SARAL Project Status

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MAJOR EVENTS

Major events since last OSTST (October 2020)

Since 4th July 2016 SARAL still in Drifting Phase

- Satellite major events

  All is nominal

- Payload major events

  All is nominal

- Ground major events
  - **Switch on GDR-F standard early 2021 :**

    Change to version F of **IGDR and GDR** (SALP) **From cycle 135 (first data 11-Nov-2019)**

    Change to version F of **OGDR** (EUMETSAT) **From cycle 137 (first data 20-Jan-2020)**
  - **Release of GDR-F complete reprocessing at the end of 2020**
  - **Additional X-band stations : KSAT stations (Inuvik + Svalbard) qualified and operational over the two last years for SARAL**

Current SARAL-Drifting Phase mission Status is OK

CNES, ISRO and EUMETSAT approved SARAL mission extension till end of 2023

Next extension to be discussed for 2023-2025

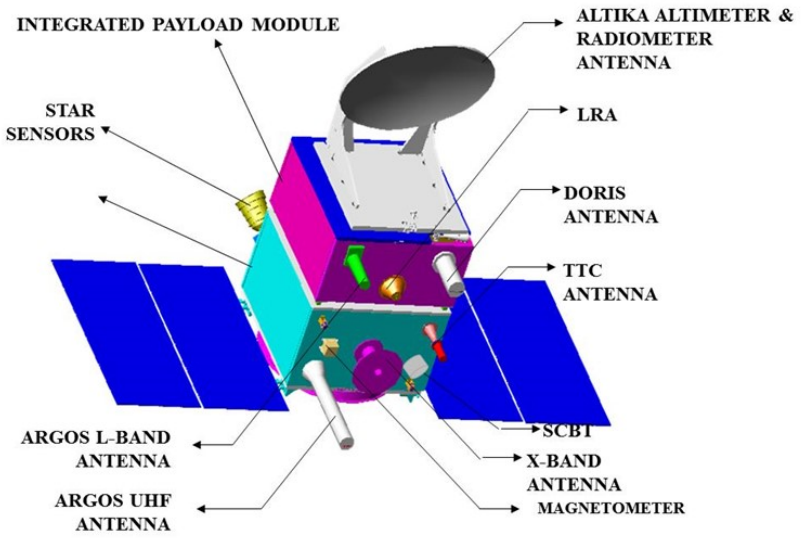
SPACECRAFT and GROUND SEGMENT STATUS

Platform Status

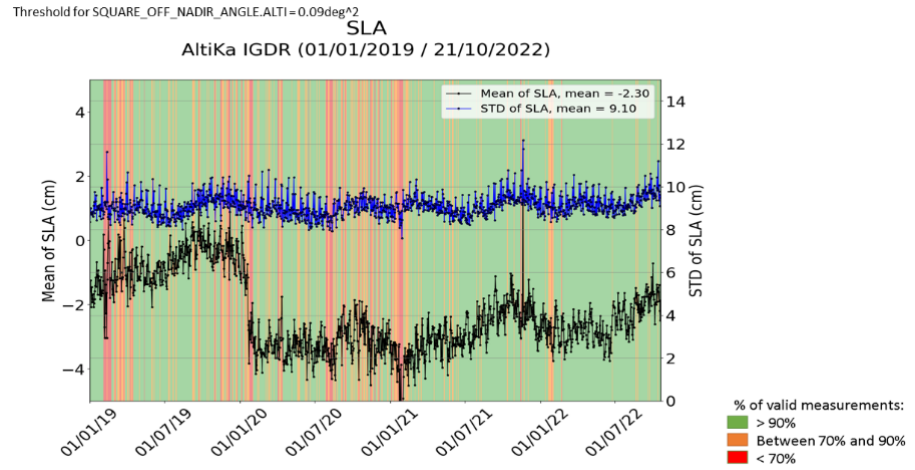
The SARAL satellite bus is **OK**

- 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 (explanations in B/U slides) : process optimized by ISRO end of 2021-beginning 2022 that leads to decrease drastically mispointing events

SARAL bus is operational for almost 10 years in orbit



Impact of mispointing on SLA



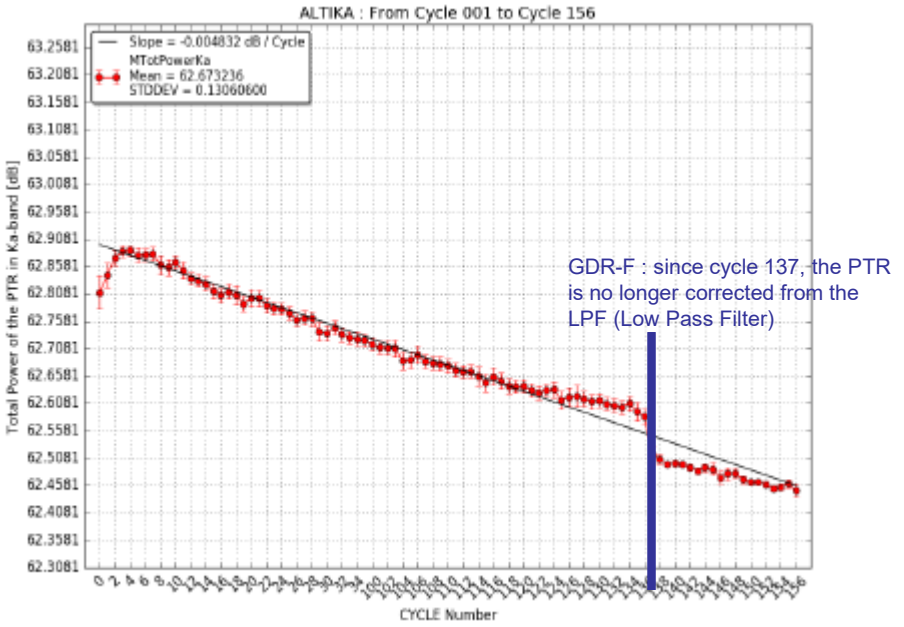
Payload Status

99.16 % **available from 01/11/2021 to 01/10/2022**

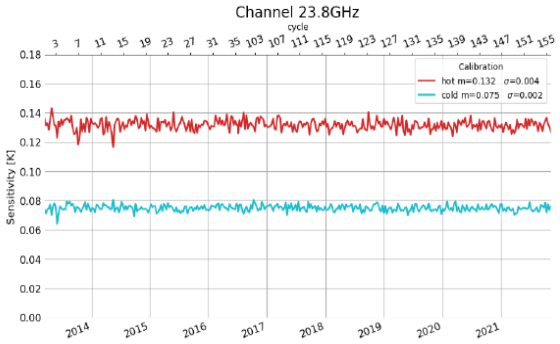
- **AltiKa** **OK**
  - routine calibrations PTR, LPF
  - quarterly CNG calibrations I^2+Q^2
  - specific calibrations over sea & ice (HD mode)
- **Radiometer** **OK**
  - Very good stability & sensitivity
- **DORIS** **OK**
  - Nominal
- **ARGOS** **OK**
  - Nominal; performance similar to other satellites, one reset over the year 2,8 days of unavailability)

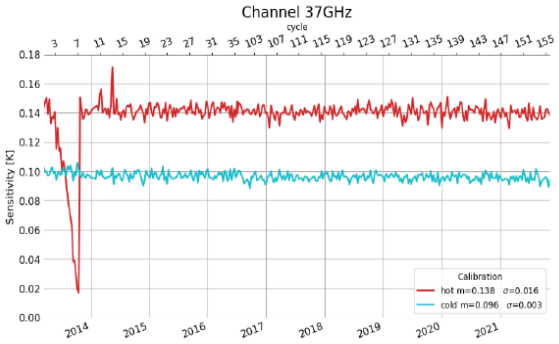
➔ **fully OPERATIONAL**

ALTIMETER total power of the PTR (Point Target Response) for Ka-band.

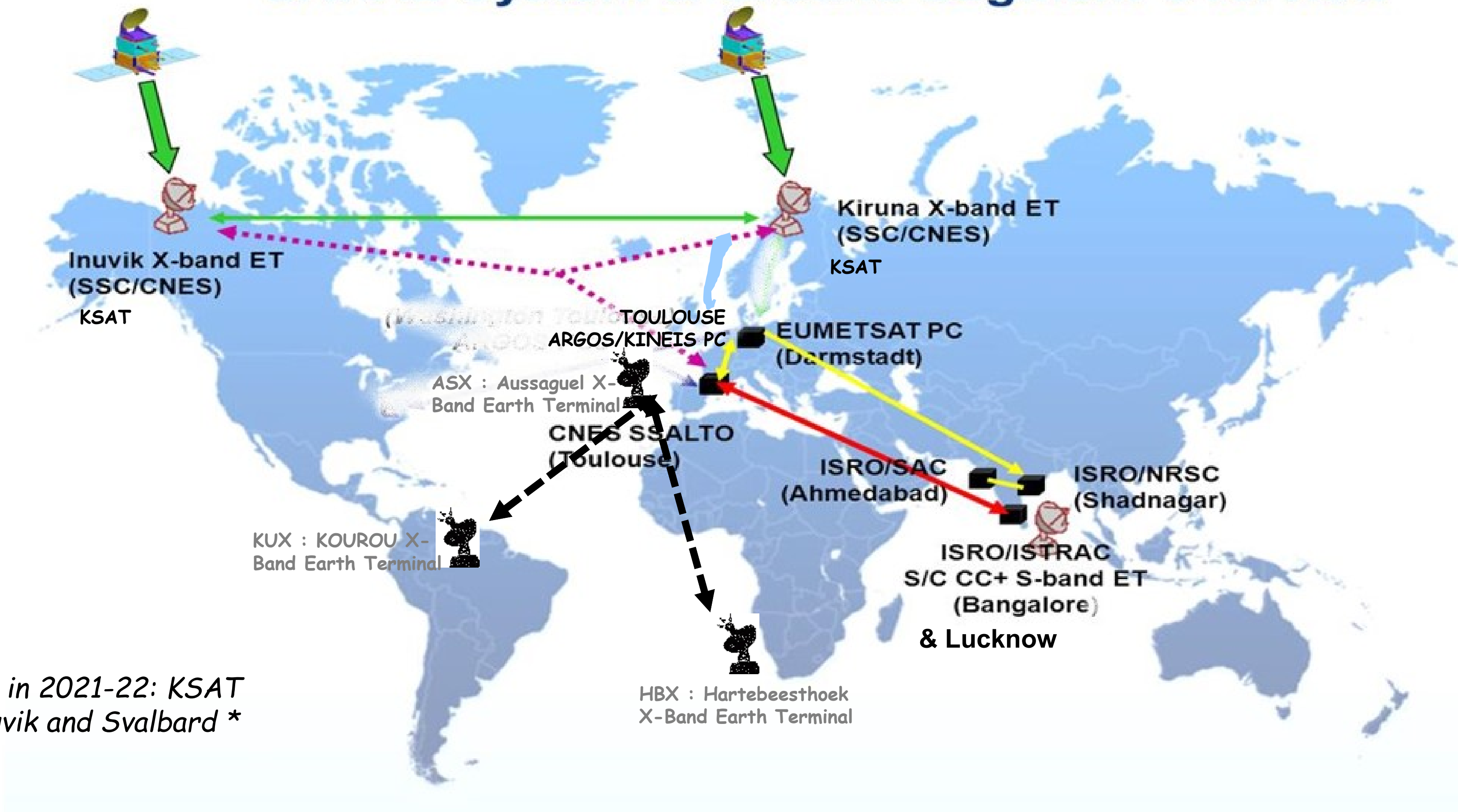


RADIOMETER sensitivity – Ch 23.8 GHz





SARAL System & Ground Segment Overview



*NEW in 2021-22: KSAT at Inuvik and Svalbard **

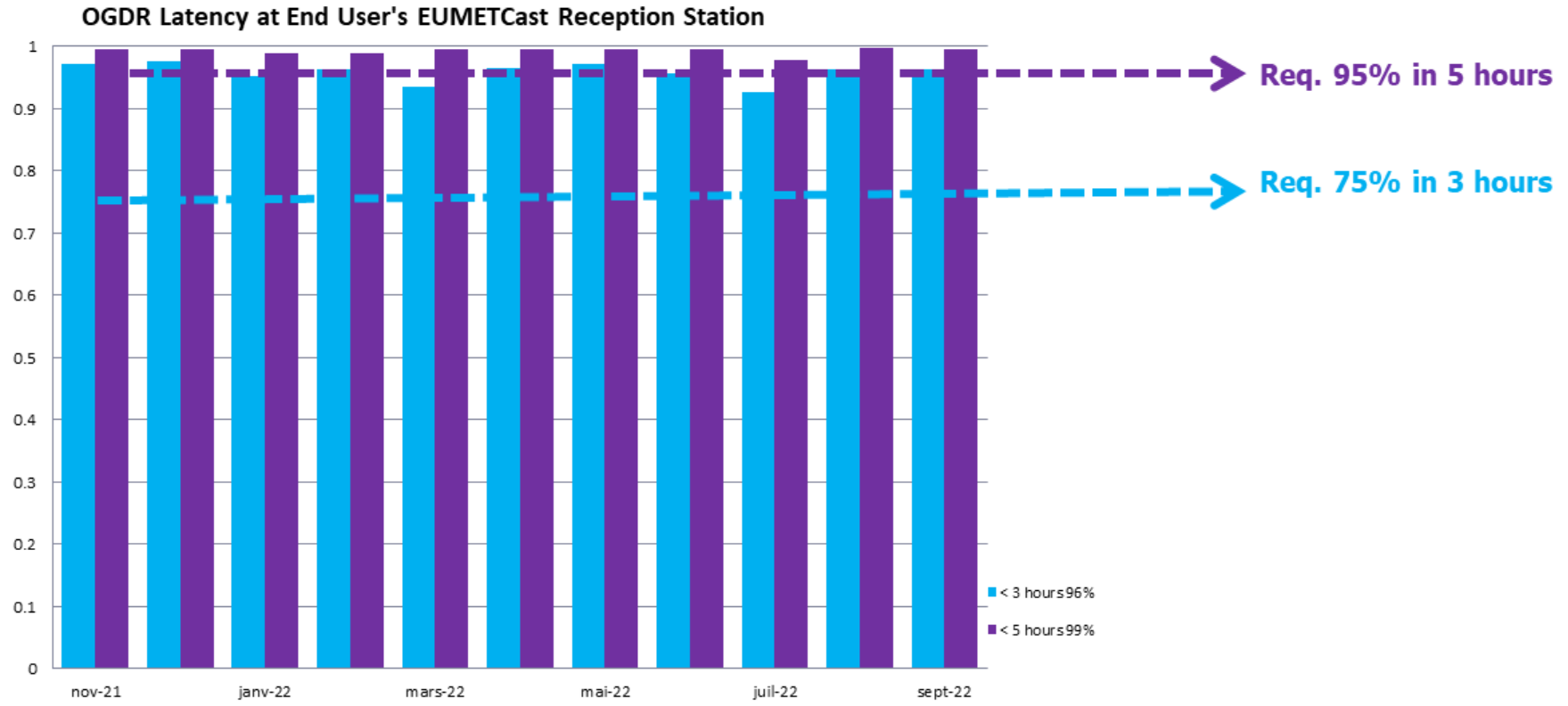
Ground & Operations - Status and performances

- Earth terminals :
  - ISRO band-S (Bangalore, Lucknow) **OK**
  - ISRO band-X (Shadnagar) **OK**
  - CNES band-X (Kiruna, Inuvik, Aussaguel, Hartebeeshoek
  - and Kourou, KSAT stations (Inuvik + Svalbard) **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**

DATA PRODUCTS

SARAL OGDR Latency at EUMETCast



SARAL/ALTIKA Products latency - IGDR (Interim Geophysical Data Record)

IGDR

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

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

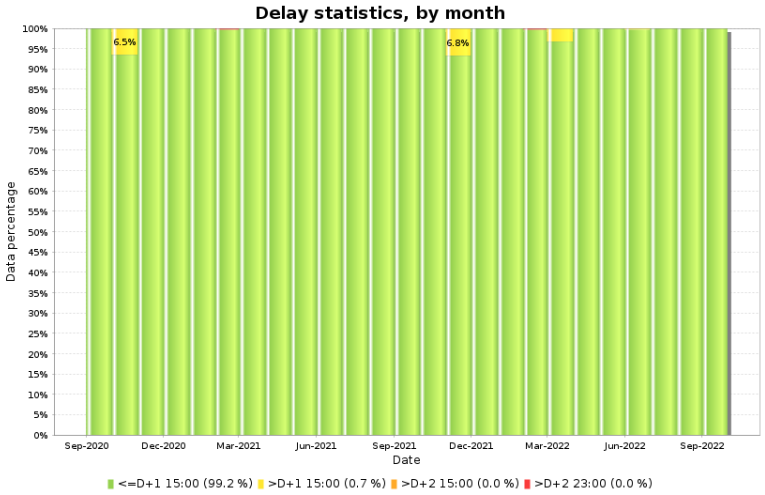
From 1/10/2016 to 30/9/2017
- 99.7 % < 3 days
- Mean delay : 1.4 days

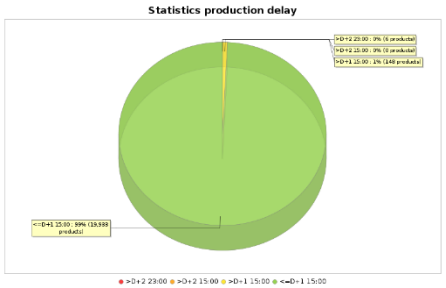
From 1/10/2017 to 01/09/2018
- 99,6 % < 3 days
- Mean delay : 1.4 days

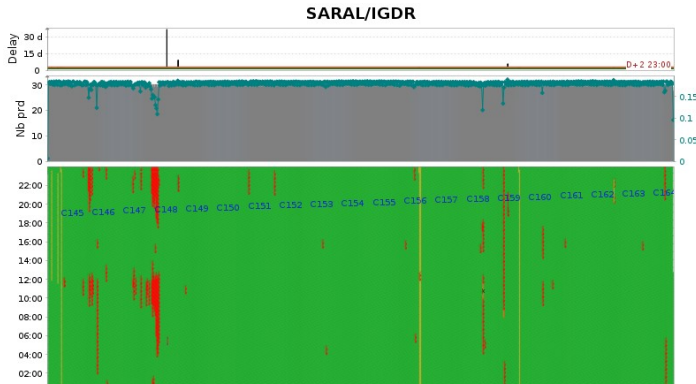
From 1/09/2018 to 01/10/2019
- 99,8 % < 3 days
- Mean delay : 1.4 days

From 30/09/2019 to 30/09/2020
- 99.2% < 3 days
- Mean Delay: 1.5 days

From 30/09/2020 to 30/09/2022
- 99.3 % < 3 days
- Mean Delay: 1.4 days







SARAL/ALTIKA Products latency

GDR (Geophysical Data Record)

GDR

Requirement ~40 days

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

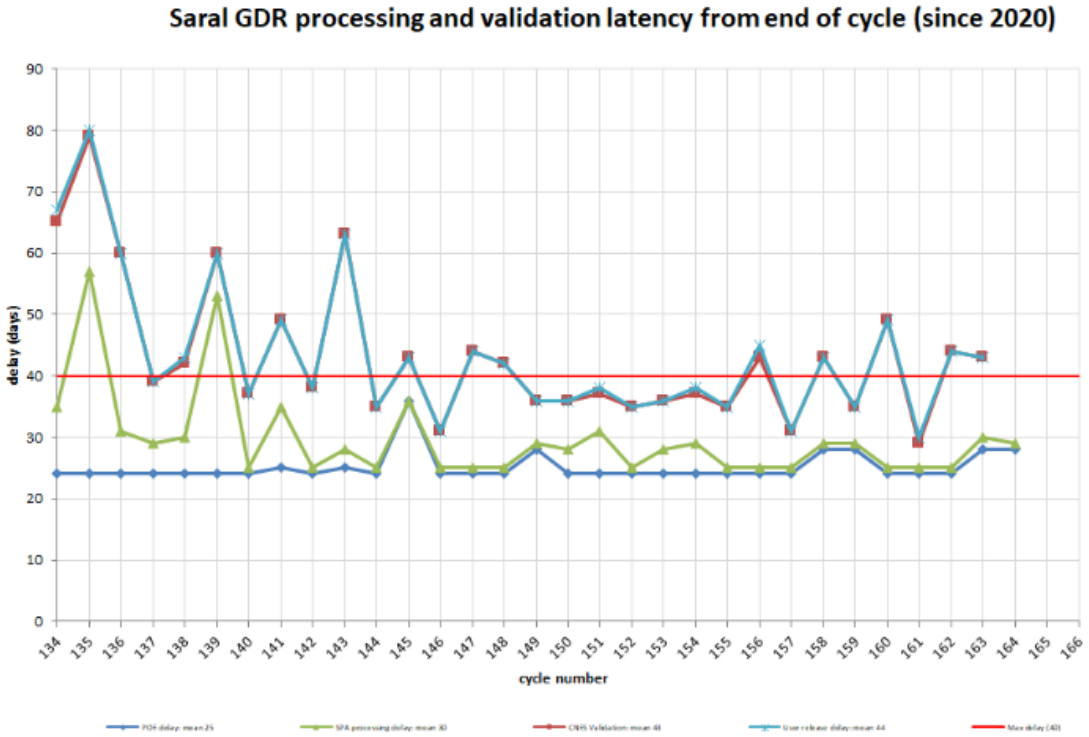
From 01/10/2016 to 30/09/2017
compliant (average: 29.5 days)

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)

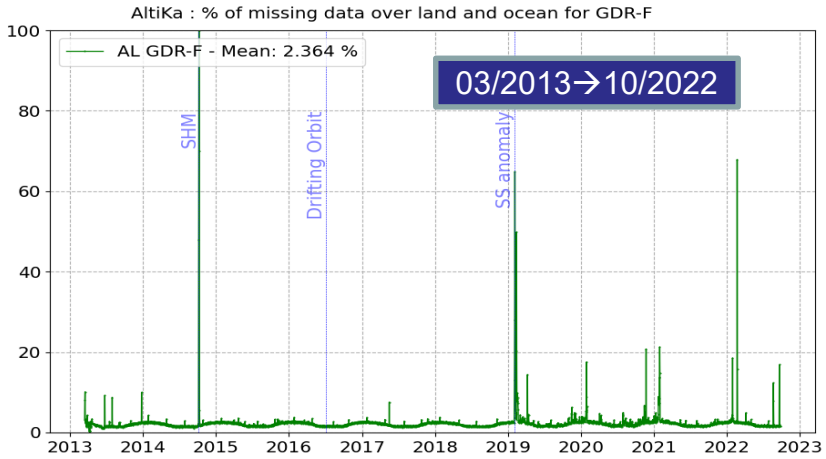
From 30/09/2019 to 30/09/2020
compliant (average: 40.3 days)

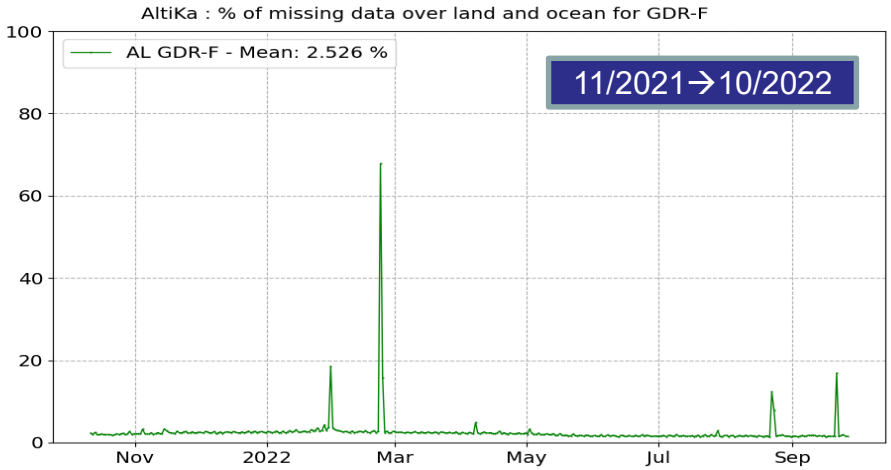
From 30/09/2020 to 30/09/2022
compliant (average: 28.4 days)

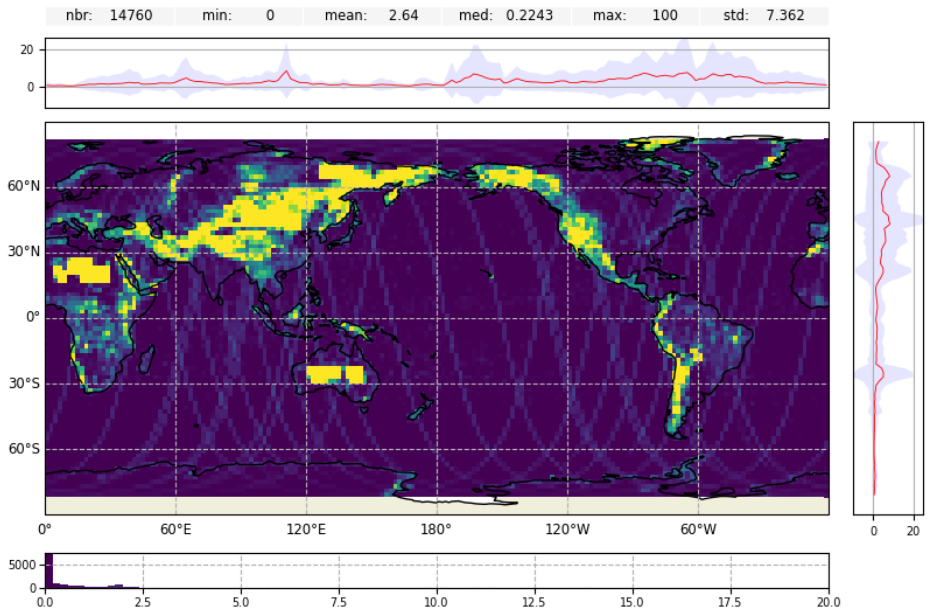


PERFORMANCES

Data availability - Global coverage







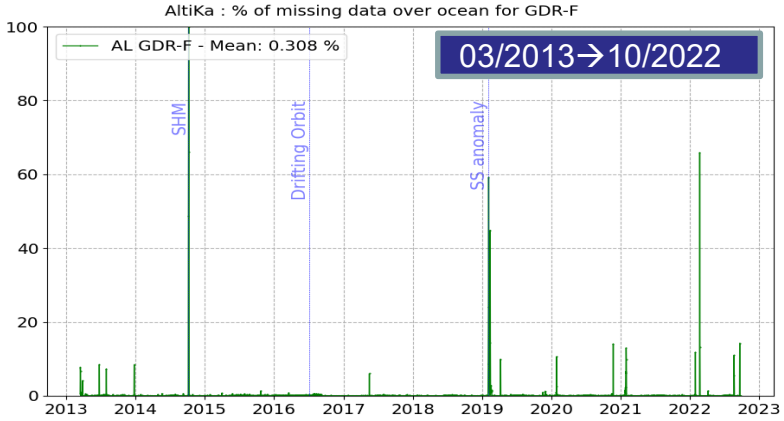
Less than 3% of missing measurements over the globe

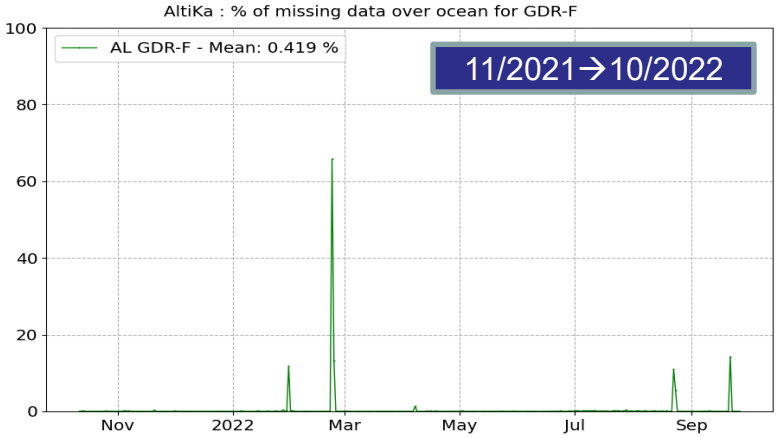
➔**Global coverage (ocean + land) :**
03/2013 to 10/2022 ≈ 97,64%

➔**Global coverage (ocean + land) :**
11/2021 to 10/2022 ≈ 97,47%

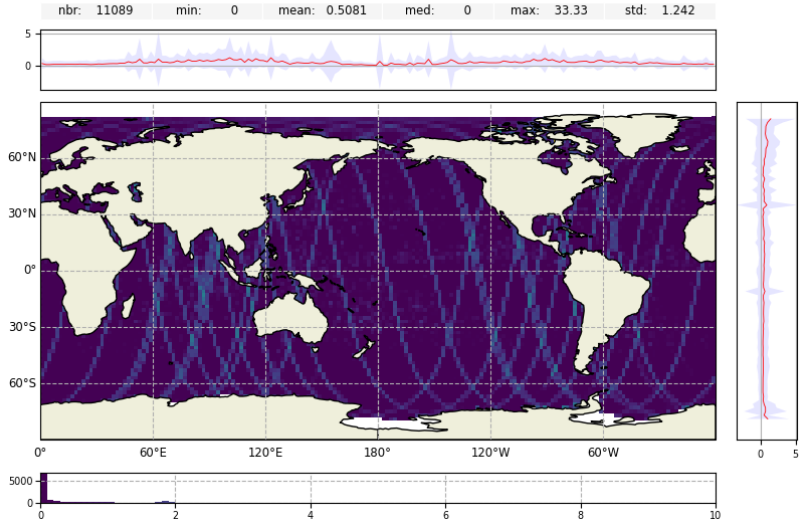
Data availability - Ocean coverage

' The GDR shall contain 90% of all possible over-ocean data (acquisition and archive) during a 3-year period with no systematic gaps '





AltiKa : % of missing data over ocean for GDR-F
10-2021 to 09-2022



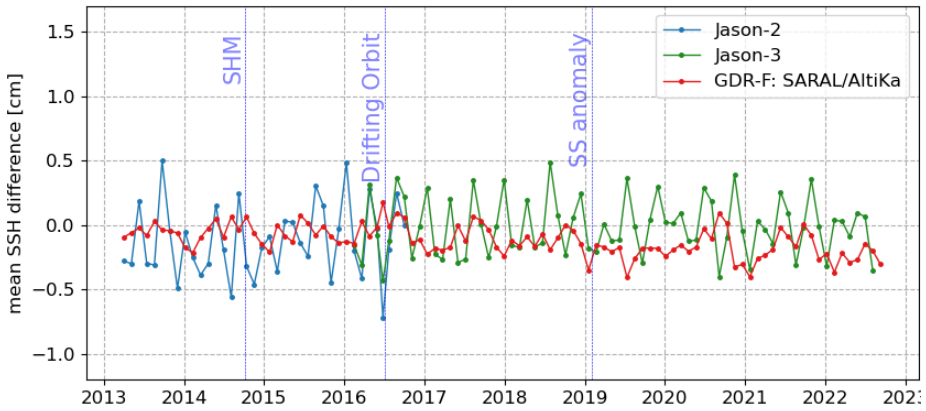
Less than 0.3% of missing measurements over oceans

- **Ocean coverage (2013 to 2022) ≈ 99.70%**
- **Ocean coverage 11/2021 to 10/2022 ≈ 99,63% > Mission requirements**

Performance Cross-over : 4,99 cm for GDR

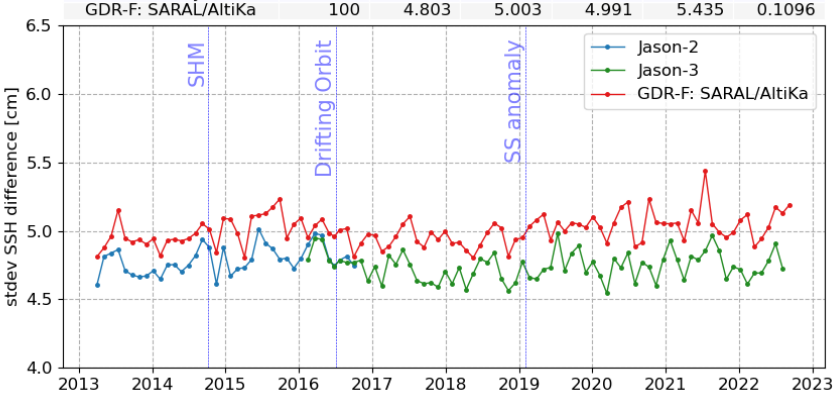
Monitoring of mono-missions crossovers
|lat.| < 50deg, bathy. < -1000m, ocean var. < 0.2m

	nbr	min	mean	med	max	std
Jason-2	38	-0.7172	-0.1225	-0.1791	0.4985	0.2837
Jason-3	69	-0.4322	-0.0148	-0.0136	0.4882	0.2239
GDR-F: SARAL/AltiKa	100	-0.4054	-0.1185	-0.1252	0.176	0.116



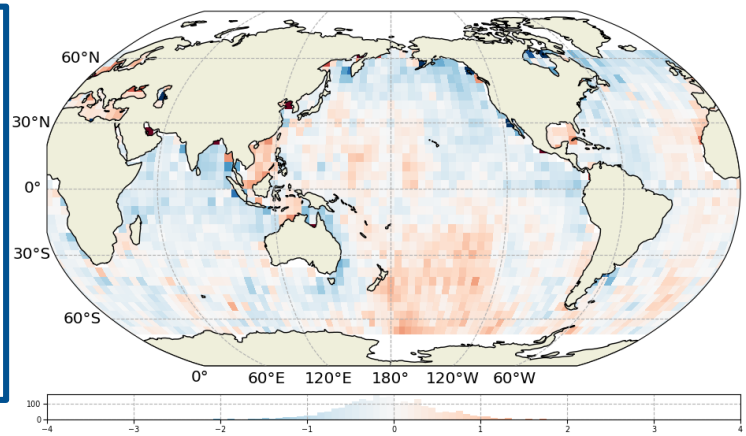
Monitoring of mono-missions crossovers
|lat.| < 50deg, bathy. < -1000m, ocean var. < 0.2m

	nbr	min	mean	med	max	std
Jason-2	38	4.607	4.785	4.788	5.013	0.1
Jason-3	69	4.544	4.741	4.739	4.981	0.1022
GDR-F: SARAL/AltiKa	100	4.803	5.003	4.991	5.435	0.1096



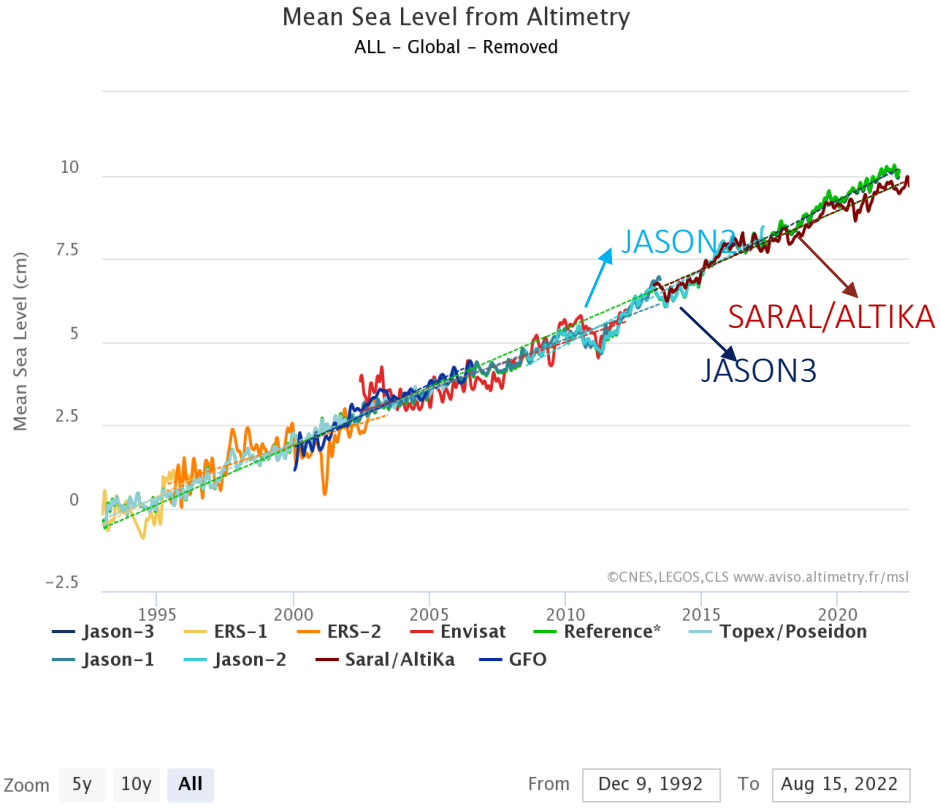
- Sea level analysis at Crossovers shows a closer performance to Jason's (GDR) with an average mean difference of -10 mm (-12 mm for J2, -4 mm for J3 compared to -4,8 cm in GDR-T)) with lesser annual signal amplitude.
- 4.99 cm for std of SSH differences at crossovers (typical Envisat value: 5.6 cm, GDR-T value : 5.3 cm)

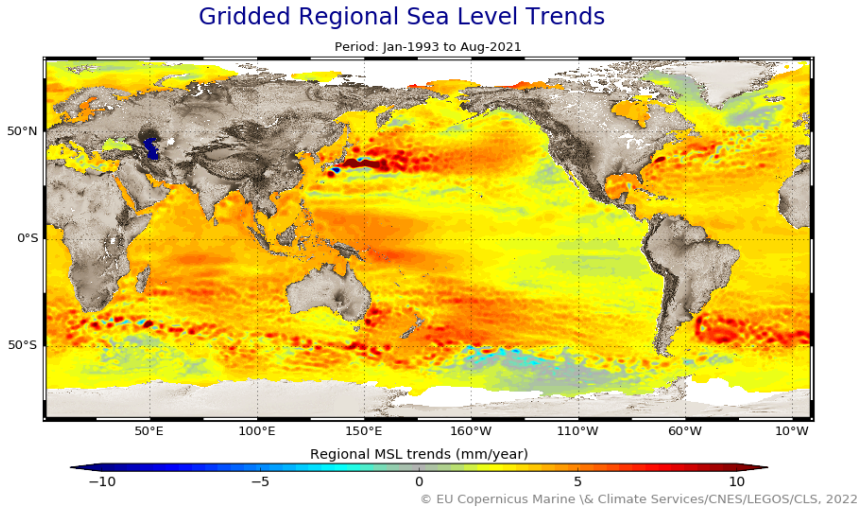
SSH difference at crossovers (cm)
centered around -0.07
01-2016 to 07-2022

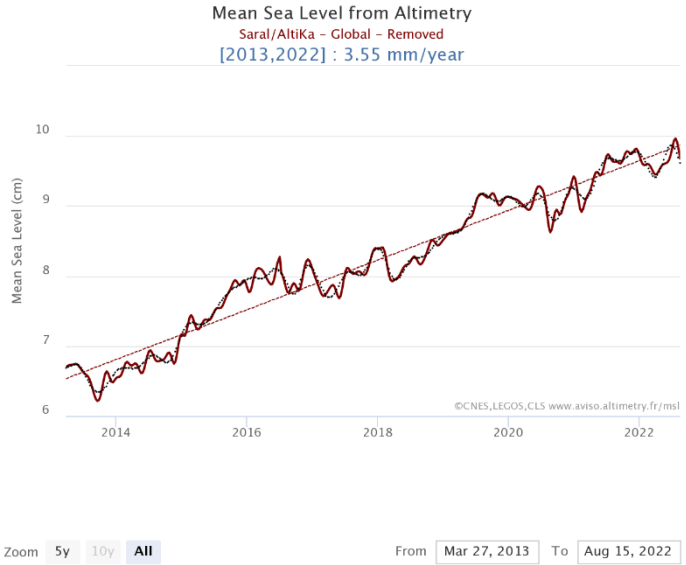


Map of mean SSH differences

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

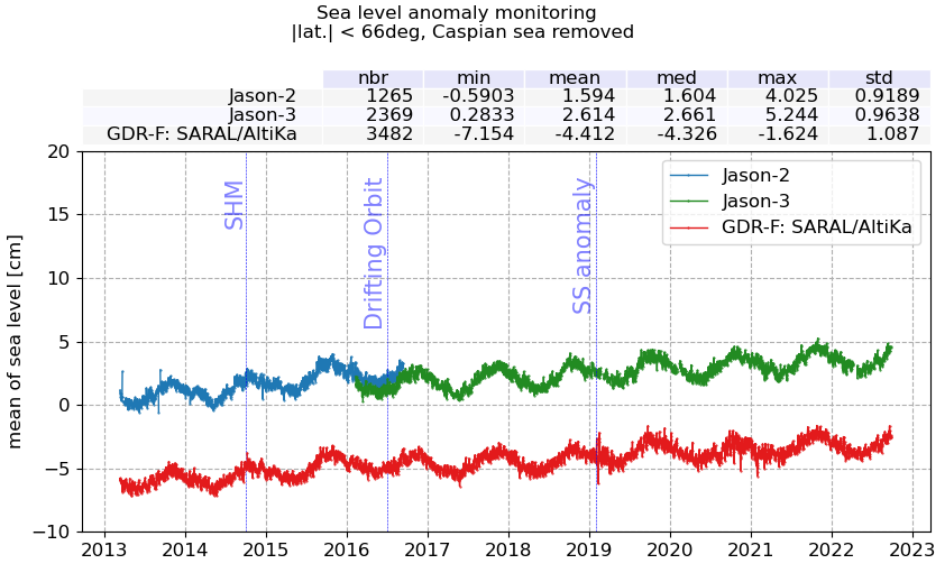


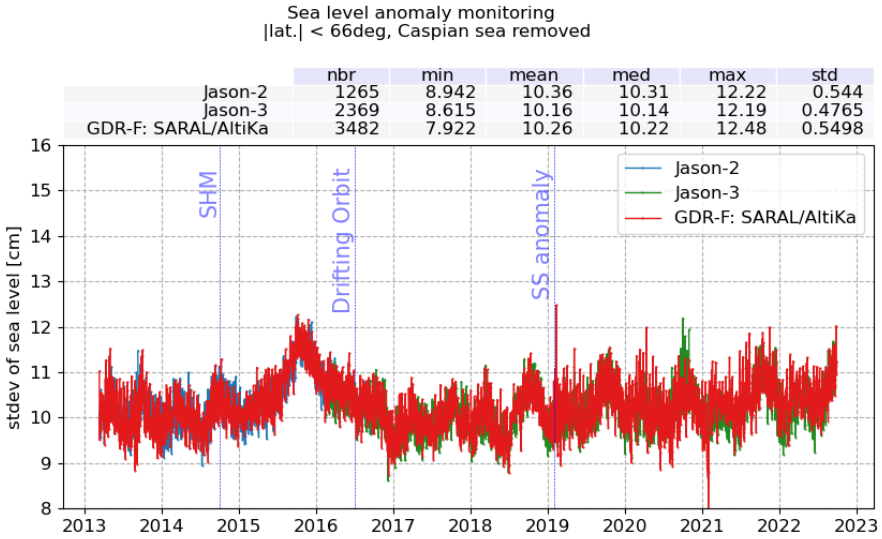




Sea-Level Anomaly performances (Altika vs Jason-2 & 3)

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°

SARAL presentations to SEE

- **Regional and Global CAL/VAL for Assembling a Climate Data Record -** Thu, Nov 03 2022, 14:00 - 15:45 - Mezzanine
  - CVL2022_010 - Global Ocean Data Quality Assessment of SARAL/AltiKa's GDR-F products -

    Jettou Ghita (CLS), Manon Rousseau (ALTEN), Nadege Queruel (CNES), Françoise Bignalet-Cazalet (CNES), Nicolas Picot (CNES), Pierre Prandi (CLS)
  - CVL2022_011 - Detecting rain cells in SARAL/AltiKa data: results from a supervised learning experiment -

    Pierre Prandi (CLS), Benjamin Pelvet (CLS), Julien Bocage (CLS), Gérald Dibarboure (CNES)

- **Science III: Mesoscale and sub-mesoscale oceanography -** Thu, Nov 03 2022, 14:00 - 15:45 - Mezzanine
  - SC32022_017 - What is the benefit of high-resolution sea level anomaly datasets? A case study in the Bay of Biscay and New Caledonia regions based on Jason2-3, Saral/AltiKA and Sentinel3

    Lionel Gourdeau (LEGOS/IRD), Nadia Ayoub (LEGOS), Rosemary Morrow (LEGOS), Robin Chevrier (CLS), MeiLing Dabat (cls), Fabien Leger (LEGOS), Fabien Blarel (LEGOS)

Summary of System Requirements and Performances

From November 2021 to October 2022

⇒ **Global satellite unavailability** **~0,99 %** **< 4% req**

bus : 0,15 % altimeter & radiometer : 0 % Doris : 0% Argos: 0.84%

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

Global SARAL system availability :
~99.1 % after almost 10 years in orbit !!

SARAL/Altika Data quality remains excellent, even when considering the various mispointing events, and provides an excellent coverage of ocean :

GDR data availability since 14th March 2013
All surfaces : 97.64%
Over Ocean : 99.70%

FOCUS on Science SARAL interest

J. Verron/ P. Bonnefond

Ka innovation and openings to other missions

SARAL/AltiKa Ka vs. Ku in Brief

- Improved vertical resolution
- Smaller footprints
- Improved along-track resolution
- Shorter decorrelation times for sea echoes
- Better discrimination in transition zones
- Lesser ionospheric errors
- *Sensitivity to small rains (no strong problem seen)*

Ka innovation and openings to other missions

SARAL/A

- Improve
- Smaller f
- Improve
- Shorter
- Better di
- Lesser io
- *Sensitivit*

- **Open ocean:** significant gain in resolution/accuracy
- **Coastal ocean:** more reliable near the coast than Jason 2/3 (twice closer)
- **Ice:** large backscatter sensitivity in space over ice and snow
- **Inland waters:** better accuracy w.r.t. ENVISAT, continuity ERS/ENVISAT/SARAL on the same track
- **Operational (SSH, SWH)** straightforward to use

An innovative Ka-band strength that gets even better with time

- For the oceans
- For geodesy
- For ice/snow
- For hydrology

.... And which inspires several projects of satellite missions scheduled or future

- For the oceans
- For geodesy
- For ice/snow
- For hydrology

.... And which inspires several projects of satellite missions scheduled or future

- **For the ocean**
- **For geodesy**
- **For ice/snow**
- **For hydrology**

- Ka-band chosen for **SWOT** (KaRIN instrument)
- Ka-band envisioned for Wide Swath Altimetry (**WiSA**), Copernicus, CNES, ESA and for Sea surface KInematics Multiscale monitoring (**SKIM**), ESA

- Ka-band envisioned for Copernicus Polar Ice Snow Topography Altimetry (**CRISTAL**), Copernicus, CNES, ESA

- Ka-band chosen for **SWOT** (KaRIN instrument)
- Ka-band envisioned for SMall Altimetry Satellites for Hydrology

Conclusion

SARAL/ALTIKA is still performing very well after almost 10 years in orbit!! ….

Hope to continue in 2023 and perhaps beyond ….

thanks to a great support of OSTST

Thanks to all the contributors :

ISRO team, EUMETSAT team, CLS team, CNES Team

And…. Scientists !!!