

New upgrades of Open-Loop Tracking Command (OLTC) tables of nadir altimeters in 2020

Benefits for inland waters users

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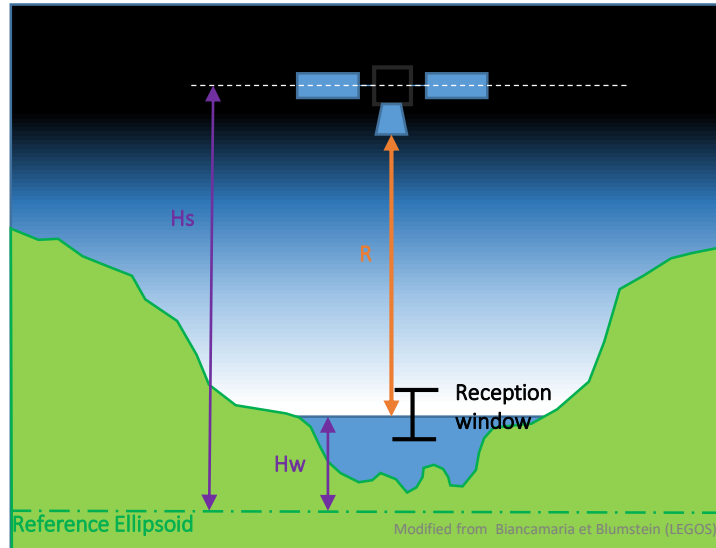
- Background on OLTC for inland waters
- OLTC upgrades 2020
- Validation results
- Conclusions

This presentation is an updated version of [Le Gac et al., OSTST2020](#)



- **Background on OLTC for inland waters**
- OLTC upgrades 2020
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• Principles of Altimetry over inland waters



R = Range distance between satellite and water surface

H_s = Altitude of satellite above ref. ellipsoid

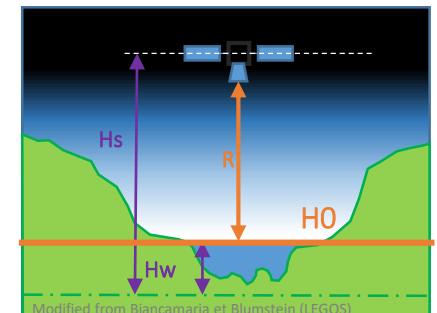
H_w = Altitude of water surface above ref. ellipsoid

Radar altimeters provide accurate **range** measurement between the instrument and the surface.

The range estimation **R** results from on-board operations (tracking) and on-ground post-processing (retracking) of the waveforms.

Waveforms are acquired in the altimeter **reception window**, which size is **60m by design**. Centering this window on a value close to the effective range is fundamental to receiving quality radar echos.

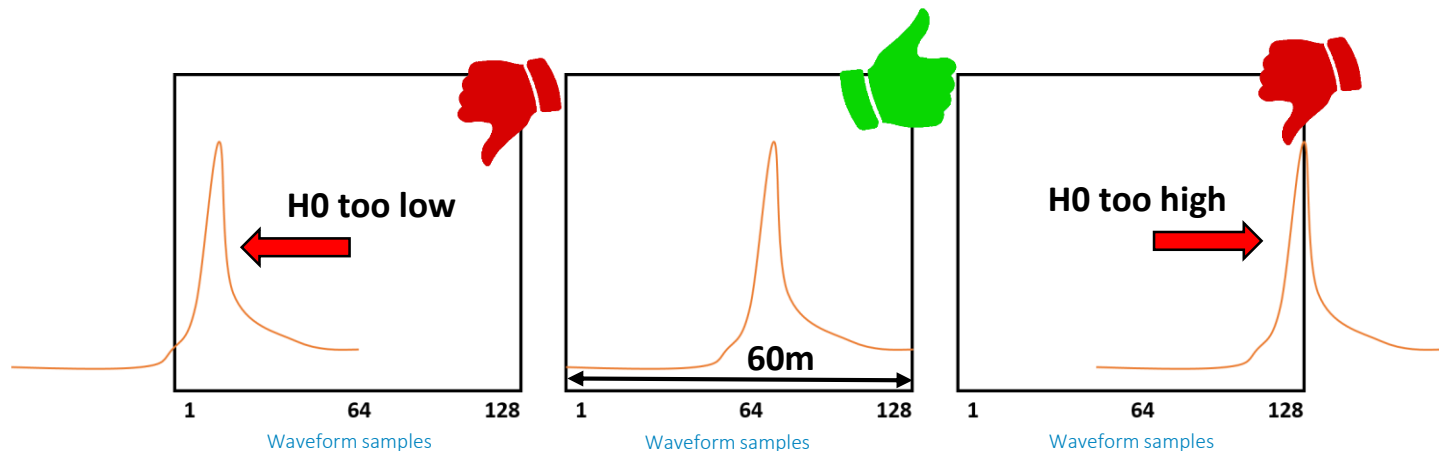
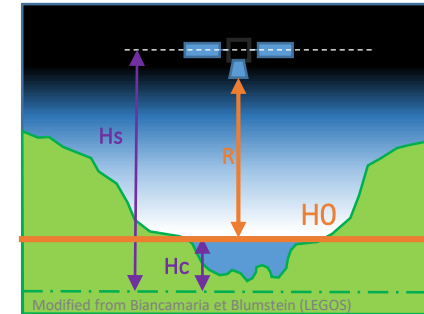
➔ OLTC Mode: Definition of an on-board *a priori* elevation (**command**) **H_0** to ensure a correct reception window centering over hydrological bodies. Key mode to acquire measurements in all terrain configurations. It greatly enhances the exploitability of the waveforms over land water.



• On-board elevations definition: OLTC tables

The succession of commands over hydro. bodies is stored as OLTC tables. Generating precise OLTC tables requires an **extensive database** of potential virtual stations:

- Hydrological targets located close (4km away maximum) to the satellite ground track (**nadir altimetry**)
- Define water body center **position and size** (along-track width)
- Define **averaged elevation command H0** at +/-10m to ensure a correct acquisition and the retracking process





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• **OLTC upgrades in 2020: context**

- Major upgrades of on-board OLTC tables of J3 and S3A&B in Spring-Summer 2020
- **OLTC content over ocean left unchanged** to ensure continuity
- **Strong densification of the virtual station network** to monitor a maximum number of hydrological targets from nadir altimeters

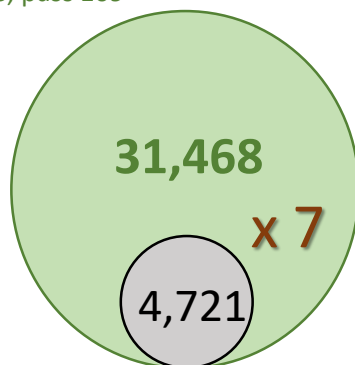
Organization

- LEGOS team and hydrology users define the targets to be included in OLTC tables
- NOVELTIS generates and validates the new OLTC on-board tables
- CNES coordinates the delivery of upgraded OLTC tables to the operational agency and reporting to the missions project teams
 - CNES/NOAA for Jason-3
 - S3MPC/Eumetsat and ESA for Sentinel-3
- NOVELTIS provides CNES with validation results (successful acquisition score – see next section)
- LEGOS scientists provide scientific validation in the frame of Volodia project (ESA/CNES project)
- All hydrology users are invited to dive into the new data !

- Total number of hydro targets**

Jason-3

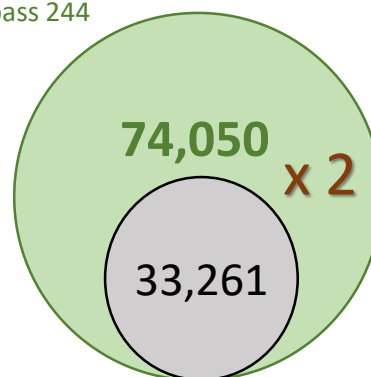
Sep. 3, 2020
cycle 168, pass 109



Aug. 31, 2017
cycle 57, pass 160

Sentinel-3A

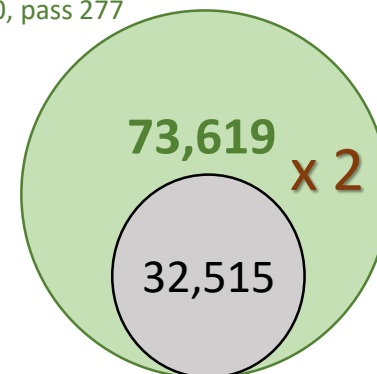
Aug. 27, 2020
cycle 62, pass 244



Mar. 19, 2019
cycle 42, pass 317

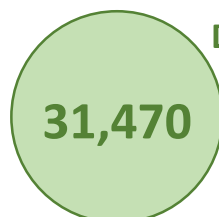
Sentinel-3B

Jun. 18, 2020
cycle 40, pass 277



Nov. 27, 2018
cycle 19, pass 219

Sentinel-6A



Dec. 17, 2020
cycle 4, pass 14

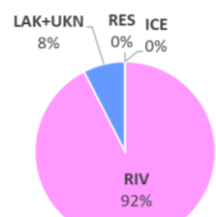
Same OLTC content as J3 to assess S6A performances over hydrological targets during commissioning phase

• Detailed numbers

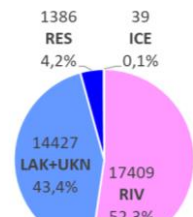
Mission	OLTC version	Date of activation	Cycle / Pass	Number of hydro targets (total)	Applicable geographical area
Jason-3	V3.0	August 31, 2017	cycle 57 pass 160	4,721	Global
Sentinel-3B	V2.0	November 27, 2018	cycle 19 pass 219	32,515	Latitudes inside $\pm 60^\circ$
Sentinel-3A	V5.0	March 19, 2019	cycle 42 pass 317	33,261	Latitudes inside $\pm 60^\circ$
Sentinel-3B	V3.0	June 18, 2020	cycle 40, pass 277	73,619	Global
Sentinel-3A	V6.0	August 27, 2020	cycle 62 pass 244	74,050	Global
Jason-3	V4.0	September 3, 2020	cycle 168 pass 109	31,470	Global
Sentinel-6A	V1.1	December 17, 2020	Cycle 4, pass 14	31,468	Global

Proportion of each type of hydro targets in the database before (*top*) and after (*bottom*) OLTC upgrade

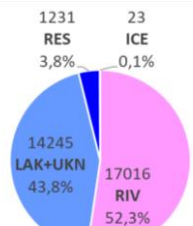
Colorcode: **Rivers**, **Lakes**, **Reservoirs**



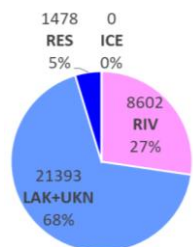
Jason-3 v3.0



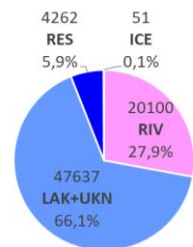
Sentinel-3A v5.0



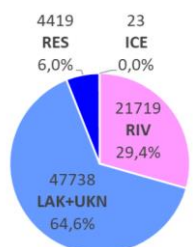
Sentinel-3B v2.0



Jason-3 v4.0



Sentinel-3A v6.0

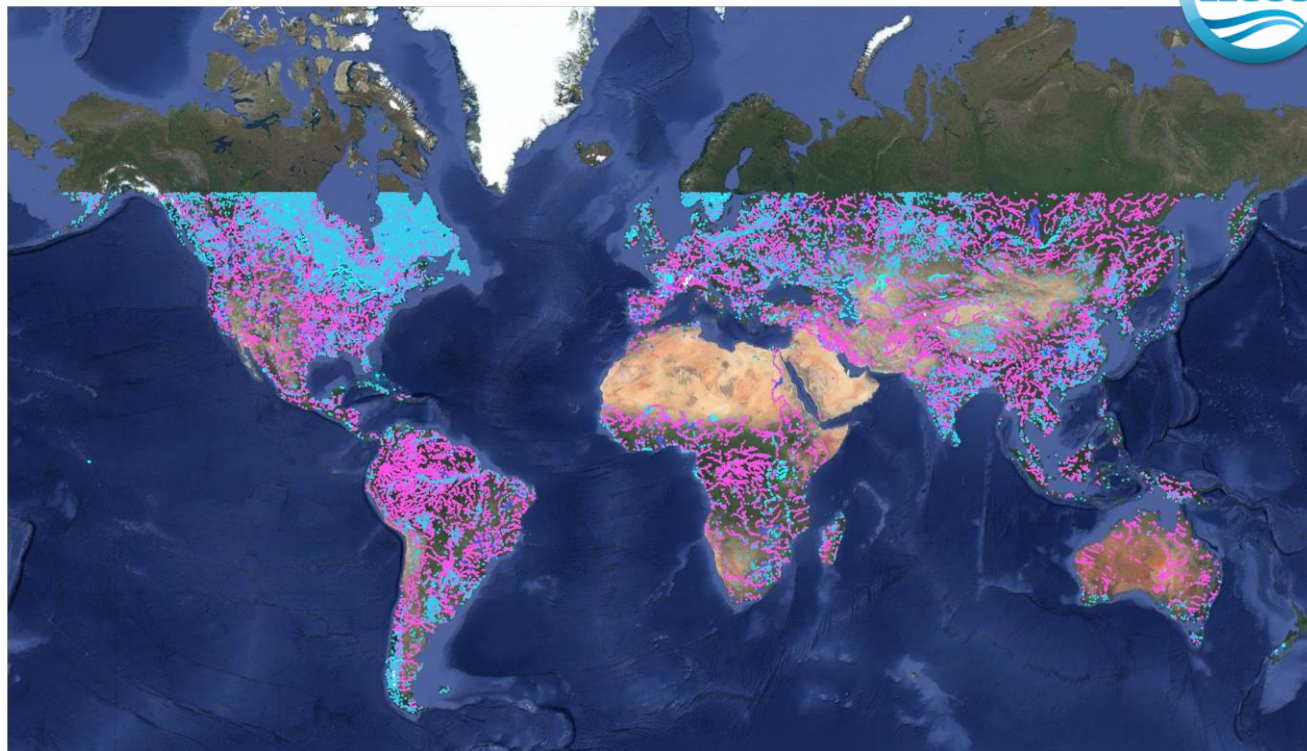


Sentinel-3B v3.0

- Maps of targets

*Global coverage of
hydro targets defined
in S3 OLTC tables*

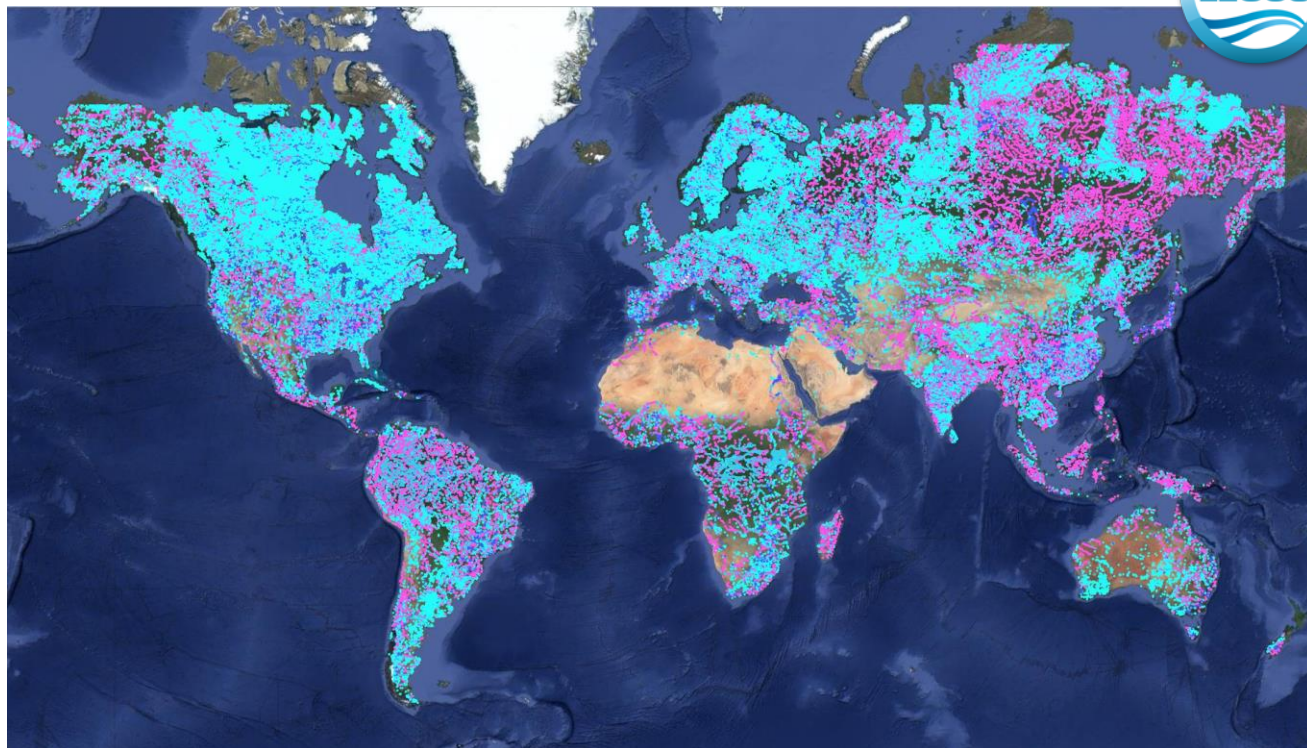
S3A + S3B
Before



- **Maps of targets**

*Global coverage of
hydro targets defined
in S3 OLTC tables*

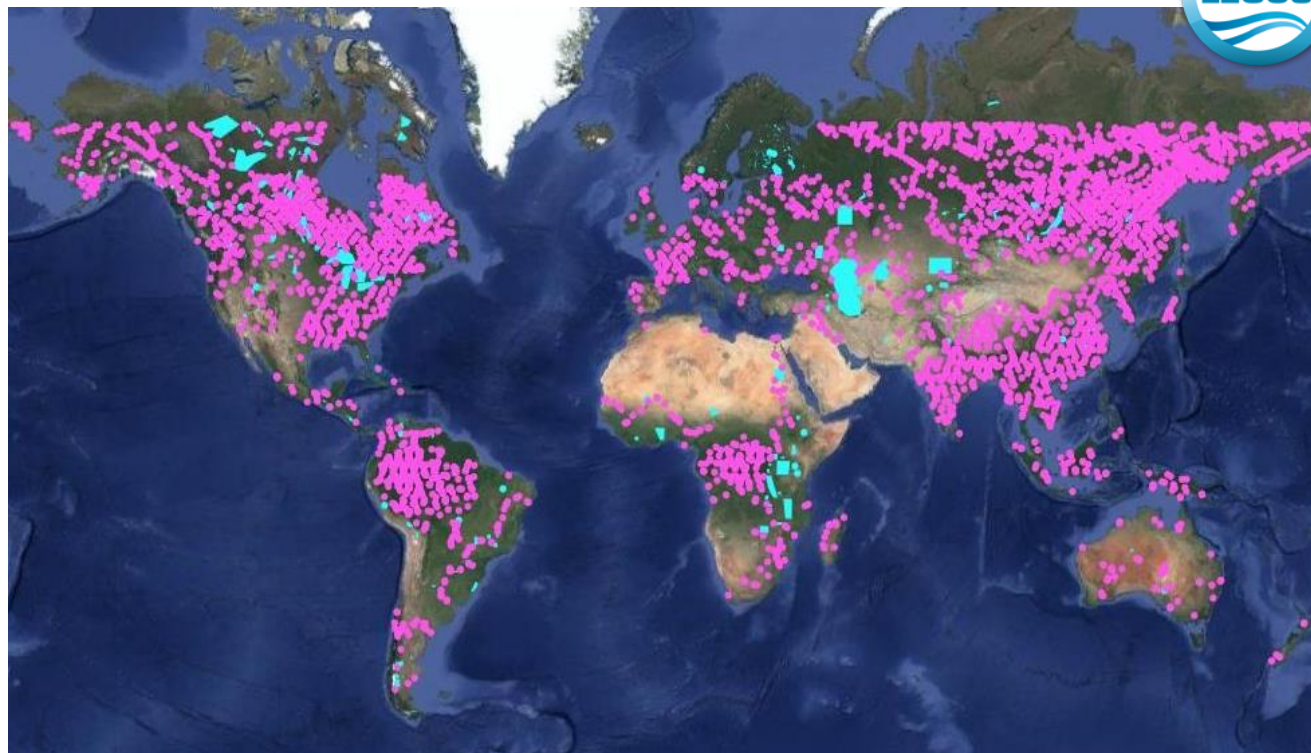
S3A + S3B
New!



- Maps of targets

*Global coverage of
hydro targets defined
in J3 OLTC tables*

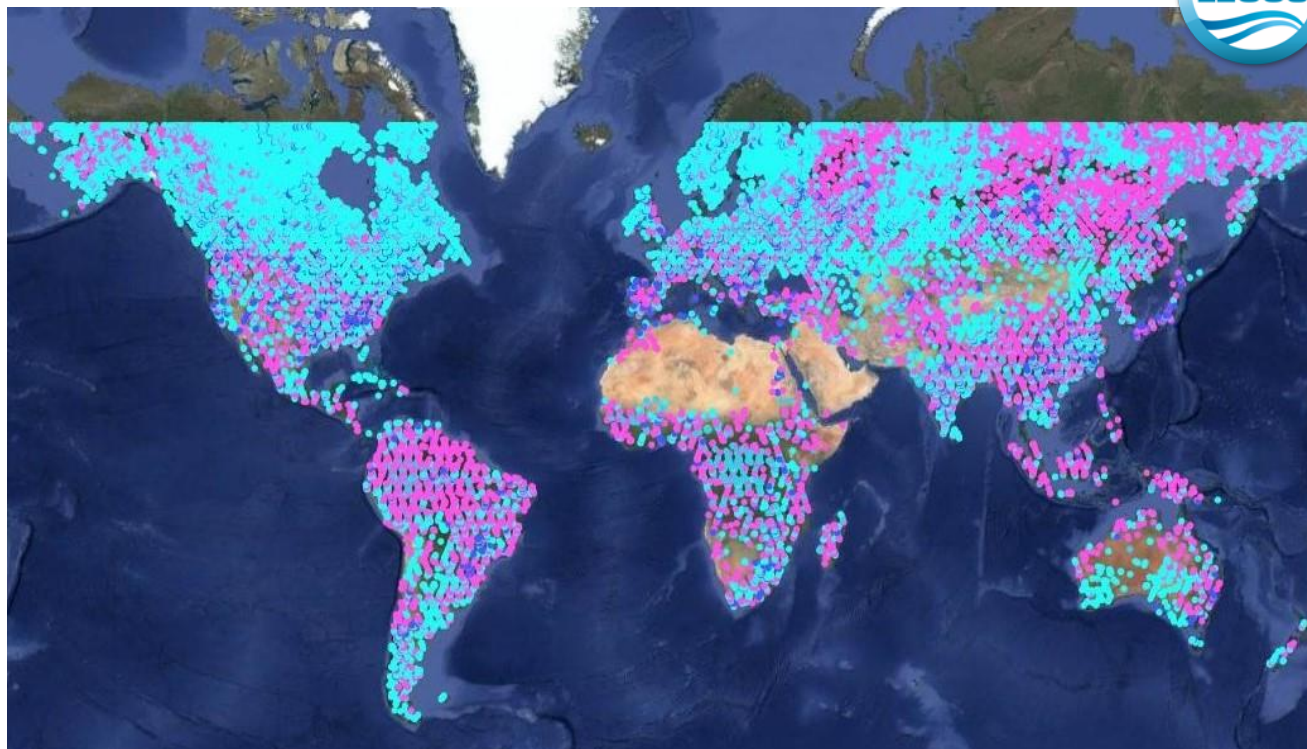
Jason-3
Before



- **Maps of targets**

*Global coverage of
hydro targets defined
in J3 OLTC tables*

Jason-3
New!



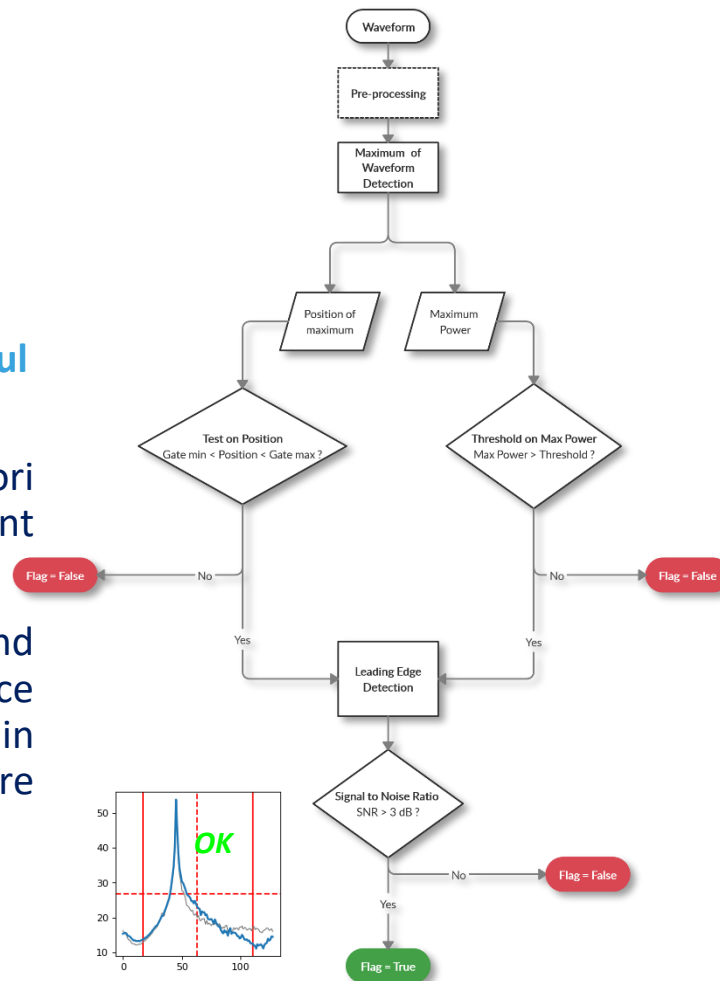


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• 2021 validation results

- First validation is performed through a **performance indicator** (Presence Flag or PF)
- **This indicator is based on the 20 Hz waveforms analysis** (position of the maximum, leading edge detection, signal to noise ratio)
- **Performance indicator** → global **rate of successful acquisitions**
- **OK** indicates that the OLTC elevation a priori information is correctly defined and a relevant WSH can be retrieved
- **NOK** indicates that the OLTC elevation command needs to be adjusted, or that the observed surface is complex with several water bodies or covered in ice, or that the altimeter was not able to acquire signal (calibration, platform manoeuvre,...)

More details in
Le Gac et al.
ASR 2019



• 2021 OLTC validation results

PF computed on target centers (20Hz measure point closest to theoretical target center defined in the database)

Warning : A filter on the targets is applied

Results based on analysis of all hydrology targets located :

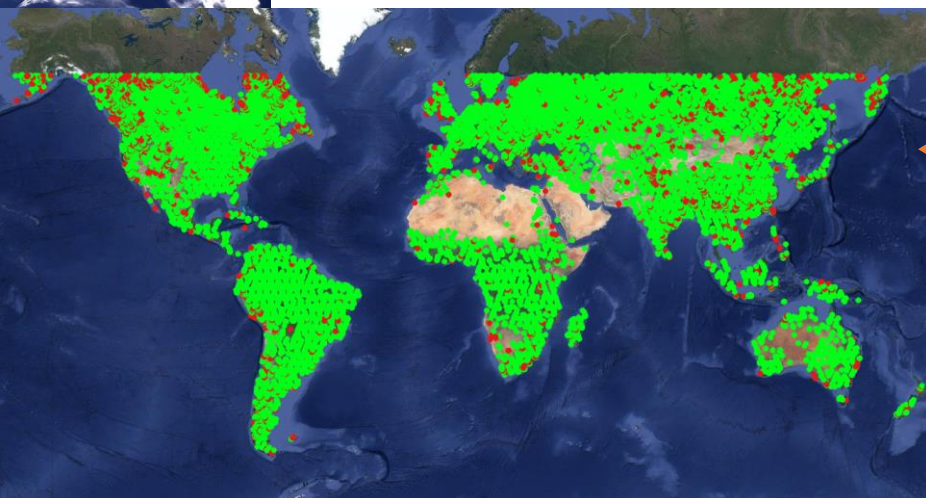
- below 60°N

Global	Jason-3 Cycle 190	S-3A Cycle 70	S-3B Cycle 50
All hydro	88,4 %	79,0 %	76,7 %



Results by target type	Jason-3 Cycle 169	S-3A Cycle 63	S-3B Cycle 41
Lakes	86,0 %	76,5 %	73,6 %
Reservoirs	86,7 %	76,3 %	75,8 %
Rivers	93,7 %	86,3 %	83,9 %

- **Very satisfactory overall acquisition performance**
- Jason-3 scores better than S3
- Overall success rate usually lower during Northern Hemisphere Winter months. This is caused by the ice coverage at high latitudes where many lakes are located



• 2021 OLTC validation results

Warning : A filter on the targets is applied

Results based on analysis of all hydrology targets located :

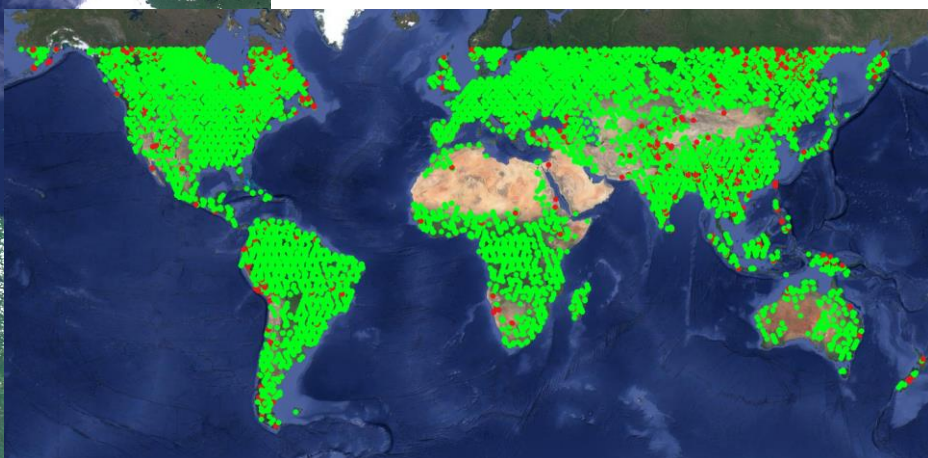
- below 60°N
- Nadir of the theo. ground track

Global	Jason-3 Cycle 190	S-3A Cycle 70	S-3B Cycle 50
All hydro	93,0 %	87,6 %	85,9 %



Results by target type	Jason-3 Cycle 169	S-3A Cycle 63	S-3B Cycle 41
Lakes	92,2 %	90,6 %	89,3 %
Reservoirs	92,0 %	82,7 %	82,2 %
Rivers	93,7 %	86,3 %	83,9 %

- **When limiting the analysis to nadir targets, the overall performance reaches better scores for all three missions**
- All river targets in the DB are defined at nadir. This explains the better acquisition score over this type of hydro. body in the last slide.
- **NB: Sentinel-6 is still in the commissioning phase. First validation results show an excellent agreement with Jason-3**





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- **Open-Loop tracking mode is key to inland waters observation**
 1. Onboard OLTC tables are used to **set the echo reception window**
 2. A **database of inland water targets** is used to generate OLTC tables over land
 3. Targets are defined with **elevation H0** and **width** of the water body (lake, reservoir, river)
- **All nadir altimeters OLTC tables have been upgraded in 2020**
 1. No changes over ocean and coastal zones
 2. More than 70,000 targets (x2) on S3A&B
 3. More than 30,000 targets (x7) on J3
 4. S6A holds the same content as J3 for validation during Tandem phase
- **Validation results show excellent performance of these upgrades**
 1. Performance evaluated thanks to waveform shape and centering analysis
 2. Global performance is very satisfactory for all three missions
 3. Acquisition failures are analyzed and affected targets will be updated in 2021



- **OLTC Web portal open to users:** <https://www.altimetry-hydro.eu>
 1. View onboard elevations
 2. Contribute to new virtual stations!
- **Massive amount of altimetry data now available over inland waters worldwide**
 1. The altimeters capability has been greatly enhanced over land thanks to OLTC tables optimization
 2. Scientific data analyses and studies are required
 3. These OLTC upgrades and inland water measurements will provide quality data for SWOT cal/val