INTRODUCTION À SWOT POUR L'ESTIMATION DES EAUX DE SURFACE

Plan de la présentation

~10h – 10h45 :

Les bases de SWOT

Les produits SWOT

~10h45 – 11h : Pause-Discussion

~11h – 11h45

SWOT : Les enjeux

Applications en hydrologie

Applications en hydraulique

~11h45 – 12h : Discussion

Les bases de SWOT

Le but de la mission est de contribuer aux connaissances du système terrestre en fournissant des **mesures de niveaux d’eau à haute résolution** pour les eaux océaniques et intérieures.

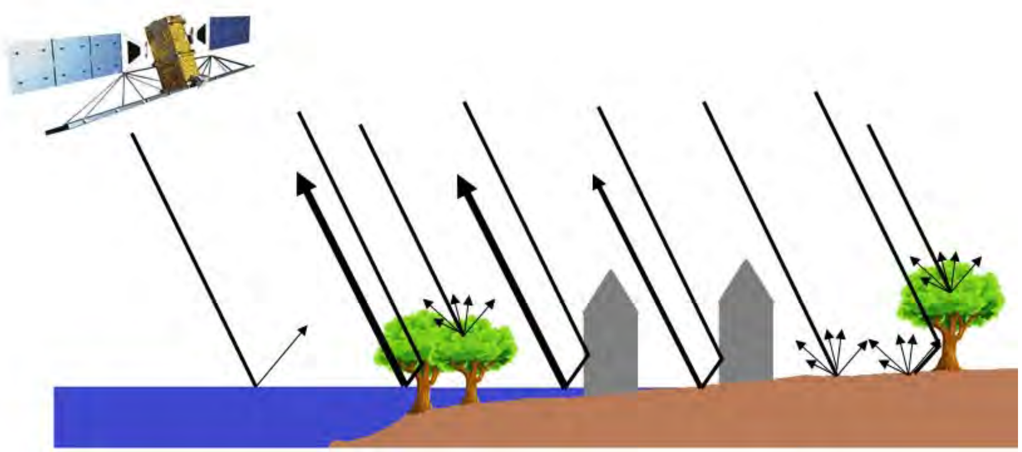
La mission SWOT est dirigée par la National Aeronautics and Space Administration (NASA) et le centre national d’études spatiales (CNES), en collaboration avec les agences spatiales canadienne (ASC) et britannique (UKSA)

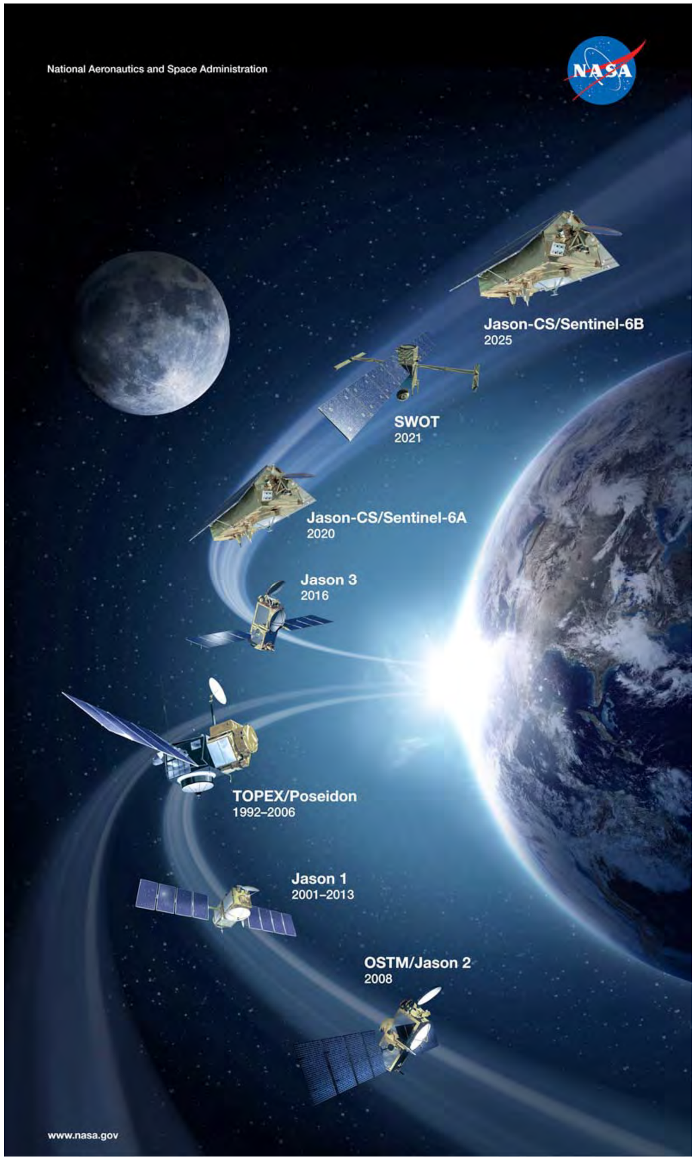
Lancement prévu fin 2022 pour une durée minimale de 3 ans

Les bases de SWOT

Mesurer les étendues d'eau et les niveaux à l'aide de la télédétection

- Altimètre
- Visible (Landsat, Sentinel-2)
- Radar à synthèse d'ouverture, RSO (Sentinel-1, Radarsat)

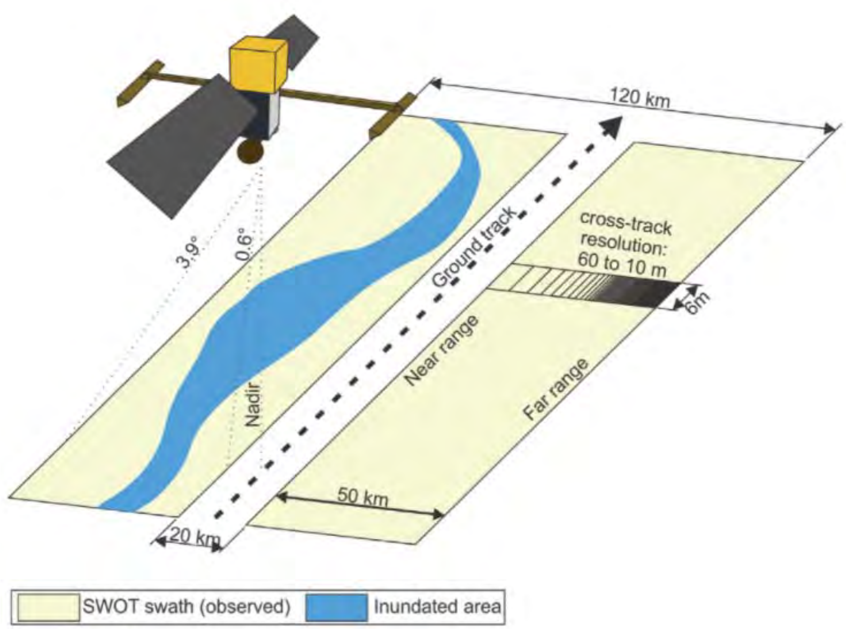




Les bases de SWOT

SWOT est un nouveau concept de capteur altimétrique

Interféromètre radar en **bande Ka** (35,75 GHz) avec un angle d'incidence proche du **nadir**



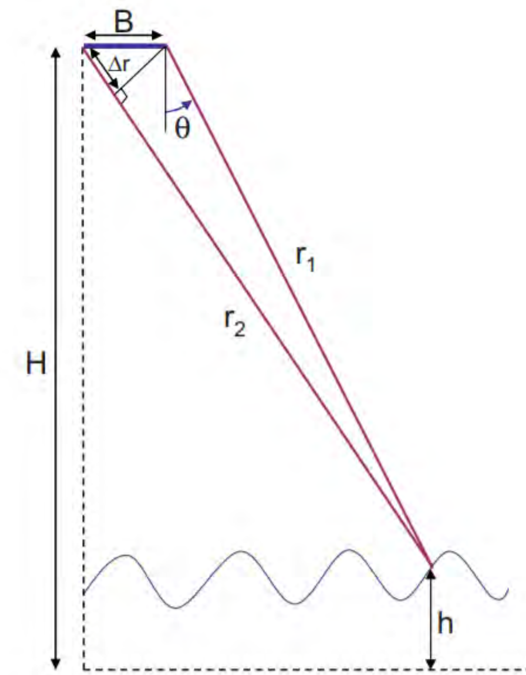
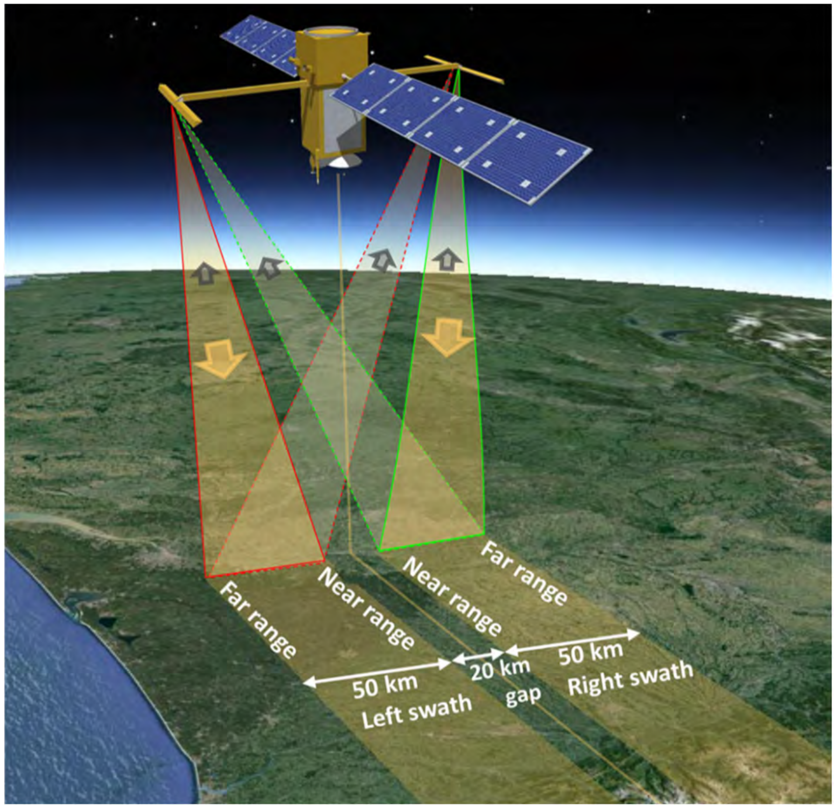


Fig. 3. KaRIn measurement principle (range profile).

Les bases de SWOT

Pour les lacs et réservoirs



Cartographier les plans d'eau de plus de 6 ha

Mesurer les niveaux d'eau pour :

Les lacs, les réservoirs et les zones humides, dont la superficie dépasse 250m x 250m (possiblement 100 m x 100 m)

Avec une précision verticale de 10 cm lorsque **moyennée sur 1 km²**

Estimer les variations de volume

Les bases de SWOT

Pour les rivières

<u>Mesurer les niveaux d'eau pour :</u>

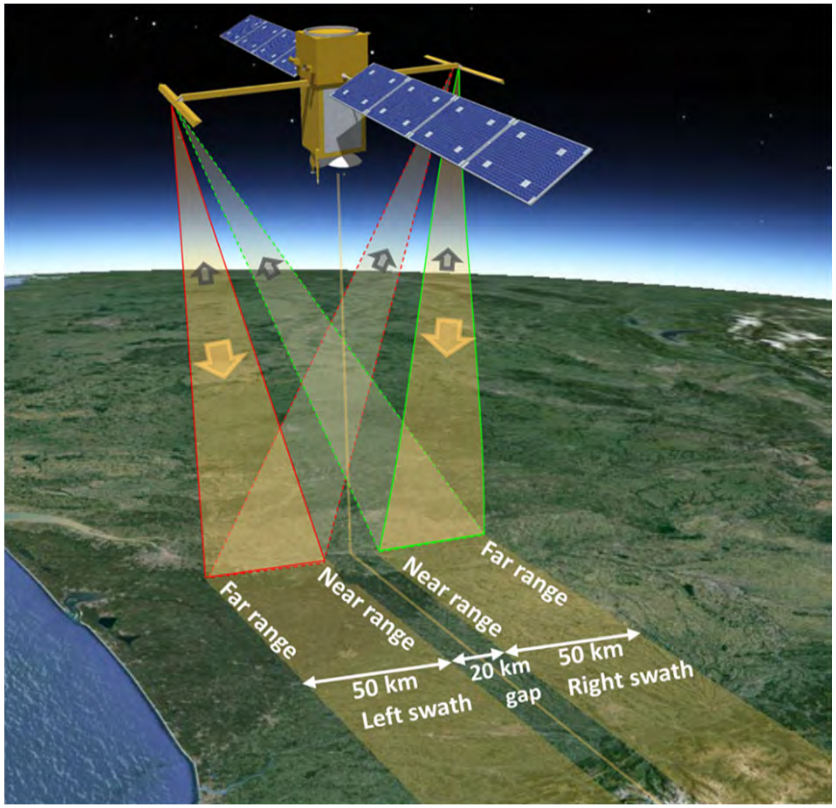
Les rivières dont la largeur dépasse 100 m (possiblement de 50 m)

Avec une précision verticale de 10 cm lorsque **moyennée sur 1 km^2**

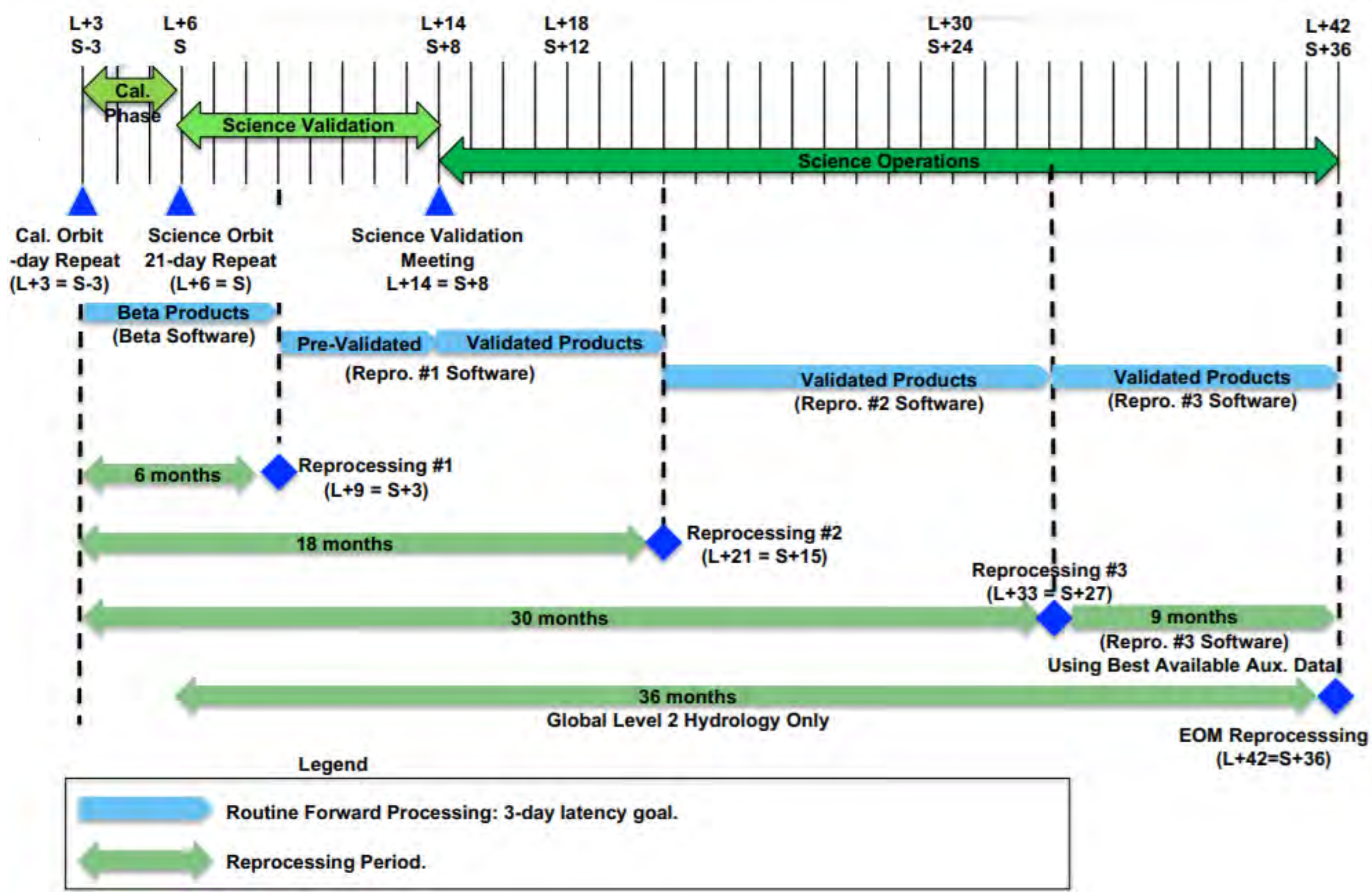
<u>Mesurer les pentes:</u>

Avec une précision verticale de 1,7cm/km

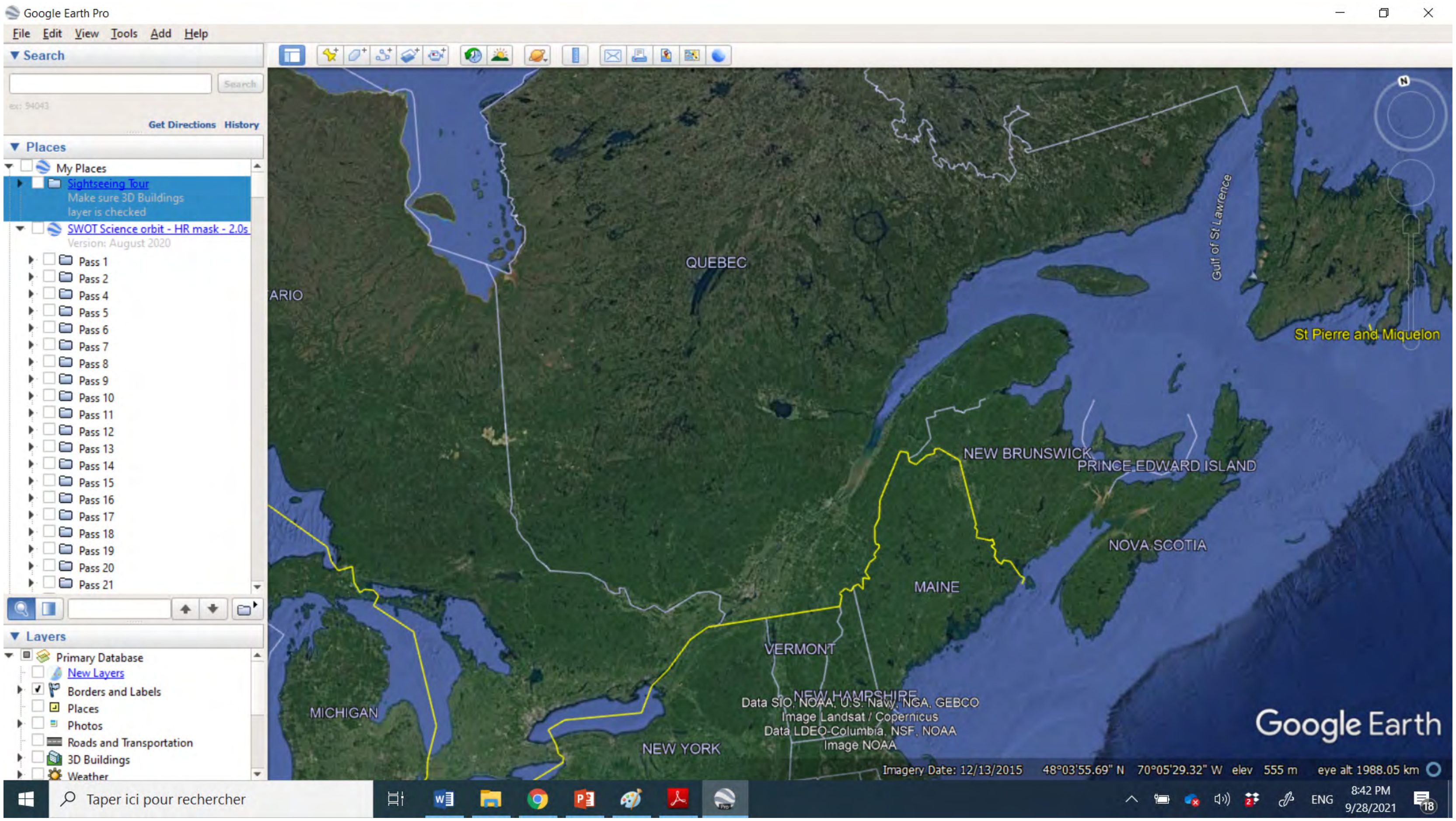
<u>Estimer les débits</u>



Les bases de SWOT



Les bases de SWOT

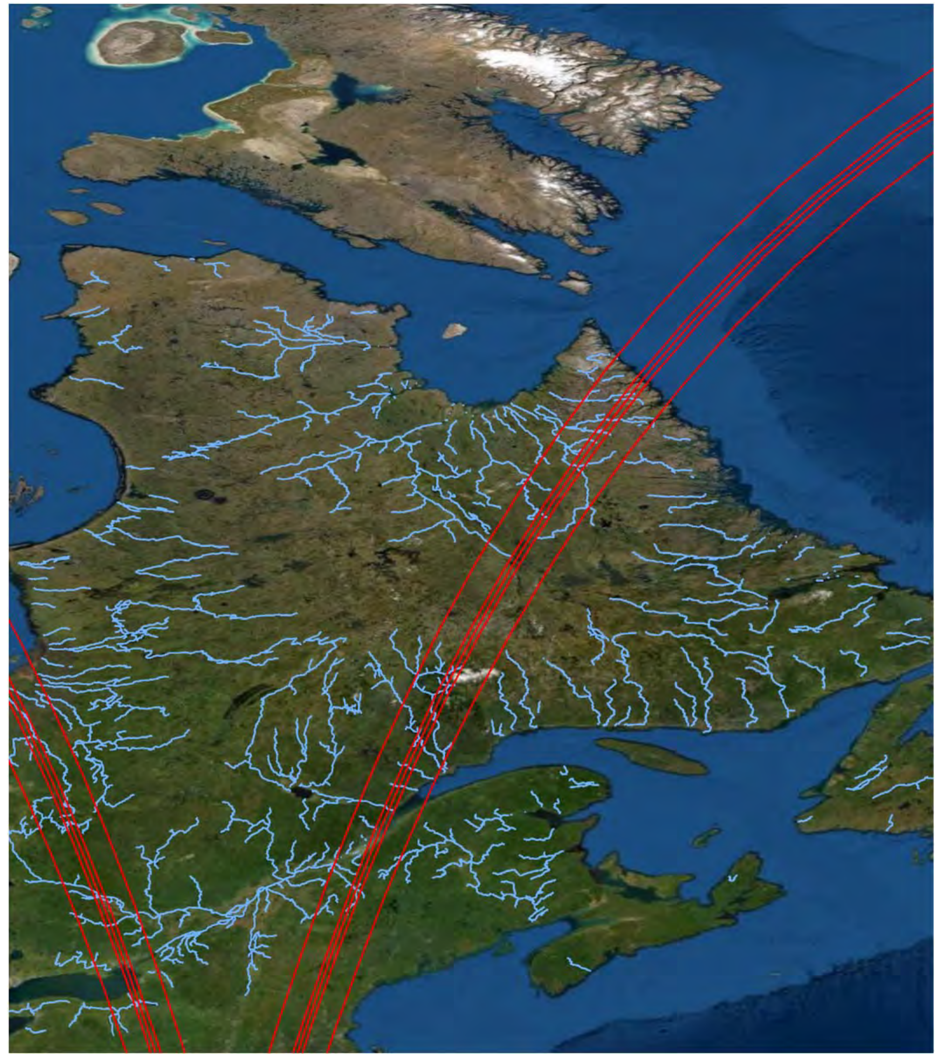


Les bases de SWOT

Bases de données *a priori* (SWORD) pour le Québec

Divisée en tronçons d'une longueur de 10 km au maximum.

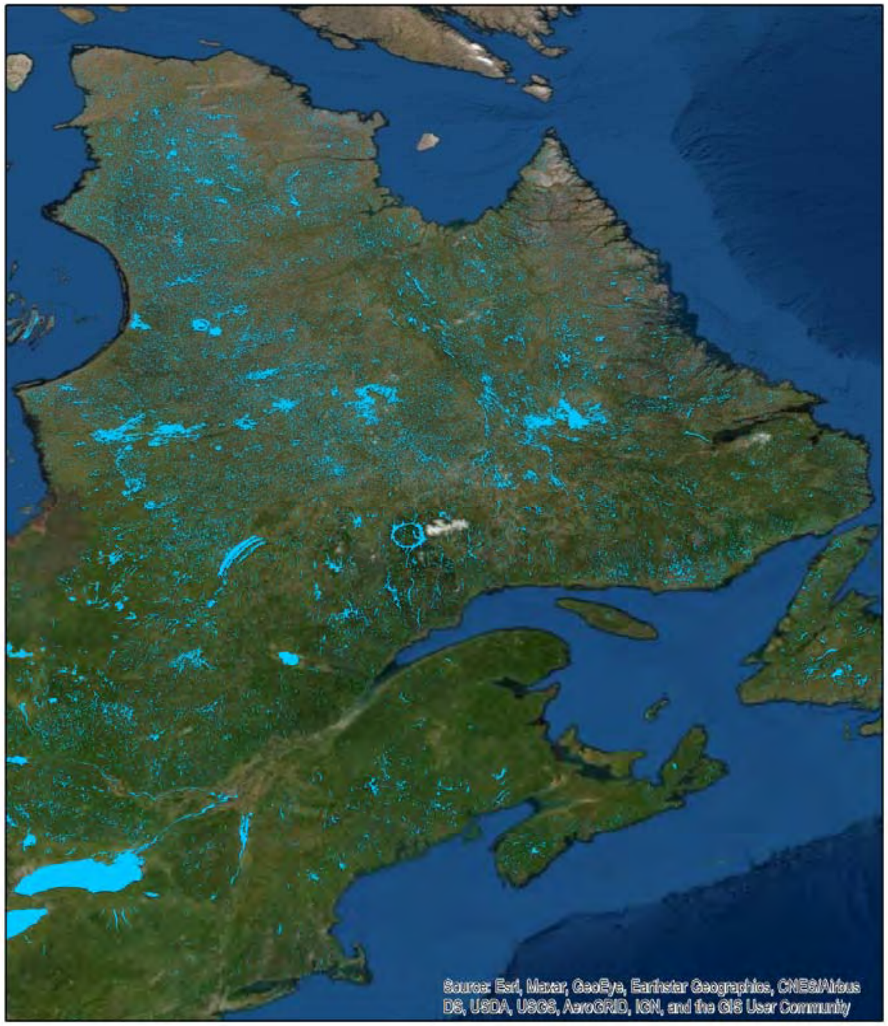
Des tronçons sont également définis lorsqu'il y a des barrages ou des confluences



Les bases de SWOT

Bases de données *a priori*

Saviez-vous que 62% des lacs (en superficie) sont situés au Canada ?

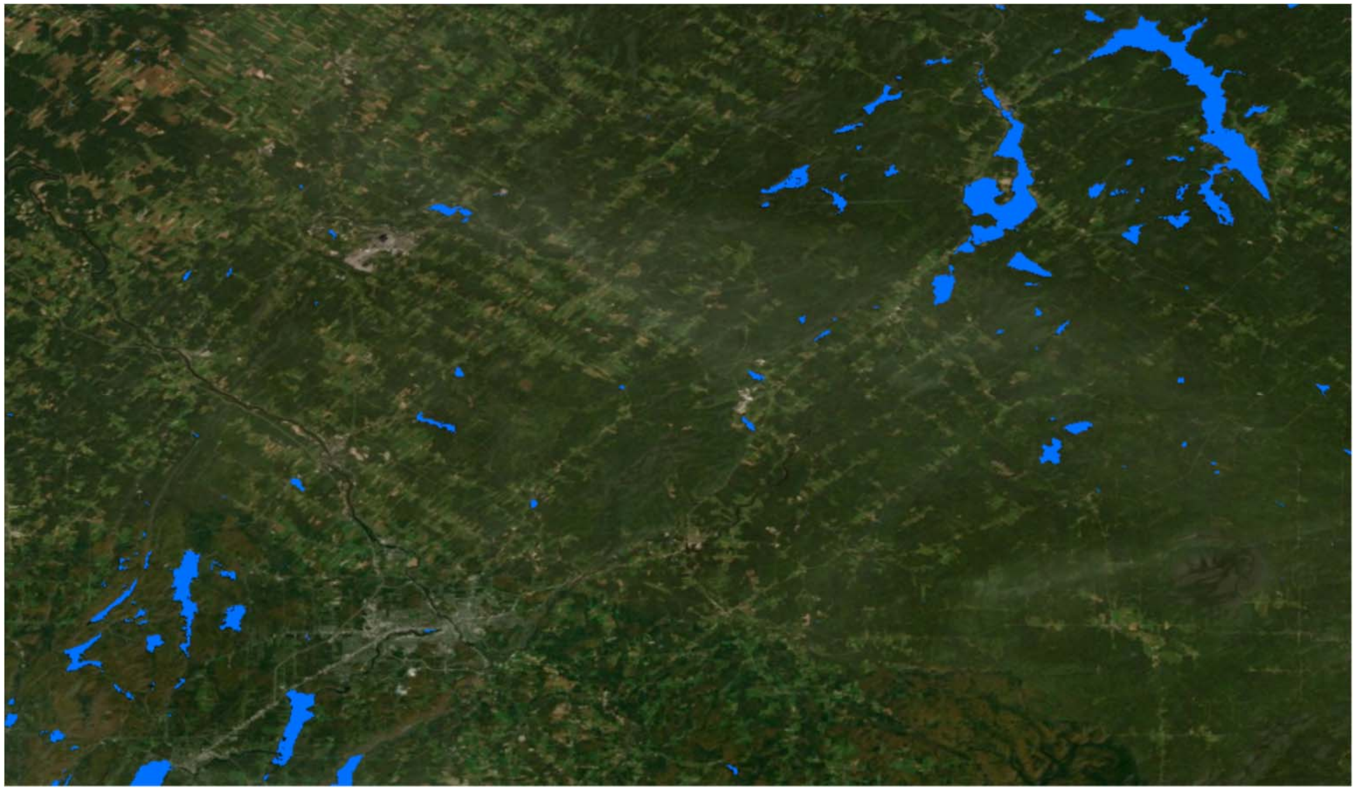


Les bases de SWOT

Exemple pour le bassin versant de la rivière Saint-François

Les bases de SWOT

Exemple pour le basin versant de la rivière Saint-François

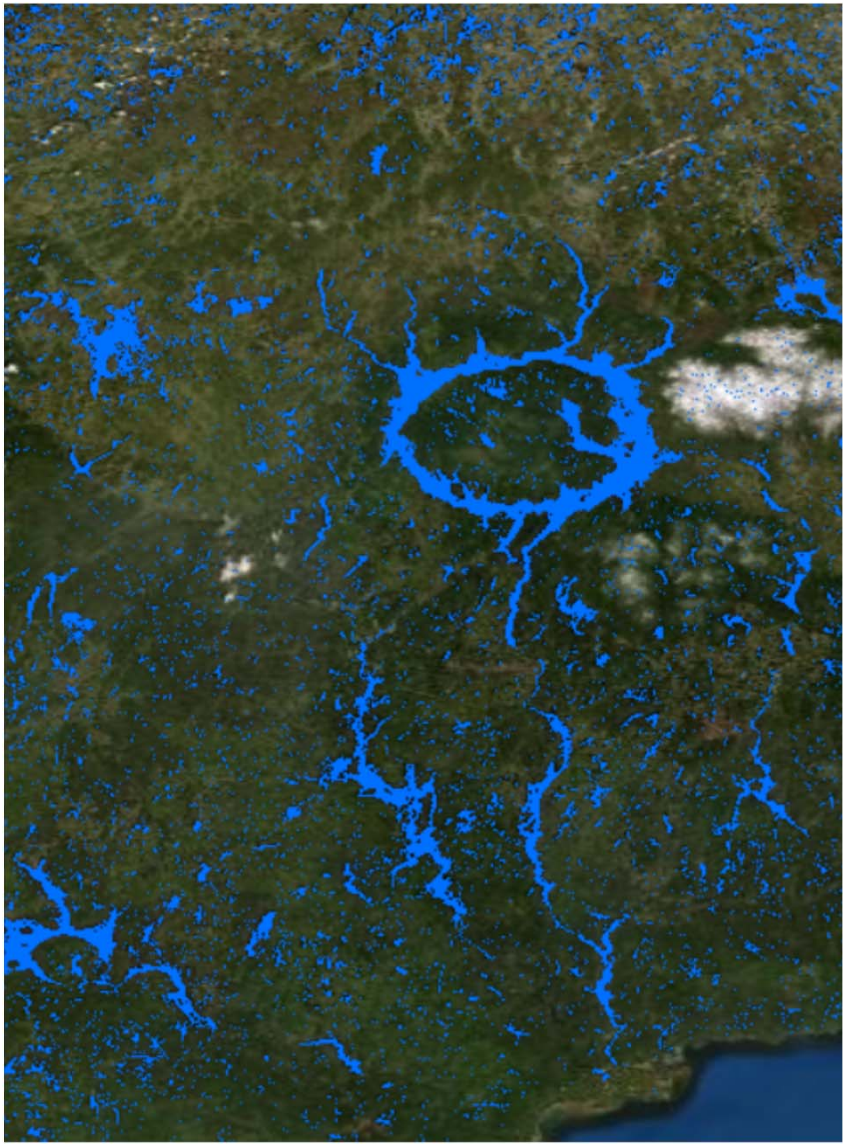


Les bases de SWOT

Exemple pour Manicouagan

Les bases de SWOT

Exemple pour Manicouagan



Les bases de SWOT

Exemple pour la Gaspésie

Les bases de SWOT

Exemple pour la Gaspésie

Les produits SWOT

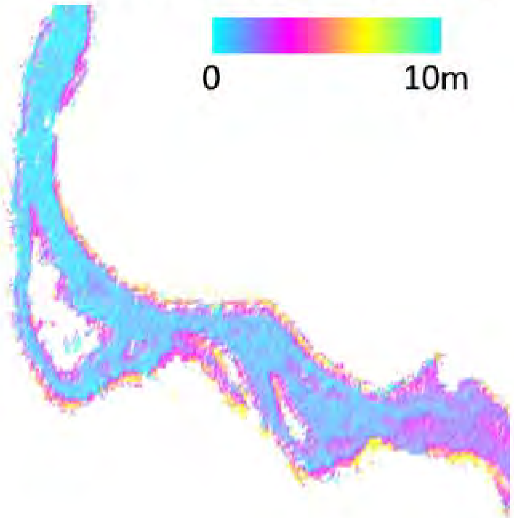
SWOT fournira différents produits en format netCDF ou shapefile

Table 1. SWOT Standard Data Products

Dataset	Description	Coverage	Format
L2_LR_SSH	Sea surface height data product with data from the KaRIn swath spanning 60 km on both sides of nadir with a nadir gap. Product provides sea surface height, sea surface height anomaly, wind speed, significant waveheight, on a geographically fixed, swath-aligned 2x2 km^2 grid, as well as sea surface height on a 250x250 m^2 native grid. Consists of four files: "Basic", "WindWave", "Expert", and "Unsmoothed".	Gridded; full swath for each half orbit	netCDF
L2_HR_PIXC	Point cloud of water mask pixels ("pixel cloud") with geolocated heights, backscatter, geophysical fields, and flags.	Point cloud over tile (approx 64x64 km^2); half swath (left or right side of full swath)	netCDF
L2_HR_RiverSP	Shapefiles of river reaches (approximately 10 km long) and nodes (approximately 200 m spacing) identified in prior river database. Reach attributes include water surface elevation, slope, width, derived discharge.	Full swath covering individual continents for each half orbit	shapefile
L2_HR_RiverAvg	Cycle average and aggregation of river reach pass data within predefined hydrological basins.	Basin for each cycle	shapefile
L2_HR_LakeSP	Shapefiles of lakes identified in prior lake database and detected features not in the prior river or lake databases. Lake attributes include water surface elevation, area, derived storage change.	Full swath covering individual continents for each half orbit	shapefile
L2_HR_LakeAvg	Cycle average and aggregation of lake pass data within predefined hydrological basins.	Basin for each cycle	shapefile
L2_HR_PIXCVec	Auxiliary information for pixel cloud product indicating to which water bodies the pixels are assigned in river and lake products. Also includes height-constrained pixel geolocation after reach- or lake-scale averaging.	Point cloud over tile (approx 64x64 km^2); half swath (left or right side of full swath)	netCDF
L2_HR_Raster	Rasterized water surface elevation and inundation extent in geographically fixed tiles at resolutions of 100 m and 250 m in a Universal Transverse Mercator projection grid. Provides rasters with water surface elevation, area, water fraction, backscatter, geophysical information. On-demand processing available to users for different resolutions, sampling grids, scene sizes, and file formats.	Gridded scene (approx 128x128 km^2, georeferenced); full swath	netCDF
L2_HR_FPDEM	Flood Plain Digital Elevation Map in raster format, derived from multiple cycles of SWOT acquisitions. Final resolution is not fixed yet (approx 50m). A large portion of the raster pixels will be void. Provides height and quality flag for each pixel.	Gridded scene (approx 1°, georeferenced); geographically fixed tiles (not aligned with SWOT swath).	netCDF

Les produits SWOT

L2_HR_PIXC



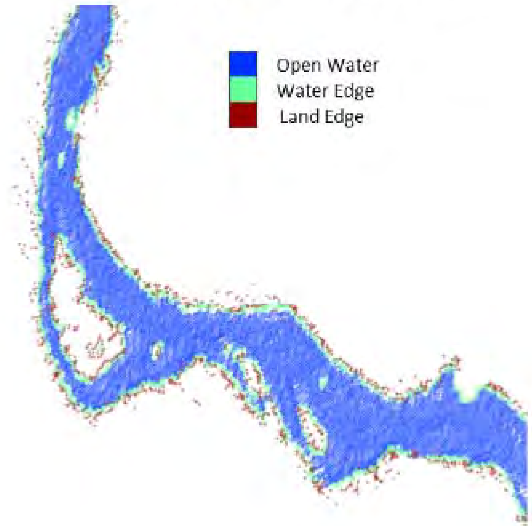


Table 3: Description of the data volume of the L2_HR_PIXC product.

Part	Group	Name	Expected Mean Volume (10% water) / Tile (GB)	Maximum Volume (100% water) / Tile (GB)
1	*pixel_cloud*	Pixel Cloud	0.28842	2.8824
2	*tvp*	Time Varying Parameters	0.0035	0.0035
3	*noise*	Noise	0.0002	0.0002
		Total	**0.292**	**2.89**

Les produits SWOT

L2_HR_RASTER

Standard Data Product (SDP)

- **Projection UTM**
- **Ellipsoïde**
- **Granules de 128 km x 128 km**
- **Résolution de 100 ou 250 m**
- **netCDF**
- **wse, wse_area, wse_frac**

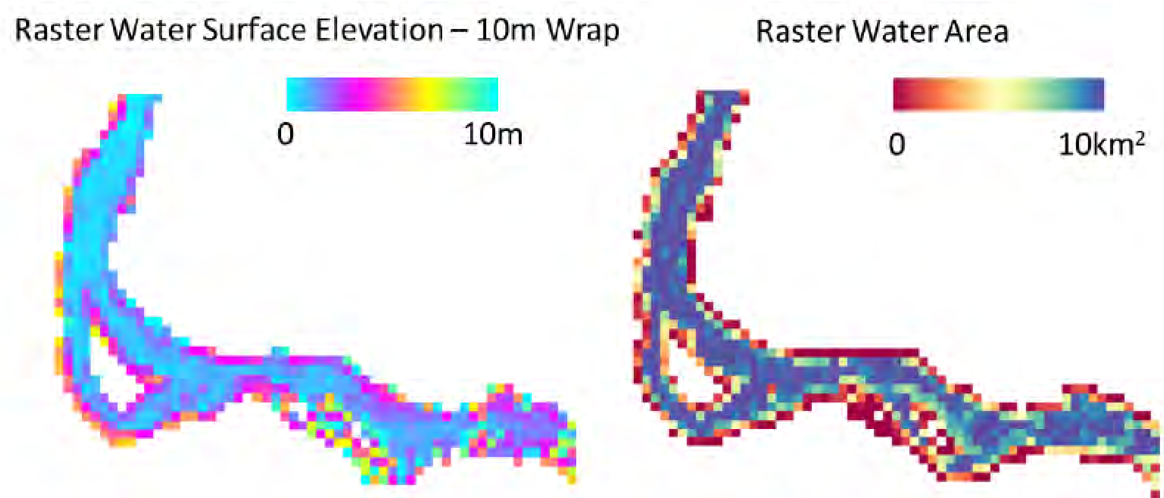


Table 2. Description of the data volume of the L2_HR_Raster SDPs

Product	Minimum Volume/Scene (MB)	Maximum Volume/Scene (MB)
L2_HR_Raster 100 m Resolution Raster	201.54	403.08
L2_HR_Raster 250 m Resolution Raster	32.25	64.50
Total	**233.79**	**467.58**

Les produits SWOT

L2_HR_Lake_SP et L2_HR_River_SP

Table 5. Water body type codes for the *reach_id* attribute.

Type Code (*T*)	Water Body Type
1	River
2	Disconnected Lake (not processed)
3	Connected Lake
4	Dam
5	No Topology

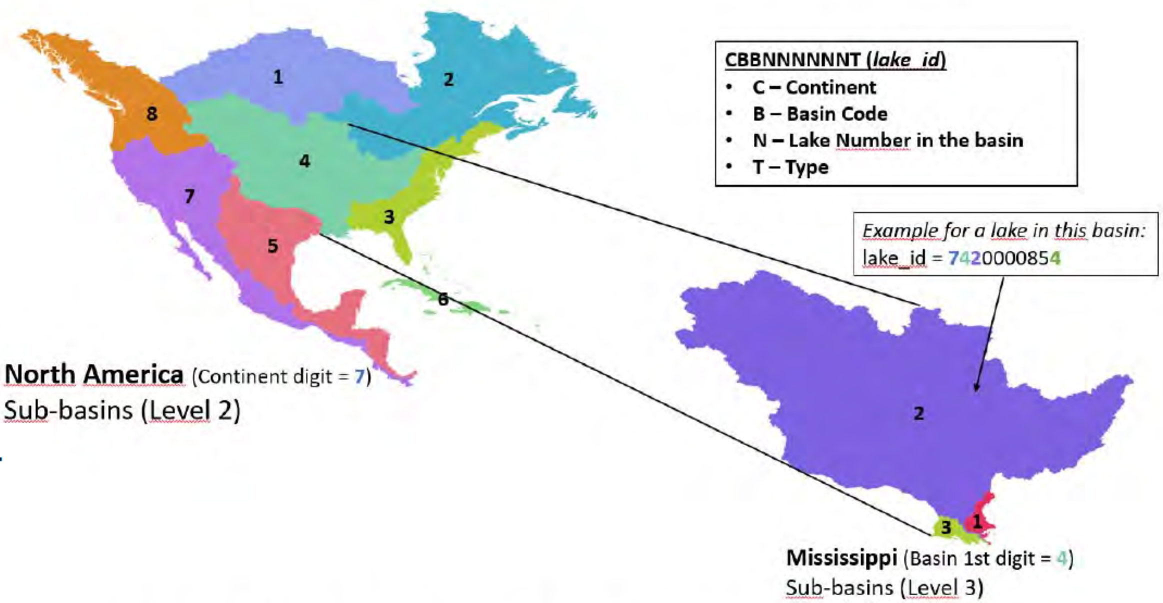


Figure 6. Example of the Pfafstetter basin coding system over North America.

Table 4. Water body type codes for the *obs_id* and *lake_id* attributes.

Type Code (T)	Water Body Type
1	River *(not used in this product)*
2	Disconnected lake
3	Connected lake
4	Dam *(not used in this product)*
5	No topology *(not used in this product)*

Les produits SWOT

SWOT_L2_HR_LakeSP_Obs_001_037_NA_20210612T072103_20210612T075103_PGA2_03.shp
SWOT_L2_HR_LakeSP_Prior_001_037_NA_20210612T072103_20210612T075103_PGA2_03.shp
SWOT_L2_HR_LakeSP_Unassigned_001_037_NA_20210612T072103_20210612T075103_PGA2_03.shp

L2_HR_Lake_SP

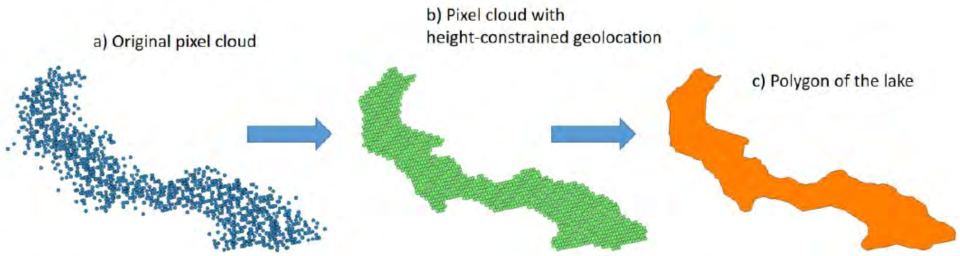


Figure 2. Synthetic scene showing that the shapefile geometry of the lake product is a polygon (c), whose shape is computed from the PIXCVec pixel cloud with height-constrained geolocation (b), rather than the more noisy PIXC pixel cloud (a).

- **Geoïde**
- **Niveau d'eau *(wse)***
- **Superficie *(area_total)***
- **Variation de volume *(delta_s_l, delta_s_q)***

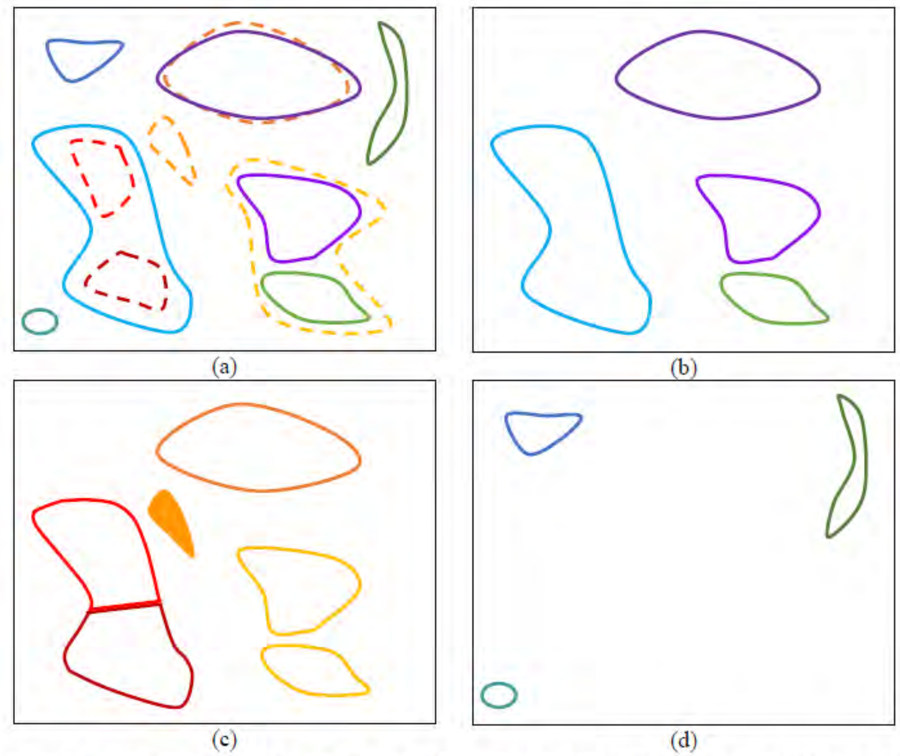
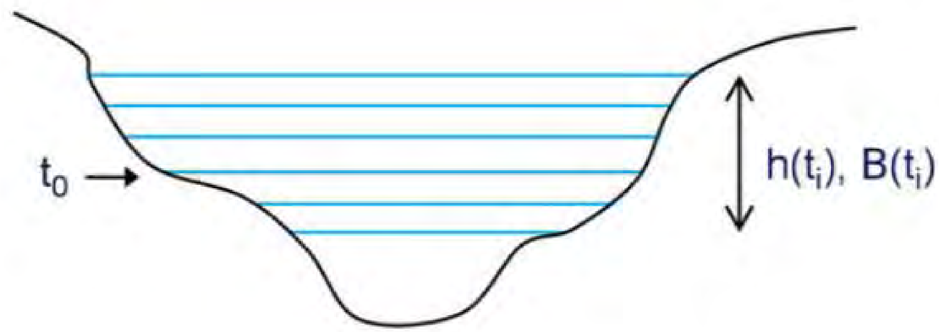


Figure 1. Illustration of how the L2_HR_LakeSP product is organized in three shapefiles. (a) All observed features (solid polygons) and PLD lakes (dashed polygons) in an area. Different colors indicate different observation identifiers or PLD identifiers. (b) Polygons of the observation-oriented lake shapefile. (c) Polygons of the PLD-oriented lake shapefile (where the unobserved PLD lake is an empty shape). (d) Polygons of the observation-oriented unassigned features shapefile.

Les produits SWOT

L2_HR_Lake_SP



$$\Delta V\left(\frac{t_i}{t_0}\right) = \Delta V\left(\frac{t_{i-1}}{t_0}\right) + \frac{[B(t_i)+B(t_{i-1})+\sqrt{B(t_i)*B(t_{i-1})}]}{3} \cdot [h(t_i) - h(t_{i-1})] \quad (1)$$

$$\Delta V\left(\frac{t_i}{t_0}\right) = \Delta V\left(\frac{t_{i-1}}{t_0}\right) + \frac{[B(t_i) + B(t_{i-1})]}{2} \cdot [h(t_i) - h(t_{i-1})] \quad (2)$$

Les produits de SWOT

L2_HR_River_SP

- **Géoïde**
- **Niveau d'eau (*wse*)**
- **Pente (*slope*)**
- **Largeur de la rivière (*width*)**
- **Superficie (*area_total*)**

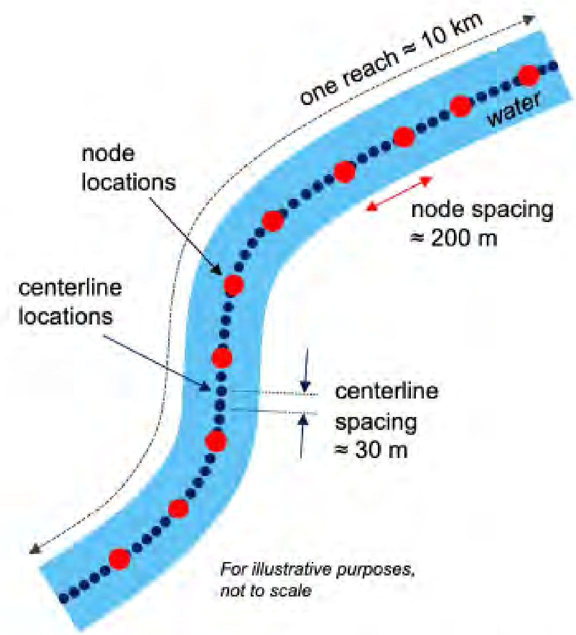


Figure 1. Illustration of the centerline locations (dark blue dots) that define the *polyline* shapes of the reach shapefile and the nodes (red dots) that define the *point* shapes of the node shapefile for a partial segment of one reach, per the PRD.

Les produits SWOT

L2_HR_River_SP

Deux versions pour chaque algorithme

- Discharge
- Gauge-constrained discharge

Possibilité de mettre à jour la base de données pour le calculs des débits « Gauge-constrained »

Table 1
Summary of the Discharge Inversion Algorithms

Algorithm	Theoretical basis	Applied variables from observation	Estimated variables	Variable estimation method
BAM	Manning flow resistance equation with constant n (Equation 1) and At-Many-stations-Hydraulic-Geometry (AMHG), Equation 2	Water surface width (W), slope (S), cross-sectional area anomaly (dA)	n, A_0, AMGH: b, Wc, Qc	Parameters optimized to preserve continuity between a set of reaches (assuming dQ/dx = 0) using Hamiltonian Bayesian inference.
MetroMan	Manning flow resistance with stage-dependent friction parameterization (Equation 3)	Water surface height (H), W, S, δA	n_a, b, A_0	Parameters optimized to preserve continuity between a set of reaches as defined by Equation 4, using the Metropolis algorithm.
HiVDI	1D Saint-Venant and Manning flow resistance with depth dependent flow resistance (Equation 5)	H, W, S, δA	a, b, A_0	Calibration of Manning-Strickler equation using discharge obtained by assimilation of SWOT measurements into the 1-D Saint Venant model.
SAD	Gradually varied flow equations (Equation 6) assuming friction slope that follows Manning-Strickler equation (Equation 7)	H, W, S	Q	Assimilation of SWOT observations into a steady-state, non-uniform hydraulic model using the Local Ensemble Transform Kalman Filter algorithm to estimate river discharge.
MOMMA	Manning flow resistance with stage-dependent friction parameterization (Equation 9)	H, W, S	n_b, H_b, B	Bankful height (Hb) is estimated by identifying breakpoints in the observed H versus W relationship. Height at 0 flow (B) is estimated by extrapolating the H versus W relationship to $W = 0$. Bankful flow friction is calibrated using the prior estimate of mean annual flow.

Notes. In this table, SWOT stands for the Surface Water and Ocean Topography mission. Description of the meaning the estimated variables can be found in each algorithm description: BAM in Section 2.1, MetroMan (2.2), HiVDI (2.3), SAD (2.4), MOMMA (2.5).
Abbreviations: BAM, Bayesian At-many-stations-hydraulic-geometry Manning; HiVDI, Hierarchical Variational Discharge Inference; MOMMA, Modified Optimized Manning Method Algorithm; SAD, SWOT Assimilated Discharge.

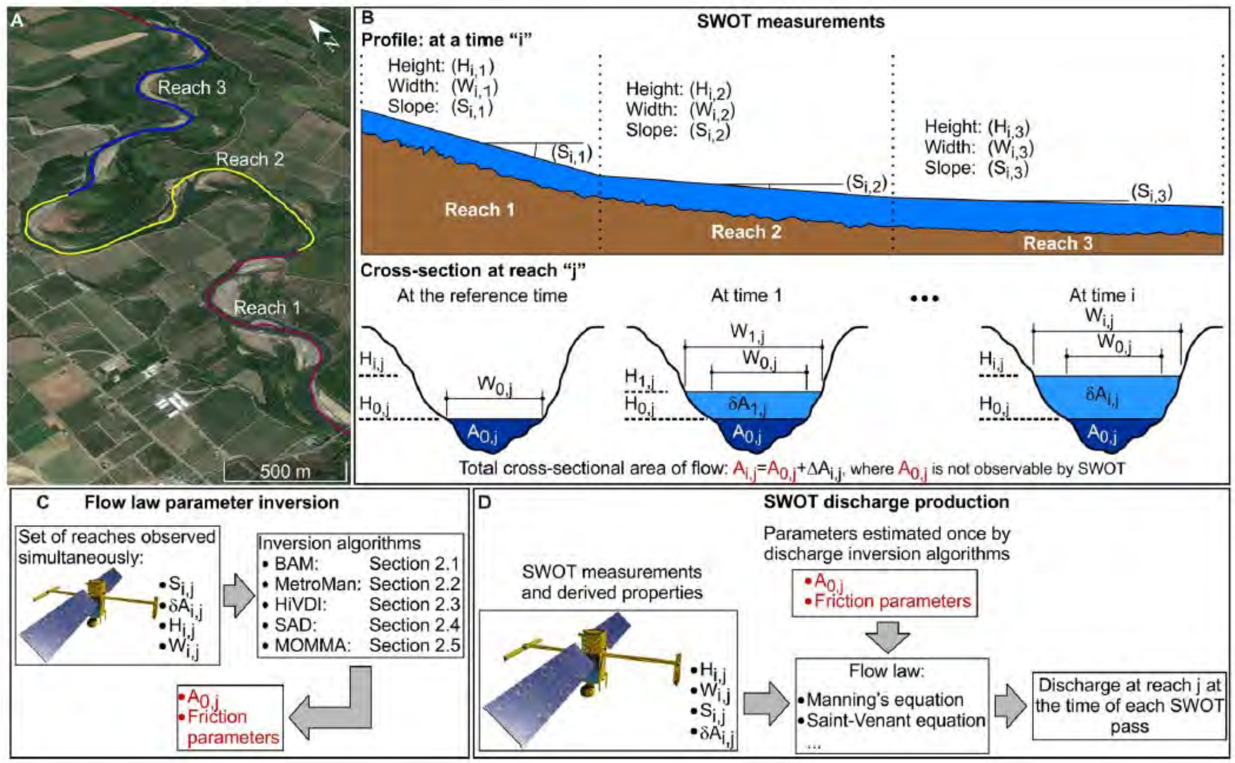
Les produits SWOT

L2_HR_River_SP

Deux versions pour chaque algorithme

- Discharge
- Gauge-constrained discharge

Possibilité de mettre à jour la base de données pour le calculs des débits « Gauge-constrained »



PAUSE

SWOT : Les enjeux

Ellipsoïde vs géoïdes

Canada

CGVD2013

Québec

CGVD1928

SWOT

EGM2008

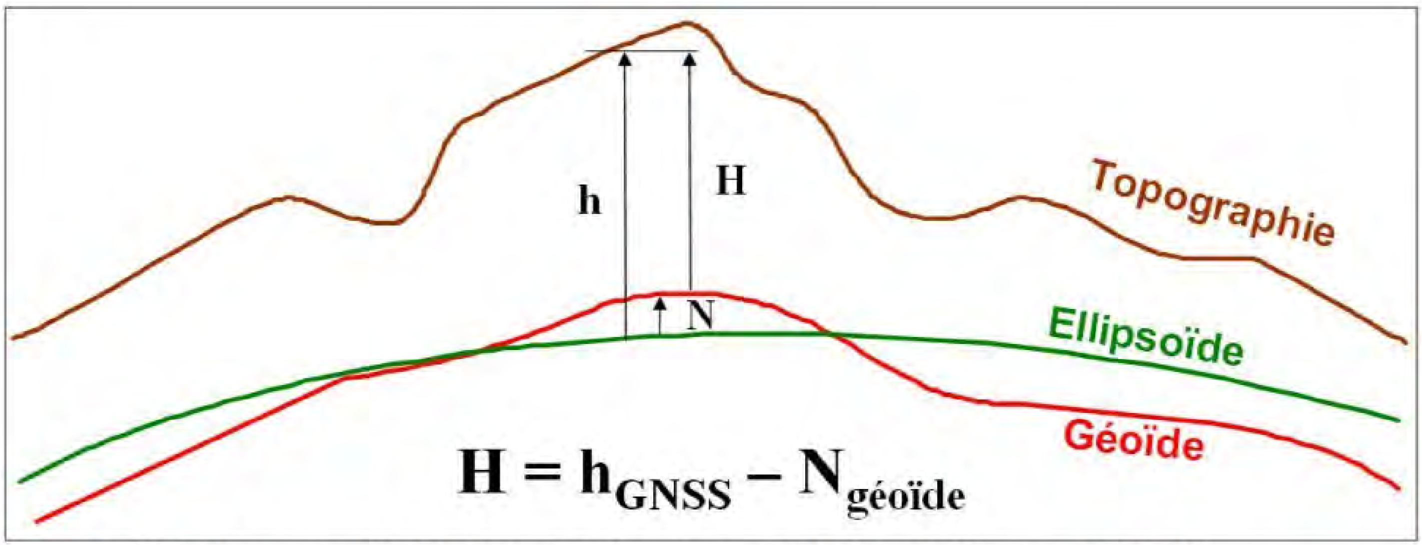


Figure 1: Altitude ellipsoïdale (h), altitude orthométrique (H) et ondulation du géoïde (N)

L'altitude orthométrique (H) (aussi appelée altitude par rapport au niveau moyen de la mer) est obtenue en soustrayant l'ondulation du géoïde (N) de l'altitude ellipsoïdale (h) venant du GNSS. L'ondulation du géoïde (N) est positive (+) lorsque le géoïde se situe au-dessus de l'ellipsoïde et elle est négative (-) lorsque le géoïde se situe en dessous de l'ellipsoïde.

SWOT : Les enjeux

Recouvrement (Layover)

Le signal de deux endroits différents retourne simultanément au capteur.

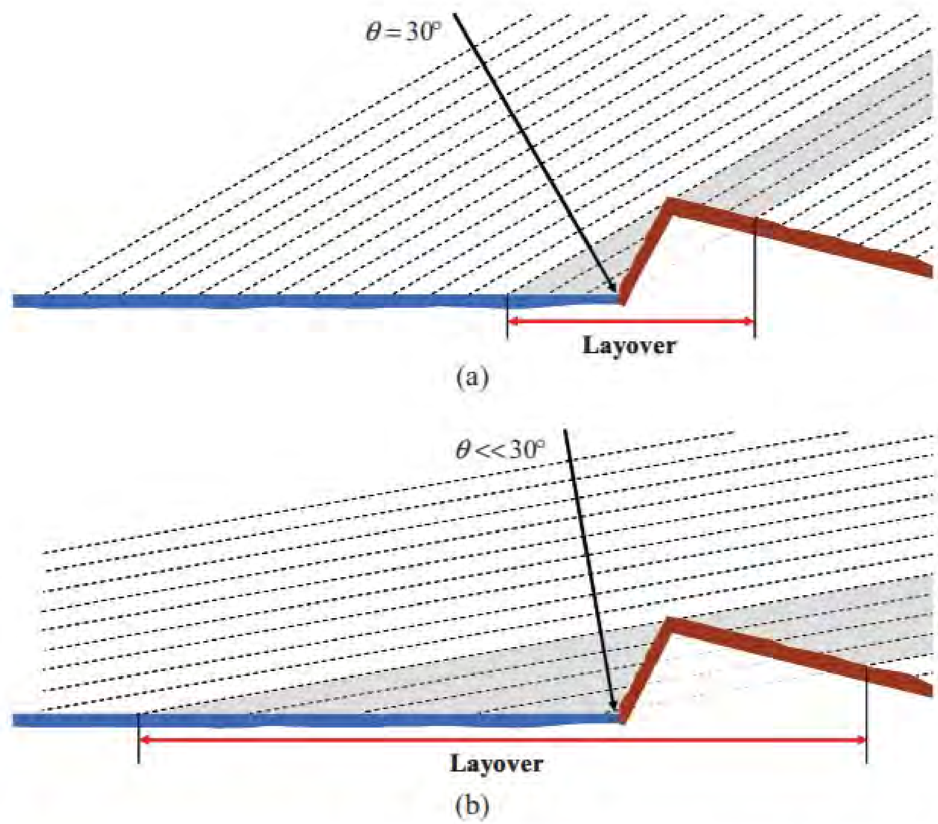


Fig. 4. Illustration of the extent of layover caused by a mountain next to a lake (a) in the case of 30° incidence and (b) for a much smaller incidence.

SWOT : Les enjeux

Recouvrement (Layover)

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Check for updates

How will radar layover impact SWOT measurements of water surface elevation and slope, and estimates of river discharge?

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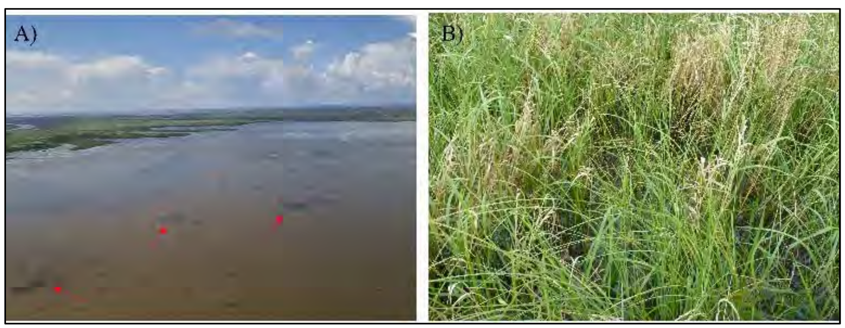
ABSTRACT

Water surface elevation (WSE), slope and width measurements from the forthcoming Surface Water and Ocean Topography (SWOT) mission will enable spaceborne estimates of global river discharge. WSE will be measured by interferometric synthetic aperture radar (InSAR). InSAR measurements are vulnerable to contamination from layover, a phenomenon wherein radar returns from multiple locations arrive at the sensor simultaneously, rendering them indistinguishable. This study assesses whether layover will significantly impact the precision of SWOT estimates of global river discharge. We present a theoretical river layover uncertainty model at the scale of nodes and reaches, which constitute nominal 200 m and 10 km averages, respectively, along river centerlines. The model is calibrated using high-resolution simulations of SWOT radar interaction with topography covering a total of 41,233 node observations, across a wide range of near-river topographic features. We find that height uncertainty increases to a maximum value at relatively low values of topographic standard deviation and varies strongly with position in the swath. When applied at global scale, the calibrated model shows that layover causes expected height uncertainty to increase by only a modest amount (from 9.4 to 10.4 cm at the 68th percentile). The 68th percentile of the slope uncertainty increases more significantly, from 10 to 17 mm/km. Nonetheless, the 68th percentile discharge uncertainty increases only marginally. We find that the impact of layover on SWOT river discharge is expected to be small in most environments.

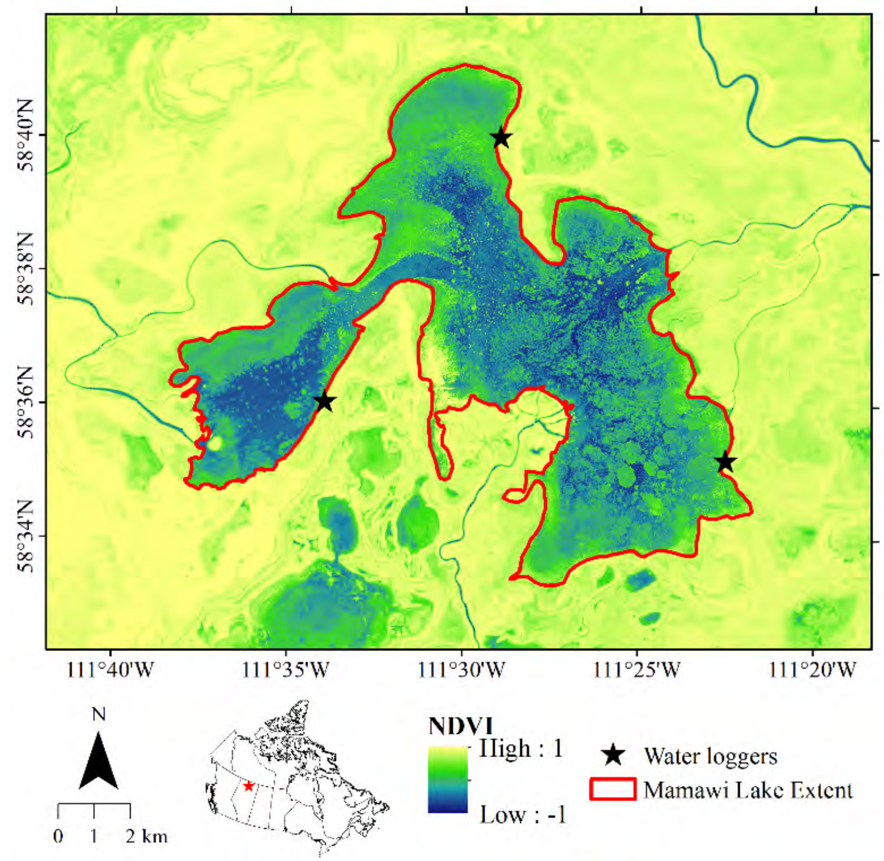
SWOT : Les enjeux

Comment la présence de végétation va affecter le signal SWOT ?

Projet de doctorat de Nicolas Desrochers



Végétation aquatique   Végétation riveraine



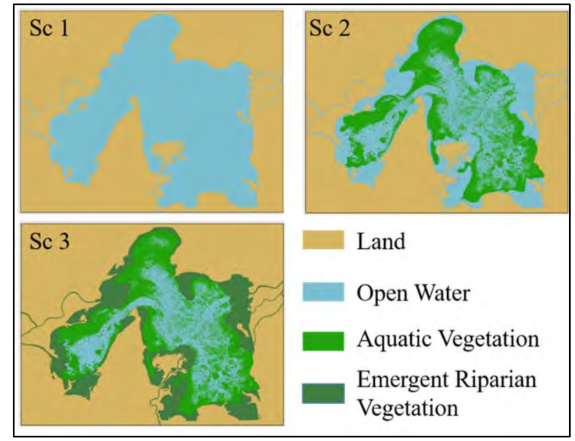
SWOT : Les enjeux

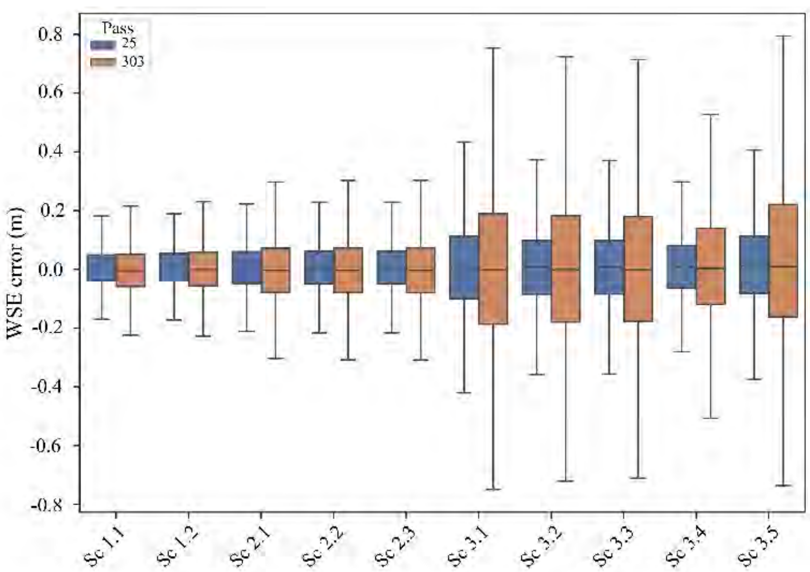
Comment la présence de végétation va affecter le signal SWOT ?

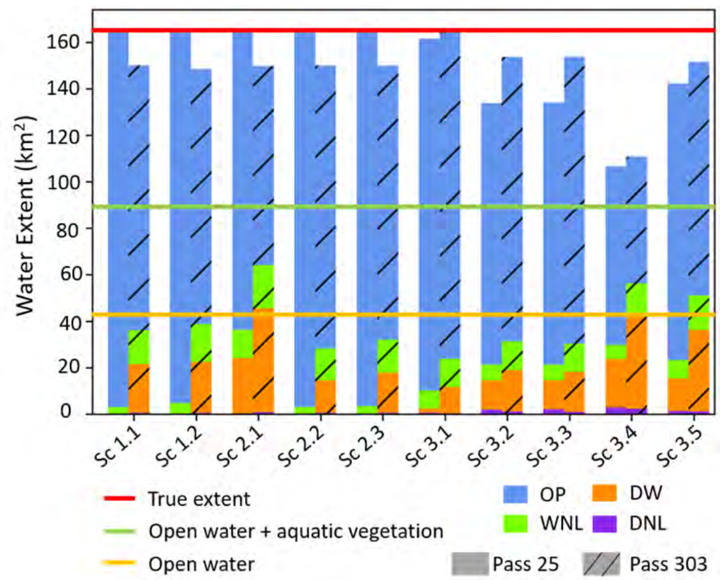
	Open Water	Aquatic vegetation	Riparian Vegetation	Wetland
Sc 1.1	10	N/A	N/A	-5
Sc 1.2	9.11	N/A	N/A	3.03
Sc 2.1	10	5	10	-5
Sc 2.2	9.11	8.52	9.11	-5
Sc 2.3	9.11	6.32	9.11	-5
Sc 3.1	9.11	8.52	5.21	-5
Sc 3.2	9.11	8.52	4.33	-5
Sc 3.3	9.11	9.11	4.33	-5
Sc 3.4	9.11	8.52	4.33	3.03
Sc 3.5	9.11	8.52	5.21	3.03

Without vegetation
Aquatic vegetation only
Aquatic and ripirian vegetation

All values are in dB*





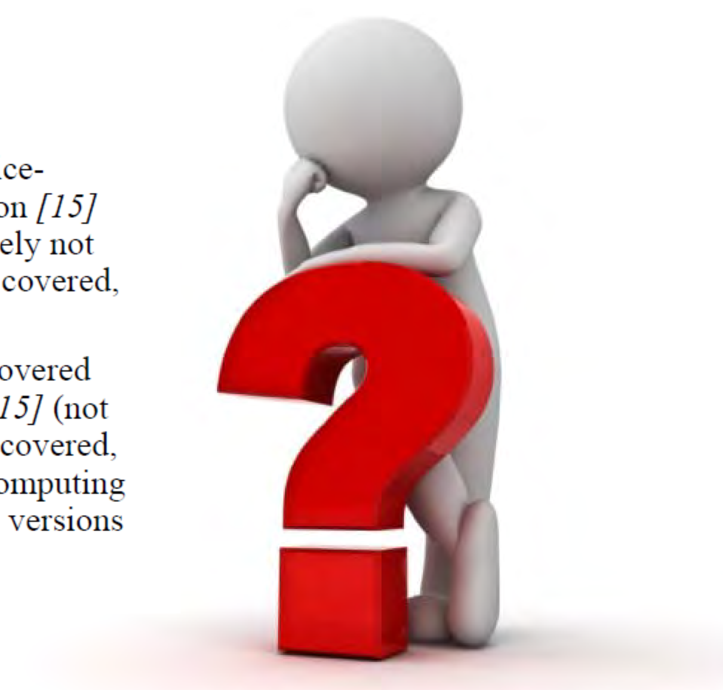


SWOT : Les enjeux

Comment la présence de glace va affecter le signal SWOT ?

Deux flags accompagneront les produits vectorisés

- *ice_clim_f* (Basic): Climatological ice cover flag indicating whether the reach is ice-covered on the day of the observation based on external climatological information *[15]* (not the SWOT measurement). Values of 0, 1, and 2 indicate that the reach is likely not ice covered, may or may not be partially or fully ice covered, and likely fully ice covered, respectively.
- *ice_dyn_f* (Basic): Dynamic ice cover flag indicating whether the surface is ice-covered on the day of the observation based on analysis of external optical satellite data *[15]* (not the SWOT measurement). Values of 0, 1, and 2 indicate that the reach is not ice covered, partially ice covered, and fully ice covered, respectively. Due to the latency of computing the dynamic ice flag, this value may be completely null filled in some processing versions of the data product. When available, *ice_dyn_f* is likely to be more reliable than *ice_clim_f* given that is is based on optical observations.



SWOT : Les enjeux

Comment la présence de glace va affecter le signal SWOT ?

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SWOT and the ice-covered polar oceans: An exploratory analysis

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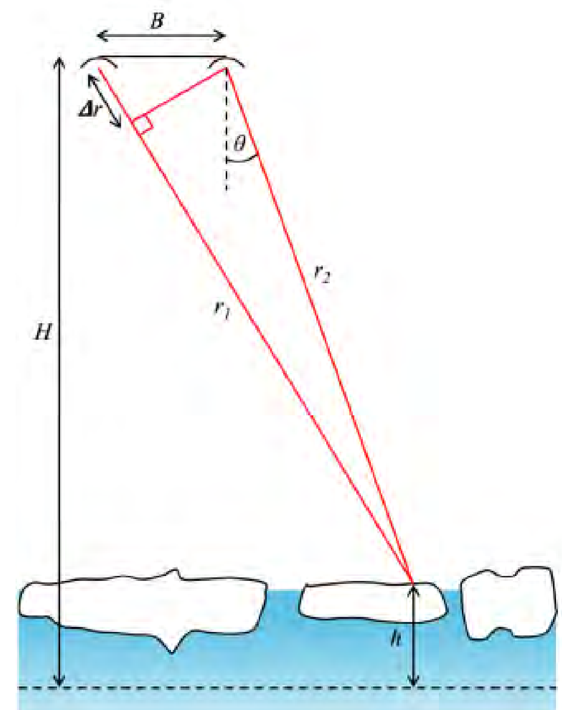
Abstract

The Surface Water Ocean Topography mission (SWOT), scheduled for launch in 2021, is the first space-borne radar interferometer capable of providing wide-swath height maps of water surfaces with centimetric precision. In addition to its primary objectives in oceanography and hydrography, the SWOT instrument offers opportunities for other applications. Here, we explore the feasibility of sea ice freeboard and sea surface height retrievals in the ice-covered oceans from SWOT data. The quality of SWOT height estimates depends on the backscatter strength and number of samples used for multi-looking. We use near-nadir radar backscatter estimates from sea ice and water over the range of SWOT incidence angles to simulate SWOT height maps and assess the retrieval precision under different backscatter, surface type and roughness conditions. Unlike wind-roughened open water, the available observations suggest that backscatter over sea ice has a moderate dependence on look angle (specularity), and the backscatter of younger, flatter sea ice has a greater degree of specularity than older, more deformed and colder sea ice. To achieve a similar freeboard precision to conventional altimeters (~3 cm) requires averaging over 15–40 km^2 in the near- to mid-swath and 90–175 km^2 in the far-swath for lower northern latitudes (<65°N), and 9–18 km^2 in the near- to mid-swath and 30–50 km^2 in the far-swath over Southern hemisphere ice. Compared to a typical altimeter grid cell used for time and area averages (~25 km × 25 km or 625 km^2), this represents an improvement in resolution of 3–70 fold between the near- and far-swath. Overall, the results suggest that SWOT has the potential to provide unique new insights in the high-latitude oceans by providing two-dimensional maps of sea ice thickness and dynamic ocean topography at higher resolution, in both space and time, than has previously been possible.



SWOT : Applications

SWOT Early Adpopters

https://swot.jpl.nasa.gov/applications/early-adopters/

SWOT : Applications en hydrologie

How accurate will SWOT estimate reservoir storage change ?

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Water Resources Research

RESEARCH ARTICLE
10.1029/2018WR023743

Key Points:
- SWOT mission can monitor most of Mekong's reservoirs
- Prediction of storage change and outflow are accurate
- One year of observation is sufficient to derive area-elevation relationship of reservoirs with SWOT

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Assessing the Potential of the Surface Water and Ocean Topography Mission for Reservoir Monitoring in the Mekong River Basin

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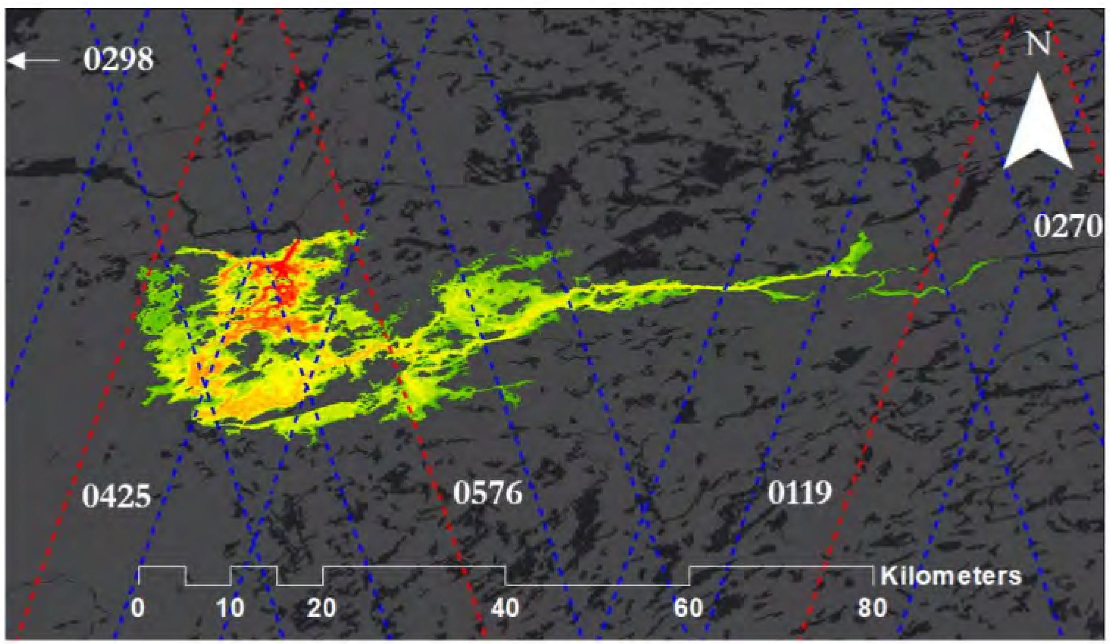
Abstract The planned Surface Water and Ocean Topography (SWOT) mission, scheduled to launch in 2021, is designed to significantly improve on current lake and reservoir remote monitoring capacity. These improvements are especially important for the Mekong River Basin (MRB), where rapid dam construction puts downstream food security at risk and upstream dam operations are largely unknown to downstream water managers due to lack of upstream hydrologic information. This study aims to answer: *How accurately will SWOT estimate reservoir storage change in the MRB?* A physically based simulation tool developed by NASA Jet Propulsion Laboratory to mimic SWOT-like observations of water bodies was applied to 20 reservoirs in the MRB and for 17 of those reservoirs, synthetic SWOT-based storage change estimates demonstrated high skill, with errors typically less than 8%. The remaining three reservoirs showed higher errors due to complex neighboring topography or long narrow reservoir shape. In comparison with current satellite observations of six reservoirs in the MRB, the synthetic SWOT observations showed between 4% and 10% lower storage change normalized root-mean-square error. Finally, the simulated elevation and surface area was successfully used to estimate the area-elevation relationships for each reservoir, with a median percent difference of 6.9%. These relationships are a potential avenue for multisensor cooperation toward improved understanding of reservoir dynamics. Such cooperation, where observations from many difference remote sensors are synthesized to provide a more complete view of human interactions on the river system, is vital for the MRB as more dams as human influence over the system increases.

SWOT : Applications en hydrologie

Détermination de la plus-value de la télédétection pour le suivi des niveaux d'eau et du bilan hydrique : Application au réservoir Eastmain-1

Mémoire de maîtrise de Sébastien Langlois



SWOT : Applications en hydrologie

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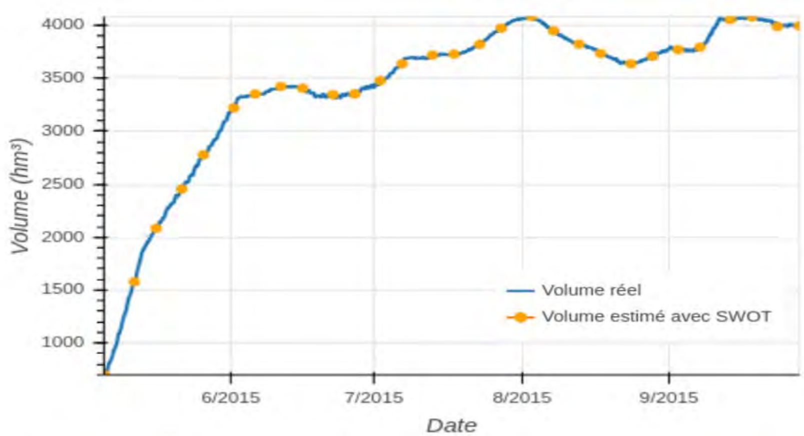


Figure 4-13 Volume d’eau réel (calculé par Hydro-Québec) et estimé par les images SWOT synthétiques prédites sur l’ensemble du réservoir Eastmain-1

4-15 Apports calculés à partir des images SWOT et du bilan hydrique réalisé par Hydro-Québec

SWOT : Applications en hydrologie

Quelle serait la valeur ajoutée du futur satellite SWOT dans l'amélioration des bilans hydriques des lacs et des réservoirs, en utilisant le **modèle WRF-Hydro** pour différentes conditions hydrométéorologiques ?

Projet de maîtrise de Zeineb Belhadj

Étape 1: Mise en œuvre du modèle hydrologique WRF-Hydro sur le bassin versant Eastmain-1

Étape 2: l'intégration des données du simulateur CNES SWOT au modèle WRF-Hydro

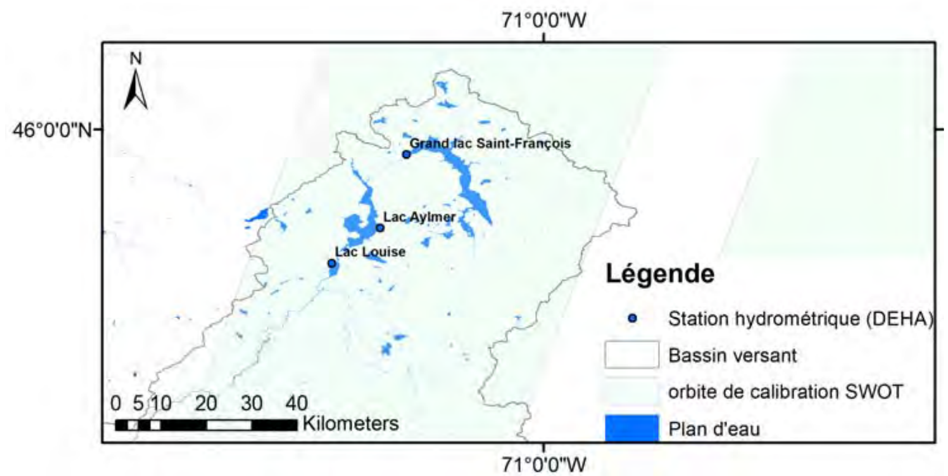
Résultat : étude comparative pour distinguer la valeur ajoutée des données du simulateur CNES SWOT

SWOT : Applications en hydrologie

Quelle est la plus-value des produits lacs SWOT pour la modélisation hydrologique ?

Projet de doctorat de Toumia Ghribi

- Mise en œuvre du modèle HYDROTEL en incluant les petits lacs
- Générer les produits SWOT à l'aide d'un simulateur (https://github.com/CNES/swot-hydrology-toolbox)
- Explorer différentes approches de paramétrage des lacs



$$\frac{dV}{dt} = A\frac{dh}{dt} = Q_{entrant} - Q_{sortant} \quad \text{(Équation 1)}$$

$$Q_{sortant} = Ch^k \quad \text{(Équation 2)}$$

où V est le volume du lac, A sa superficie, h la hauteur d'eau, C et k sont des paramètres dépendant de la forme de la section de sortie

SWOT : Applications en hydrologie

Calage des modèles hydrologiques

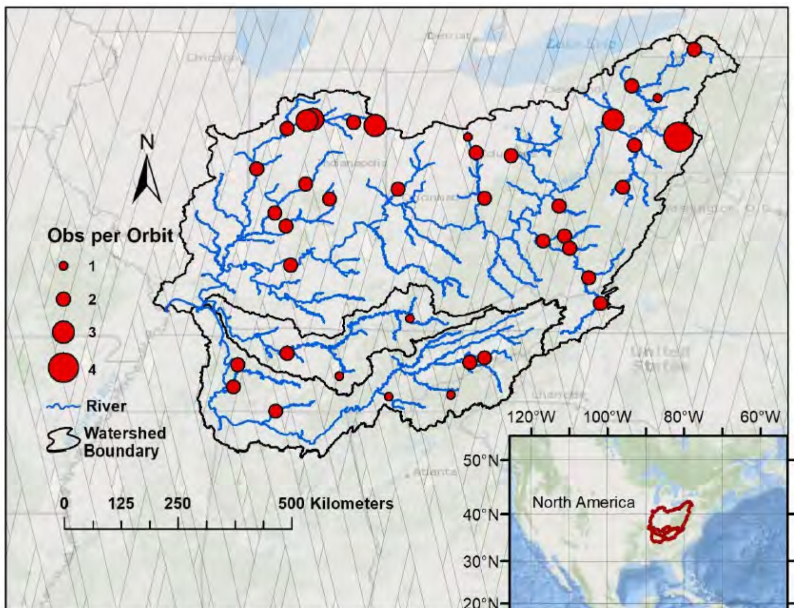


Figure 1. The 39 US Geological Survey (USGS) gauges used for calibration in the Ohio River basin, a 525,300 km^2 watershed, showing streams greater than 90 m wide and Surface Water and Ocean Topography (SWOT) swaths. The differing gauge sizes indicate the number of days SWOT will obtain measurements at each site per 21-day orbit cycle.

remote sensing

MDPI

Article

The Applicability of SWOT's Non-Uniform Space–Time Sampling in Hydrologic Model Calibration

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check for updates

Abstract: The Surface Water and Ocean Topography (SWOT) satellite mission, expected to launch in 2022, will enable near global river discharge estimation from surface water extents and elevations. However, SWOT's orbit specifications provide non-uniform space–time sampling. Previous studies have demonstrated that SWOT's unique spatiotemporal sampling has a minimal impact on derived discharge frequency distributions, baseflow magnitudes, and annual discharge characteristics. In this study, we aim to extend the analysis of SWOT's added value in the context of hydrologic model calibration. We calibrate a hydrologic model using previously derived synthetic SWOT discharges across 39 gauges in the Ohio River Basin. Three discharge timeseries are used for calibration: daily observations, SWOT temporally sampled, and SWOT temporally sampled including estimated uncertainty. Using 10,000 model iterations to explore predefined parameter ranges, each discharge timeseries results in similar optimal model parameters. We find that the annual mean and peak flow values at each gauge location from the optimal parameter sets derived from each discharge timeseries differ by less than 10% percent on average. Our findings suggest that hydrologic models calibrated using discharges derived from SWOT's non-uniform space–time sampling are likely to achieve results similar to those based on calibrating with in situ daily observations.

SWOT : Applications en hydrologie

Assimilation de données

Journal of Hydrology 590 (2020) 125473

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Research papers

Assimilation of future SWOT-based river elevations, surface extent observations and discharge estimations into uncertain global hydrological models

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Keywords:
Continental Modeling
Global hydrological model
Data assimilation
Observing System Simulation Experiment
Surface Water and Ocean Topography

A B S T R A C T

Global estimates of river dynamics are needed in order to manage water resources, mainly in developing countries where in-situ observation is limited. Remote sensors such as nadir altimeters can complement ground data. Current altimeters miss however a large number of continental surface water bodies. This issue will be largely resolved by the future Surface Water and Ocean Topography (SWOT) mission, thanks to its wide swath altimeter. SWOT will provide almost globally two-dimensional water elevation maps for rivers over 100 m wide and water bodies over 250 m × 250 m. During this research, we investigated the potential of SWOT to correct hydrological models on a global/continental scale, through data assimilation. For this purpose, an Observing System Simulation Experiment (OSSE), also known as "twin experiment", has been implemented. Model forcings and parameters were perturbed to jointly achieve global hydrological models (GHMs) uncertainties, which is the expected scenario in which the SWOT community will mainly evaluate the future SWOT data. SWOT-like observations of water surface elevation (WSE), flooded water extent (FWE), and/or SWOT derived discharge (Q) were used to correct modelled Q, WSE and FWE from a large-scale hydrological and hydrodynamic model (MGB – portuguese acronym of "Modelo de Grandes Bacias"), using a Ensemble Kalman filter (EnKF). The results indicate that SWOT products could largely improve hydrological simulations on a global and continental scale. SWOT-like discharge can reduce ~40% of model errors in daily discharge. Furthermore, when anomalies of the WSE DA approach were implemented, the error reduction was even greater for all state variables compared to the absolute WSE DA, achieving average error reduction values of about ~30% compared to ~24%. Finally, the simultaneous DA of all the SWOT-like variables together reduces errors from ~14% to ~22% compared to the average of assimilating only one variable.

SWOT : Applications en hydraulique

frontiers in Earth Science

ORIGINAL RESEARCH
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Anticipated Improvements to River Surface Elevation Profiles From the Surface Water and Ocean Topography Mission

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Existing publicly available digital elevation models (DEMs) provide global-scale data but are often not precise enough for studying processes that depend on small-scale topographic features in rivers. For example, slope breaks and knickpoints in rivers can be important in understanding tectonic processes, and riffle-pool structures are important drivers of riverine ecology. More precise data (e.g., lidar) are available in some areas, but their spatial extent limits large-scale research. The upcoming Surface Water and Ocean Topography (SWOT) satellite mission is planned to launch in 2021 and will provide measurements of elevation and inundation extent of surface waters between 78° north and south latitude on average twice every 21 days. We present a novel noise reduction method for multitemporal river water surface elevation (WSE) profiles from SWOT that combines a truncated singular value decomposition and a slope-constrained least-squares estimator. We use simulated SWOT data of 85–145 km sections of the Po, Sacramento, and Tanana Rivers to show that 3–12 months of simulated SWOT data can produce elevation profiles with mean absolute errors (MAEs) of 5.38–12.55 cm at 100–200 m along-stream resolution. MAEs can be reduced further to 4–11 cm by averaging all observations. The average profiles have errors much lower than existing DEMs, allowing new advances in riverine research globally. We consider two case studies in geomorphology and ecology that highlight the scientific value of the more accurate in-river DEMs expected from SWOT. Simulated SWOT elevation profiles for the Po reveal convexities in the river longitudinal profile that are spatially coincident with the upward projection of blind thrust faults that are buried beneath the Po Plain at the northern termination of the Apennine Mountains. Meanwhile, simulated SWOT data for the Sacramento River reveals locally steep sections of the river profile that represent important habitat for benthic invertebrates at a spatial scale previously unrecognizable in large-scale DEMs presently available for this river.

Keywords: SWOT simulator, DEM, river water surface elevation, elevation profile smoothing, satellite altimetry

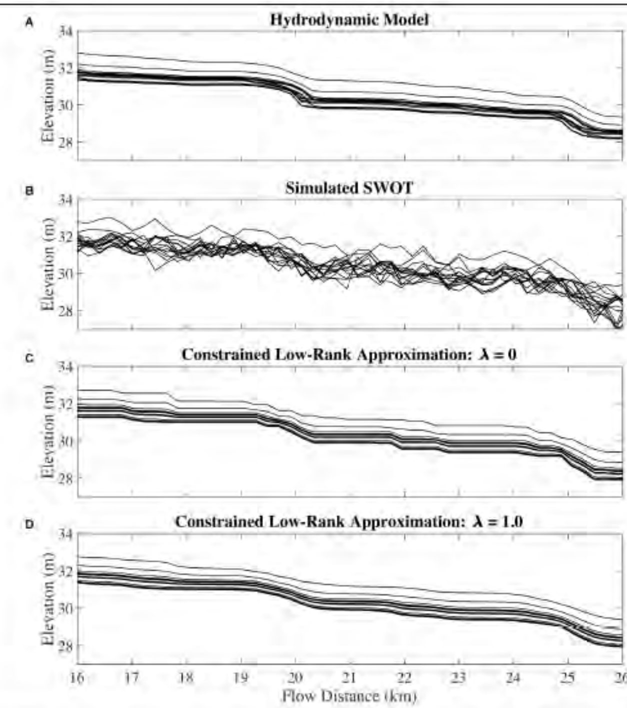


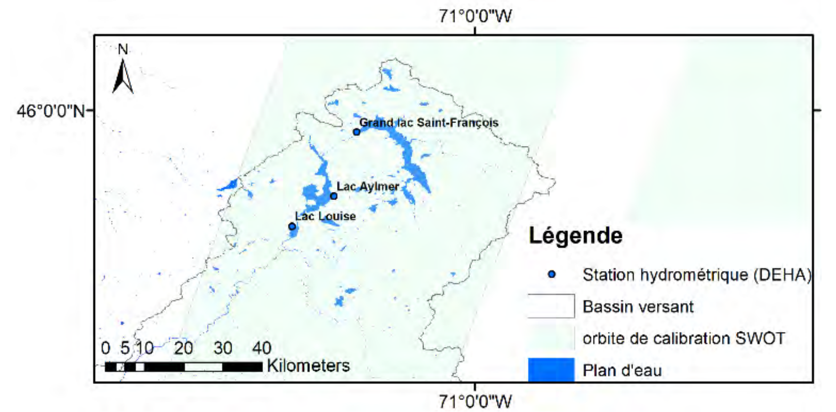
FIGURE 4 | Profile view of a 10 km section of the Sacramento River **(A)** before and **(B)** after the simulator noise is added, and **(C,D)** after the CLRA method is applied. One eigenvector is used in this section.

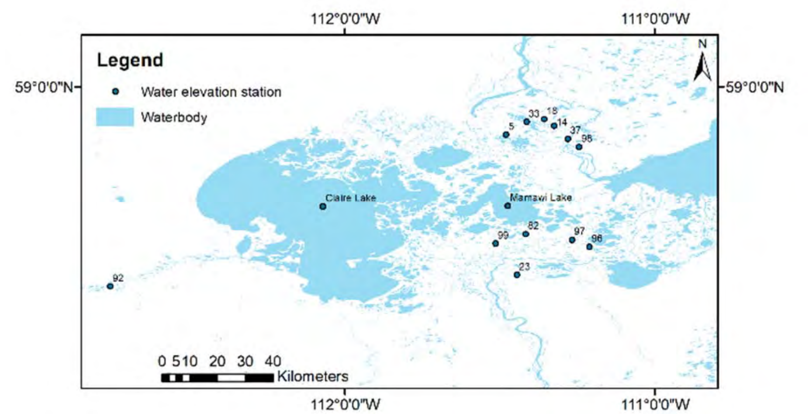
SWOT : Applications en hydraulique

Quelle est la plus-value des produits lacs SWOT pour la modélisation hydrodynamique ?

Objectifs :

1) Analyser les erreurs des produits SWOT pour différents lacs (forme, taille, orientation)
2) Participer à l'effort de calibration du satellite SWOT
3) Développer un produit combiné SWOT-RSO;
4) Intégrer les données SWOT et RSO dans des modèles hydrodynamiques (LISFLOOD et HEC-RAS).





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