Potential applications for highly resolved shorelines: a cross-validation approach with radar altimetry

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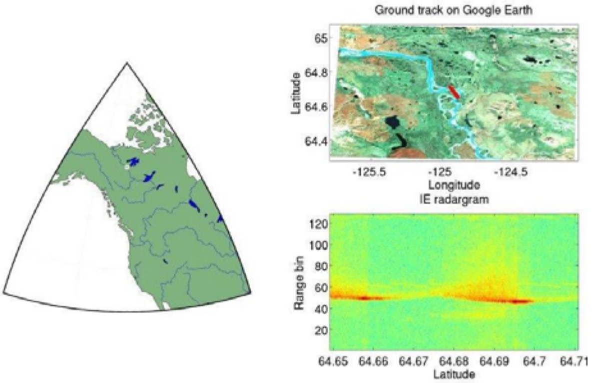
Motivations

Rivers are challenging targets for satellite remote sensing. Most of them are narrow in width and shallow in depth. There is a growing interest in monitoring river water levels and bathymetry. Generally, river levels derived from satellite radar altimetry represent an incoherent average of values calculated for a large number of echo reflected back. However, if the footprint touches the shoreline the reflected echo may be contaminated with some effect on the average. Concerning bathymetry, there is also the issue of accurately mapping shorelines. High resolution satellite imagery could be used, unfortunately their availability is expensive, not available everywhere and with poor temporal resolution. Instead, the 30 years long archive of Landsat images represents an asset. However, the native resolution of Landsat data is not accurate enough for most applications. The main idea in rivers is high resolution shoreline combined with high resolution altimetry. A subpixel method to accurately map land-water boundaries with the Landsat multi-spectral satellite was presented at EGU conference in April 2013. Here we propose the use of individual echoes (IEs) and the possibility of applying coherent processing for a better exploitation of satellite radar altimetry over rivers. Abileah et al. (2013) showed that there is sufficient pulse-to-pulse coherence for Doppler processing with Envisat IEs in open ocean and that some improvement in determining the water level can be achieved. In addition, it was supposed that coherent processing enables more efficient use of fewer pulses, which is the typical situation of narrow rivers.

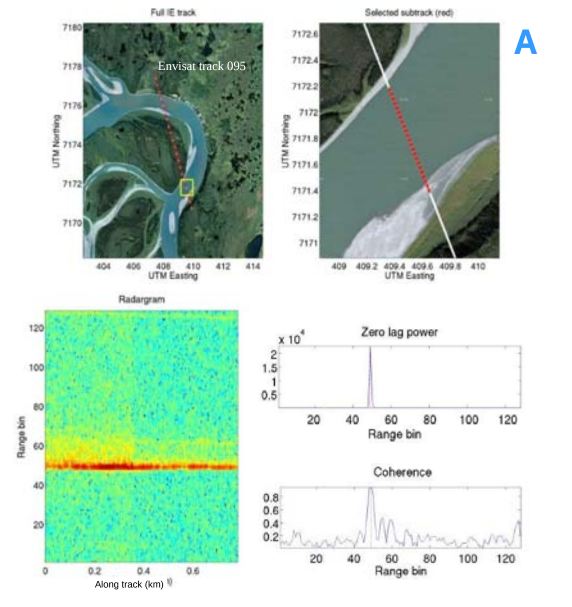
Area of investigation

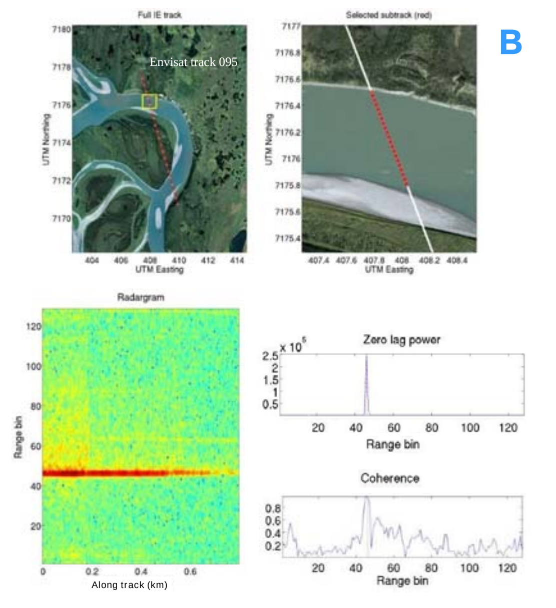
The Mackenzie River (Canada) is a perfect target because there is a double crossing of Envisat along the track. So the change in level between one and the next crossing can be measured. The figure on the right side shows the portion of the Envisat track selected for analysis, approximately centred on the two river crossings.



Results

The individual echoes data are selected for analysis, approximately centred on the two river crossings (panels **A** and **B**). There is a sampling of water levels over a long stretch of river at both places.
The IE power peaks very sharply at range bin 49 in one crossing (panel **A**) and around bin 46 in the other one (panel **B**). Also the coherence is high at same bins for both river crossings.





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Summary

The two crossings of the Mackenzie River highlight that waveforms are highly peaked at one range bin. This means that they can be treated as near specular echoes, which also implies virtually no land interference. Both examples show that specular returns provide very high coherence, enabling accurate ranging with one or a few pulses, hence the ability to measure water levels of very narrow water bodies and much less concern about land interference. Exploiting strong specular return is possible only with IEs. The usual integration of hundreds individual echoes will often smear out the small details. The next step will be to quantify the statistical significance of coherence and develop an algorithm for subpixel water level estimation.

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