SARAL Project Status

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MAJOR EVENTS SINCE LAST OSTST

Major events since last OSTST (September, 2018)

Since 4th July 2016 SARAL still in Drifting Phase*

- Satellite major events

  Anomaly encountered on Stellar Sensor from 3rd of February to mid-April 2019 (see slides after)

  Workaround found by ISRO thanks to a great work of SARAL ISRO team

- Payload major events

  Dec 2018- March 2019 : High Data rate mode measurement on SALAR of Yuni lake

  Since 15th April 2019 High Data rate mode measurement performed every 50 min randomly around equator (~200TC per week in addition to others ones)

- Ground major events

  Change of MOEs/POEs from version "E"=>"F" on December 10th 2018

Current SARAL-Drifting Phase mission Status is OK

CNES approved SARAL mission extension till end of 2021, EUMETSAT approval under process

No concern on ISRO side for extending the mission

** Cf article : The drifting phase of SARAL/AltiKa: securing a stable mesoscale sampling with an unmaintained decaying altitude*
*Authors: Gerald Dibarboure *, Alain Lamy, Marie-Isabelle Pujol, Ghita Jettou – April 2018*

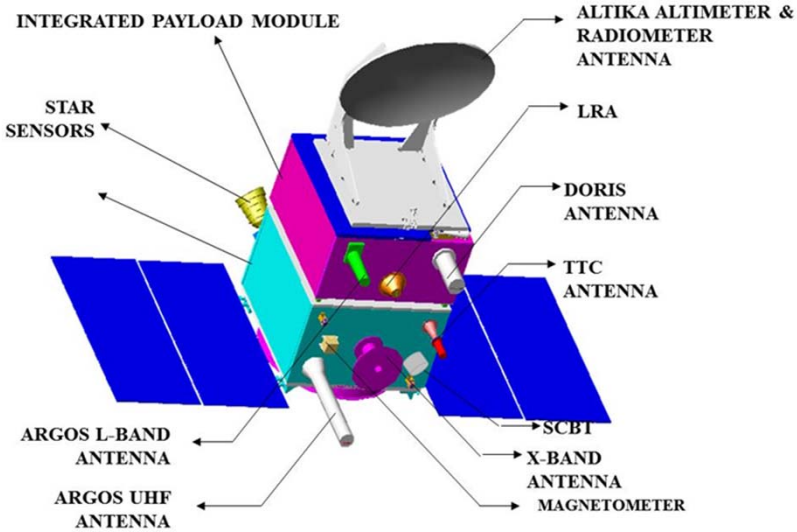
SPACECRAFT and GROUND SEGMENT STATUS

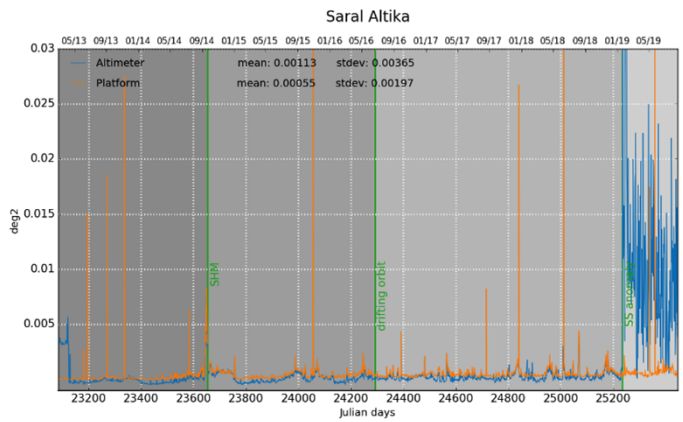
Platform Status (1/2)

The SARAL satellite bus is **OK**

- Command / control , RF : **OK**
- Thermal aspects : **OK**
- Electrical aspects : **OK**
- AOCS (attitude and orbit control system) : **OK**
  - few concerns on reaction wheels but stable and under control by ISRO since 2016
  - Star Sensors anomalies under control since mid-April 2019 (see next slide)

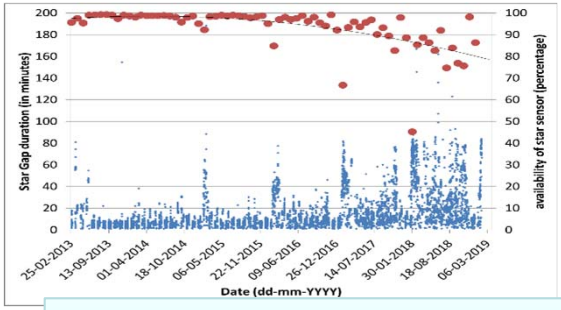
SARAL bus is operational after 6,5 years in orbit





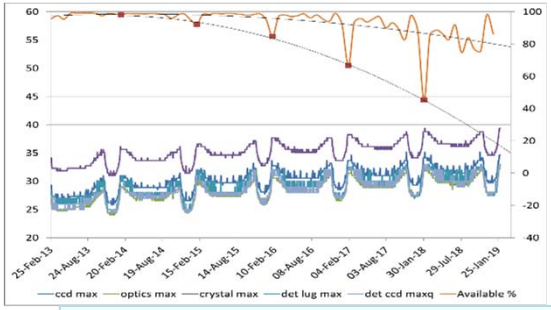
Platform Status (2/2) : Focus on Star sensor Workaround

Normal Ageing effect => ↘ availability



SS data availability is reducing over time
Every February, SS availability is less compared to other months

Normal Ageing effect => ↗temperature



Star sensor availability is reducing with increase in temperature

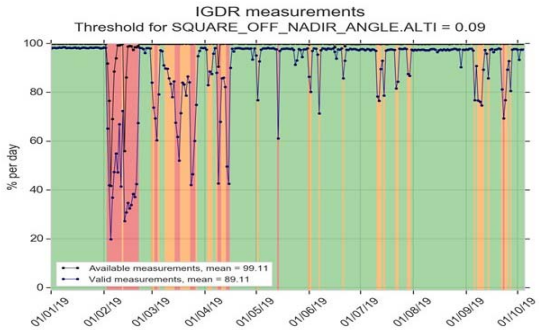
Some Mispointings on platform, but high for ALTIKA altimeter :
ALTIKA CONSTRAINT : KEEP mispointing below 0,3° (0,09 deg² square off nadir)

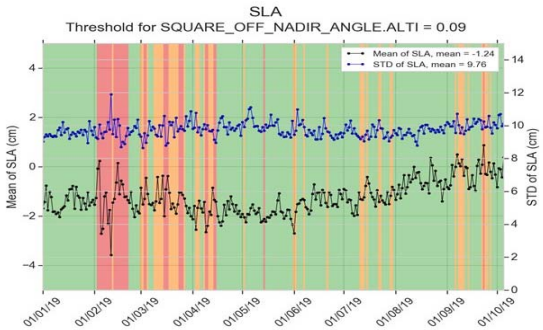
ISRO WORKAROUND :
Star sensor switch ON every 12 hour once
- ON Duration is 8 hours
- OFF Duration 4 hours

DTG Residual drift estimation with respect to measurement sources

With this method ISRO maintains S/C attitude within 0.3 deg

Available and valid measurements: estimated 92% valuable datas available per year with this ISRO SSB strategy in worst case for ALTIKA





% of valid measurements:
- > 90%
- Between 70% and 90%
- < 70%

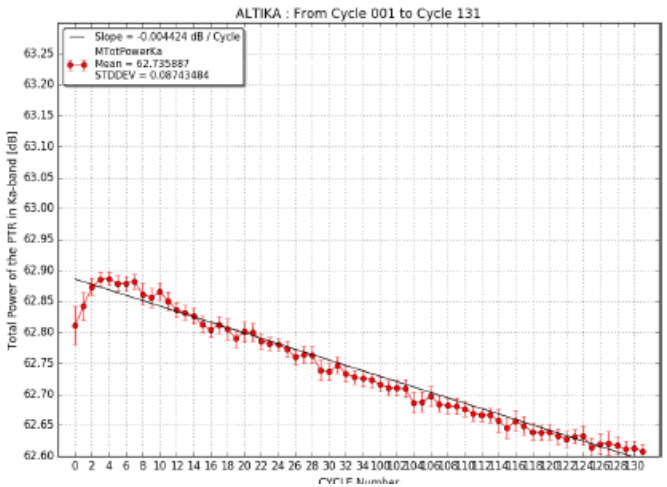
Payload Status since last OSTST (September, 2018)

99.5 % **available from 01/09/2018 to 01/10/2019**

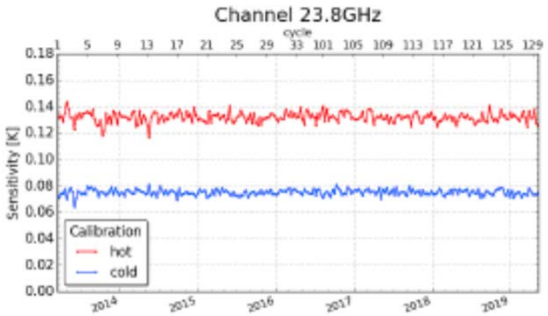
- **AltiKa** **OK**
  - routine calibrations PTR, LPF
  - quarterly CNG calibrations I^2+Q^2
  - specific calibrations over sea & ice (HD mode)
- **Radiometer** **OK**
  - Very good stability & sensitivity
- **DORIS** **OK**
  - Nominal
- **ARGOS** **OK**
  - Nominal; performance similar to other satellites, one reset over the year

➔ **fully OPERATIONAL**

ALTIMETER total power of the PTR for Ka-band.



Radiometric sensitivity - Ch 23.8GHz



	Mean (K)	σ (K)
hot	0.13	0.00
cold	0.07	0.00

Ground & Operations - Status and performances

- Earth terminals :
  - ISRO band-S (Bangalore, Lucknow) **OK**
  - ISRO band-X (Shadnagar) **OK**
  - CNES band-X (Kiruna and Inuvik) **OK**
- Control Centers : **OK**
  - ISRO/ISTRAC Control center

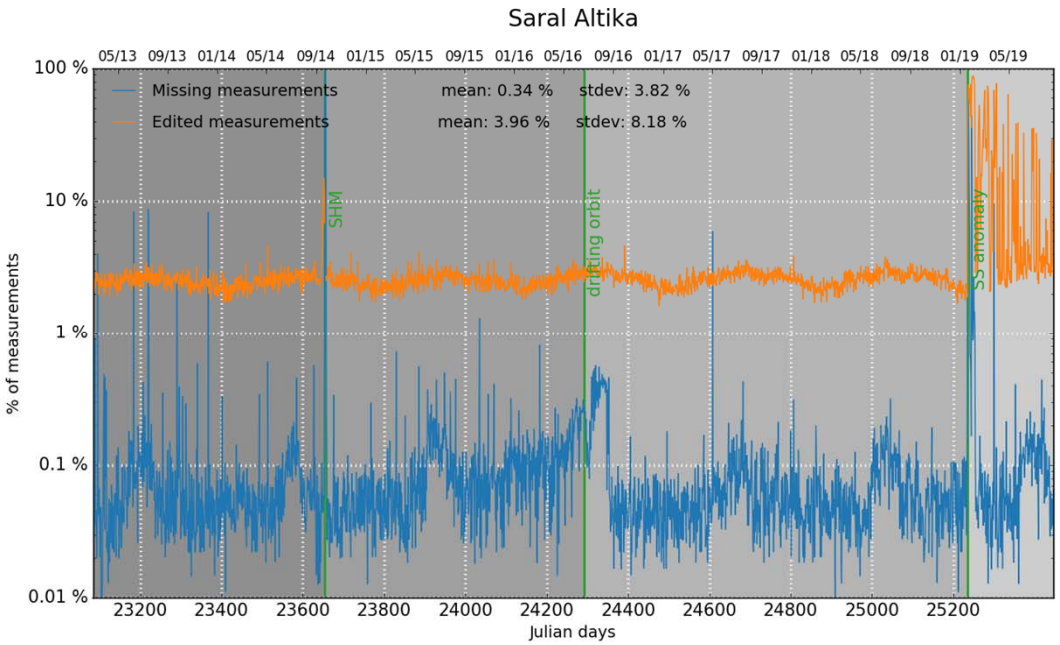
    SARAL spacecraft operations is handled from Alternate Spacecraft Control Center at **Lucknow** instead of Mission Operations Complex (MOX) at **Bangalore**, since November 2017
- Instrument Commanding and Monitoring Centers :
  - SSALTO for Altimetry **OK**
  - ARGOS PC for ARGOS **OK**

PERFORMANCES

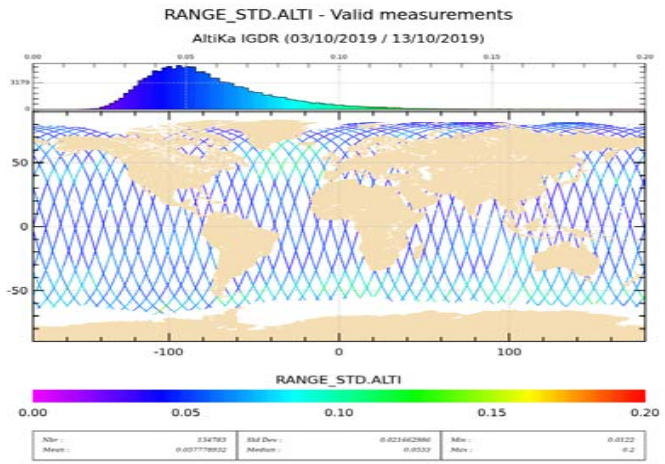
Performances : Data availability – ocean only

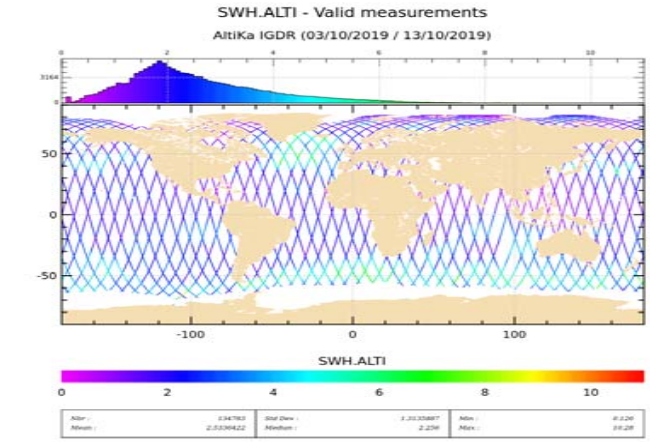
Due to Star Sensor, mispointing events impacts Data availability since cycle 127.

But data availability remains very satisfying with less than over 0.5% of missing data over Ocean => **99.5%** of available data over oceans

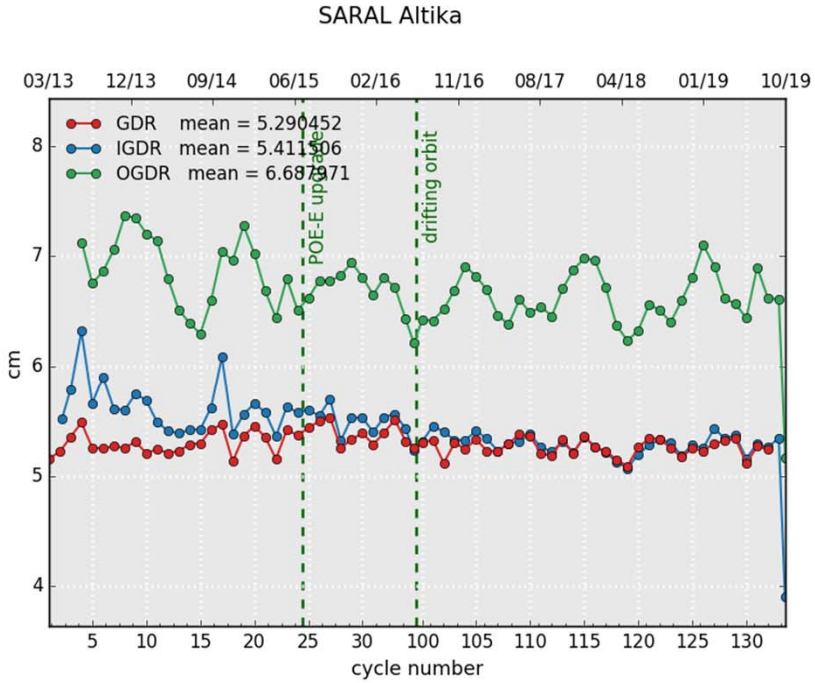


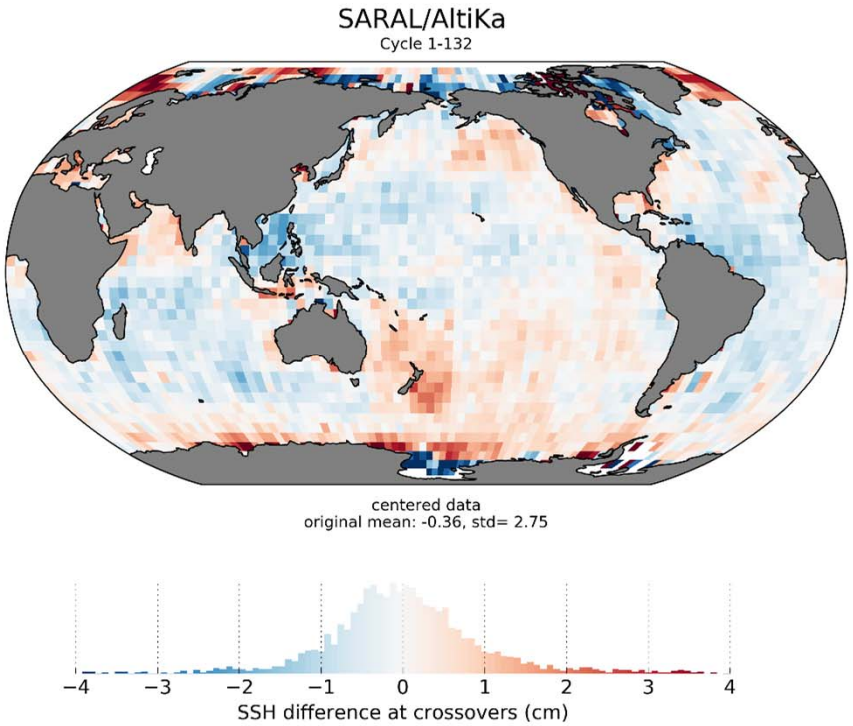
Percentage of missing data: GDR cycle 1 to 131





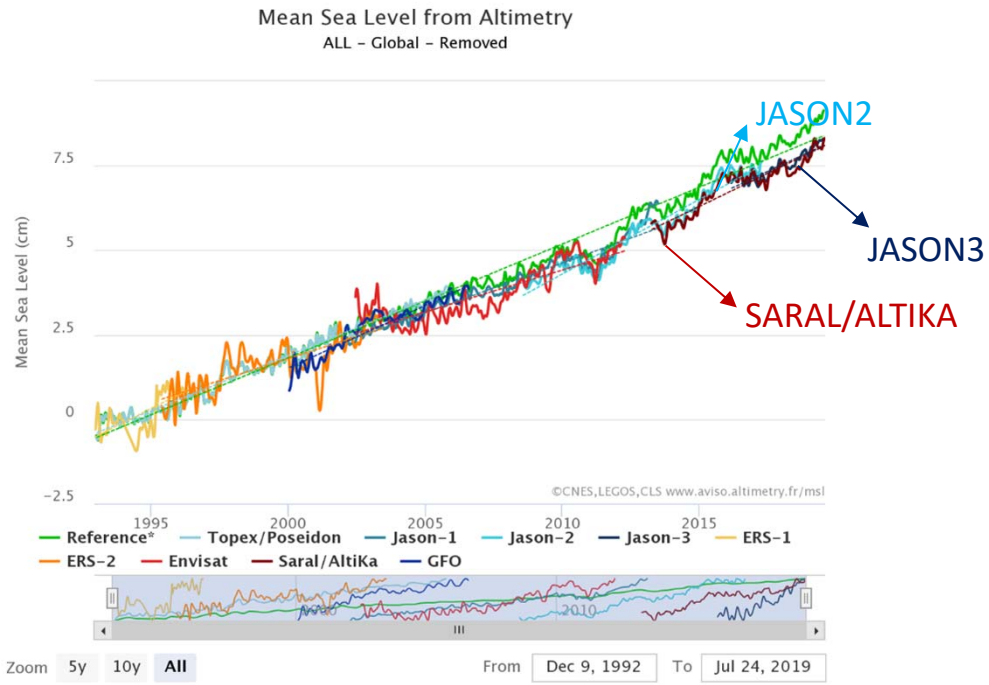
Performances : Xover - 5.29 cm for GDRs

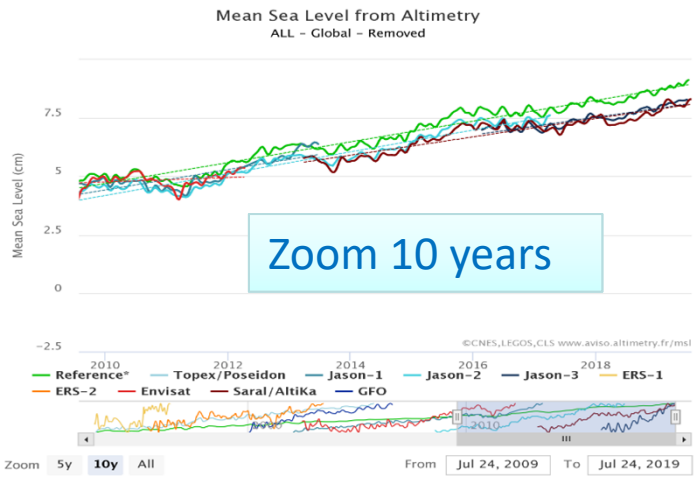


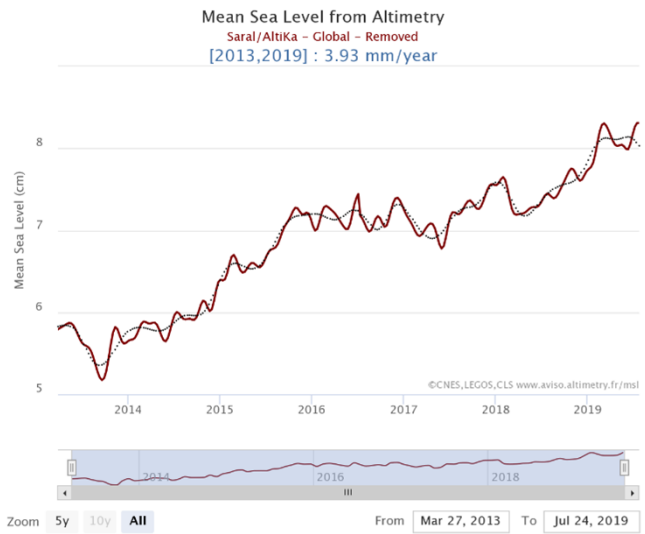


Performance at crossovers :
[Left]: Monitoring of standard deviation SSH difference
[Right]: Map of mean SSH differences

Mean Sea Level : same pattern as Jason-2 (before change of orbit) and Jason-3

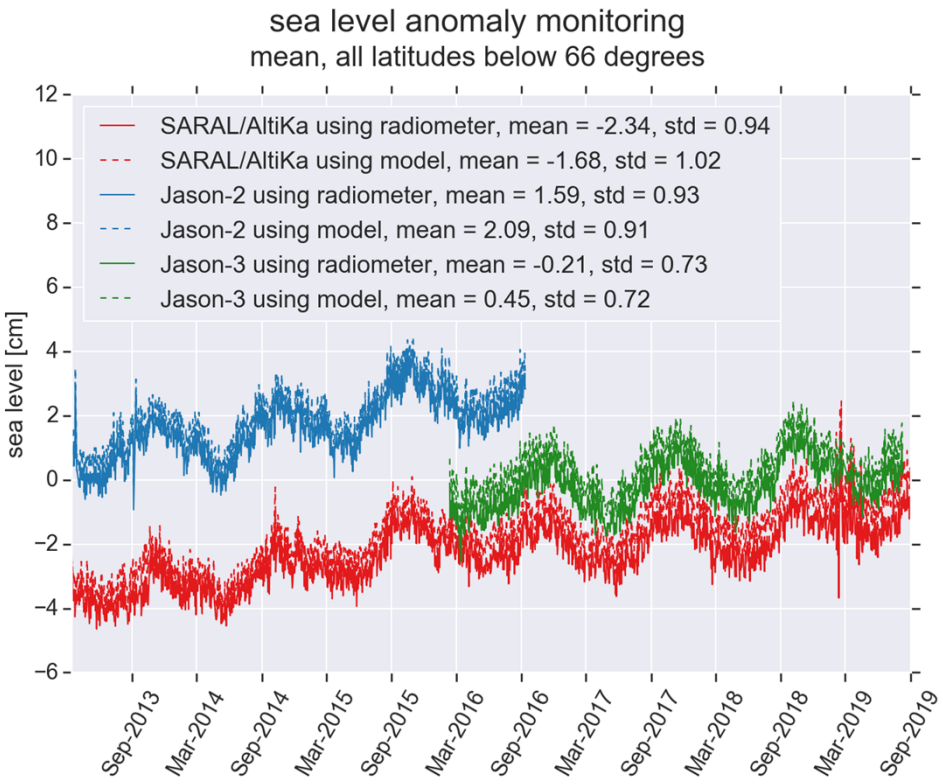


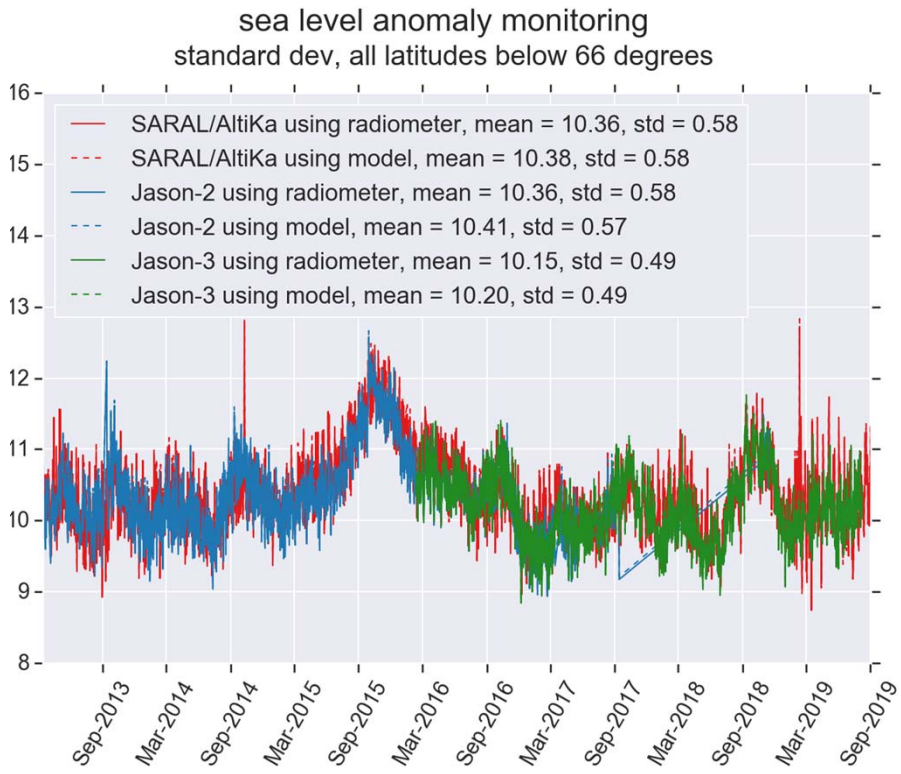




Sea-Level Anomaly performances (Altika vs Jason-2 & 3)

SARAL/AltiKa Jason-2 and Jason-3 daily mean of SLA show similar signals and evolution.
The standard deviation of daily averages of SLA differences is below 5 mm.

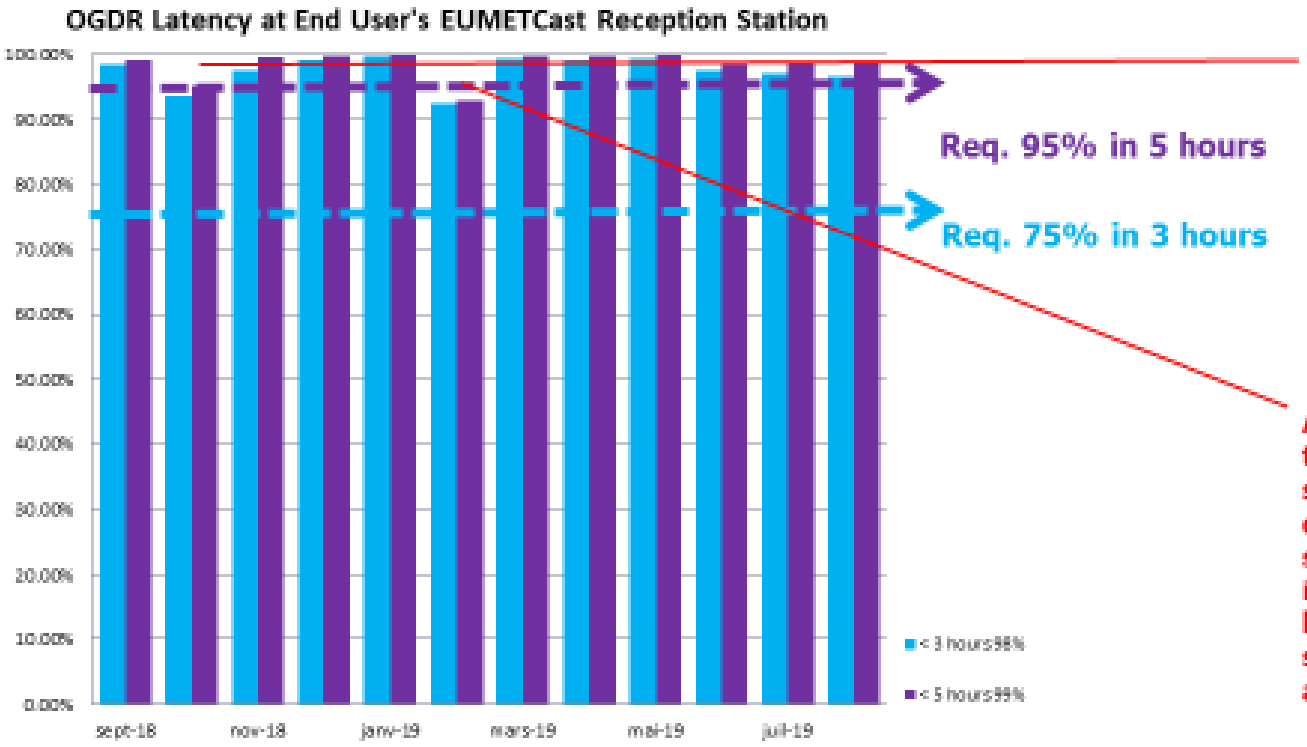




Monitoring of daily mean (left) and daily standard deviation (right) of SLA of GDR data using the radiometer (plain lines) and the model (dotted lines) wet tropospheric corrections. Global statistics are estimated for all latitudes between -66° and 66°

DATA PRODUCTS

SARAL OGDR Latency at EUMETCast



Product outage caused by an anomaly with the nominal and backup product generation software. They were restarted following guidance from CNES.

An anomaly was reported with the SARAL star tracker (STR). The subsequent OGDR products were degraded due to unstable satellite attitude. ISRO investigated the combined use of both the nominal and redundant star trackers to mitigate the anomaly

SARAL/ALTIKA Products latency

IGDR (Interim Geophysical Data Record) from 01/09/2018 to 01/10/2019

IGDR

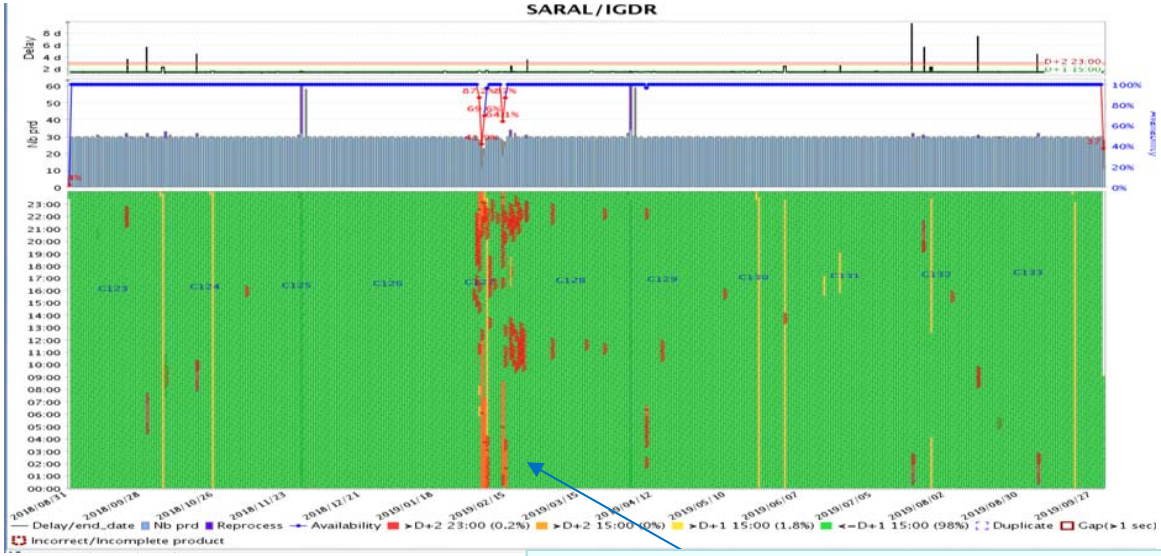
Requirement < 3 days
(objective : 1 or 1,5 days max)

From 1/10/2015 to 30/9/2016
- 99,5% < 3 days

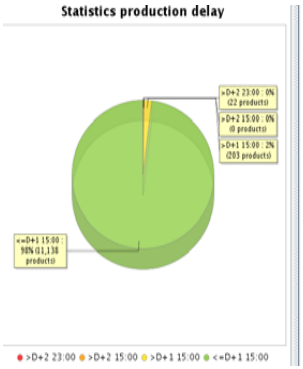
From 1/10/2016 to 30/9/2017
- 99.7 % < 3 days
- Mean delay : 1.4 days

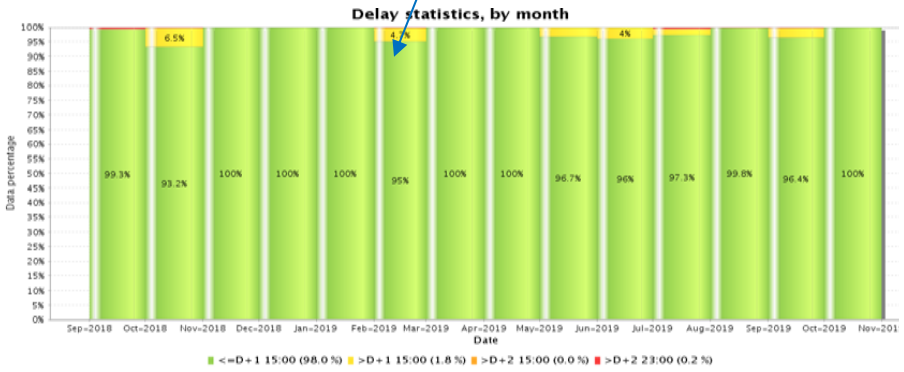
From 1/10/2017 to 01/09/2018
- 99,6 % < 3 days
- Mean delay : 1.4 days

From 1/09/2018 to 01/10/2019
- 99,8 % < 3 days
- Mean delay : 1.4 days



Period of Star sensor degradation and workaround





SARAL/ALTIKA Products latency

GDR (Geophysical Data Record)

GDR

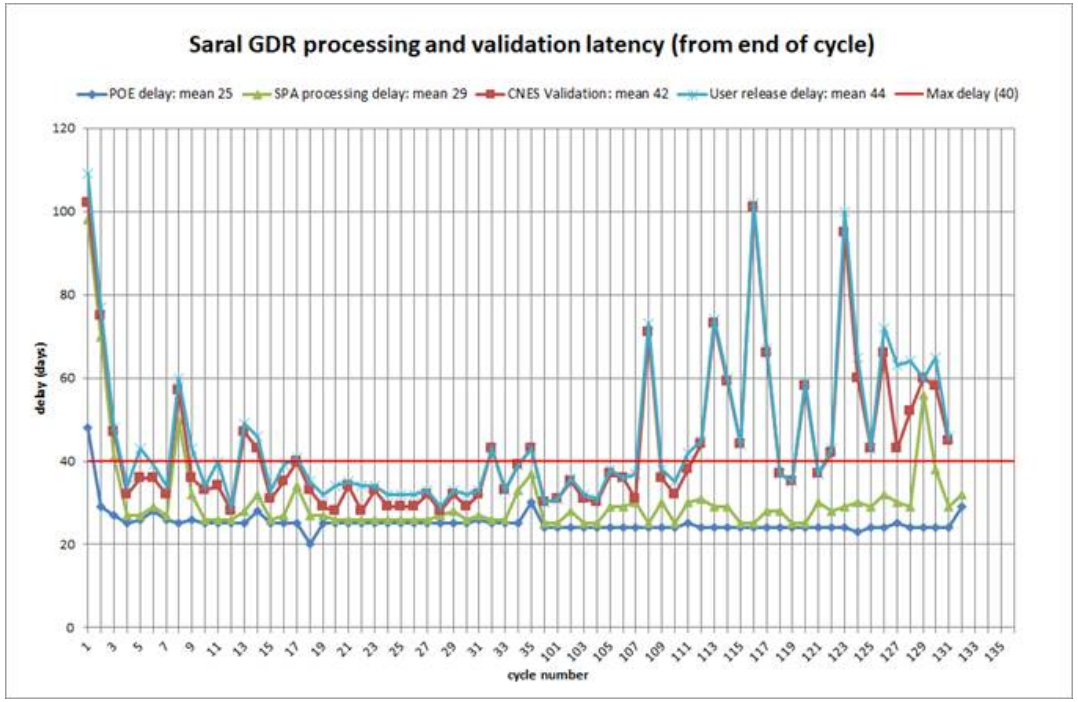
Requirement ~40 days

From 01/10/2015 to 30/09/2016
compliant (average: 34 days)

From 01/10/2016 to 30/09/2017
compliant (average: 29.5 days)

From 01/10/2017 to 01/09/2018
compliant (average: 29.6 days)

From 1/09/2018 to 01/10/2019
compliant (average: 37.1 days)



Nota: delays during the period of Star sensor workaround

SARAL GDR-E=> GDR-F standard – implementation status

GDR-F implementation for SARAL mission started in 2018

Current schedule :

- 3 cycles processed and validated by CAL/VAL in 2019
  - ✓ **Cycle 7 (10-10-2013 - 14-11-2013)** :
    Cycle on nominal ground track, during HOT COUNT saturation and after, no mispointing.
  - ✓ **Cycle 17 (25-09-2014 - 30-10-2014)** :
    Cycle with mispointing and SHM on the period
    2 processes: one with LUTs and platform mispointing, one with LUTs and no mispointing
  - ➢ **Cycle 31 (28-01-2016 - 03-03-2016) :**
    Cycle post SHM on drifting orbit for a global check, no mispointing

- The year 2015 reprocessed for SSB computation; use orbits with POE-F standard; validation finalized in October 2019

- Implementation for routine processing at CNES, EUMETSAT and ISRO in early 2020

- Full re-processing (2013-2019) planned in 2020

System Requirements and Performances

From September 2018 to October 2019

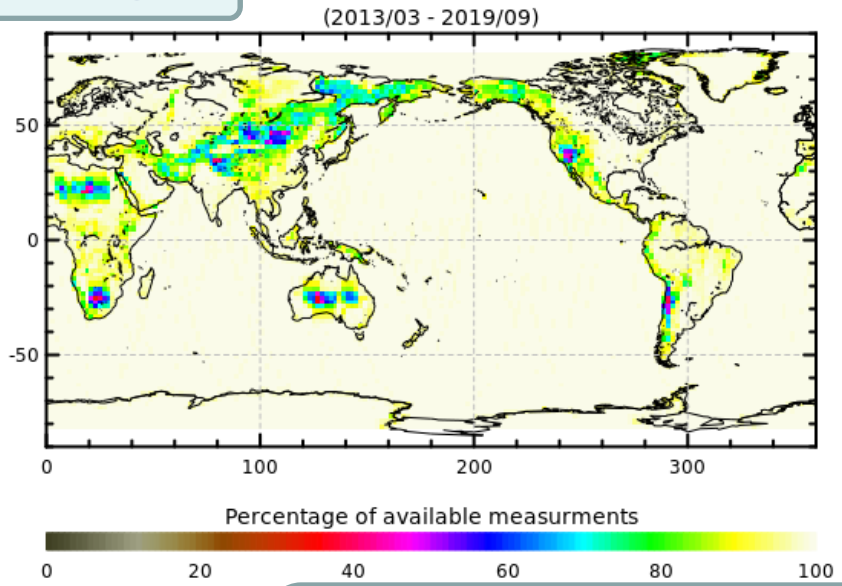
⇒ **Global satellite unavailability** **~1 %** **< 4% req**

bus : 0.5 % altimeter & radiometer : 0 % Doris : 0% Argos: 0.5%

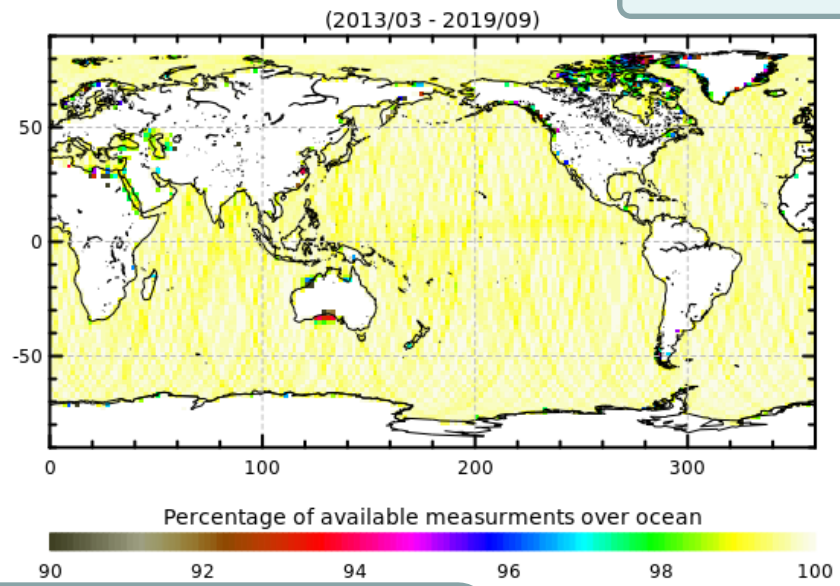
⇒ **ground unavailability** **~0 %** **< 1% req**

➔ Global SARAL system availability : ~99 %

Over all surfaces



Over oceans



GDR data availability vs theory 95% till 09/2019

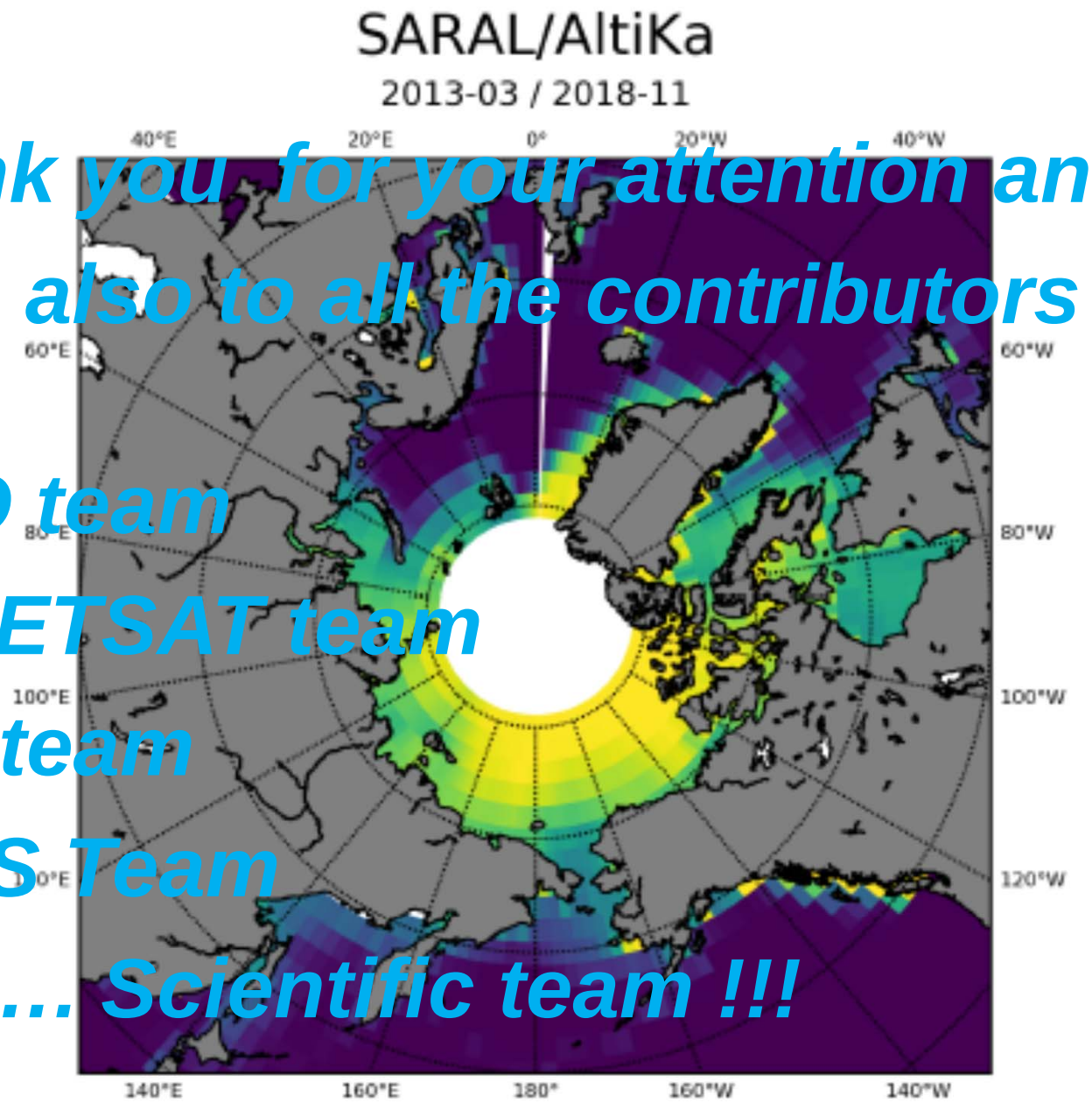
All surfaces : 97.81% (96.85 % in 2018, 96.7% in 2017)

Over Ocean : 99.66% (99.7 % in 2018, 99.6% in 2017)

Conclusion

- SARAL/ALTIKA is still performing well after -,5 years and will continue for two more years (2020-2021)

- **Always new improvements :**
  - **GDR-F in 2020**
  - **Ice campaigns and hydrologic improvements thanks to HD mode acquisitions in 2020**



Thank you for your attention and ….. also to all the contributors

ISRO team

EUMETSAT team

CLS team

CNES Team

And…. Scientific team !!!