SWOT IN-SITU AND AIRBORNE VALIDATION CAMPAIGN IN THE ST. LAWRENCE ESTUARY AND SAGUENAY FJORD

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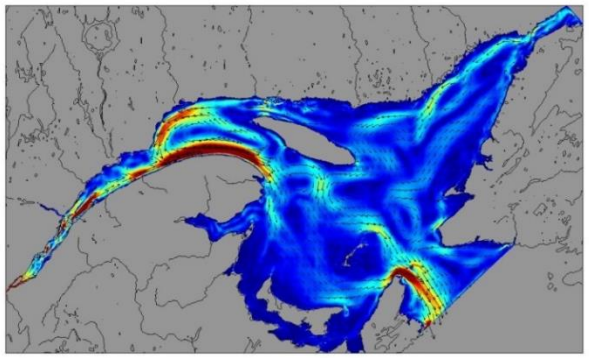
SWOT Science Team Meeting

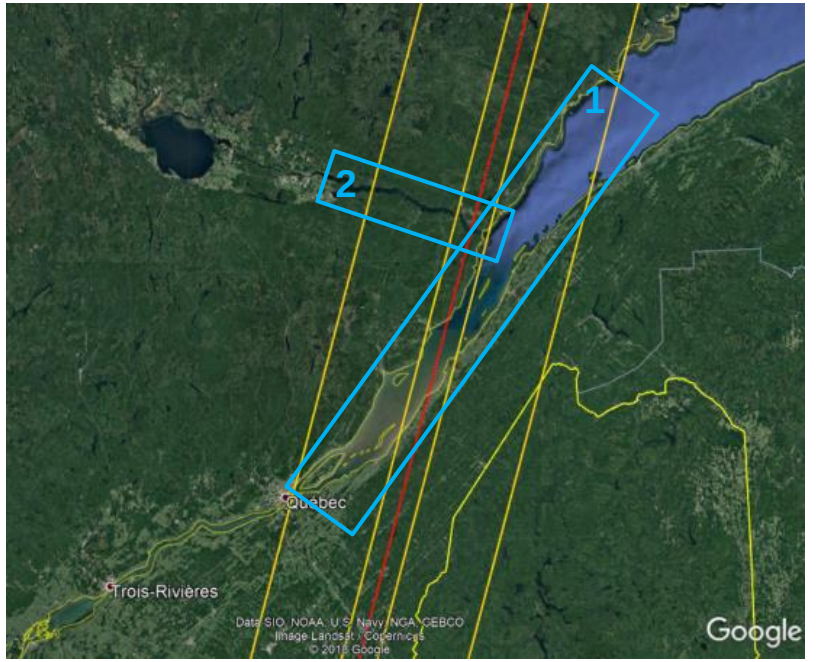
September 18-22, 2023

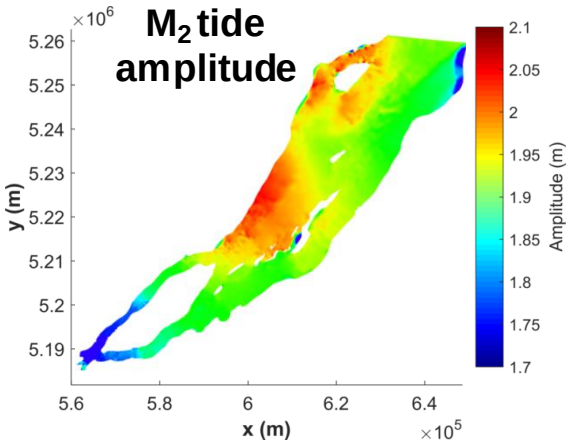
STUDY SITES

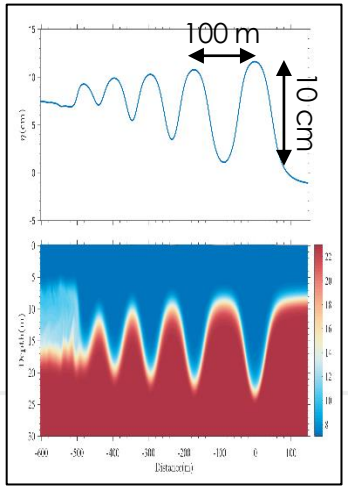
1. St. Lawrence Estuary

- 1-25 km wide with numerous islands
- Spatially variable macro-tides (<7m range)
- Reversing flows
- Salinity intrusion limit
- River influenced
- Internal tides



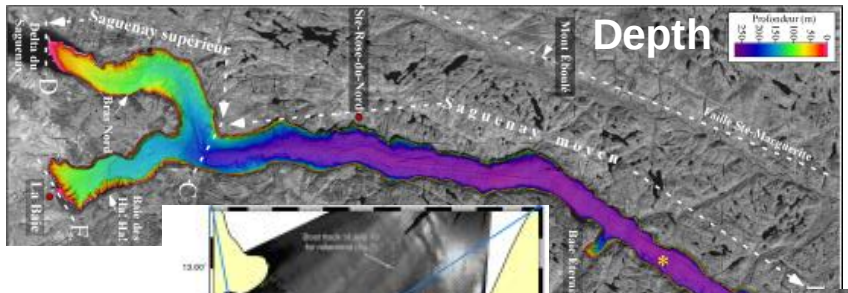




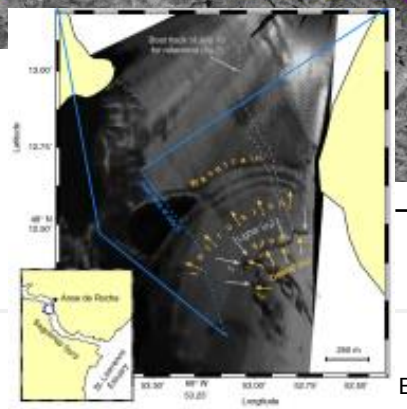


2. Saguenay Fjord

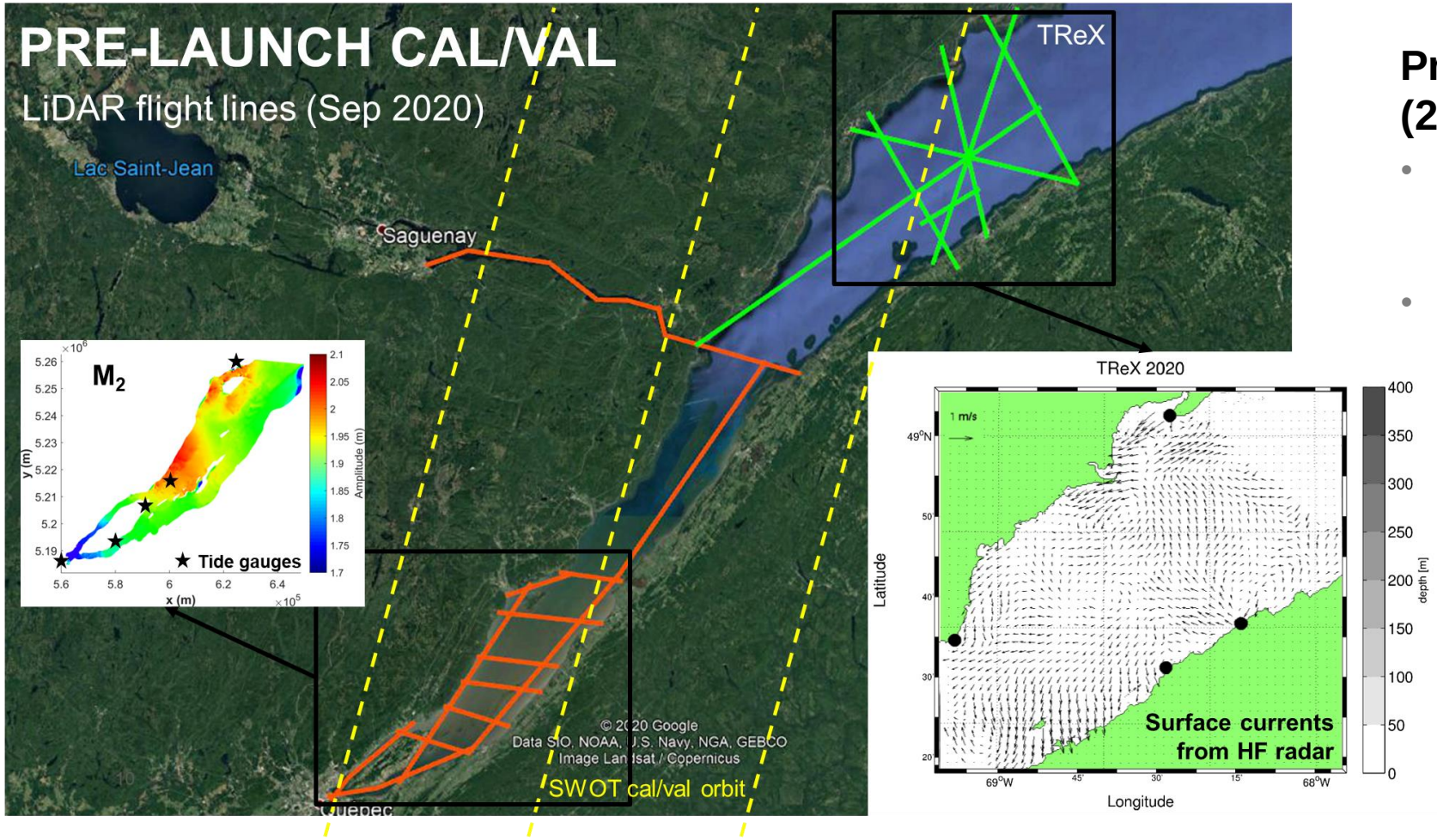
- 2-4 km wide, <270 m deep, with <350 m high cliffs
- Standing tidal wave
- Low surface slopes
- Internal tides



Locat & Levesque (2009)



Bourgault et al. (2016)

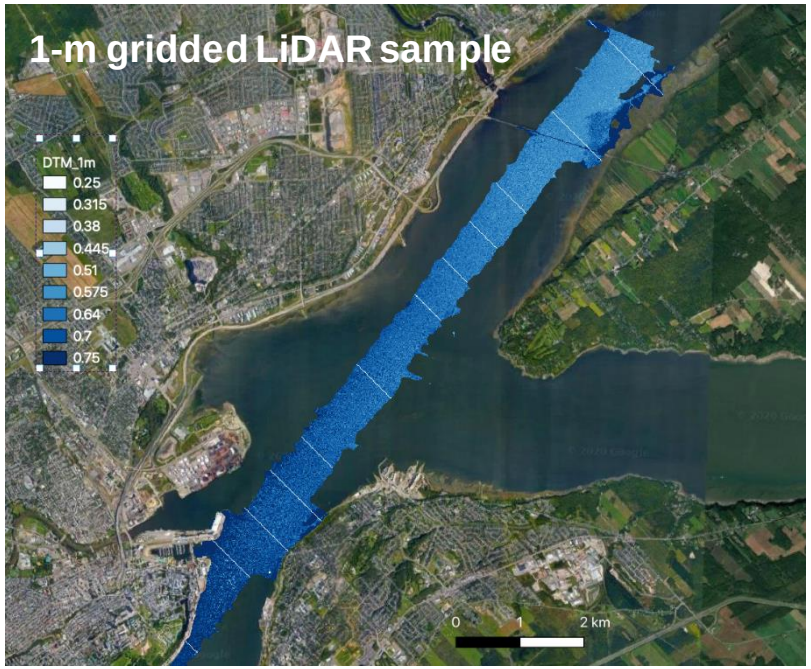


Pre-launch cal/val objectives (2020-2022)

- Characterize the 2D variability
  - Tides, water surface slopes, waves, currents, etc.
  - Test instrumentation and monitoring strategies
- Improve numerical models
  - Calibrate and validate models using 0D-1D-2D data

Test algorithms with SWOT-like data

- Tides and discharge reconstruction
- Data assimilation

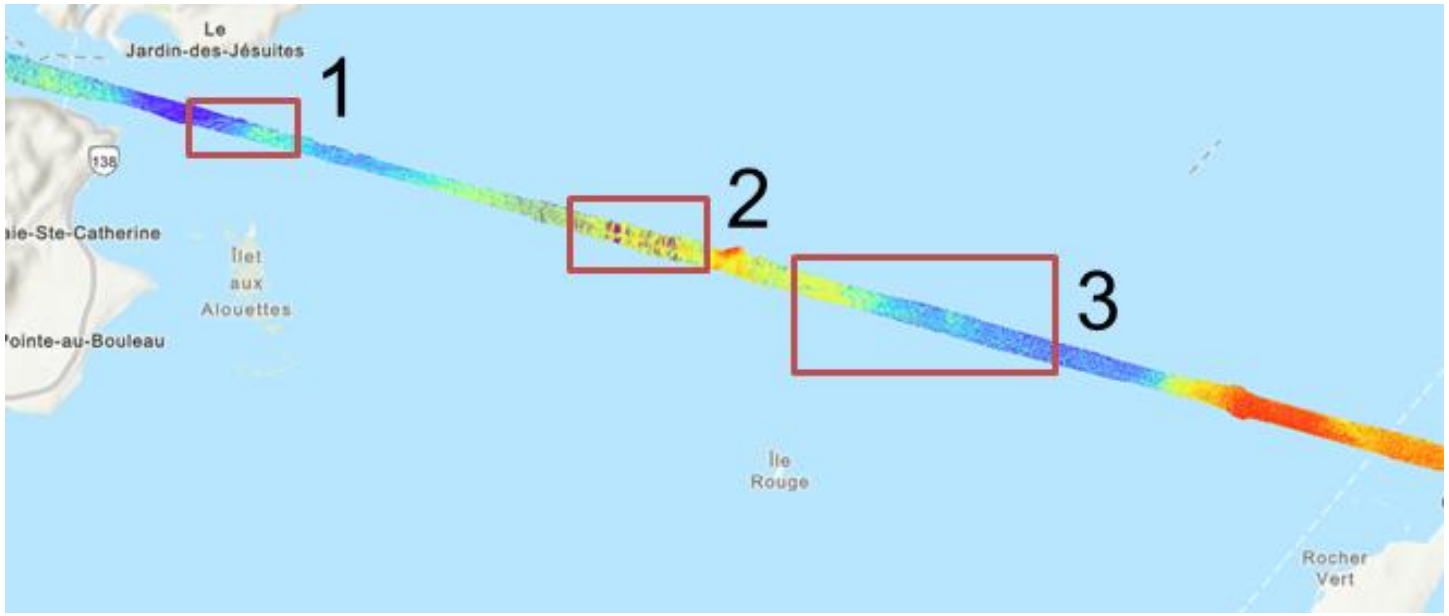


Processing steps with SPDLib (Bunting et al. 2013)

1. Spatial indexing
2. Noise reduction and outliers removal
3. Progressive morphology filter
4. Gridding and interpolation
5. Water/land delineation
6. Validation

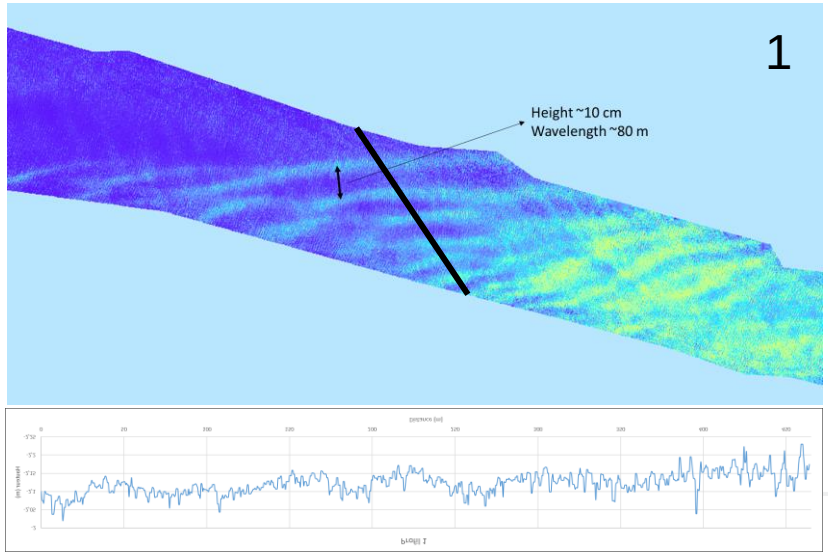
Type of measurement	MAE [m]	RMSE [m]
Ground control	0.0465	0.0613
Tide gauge	0.1886	0.3450
Wave buoy	0.0733	0.0794

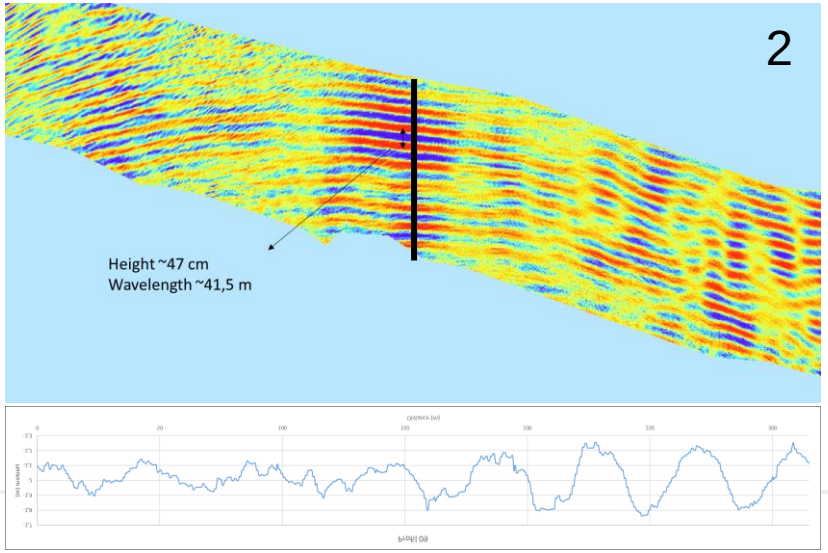
LIDAR GRIDDED ELEVATIONS

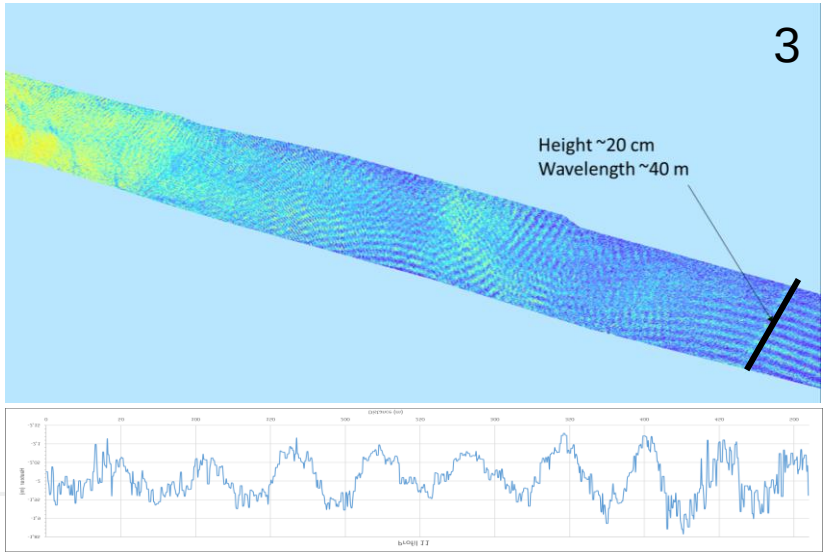


Head of Laurentian Channel

- Low tide conditions
- Sep 15, 2020







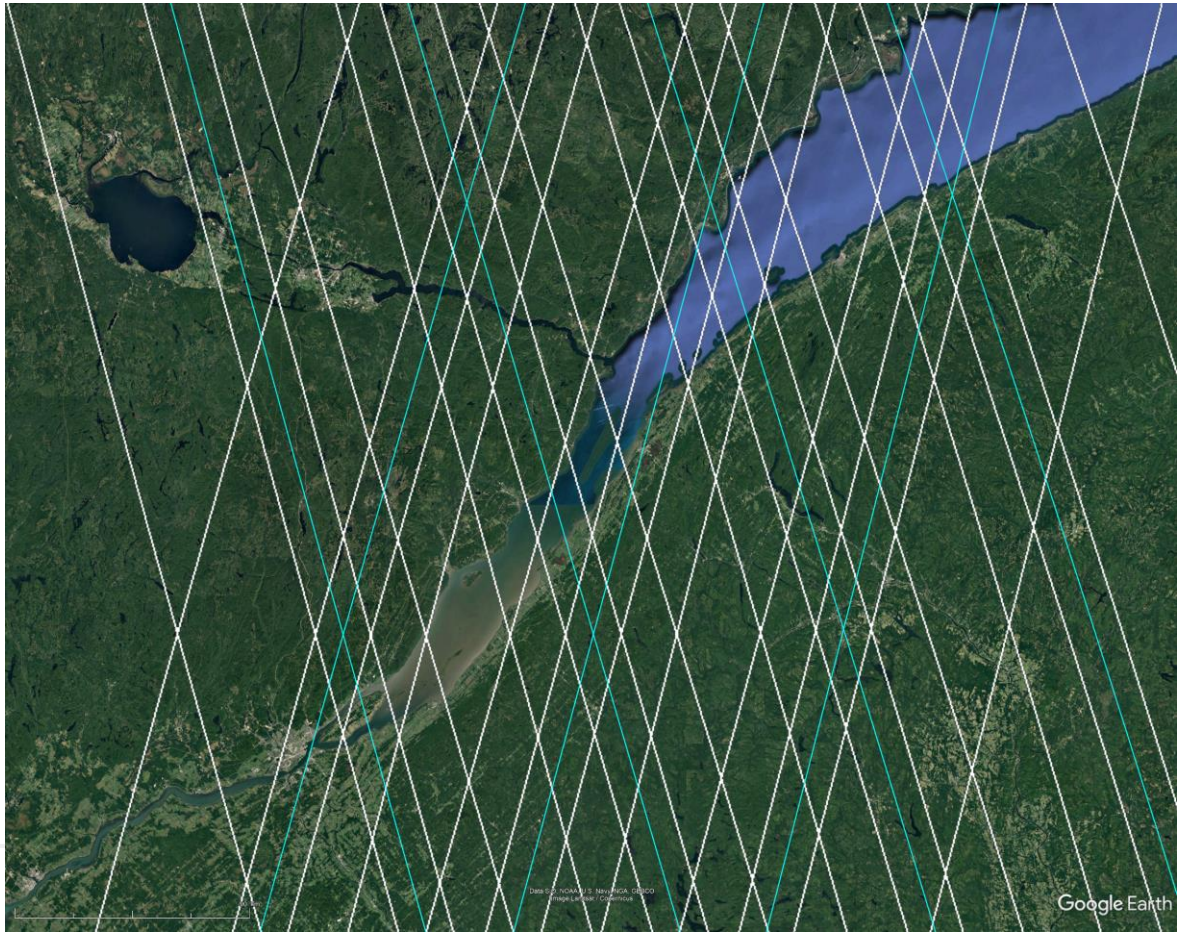
POST-LAUNCH CAL/VAL + SCIENCE VALIDATION

SWOT Cal/Val Orbit

- Pass 9
- Ascending

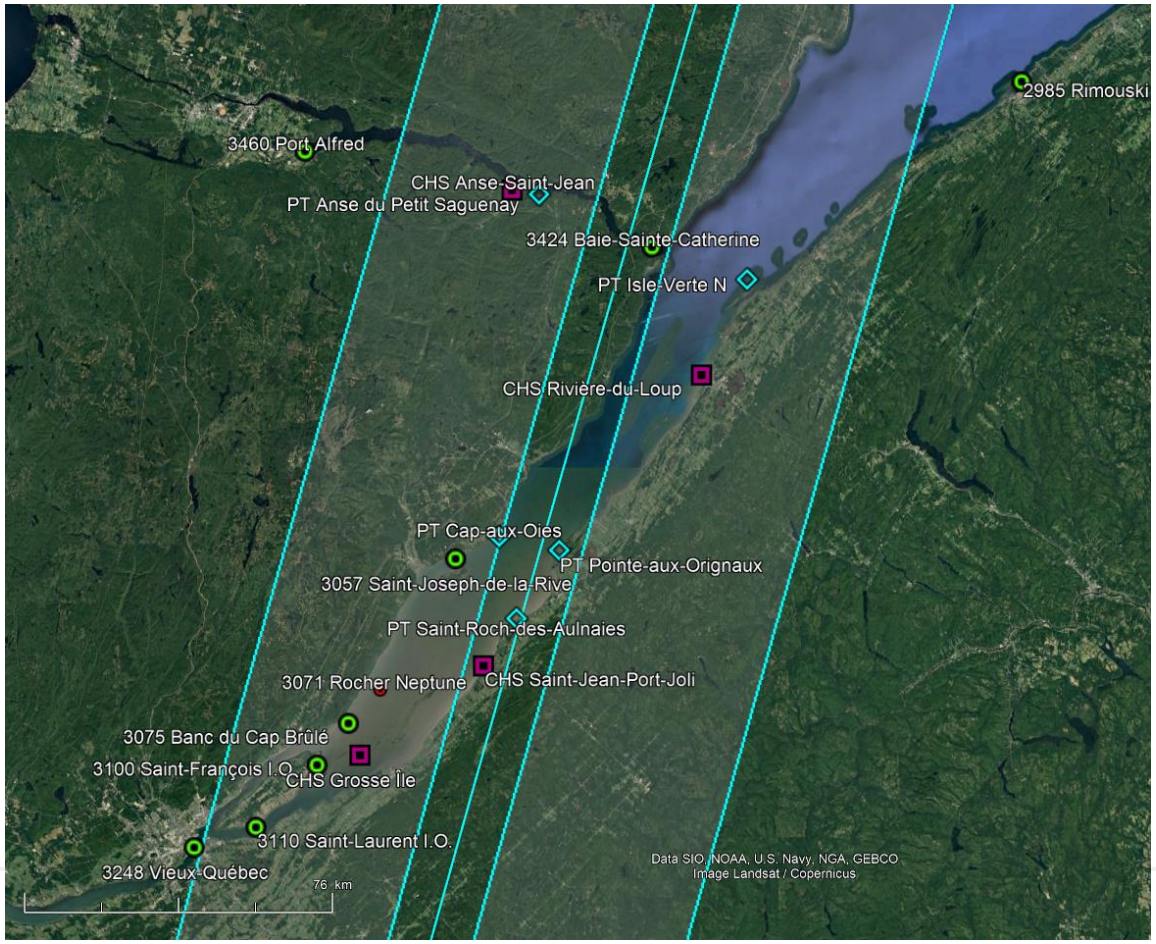
SWOT Science Orbit

- 3 ascending (Passes 35, 313, 341)
- 4 descending (Passes 214, 242, 520, 548)



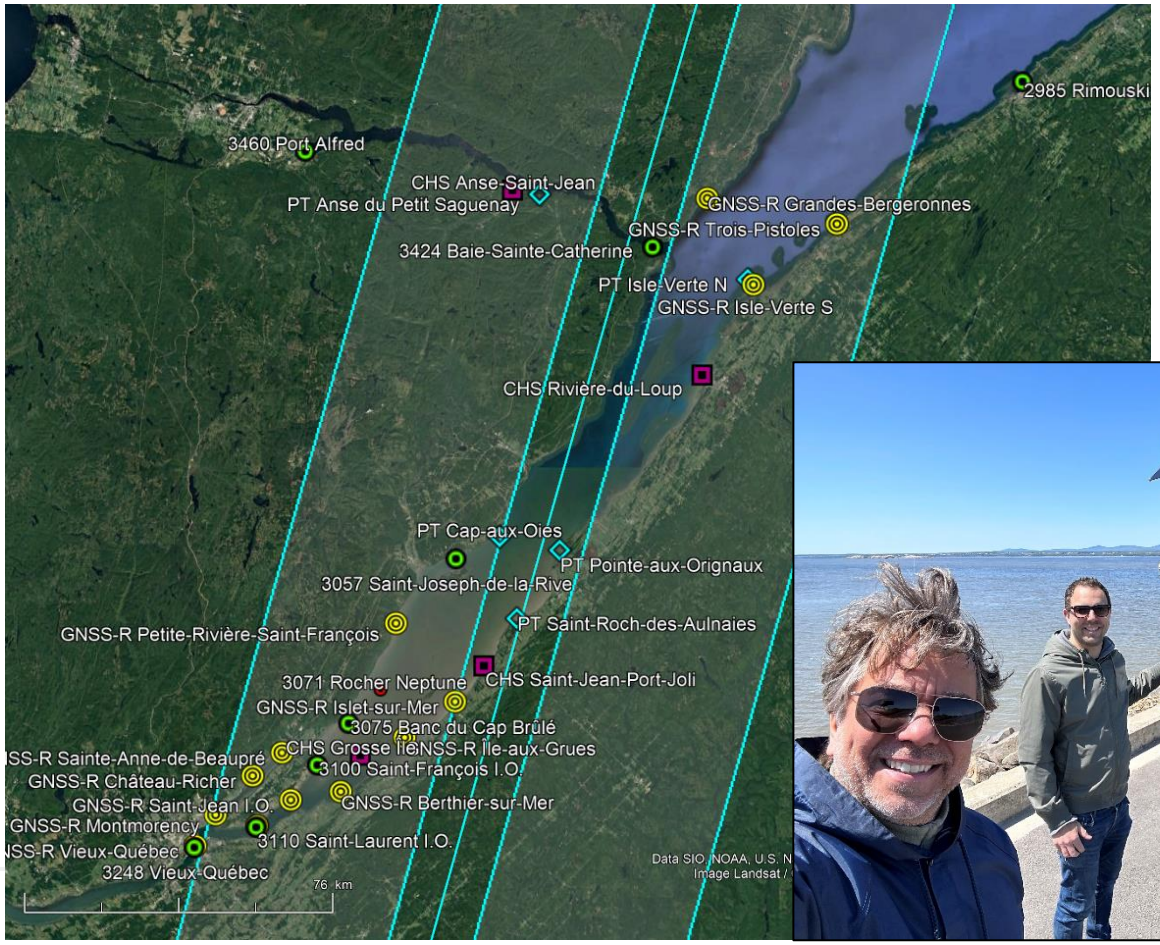
IN-SITU GAUGES

- **11 tide gauges + 5 pressure transducers (May-Oct 2023)**
  - Continuously measure tides and water surface slopes
  - Validate AirSWOT and numerical models
  - Validate SWOT water surface elevations and slopes

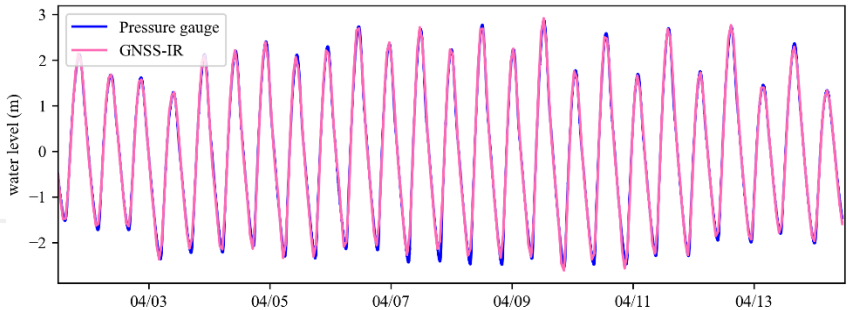


GNSS-IR

- **13 GNSS-Interferometric Reflectometry (GNSS-IR) (Mar 2023 ongoing)**
  - Continuously measure tides, water surface slopes, waves, ice
  - Validate AirSWOT and numerical models
  - Validate SWOT water surface elevations and slopes under contrasting wave and ice conditions

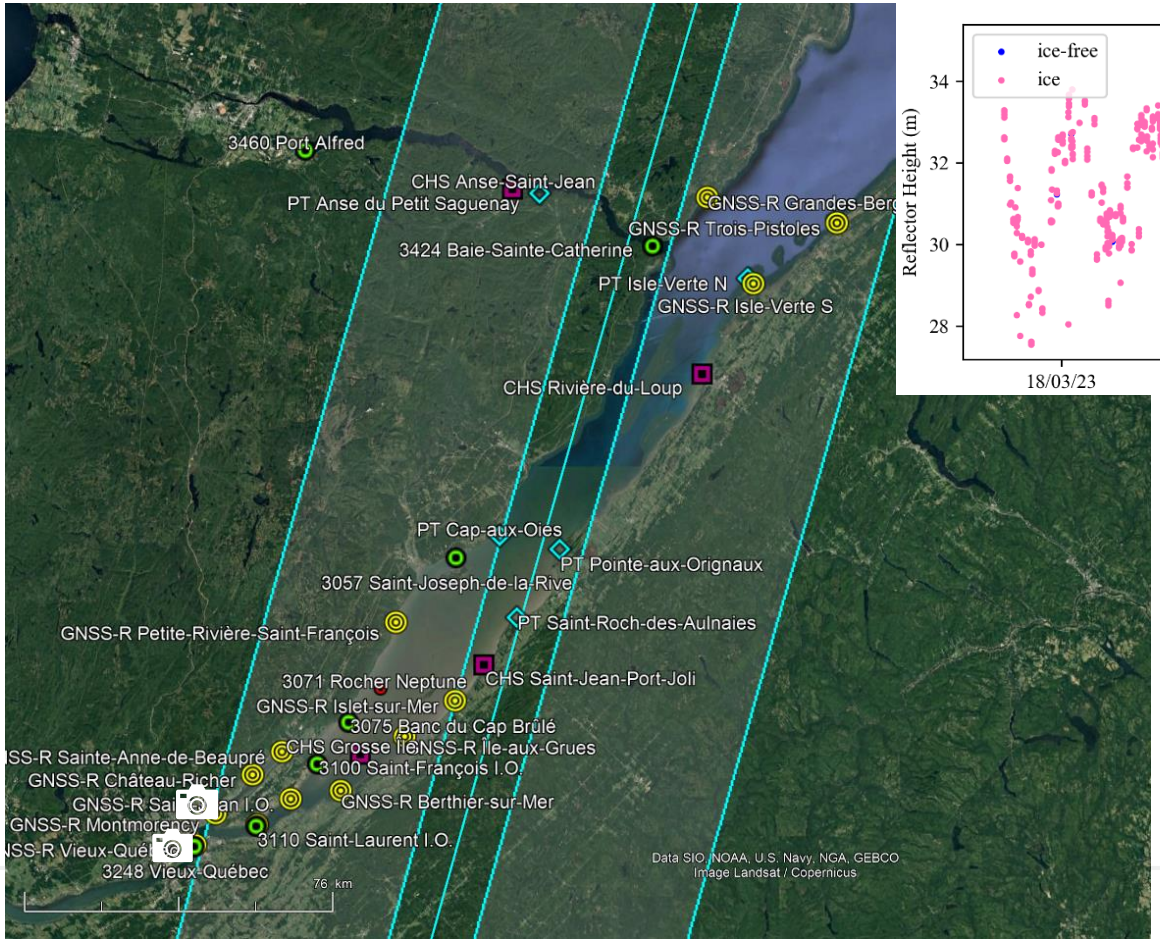


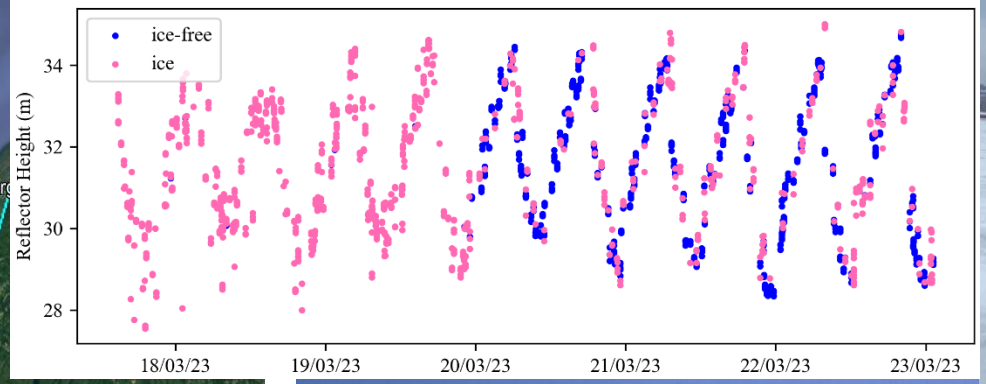
GNSS-IR @ Saint-Laurent (Orleans Island)



CAMERAS

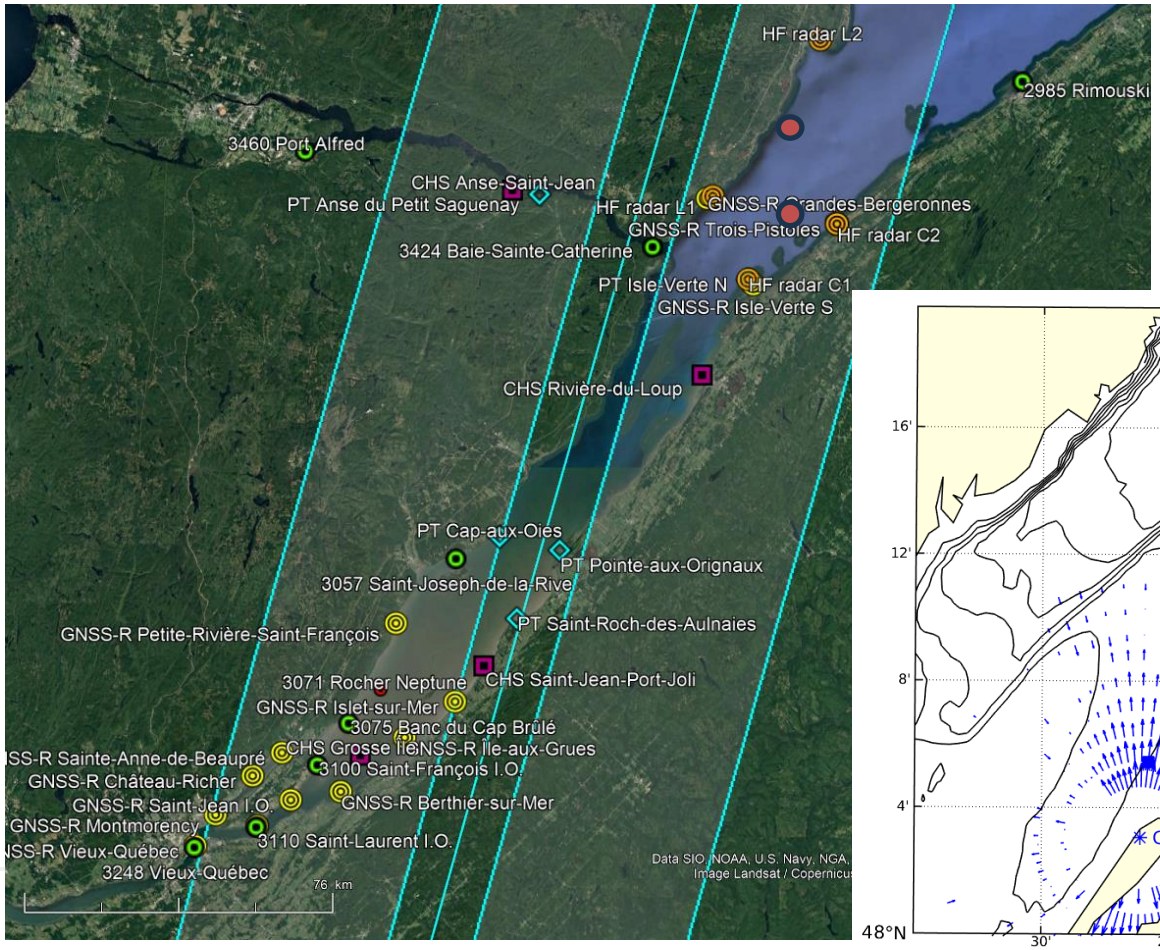
- **2 cameras (Mar 2023)**
  - Observe surface conditions (ice distribution/roughness, waves)
  - Correlate with colocated GNSS-IR measurements
  - Assess SWOT performance under contrasting surface types and roughness

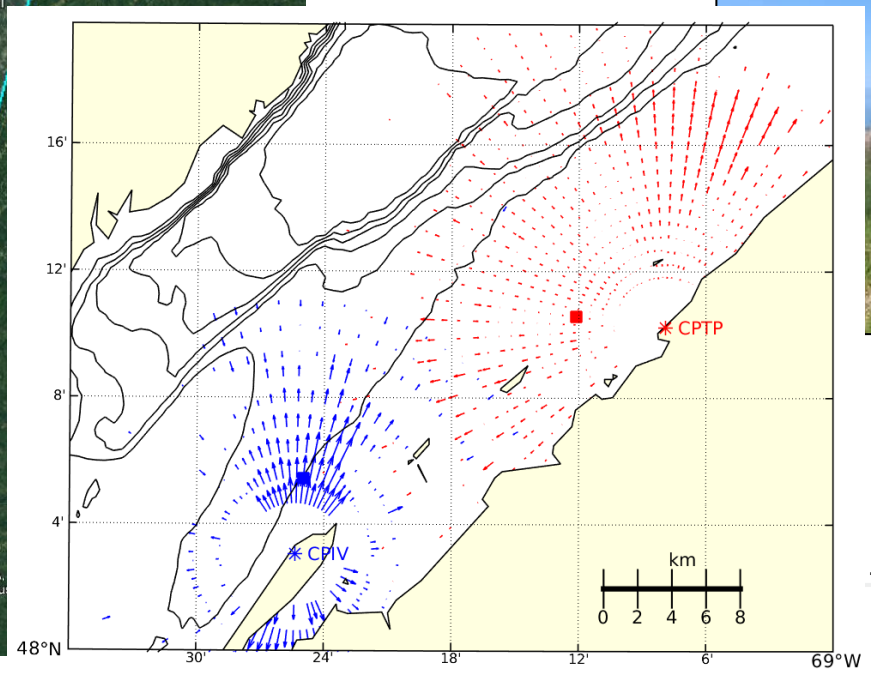


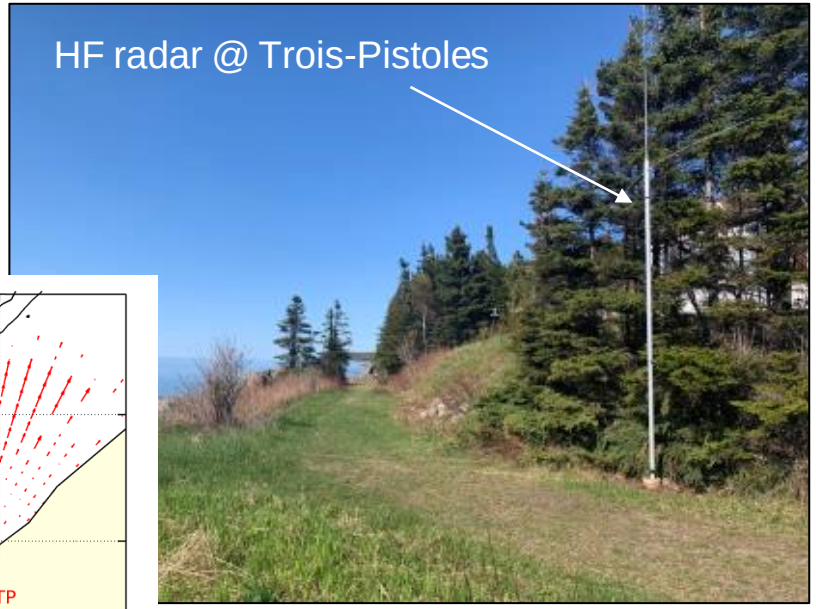


HF RADARS

- **4 high-frequency (HF) radars + 2 wave buoys (May 2023 ongoing)**
  - Measure hourly surface currents and waves at ~1 km resolution
  - Resolve mesoscale and submesoscale structures
  - Separate contributions of balanced and unbalanced motions to SWOT sea surface height



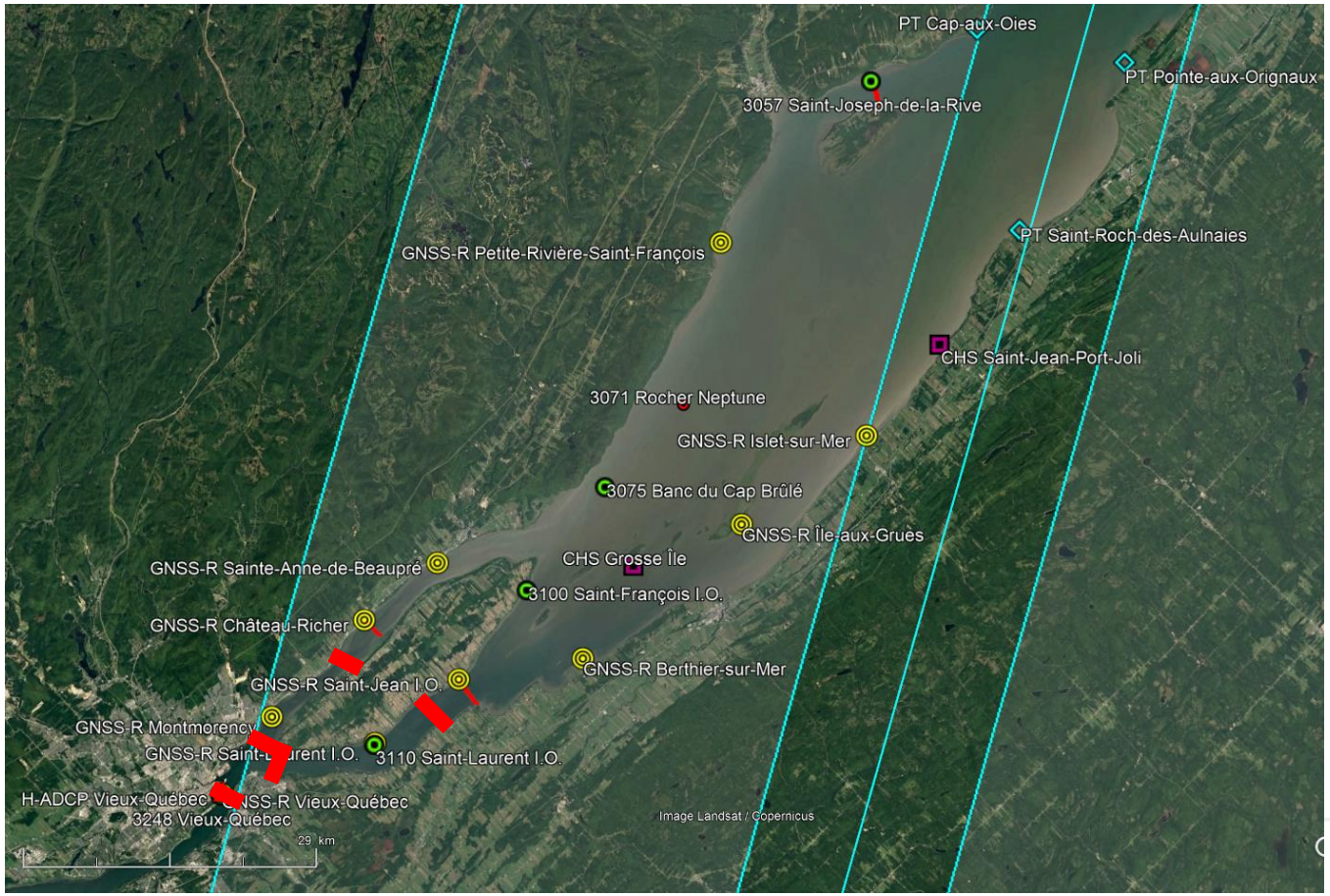




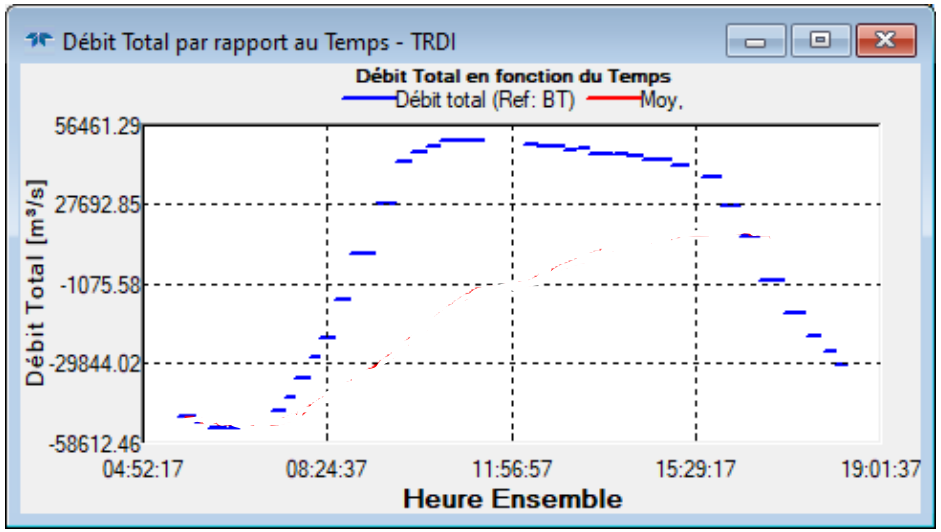
Raw surface currents from two HF radars

ADCP

- **1 fixed H-ADCP (May-Oct 2023) + repeated ADCP transects (3 days, 2 boats, 6-8 June 2023)**
  - Measure currents and discharge continuously (fixed H-ADCP) and over a tidal cycle (boat-mounted ADCP) in the main river and channels around islands
  - Reconstruct discharge from index-velocity relationships or multiple-gauge water levels
  - Validate SWOT discharges at SWORD reaches + test new algorithms



Measured discharges from
-55,000 m³/s to 55,000 m³/s



AIRSWOT

- **AirSWOT survey – 4 flights (22,23,29,31 Aug 2023)**
  - Measure tides and water surface slopes over repeated flights
  - Evaluate SWOT along- and cross-swath errors
  - Calibrate/validate numerical models