

Ocean Surface Topography Science Team Meeting (OSTST)

October 23-27, 2017

“The 25th Anniversary of TOPEX/Poseidon”



TOPEX/Poseidon
1992-2006

Jason 1
2001-2013

OSTM/Jason 2
2008

Jason 3
2016

Sentinel-6A
2020

Sentinel-6B
2025

Update and validation of Jason-3 onboard DEM

Enhanced acquisitions over inland water targets

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Overview

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The Diode/DEM mode onboard Jason-3

Contents of the updated targets database

Validation

Perspectives on Jason-3 and other missions

The Diode/DEM mode onboard Jason-3

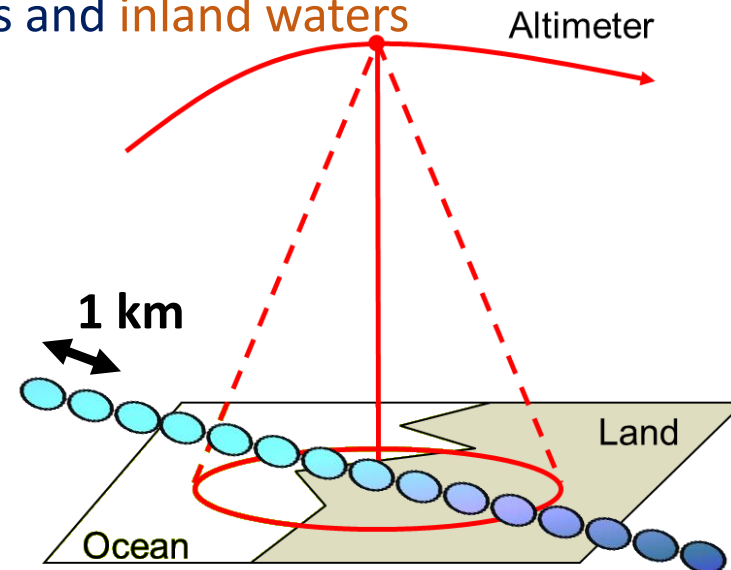
Jason-3 has the ability to **switch automatically** between Autonomous and Diode/DEM tracking modes [Desjonquieres et al. OSTST 2016]

Diode/DEM mode (also called « open loop ») is the **nominal operating mode** for Jason-3/POSEIDON-3B over all surfaces incl. oceans and **inland waters**

Building the onboard DEM :

- Sampling along the orbit : 0.01° (~ 1 km)
- Elevation assigned to the **nadir point**
- Priorities between surfaces :
Transponder > Ocean > Lakes > Rivers
- Coding and compression

On board memory is limited : **1 Mb** for Jason-3

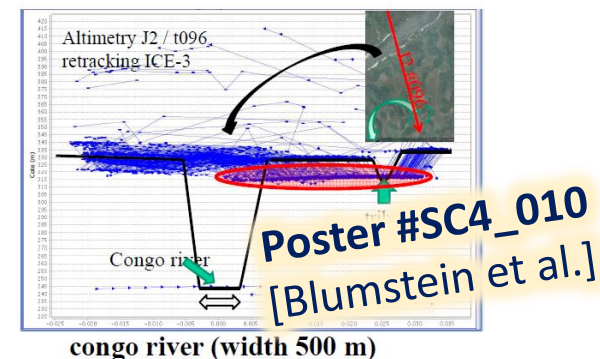


[Augé et al., OSTST 2016]
(modified)

The Diode/DEM mode onboard Jason-3

Primary rationale : get successful acquisitions over rivers and lakes

- **Autonomous mode** is able to track water bodies, but :
 - No control on the tracked surface (hills or rivers banks ?)
 - Data gaps over land due to tracking losses



- **Diode/DEM mode** is « target-oriented » with **a priori knowledge of the water body elevation**
 - Target elevation shall be defined precisely to fall in the altimeter tracking window (reference sample 44)
- ➔ **The more rivers and lakes defined in the onboard DEM, the more expected successful acquisitions**

The onboard elevation database

History of Jason-3 onboard DEM versions		
Launch → Cycle 11	v1.0	Pre-launch DEM defined over transponder, ocean, Hydroweb lakes
Cycle 11 → Cycle 57	v2.0	[v1.0] + a new geoid reference over ocean + a new VS network over France <i>[Biancamaria et al., RSE in review]</i>
Cycle 57 onwards	v3.0	Updated DEM
« Updated DEM operational since August 31 at 22:07:45 » (Cycle 57 – Pass 160) <i>[C. Marechal, Jason-3 Operations Manager]</i>		

Collaborative work between CNES & hydro experts to update the existing database on JA-3

- « Clean » v2.0 (e.g. remove lakes or virtual stations located outside of Jason-3 ground track)
- Lakes : inputs from Hydroweb and G-REALM databases (**polygons**)
- Rivers and lakes : **virtual stations (points)**, i.e. crossing points between J3 satellite ground track and water bodies

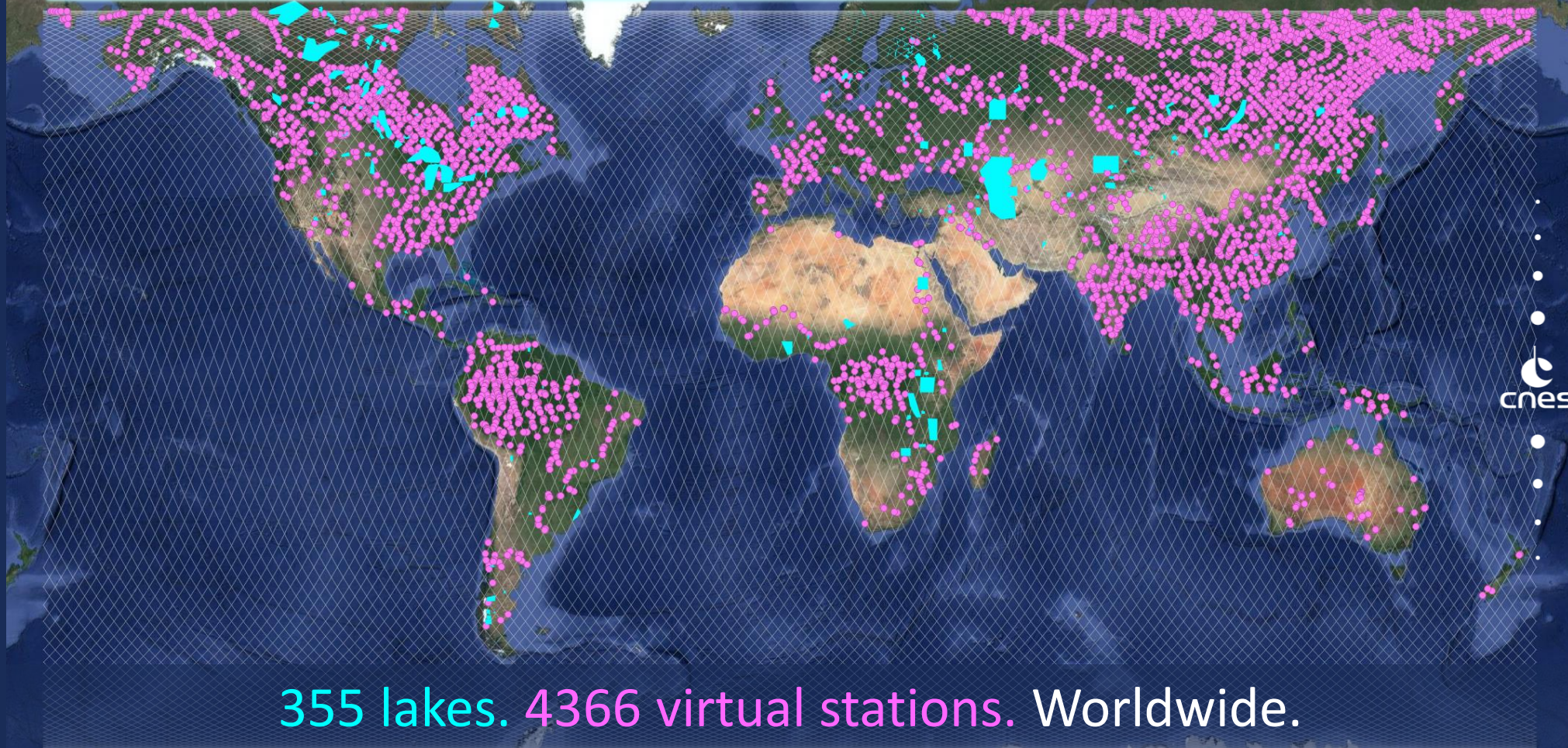
- **Several constraints to define new targets in the onboard DEM :**
 - Targets have to be located, and defined, under the satellite ground track (to be observed at **nadir**)
 - Respect a minimum **along-track distance between targets** (minimum 30 km) to secure transitions
 - Know target elevation with a **precision of about 15 m** (to fall in the tracking window)
 - Targets with a **strong seasonal variability** (autonomous or Diode/DEM ?)

v2.0 (cycle 11 – cycle 57)

245 lakes. 1644 virtual stations.



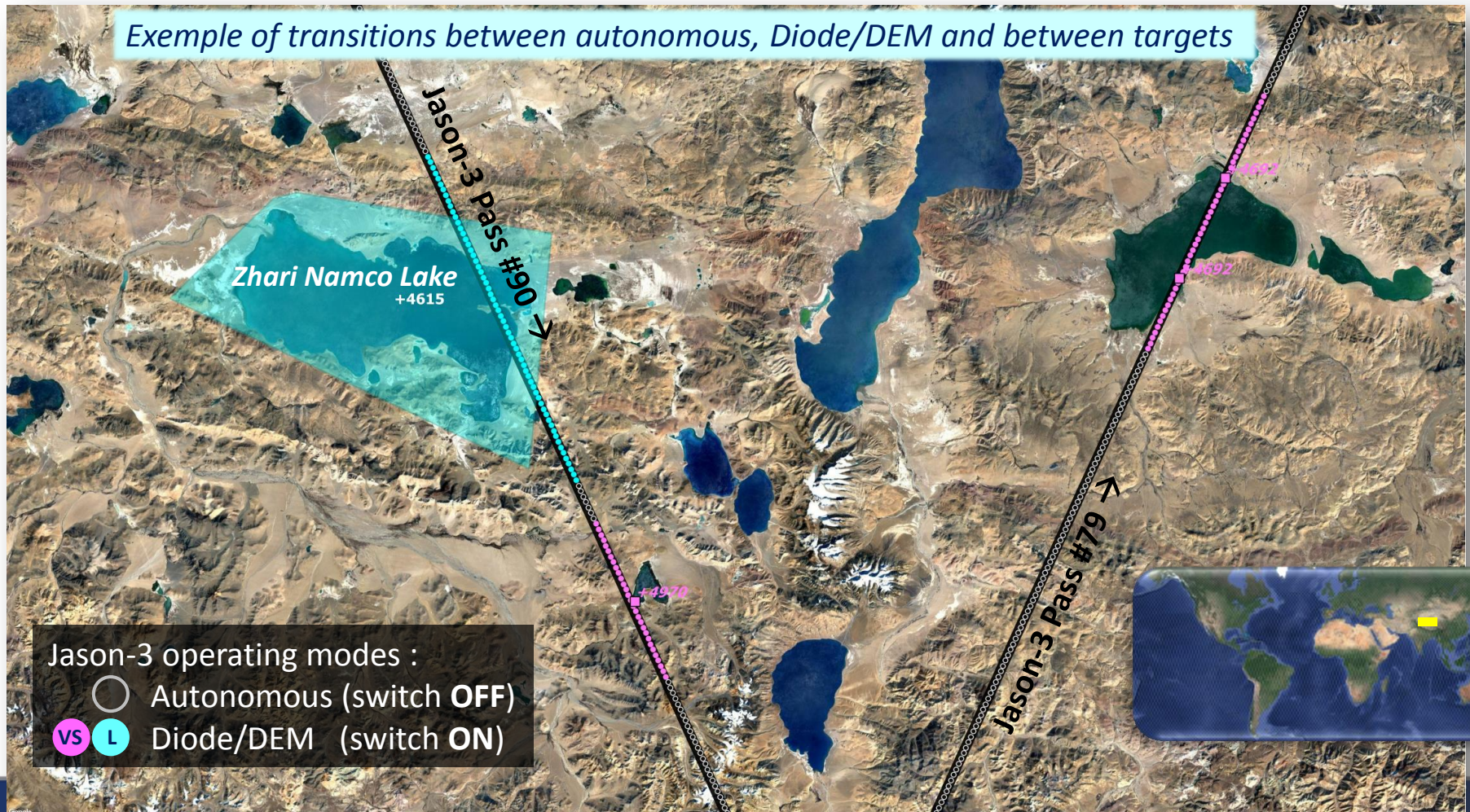
... As of Aug. 31, 2017 : v3.0 (Cycle 57, Pass 160 onwards)



355 lakes. 4366 virtual stations. Worldwide.

The onboard elevation database

Exemple of transitions between autonomous, Diode/DEM and between targets



Validation

Different strategies to evaluate the performance of the onboard DEM :

- Globally : average statistics per cycle
- Locally (for each target) : detailed elevation profile during target overflight, cyclic monitoring
- Separate validation virtual stations / lakes

Check the successful acquisition of echoes

- « Presence flag » (OK/KO)
Combination of controls based on
- Position of echo max
 - Level of maximum power
 - SNR

Evaluate improvement brought by the DEM

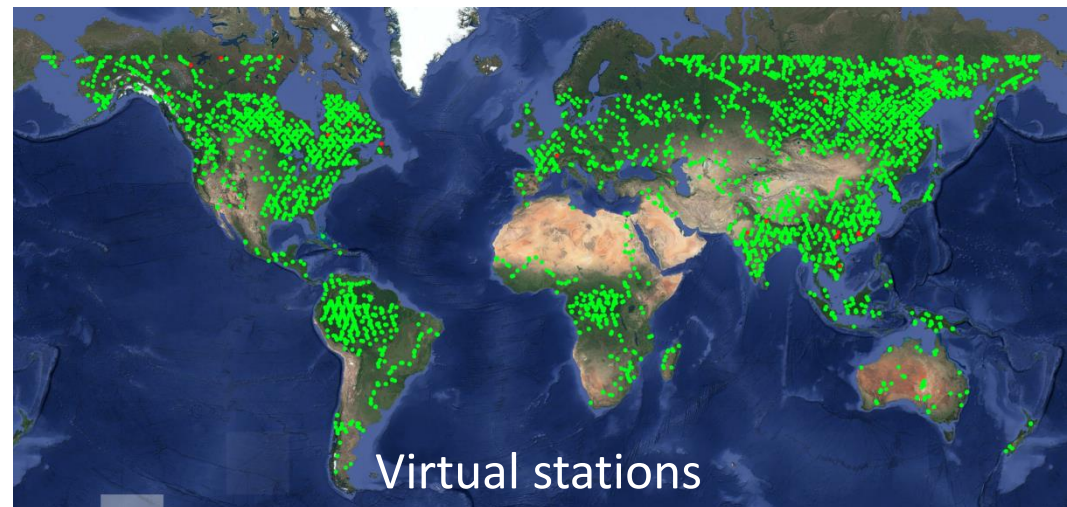
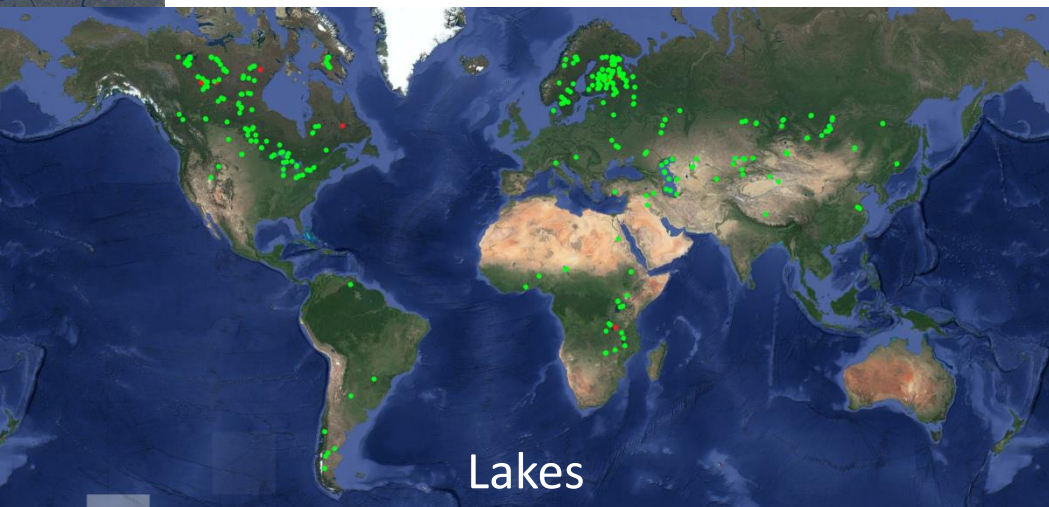
→ Compare **autonomous vs. Diode/DEM** tracking modes

Evaluate the robustness of onboard elevations

→ Compare elevation retrieved from the **altimeter with the target elevation** (presumed « real » elevation)

Validation : check echoes acquisition

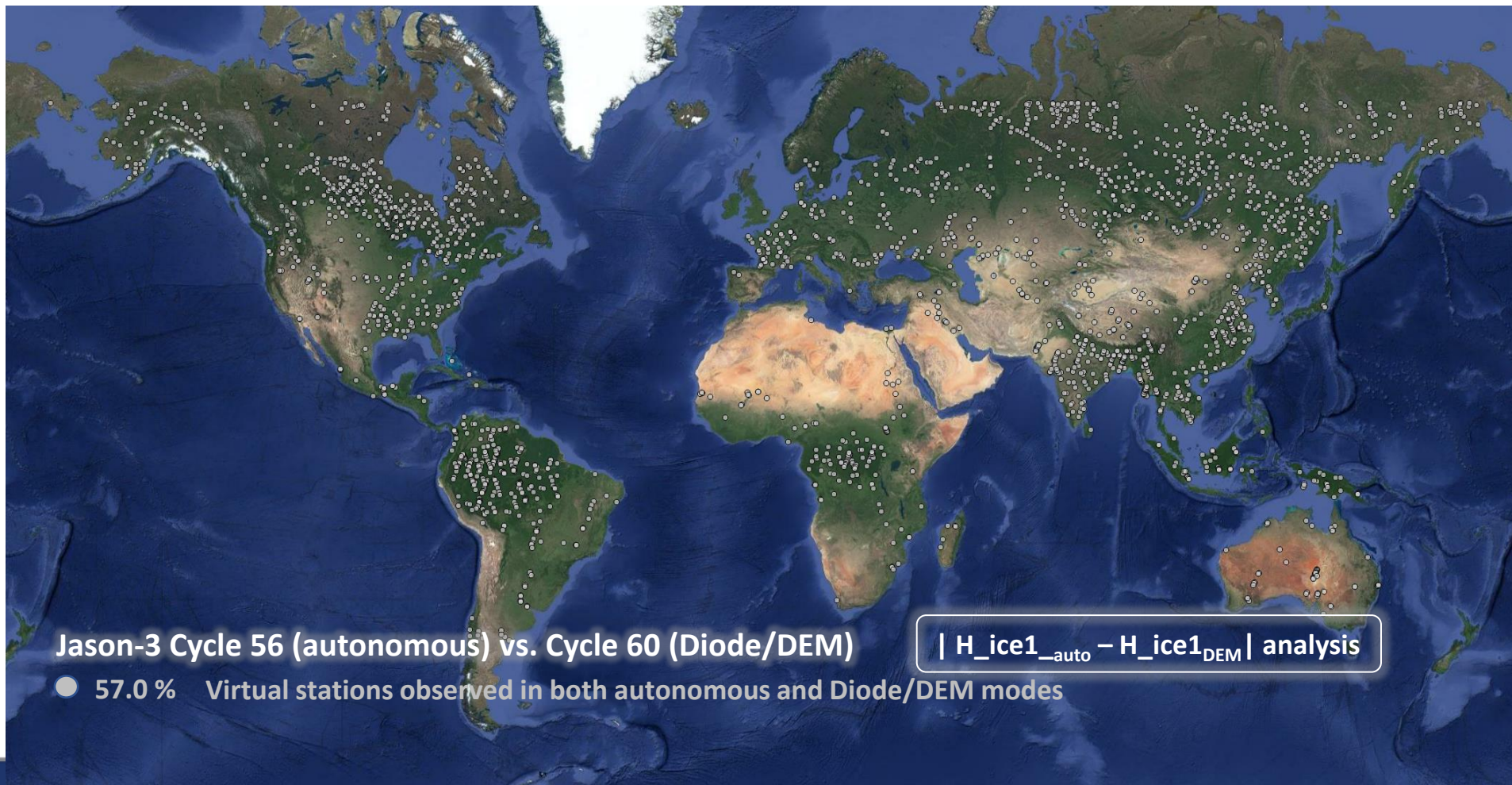
Results of the echo presence flag for Jason-3 (cycle 60)



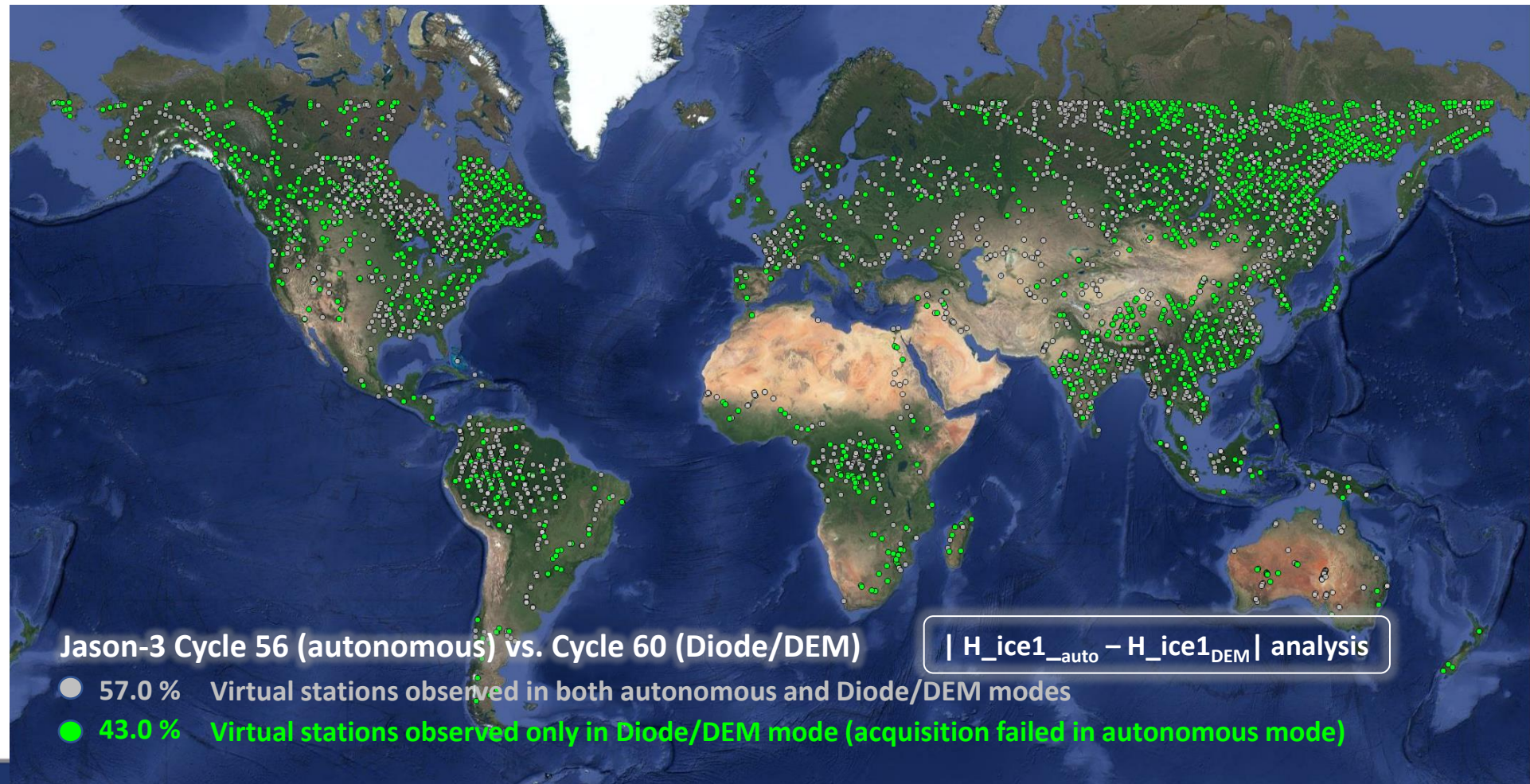
Lakes	OK ●	● KO	Operating mode	Stations ●	OK ●	● KO
Cycle 56			Autonomous mode	Cycle 56	80.0 %	20.0 %
Cycle 59	97.5 %	2.5 %	Diode/DEM Mode	Cycle 59	94.5 %	5.5 %
Cycle 60	97.6 %	2.4 %	Diode/DEM Mode	Cycle 60	95.4 %	4.6 %
Cycle 61	98.4 %	1.6 %	Diode/DEM Mode	Cycle 61	95.0 %	5.0 %

No warranty that the water is **actually** tracked in autonomous mode (e.g. narrow valleys)

Validation : comparison with autonomous mode



Validation : comparison with autonomous mode

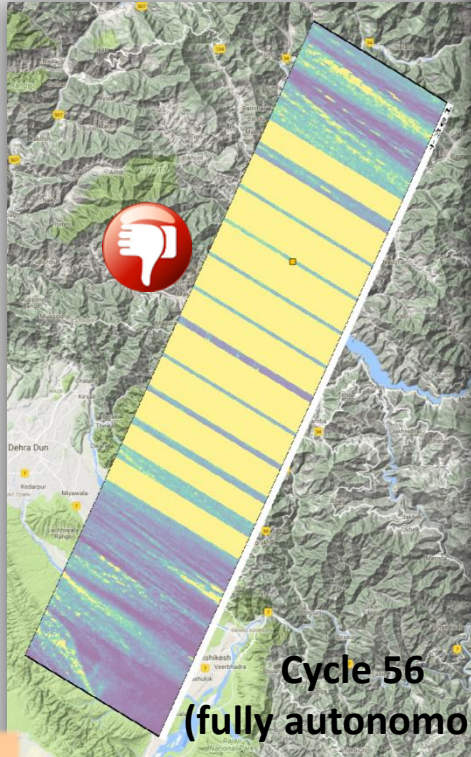
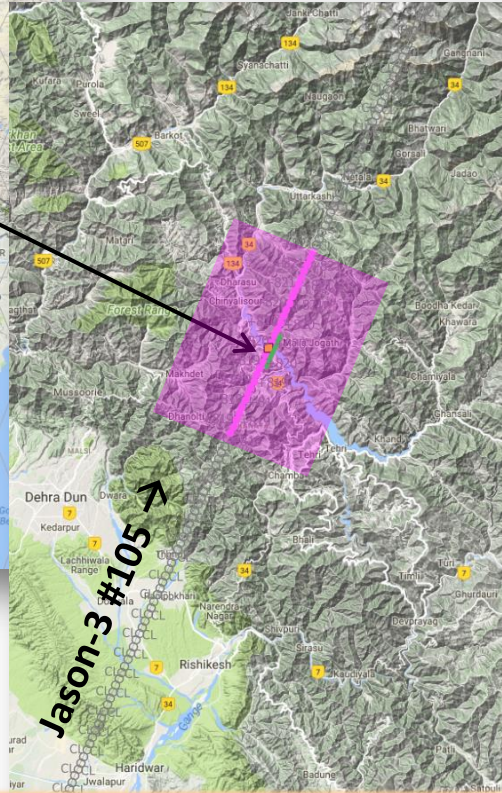
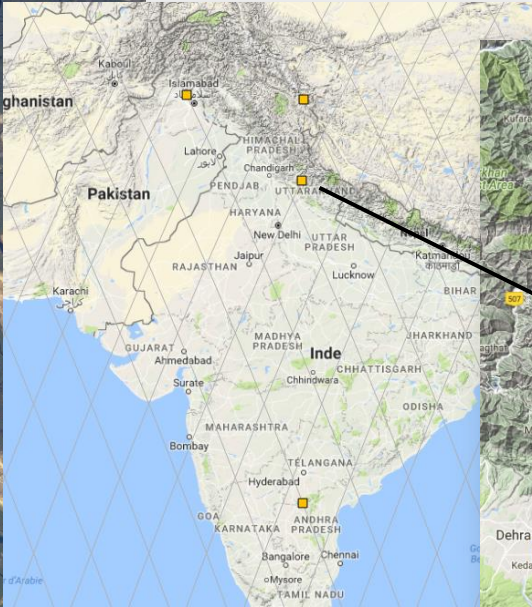


Jason-3 Cycle 56 (autonomous) vs. Cycle 60 (Diode/DEM)

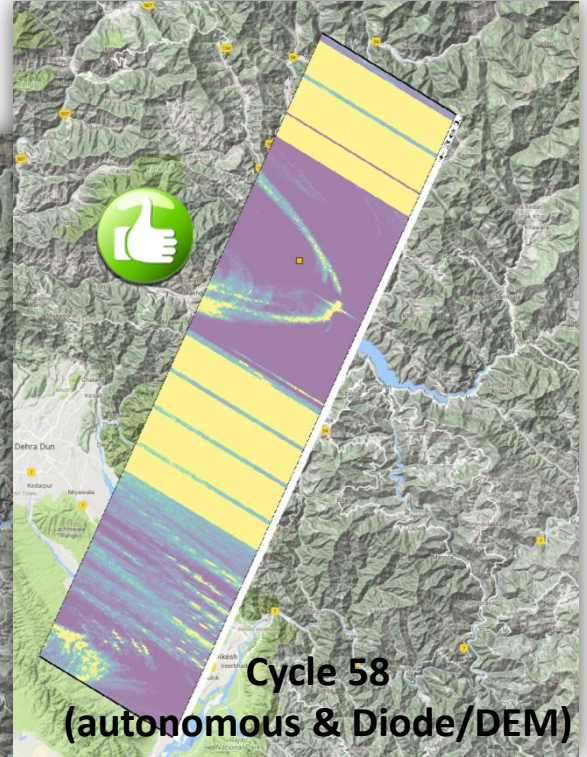
| $H_{ice1_auto} - H_{ice1_{DEM}}$ | analysis

- 57.0 % Virtual stations observed in both autonomous and Diode/DEM modes
- 43.0 % Virtual stations observed only in Diode/DEM mode (acquisition failed in autonomous mode)

Validation : comparison with autonomous mode - Example



Cycle 56
(fully autonomous)

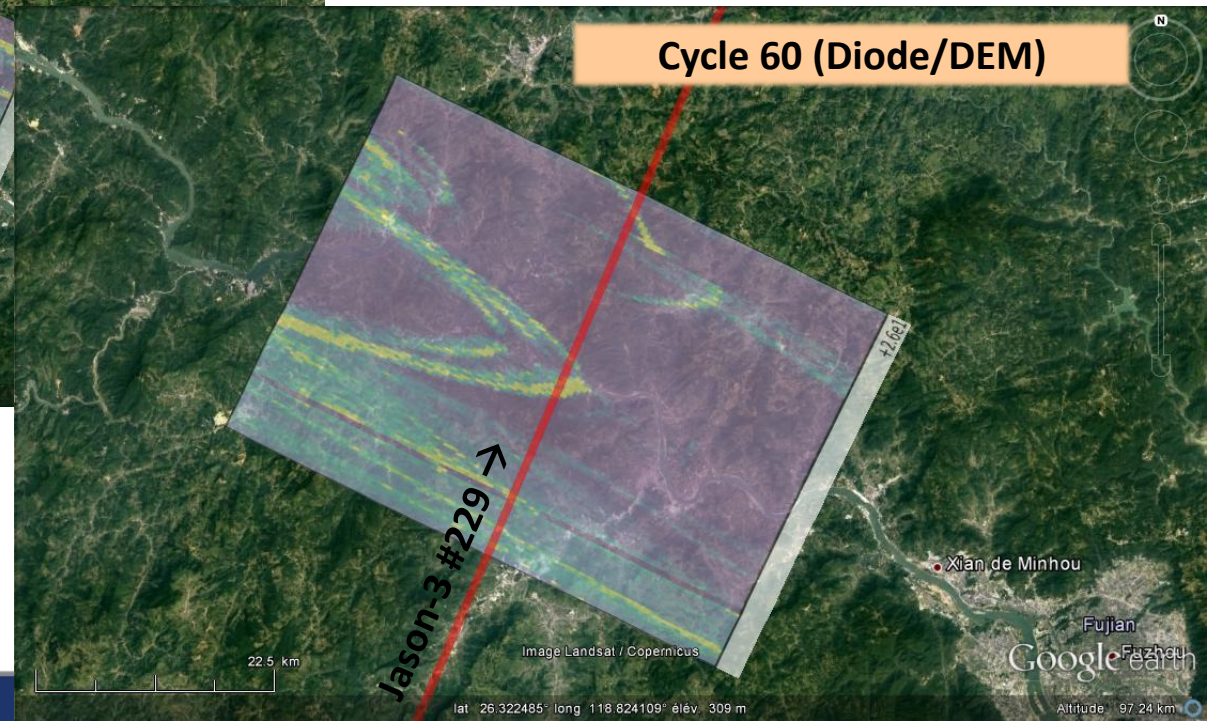
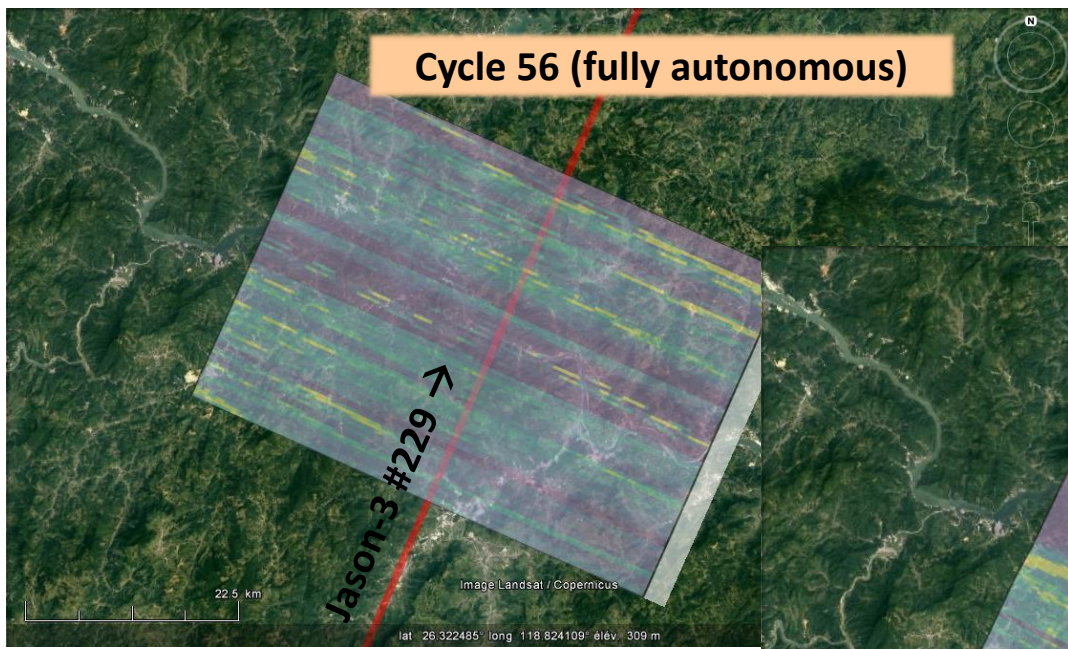


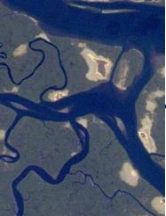
Cycle 58
(autonomous & Diode/DEM)

G-REALM station
Very narrow valley surrounded by mountains

Validation : comparison with autonomous mode - Example

River near Fujian (China)
400 m wide



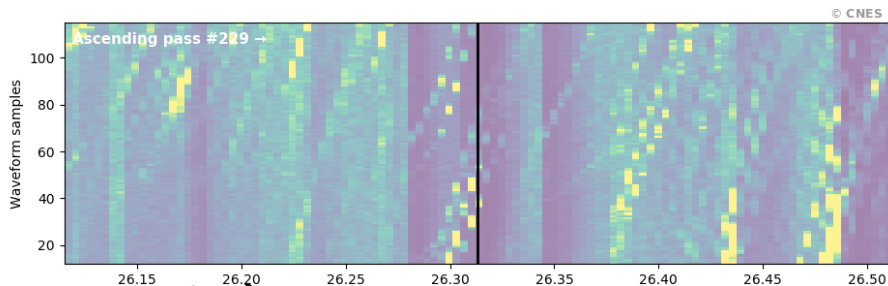


Validation : detailed example (River near Fujian – China)

JAN_0229_N2631_id02_h60m
lon = 118.79° ; lat = 26.31°
Target elevation = 67 m

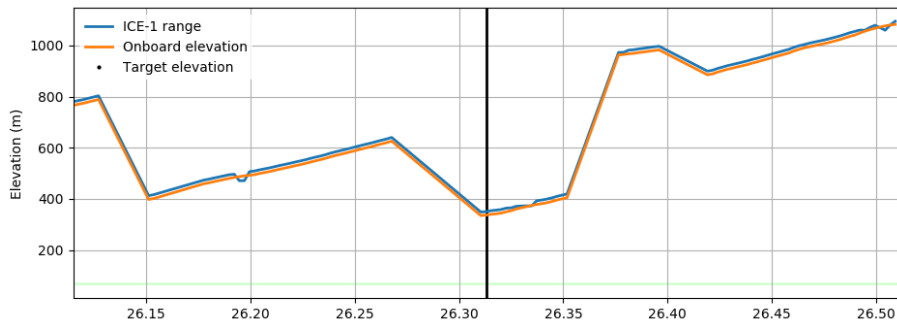
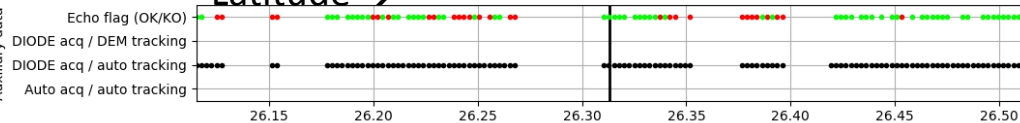
Cycle 56

(I)GDR file : JA3_GPS_2PdP056_229_20170824_164442_20170824_174055



Auxiliary data

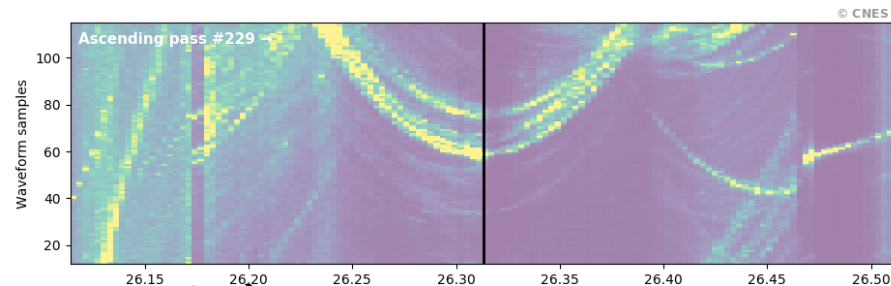
Latitude →



JAN_0229_N2631_id02_h60m
lon = 118.79° ; lat = 26.31°
Target elevation = 67 m

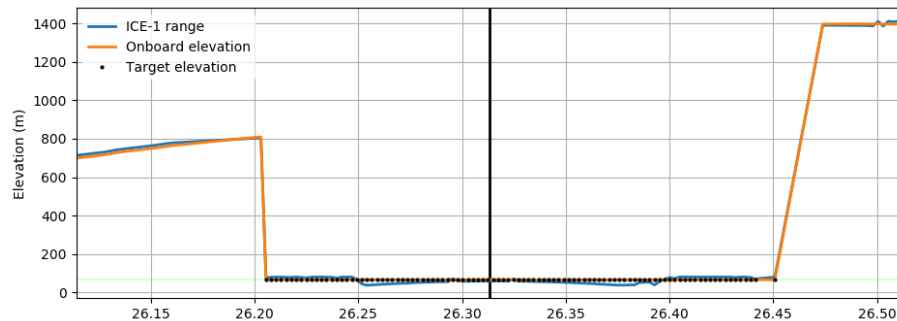
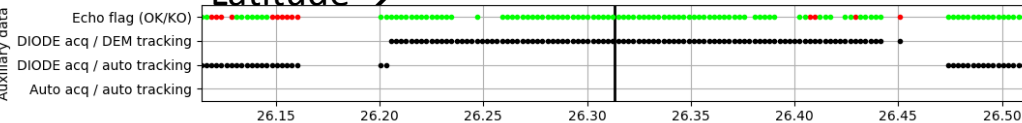
Cycle 60

(I)GDR file : JA3_IPS_2PdP060_229_20171003_083849_20171003_093502



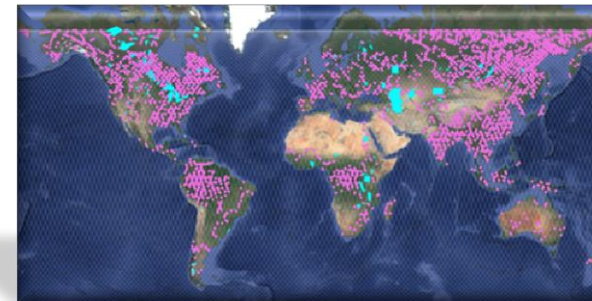
Auxiliary data

Latitude →



Conclusions on Jason-3

- Updated DEM has been uploaded onboard Jason-3 – operational since Aug. 31, 2017 (Cycle 57 / Pass 160)
 - **Major leap forward** in the number of targets defined for Jason-3 (times 2.5), **worldwide**
 - **More successful acquisitions than ever before** thanks to :
 - the **quality of targets elevations** defined in the onboard DEM
 - the **automatic switch** between autonomous and Diode/DEM modes
- **43% of virtual stations were not observed in autonomous mode**



Pre-requisite to fancy processing is to have a proper echo !

Do we need more validation ?

YES !

Can we define more targets for Jason-3 ?



Will this DEM be updated in the future ?

YES

A database of hydrology targets for the new DEM onboard Jason3

Poster #SC4_010 [Blumstein et al.]

Perspectives for other missions

- These very good results on Jason-3 pave the way for **improving inland water monitoring using altimetry**
- What's next ?
 - **Sentinel-3 B launch Q1 2018, tandem phase with Sentinel-3 A**
 - Ongoing discussions with ESA to apply same methodology to **Sentinel-3 A&B OLTC tables**
 - 2 satellites in interleaved orbit, 3x more passes, higher latitudes !
 - **Web interface** under development to **collect users' requests**
- Preparation of the future : Jason-CS/Sentinel-6 and SWOT will benefit from these major improvements and expertise



Thank you for your attention

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