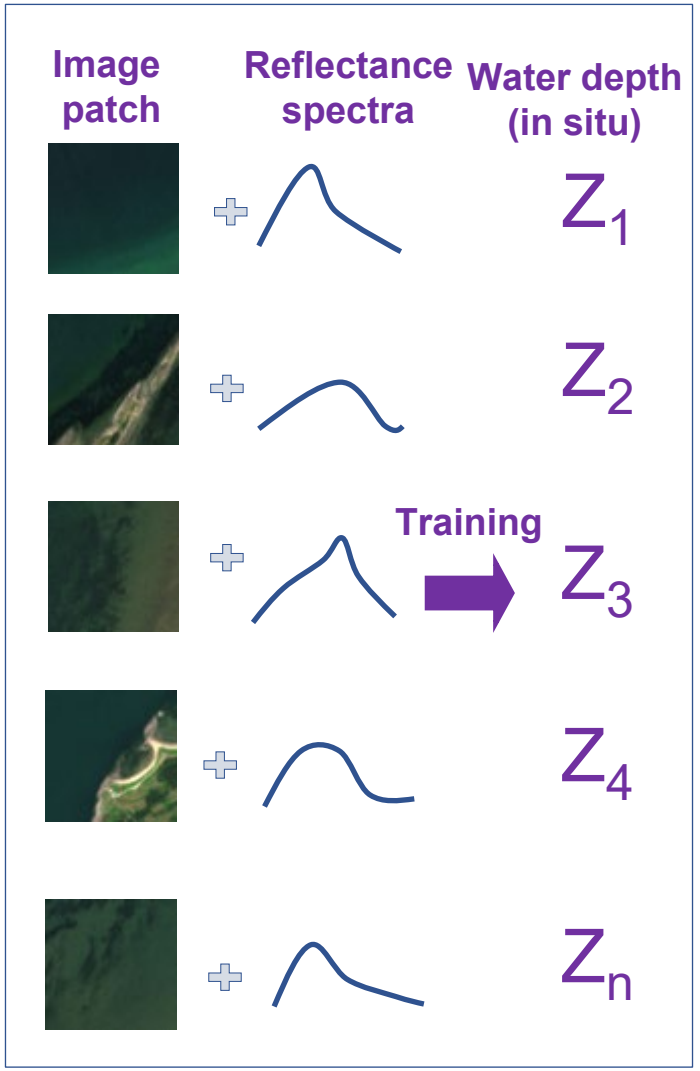
The ARCTUS AI-assisted SDB solution

Physical method



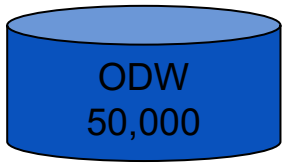
Empirical method

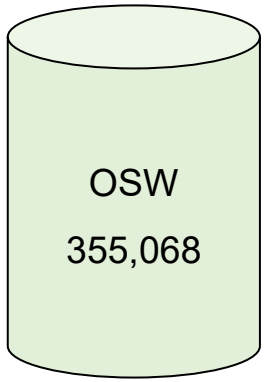


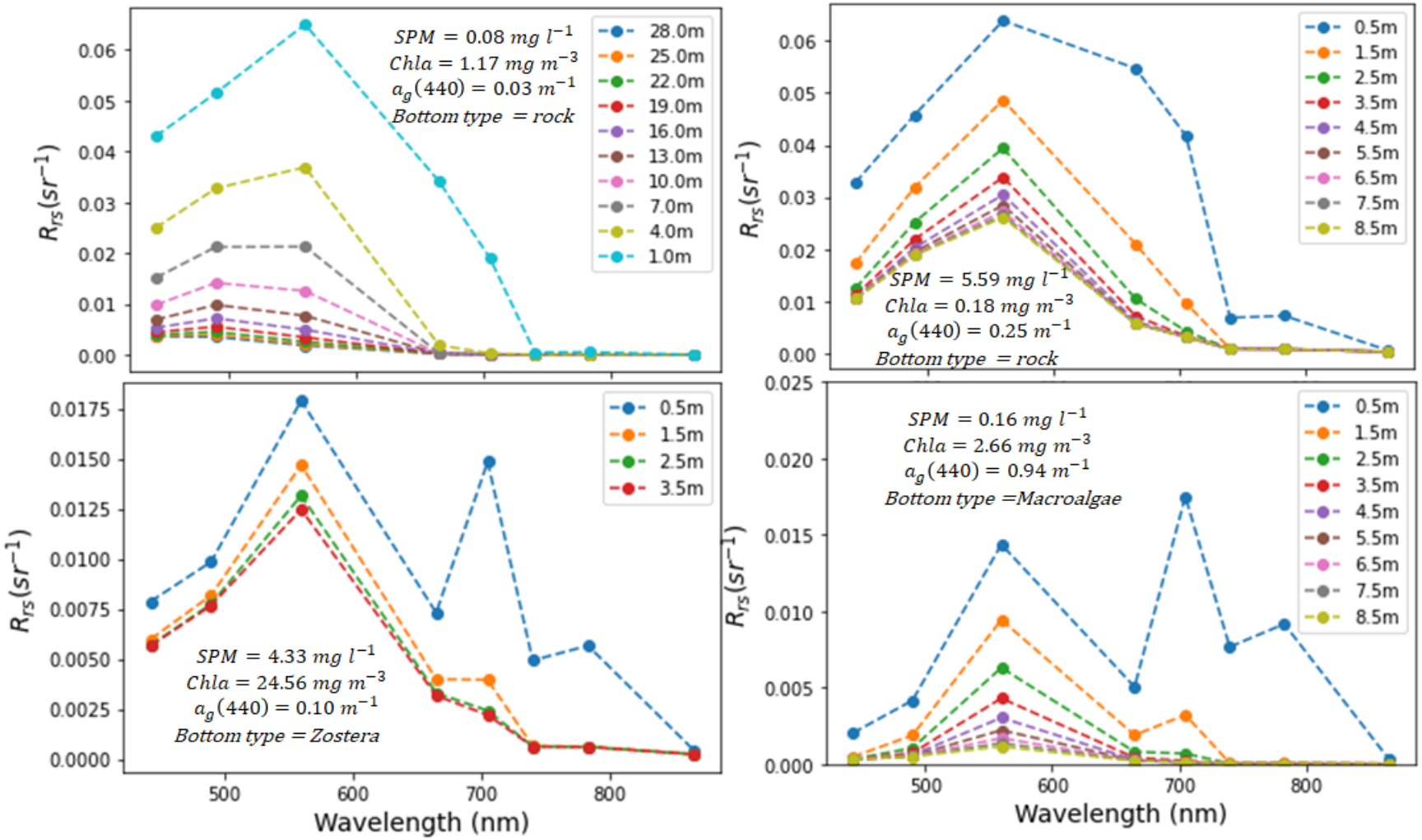
OSW: Optical Shallow Waters ODW: Optical Deep Waters IOPs: Inherent Optical Properties BREF: Bottom REFlectance TS: Time Series

Radiative transfer model and simulations

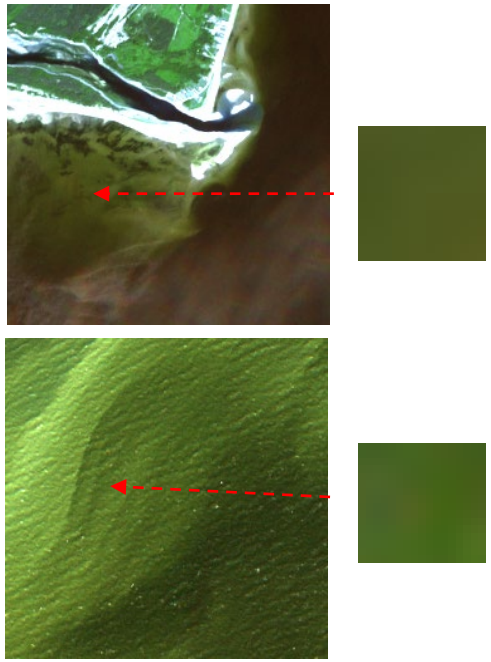
Model: **Albert & Mobley** (Albert et al., 2003)
IOPs Parameterization: Cizimedi (2008)
Bottom types and reflectance: **AquaTel** UQAR (https://aquatel.uqar.ca/)

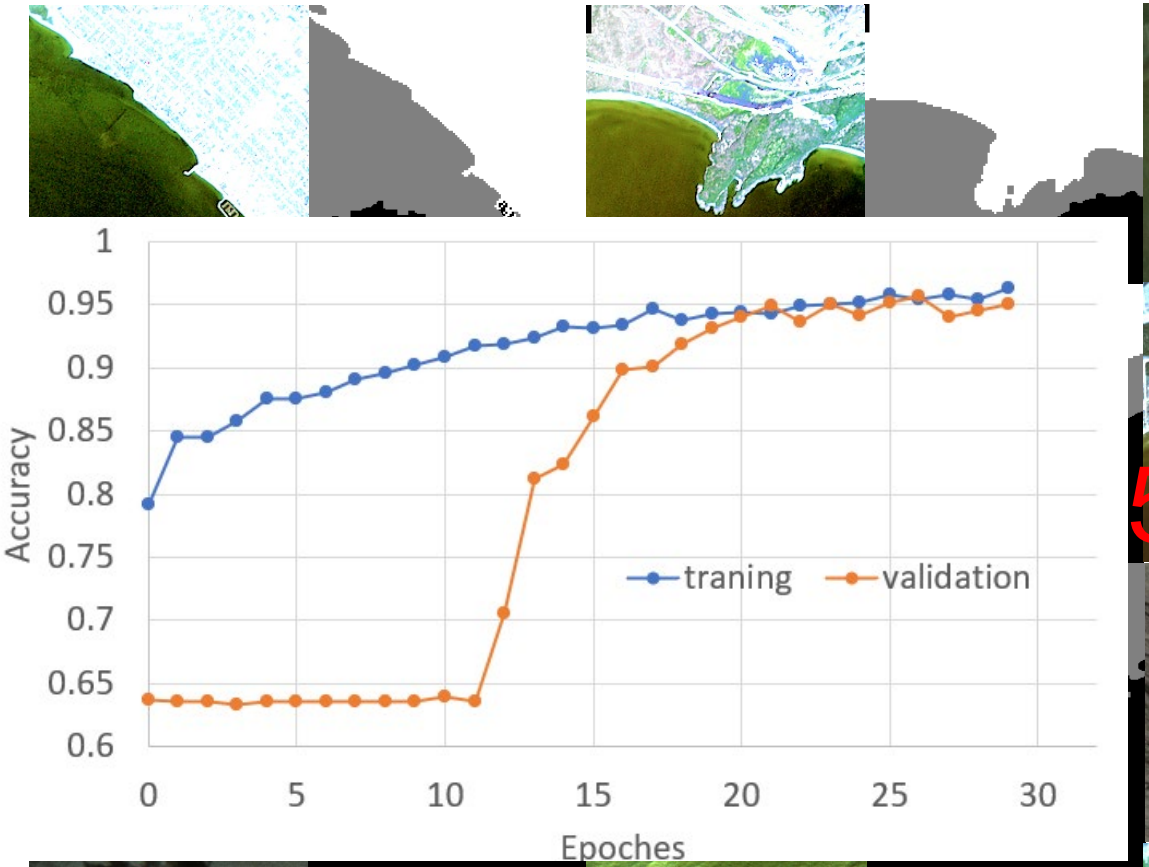


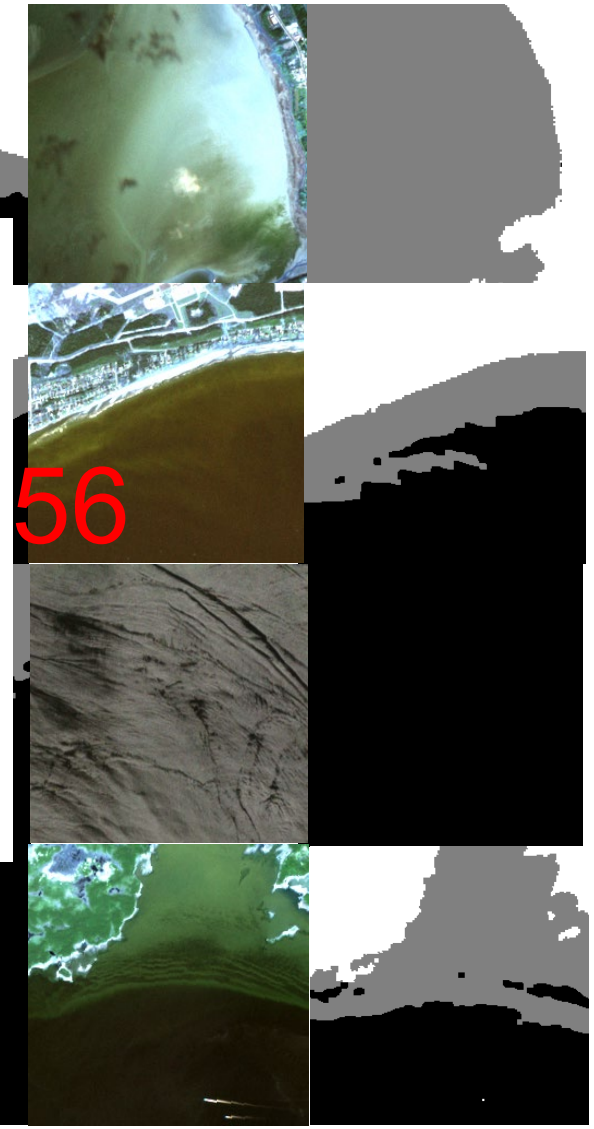




OSW&ODW detection







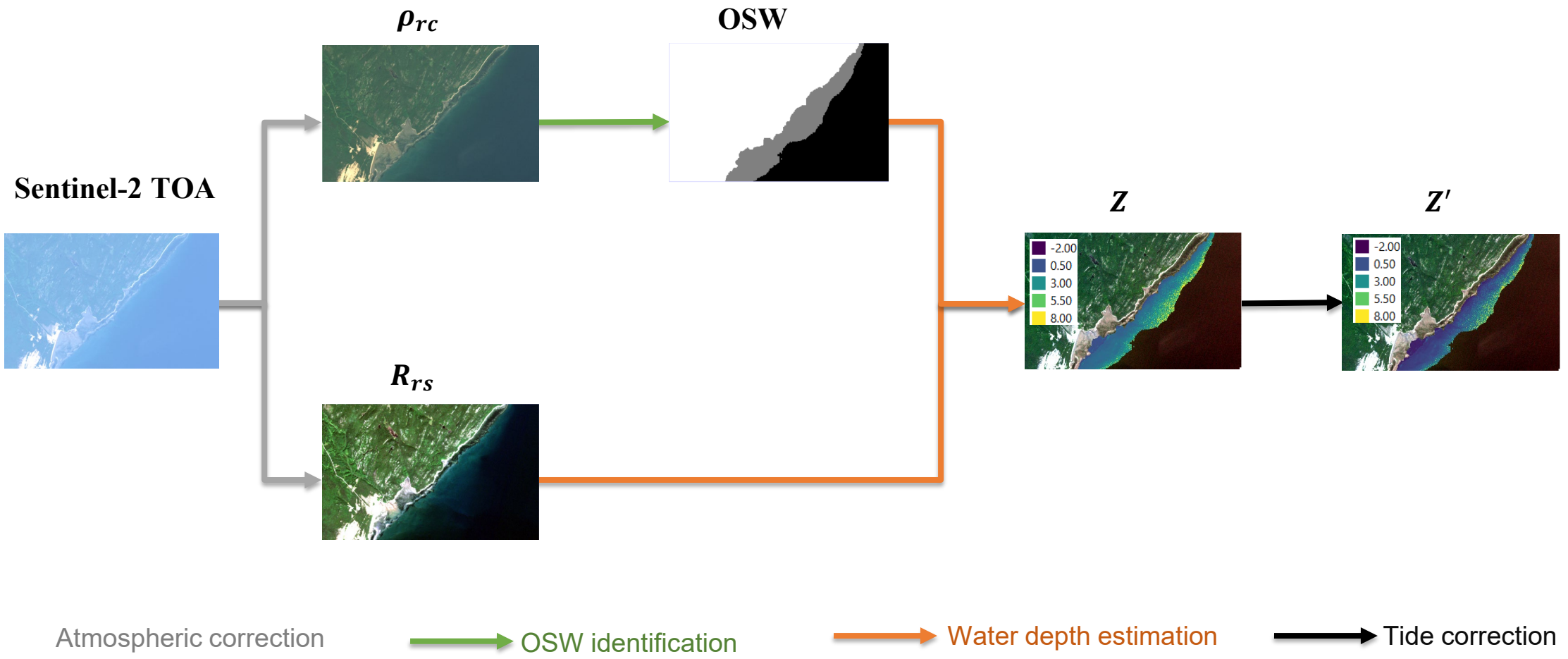
UNET

SDB models

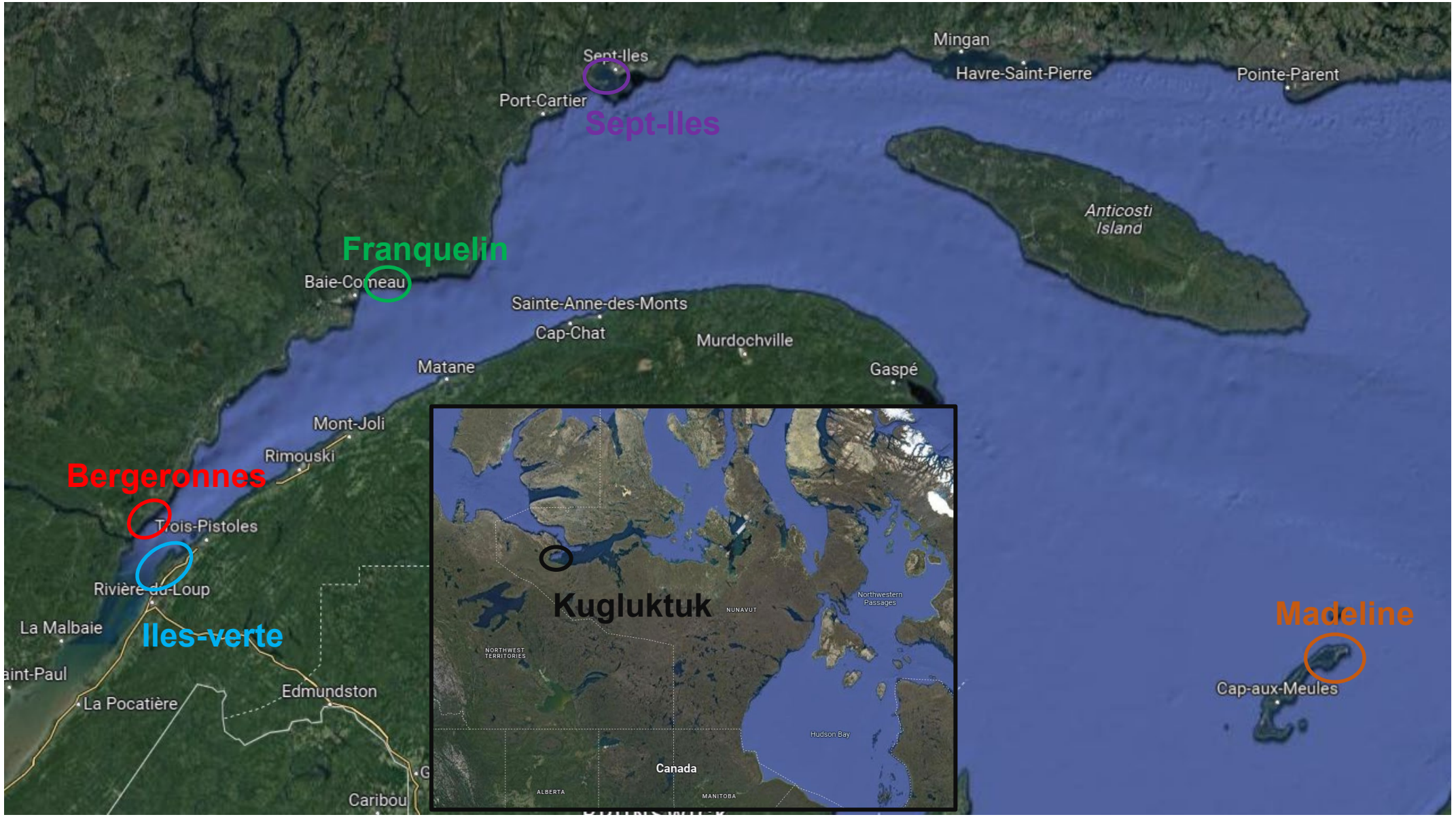
$$R_{rs} = f(\text{IOPs}, u, R_b, z)$$

Inputs		Modèle:				
		SDB-NI	SDB-IOPs	SDB-BREF	SDB-IOPs-BREF	SDB-TS
$R_{rs}(\lambda)$		√	√	√	√	√ (6)
$R_b(\lambda)$		x	x	√	√	x
IOPs		x	√	x	√	x
Données auxiliaires (Vitesse du vent)		√	√	√	√	√
Performances du modèle	MSE (m)	3.22	1.40	1.16	0.70	1.23
	MAE (m)	1.25	0.74	0.70	0.44	0.86
	MedAE (m)	0.83	0.39	0.40	0.16	0.67
	r	0.65	0.88	0.91	0.94	0.92

Single image processing flow chart

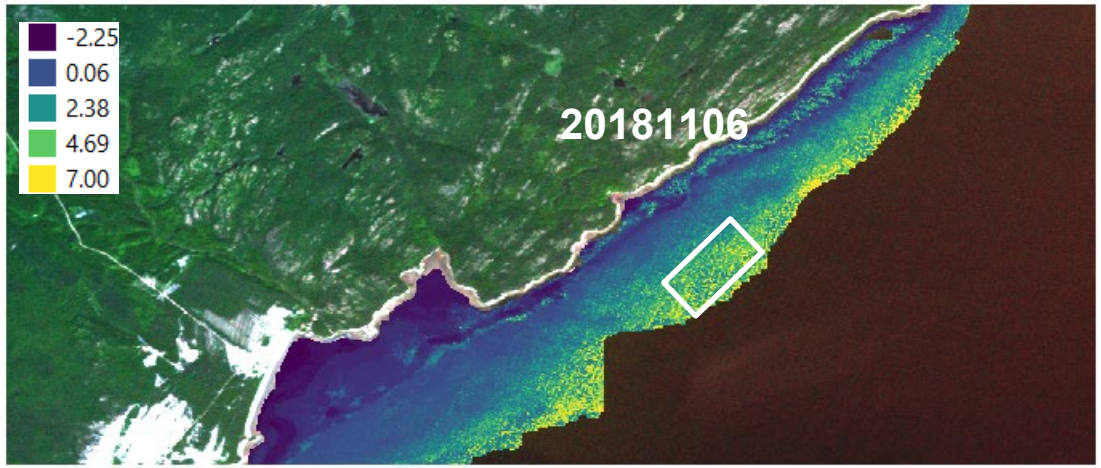


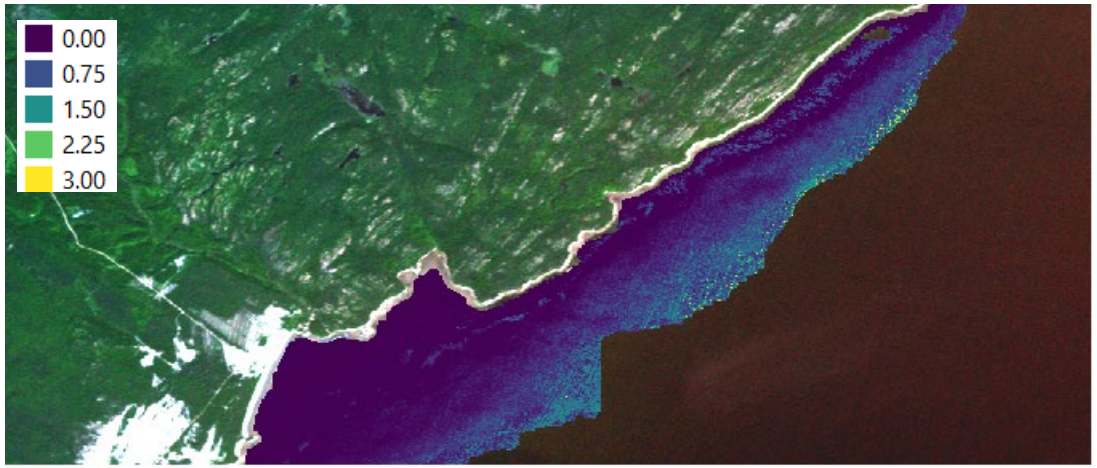
Case studies

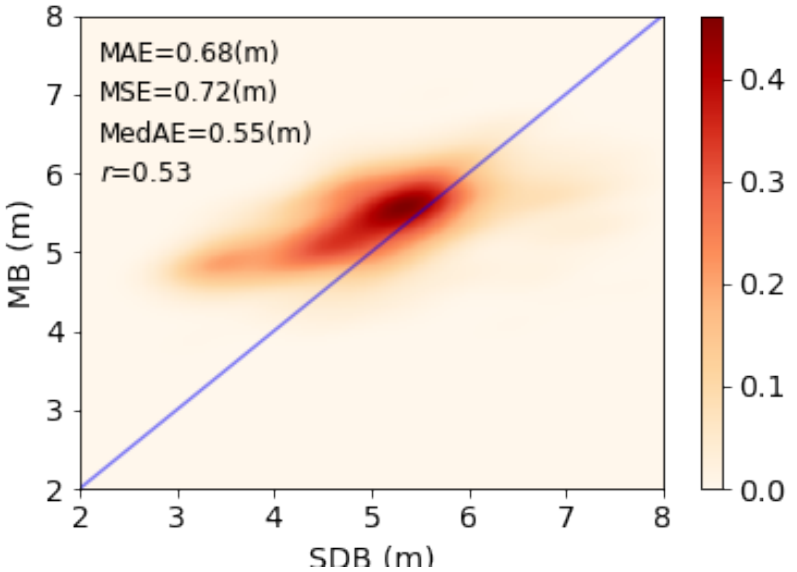


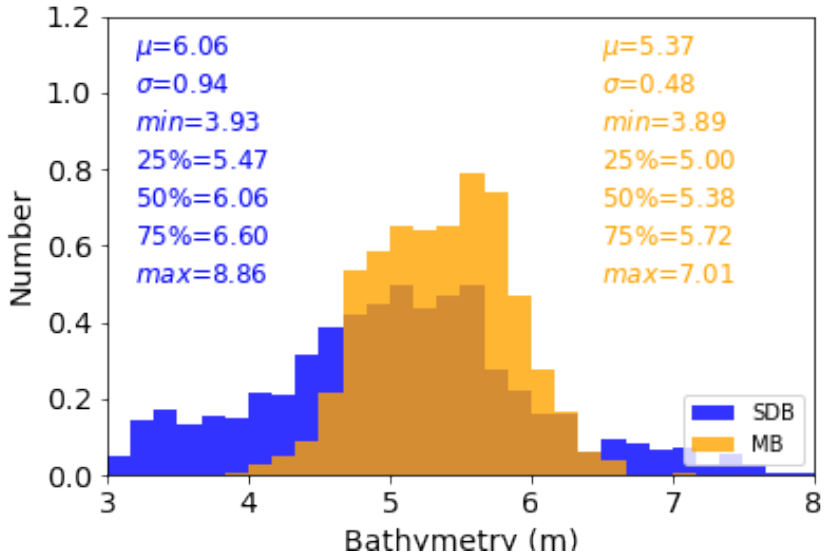
Case study #1 **Bergeronnes**

IOPs are estimated from the neighbouring Optical Deep Water





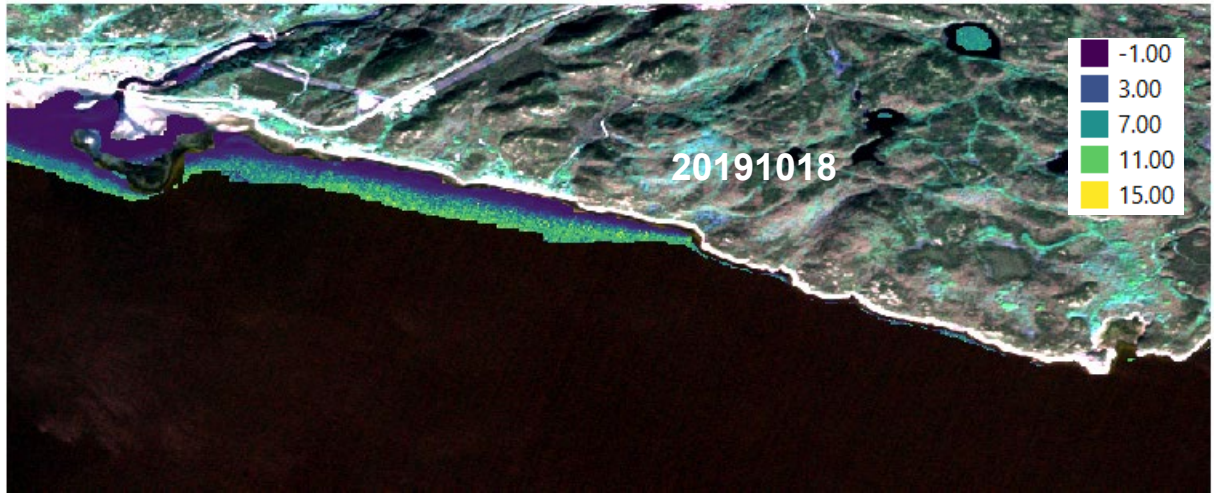


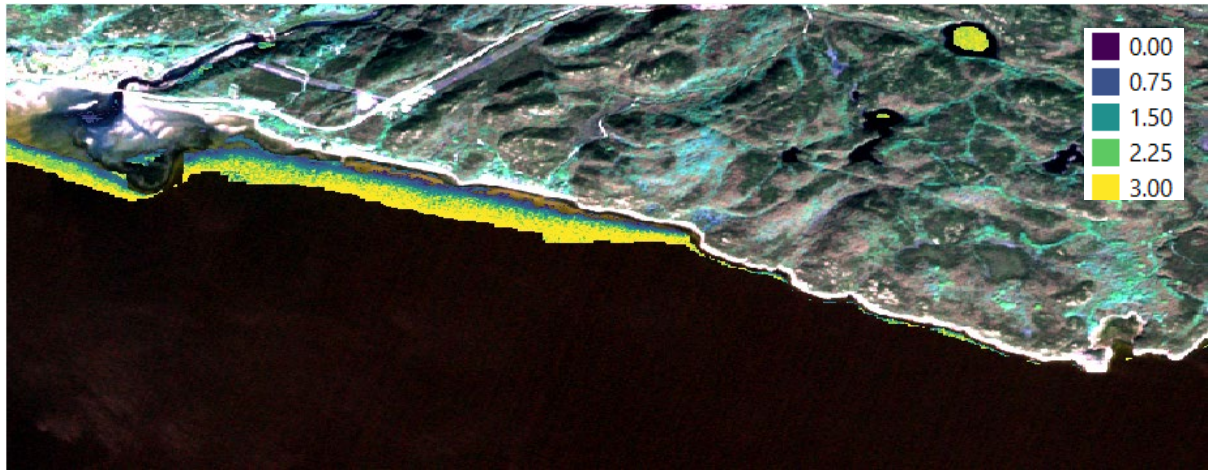


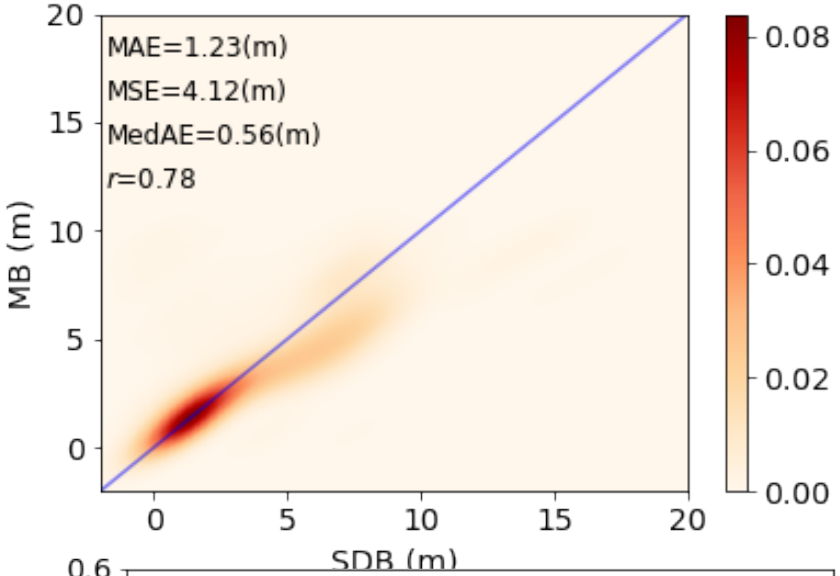
Four images: 20180813 20180907 20180910 20180927

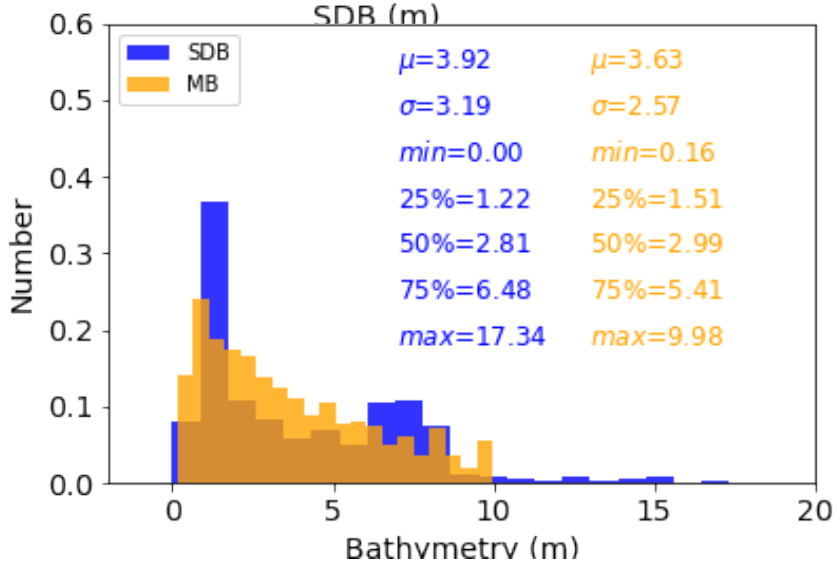
Case study #2 Franquelin

IOPs are estimated from the neighbouring Optical Deep Water









Two images: 20191005
20191020

Case study #3 **Sept-iles**

IOPs are from semi-synchronized measurements provided by UQAR

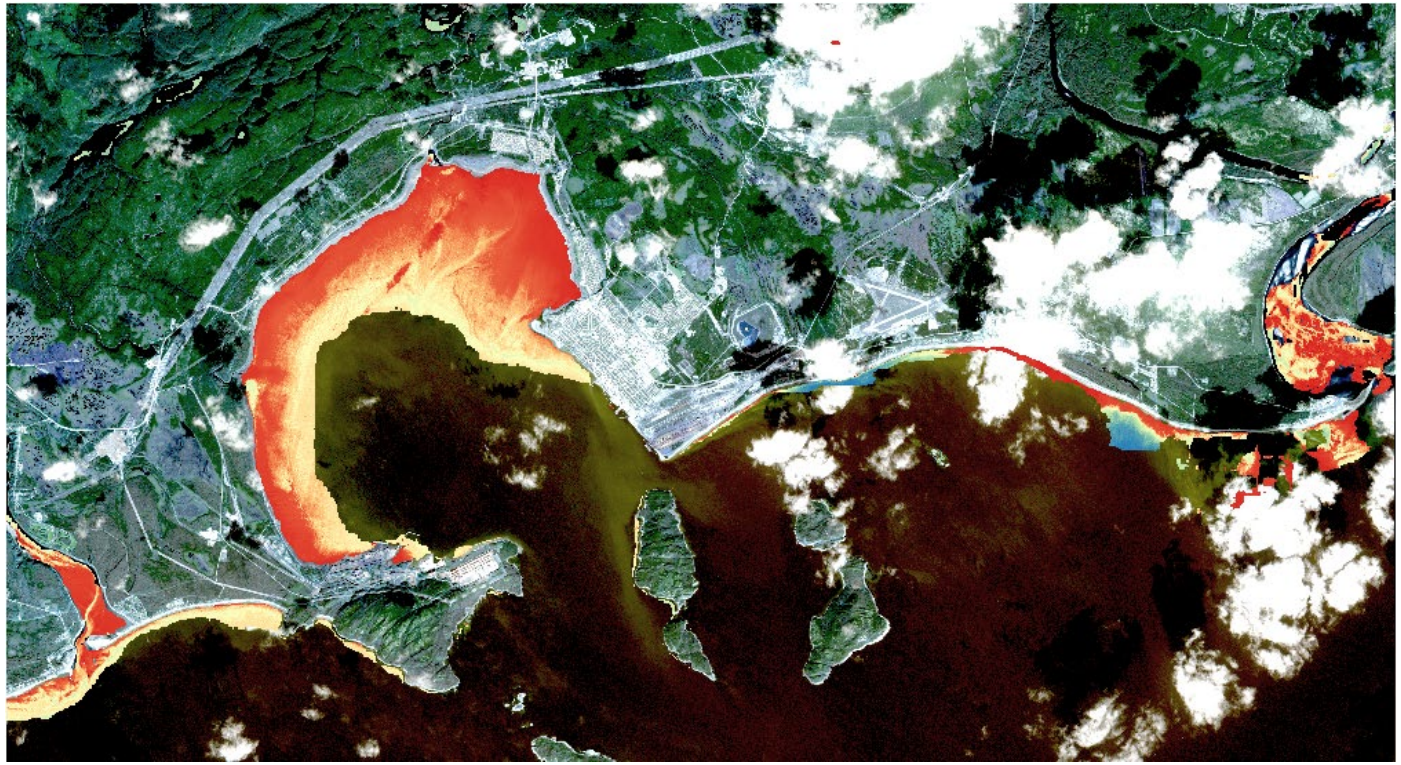
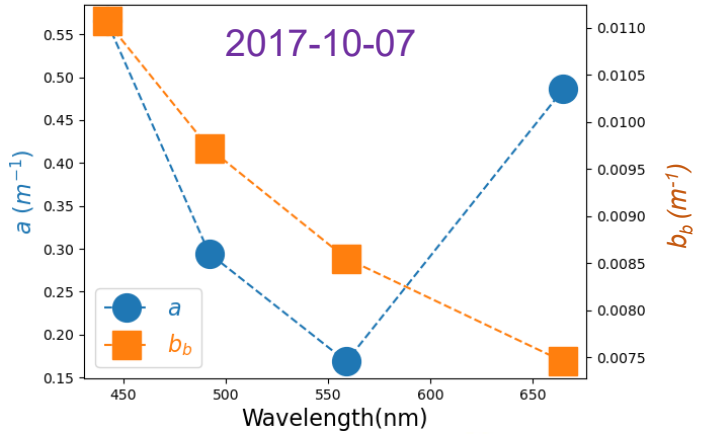
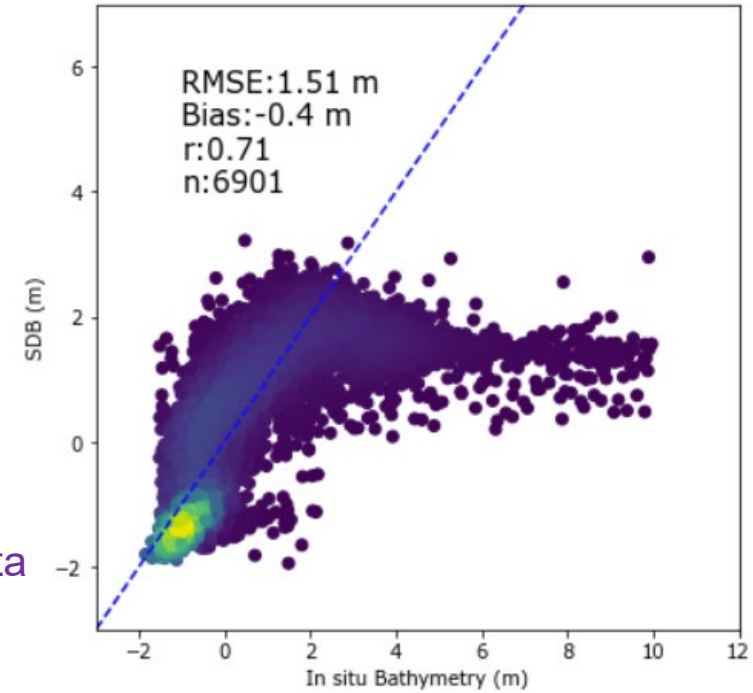


Image: 2017-10-12

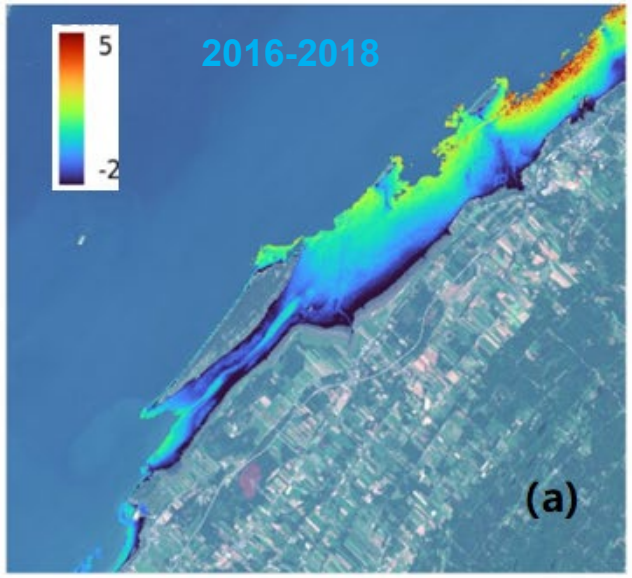


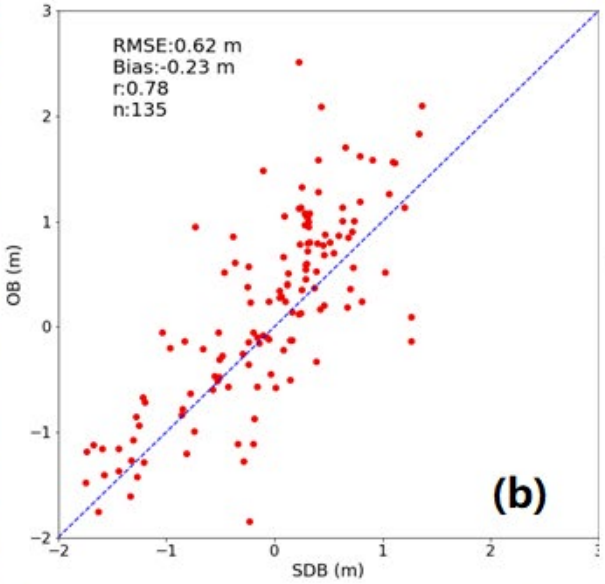


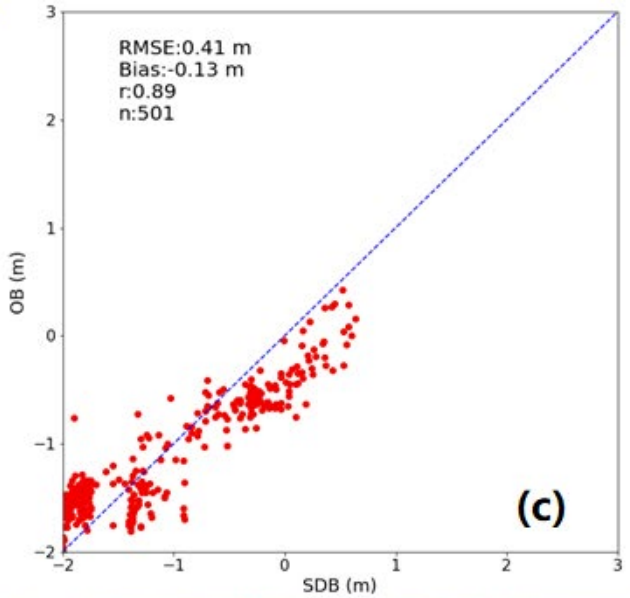
The new released NONNA 10m data

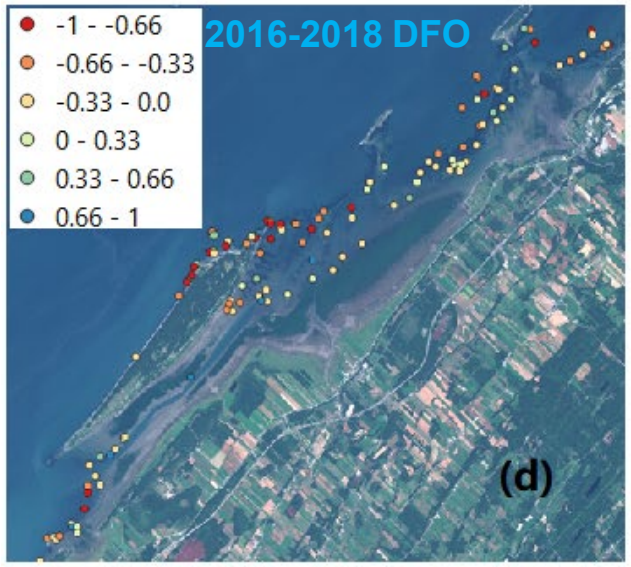
Case study #4 Iles-verte

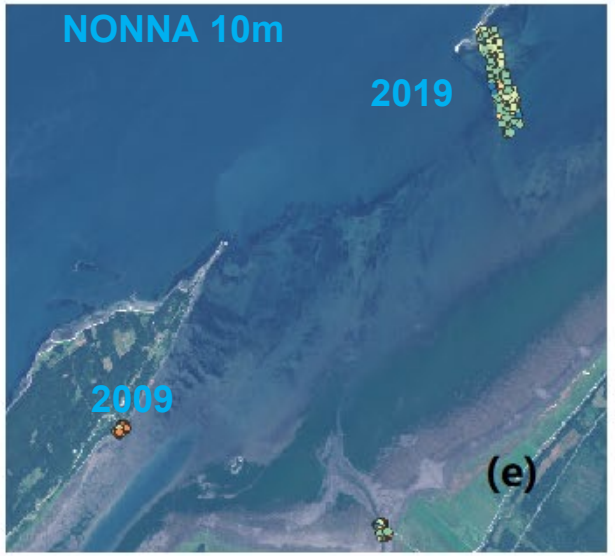
IOPs are estimated from the neighbouring Optical Deep Water

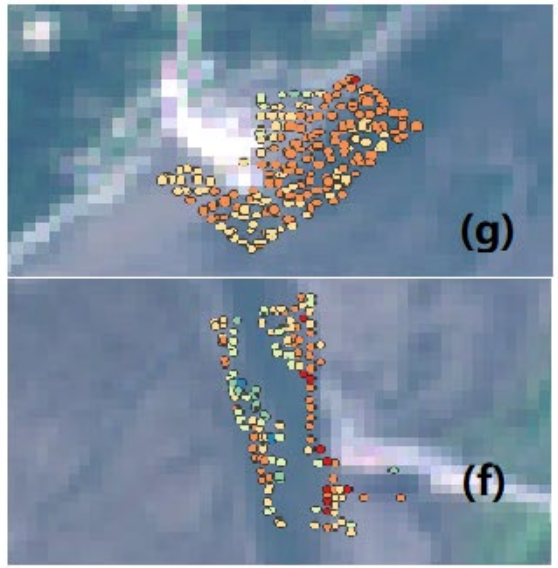






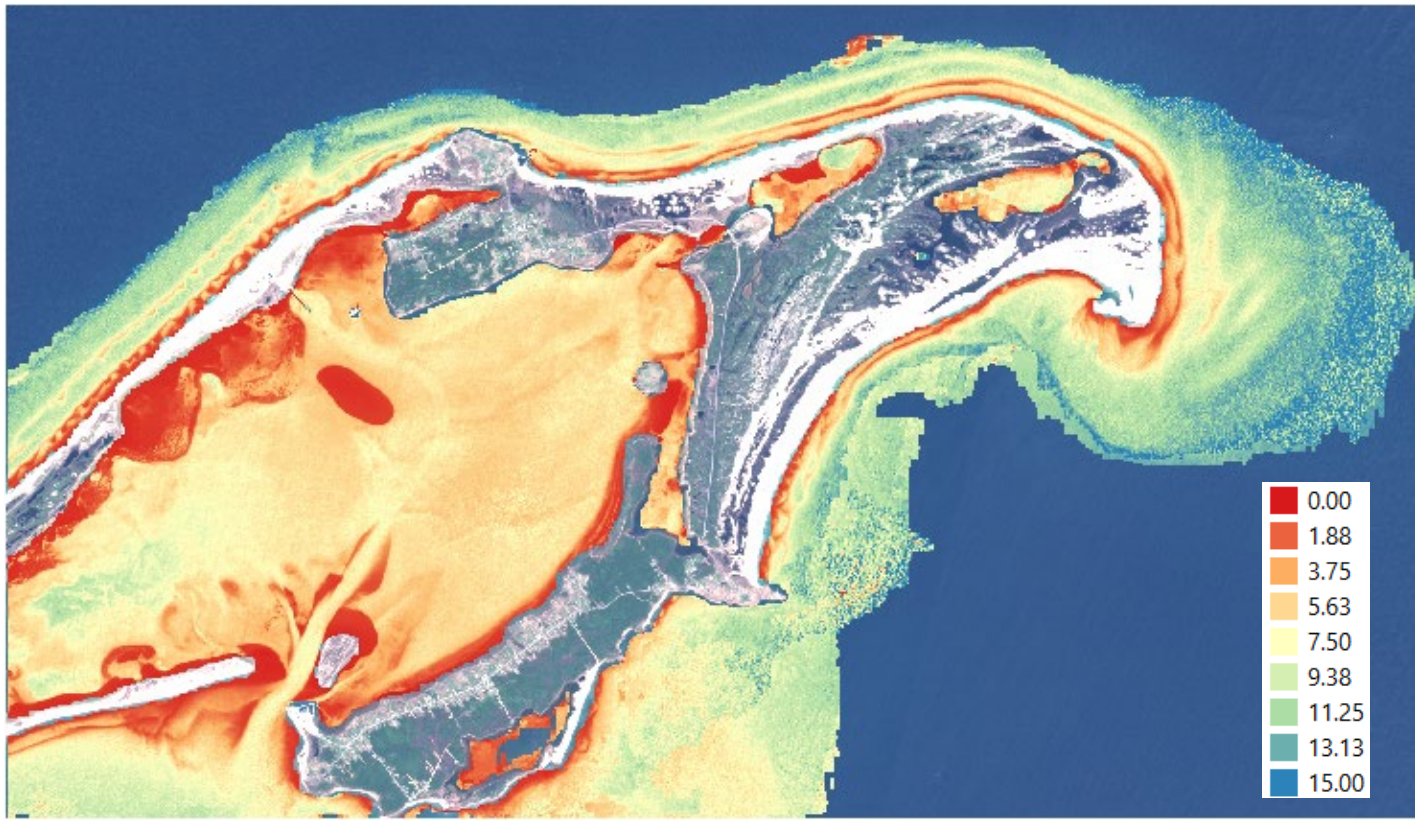


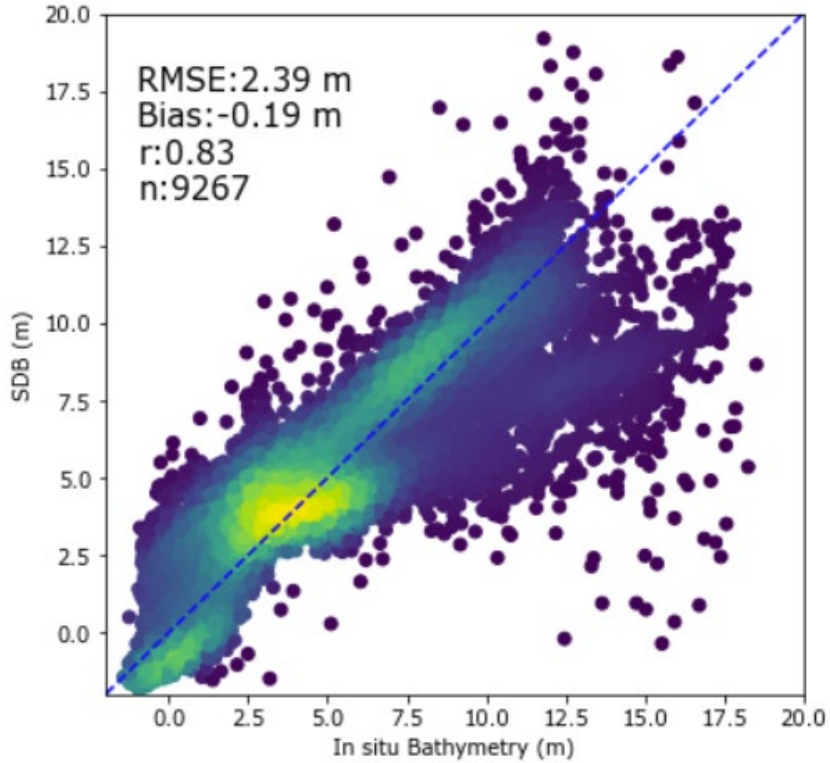




Case study #5 **Madeleine**

The bottom reflectance are estimated from the neighbouring inter-tidal zone



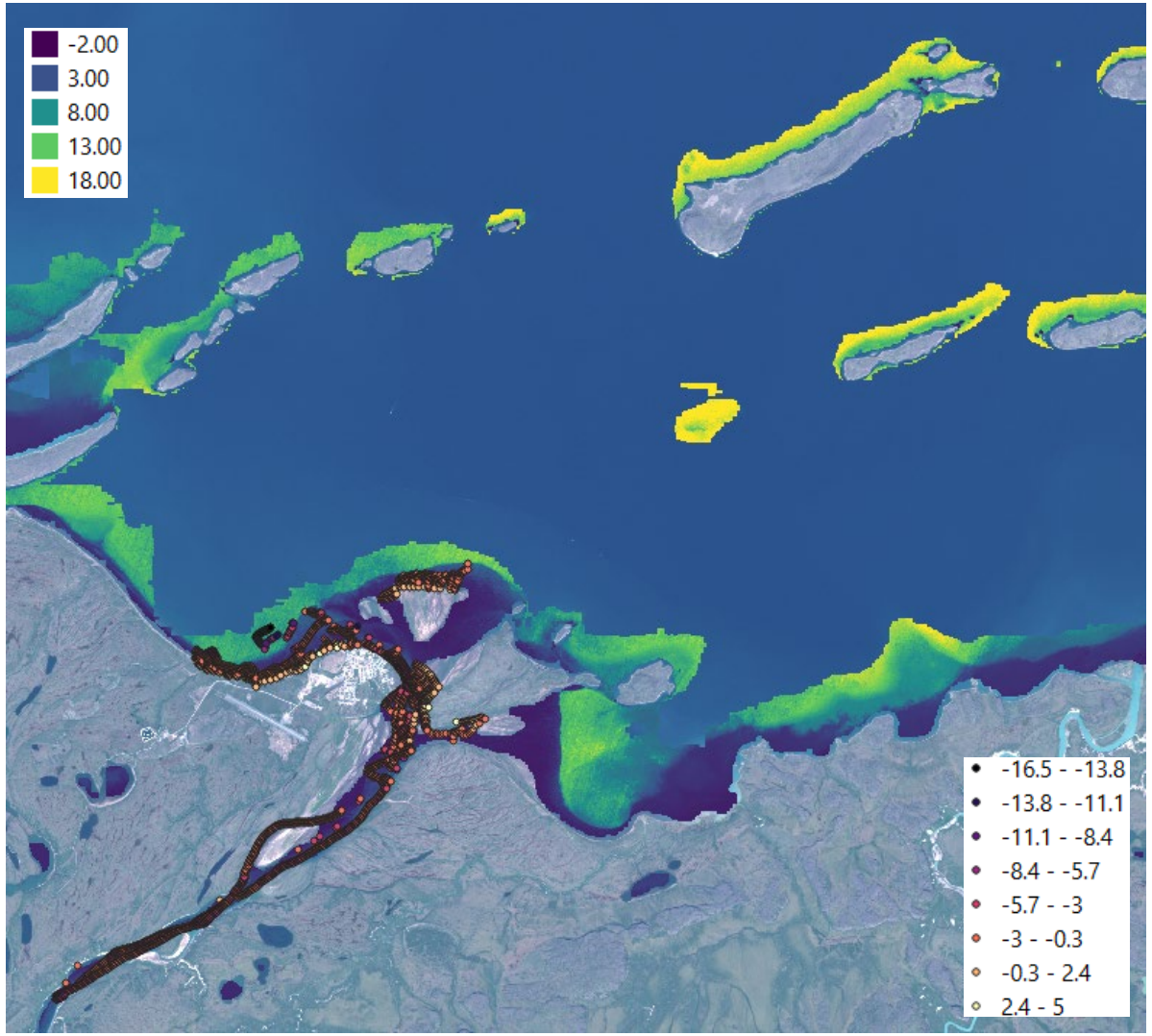


2019/06 – 2019/08 6 Images

NONNA 10m

Case study #6 **Kugluktuk**

The bottom reflectance are estimated from the neighbouring inter-tidal zone



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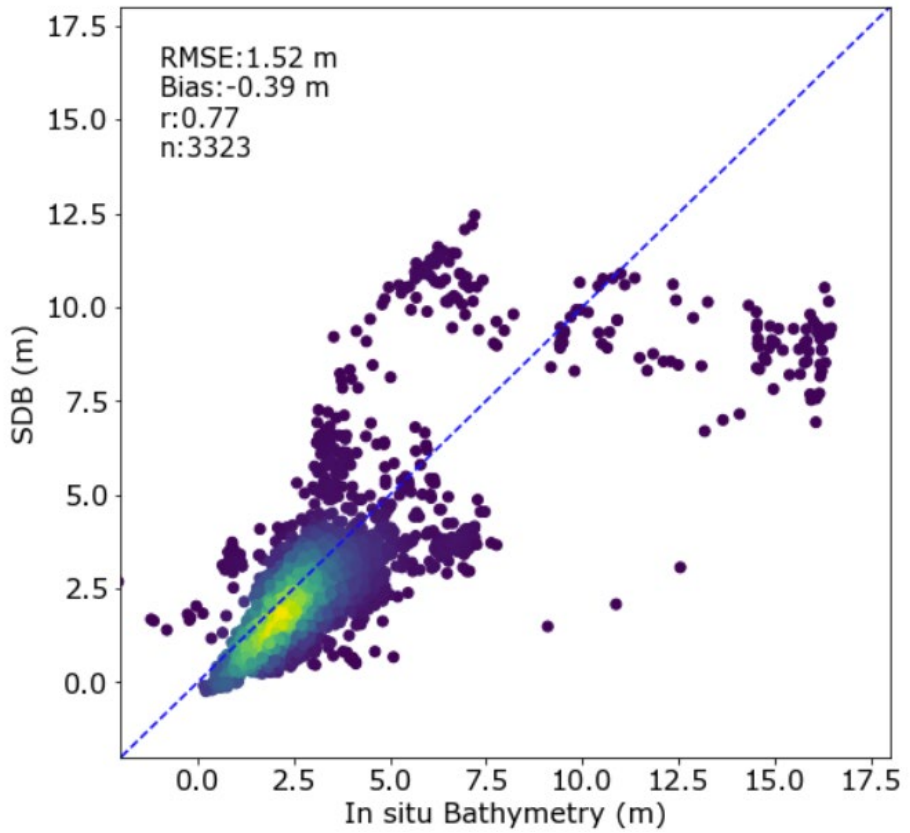
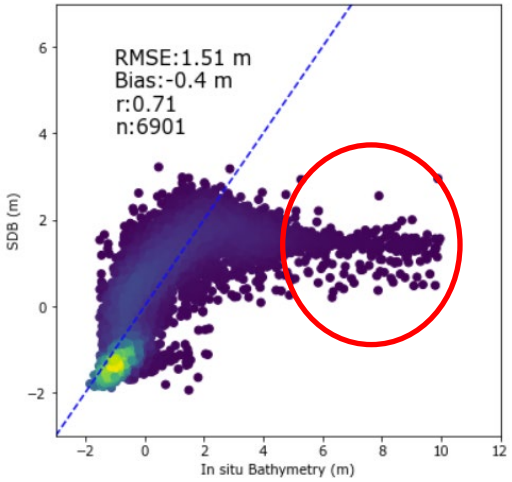


Laboratoire Hydraulique Environnemental, INRS

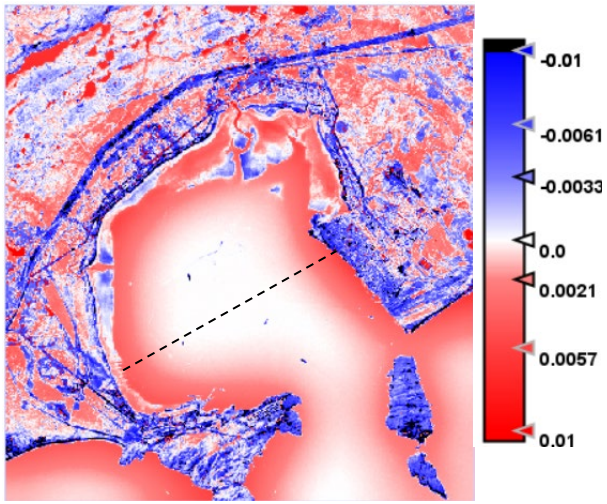
Hydroball + rover (2022)

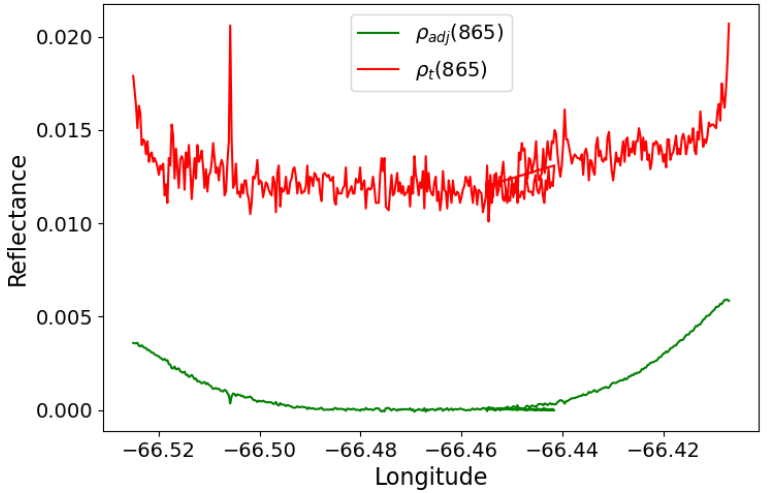
Discussion

- Underestimation caused by wrongly identification of OSW



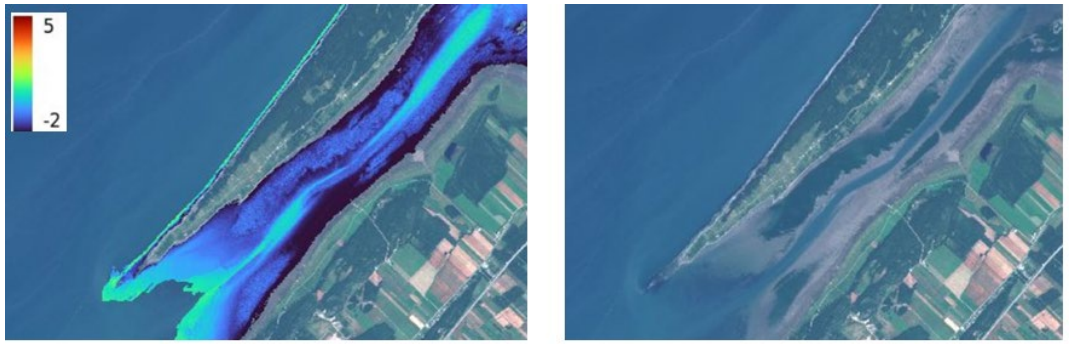
- Atmospheric correction



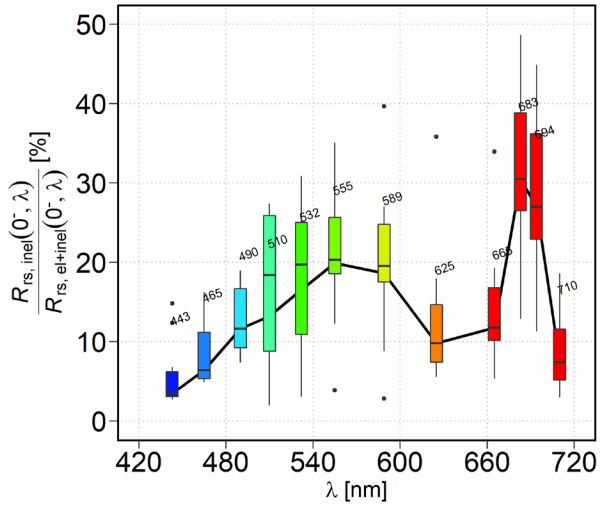


The reflectance contribution of adjacency effects estimated by GAAC (Pan et al.,2022)

- Overestimation caused by dark seagrass



- The water radiative transfer model



Mukherjee et al., 2022
Ocean Optics XXV

Conclusion

- ✓ The ARCTUS AI-assisted physic-based method is showing promising results for mapping bathymetry in Quebec waters
- ✓ It has great potential to be continuously improved with the improvement of the relevant physical models and techniques, such as, water radiative transfer and atmospheric correction.

Acknowledgements

Économie et Innovation Québec

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Pêches et Océans Canada

UQAR
Université du Québec à Rimouski

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