# CryoSat-2 multiple waveform retracking over inland waters

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## A stable water surface

Altimetric waveforms over inland water show extreme variation due to the high number of different surfaces within the satellite footprint. One of the often encountered problems with radar altimetry is snagging, which is when we accidentally retrack a point that lies off nadir and get an incorrect height.

A lake level can be assumed to be constant, and therefore we can utilize what is seen in the surrounding waveforms.

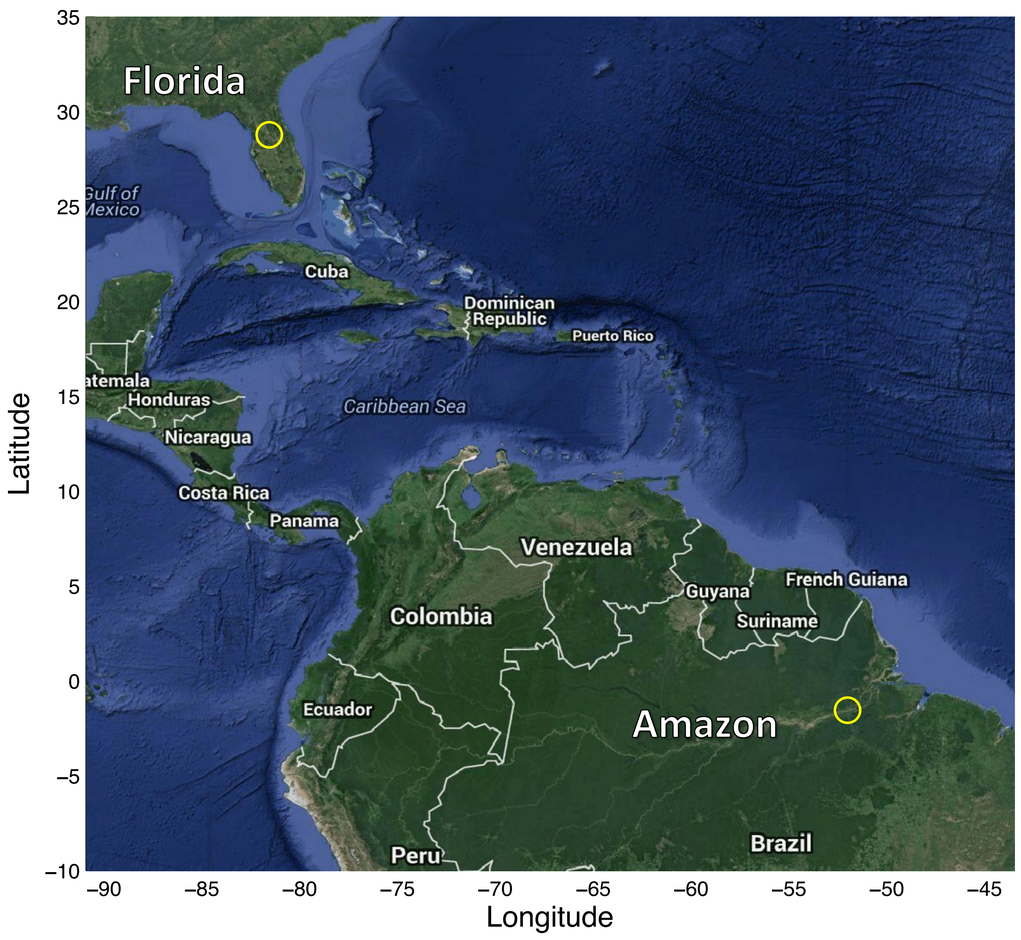
## Method description:

- For each track all the waveforms are *interpolated* with an FFT to get high resolution waveforms. This is done to avoid capped off peaks due to insufficient sampling. The resolution is increased with a factor of 8, which results in 1024 bins instead of 128.
- All waveforms are then *resampled* and extrapolated to a common reference sampling heights at 1 cm from the lowest to highest possible height within the track.
- Iterating through all waveforms each waveform is *stacked* with the surrounding four waveforms, while taking the corresponding range of each bin into account.
- The location of the *first peak* in the stacked waveform after a 20% threshold is noted.
- The closest peak in the original waveform is found and retracked using a threshold retracker.

## Conclusions

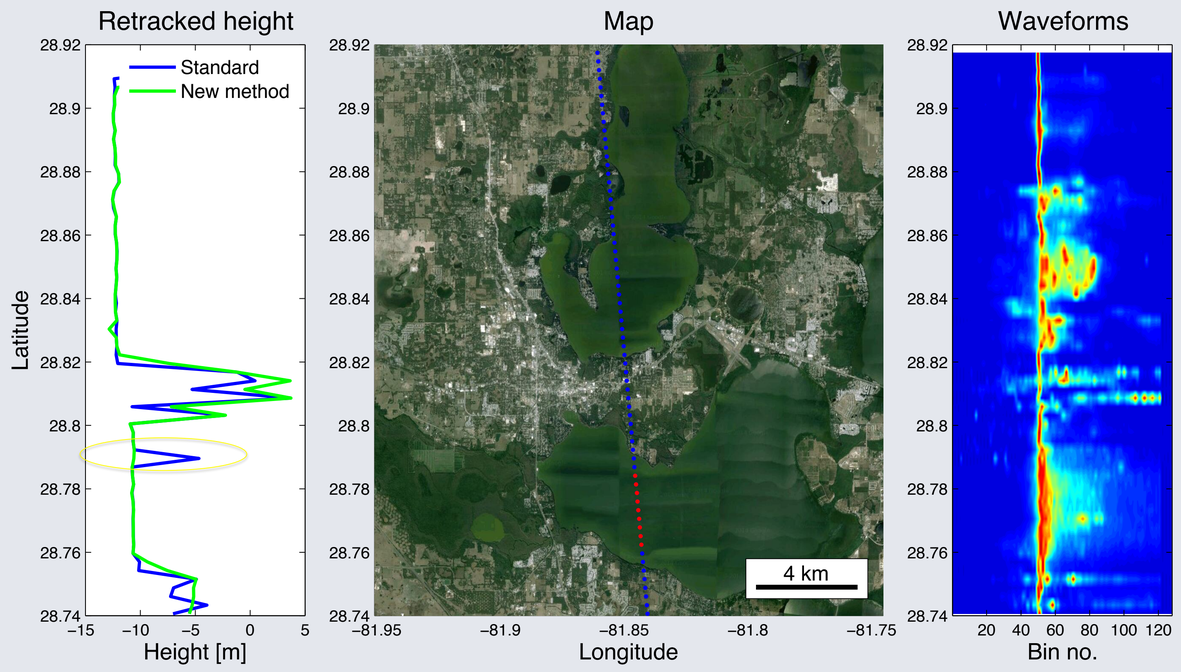
By stacking the waveforms while taking the range window into account we can determine the peak in the waveform which is most likely to represent the water surface at nadir.

As seen in the examples below, severe snagging can be avoided, which is hard to achieve by simply adjusting the standard retracking method.



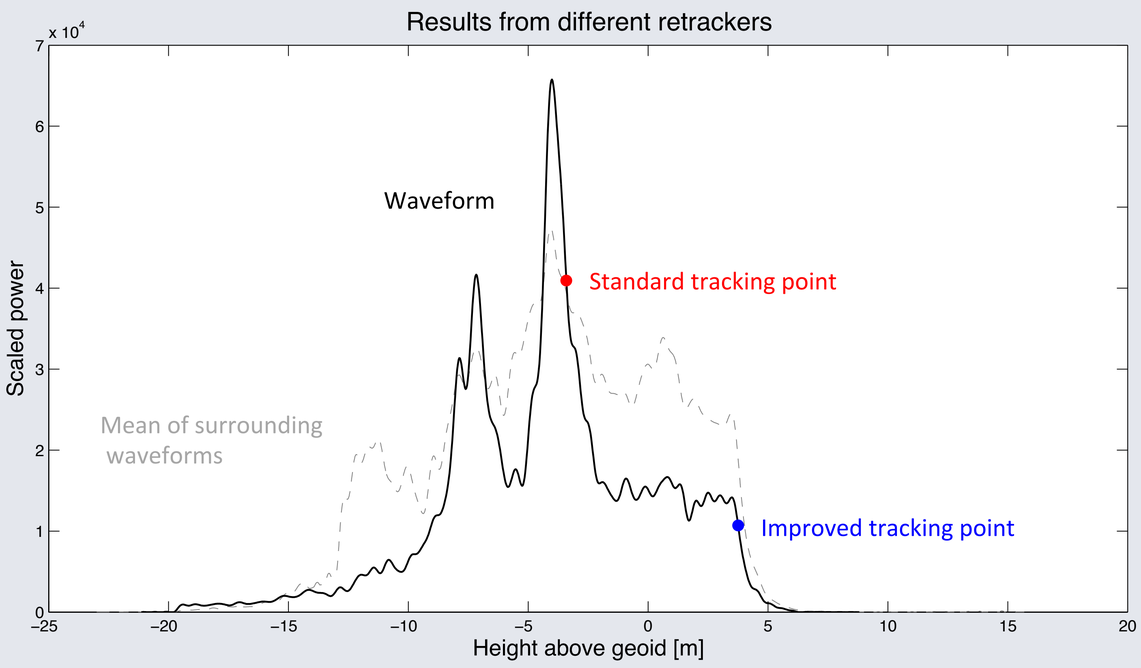

## Example: Florida

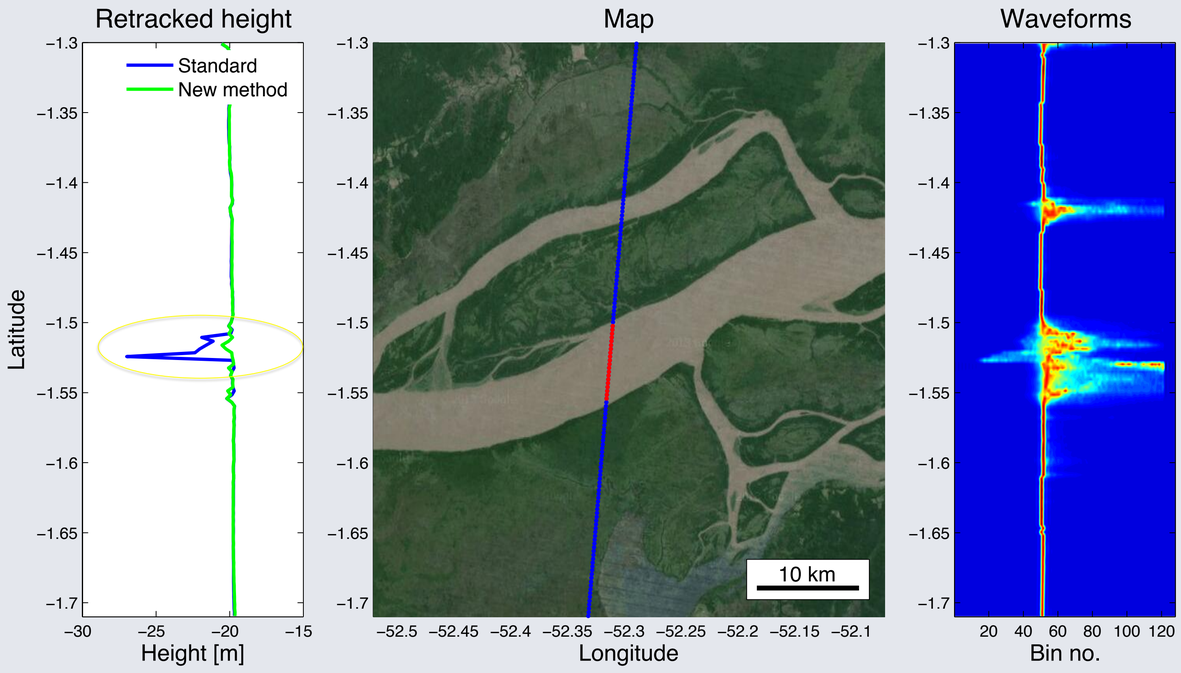
As the water level should be constant in the lake, the retracked height within the yellow circle must be snagging due to topography. The standard method refers to a 80% primary peak threshold retracker.




## Example: Amazon

Snagging from a specular tributary is removed by looking at the stacked waveform to find the peak that corresponds to the main river level.

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**References**

**CryoSat-2:** Wingham et al. (2006). CryoSat: A mission to determine the fluctuations in Earths land and marine ice fields.

**Primary peak retracker**: Jain et al. (2014). Sea surface height determination In The Arctic using Cryosat-2 SAR data from primary peak empirical retrackers.