A first assessment of swath processing for inland water

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serco cryosat → ESA'S ICE MISSION

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→ Introduction

With an along-track resolution of around 300 m, the **ESA's CryoSat-2 (CS2)** mission brought along a whole new range of monitoring possibilities of inland water bodies. SAR altimetry enabled the study of rivers and lakes that were not visible with conventional LRM altimeters. However, none or only a single observation is available for small inland water bodies. Over some selected targets, CS2 operates **SARIn mode**, using both the antennas on board. In this work, we investigate the potential of **swath processing** SARIn waveforms over three river sections: Mackenzie (Canada), Athabasca (Canada), and Amazon. We look at the number of valid water level estimates (WLE) retrieved compared with nadir altimetry and their precision by comparison with in-situ hydrometric data. The results presented in this work are also relevant for the future Copernicus Polar Ice and Snow Topography Altimeter mission (**CRISTAL**), which will also fly an interferometric altimeter.

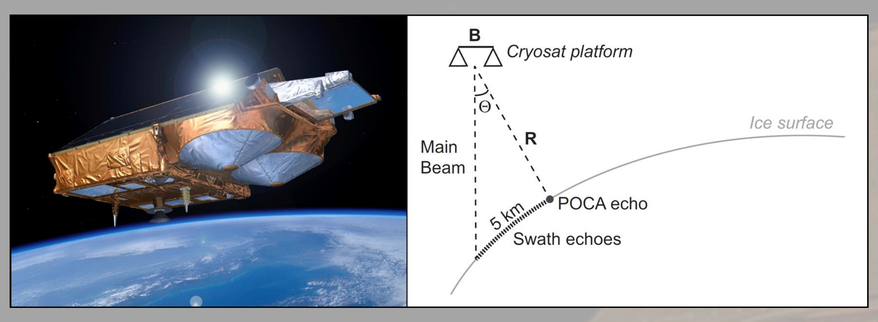
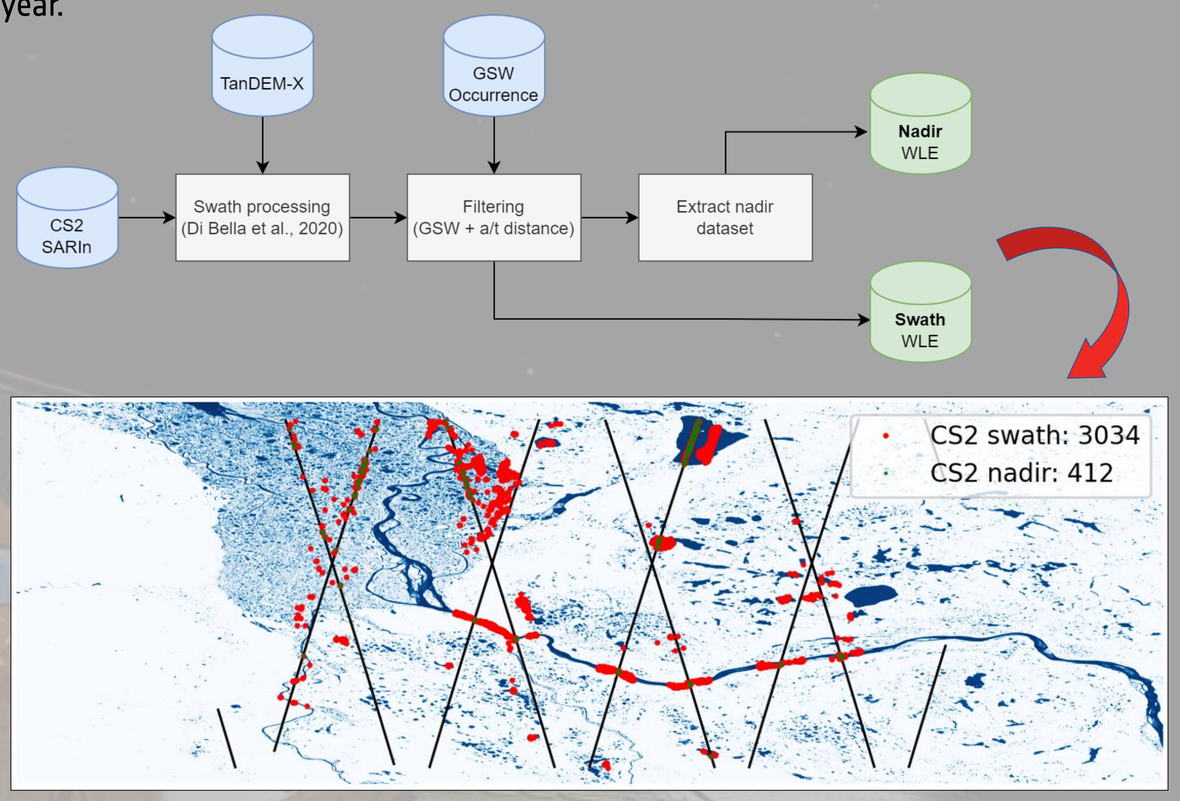


Figure 1. *The CryoSat satellite, seen from below (left). The phase difference measured by the 2 antennas is used to determine the across-track location of the echoes on the Earth's surface and to retrieve elevation across the satellite ground track beyond the point of closest approach (POCA). In the figure to the right, B is the interferometric baseline, R is the slant range, and Θ is the look angle (image credits: Gourmelen et al., 2018).*

→ Data & Processing

Processing diagram (top) and example of WLE retrieved using regular **nadir** (green) and **swath** (red) altimetry (bottom) over a section of the Mackenzie river. CryoSat tracks are shown in black. During Jan 2018, we obtain more than **8 times the amount of WLE from swath** (~3000) compared to nadir processing (~400). The map on the background show the pixel-wise GSW water occurrence (Pekel et al., 2016) with blue (white) representing areas covered by water during 100% (0%) of the year.



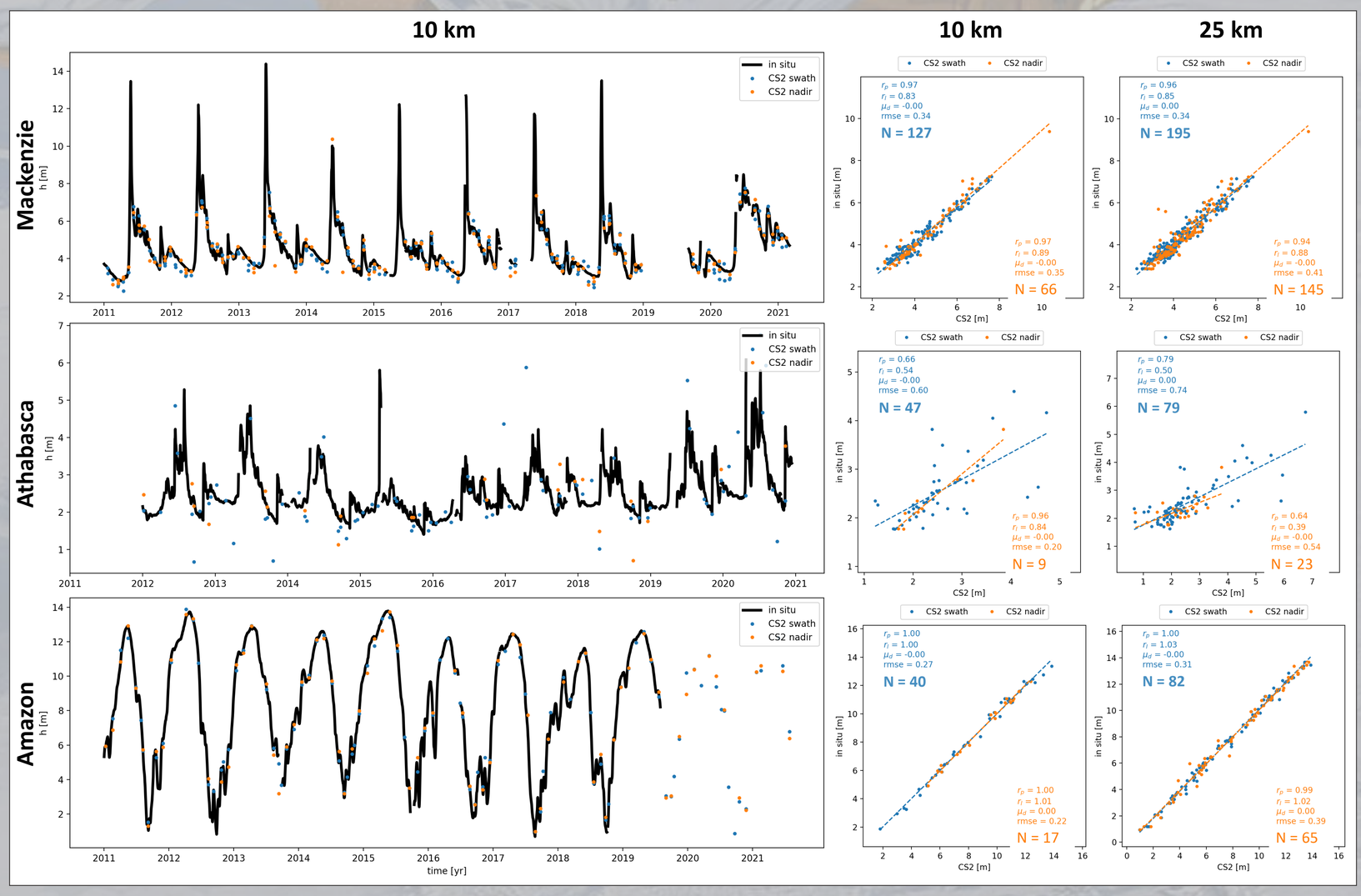
→ In situ analysis

➢Study areas

We compare CS2 WLE with in situ measurements from sections of the Mackenzie and Athabasca rivers in Canada, and of the Amazon river. The blue lines are the rivers centerline and the red triangles the location of the **Mackenzie Arctic Red River** (10LC014), the **Athabasca Below Fort McMurray** (07DA001) and **Amazon Tabatinga** (10100000) in situ stations (background image credits: Google).

➢Time series comparison

We compare **daily WLE time series from CS2 with in situ measurements**. Left column shows the CS2 time series overlapped to the in situ data; central column shows scatter plots of the CS2 time series computed from elevations within 10 km from the stations vs in situ WLE and the associated statistics (**correlation coeff. (r_p), linear regression coeff. (r_l), root mean square error (rmse), number of measurements (N)**); right column shows the same scatter plots based on CS2 measurements within 25 km from the station. CS2 elevations within the main river stem are projected to its centerline and the slope along the river is removed using a Digital Elevation Model (DEM) created by averaging ICESat-2 (IS2) measurements.



→ Summary& conclusions

- Applied experimental **swath processing** algorithm to CS2 SARIn L1B data over 3 rivers
- Swath processing provides **significantly more WLE** with **precision comparable** to traditional nadir processing: **further investigation** needed over Athabasca and **lakes**
- Swath processing enables time series analysis at **higher spatial and temporal resolution** than with nadir retracked data, and could be **beneficial for river discharge modelling**
- Great potential to be further investigated in vision of the launch of **CRISTAL** which could offer dedicated swath products for some inland water targets (in addition to other exciting **thematic products**)!

→ References

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