Global SARAL/AltiKa Data Quality Assessment of IGDR and GDR data

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Overview

- Saral was launched on 2013-02-25
- Mostly Gdr (cycles 1 to 3), but also Igdr and some Ogdr 1Hz data are analysed and compared to Jason-2 data
- Products produced with patch 1 for:
  - GDR since cycle 1
  - IGDR since cycle 4 pass 395 (2013-07-10 23h56)
  - OGDR since cycle 4 pass ~611 (2013-07-18 13h44)

Data availability:

- Data coverage and data editing

Instrumental performance:

- Altimeter and radiometer parameters

System performance:

- Sea Level Anomaly
- Crossover analysis
- Spectrum

Investigations:

- Ground track and inclination maneuver

Data coverage

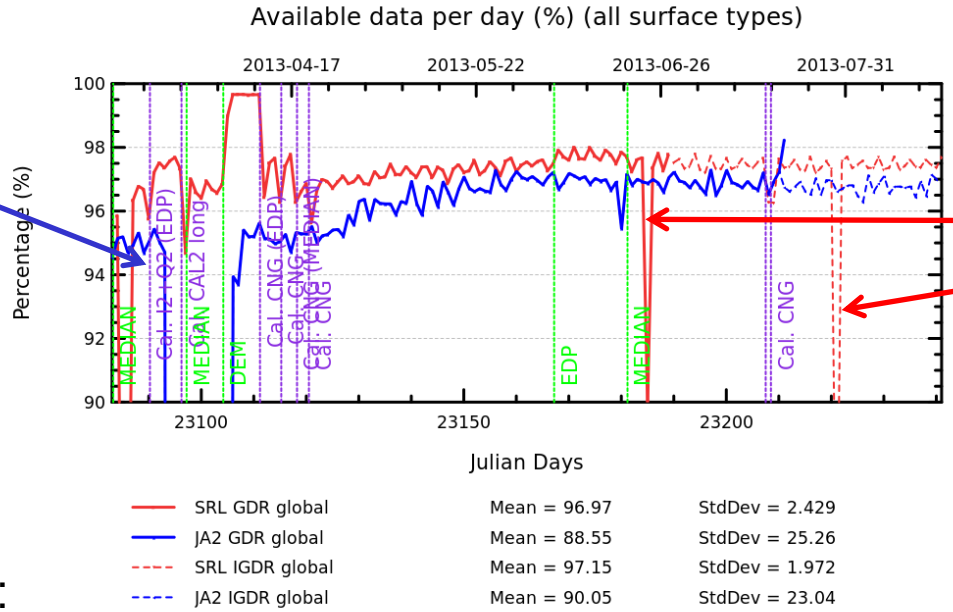
Data coverage

- **Requirements: 95% of all possible over-ocean data during a 3-year period with no systematic gaps**
- Missing data for Saral: Xband stations acquisition problems (especially during the beginning of the mission and for OGDR) + planified calibrations
- Missing data for Jason-2: safehold + Usingen acquisition station problem

Jason-2

Safehold mode

All surface types



SARAL

X-band station problems

GDR ——

IGDR - - - -

Except anomalies:

Missing data	SARAL	JASON-2	
All surfaces	~97 % (varies with season)	~96%	SRL exceeds JA2 data return
Ocean			

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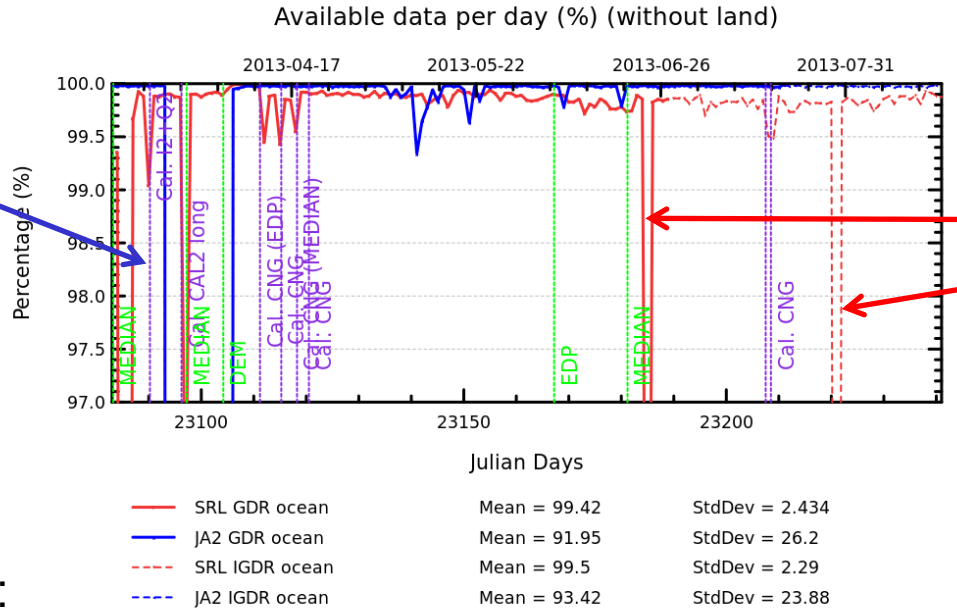
Jason-2

Safehold mode

Over ocean



SARAL

X-band station problems

GDR ——

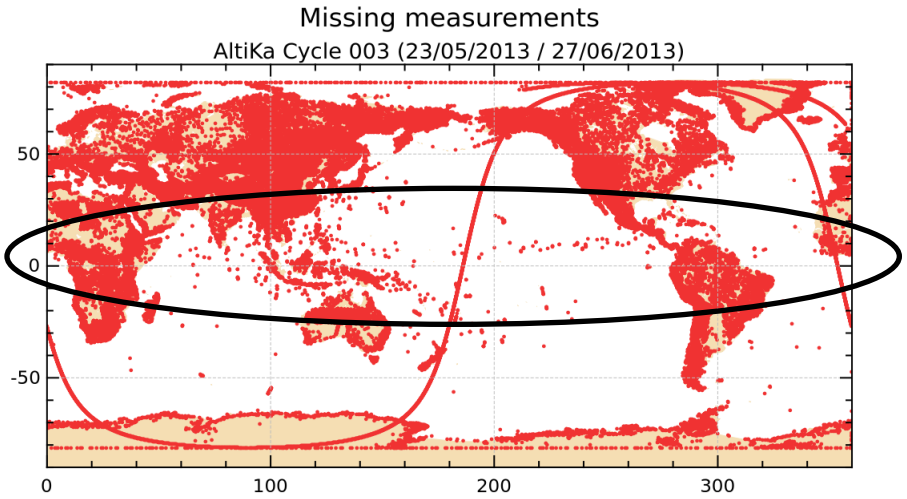
IGDR - - - -

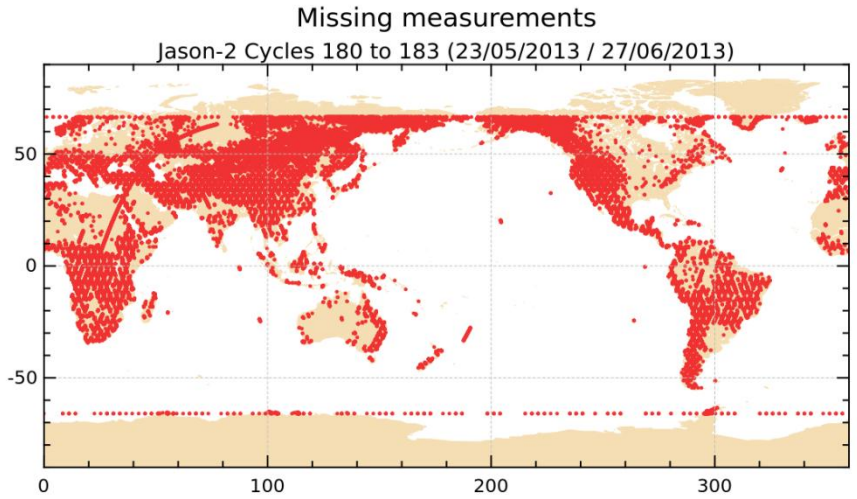
Except anomalies:

Missing data	SARAL	JASON-2	
All surfaces	~97 % (varies with season)	~96%	SRL exceeds JA2 data return
Ocean	~99.9 %	~99.98%	JA2 has slightly better data availability

Data coverage

- **Requirements: 95% of all possible over-ocean data during a 3-year period with no systematic gaps**
- Saral has excellent data coverage (over-ocean: 99.4%)
- SRL has slightly better data coverage over land (smaller footprint for SRL, high SNR) than JA2
- SRL has some missing data over ocean (likely due to rain -> Ka-band), but is less impacted than expected





SRL

Maps of missing data

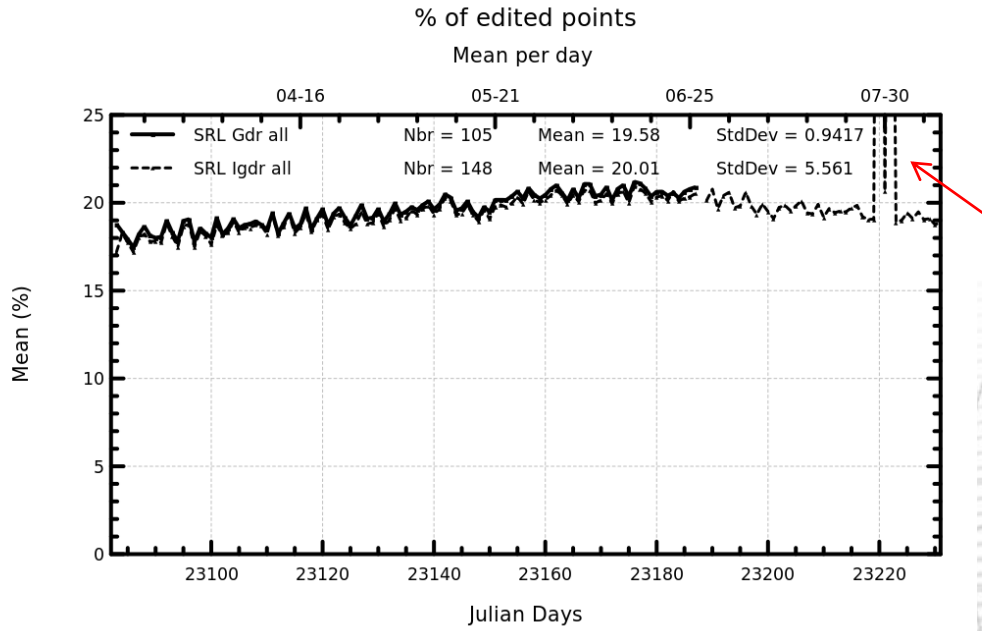
JA2

SRL Missions requirements are largely fulfilled

Data editing

Data editing

- Editing applied is derived from Jason-2, land is already removed
- ~20% of available ocean data edited for SRL (varies with time)



maneuver

Data editing

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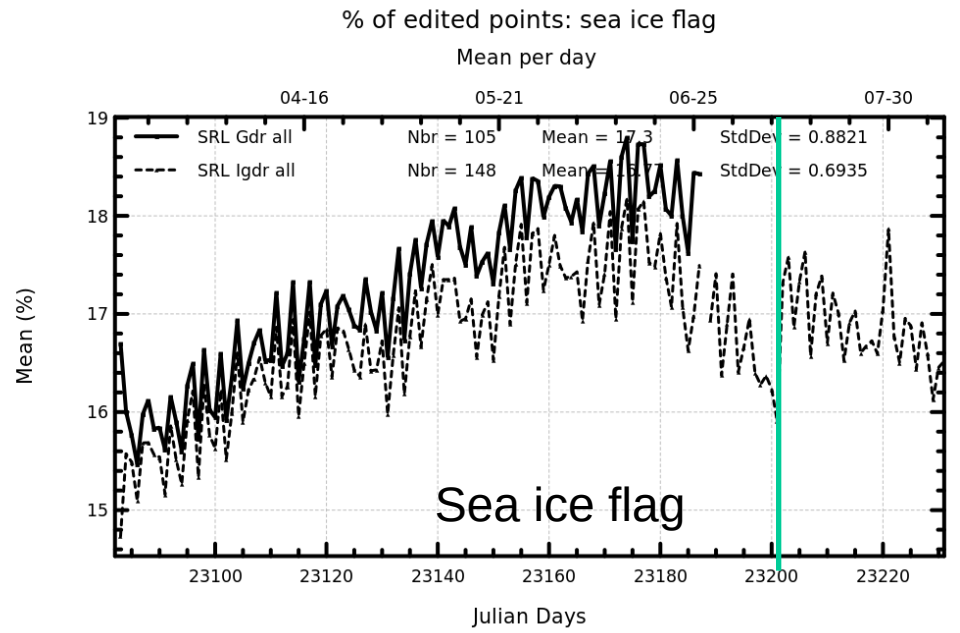
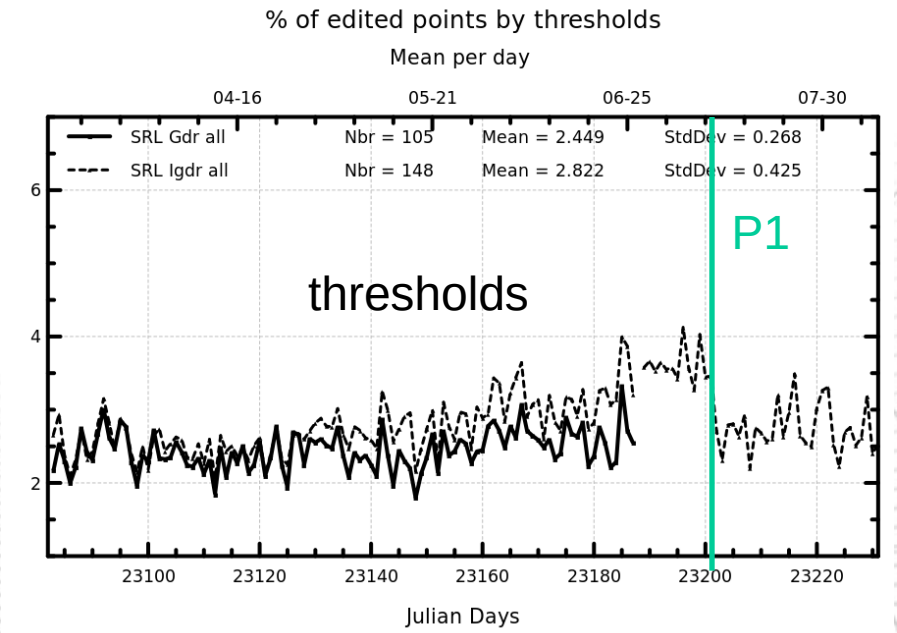
- ~20% of available ocean data edited for SRL (varies with time)
  - ~17.5 % edited by sea ice (varies periodically with ice coverage)
  - ~2.5 % edited by threshold criteria

GDR ——
IGDR - - - -





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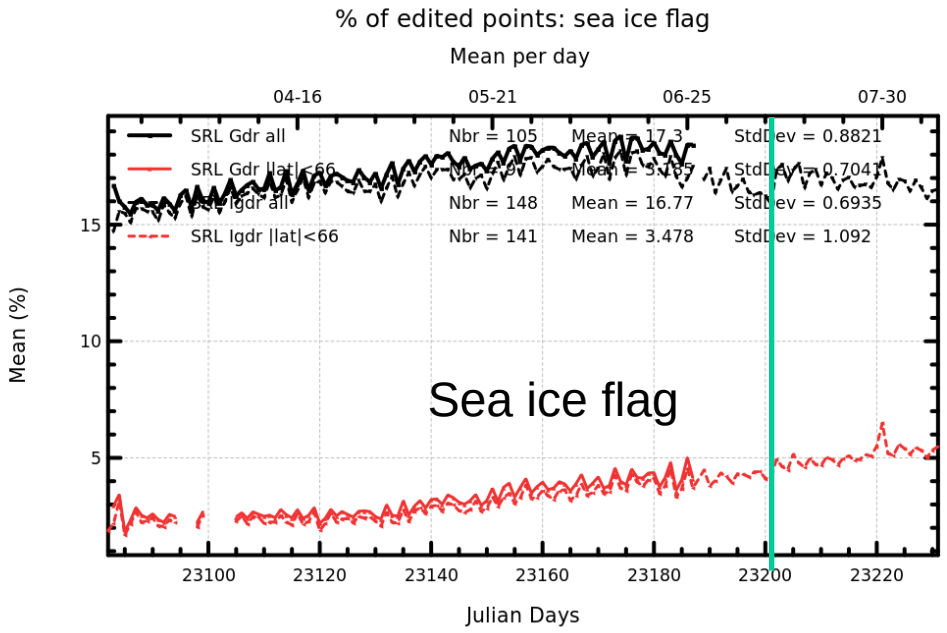
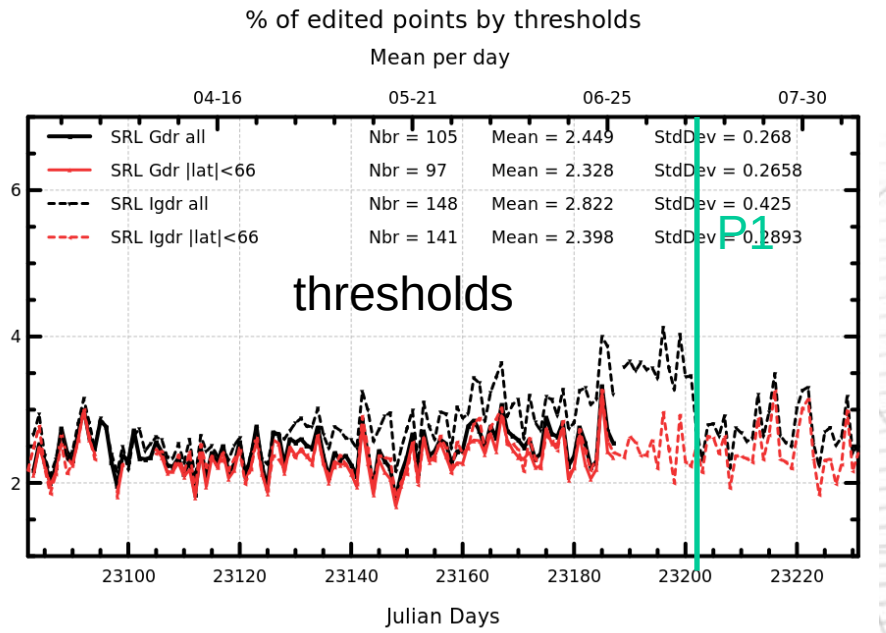
GDR ——
IGDR - - - -





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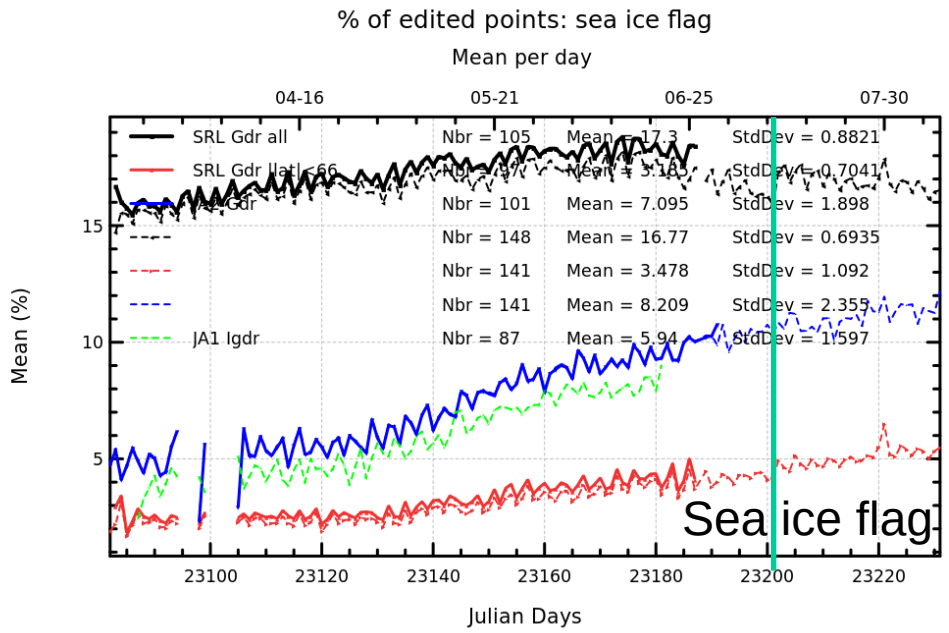
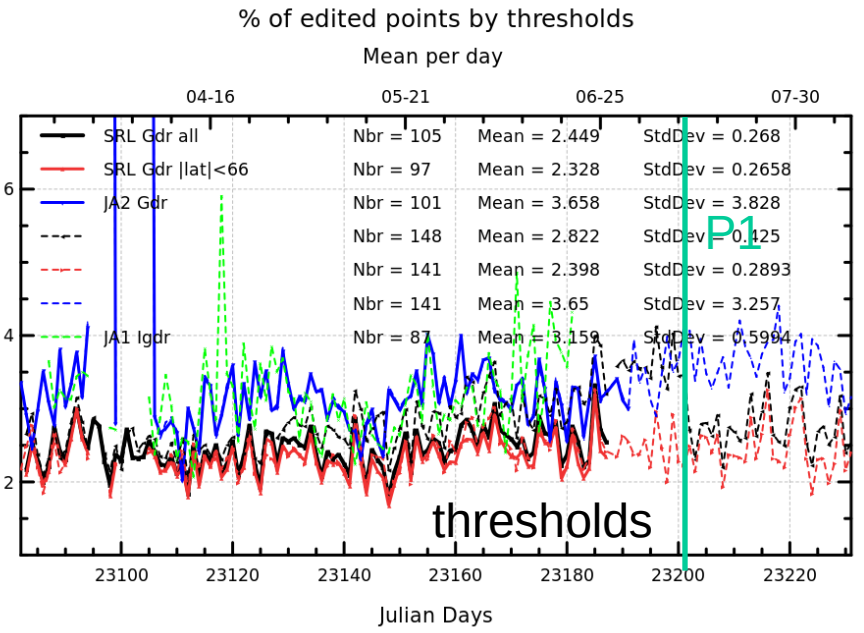
- Less data are edited by thresholds on AltiKa compared to Jason-2

GDR ——
IGDR - - - -



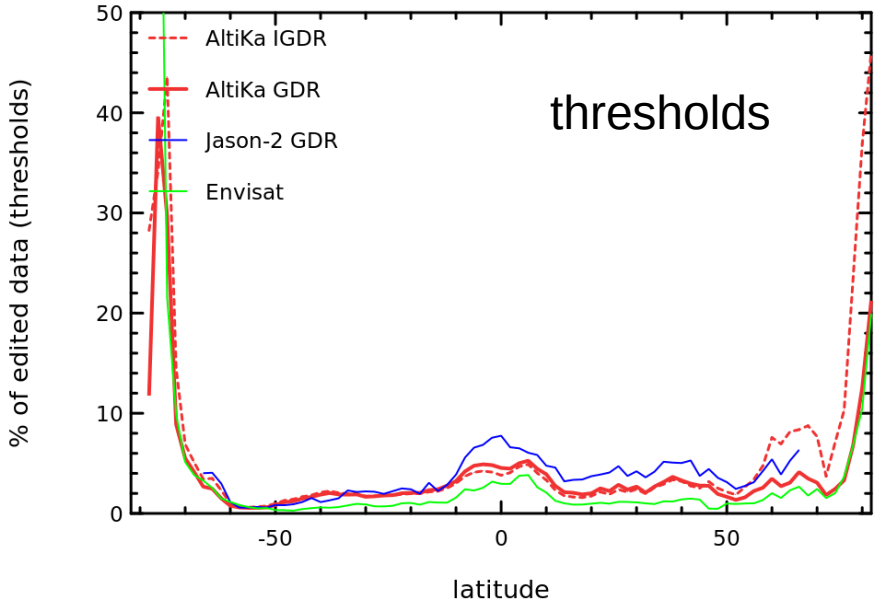


- Figures are influenced by mesurement distribution (more data in high latitudes than in low latitudes)

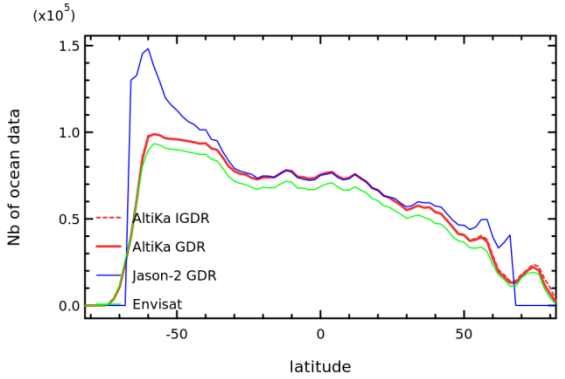
Data editing

- Editing applied is derived from Jason-2, land and ice already removed
- Statistics per latitude band
- Less data are edited on AltiKa compared to Jason-2,
- But more than on Envisat (same orbit altitude)

GDR ——
IGDR - - - -



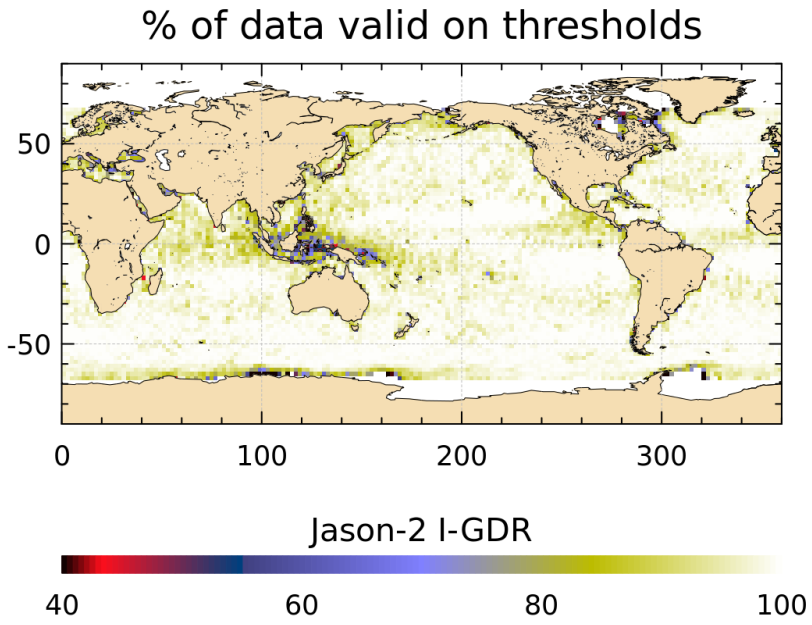
SRL Igdr: Cycle 001 - 003
Envisat: same period 2010

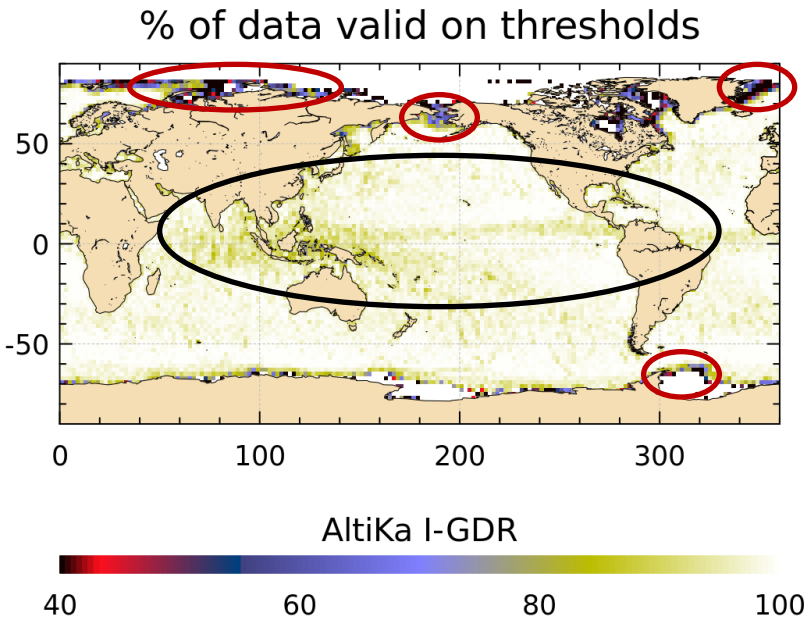


stats weighted by latitude	SARAL	Jason-2	Envisat
Edited data (-60°/60°)	2.6 %	3.6 %	1.3 %
Edited data (-30°/30°)	3.1 %	4.3 %	1.7 %

Data editing

Jason-2 IGDR SARAL (cycle 1-3)

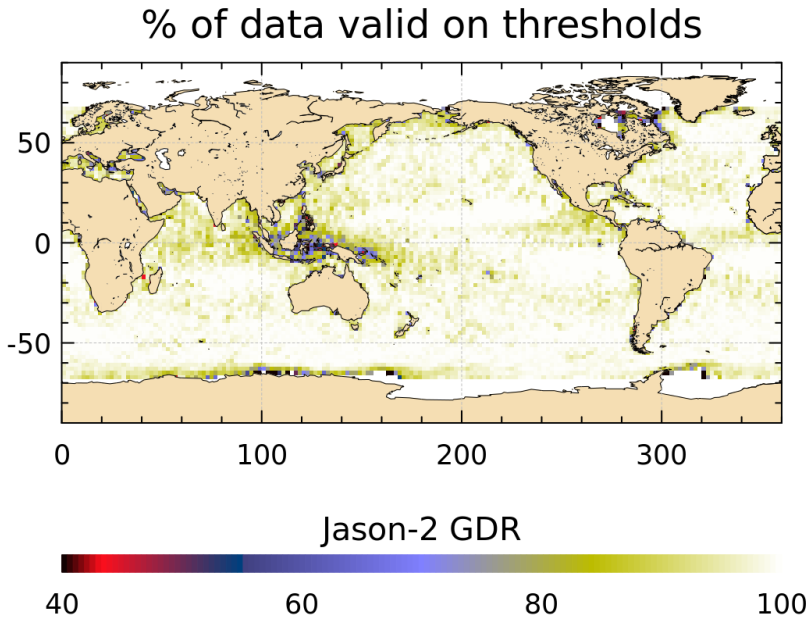


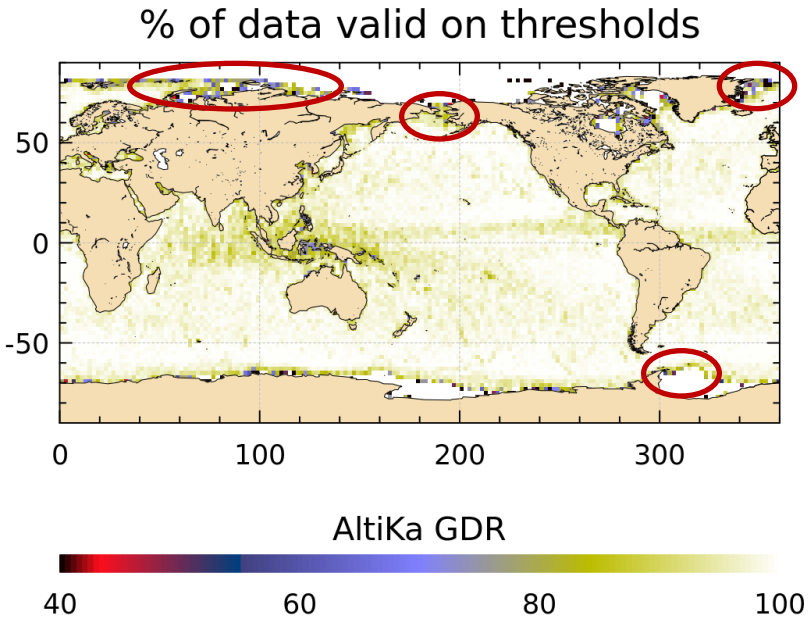


- sea ice flag did not work very good for IGDR (before P1)
- some data edited in rain cell areas, but less than expected

Data editing

Jason-2 GDR SARAL (cycle 1-3)



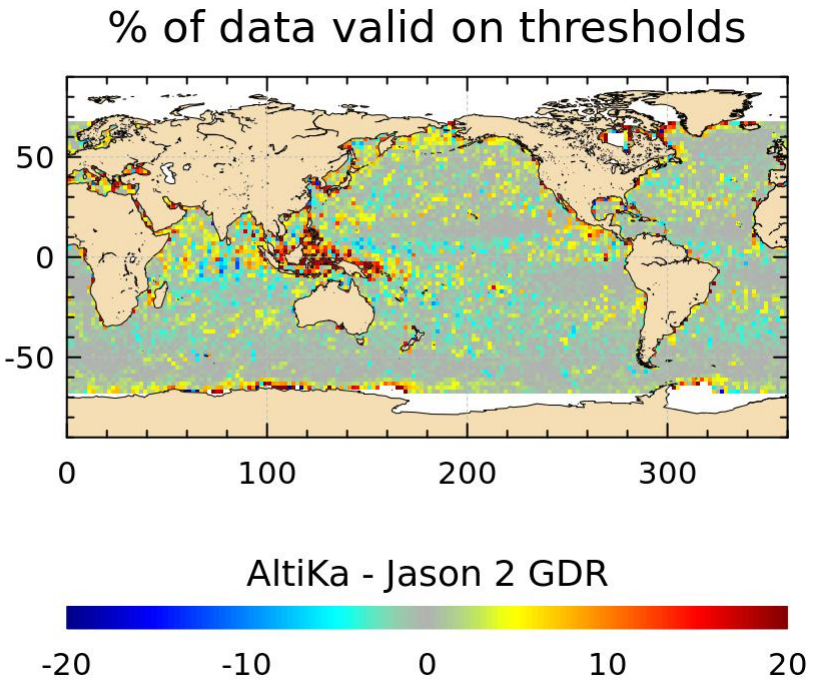


- For GDR (use of P1), the sea ice flag works better
- some data edited in rain cell areas, but less than expected

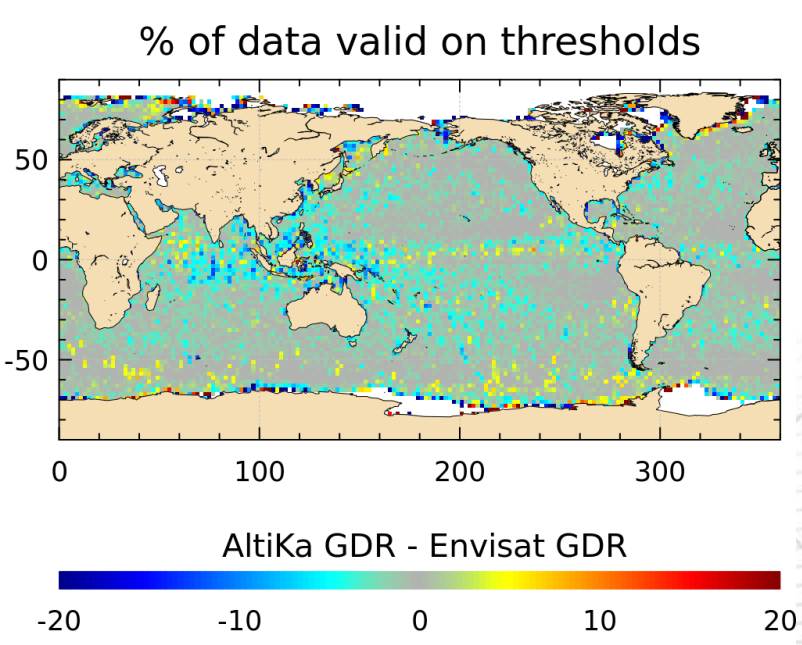
Data editing

GDR

Comparison to Jason-2
(over the same period)



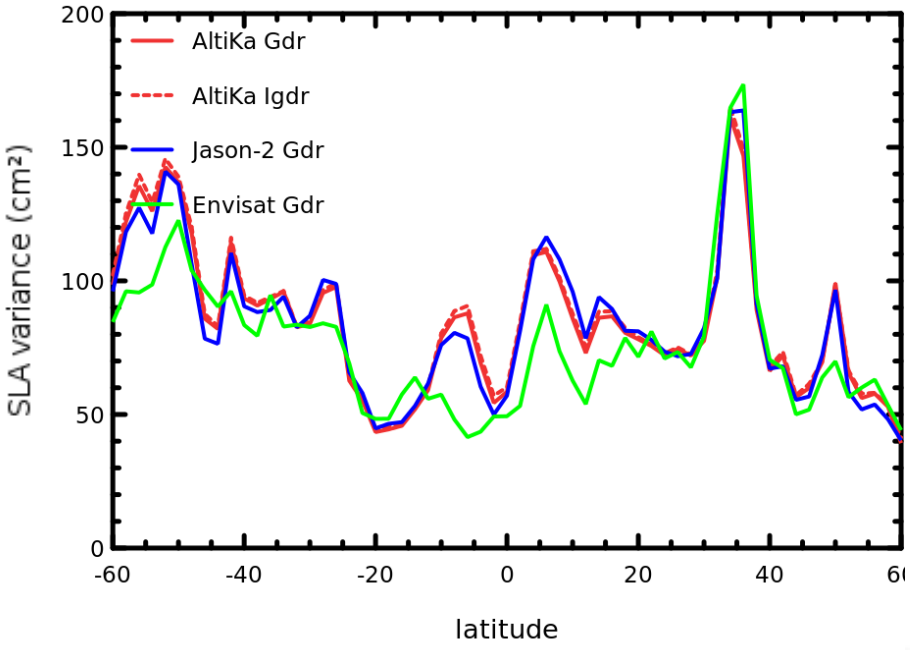
Comparison to Envisat
(three years earlier)



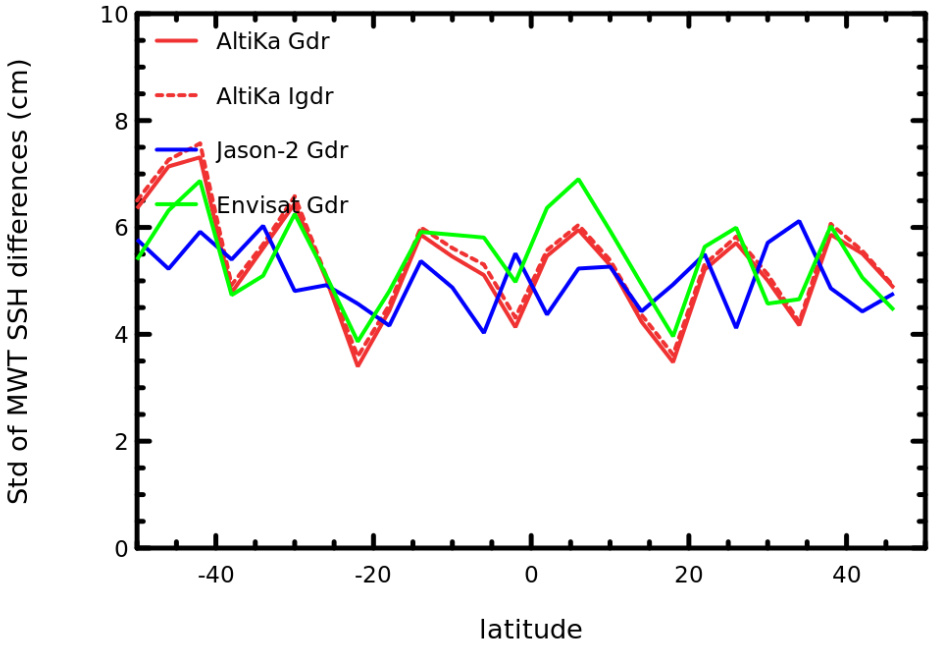
- Much more valid data in the Western Pacific for SARAL than Jason-2,
- More data edited than Envisat (in rain cell areas ?)

Editing performance

Latitude average of SLA variance



Latitude average of Xover SSH standard deviation

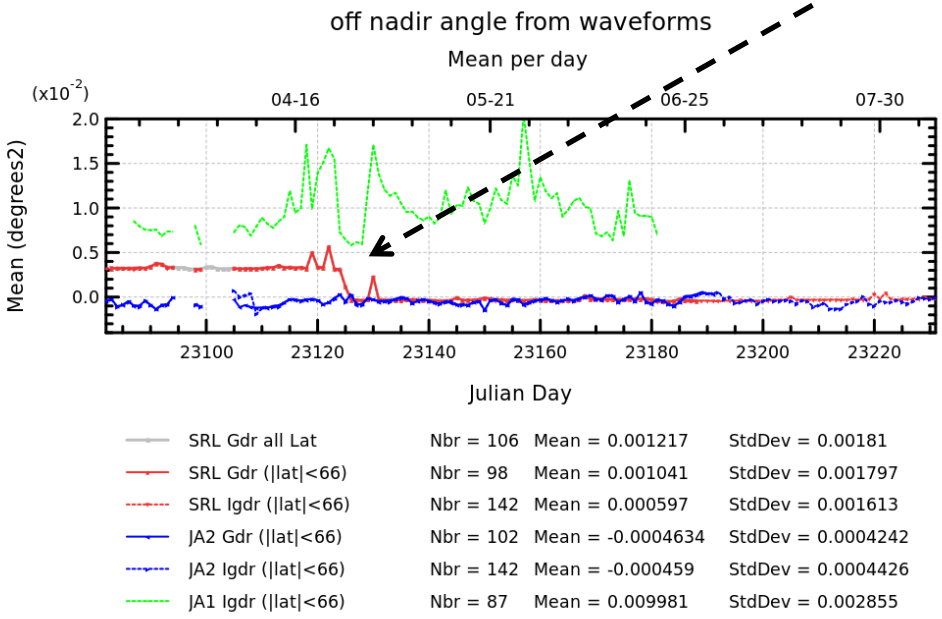


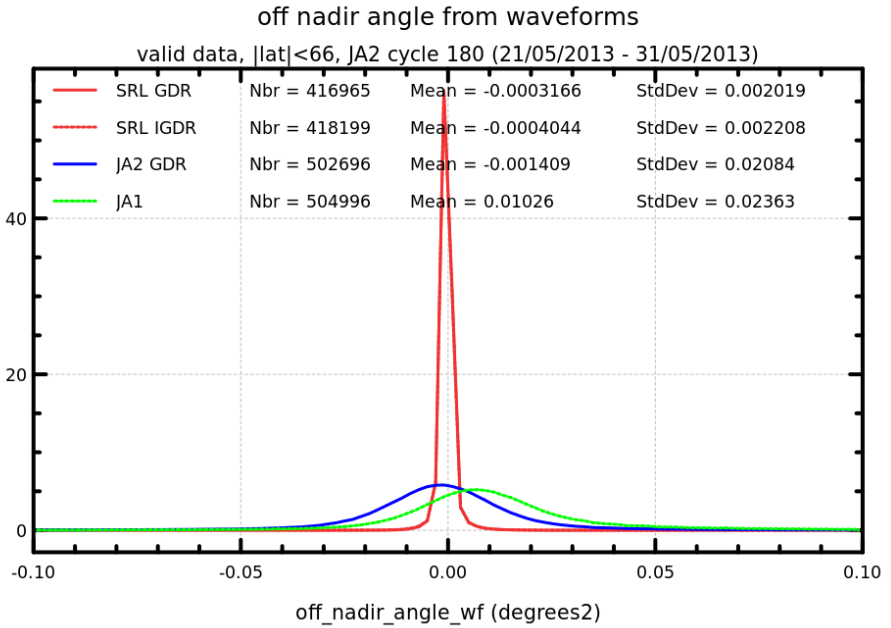
- AltiKa performances are in line with Jason-2 and Envisat.

Instrumental performance

Off nadir angle from waveforms

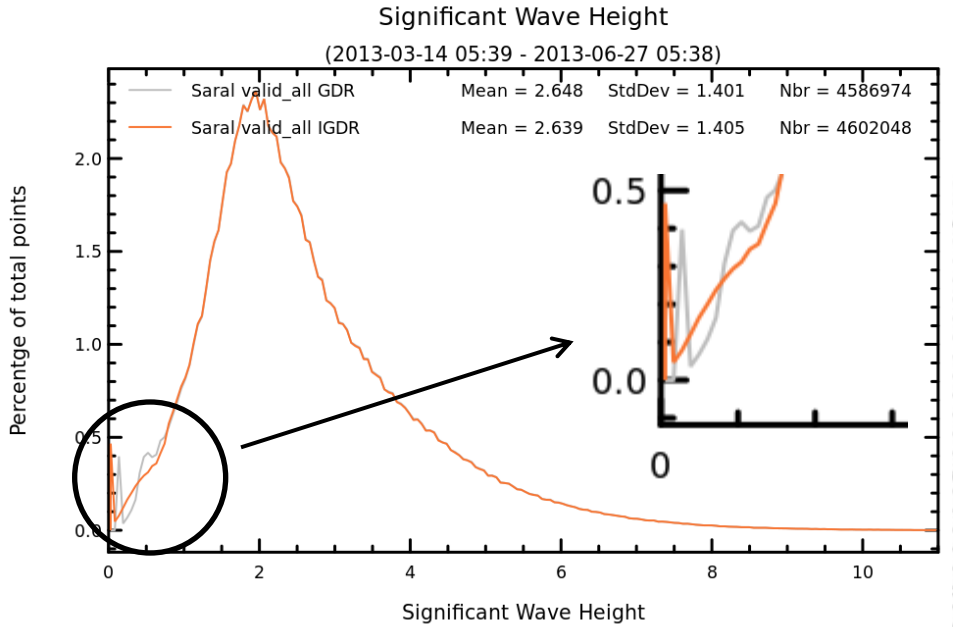
- Off nadir angle from waveforms is for Saral very close to 0, especially since 2013/04/25 (use of new geodetic bias after X-Cal maneuvers)





Significant wave height

- Patch 1: update of retracking look-up tables (using flight calibration data (PTR)) -> impact of the order of 15 cms on SWH for low sea states.
- Minimum of SWH is 12.6 cm since Patch 1, small bump appears around 50 cm



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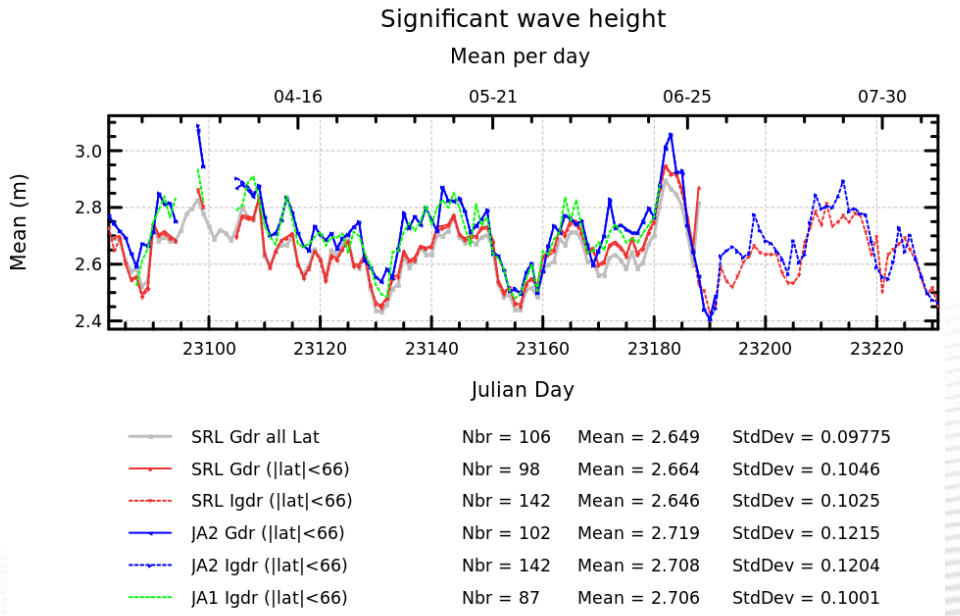
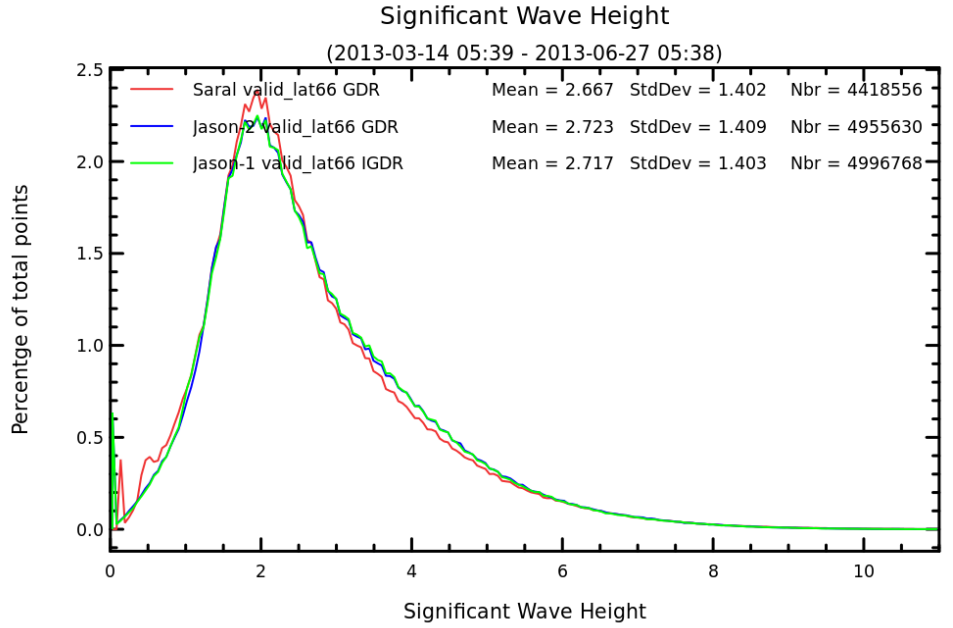
- Global mean of SRL SWH is similar to Jason-2 and Jason-1





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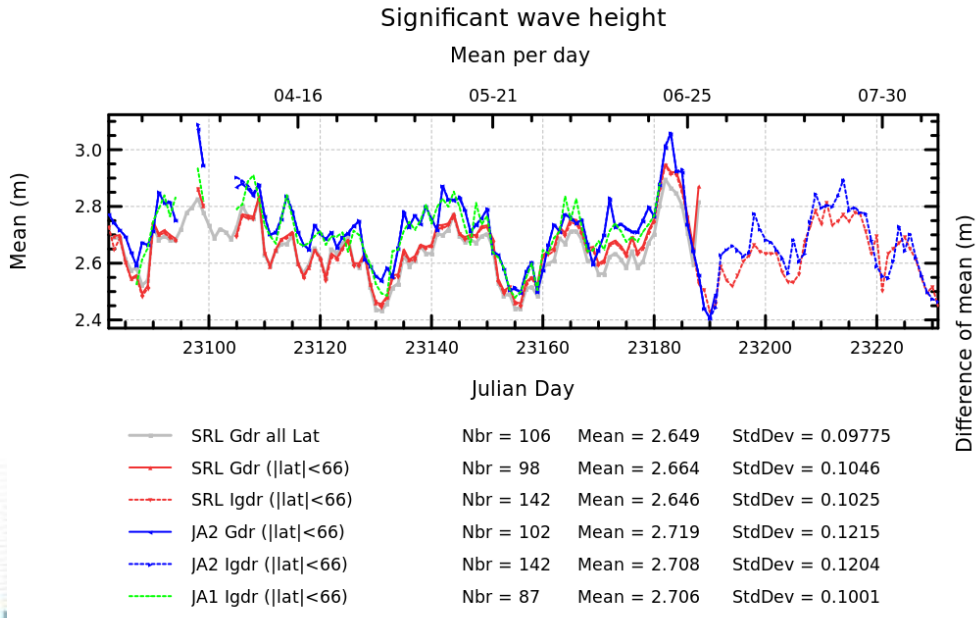
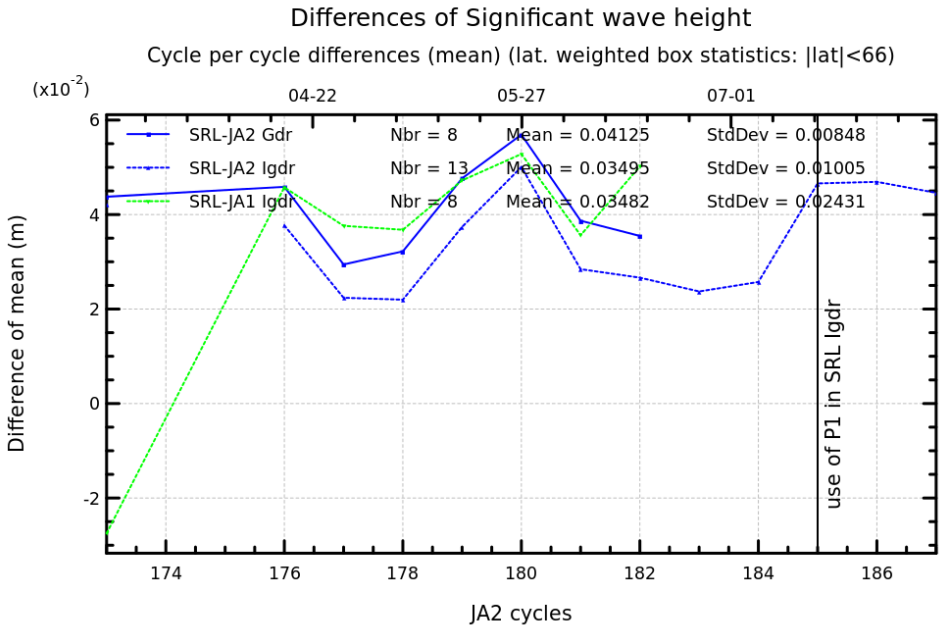
- Minimum of SWH is 12.6 cm since Patch 1 , small bump appears around 50 cm
- Global mean of SRL SWH is similar to Jason-2 and Jason-1
- Approx. 4 cm global mean bias between SRL and JA2 when using latitude weighted box statistics

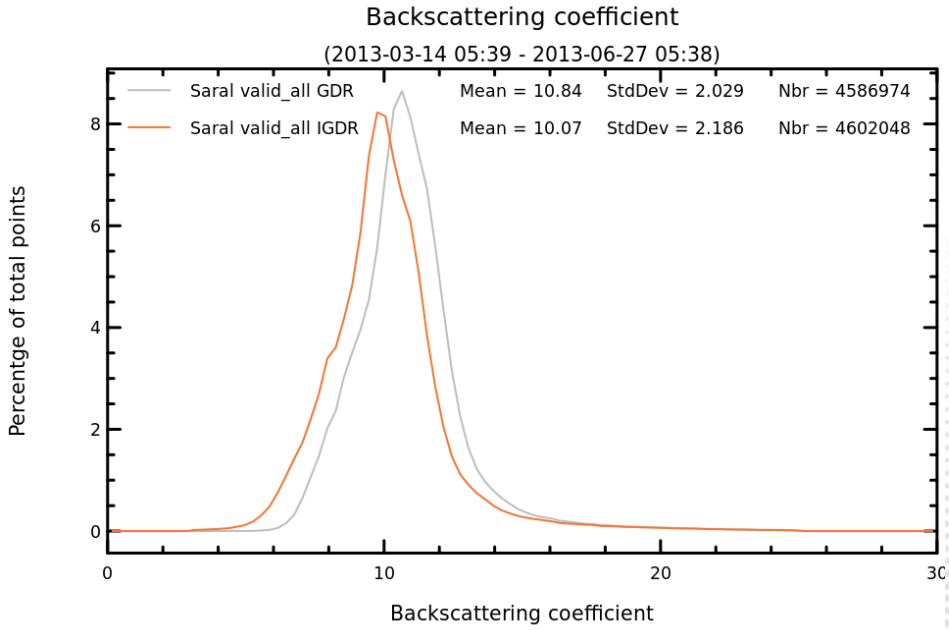


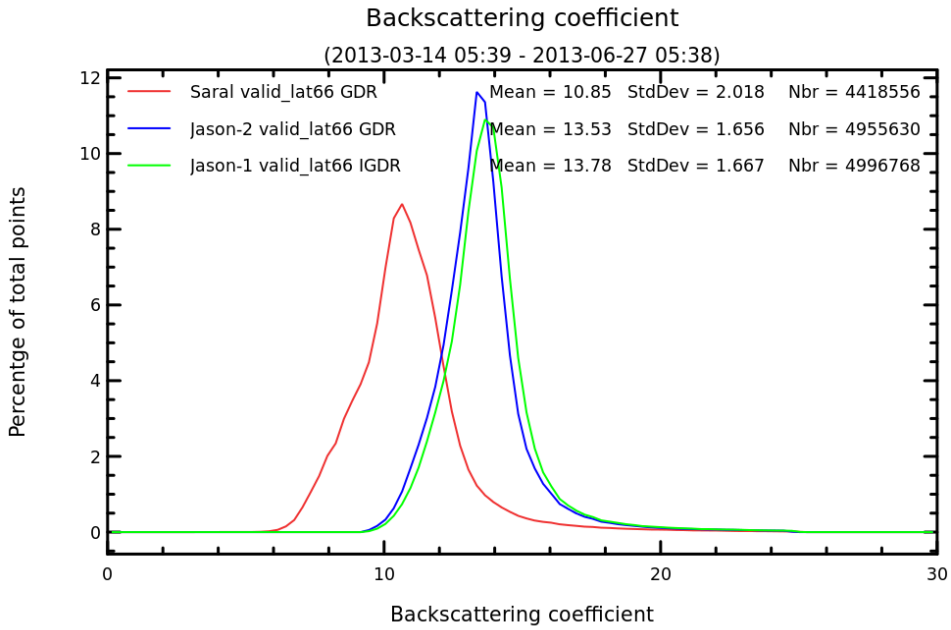


Backscattering coefficient

- Patch 1: atmospheric attenuation is now computed and applied to backscattering coefficient
- Shape of histograms is different for Ku- and Ka-band sig0

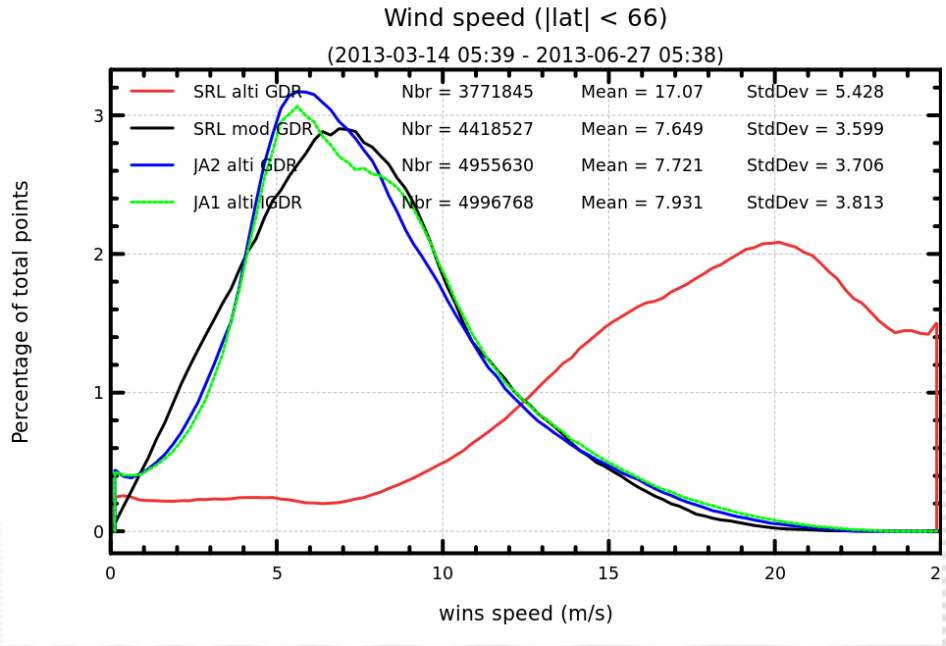
	Mean (without weight)	Mean (latitude weighted)
Saral (using patch 1)	10.8 dB	11.1 dB
Jason-2	13.5 dB	13.8 dB





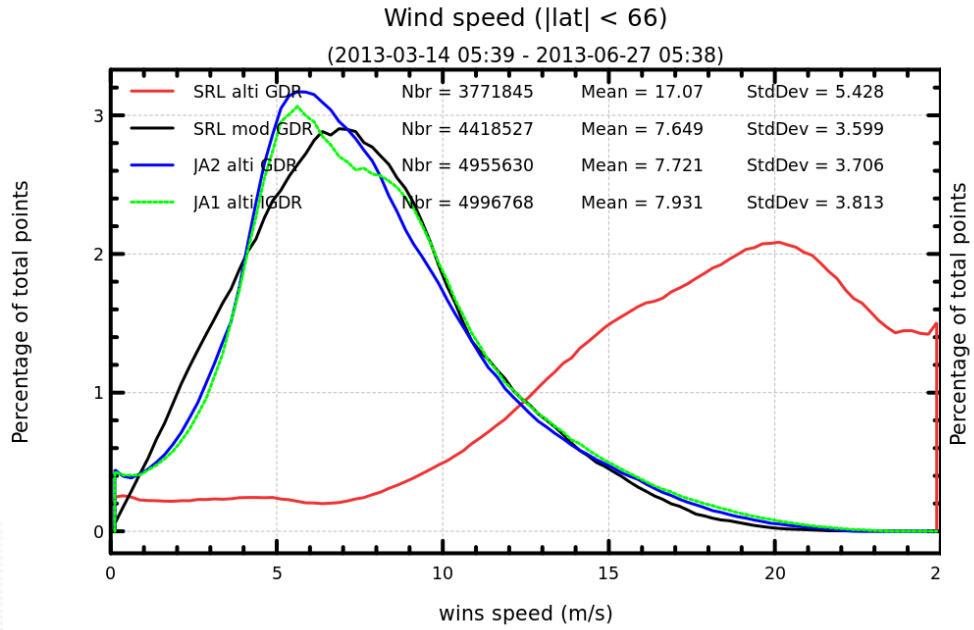
Altimeter wind speed

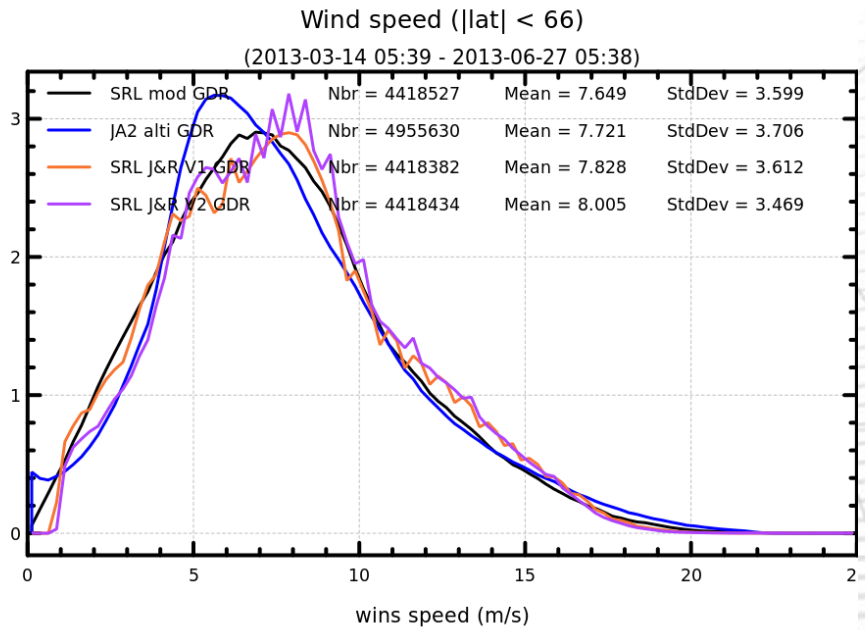
- Altimeter wind speed currently provided in SRL products is not usable



Altimeter wind speed

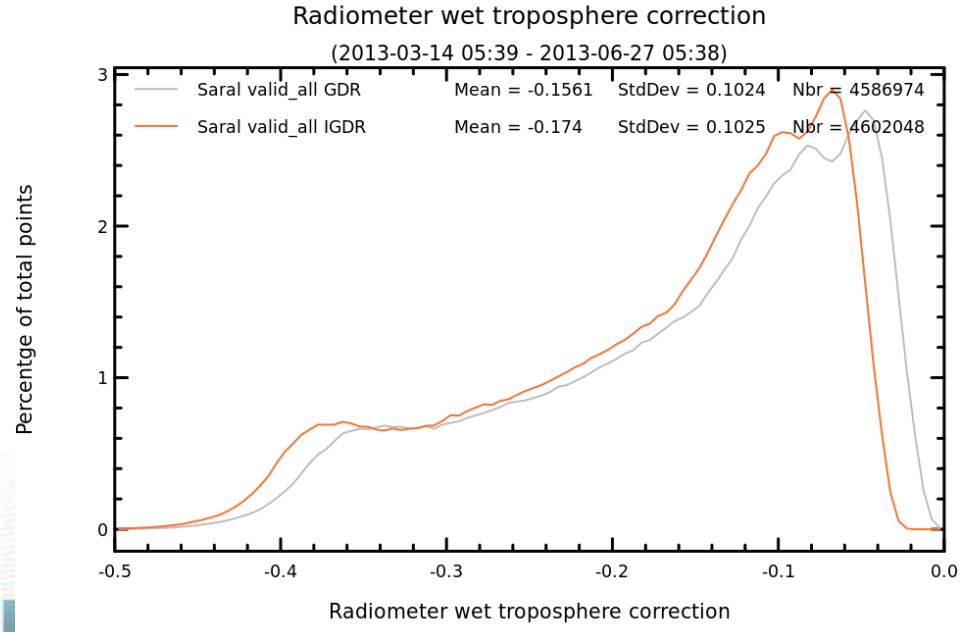
- Altimeter wind speed currently provided in SRL products is not usable
- Lillibridge et al propose 1D wind algorithms adapted from Abdalla
  - Proposed wind speed are close to model wind speed
  - Wind speed starts around 1 m/s

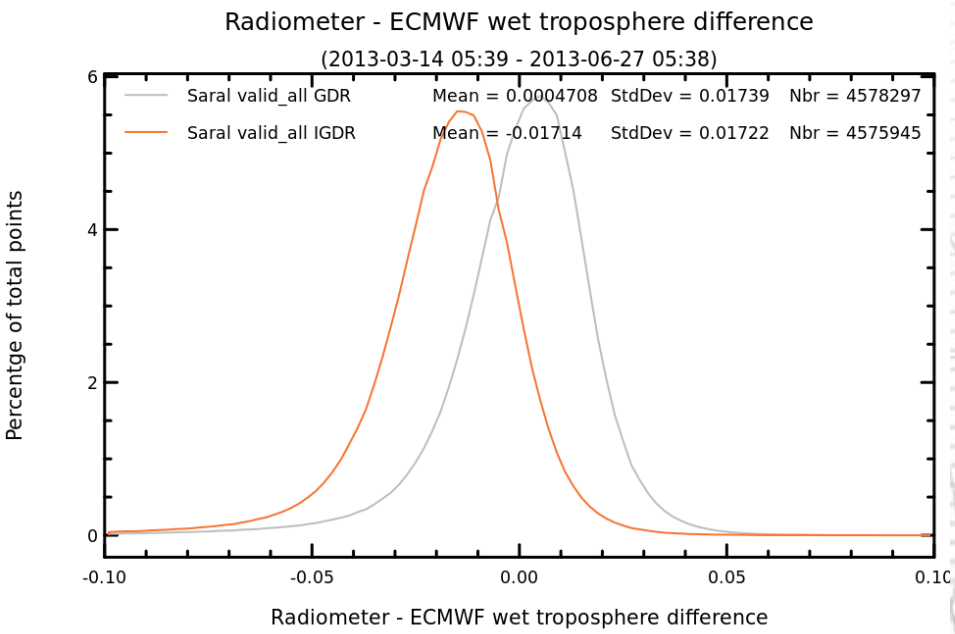




Wet tropospheric correction

- Quite good quality of the wet tropospheric correction
- Patch1 : “A first linear relation has been computed between the measured BT and the simulated one. This linear relation is applied on the 23.8 GHz only. The radiometer wet tropospheric correction which is now much more consistent with the model one.





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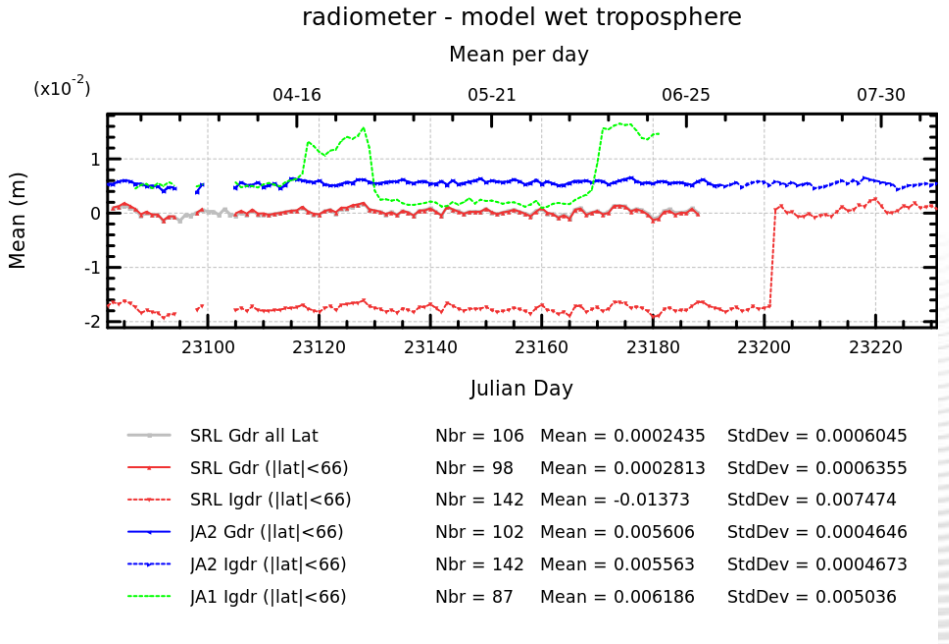
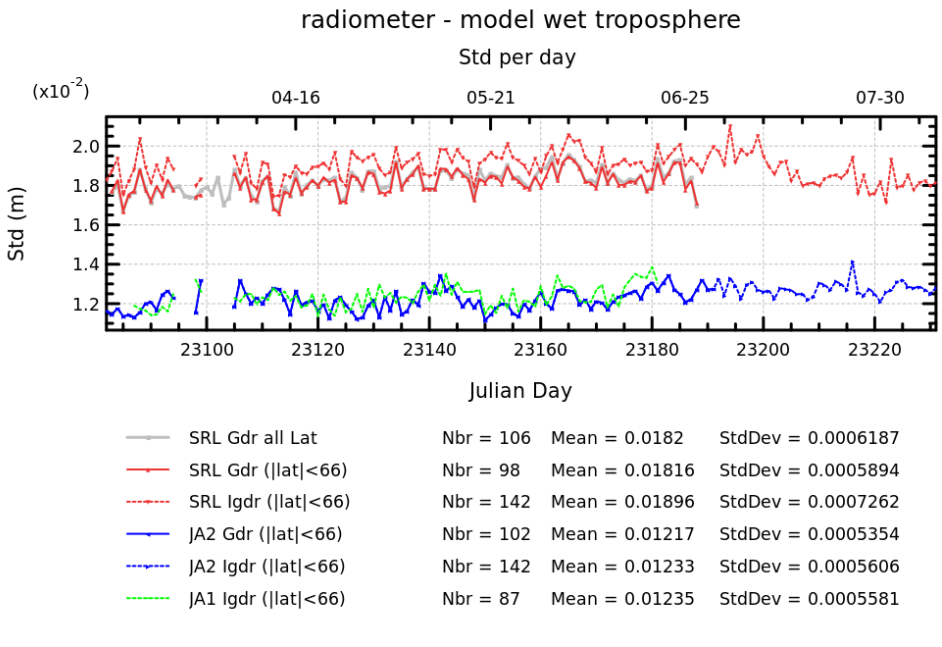
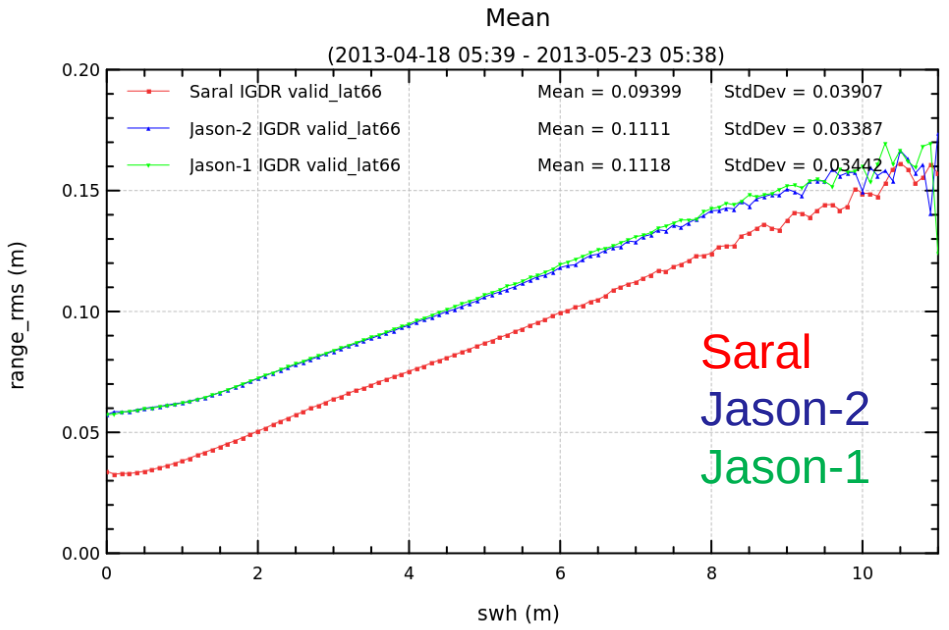
- Mean of wet troposphere difference is now for SRL very close to zero
- Std of wet troposphere difference is now slightly reduced for SRL

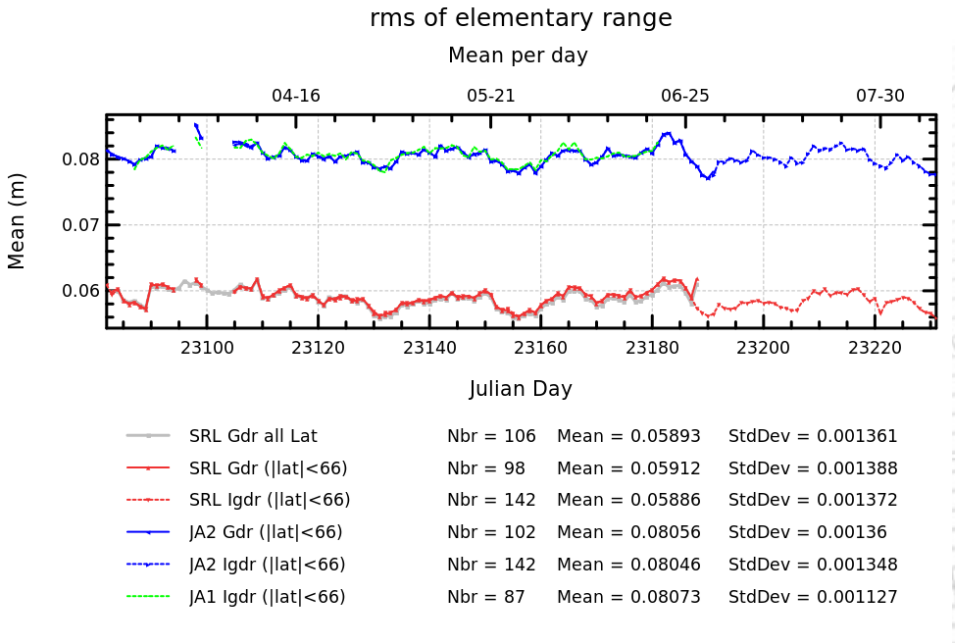




Noise on range

- At SWH=2m, range_rms (40Hz for SRL, 20 Hz for JA2/JA1) is:
  - Saral: 5.1 cm
  - JA2/JA1: 7.2 cm





System performance

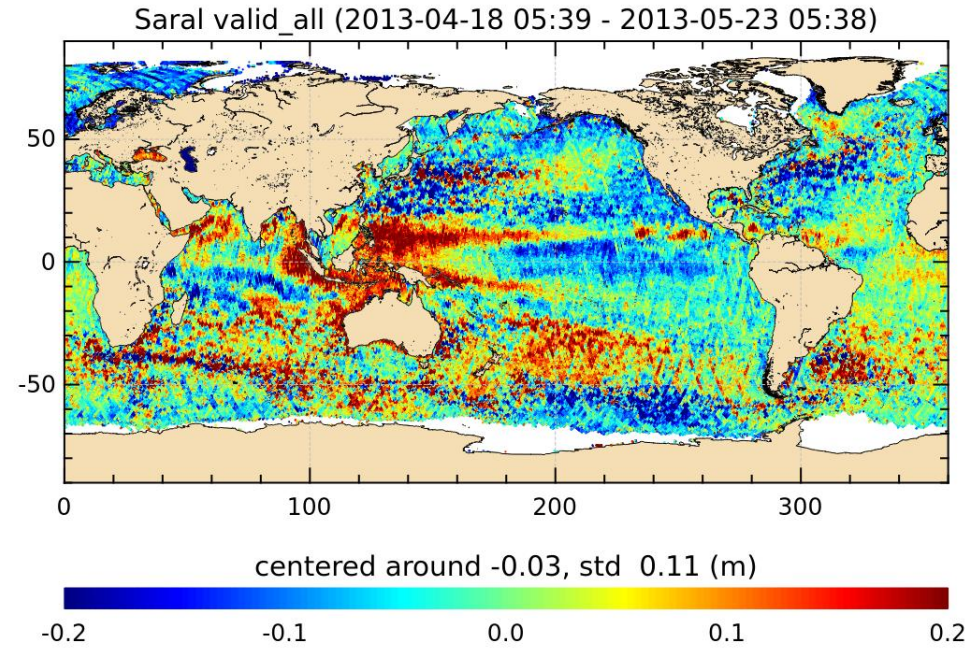
Sea level anomaly

- Maps of SLA (orbit – range – corrections - MSS) are very similar for Saral and Jason-2

IGDR

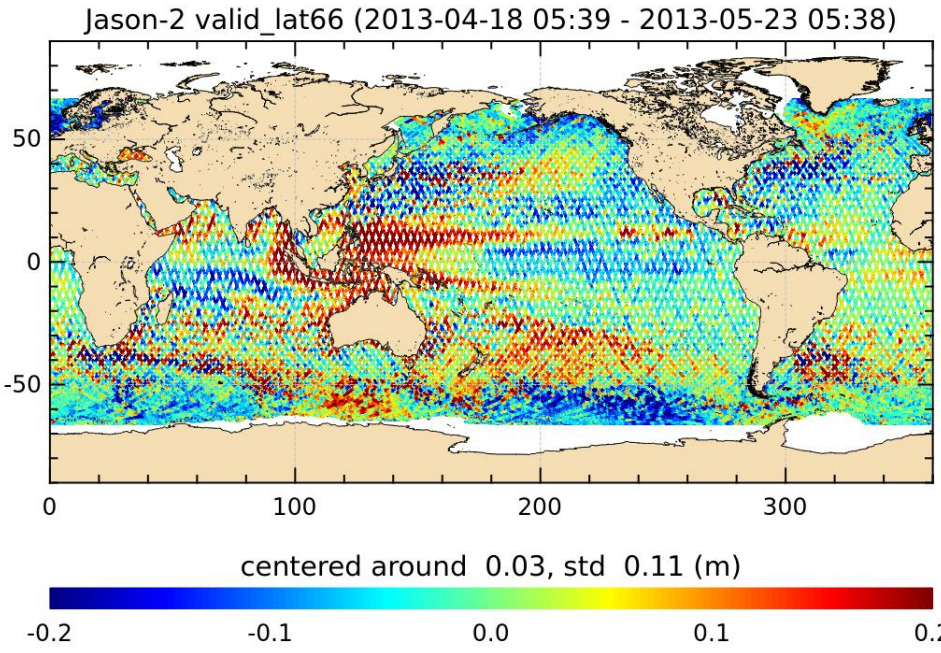
Saral

Ka-band SLA



Jason-2

Ku-band SLA



Using model wet tropopshere correction

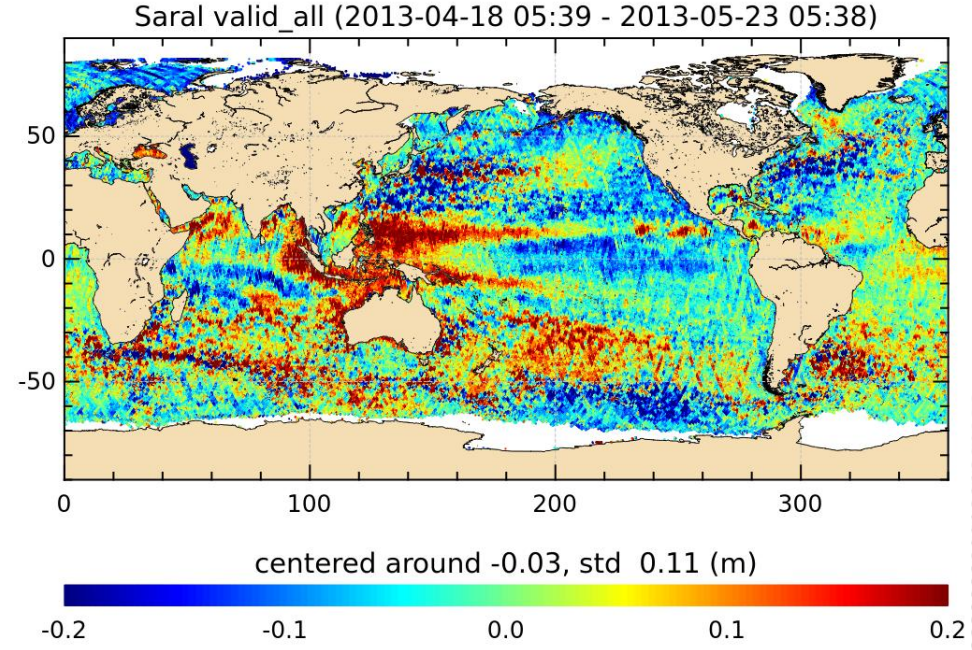
Sea level anomaly

- Maps of SLA (orbit – range – corrections - MSS) are very similar for Saral and Jason-2, as well as Jason-1

IGDR

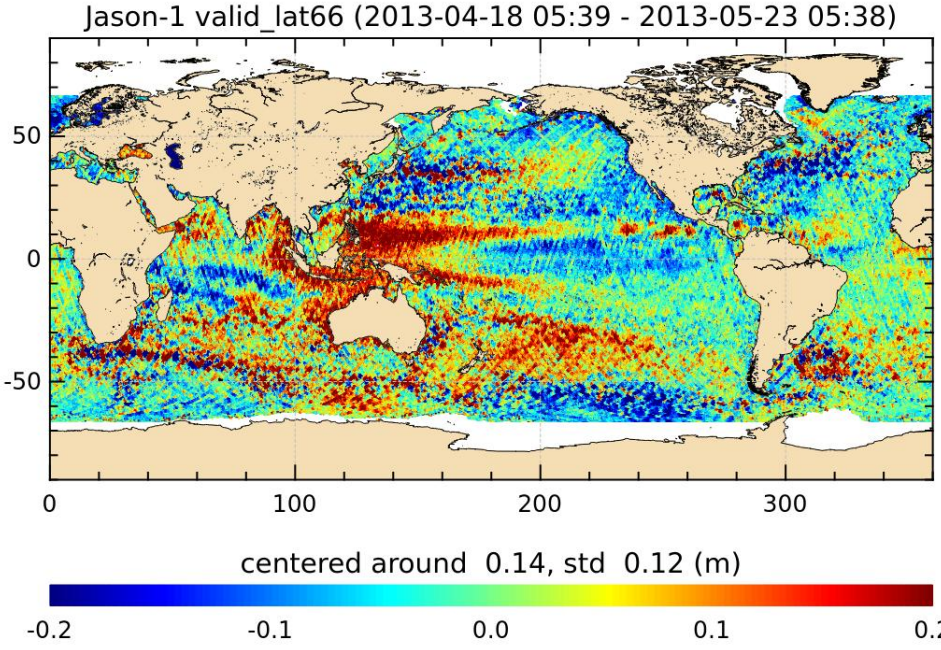
Saral

Ka-band SLA



Jason-1

Ku-band SLA



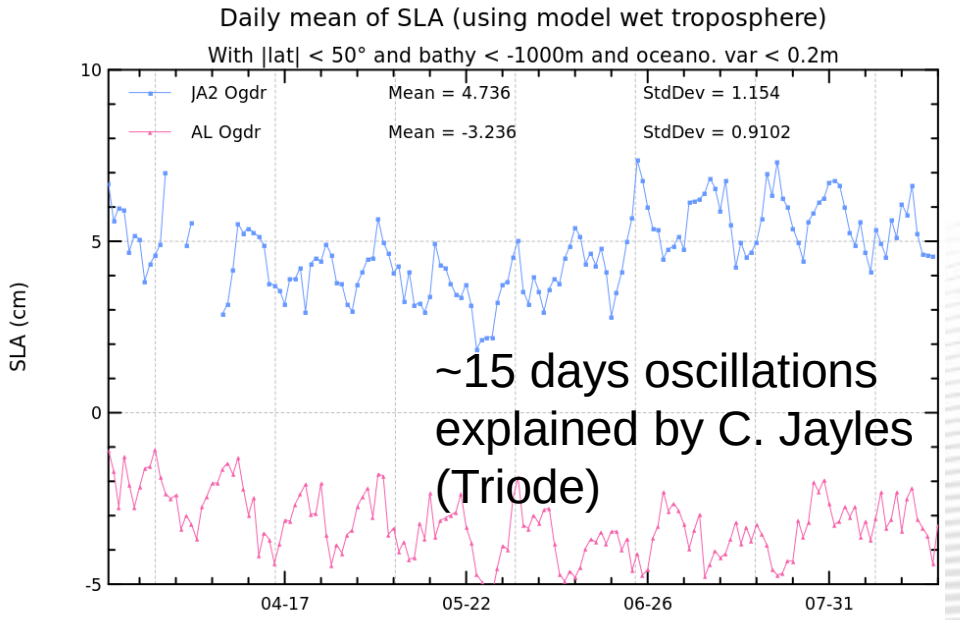
Using model wet tropopshere correction

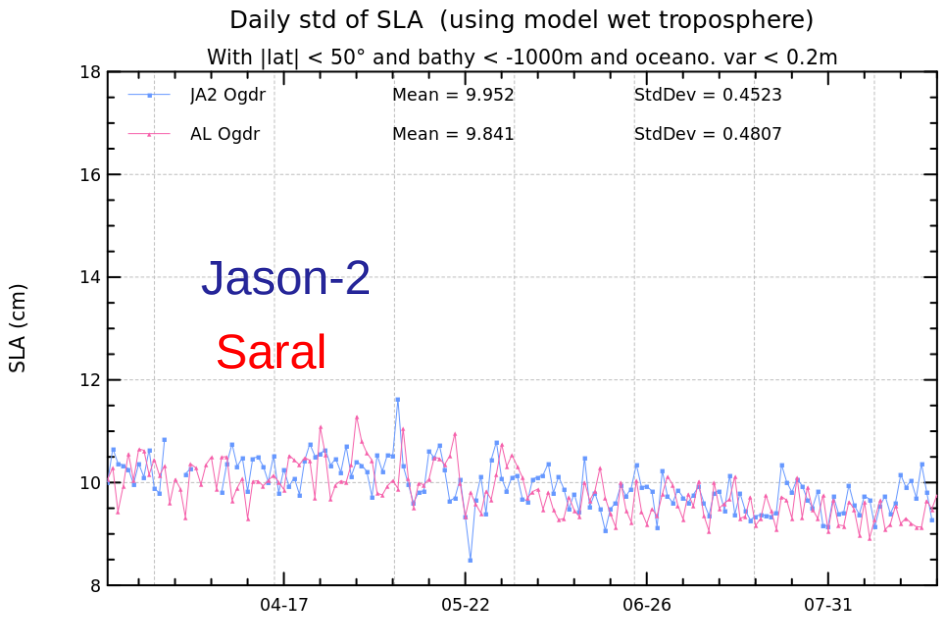
Sea level anomaly

- Using open ocean selections (|lat|<50 , bathymetry <-1000m, ocean variability<0.2m) and model wet tropo

	Mean (Ogdr)	Mean (Igdr)	Mean (Gdr)	Std (Ogdr)	Std (Igdr)	Std (Gdr)
Saral	-3.2 cm			9.84cm		
Jason-2	4.7 cm			9.95 cm		

OGDR





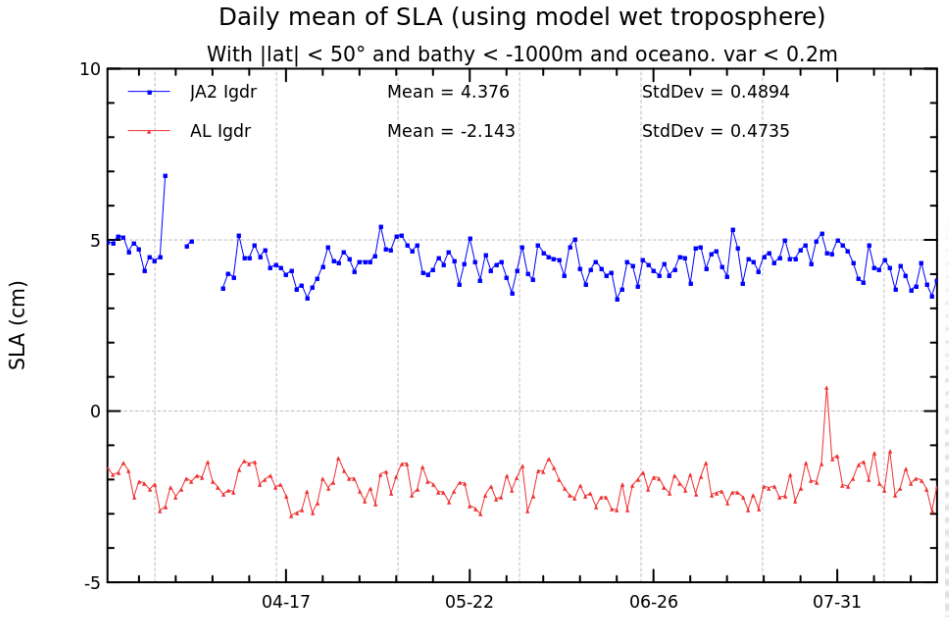
Using model wet troposphere correction

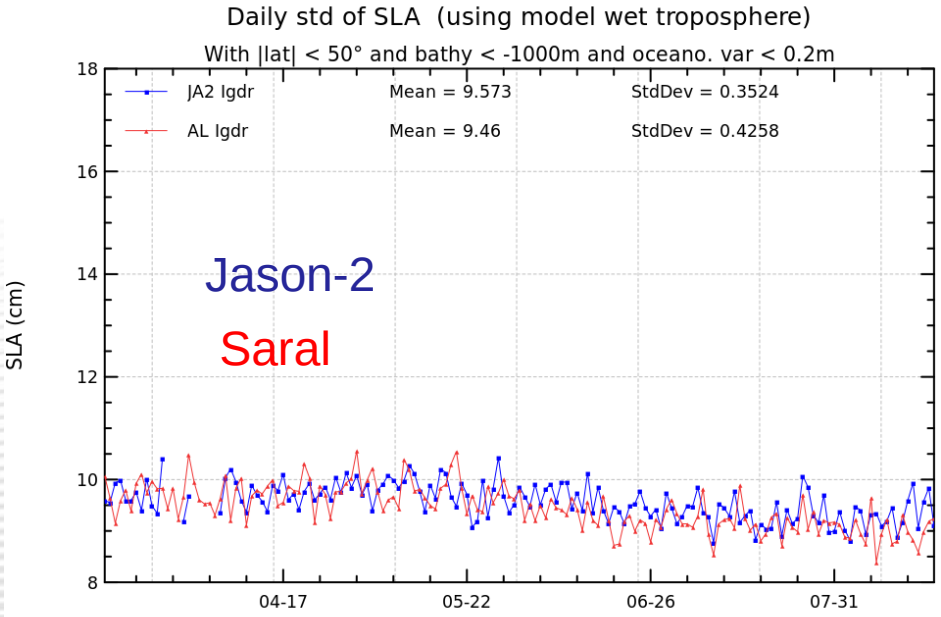
Sea level anomaly

- Using open ocean selections (|lat|<50 , bathymetry <-1000m, ocean variability<0.2m) and model wet tropo

	Mean (Ogdr)	Mean (Igdr)	Mean (Gdr)	Std (Ogdr)	Std (Igdr)	Std (Gdr)
Saral	-3.2 cm	-2.1		9.84cm	9.46	
Jason-2	4.7 cm	4.4		9.95 cm	9.57	

IGDR



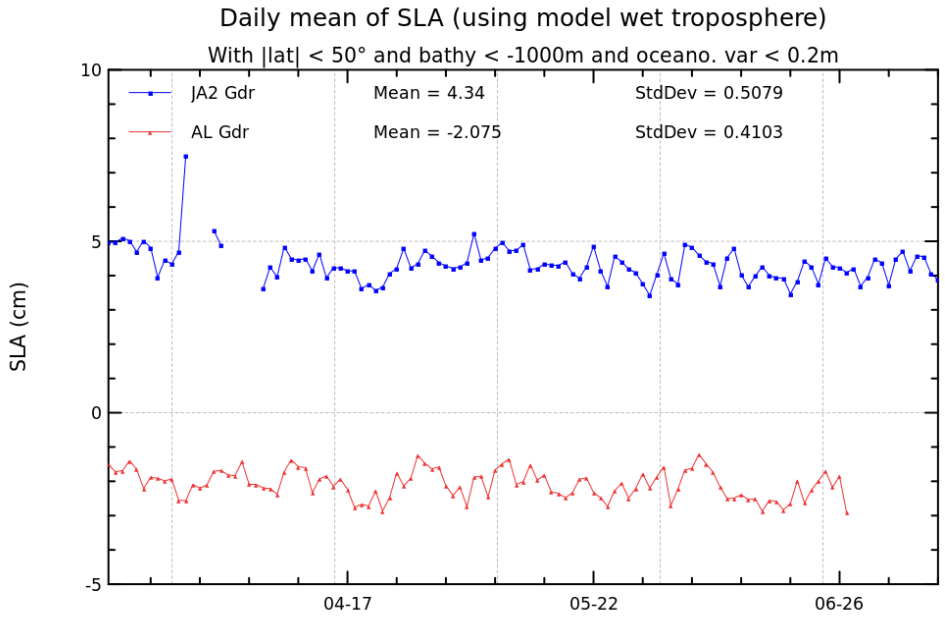


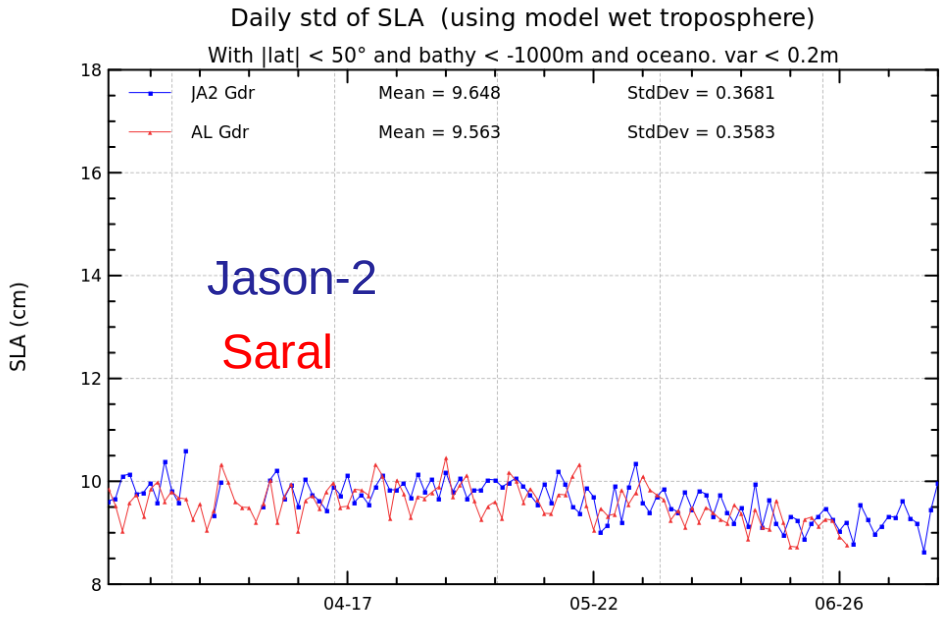
Using model wet troposphere correction

Sea level anomaly

- Using open ocean selections (|lat|<50 , bathymetry <-1000m, ocean variability<0.2m) and model wet tropo

	Mean (Ogdr)	Mean (Igdr)	Mean (Gdr)	Std (Ogdr)	Std (Igdr)	Std (Gdr)	
Saral	-3.2 cm	-2.1	-2.1	9.84cm	9.46	9.56	
Jason-2	4.7 cm	4.4	4.3	9.95 cm	9.57	9.65	**GDR**



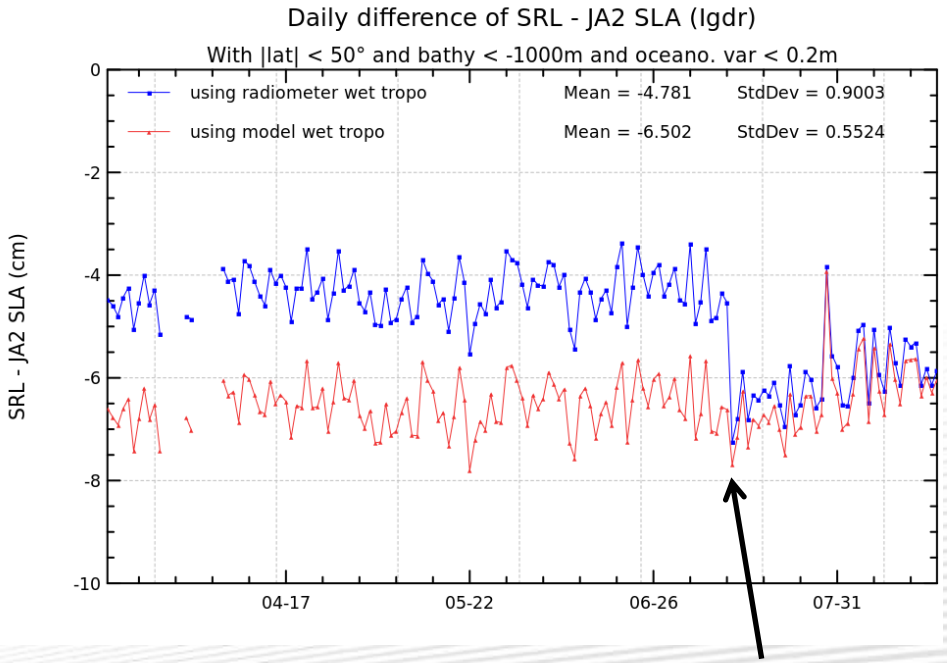


Using model wet troposphere correction

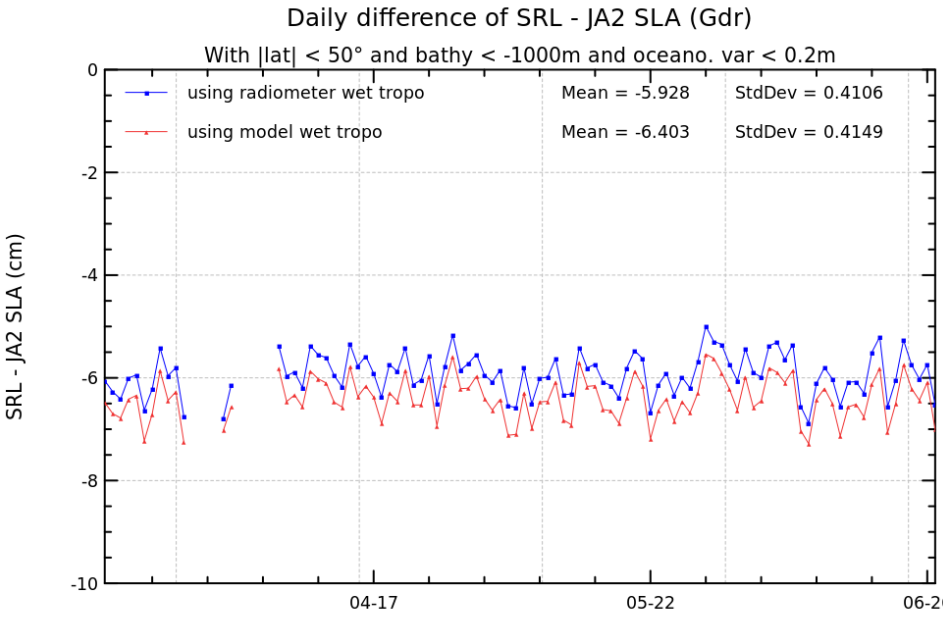
Bias between Saral and Jason-2

	Model wet tropo + iono alti (JA2)
Difference SLA SRL –JA2	-6.5 cm

IGDR



GDR

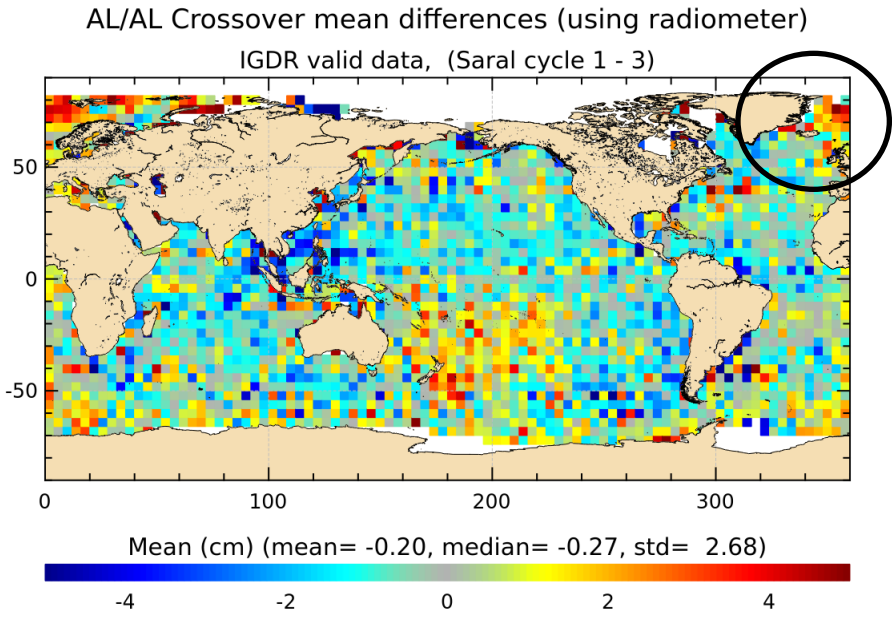


Use of patch 1 in IGDR

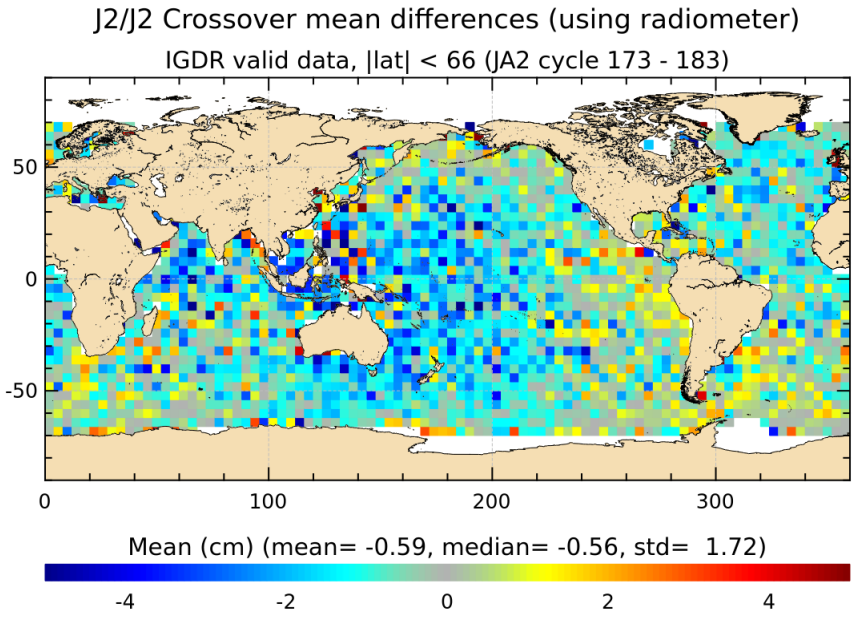
Crossover analysis

- Asc/dsc SSH differences at crossovers limited to 10 day time differences (using radiometer wet troposphere correction)
  - No large systematic asc/dsc differences
  - Small positif patch near greenland

IGDR



Saral

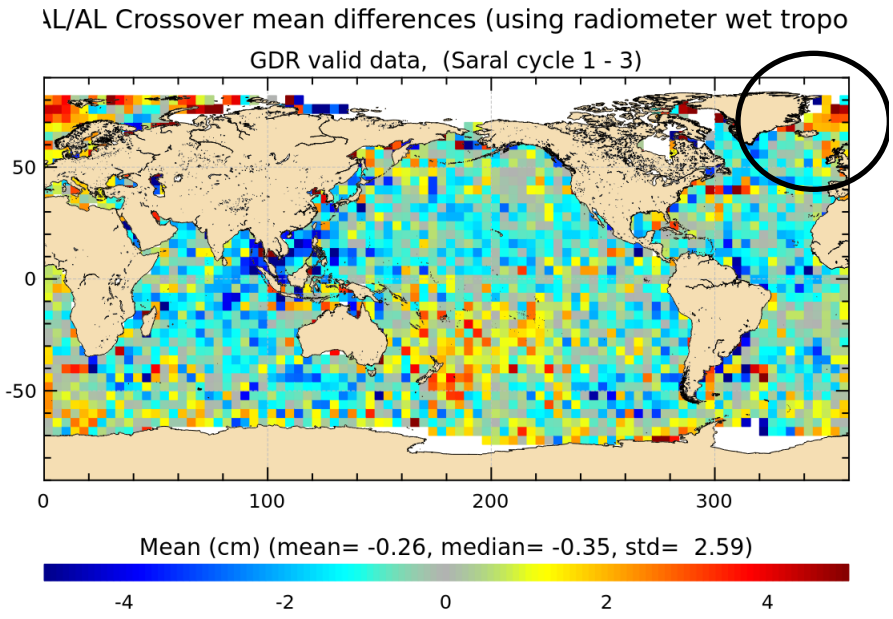


Jason-2

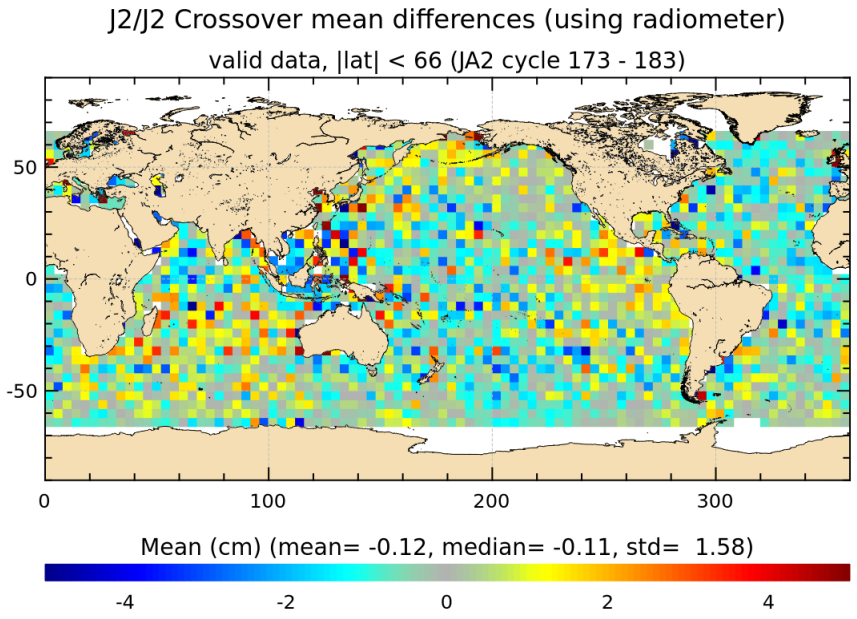
Crossover analysis

- Asc/dsc SSH differences at crossovers limited to 10 day time differences (using radiometer wet troposphere correction)
  - No large systematic asc/dsc differences
  - Small positif patch near greenland

GDR



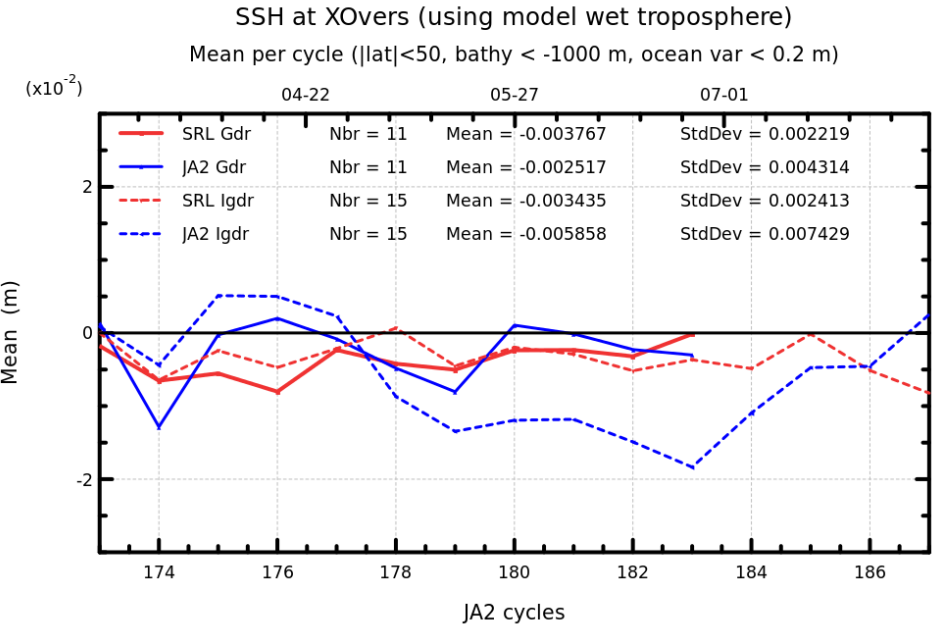
Saral

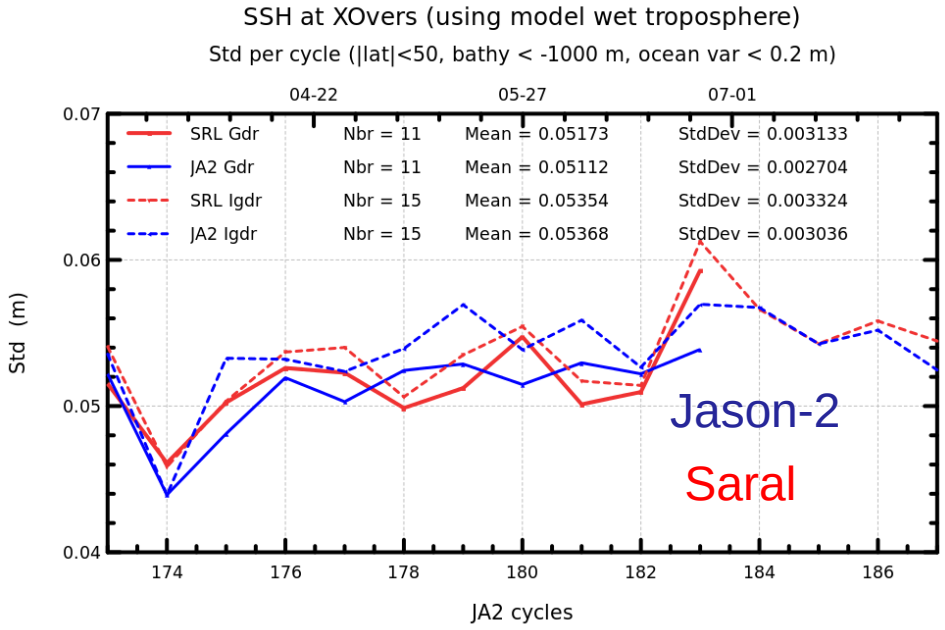


Jason-2

Crossover analysis

- Mean of asc/dsc SSH differences at crossovers is close to 0
  - JA2 Igdr show periodical signal, more stable for SRL, though slightly negatif
- Std of SSH differences (limited to 50 latitude, bathy < -1000m, ocean variability < 0.2 m) are similar for Saral and Jason-2 (Igdr: 5.3 cm, Gdr: 5.1 cm).

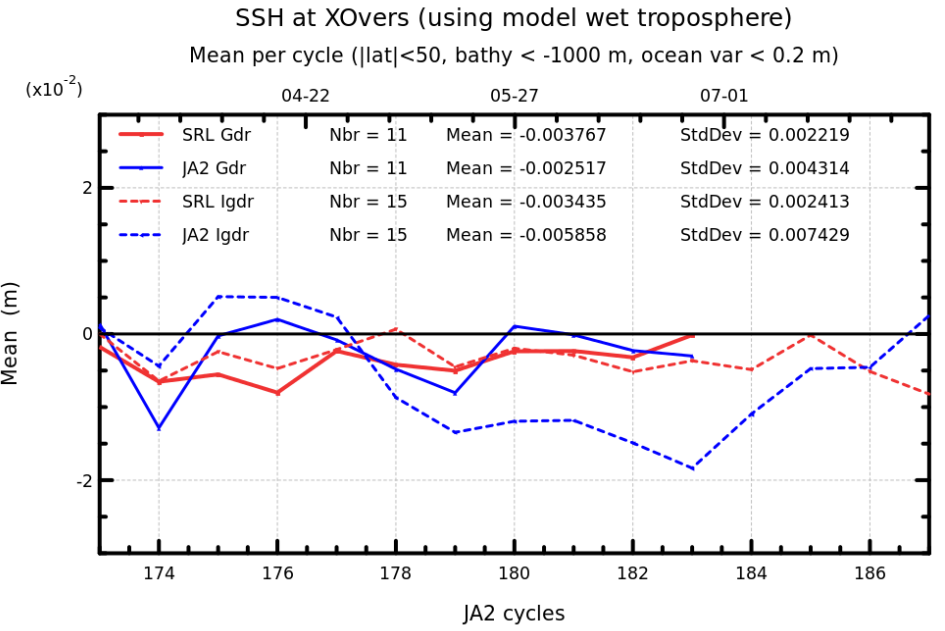


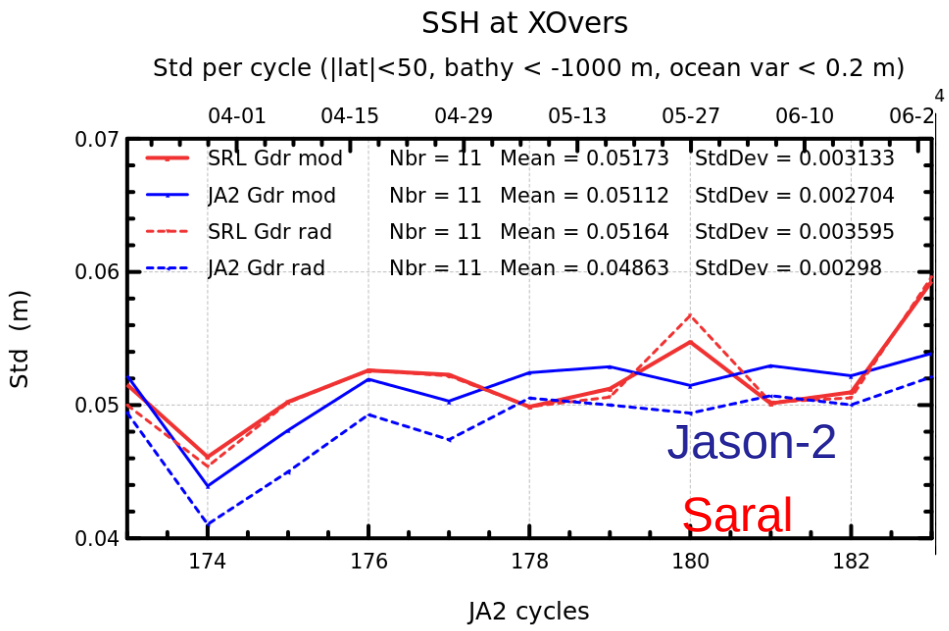


Using model wet tropopshere correction

Crossover analysis

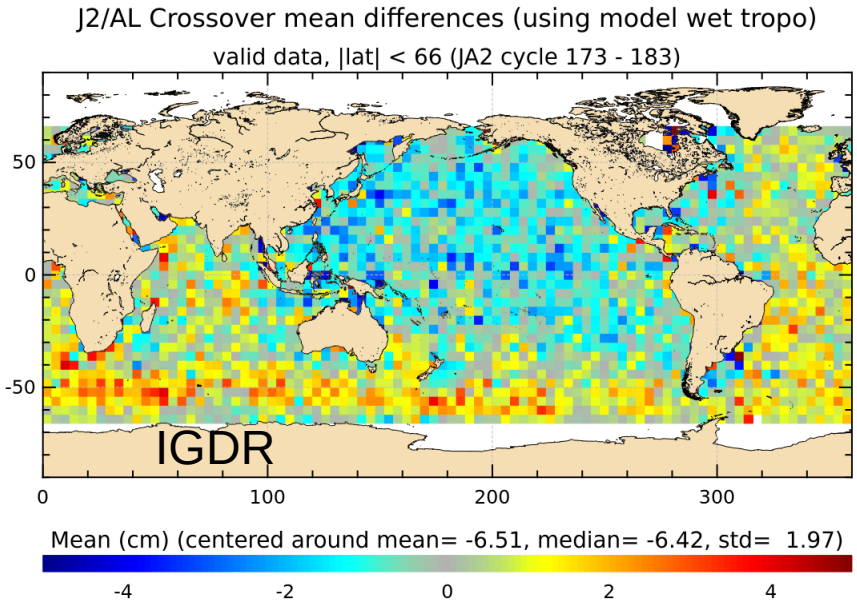
- Mean of asc/dsc SSH differences at crossovers is close to 0
  - JA2 Igdr show periodical signal, more stable for SRL, though slightly negatif
- Std of SSH differences (limited to 50 latitude, bathy < -1000m, ocean variability < 0.2 m) are similar for Saral and Jason-2 (Igdr: 5.3 cm, Gdr: 5.1 cm).
  - For SRL, performances are similar using radiometer or model wet troposphere correction, whereas for JA2 use of radiometer improves performances at mesoscale

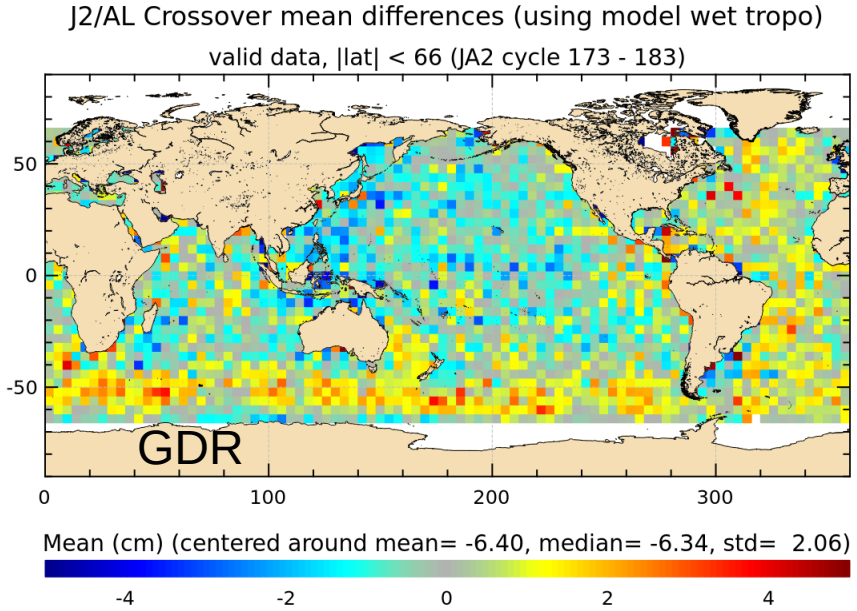




Multi-mission crossover analysis

- Maps of Saral – Jason-2 crossovers for IGDR and GDR (3 cycles)
- Positif values for Atlantic, Negatif values for Pacific
- Positif structure in region of high SWH (near Antarctic)
- Using GDR reduces the amplitude of these structures

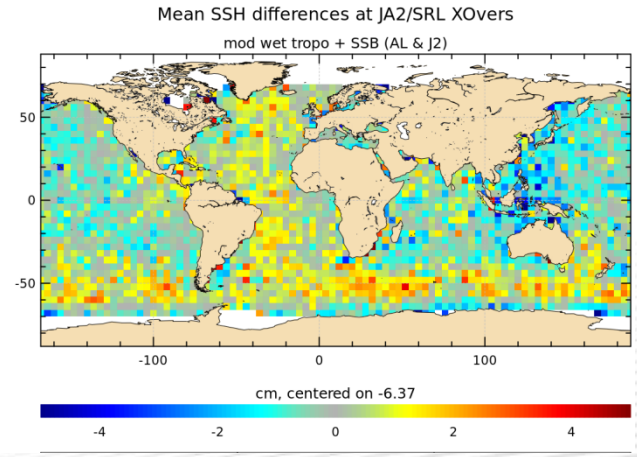




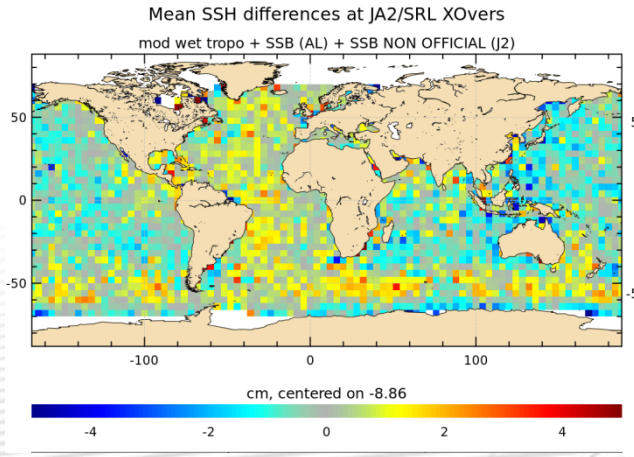
Multi-mission crossover analysis

- Maps of Saral – Jason-2/Jason-1 crossovers (for GDR (3 cycles))
- Positif values for Atlantic, Negatif values for Pacific
- Positif structure in region of high SWH (near Antarctic)
- Currently SRL SSB=3.5%SWH. Using different SSB solutions, modifies the structures

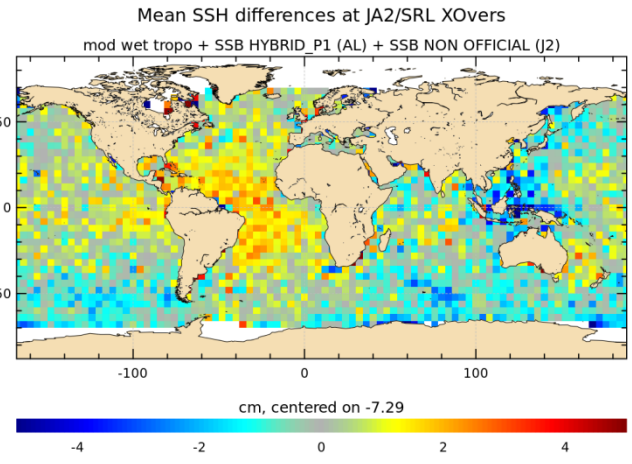
SSB from products



SRL product SSB
JA2 SSB 2012 (N. Tran)



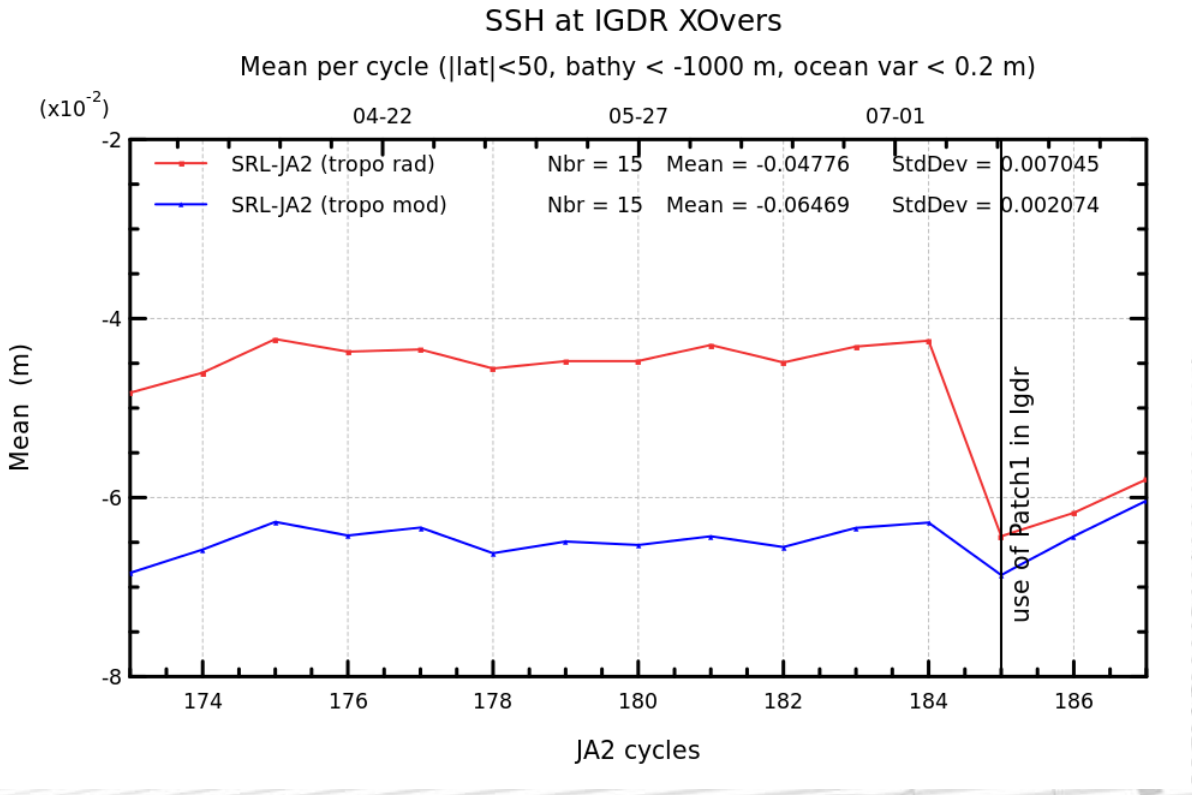
SRL hybid SSB (R. Scharro)
JA2 SSB 2012 (N.Tran)



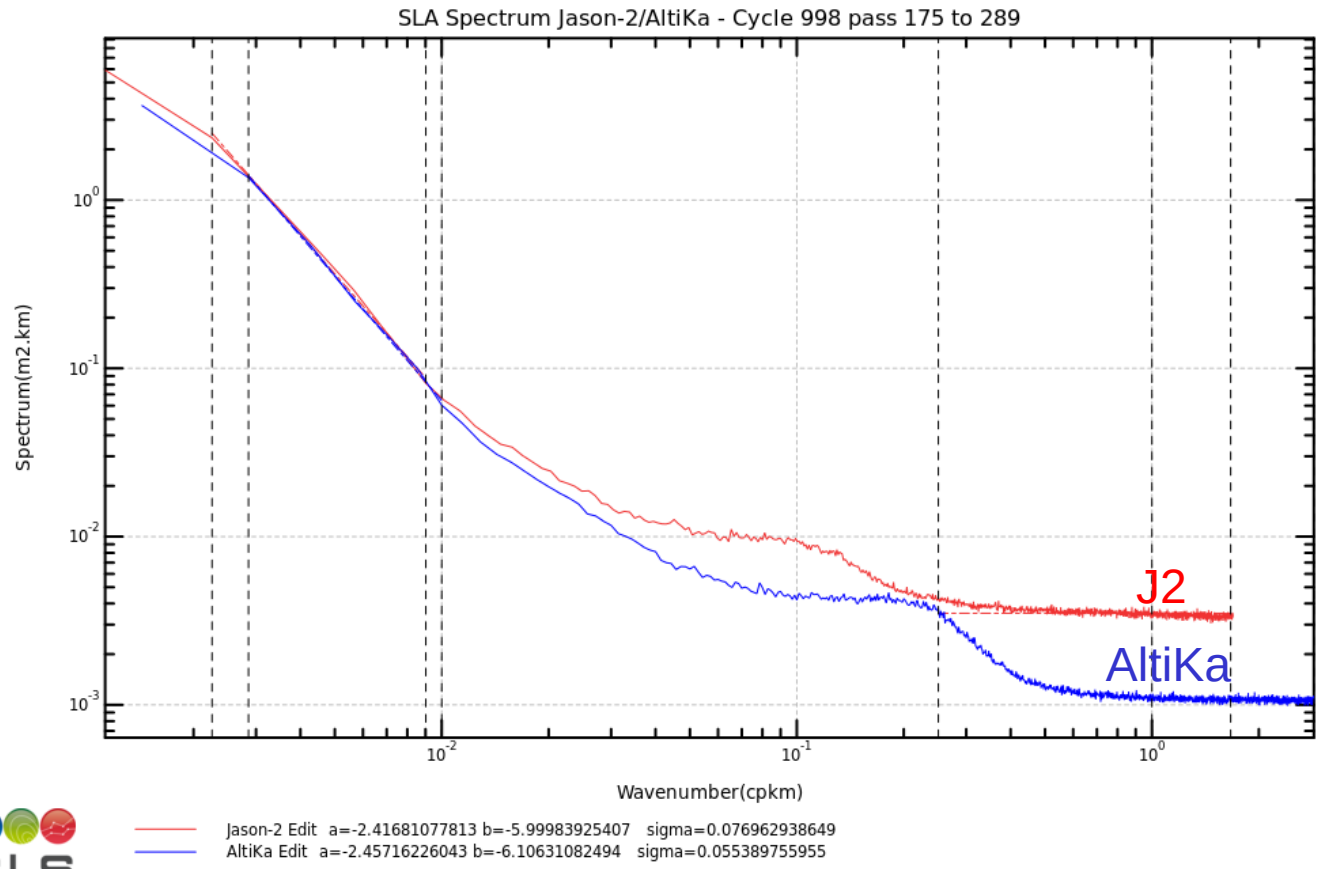
3 35-day cycles GDR

Multi-mission crossover analysis

- Bias between SRL and JA2 at crossovers stays stable



Global Ku/Ka SLA PSD



HR Noise:

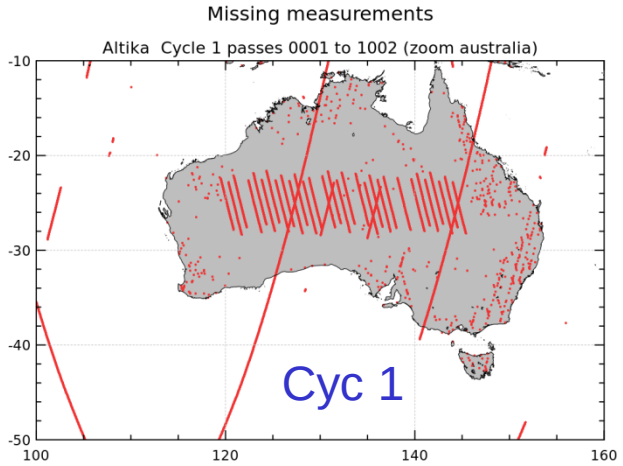
7.7 cm @ 20Hz

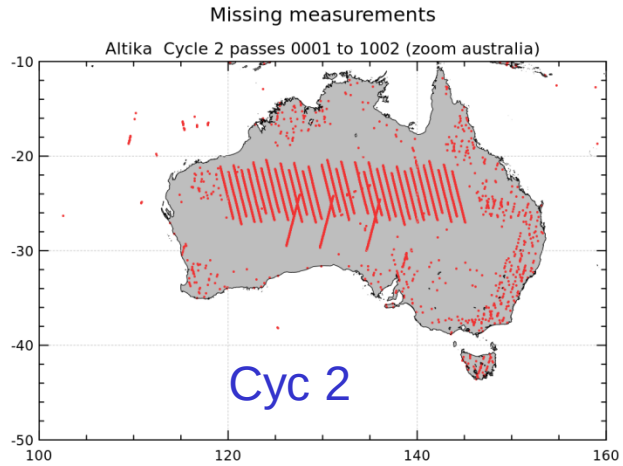
5.6 cm @ 40Hz

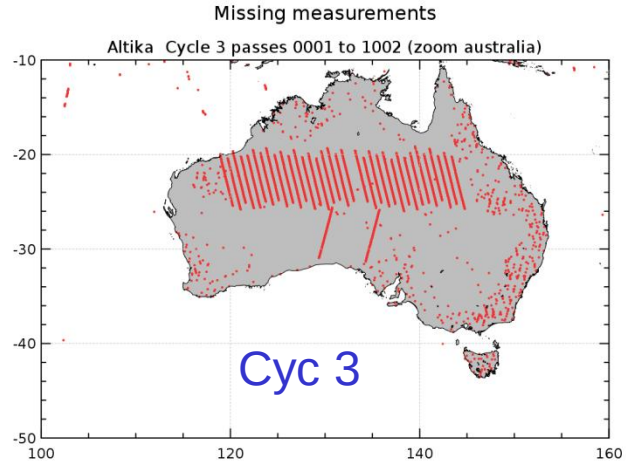
- 40Hz AltiKa SLA noise < 20Hz Jason-2 SLA noise ➔ good performances of the altimeter
- Spectral hump is still present on AltiKa SLA PSD but shifted to shorter scales (mainly due to the smaller waveform footprint)
- The AltiKa SLA PSD is closer to the theoretical ocean PSD for wavelength between 90 to 50 km

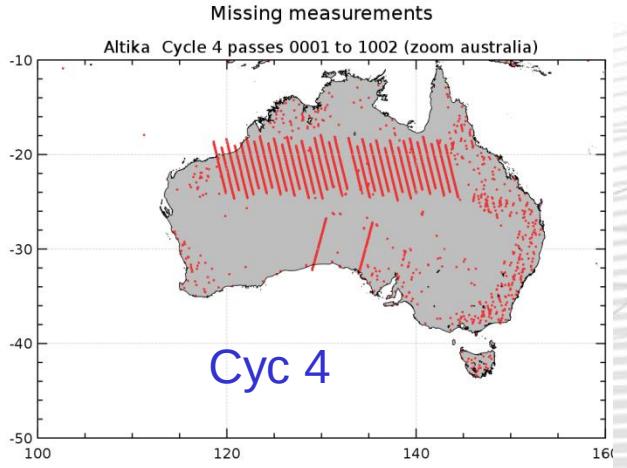
Ground track and inclination maneuver to reach Envisat orbit

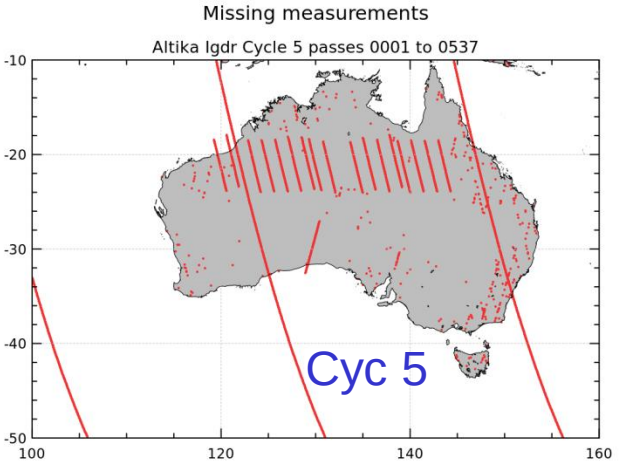
- Saral/ Altika is currently not exactly over the historically Envisat ground track
- routine calibrations (over Australia) started to drift over ocean -> will be taken into account early september onwards







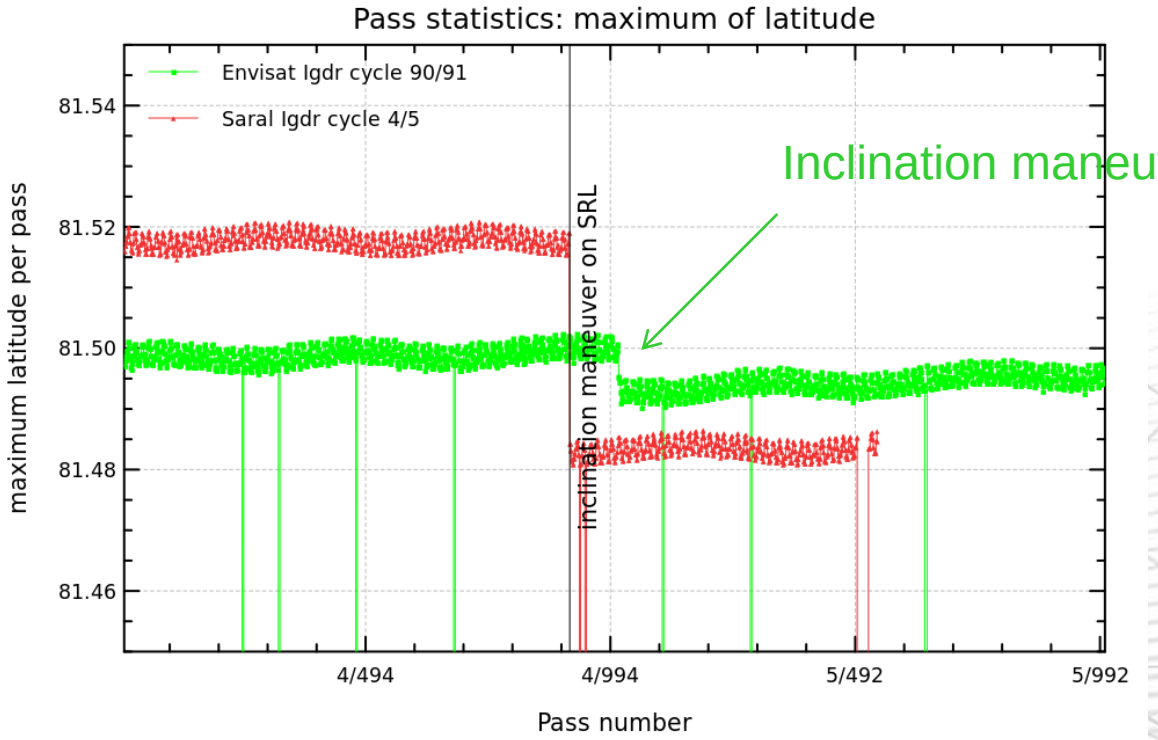




Ground track and inclination maneuver to reach Envisat orbit

- Saral/ Altika is currently not exactly over the historically Envisat ground track
- On 2013-07-29 00h53 , an inclination maneuver took place for Saral, in order to put it on the same ground track as Envisat.

Maximum of latitude per pass



- the inclination of Saral is still different from Envisat
- the maneuvers of 29/07 (inclination) and 31/07 had a negative impact on the quality of the orbit of the IGDR (for large periods of the day)

Conclusion

- SRL has excellent data coverage (slightly less in open ocean than for JA2 due to sensitivity to rain, but much more than expected)
- SRL has excellent data quality (some data edited due to rain cells, but less than expected)
- Performances of along-track data and at crossover points are similar to Jason-2, as well as for IGDR as for GDR.
- Some patches between Saral and Jason-2 remain:
  - SSB
- Radiometer ground processing can still be improved

- Only 5 months after the launch, Saral shows excellent data quality