Sentinel-3 Land STM: New Hydrology Thematic Products performances over Inland Waters

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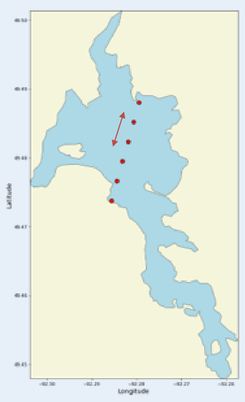
To further improve the performances of the Sentinel-3 Altimetry LAND products, ESA and the Sentinel-3 Mission Performance Cluster (MPC) recently developed specialized delay-Doppler and Level-2 processing chains over (1) Inland Waters, (2) Sea-Ice, and (3) Land Ice areas. The objective is to provide new dedicated “thematic products” to the users for the three surfaces mentioned. Over hydrology the T-IPF will including new algorithms, in particular the hamming window and the zero-padding processing.
In this poster, the MPC Hydrology ESLs (Expert Support Laboratories) provide a first performance assessment of the Hydrology thematic products and comparisons with the previous PDGS products. The analyses include comparisons with InSitu datasets, benefiting from the contribution of the St3TART project, and provide an estimate of the Water Surface Height accuracy. Inter satellite comparisons are also in the scope of the studies and Water Surface Height estimates consistency in between Sentinel-3 and ICESat-2 will complement this analyses. From now on, the Sentinel-3 Land Thematic Products will independently evolve, to better meet and fulfil the requirements from the Copernicus Services and the scientific Hydrology community. A Full Mission Reprocessing is planned early 2023, to produce fully homogeneous S3A and S3B Hydrology thematic datasets.

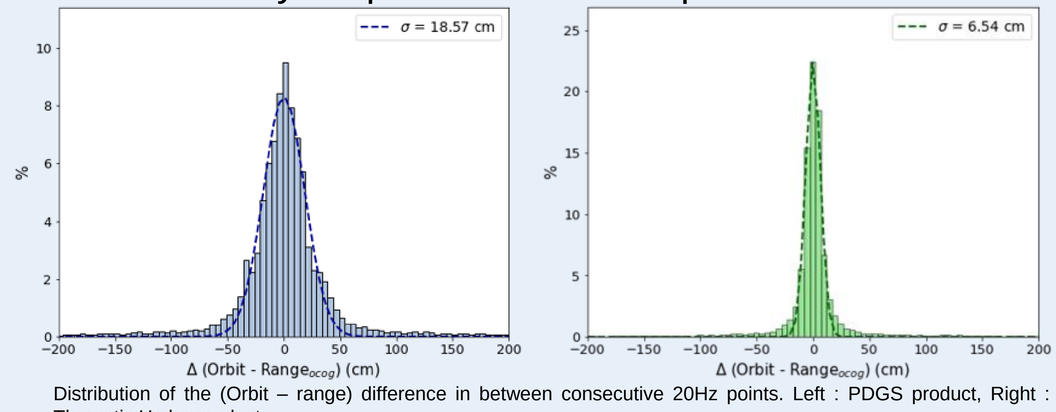
Assessment of the benefits of 0-padding over one cycle reprocessed with the thematic Hydro products and comparison with current PDGS products

Retracking noise estimate

The metric used is (Orbit – range) difference in between consecutive points:
(Orbit – Range)n - (Orbit - Range)n+1 = Δ(Orbit - Range)
Over lakes to avoid slope issues, small to be representative of peaky waveforms (OCOG retracking)

⇒ 0-padding processing improves epoch estimation for steep leading edges, the retracking noise decreases from 18.5cm (PDGS) to 6.5cm (Thematic Hydro) over small lakes.

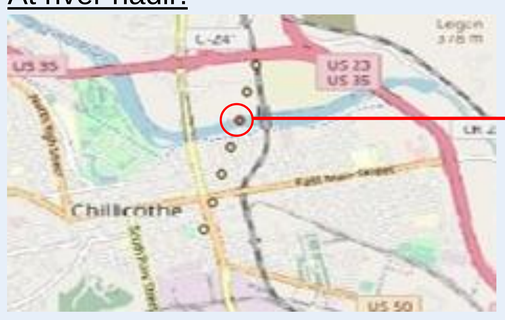


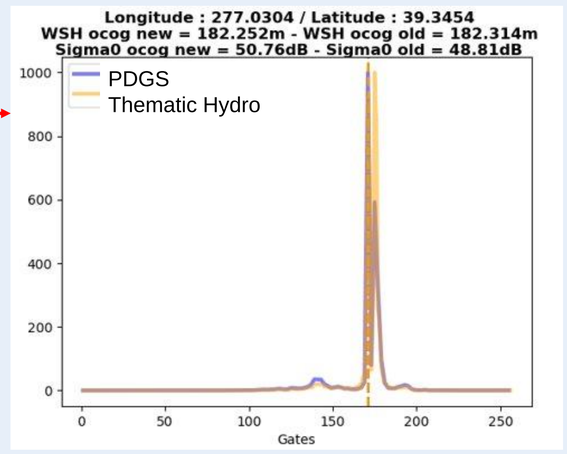


Distribution of the (Orbit – range) difference in between consecutive 20Hz points. Left : PDGS product, Right : Thematic Hydro product

Assessment of the benefits of Hamming processing in the thematic Hydro products and comparison with current PDGS products

At river nadir:

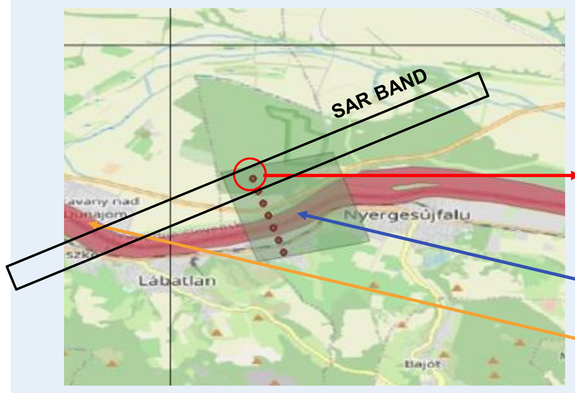


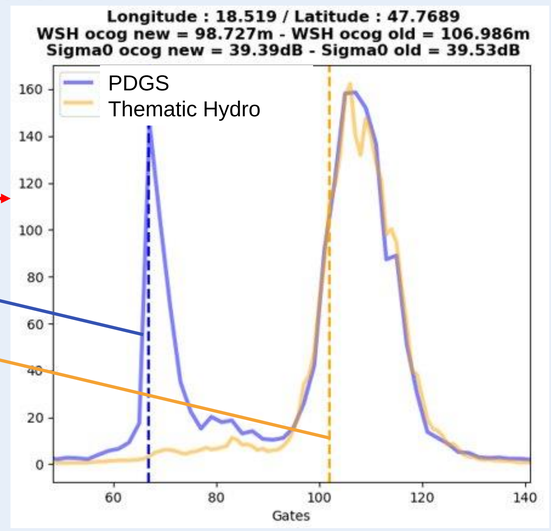


⇒ Sigma0 consistency and retracking of the same leading edge

Waveforms of PDGS and Thematic Hydro products associated to the 20Hz point in the circle

Off-nadir configuration:
Differences in between epoch estimations





Waveforms of PDGS and Thematic Hydro product associated to the 20Hz point in the circle. PDGS product waveform presents two peaks. The first (blue arrow) is associated with the closest section of the river in the south, the second (orange arrow) is associated to signal from the 4km western off nadir meander.

As PDGS products do not use Hamming processing, the signal comes from secondary lobes outside of the SAR band. The first peak, corresponding to the river in the south is retracked in the PDGS product. The Thematic Hydro product, with Hamming processing, focuses the signal on the SAR band and measures the WSH 4km off nadir across track distance.

The epoch point may not have the same location in both products as Hamming filter focuses the along track footprint on the SAR band.

⇒ Across track signal emerges : other targets or other positions over river can be measured.

⇒ To be considered to adapt the processing in your downstream applications

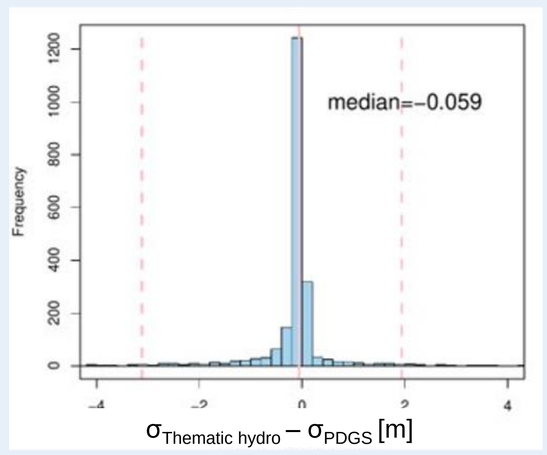
PDGS / Thematic Hydro products comparisons over lakes

Comparisons in the standard deviation of the data per transects were performed

- Over 2185 globally distributed lakes
- In between PDGS and Thematic Hydro products

⇒ The median of the differences of the standard deviation is ~6 cm smaller in the Hydro Thematic products.

⇒ This confirms that 0-padding improvement on range estimation results in Water Surface Height estimate improvement

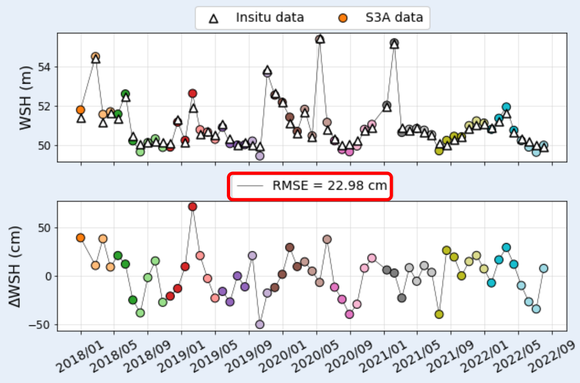


Distribution of the difference of the standard deviation of the measurements per lake transect in between the Hydro Thematic Data Products and the PDGS products.

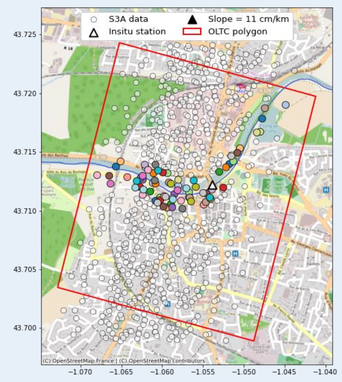
Insitu comparisons for accuracy analysis over French rivers

- InSitu data are re-referenced to same ellipsoid as altimetric data

⇒ Accuracy analysis can be performed



Top : Timeseries of water level derived from the PDGS products and comparison with InSitu
Bottom : Timeseries of the differences



- Over this favourable station (low river slope) RMSE is of 23cm.
- Will be performed on Hydro Thematic dataset as the reprocessing progresses
- Will benefits for FRM being defined in St3tart project

Upcoming evolutions in the Hydro Thematic products

The following evolutions are planned in 2023 in the Thematic Hydro products :

- Inclusion of Open Loop Tracking Command flag: to detail whether or not the OLTC used for each L2 data point is fine tuned or interpolated
- Water mask information based on Global Surface Water Explorer occurrence mask (versions regularly updated, article of reference is Pekel et al. 2016)
- Waveform classification

More comparisons to InSitu will be performed as the reprocessing progresses and based on the insights from St3TART project to quantify the error budget

Conclusions

- First analyses performed by the MPC Expert Support Laboratories (ESL) show that data quality of the Thematic Hydro products is improved compared to current PDGS products
- A Product Handbook is coming soon

Useful links

•The Sentinel-3 LAND Thematic products are already being generated routinely since August 2022, for S3A and S3B, as pilot products, NTC timeliness (*in parallel of the current operational LAND products*)
https://sentinels.copernicus.eu/fr/web/sentinel/-/copernicus-sentinel-3-stm-land-thematic-products-operationa-release-of-pilot-data-set/1.6

- These pilot products can be downloaded in the **Copernicus Data Hub:** ***https://scihub.copernicus.eu/***

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