

Combining SWOT and Sentinel-1 data to map flooded vegetation

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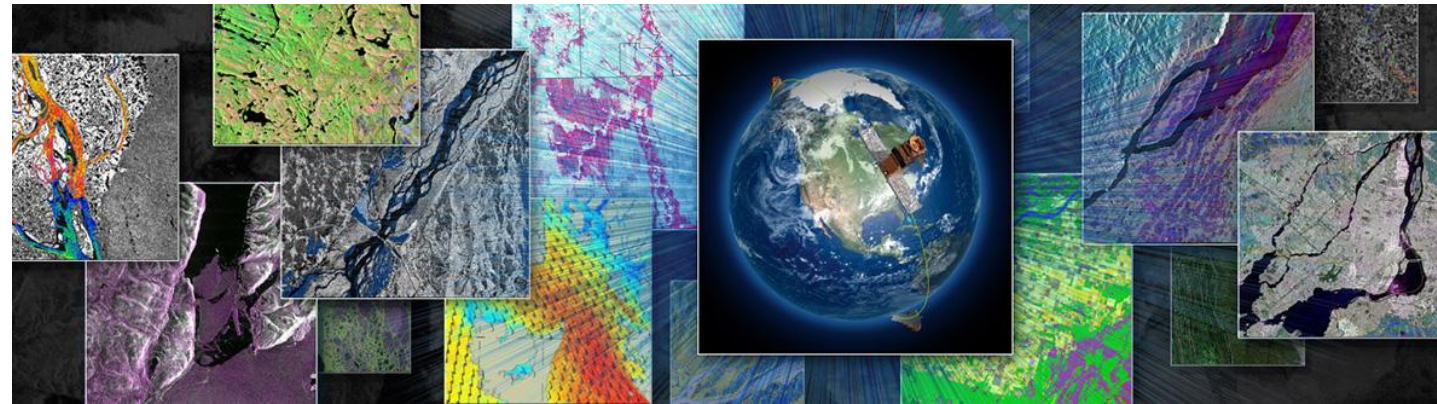
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2026 ASAR/RCM Users' Forum

October 29



Team members

NOVA - FRQNT-NSERC PROGRAM



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Professor
Remote sensing



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Hydrological modelling



Wetlands

“an area that is saturated with water long enough to promote wetland or aquatic processes as indicated by poorly drained soils, hydrophytic vegetation and various kinds of biological activities that are adapted to a wet environment.”

National Wetlands Working Group. 1997. *The Canadian Wetland Classification System*. Wetlands Research Branch, University of Waterloo.

SWOT's potential to measure water surface elevation (WSE) in herbaceous wetlands

Geophysical Research Letters*

RESEARCH LETTER
10.1029/2025GL114956

Special Collection:
Science from the Surface Water
and Ocean Topography Satellite
Mission

SWOT Water Surface Elevation in Herbaceous Wetlands of Florida's Everglades

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12467

Effects of Aquatic and Emergent Riparian Vegetation on SWOT Mission Capability in Detecting Surface Water Extent

Nicolas M. Desrochers , Mélanie Trudel, Sylvain Biancamaria , Gabriela Siles, Damien Desroches , Denis Carbonne, and Robert Leconte

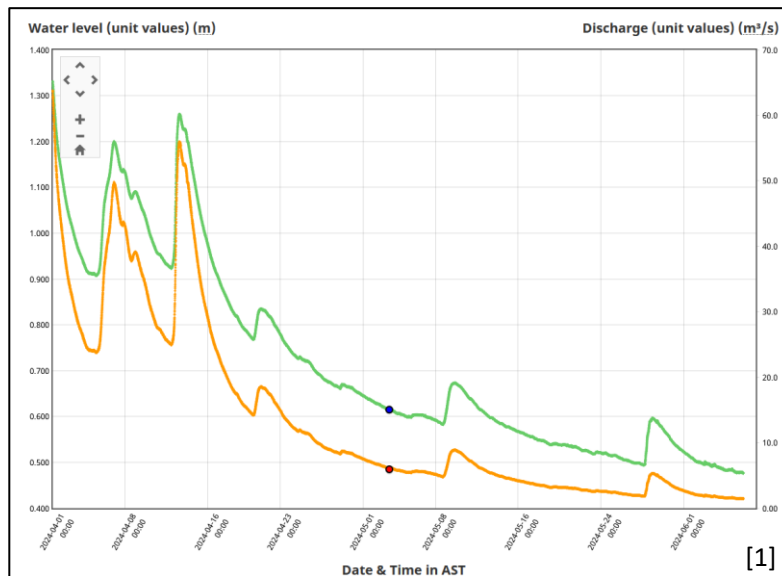
Objectives

The main objective is to **improve our knowledge of ungauged watersheds** using new Earth Observations from remote sensing.

The project focuses on two research questions:

- 1) Can advance **spatial knowledge of river flows** and lake/reservoir water levels **improve hydrological modelling** of a basin?
- 2) Can **satellite data** improve the parameterization of **wetlands in hydrological modelling**?

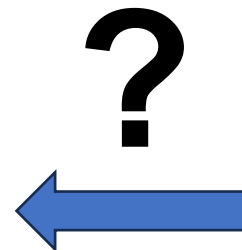
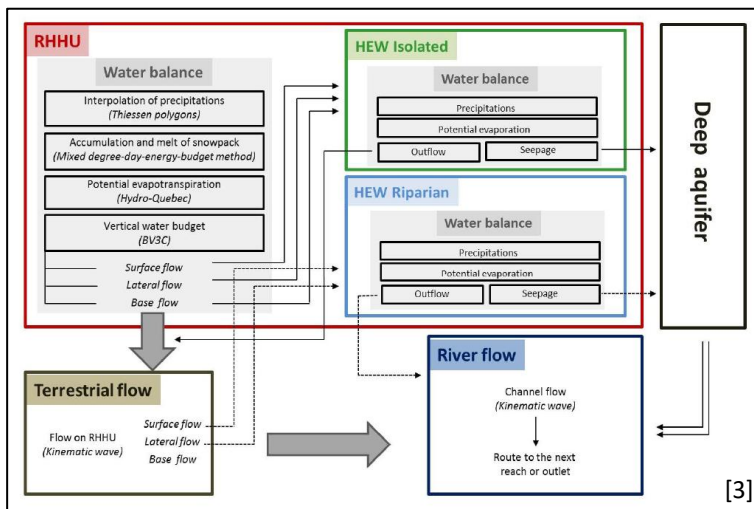
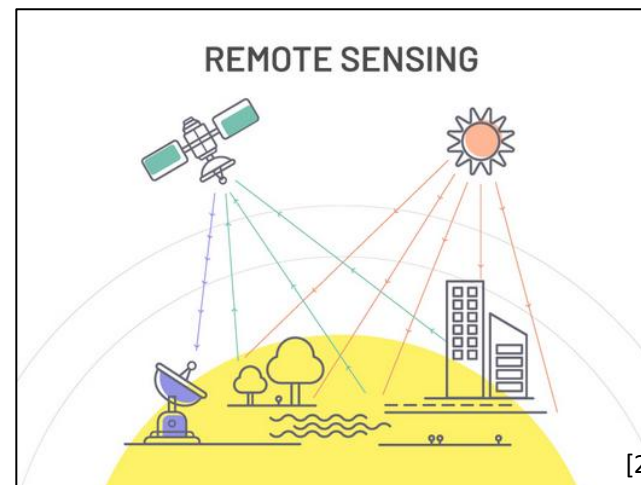
Context



Hydrological modelling challenges



Wetlands

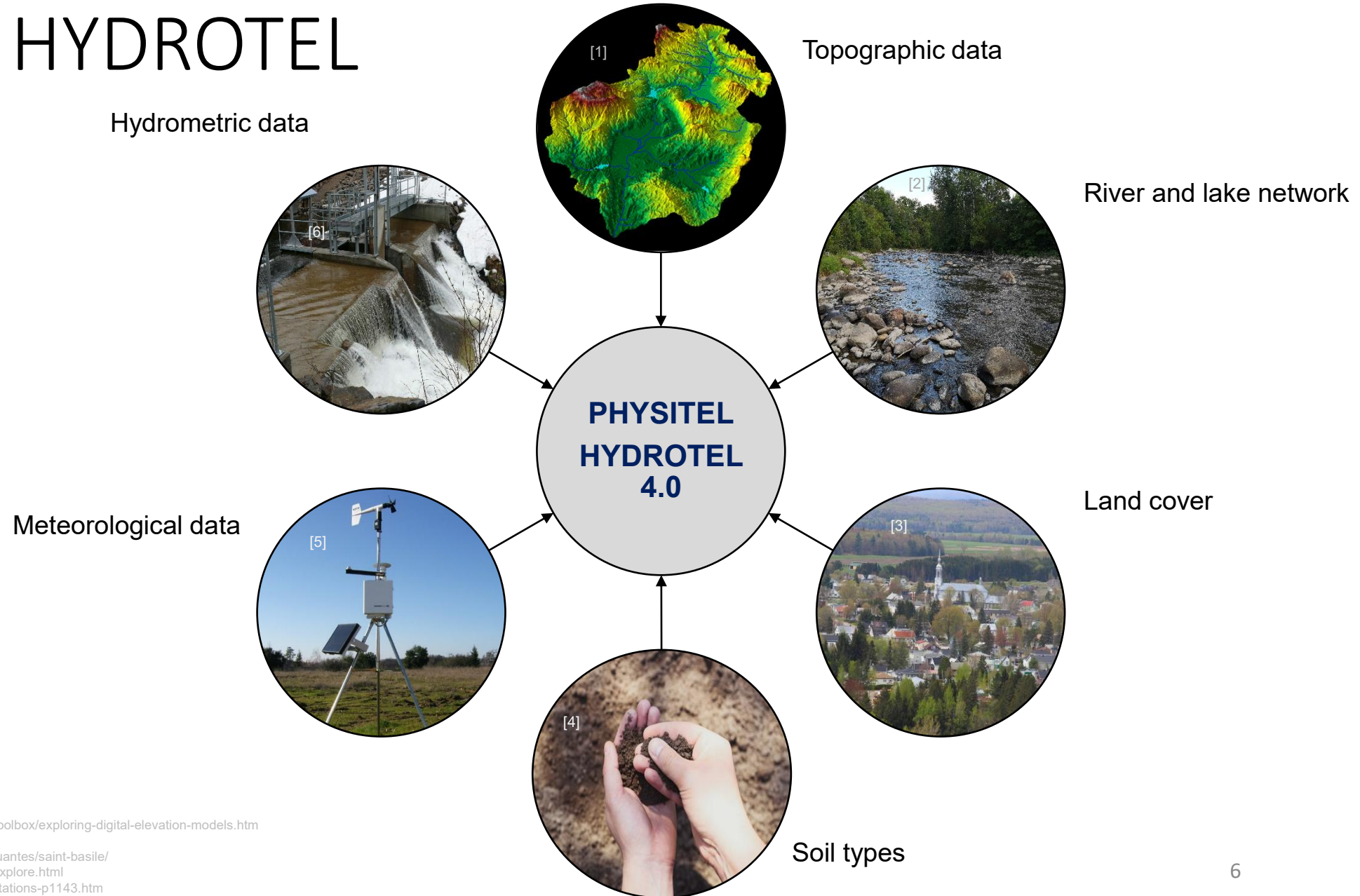


Alternative sources



- 1) https://wateroffice.ec.gc.ca/mainmenu/real_time_data_index_e.html
- 2) <https://www.sgligis.com/remote-sensing-and-gis-introduction/>
- 3) <https://espace.inrs.ca/id/eprint/4851/1/T822.pdf>

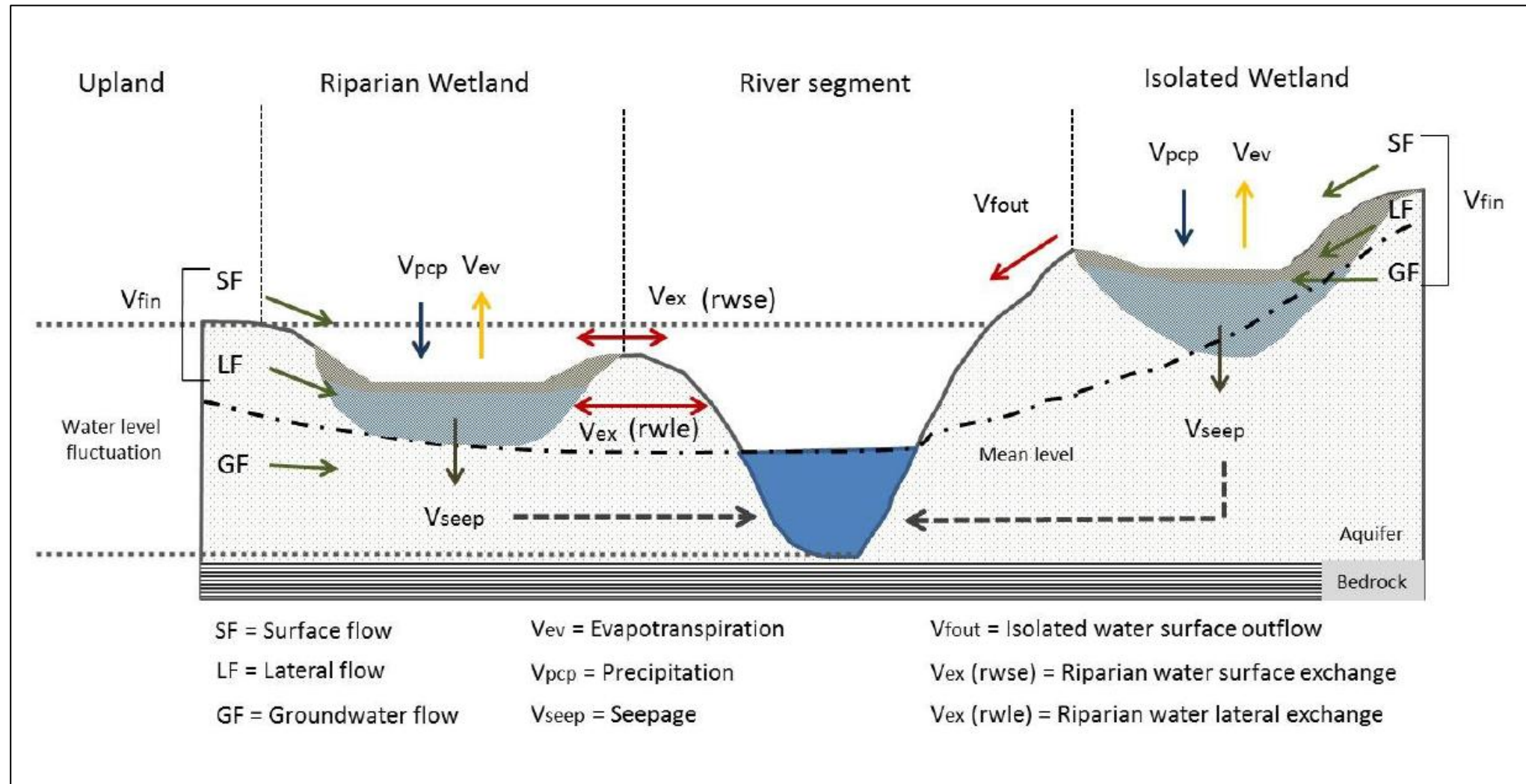
Distributed hydrological modelling using PHYSITEL & HYDROTEL



Distributed hydrological modelling using PHYSITEL & HYDROTEL

- Based on mass and momentum conservation equations applied to river segments (water routing) and hillslopes (surface runoff routing, snow accumulation/melt, soil water balance, wetland hydrology)
- At the core of...
 - Operational hydrologic forecasting systems in Quebec and Yukon
 - Southern Québec Hydroclimatic Atlas
 - Several studies on...
 - Effect of land management and global warming on flows
 - Role of wetlands on mitigating floods and droughts
 - Effect of individual and cumulative surface water allocations (agricultural, municipal, industrial, institutional) on flows

WETLAND MODULE - HYDROTEL



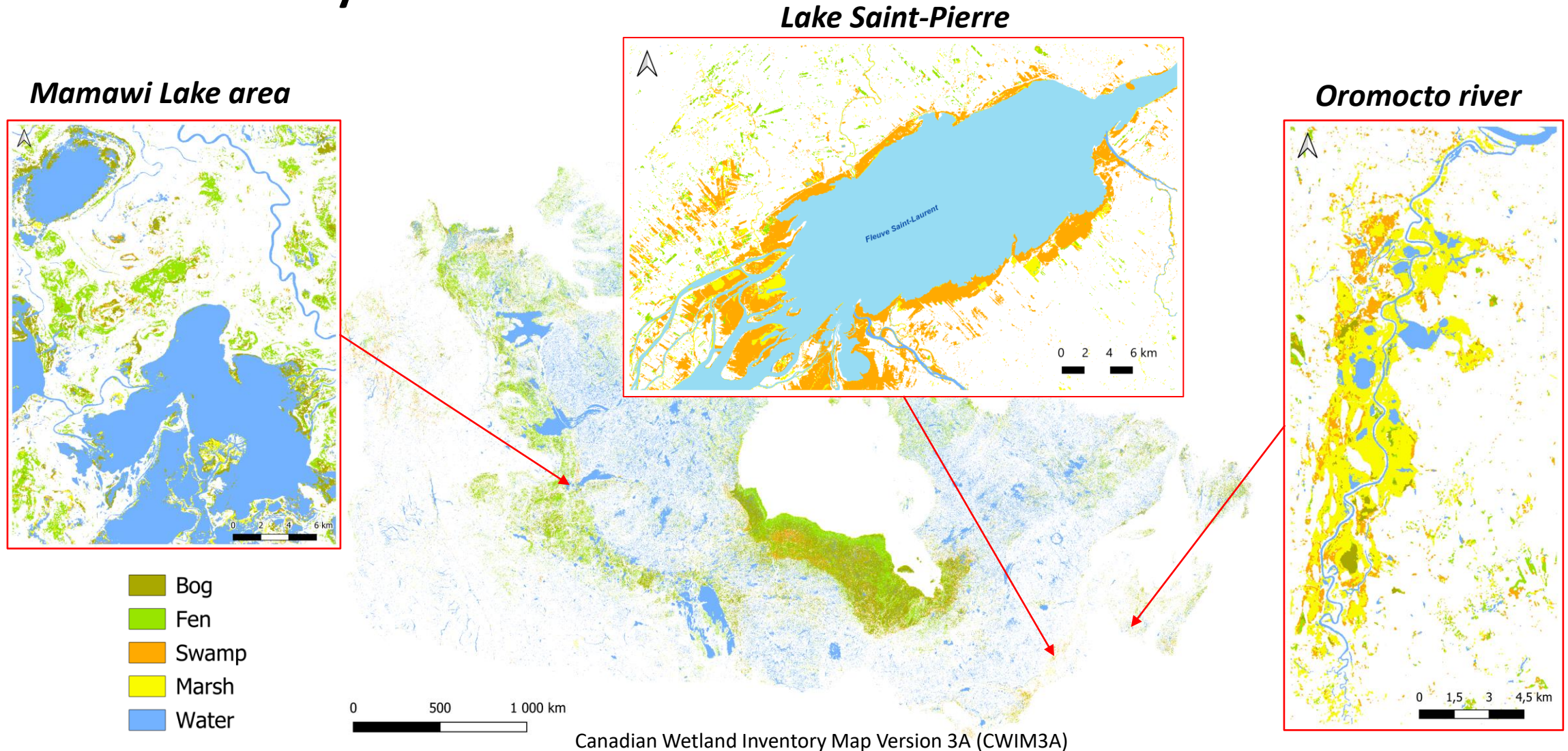
Fossey, M. (2016). Contribution à un cadre de modélisation hydrologique des milieux humides des Basses-terres du Saint-Laurent : fonctionnement, dynamique et impacts en contexte de changement climatique (Thèse de doctorat). Université du Québec, Institut National de la Recherche Scientifique, Centre Eau Terre Environnement. <https://espace.inrs.ca/id/eprint/4851/1/T822.pdf>

Objective

Can **satellite data** improve the parameterization of **wetlands** in hydrological modelling?

Mapping flooded vegetation in wetlands using Sentinel-1 and SWOT

Study areas

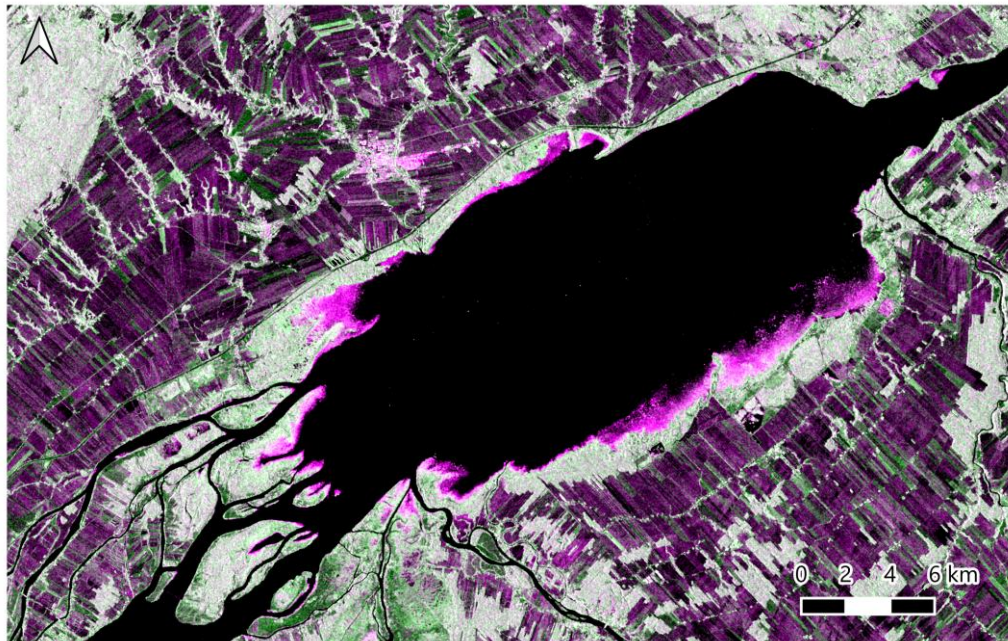


Why use Sentinel-1?

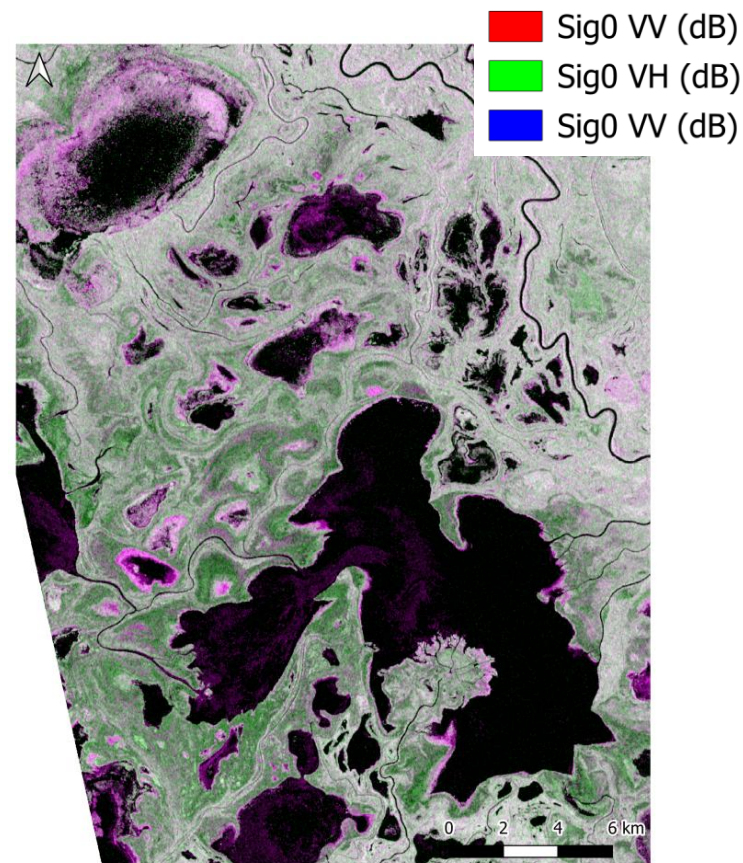
Identify Flooded vegetation

Higher spatial resolution
(10m)

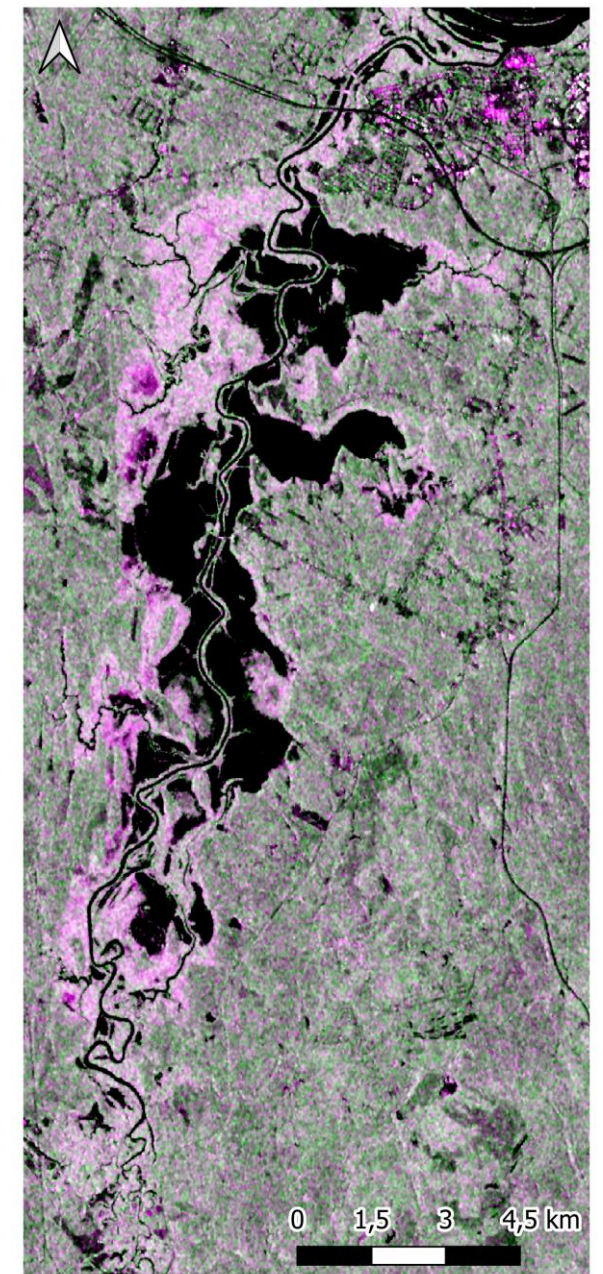
Finer segmentation of
wetland areas



Lake Saint-Pierre, Sentinel-1 May 30 2024



Mamawi Lake, Sentinel-1 July 03 2025



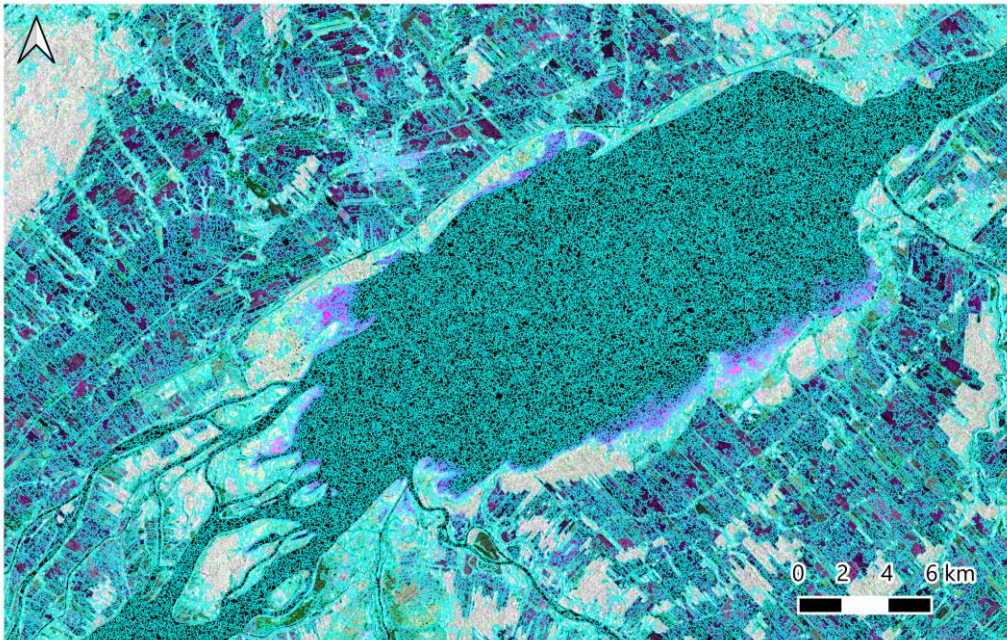
Oromocto, Sentinel-1 April 28 2025

Image segmentation

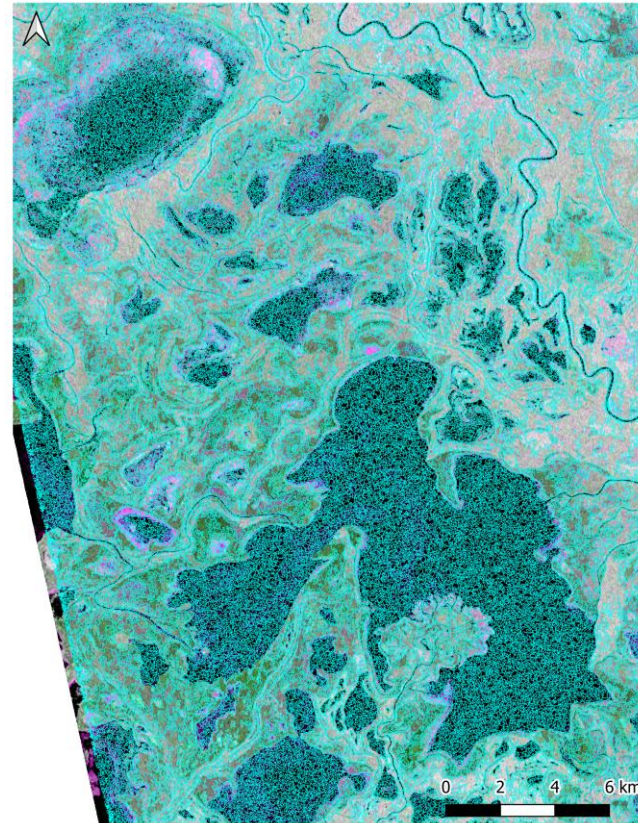
Preprocess Sentinel-1 images in Google Earth Engine

Automated Mean Shift segmentation using

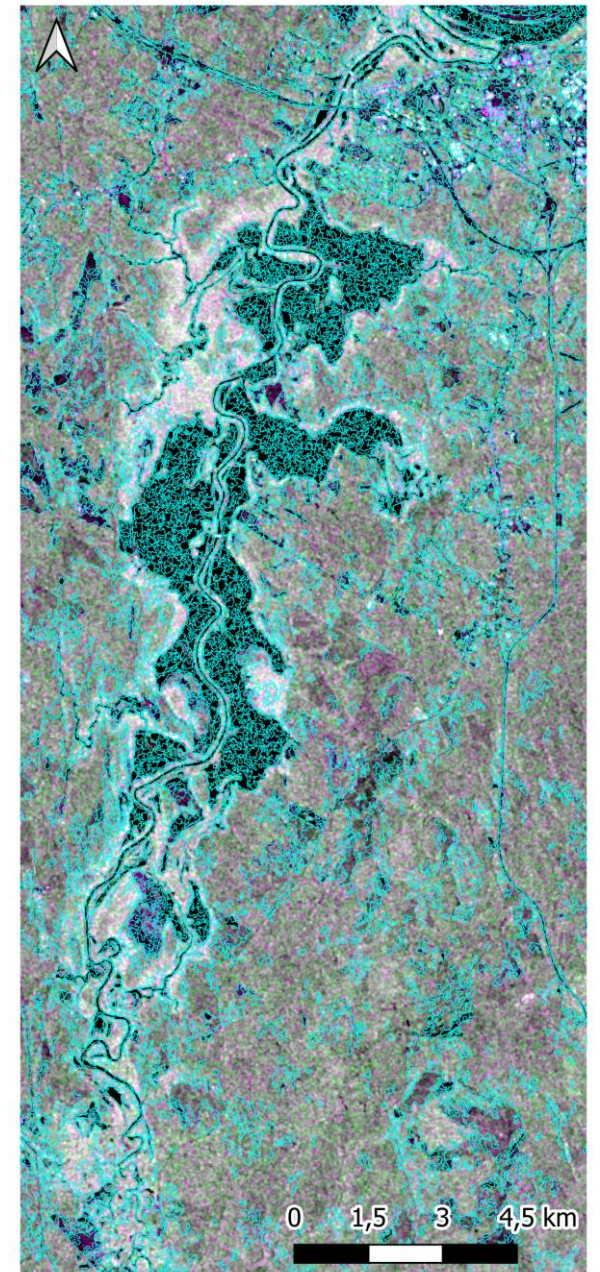
Orfeo Toolbox to create superpixels



Lake Saint-Pierre, Sentinel-1 May 30 2024



Mamawi Lake, Sentinel-1 July 03 2025



Oromocto, Sentinel-1 April 28 2025

Class Assignment

3 classes:

1. Open water
2. Flooded vegetation
3. Ground

Sample within segmented polygons

Gaussian Mixture Model

Unsupervised -> no training needed

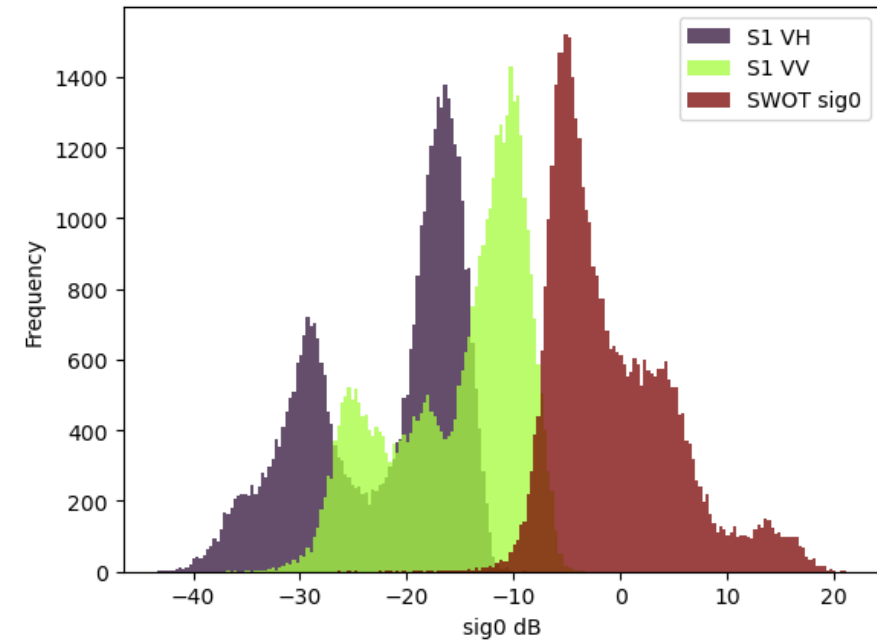
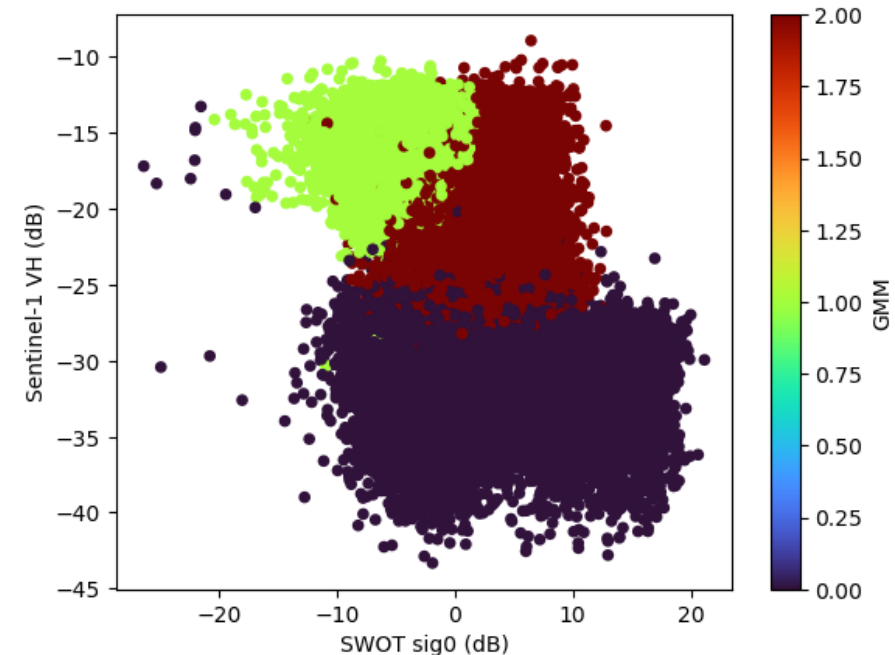
Sentinel-1:

Sig0 VV median + std,

Sig0 VH median + std

SWOT (PIXC):

Sig0, $\sigma_{\text{phase noise}}$, classification,
incidence angle



Classification results, Mamawi Lake area

Mamawi Lake, Sentinel-1 July 03 2025, SWOT July 1 2025

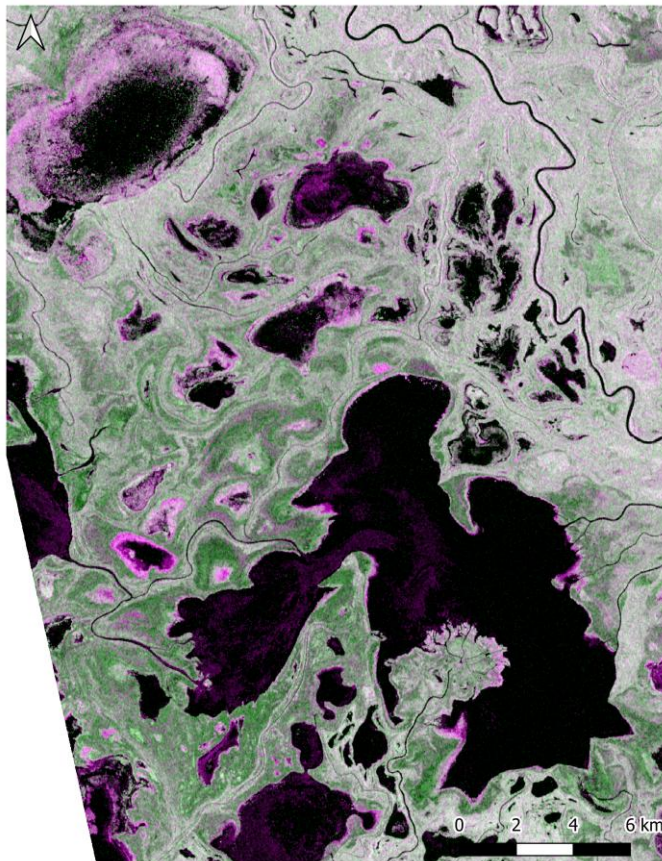
classes

Open water

Flooded vegetation



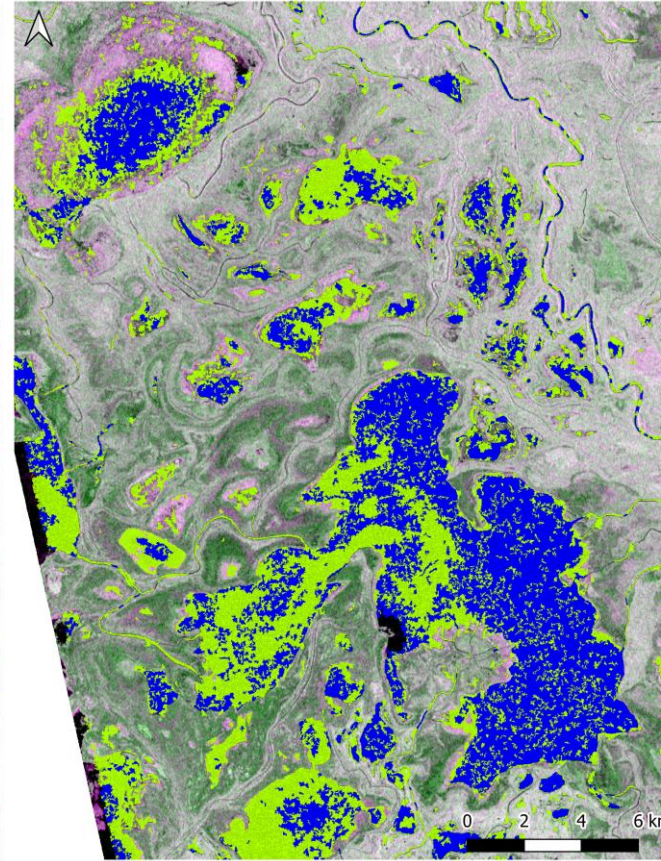
Aquatic (a) and riparian (b) vegetation
(Desrochers et al. 2021)



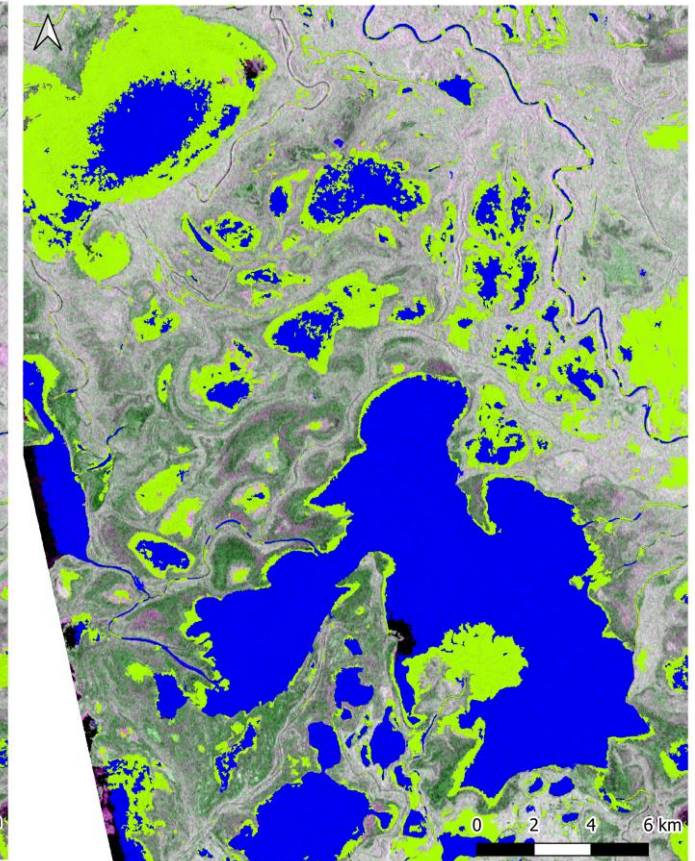
Sig0 VV (dB)

Sig0 VH (dB)

Sig0 VV (dB)



GMM Sentinel-1 only



GMM Sentinel-1 + SWOT

Classification results, Oromocto

classes

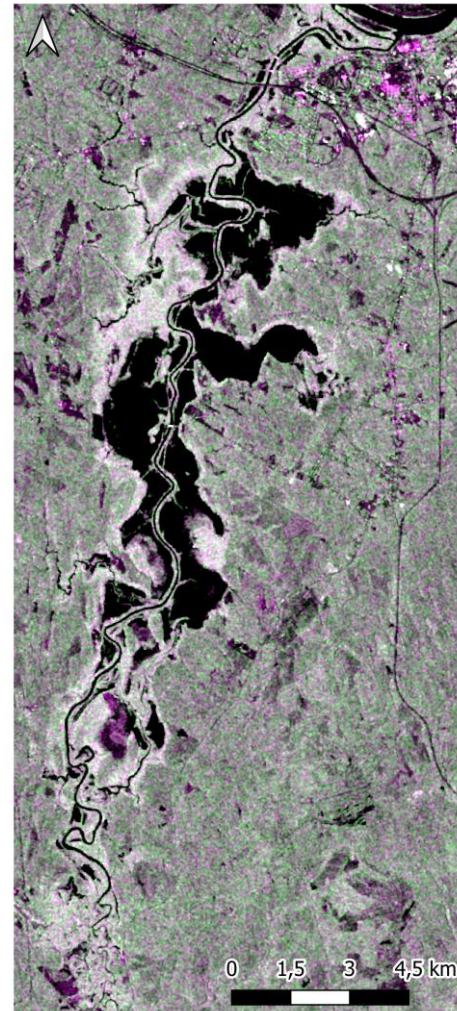
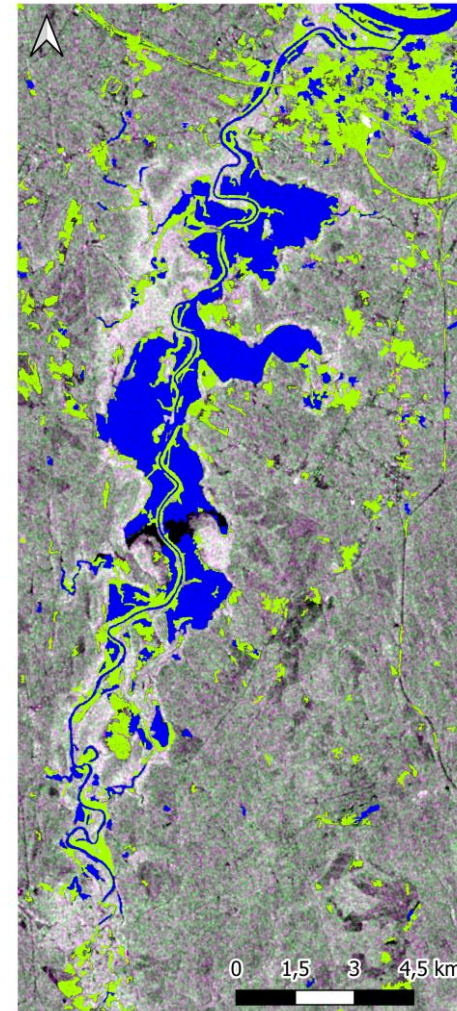
- Open water
- Flooded vegetation

Oromocto, Sentinel-1 December 23 2023, SWOT December 21 2023

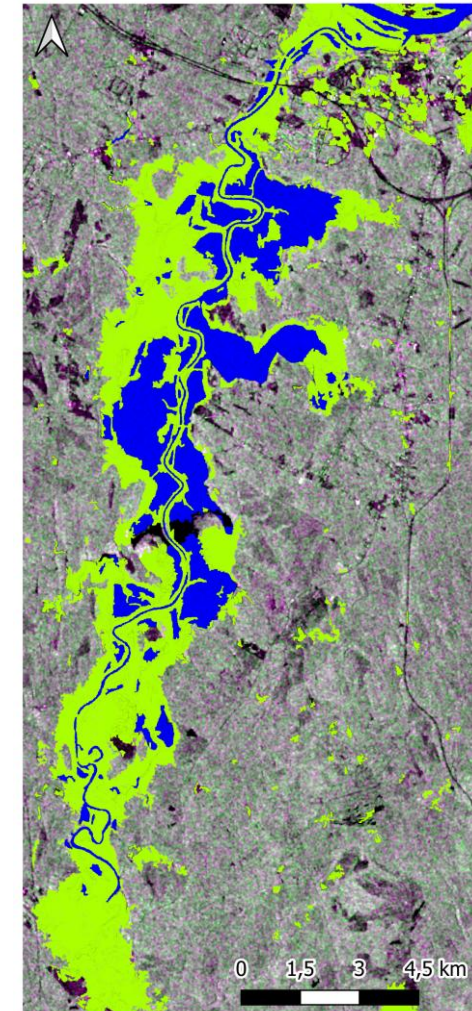


May 15, 2024

- Sig0 VV (dB)
- Sig0 VH (dB)
- Sig0 VV (dB)



GMM Sentinel-1 only



GMM Sentinel-1 + SWOT

Classification results, Oromocto

classes

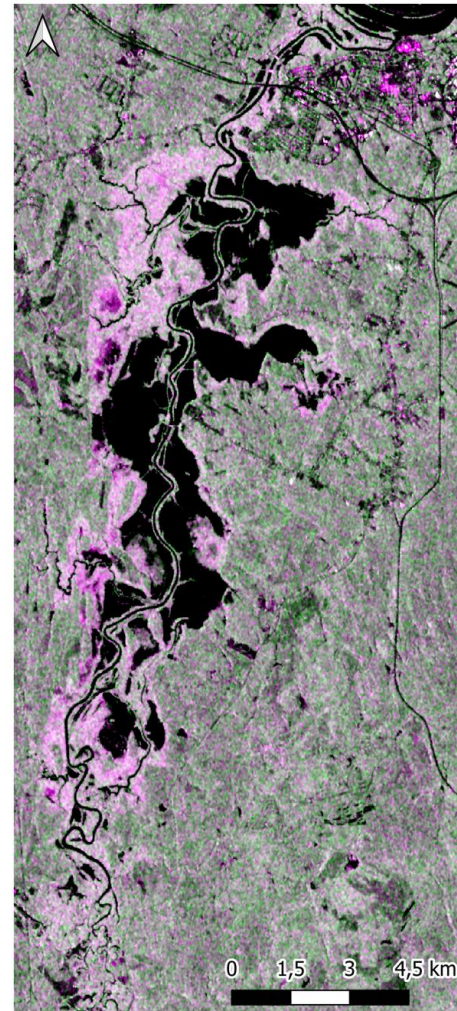
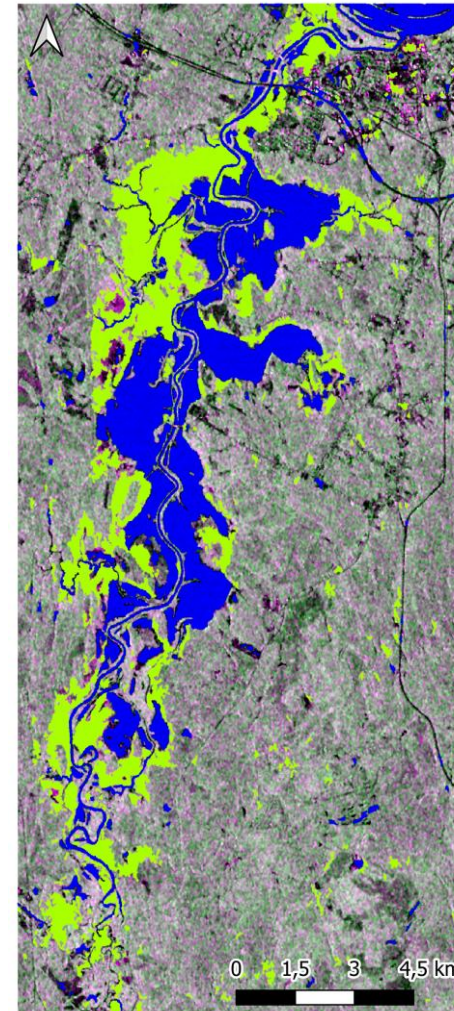
- Open water
- Flooded vegetation

Oromocto, Sentinel-1 April 28 2025, SWOT April 14

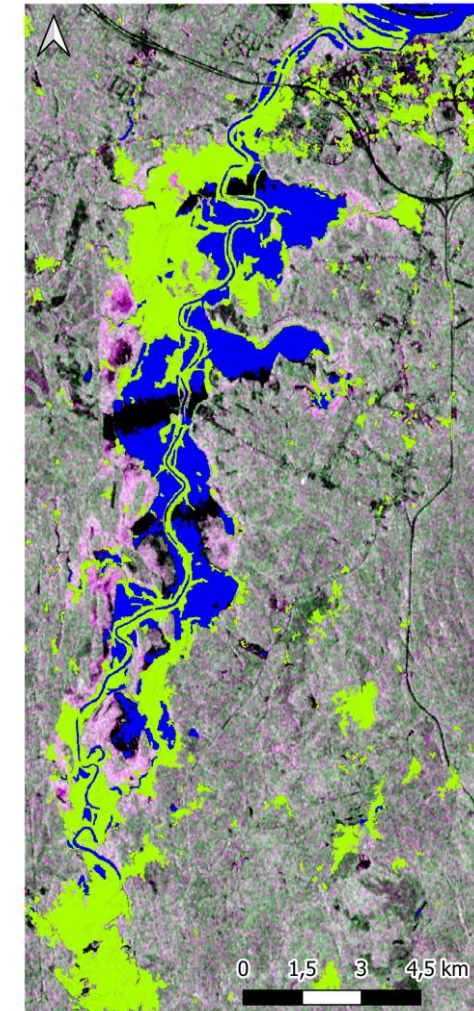


May 15, 2024

- Sig0 VV (dB)
- Sig0 VH (dB)
- Sig0 VV (dB)



GMM Sentinel-1 only

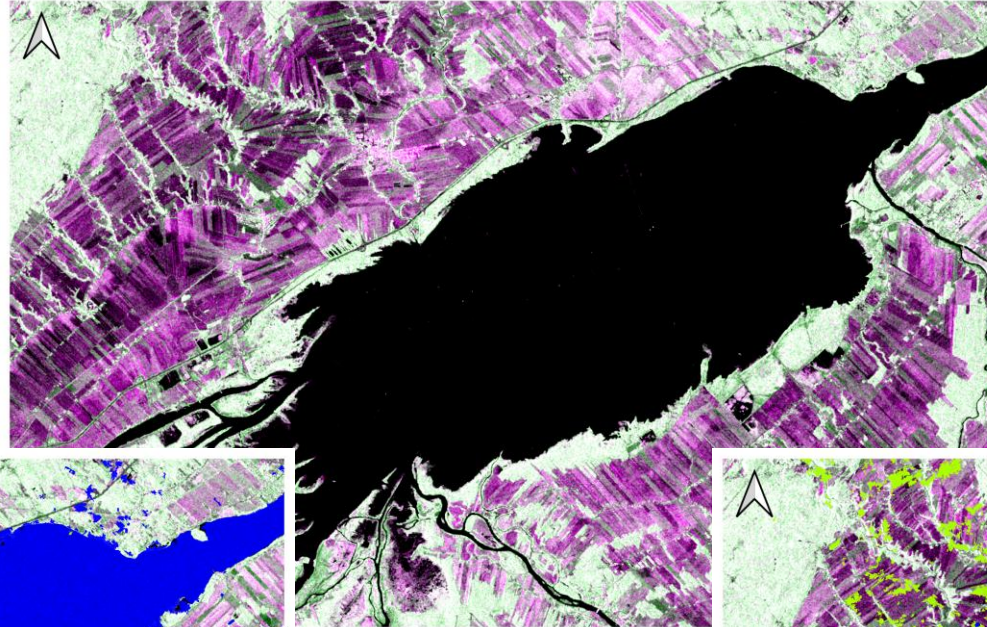


GMM Sentinel-1 + SWOT

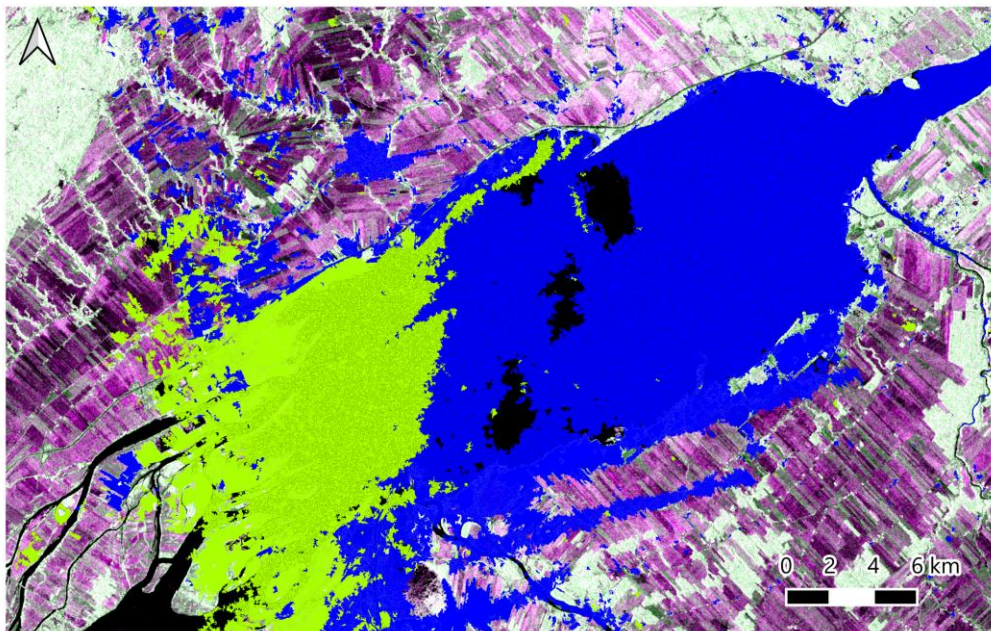
Classification results, Lake Saint-Pierre area

Lake Saint-Pierre, Sentinel-1 **May 6** 2024, SWOT **May 8** 2024

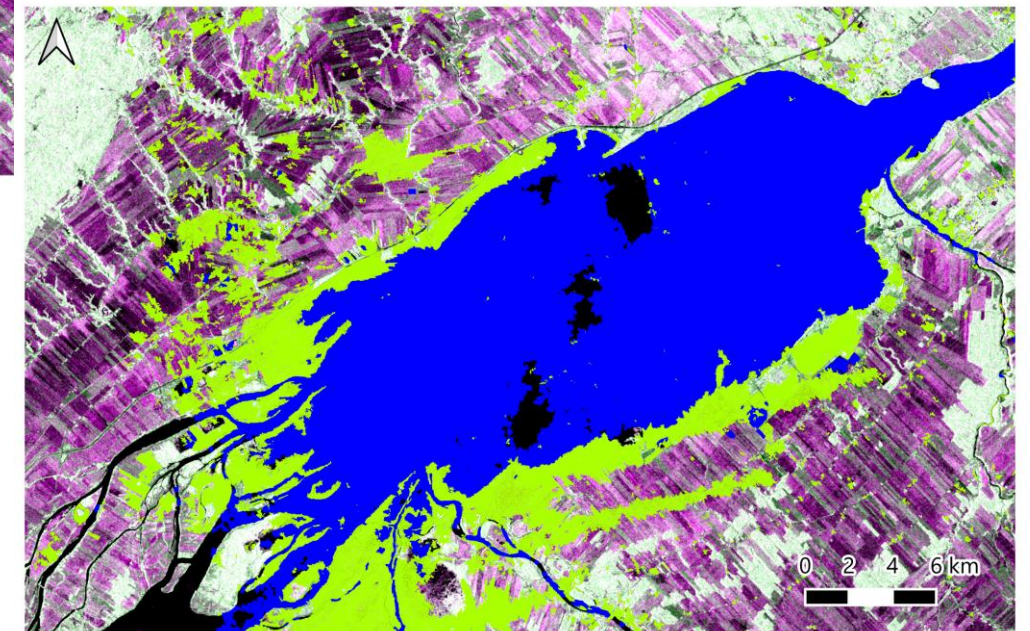
 Sig0 VV (dB)
 Sig0 VH (dB)
 Sig0 VV (dB)



classes
 Open water
 Flooded vegetation



GMM Sentinel-1 + SWOT with Sig0

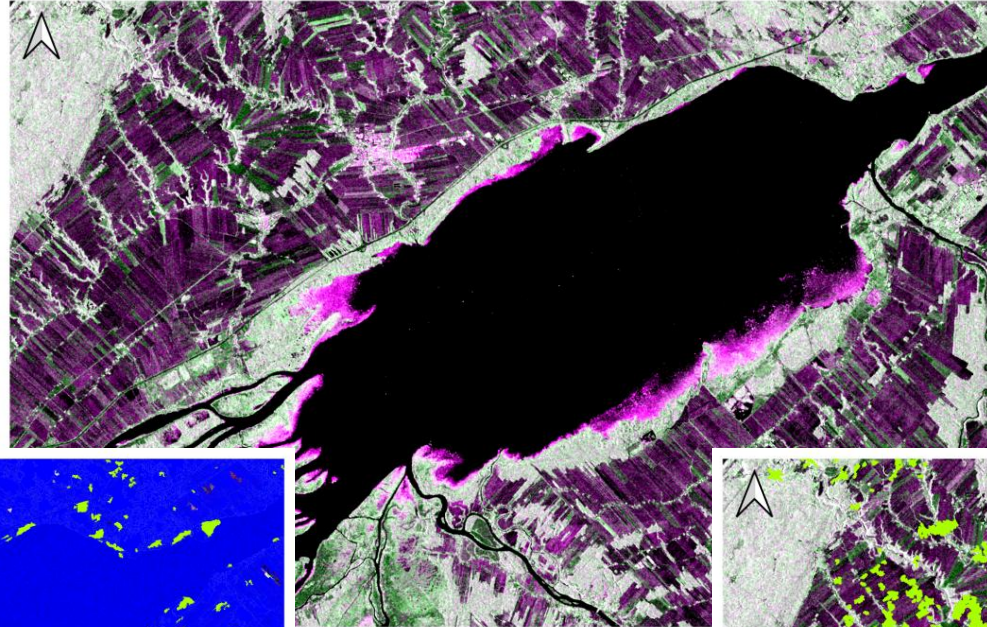


GMM Sentinel-1 + SWOT without Sig0 16

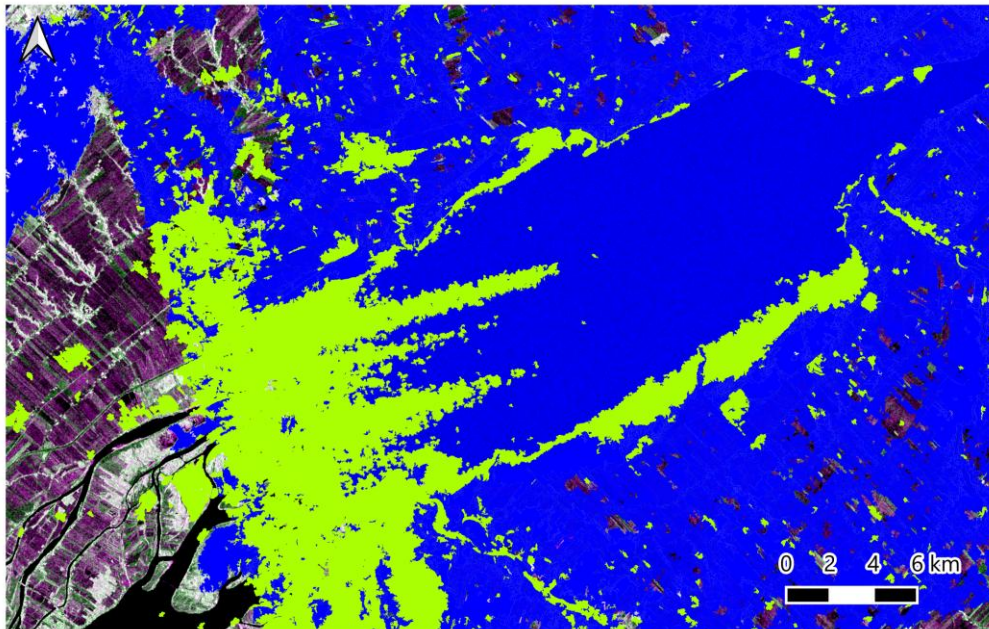
Classification results, Lake Saint-Pierre area

Lake Saint-Pierre, Sentinel-1 **May 30** 2024, SWOT **May 28** 2024

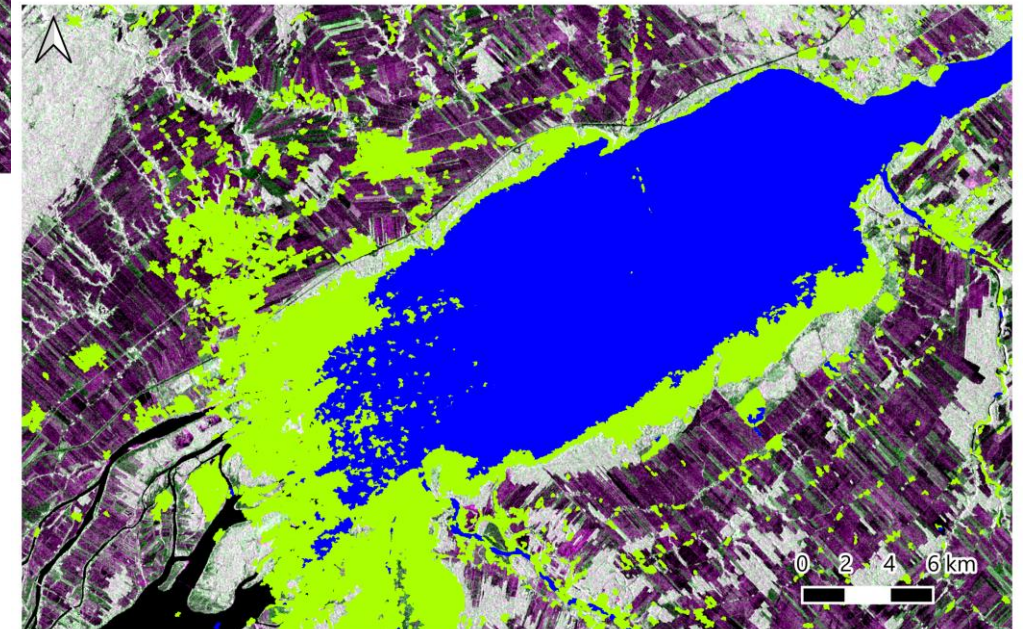
- Sig0 VV (dB)
- Sig0 VH (dB)
- Sig0 VV (dB)



- classes
- Open water
 - Flooded vegetation



GMM Sentinel-1 + SWOT with Sig0



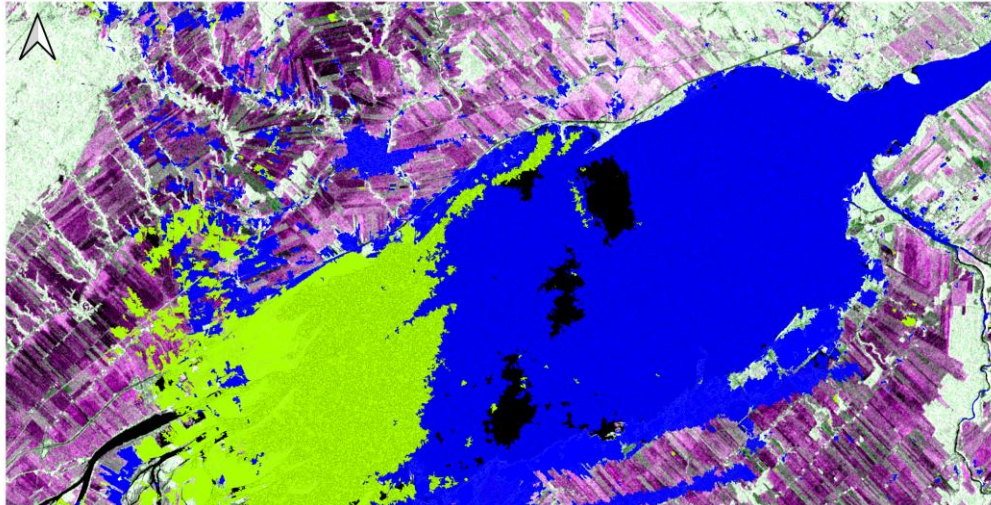
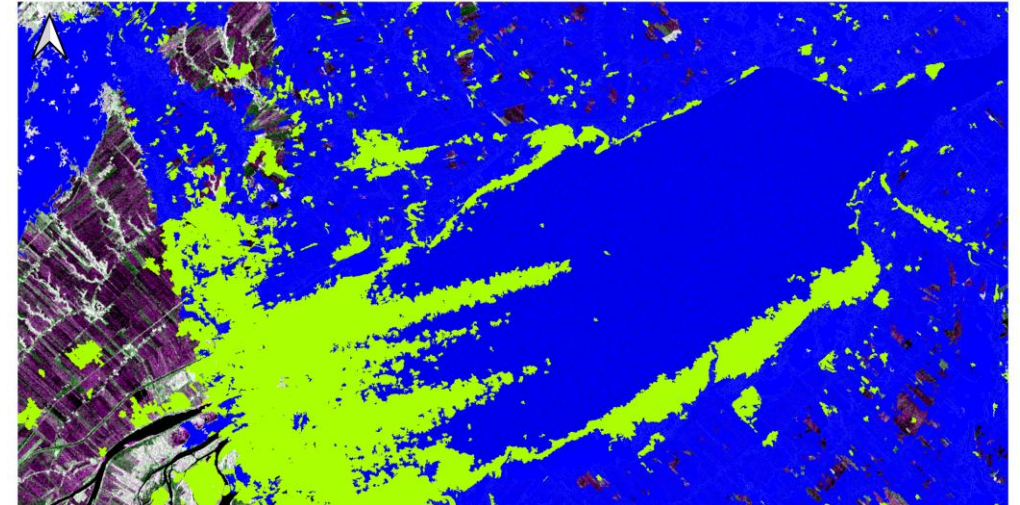
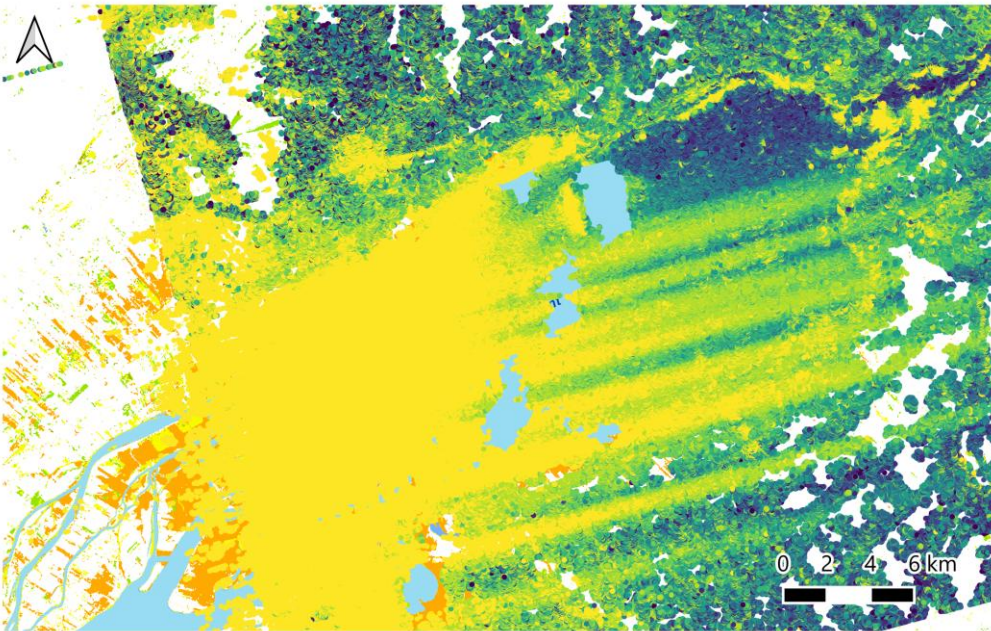
GMM Sentinel-1 + SWOT without Sig0

Classification results, Lake Saint-Pierre area

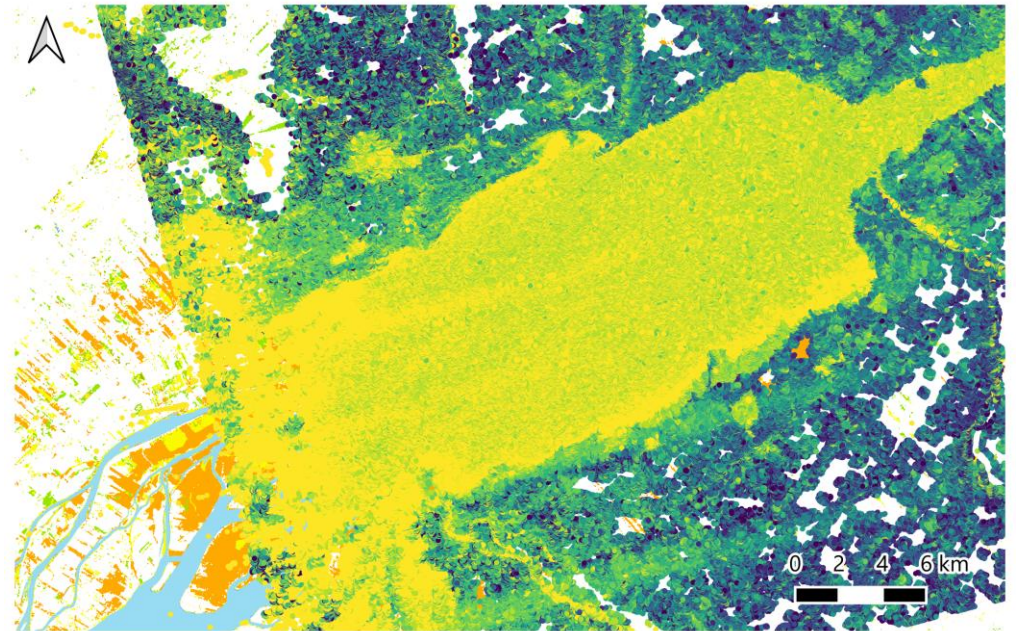
classes

Open water

Flooded vegetation



SWOT Sig0 May 8 2024

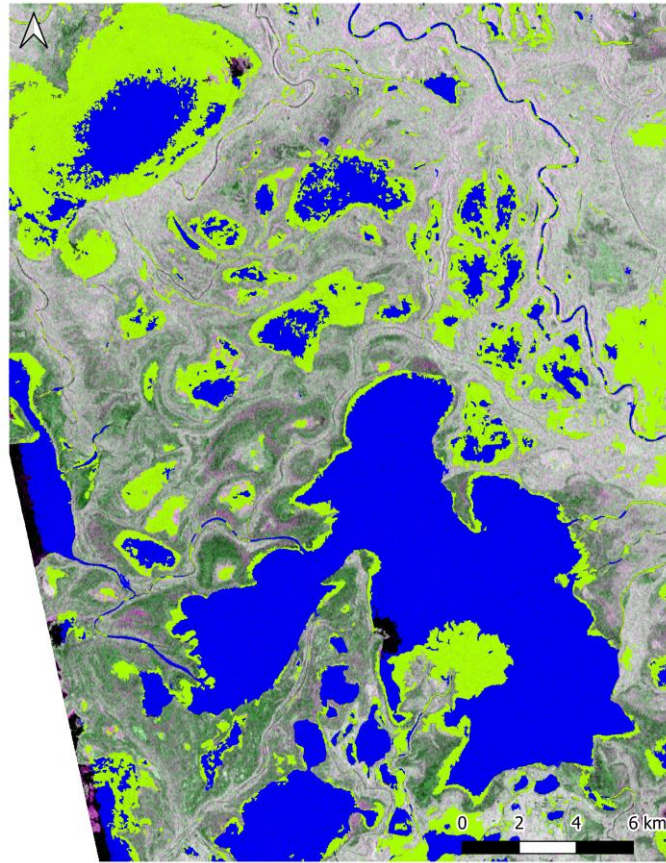


SWOT Sig0 May 28 2024

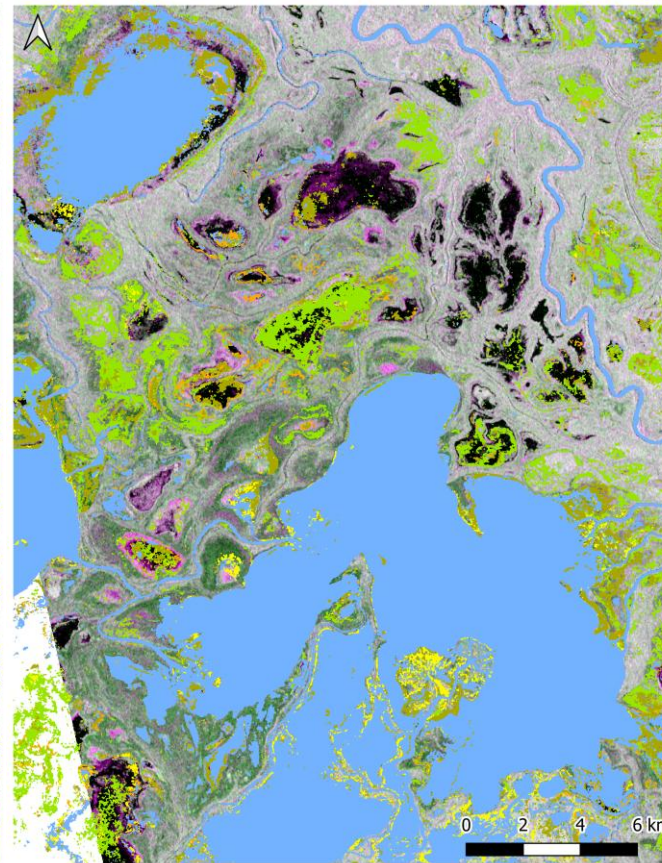
Potential to improve existing classifications

Mamawi Lake, Sentinel-1 July 03 2025, SWOT July 1 2025

classes
Open water
Flooded vegetation



GMM Sentinel-1 + SWOT



Canadian wetlands classification

Future work

Test methodology with other SAR sensors (RCM, NISAR)

Improve methodology to streamline and limit uncertainties

Use SWOT data to improve the parameterization of **wetlands in hydrological modelling:**

- WSE variation
- Delineation of maximum extent
- Water Fraction Variation

Funding organisations

