SARAL Project Status

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MAJOR EVENTS SINCE LAST OSTST

Major events since last OSTST (October, 2017)

Since 4th July 2016 SARAL still in Drifting Phase

- Satellite major events
  - None
- Payload major events
  - Lost of 1h26min of Telemetry for Cycle 109, the 17-05-2017 due to a SEU on payload that leads to anomaly of exchange between payload and on board memory
- Ground major events
  - Renewal of the CNES X-band network management **IDEFIX** (service d'**I**ngestion et de **D**iffusion **E**xterne des **FI**chiers reçus en bande-**X**). The service is now fully operational after 5 years of development and qualification

SARAL will switch on this new service by mid of November 2017

  - Successful migration of EUMETSAT Operational Ground Segment into TIB (Technical Infrastructure Building)

Current SARAL-Drifting Phase mission Status is OK

CNES approved SARAL mission extension for 2 more years during Summer 2017 - no concern on ISRO side for extending the mission

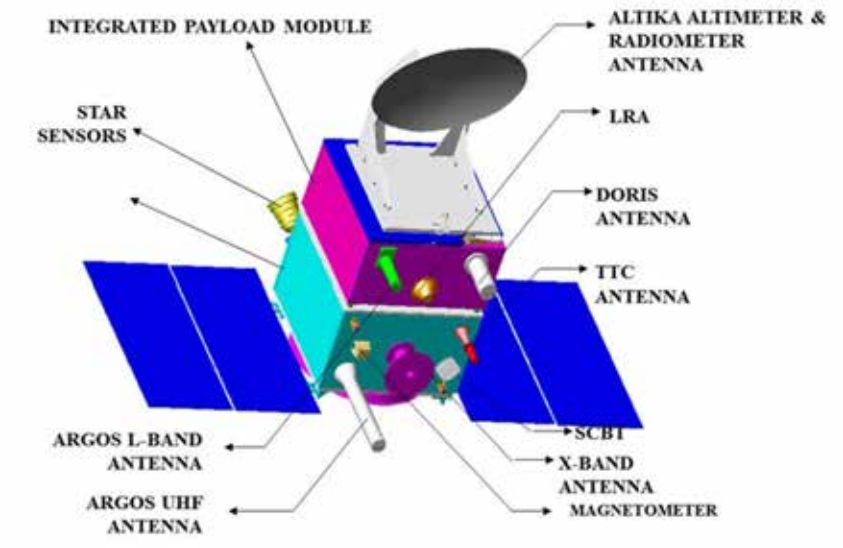
SPACECRAFT and GROUND SEGMENT STATUS

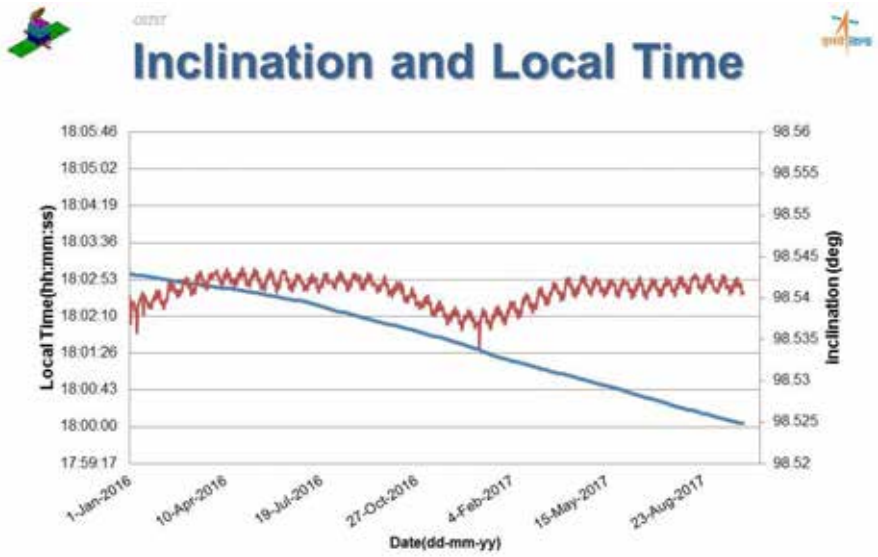
Platform Status

The SARAL satellite bus is **OK**

- Command / control , RF : **OK**
- Thermal aspects : **OK**
- Electrical aspects : **OK**
- AOCS (attitude and orbit control system) : **OK**
  with some concerns on reaction wheels :
  - RW-2 and RW-4 DFC (Dynamic Friction Compensation) torque reaches saturation level frequently (-0.01 Nm)
  - Unlike RW-1, such observations on RW-2 and RW-4 are episodic, period of increased DFC varies from few hours to few days
  - **RW-3 friction is also showing episodic increase up to saturation level since end of 2016**

SARAL bus is operational after 4,5 years in orbit

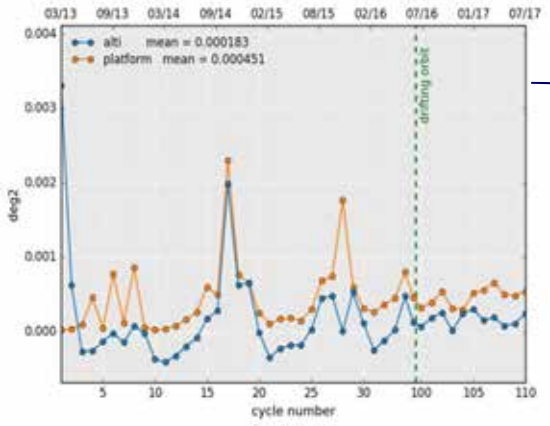


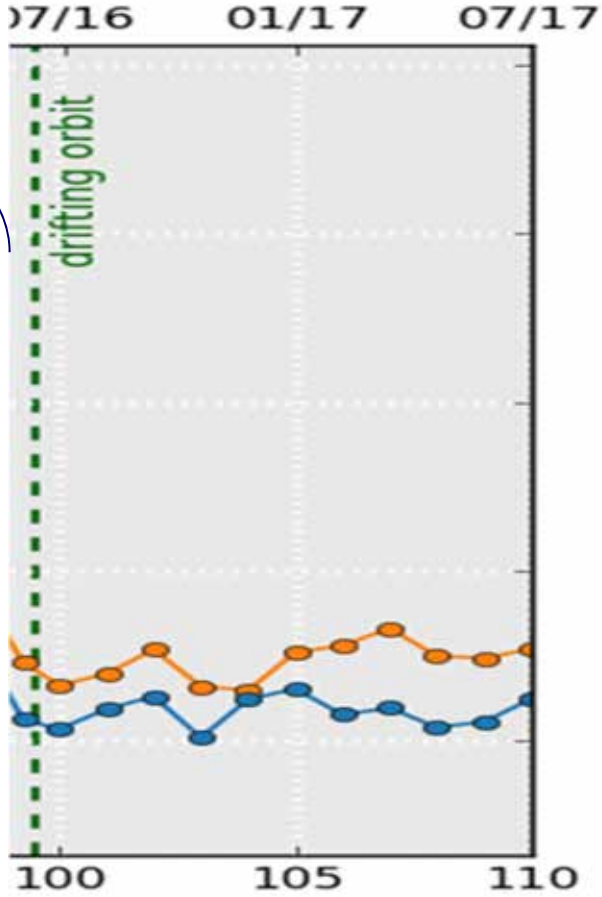


No OPC carried out after Oct 2013

Some issues with nadir pointing but minor since OSTST 2016 and drifting orbit

By cycle

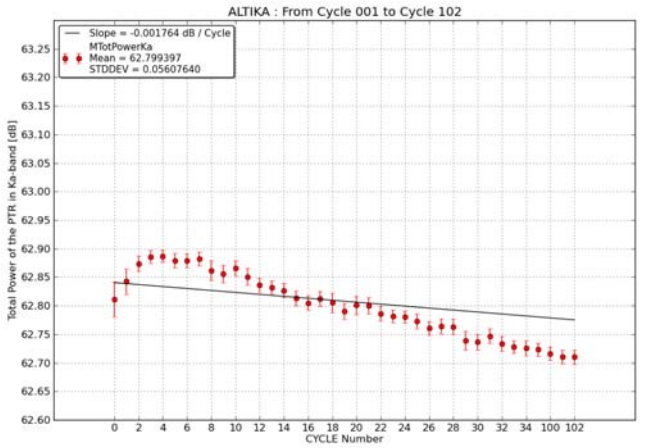




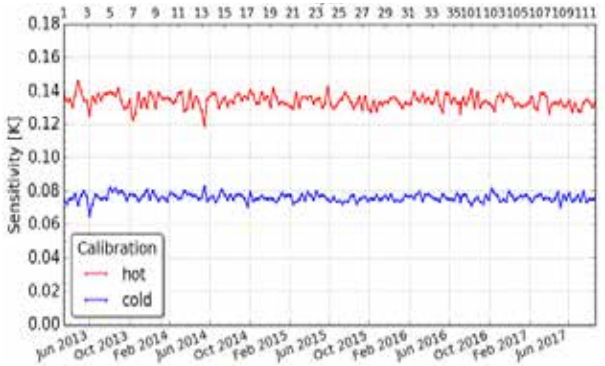
Payload Status since last OSTST (October, 2016)

- 99.98 % **available**
  - **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

ALTIMETER total power of the PTR for Ka-band.



Radiometric sensitivity - Ch 23.8GHz



	Mean (K)	σ (K)
hot	0.13	0.00
cold	0.08	0.00

➔ **fully OPERATIONAL**

Ground & Operations - Status and performances

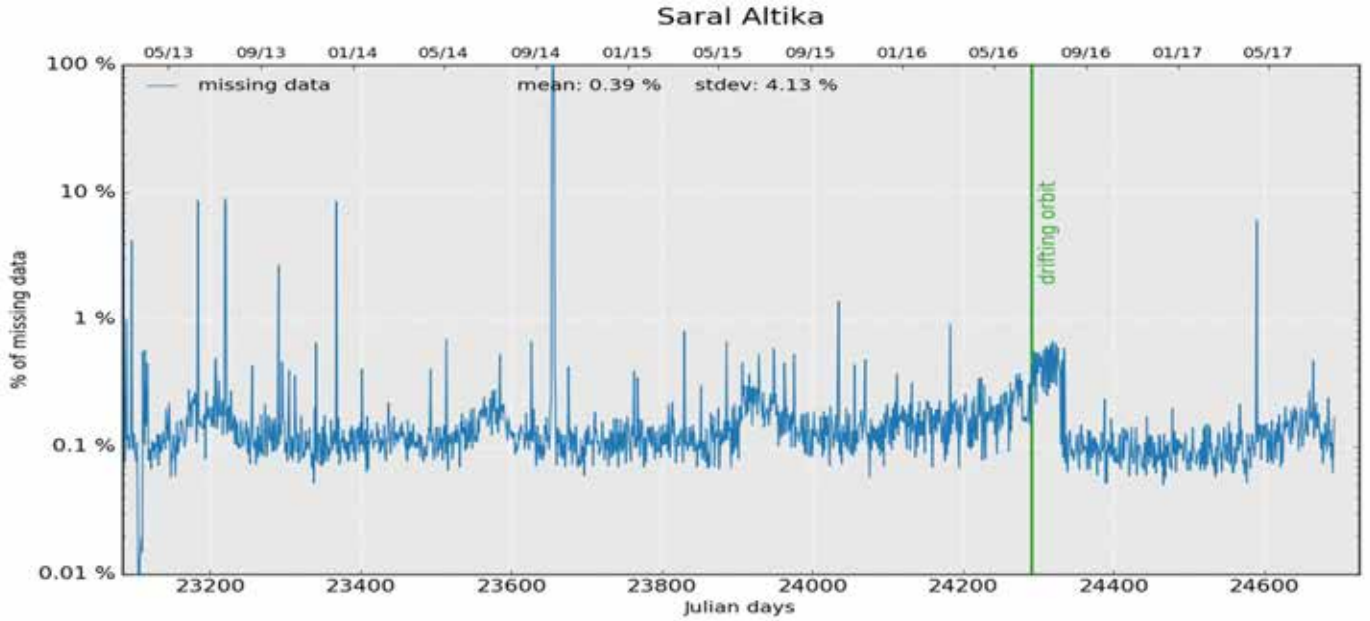
- Earth terminals :
  - ISRO band-S (Bangalore, Lucknow) **OK**
  - ISRO band-X (Shadnagar) **OK**
  - CNES band-X (Kiruna and Inuvik) **OK**
- Control Centers : **OK**
  - ISRO/ISTRAC Control center

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

PERFORMANCES

Performances : Data availability – ocean only

- Excellent Data availability over Ocean : **99.6%** of available data over oceans since no maneuvers



Percentage of missing data : GDR cycle 1 to 111

See CALVAL poster CVL_013

Performances : Xover - 5.3 cm for GDRs

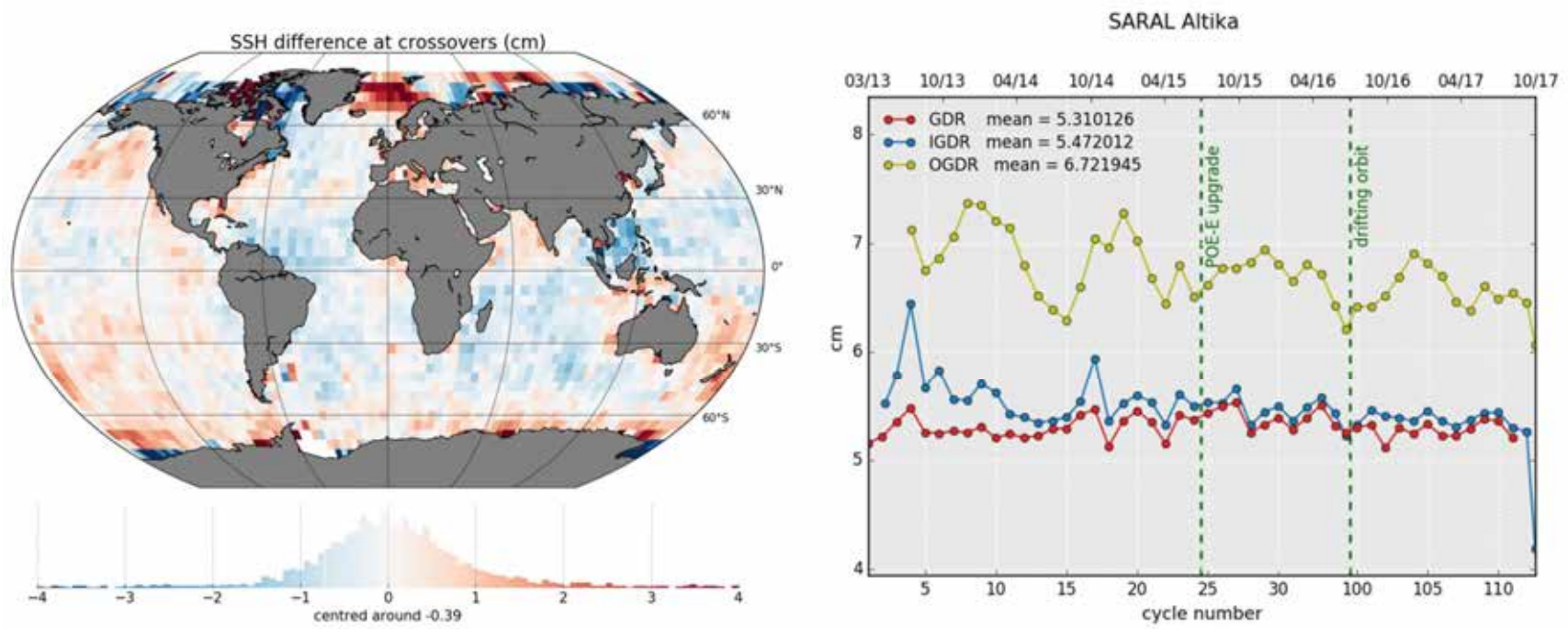
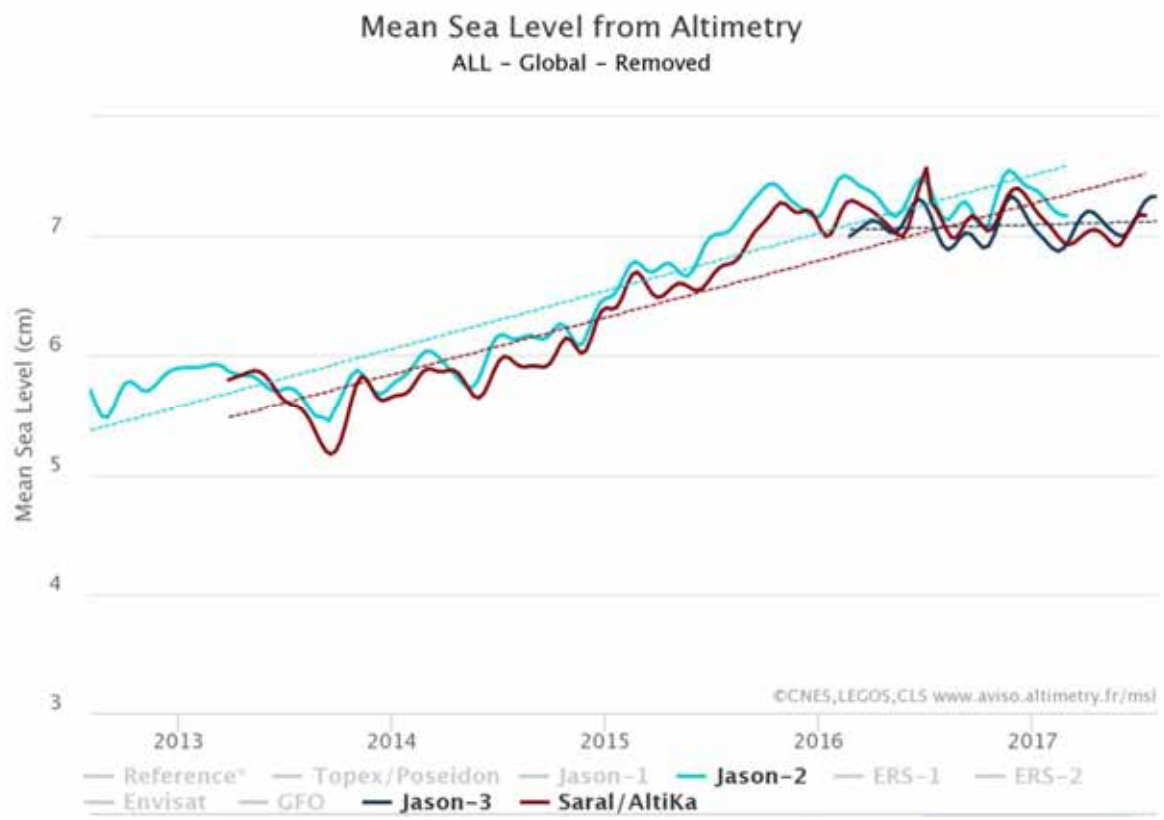


Fig5 **Performance at Xovers: [left] monitoring of standard deviation of SSH differences and [right] map of mean SSH differences**

See CALVAL poster CVL_013

Mean Sea Level same pattern as Jason-2

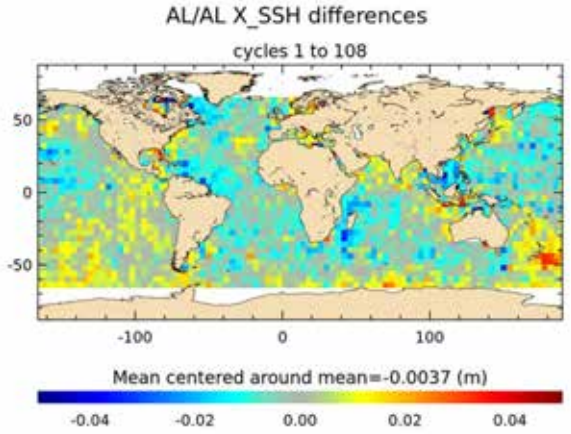
(Jason 3 not enough values for statistic point of view) even if SARAL/ALTIKA is not optimized for climate aim (season variations and sea level modifications)

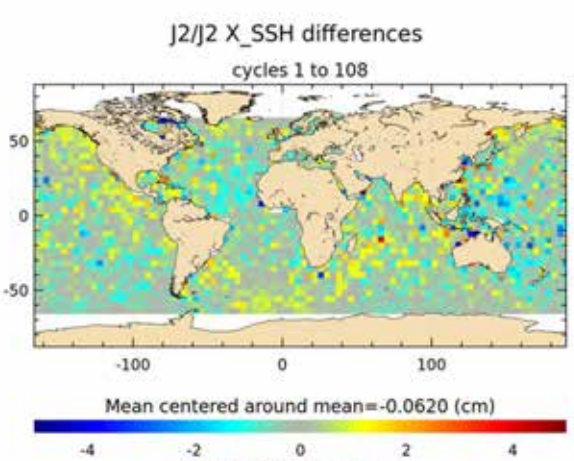


Sea-level anomaly performances (Altika vs Jason-3)

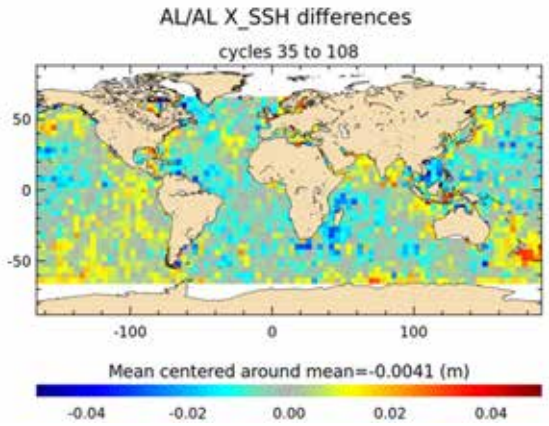
Good agreement between SARAL and JASON3

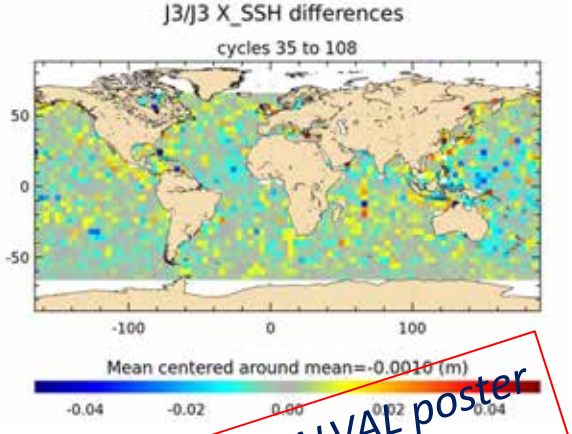
Common period AL/J3
(cycles 1 to 108)





Common period AL/J3
(cycles 35 to 108)



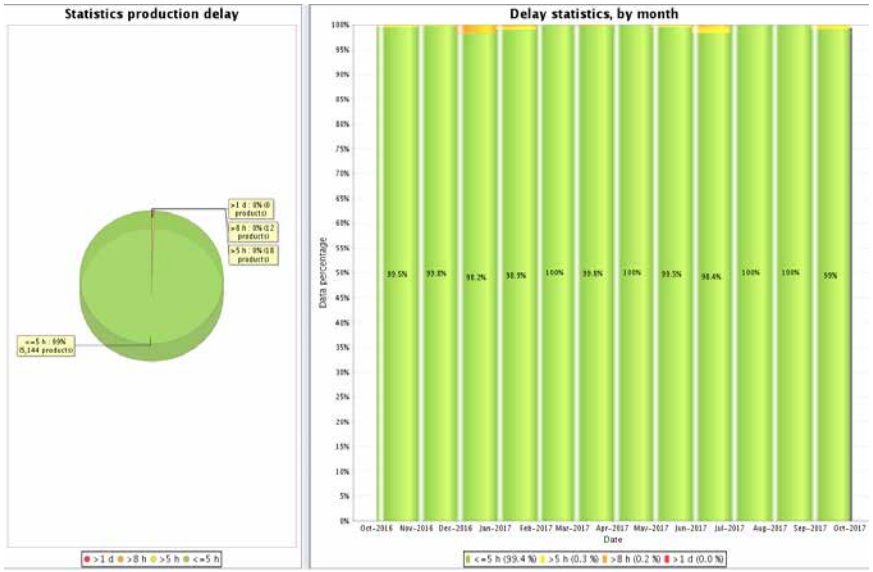


See CALVAL poster CVL_013

DATA PRODUCTS

SARAL/ALTIKA Products latency

OGDR (Operational Geophysical Data Record) from 01/10/2016 to 30/09/2017-



OGDR

Requirement 95% ≤ 5 hours

From 1/10/2015 to 30/9/2016

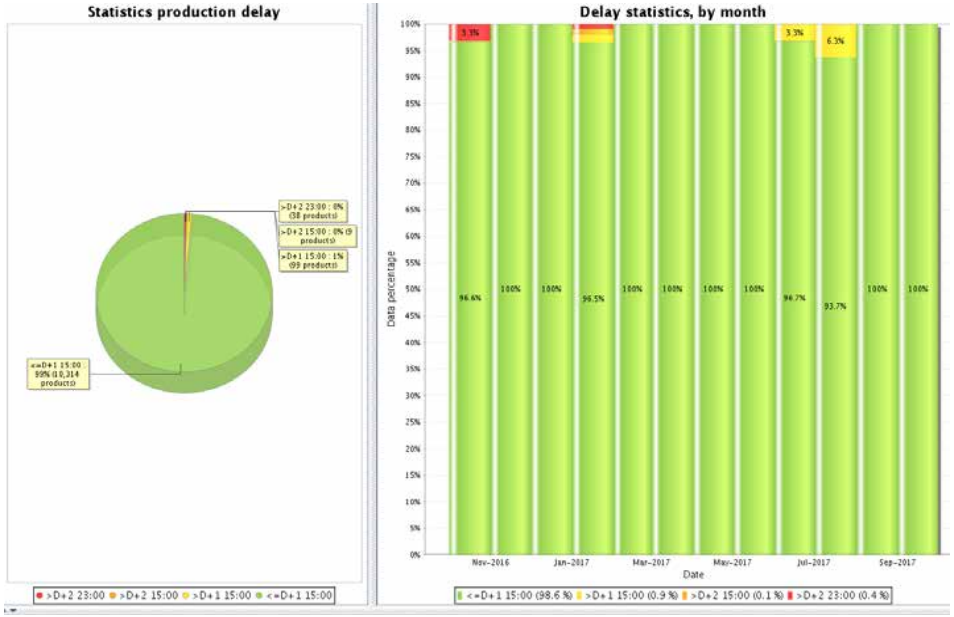
- **99.3% < 5 hours**

From 1/10/2016 to 30/9/2017

- **99.4 % < 5 hours**

SARAL/ALTIKA Products latency

IGDR (Iterim Geophysical Data Record) from 01/10/2016 to 30/09/2017-



IGDR

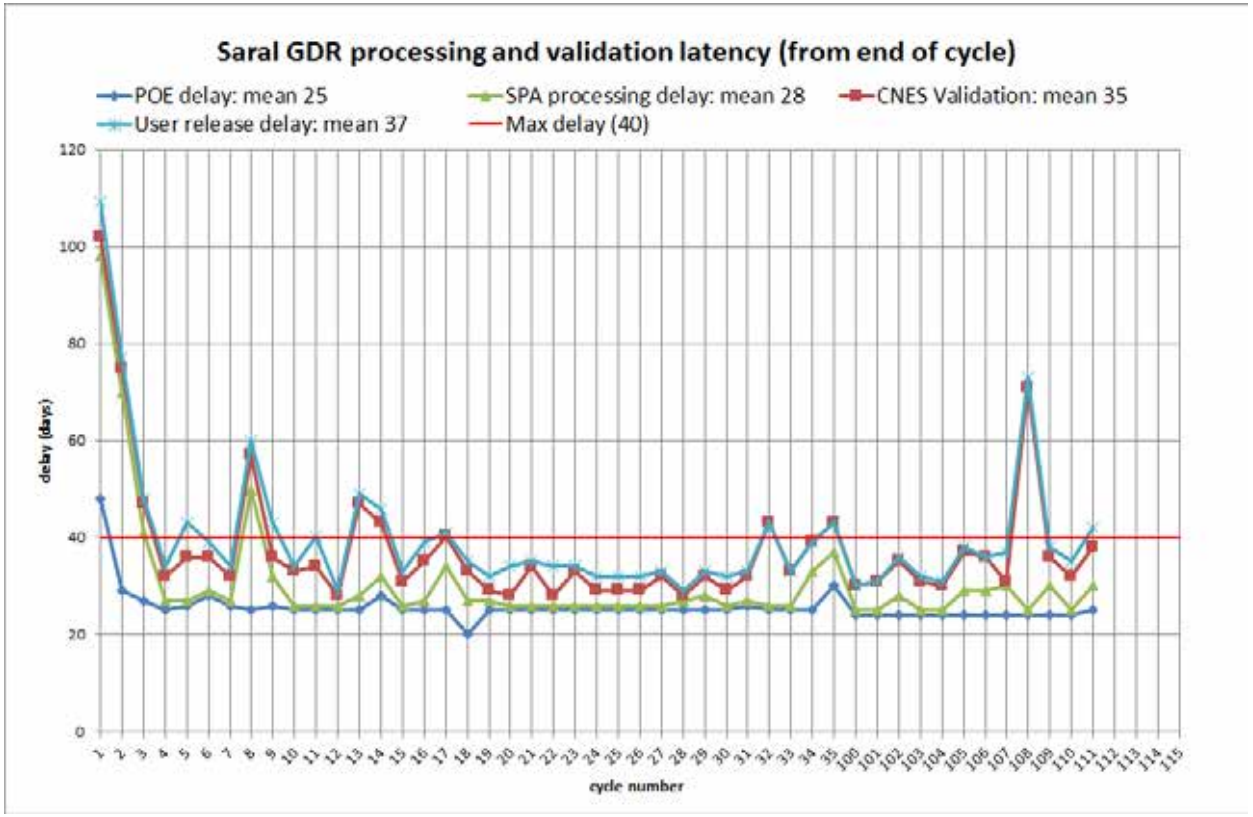
Requirement < 3 days
(objective : 1 or 1,5 days max)

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**

SARAL/ALTIKA Products latency

GDR (Geophysical Data Record) from 01/10/2016 to 30/09/2017



GDR

Requirement ~40 days

From 1/10/2015 to 30/9/2016
compliant (average: 34 days)

From 1/10/2016 to 30/9/2017
compliant (average: 29.5 days)

System Requirements and Performances

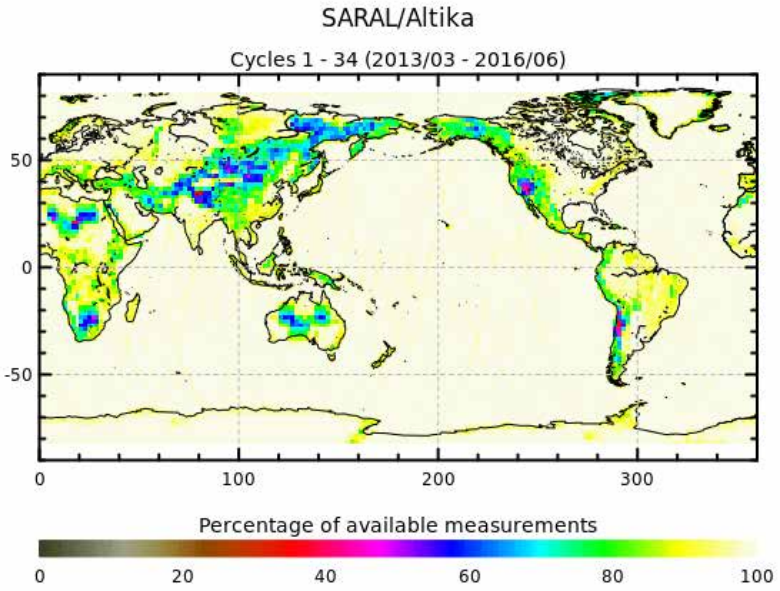
From October 2016 until October 2017

⇒ **satellite unavailability** **~0 %** **< 4% req**

bus : 0% altimeter & radiometer : 0.016% Doris : 0%

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

➔ Global SARAL system availability : 99.98 %



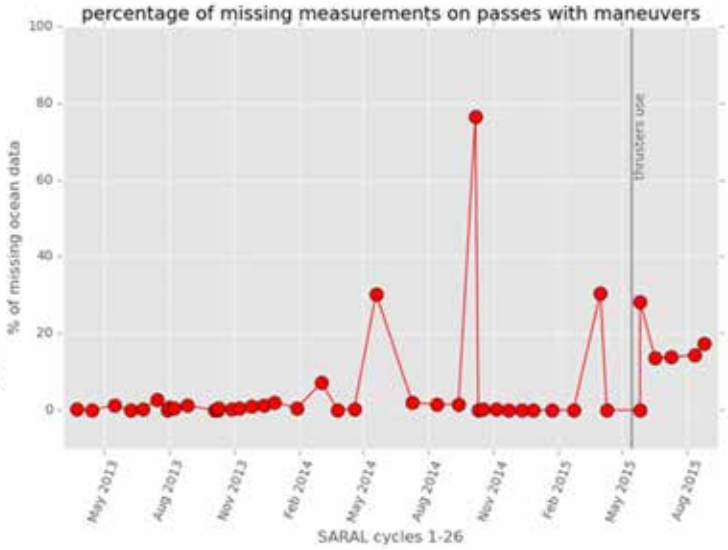
NB : GDR data availability vs theory (from 2016 annual CALVAL report)
All surfaces : 96.73 % (99.7% in 2015)
Over Ocean : 99.6 % (99.5% in 2015)

Map of the percentage of available measurements over land for SARAL/AltiKa on cycles 1 to 34

LESSONS LEARNED ~1,5 year
Of DRIFTING PHASE

SARAL Drifting Phase - history

- Since March 2015, maneuvers with thrusters in place with concerns for OPS team, altimetry, ARGOS
- October 2015 : 2 recommendations from the OSTST
- 25 February 2016 : SARAL/AltiKa 3 years in orbit
- Early 2016 : CNES study for determining the optimum orbit
- April 2016 : ISRO and CNES decide to implement a new phase for SARAL – **SARAL Drifting Phase**
- **4 July 2016 : start of the new phase**



2 AIMS for SARAL DRIFTING PHASE :

- OPERATIONAL :

Secure continuity for OCEAN CIRCULATION models (OGDR et IGDR: Sea Surface Height)
Secure continuity for OCEAN WAVE models (OGDR: SWH Significant Wave height)

- SCIENCE:

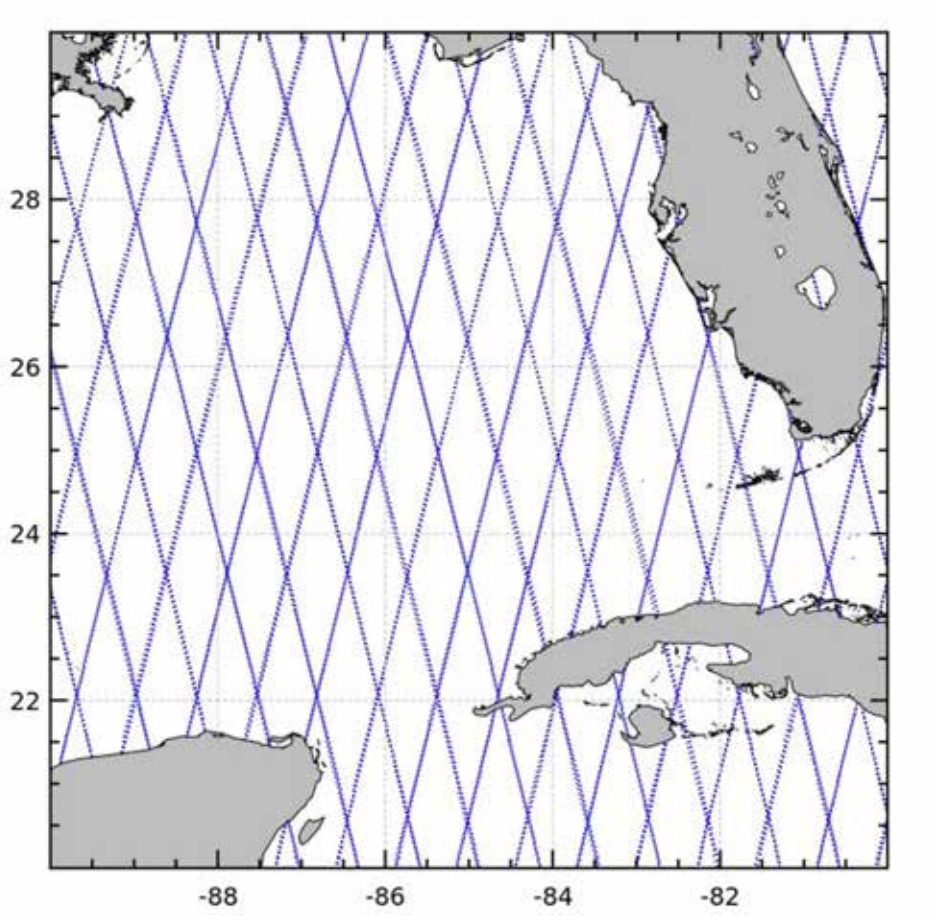
Increase density of the ground track for MARINE GEODESY

Since 4th July 2016 SARAL still in Drifting Phase

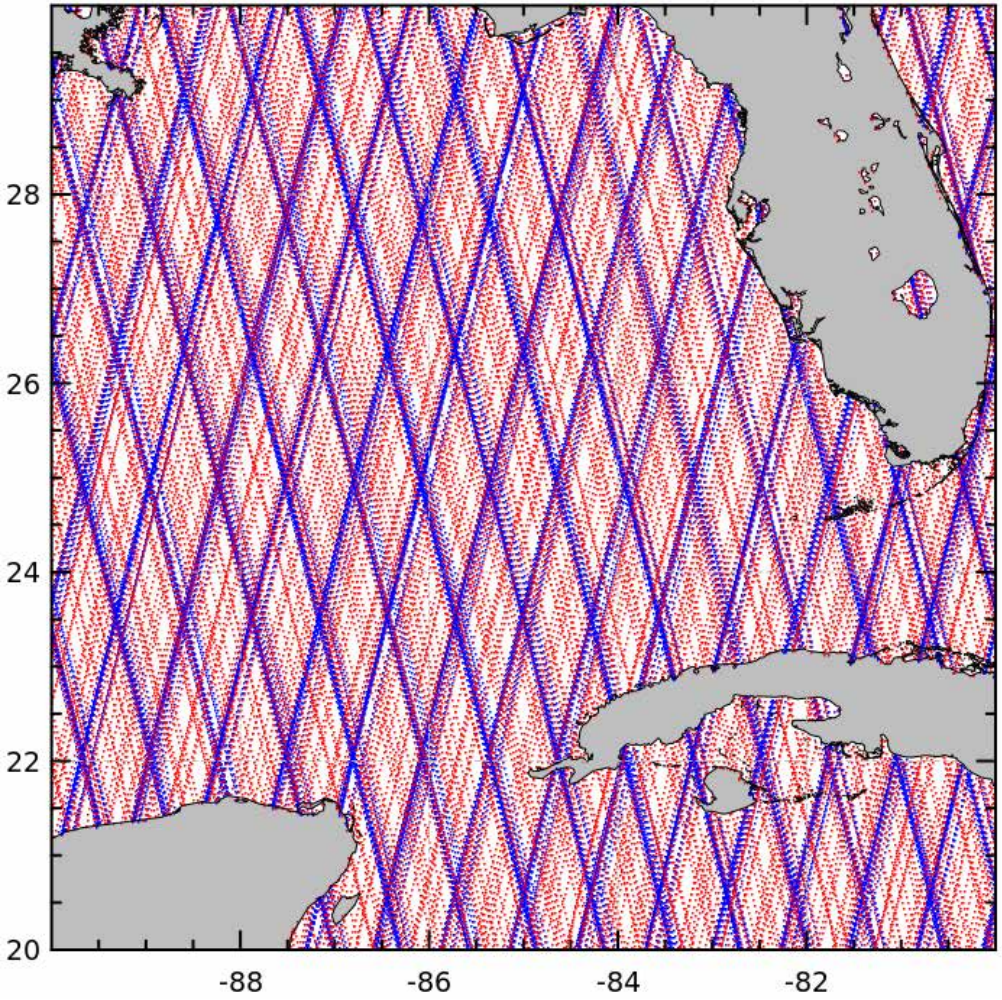
Ground track of SARAL

- Blue line : before drifting phase
- Red line : drifting phase

Note : Densification of grid as planed

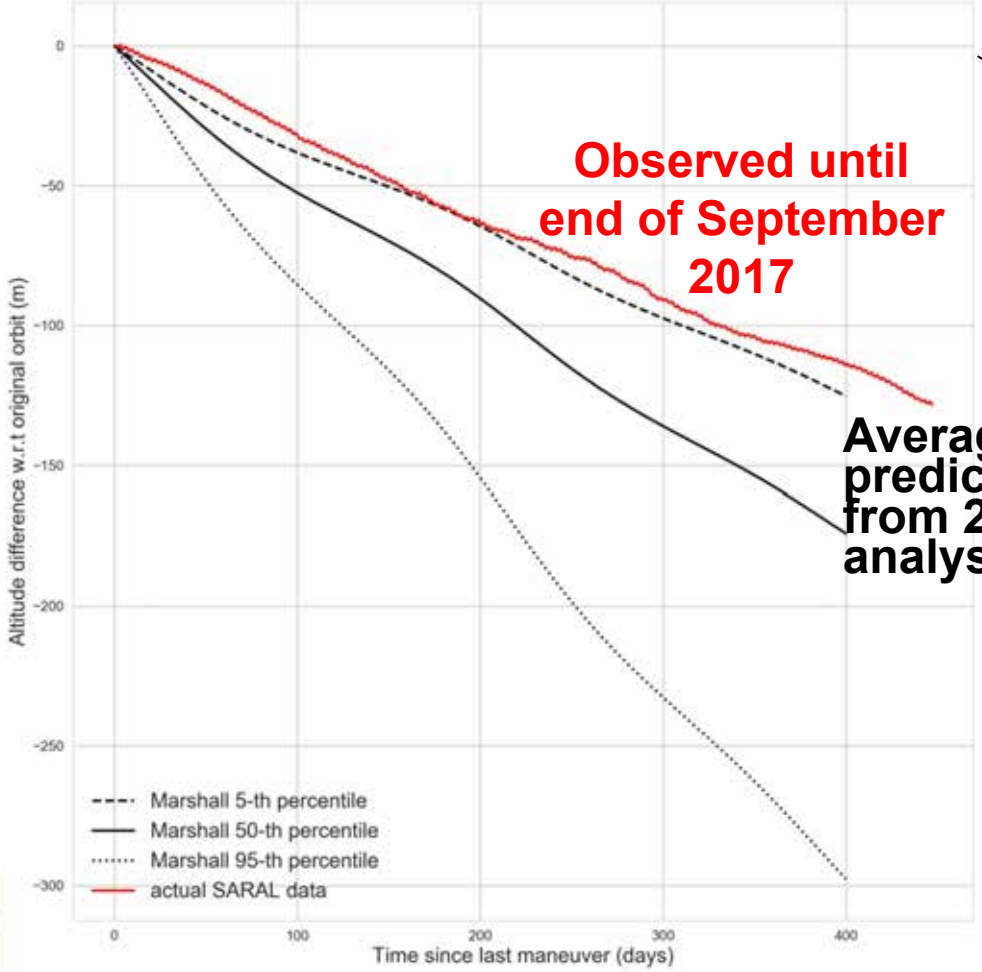


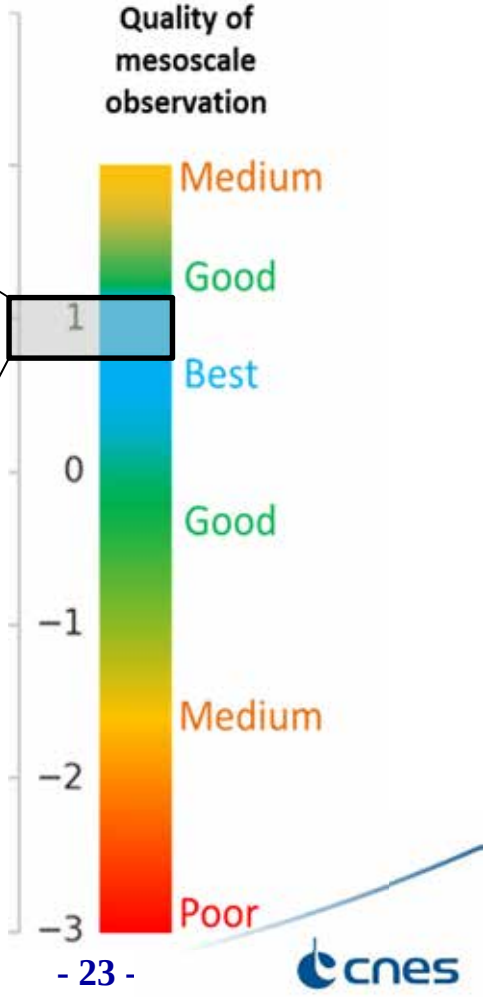
Since 4th July 2016 SARAL still in Drifting Phase



Altitude Status after 15 months

- Altitude decay is approx 3 times less than « fastest scenario » discussed in 2016
- Best sampling point should be reached in approx 3 years (slowly improving until then)
- Mesoscale sampling should remain excellent for 10 years

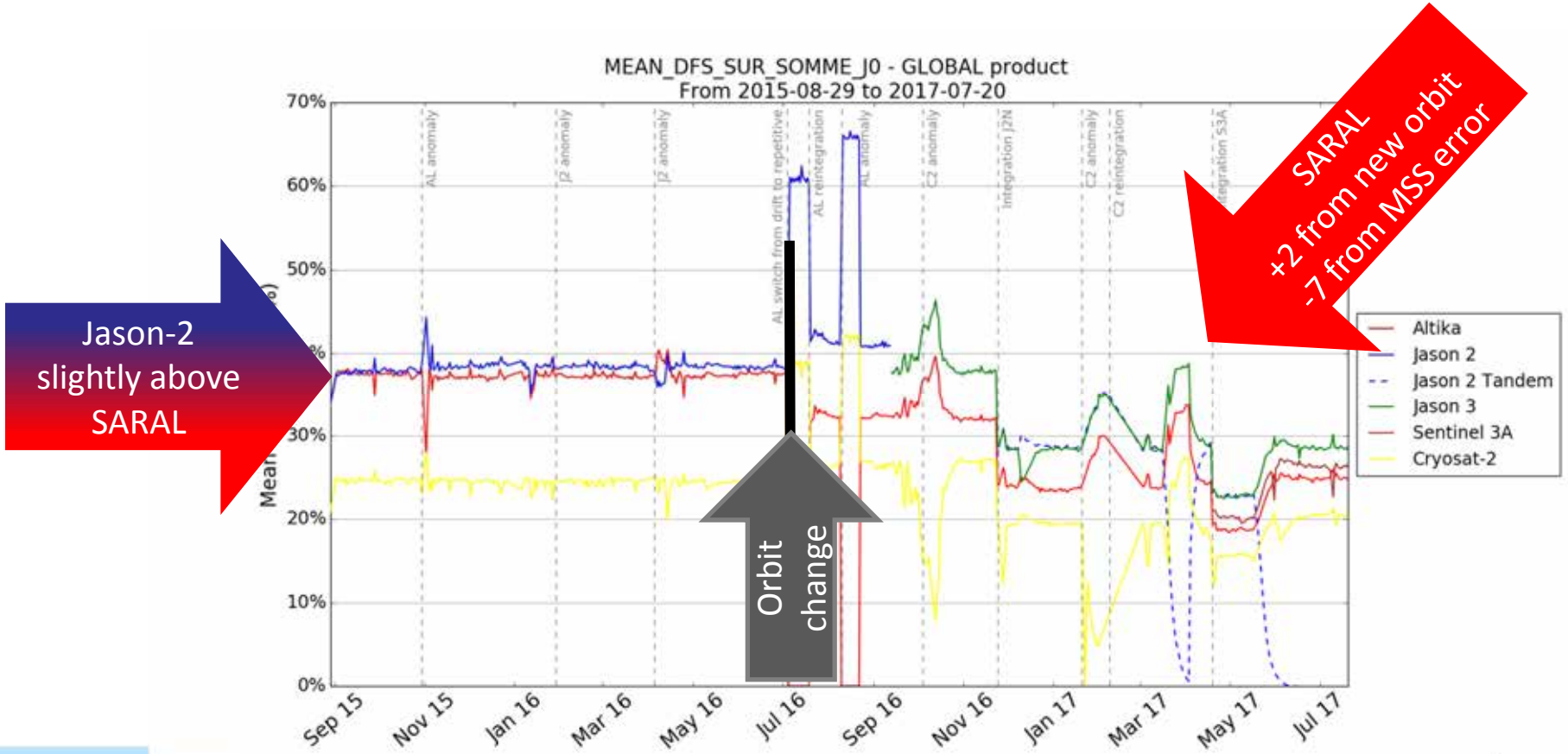




Contribution of SARAL in DUACS/CMEMS maps (%)

ALTIKA provides more than 25% of the coverage used by CMEMS (ocean forecast)

- Improved SARAL sampling is captured by DUACS/CMEMS metrics (approx +2 points)
- Altika now on an uncharted ground track (approx.– 7 points)



Conclusion

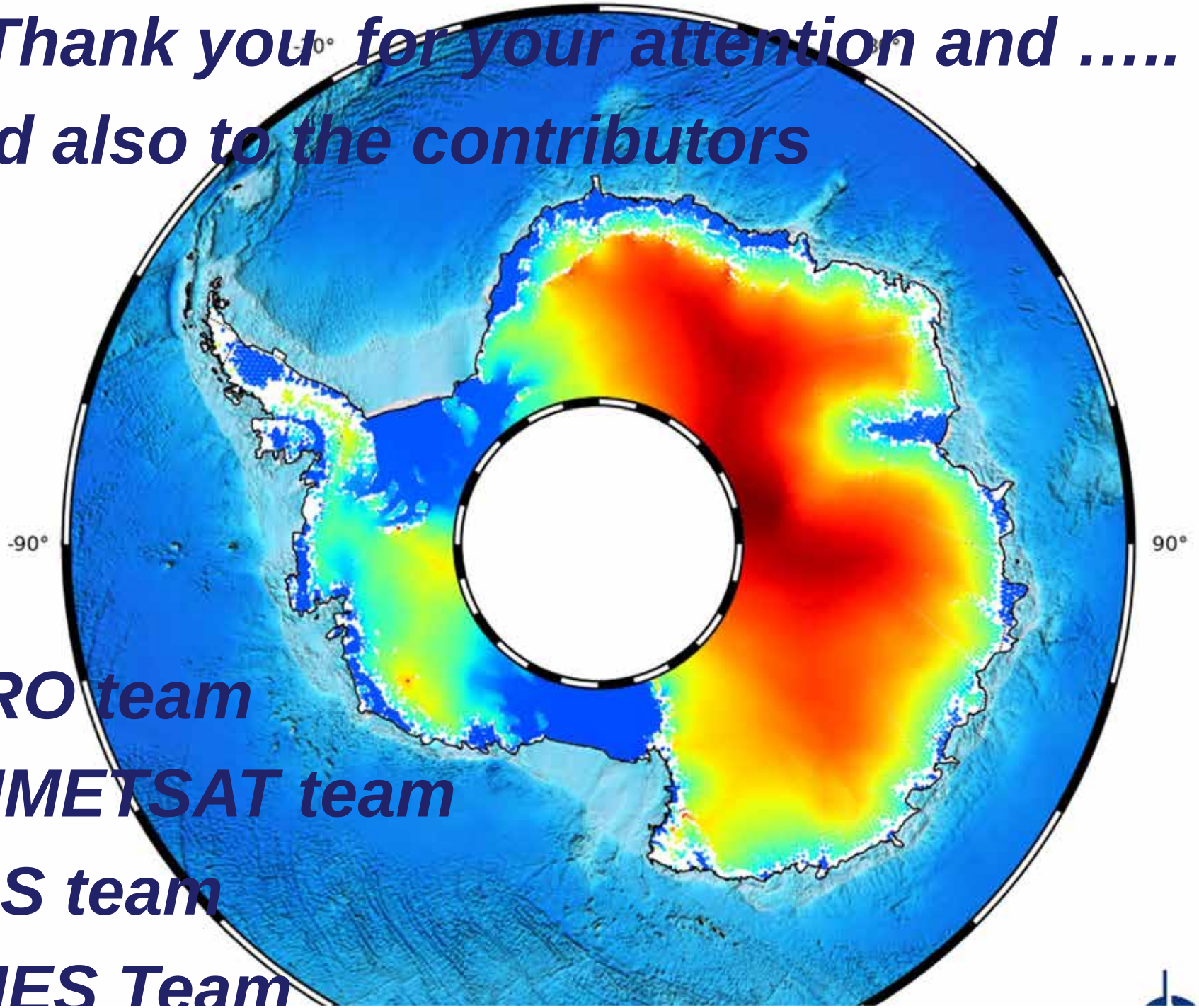
- SARAL/ALTIKA is performing well

- **Drifting Phase since July 2016 secure continuity for OCEAN Waves OCEAN circulation and MARINE GEODESY**

- **Mission extension for period [2018-2019] approved**

!! Thank you for your attention and …..

and also to the contributors



ISRO team

EUMETSAT team

CLS team

CNES Team

Backup slides

New scenario

- **After REVEX #2, CNES has lead a dedicated study. It confirms the scenario proposed in October ➔ move to a drifting orbit**

- **Oceanography (mesoscale)**

Stopping maneuvers on SARAL will not degrade the sampling for 3 years
Recommended to stay within [-0.9 km, +1.2 km] of current altitude
Recommended to increase the altitude by 1 km before the drifting phase
No benefit in a maneuver after the drift starts
Results are the same for all values of solar activity

- **Geodesy**

Uncontrolled drift provides a random sampling (decent but suboptimal)
Performing maneuvers (even 1/year) is highly undesirable
Results are the same for all values of solar activity

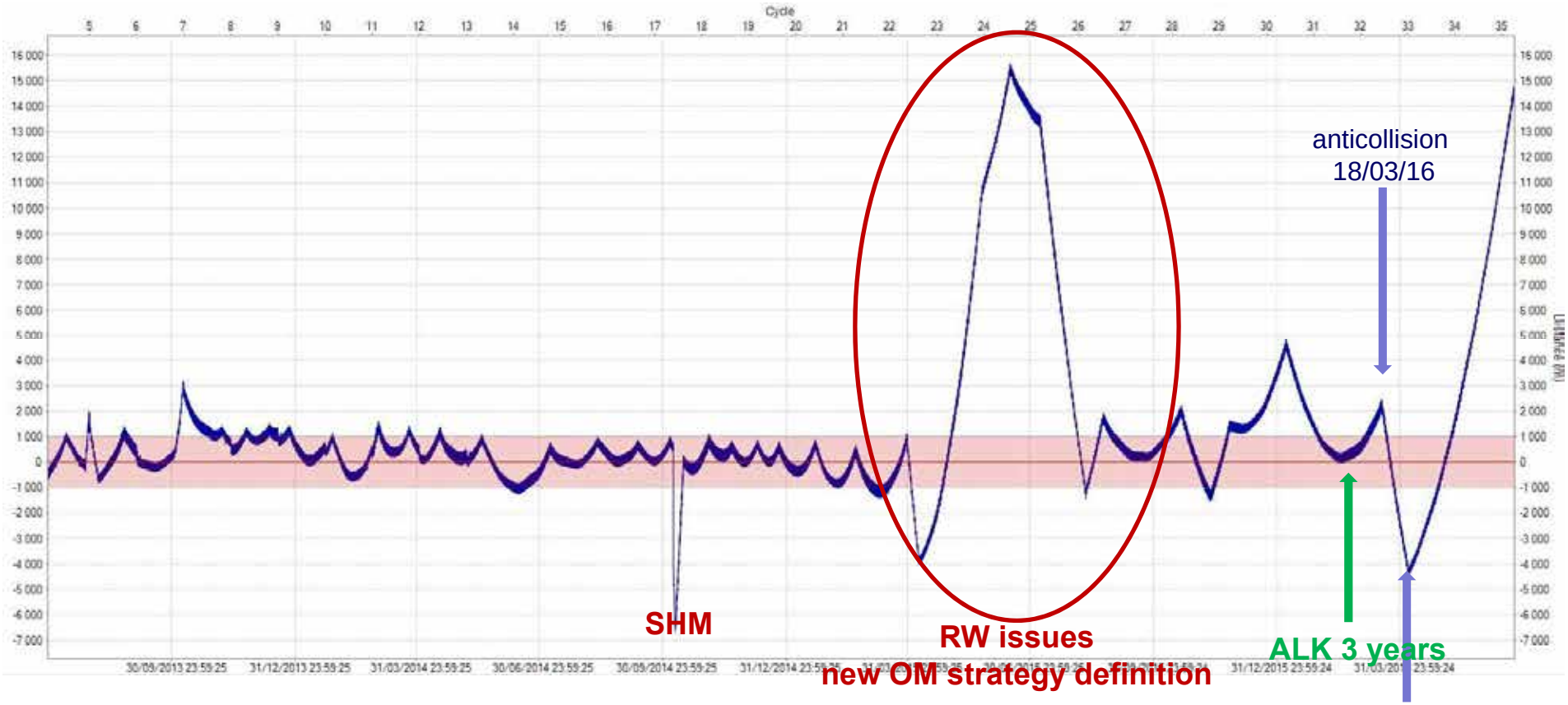
- **Link between both applications**

Short term: leaving the 1km control band increases SLA error budget (undesirable but not a showstopper on ocean)

Long term: using a drifting orbit helps improving MSS models along uncharted tracks (e.g. SWOT, Sentinel-3, CFOsat)

A updater avec planche REDEM

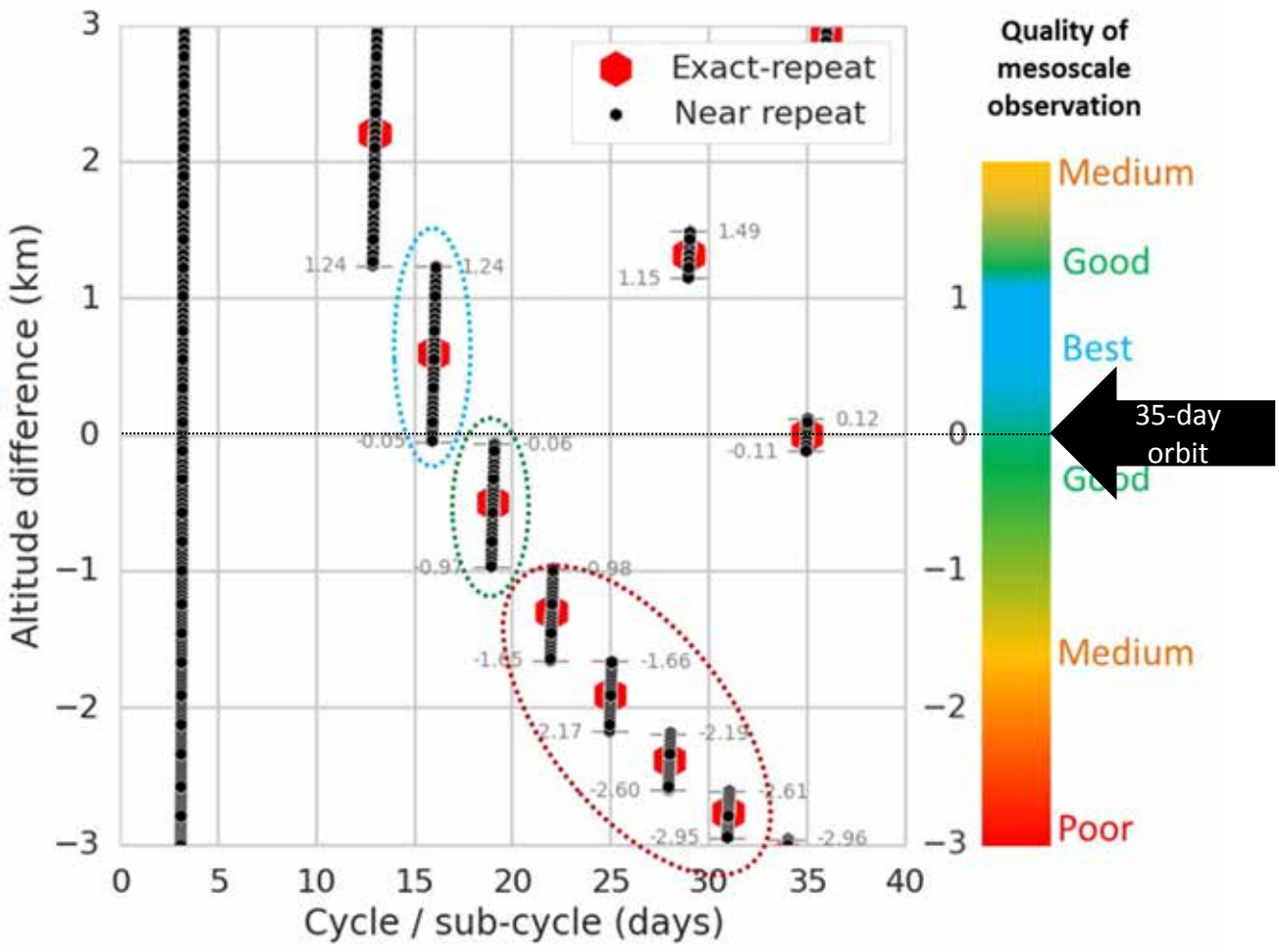
SARAL Drifting Phase



Before March 2015, 90% of time in the ground track

MESOCALE SAMPLING : Context and EXPECTATIONS

- Mesoscale monitoring requires sub-cycles ranging from 15 to 20 days
- Optimum is in the 15-17 day range (e.g. GFO)
- Long sub-cycles alone are highly undesirable (e.g. Cryosat-2)

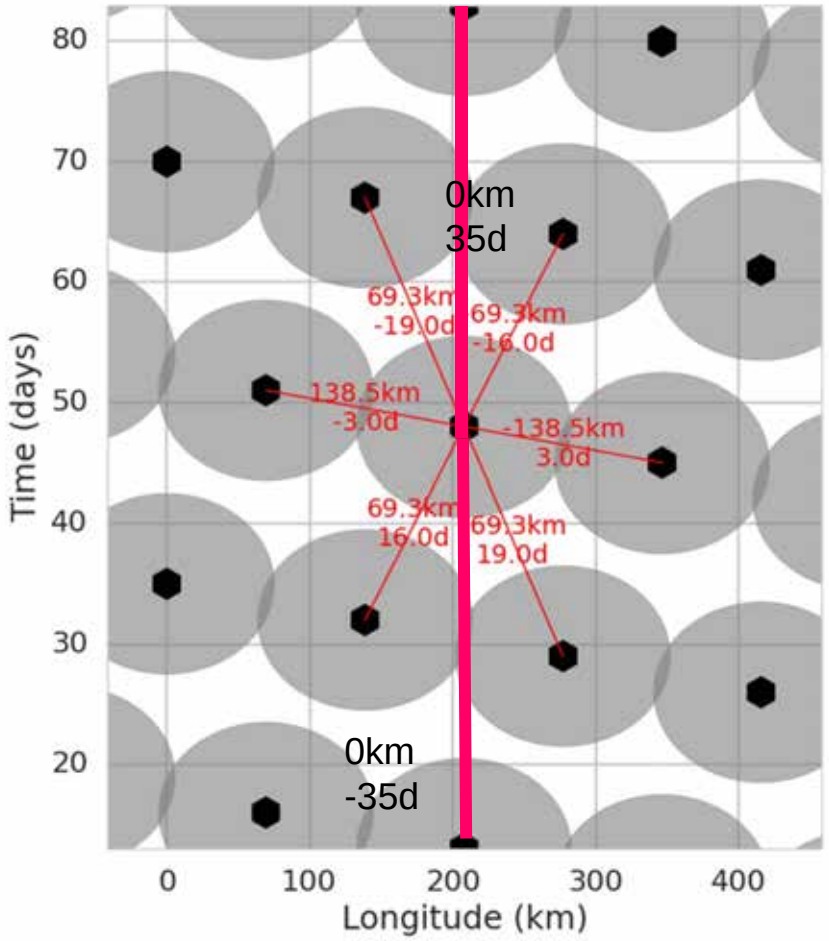


➡ 2016 plan was to increase altitude by 1 km and to let it decay
Predicted impact: mesoscale sampling excellent for 3+ years

SARAL 35 days orbit
Influence of sub-cycles on mesoscale sampling

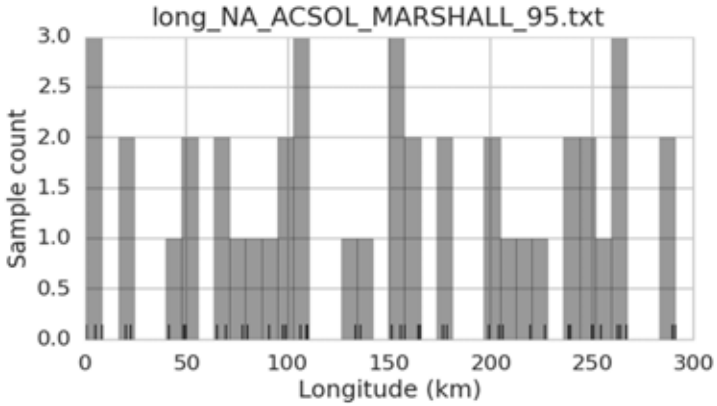
- Altimeter tracks are displayed in the space / time plane (black dots)
- The circle around each dot is the region and period where the track is useful for mesoscale monitoring (correlation > 0.5)
- Sub-cycles control the circles alignments (here 3, 16 and 19 days)
- Good mesoscale sampling:
  - Minimizes the white areas (unsampled regions/periods)
  - No overlap between circles (information is not duplicated)
- Bad mesoscale sampling:
  - Circles overlap in space or in time (information is duplicated)

Longitude of SARAL tracks at 30°N as a function of time



Geodetic sampling

- Geodetic sampling is very good (albeit irregular) ➔ as expected
- The geodetic dataset keeps getting denser each day AltiKa is operated on the drifting orbit
- AltiKa's precision : SARAL is a



Random sampling expected after 1 year

Geodetic sampling observed after 10 months