Jason-3 GDR-F standard : ready for operational switch

OSTST 2020

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(4) EUMETSAT
(5) NOAA

Introduction

The Jason-3 GDR is produced in standard GDR-D since the end of the commissioning phase (Sept 2016).

The decision to **upgrade** to standard **GDR-F**, took during OSTST 2018 (Açores), was confirm during Jason-3 2019 REVEX and OSTST 2019 (Chicago).

The Jason-3 GDR-F standard, following OSTST recommendations and 4P work held during past REVEX, was development with the double aim of improving the quality of the product, and to share a **common standard** with Sentinel-6/Jason-CS, thanks to a very cooperation between agencies.

The Jason-3 GDR standard will upgrade to GDR-F on **2020 October, 29th** , and GDR-F will become the **operational baseline standard** for Jason-3 OGDR and IGDR (from cycle 174 onwards) and GDR (from cycle 171 onwards)

This presentation focusses on the models evolution between GDR-D and GDR-F, the facilities involved in this upgrade, the project schedule, and the Calval assesement performed to validate this new standard.

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Outline

1. **Science upgrade wrt GDR-D Standard**
2. Project Schedule
3. Facilities
4. Calval Results

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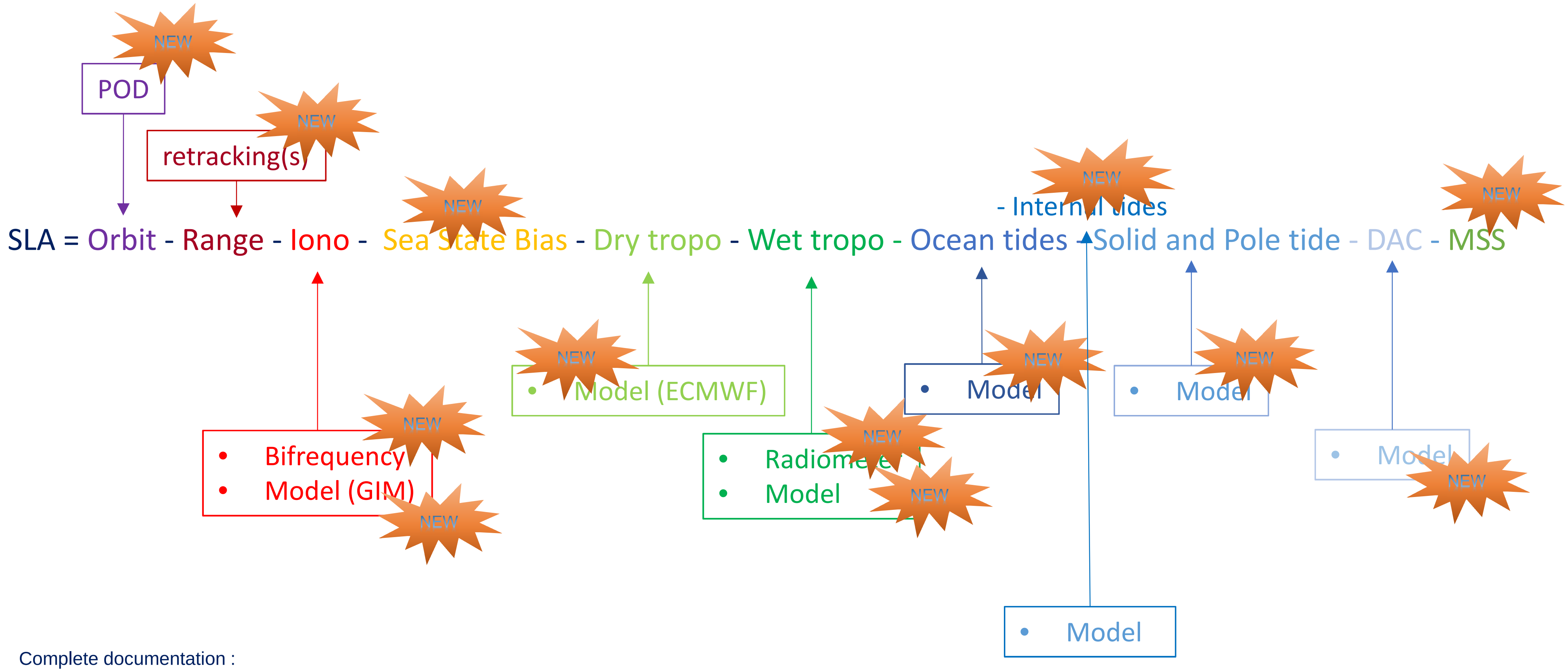
GDR-F novelties in a look



Complete documentation :

- SALP-MU-M-OP-16118-CN Ed02 Rev00 : **Jason-3 Products Handbook**
- SALP-ST-M-EA-16122-CN Ed02Rev00 : **Jason-3 User Products**

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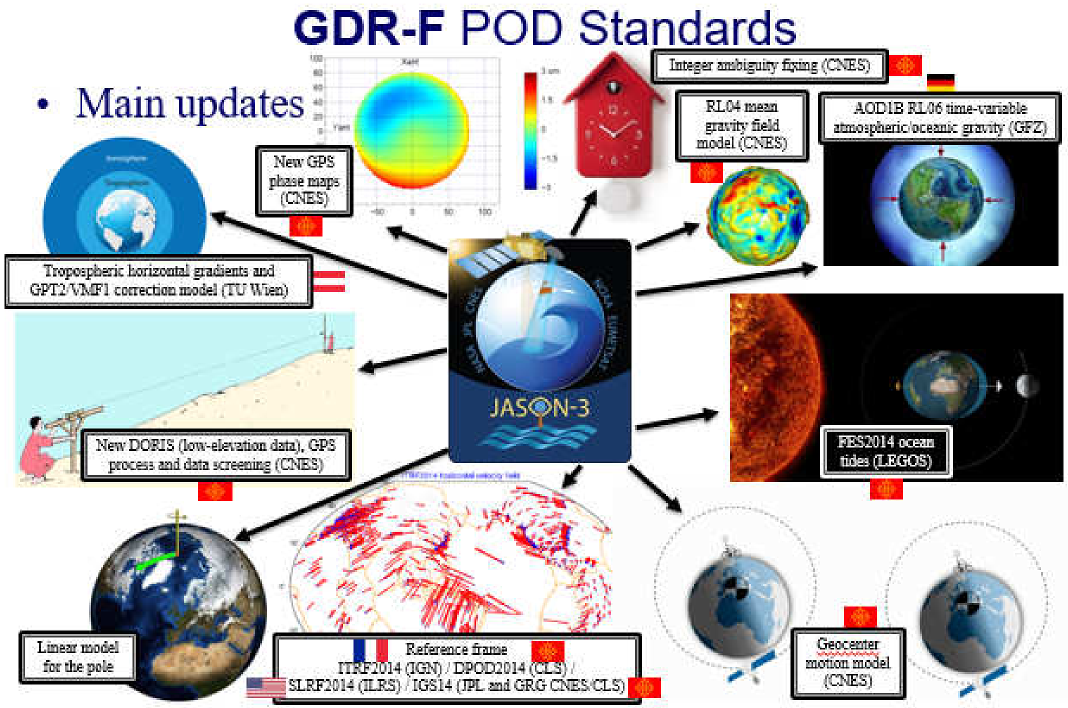
Orbit

	Jason-3 GDR-D	Jason-3 GDR-F	
IGDR Orbit Standard	MOE-E MOE-F since Sept. 2018	MOE-F	IGDR
GDR Orbit Standard	POE-E POE-F since Sept. 2018	POE-F	GDR



Courtesy of A. Couhert

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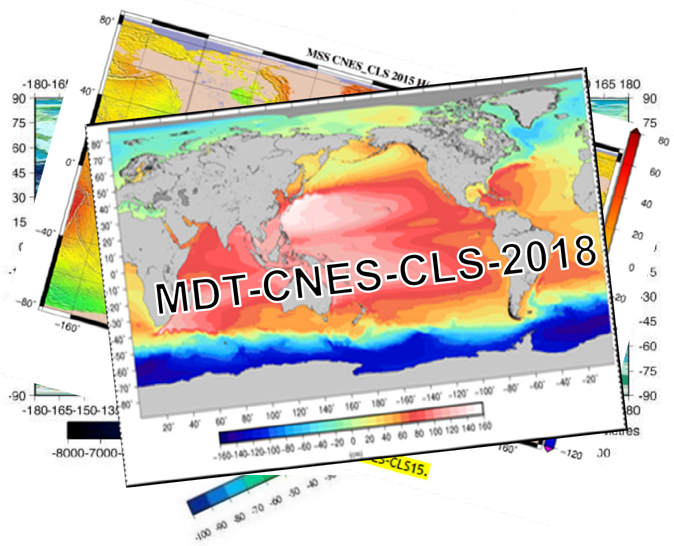
Geophysical Evolutions

	Jason-3 GDR-D	Jason-3 GDR-F	
Ellipsoïd	Topex/Poseidon	WGS84 *	O/I/GDR
Geoid	EGM 1996	EGM 2008	O/I/GDR
Bathymetry	DTM2000.1	ACE-2	O/I/GDR
MSS	MSS_CNES_CLS2011	MSS_CNES_CLS2015	O/I/GDR
MSS 2nd solution	N/A	MSS DTU 2018 *	O/I/GDR
MDT	MDT-CNES-CLS-2009	MDT-CNES-CLS-2018	O/I/GDR
Global slope correction *	N/A	Sandwell 2013	O/I/GDR



* : different from SARAL GDR-F

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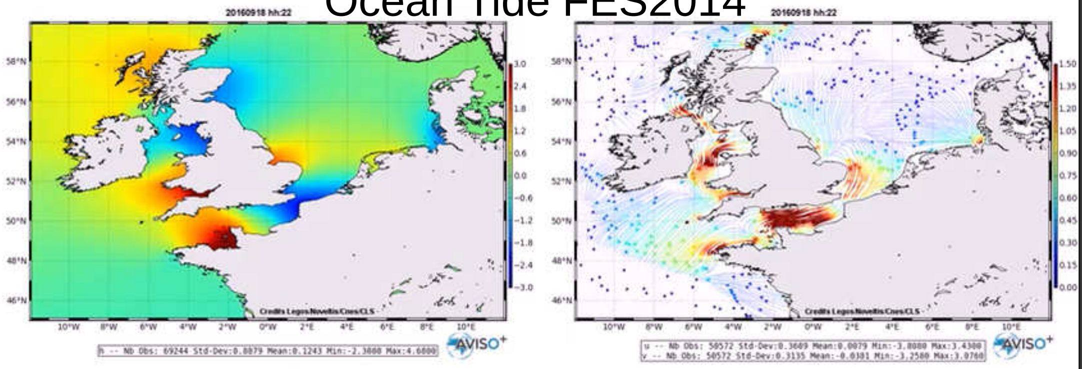
Tides

	Jason-3 GDR-D	Jason-3 GDR-F	
Ocean Tide FES	FES 2012	FES 2014b	O/I/GDR
Ocean Tide GOT	GOT 4.8	GOT 4.10c	O/I/GDR
Tidal correction on hydrological areas, enclosed seas and lakes	including ocean tide and equilibrium ocean tide	Keep only load tide contribution	O/I/GDR
Pole Tide	Wahr 1985	Desai 2015 with 2017 MPL	O/I/GDR
Internal Tide	N/A	Zaron 2019 HRET_8.1 *	O/I/GDR

Ocean Tide FES2014



* : different from SARAL GDR-F

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Meteo

		Jason-3 GDR-D	Jason-3 GDR-F	
Iono model in OGDR		N/A	GIM predicted	OGDR
Bifrequency Iono *		Unsmoothed	Unsmoothed & Smoothed	O/I/GDR
Atmospheric Attenuation	radiometer	from AMR	from recalibrated AMR	O/I/GDR
	Model	Keihm 1995 with ECMWF 2D data	Lilibridge 2014 with 3D ECMWF data	GDR
Wet Tropo	radiometer	from AMR	from recalibrated AMR	O/I/GDR
	Model at measurement level	From model ECMWF pressure at measurement level	3D ECMWF data integration at measurement level from retracked range	GDR
	Model at sea level	N/A	From ECMWF pressure at mean sea level	O/I/GDR
Dry Tropo	Model at measurement level	From model ECMWF pressure at measurement level	3D ECMWF data integration at measurement level from retracked range	GDR
	Model at sea level	N/A	From ECMWF pressure at mean sea level	O/I/GDR
DAC in OGDR		N/A	predicted MOG2D data	OGDR
DAC HF *		hf_fluctuations_corr	dac = inv_bar_corr + hf_fluctuations_corr	O/I/GDR

* : different from SARAL GDR-F

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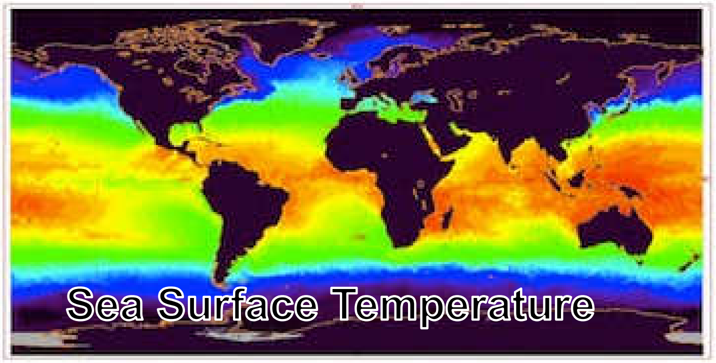
Auxiliary Data

	Jason-3 GDR-D	Jason-3 GDR-F	
SST	N/A	OISST v2.1	GDR
Wave period	N/A	MFWAM T02	I/GDR
Wave direction	N/A	MFWAM	I/GDR
Sea Ice Concentration	N/A	OSISAF SSMIS OSI-401-b	I/GDR
Coastal Distance	N/A	S6 GSHHG 2.3.7 shoreline dataset	O/I/GDR
Angle of approach to coast	N/A	S6 GSHHG 2.3.7 shoreline dataset	O/I/GDR
Surface Classification	4 state flag	7 state flag From GMT (Noveltis) ; GLOBCOVER LC V2.0 ; MODIS Mosaic of Antarctica	O/I/GDR



* : different from SARAL GDR-F

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AMR*

AMR land flag	Fix the anomaly on the AMR land flag
New Radiometer Surface Mask	New AJ3_SUR static file
New Reference (J-CS/S6) for antenna temperature coefficient	New AJ3_ANT dynamic file : [Sh Brown 2020] coeff file . Improves the wet tropospheric correction for early JA3 cycles (2.4 mm drift)
Level-1B AMR algo	Update the Level-1B AMR algorihtm in order to take into account a specific computation of the brightness temperature quality flags (algorithm called AMR_TB_QUAL_01) (change request 10551)

* : different from SARAL GDR-F

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Waveforms, Calibration, Retracking, Range

	Jason-3 GDR-D	Jason-3 GDR-F	
CAL1 Total Power of the PTR	1e-2 precision	1e-4 precision	O/I/GDR
CAL2 (LPF) normalization	normalization by max gate	normalization by averaging gates	O/I/GDR
CAL1 (PTR)	corrected from CAL2	not corrected from CAL2	O/I/GDR
MLE4 Mispointing validity map	Not provided	Provided	O/I/GDR
Waveform classification	N/A	Neural Network	O/I/GDR
Adaptive retracking *	N/A	Adaptive retracking	GDR
Tracker Range Rate	Not reported in S-IGDRs and S-GDRs	reported in S-IGDRs and S-GDRs	O/I/GDR
Waveform	Provide the waveforms non corrected from the LPF filter	Provide the waveforms corrected from the LPF filter	S-I/GDR
Doppler correction	Applied on ocean retracked ranges	Applied on all retracked ranges	O/I/GDR

* : different from SARAL GDR-F

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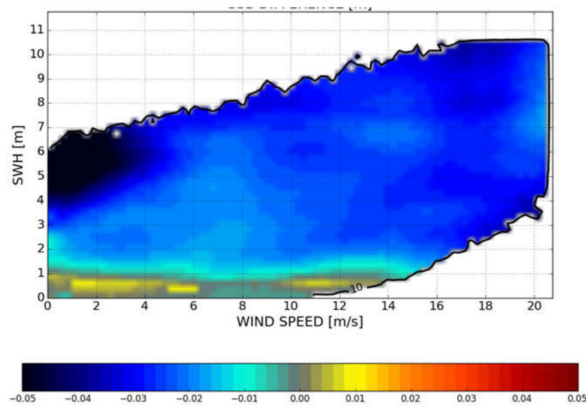
Wind, Rain

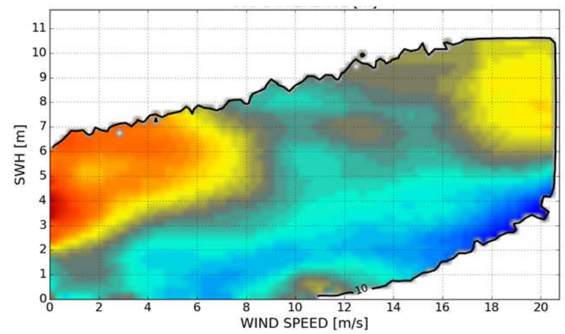
	Jason-3 GDR-D	Jason-3 GDR-F	
Wind speed	Update the bias applied on sigma0 product (MLE4 and ADAPTIVE) before using Collard's algorithm [2005] Higher wind speed estimates closer to ERA-5 statistics		O/I/GDR
Rain Table	Update the Rain Table Lower setting of the flag to rain, it reduces the number of false detection of rain-distorted data		O/I/GDR
Rain Flag	2-states rain flag	6-states S6 like rain flag	O/I/GDR



SSBKu_J3_MLE4_2020 - SSBKu_J2_MLE4_2011

SSB

	Jason-3 GDR-D	Jason-3 GDR-F	
Ku/C MLE4 2D SSB	[Tran2011] (Empirical solution fitted on Jason-2 GDR_C data)	[Tran 2020] (computed using 2016/17 GDR-F dataset)	O/I/GDR
Ku MLE4 3D SSB	N/A	[Tran 2020] (computed using 2016/17 GDR-F dataset)	O/I/GDR
Ku Adaptive 2D SSB *	N/A	[Tran 2020] (computed using 2016/17 GDR-F dataset)	GDR
Ku Adaptive 3D SSB *	N/A	[Tran 2020] (computed using 2016/17 GDR-F dataset)	GDR



SSBKu_J3_ADAP_2020 -SSBKu_J2_MLE4_2011

* : different from SARAL GDR-F

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SSHA formula

	Jason-3 GDR-D	Jason-3 GDR-F	
SSHA Tide solution	GOT	FES	O/I/GDR
SSHA *	not corrected from ocean tide non equilibrium	corrected from ocean tide non equilibrium	O/I/GDR
SSHA	not corrected from Internal Tide	corrected from Internal Tide	O/I/GDR

* : different from SARAL GDR-F

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Dataset Format

- SALP-MU-M-OP-16118-CN Ed02 Rev00 : **Jason-3 Products Handbook**
- SALP-ST-M-EA-16122-CN Ed02Rev00 : **Jason-3 User Products**

	Jason-3 GDR-D	Jason-3 GDR-F	
GDR Version	GDR-D.	GDR-F	O/I/GDR
NetCDF Version	NetCDF-3 without compression	NetCDF-4/HDF5 enhanced model format with native compression	O/I/GDR
CF Version	1.1	1.7	O/I/GDR
Variables names *	GDR-D names	Large renaming of variables (S6 reconcile)	O/I/GDR
NetCDF groups *	No groups	data_01/ data_01/ku data_01/c data_20/ data_20/ku data_20/c	O/I/GDR

All dataset impacted :

	OGDR	IGDR	GDR
GDR Reduced	OGDR-SSHA	IGDR-SSHA	GDR-SSHA
GDR Native	OGDR	IGDR	GDR
GDR Expert		S-IGDR	S-GDR

* : different from SARAL GDR-F

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Outline

1. Science upgrade wrt GDR-D Standard
2. **Project Schedule**
3. Facilities
4. Calval Results

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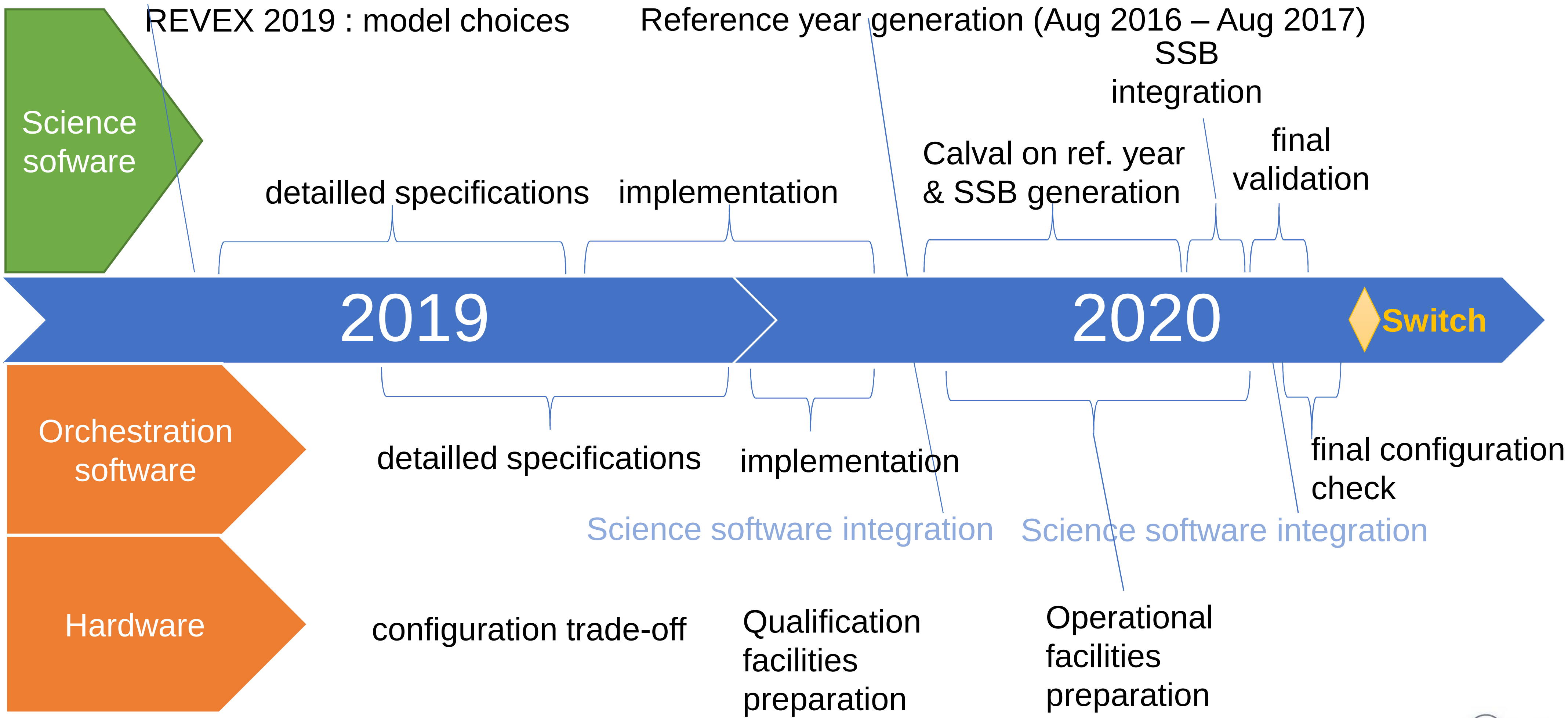
Project Schedule



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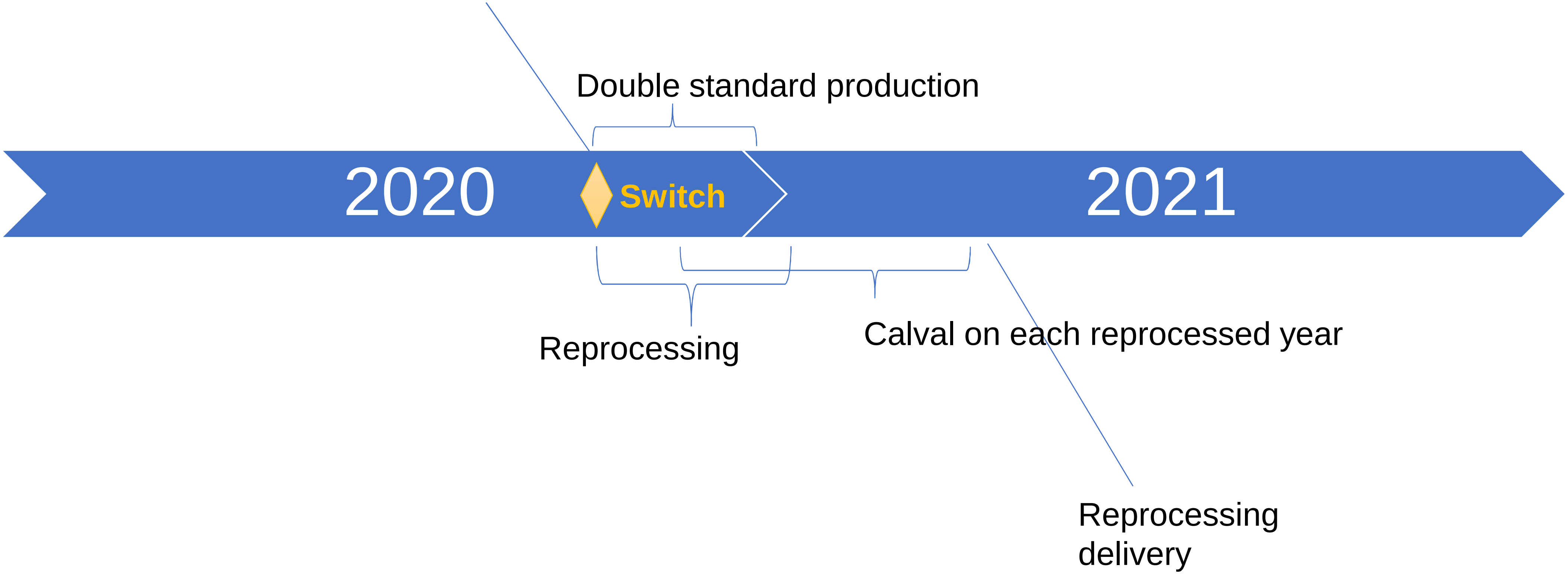
Project Schedule

Operational Switch : 29 Oct. 2020

- First IGDR in “F” standard : 174
- First GDR in “F” standard : 171



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Outline

1. Science upgrade wrt GDR-D Standard
2. Project Schedule
3. **Facilities & performances**
4. Calval Results

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System Architecture

- **OGDR**
  - No hardware change for TM-NRT at NOAA / EUMETSAT
  - Software updates (pilot processing software and integrated scientific libraries)

- **I/GDR**
  - For operational production and for reprocessing activities
  - Hardware major change to sustain performances required by the GDR-F standard: switch from standalone servers to the CNES Computer Center
  - Software major updates, especially in integrated scientific libraries (such as multi-threading introduction)

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Performances

- **Operational production (estimations based on qualification activities)**
  - OGDR processing time: about 5 minutes per flow.
  - IGDR processing time: about 2 minutes 30 seconds per trace. The processing time of an IGDR day highly depends on the parallelization configuration (with current configuration, about 40 minutes for the whole day)
  - GDR processing time: about 30 minutes per trace. The processing time of a GDR cycle highly depends on the parallelization configuration (currently, about 5 hours for the whole cycle)
- **Reprocessing (estimations based on qualification activities)**
  - GDR reprocessing time: about 20 minutes per trace. The processing time of a GDR year highly depends on the parallelization configuration (currently, about 3 days for the whole year)
  - Level1 reprocessing time: about 6 hours per year.
  - LTM reprocessing time: about 6 hours per year.

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Outline

1. Science upgrade wrt GDR-D Standard
2. Project Schedule
3. Facilities
4. **Calval Results**
   - ✓ Coverage and quality
   - ✓ MLE4 performances (GDR-F vs GDR-D)
   - ✓ Retracking performances (GDR-F MLE4 vs GDR-F adaptive)

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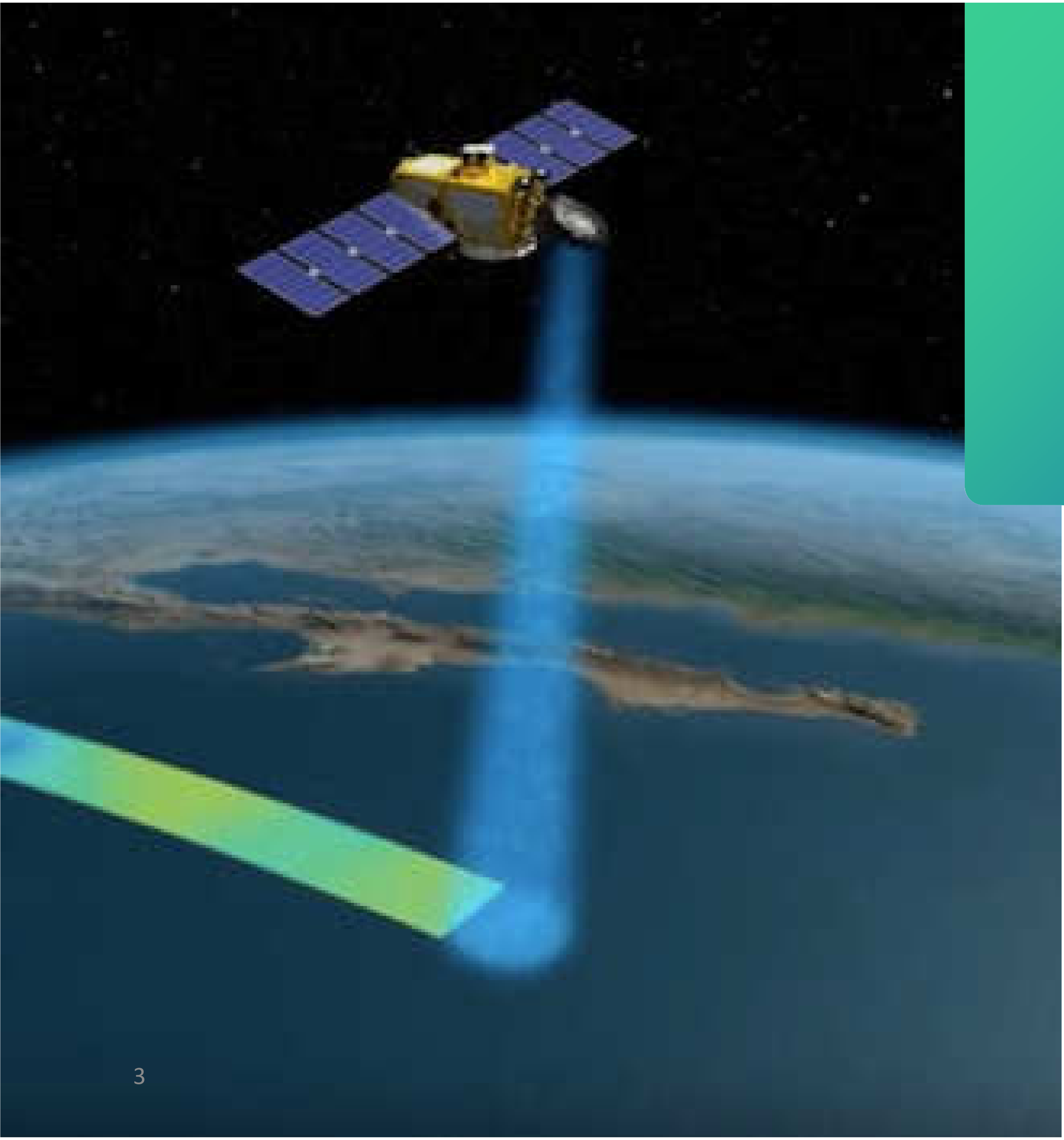


Coverage and quality

...

Coverage

Differences in number of available points

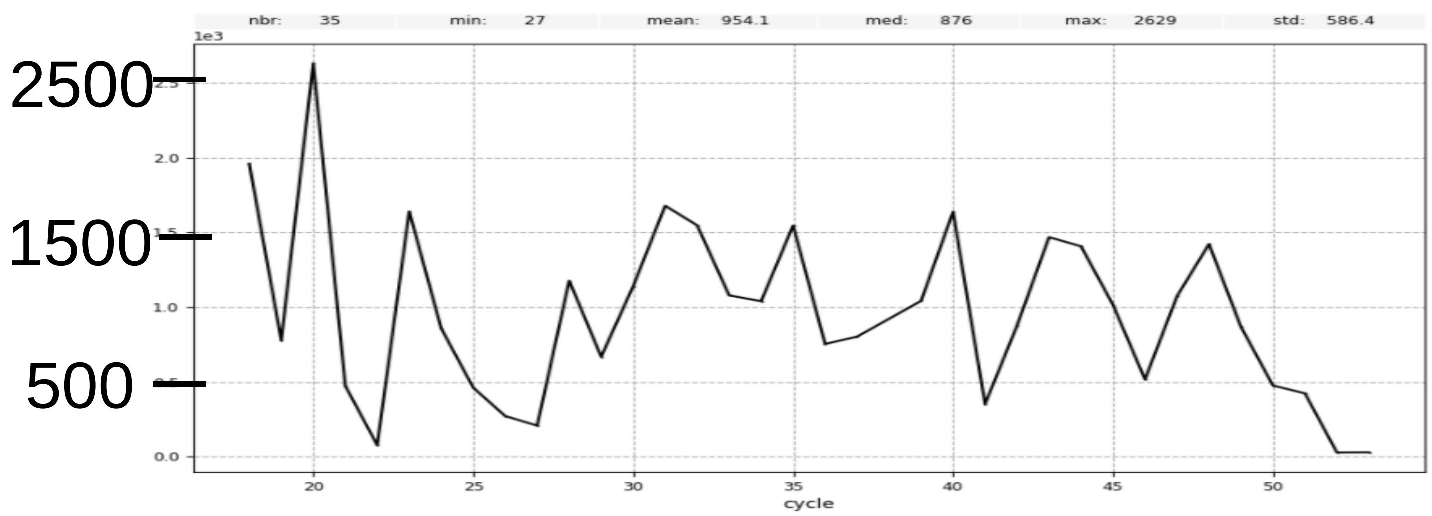
Over the period covered (cycles 17 to 53), no loss of data from GDR-D to GDR-F

Difference in datation

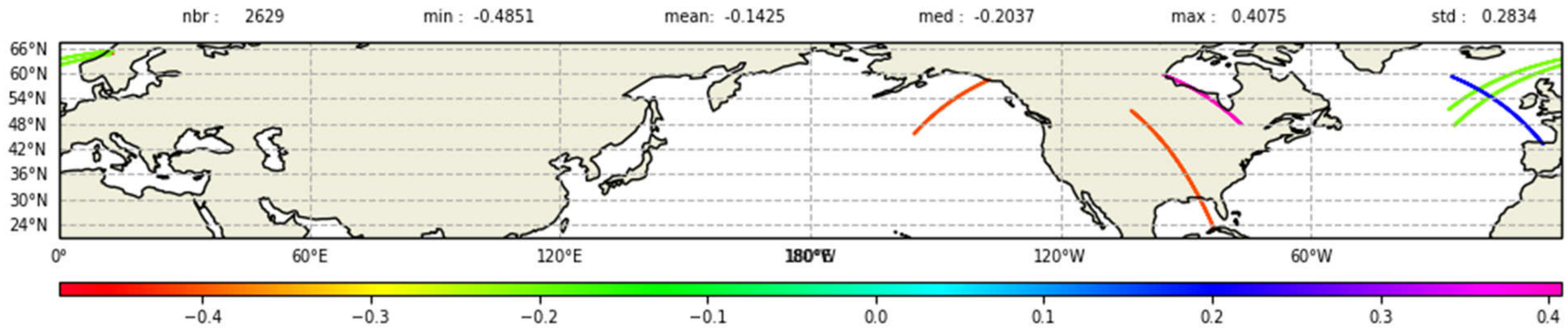
time

Datation can be slightly different between GDR-F and GDR-D. Over the analysed period: number of point per cycle with datation difference >1µs :

This is due to slight difference in the 20Hz measurements that are taken into account to compute 1Hz point.

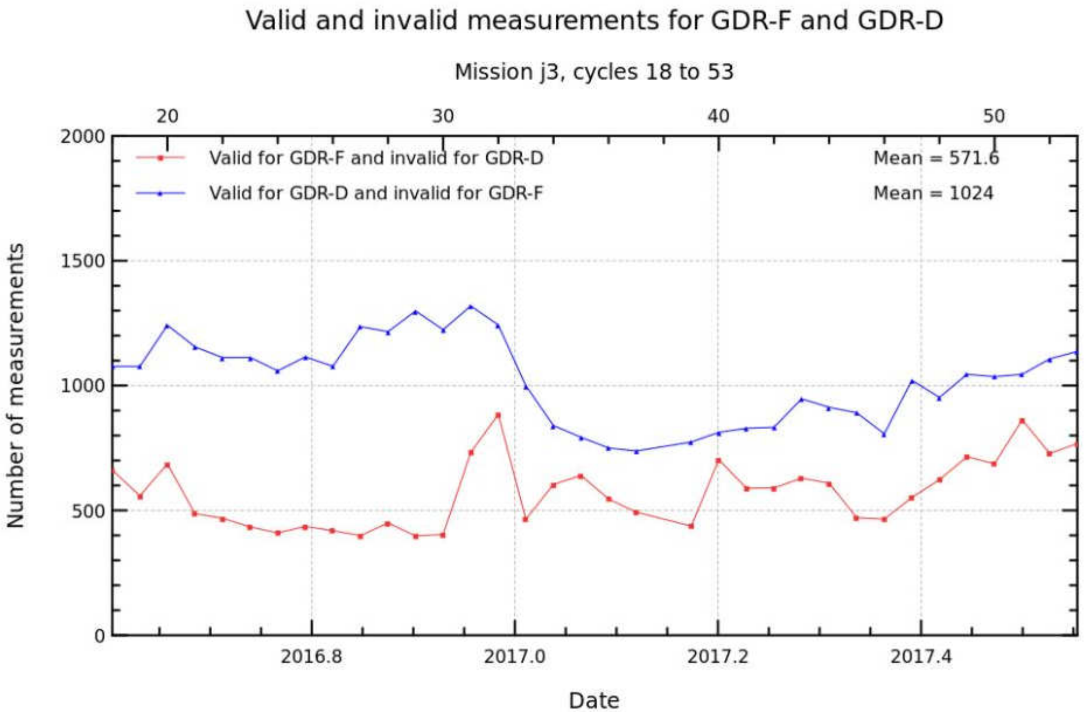


Example over cycle020, 6 part of passes with datation difference (difference in second):

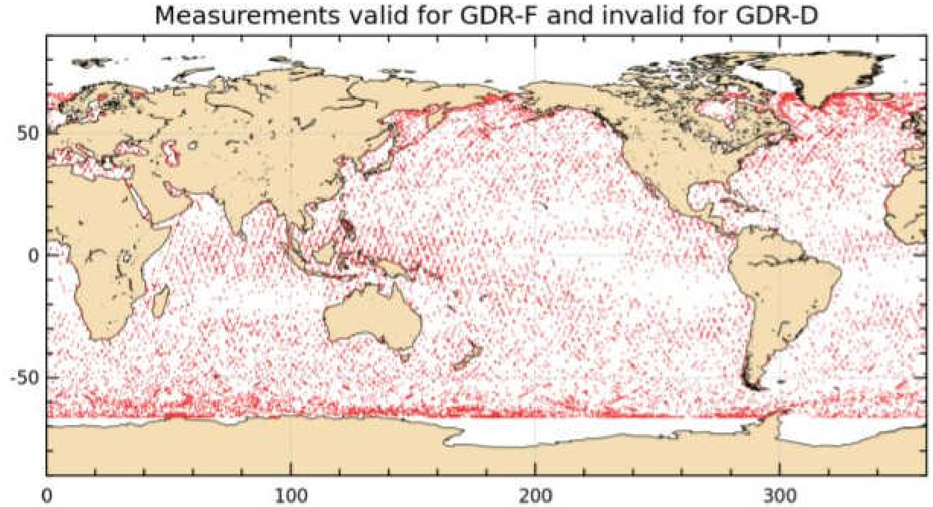


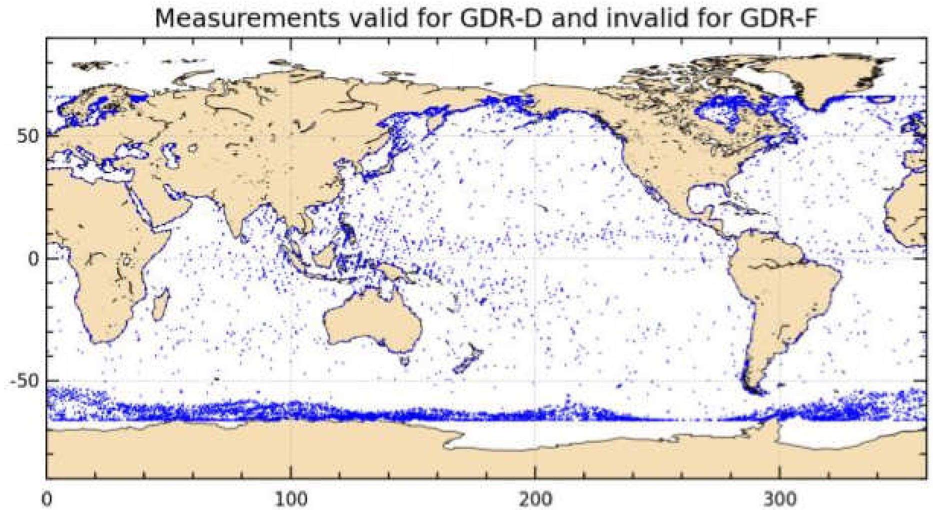
Validation procedure

Difference in rejected points from GDR-D dataset to GDR-F



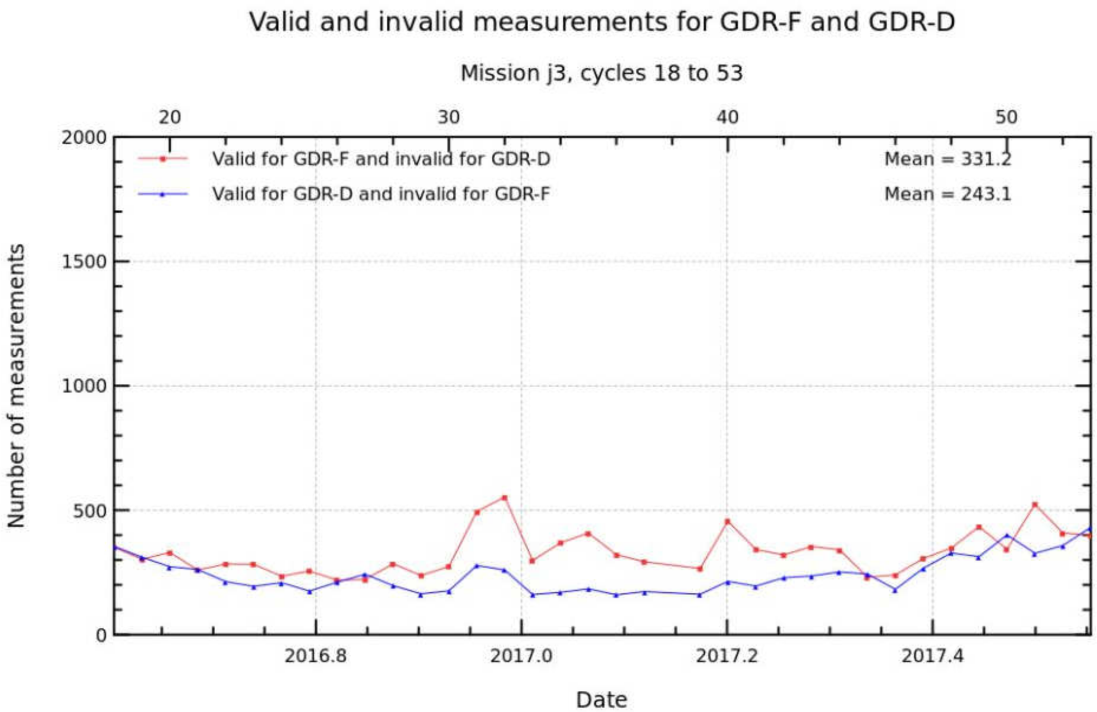
The level of rejected data is globally higher with GDR-F than GDR-D due to filtering of ionospheric correction at |latitude| > 50°



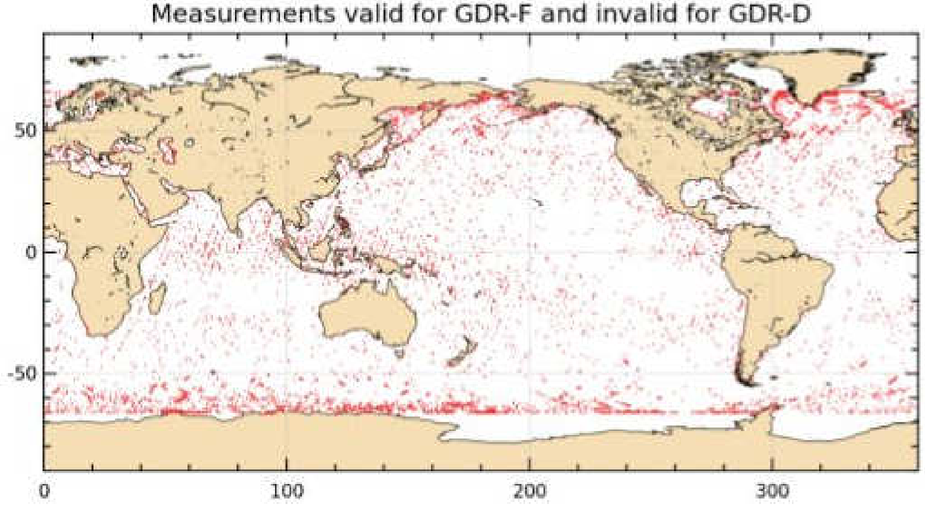


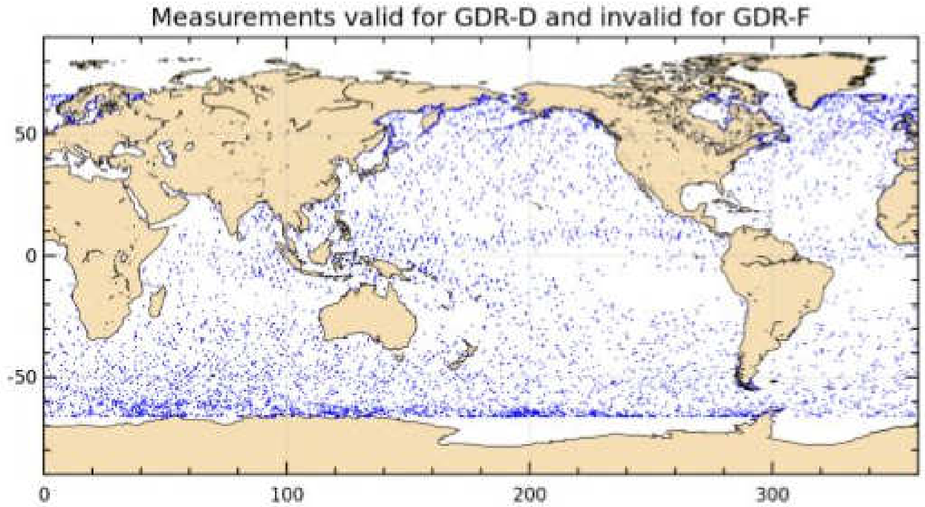
Validation procedure

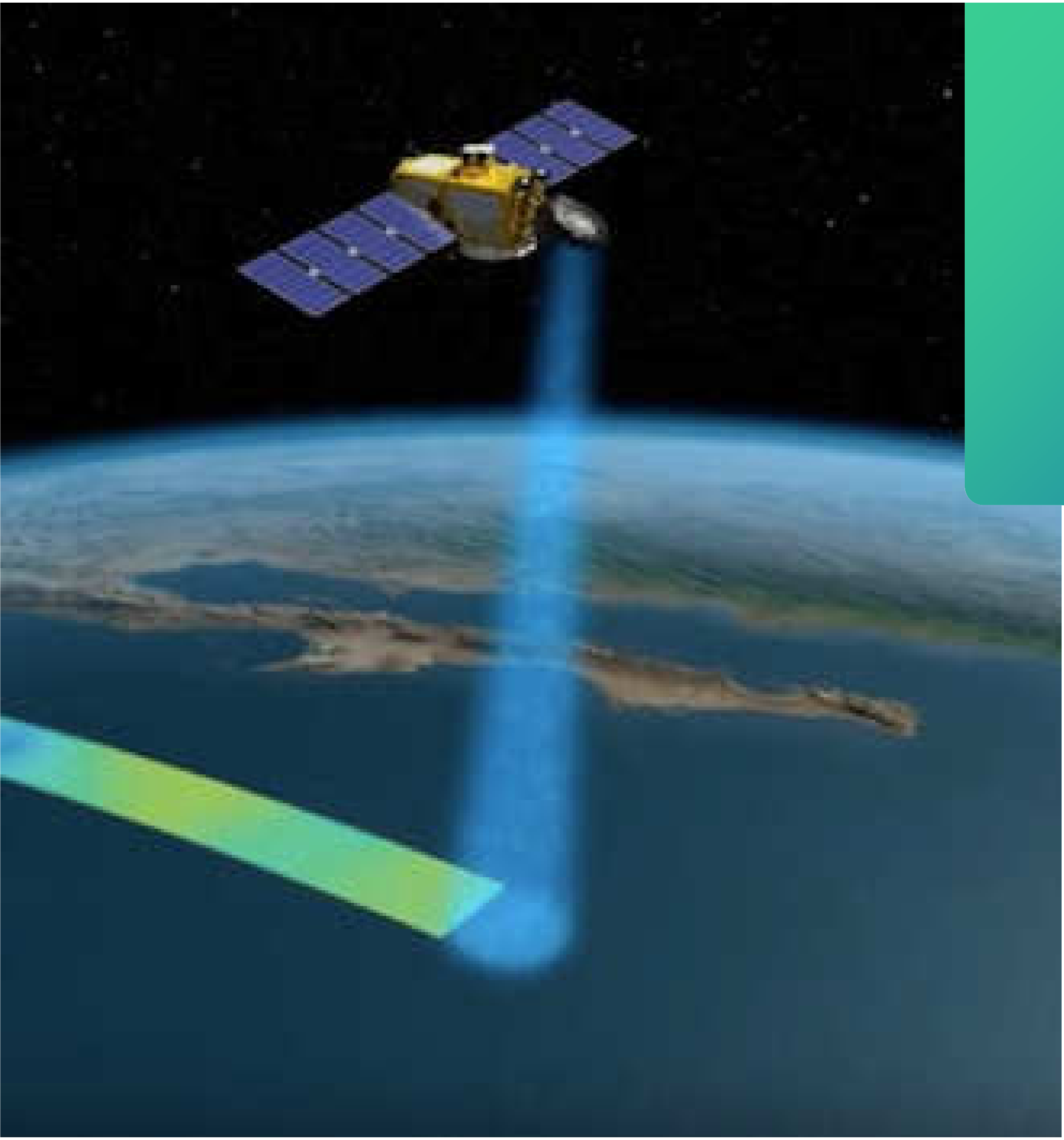
Difference in rejected points from GDR-D dataset to GDR-F



Using non filtered ionospheric correction, GDR-F data are globally slightly less rejected than GDR-D data, but there is more noise over open ocean





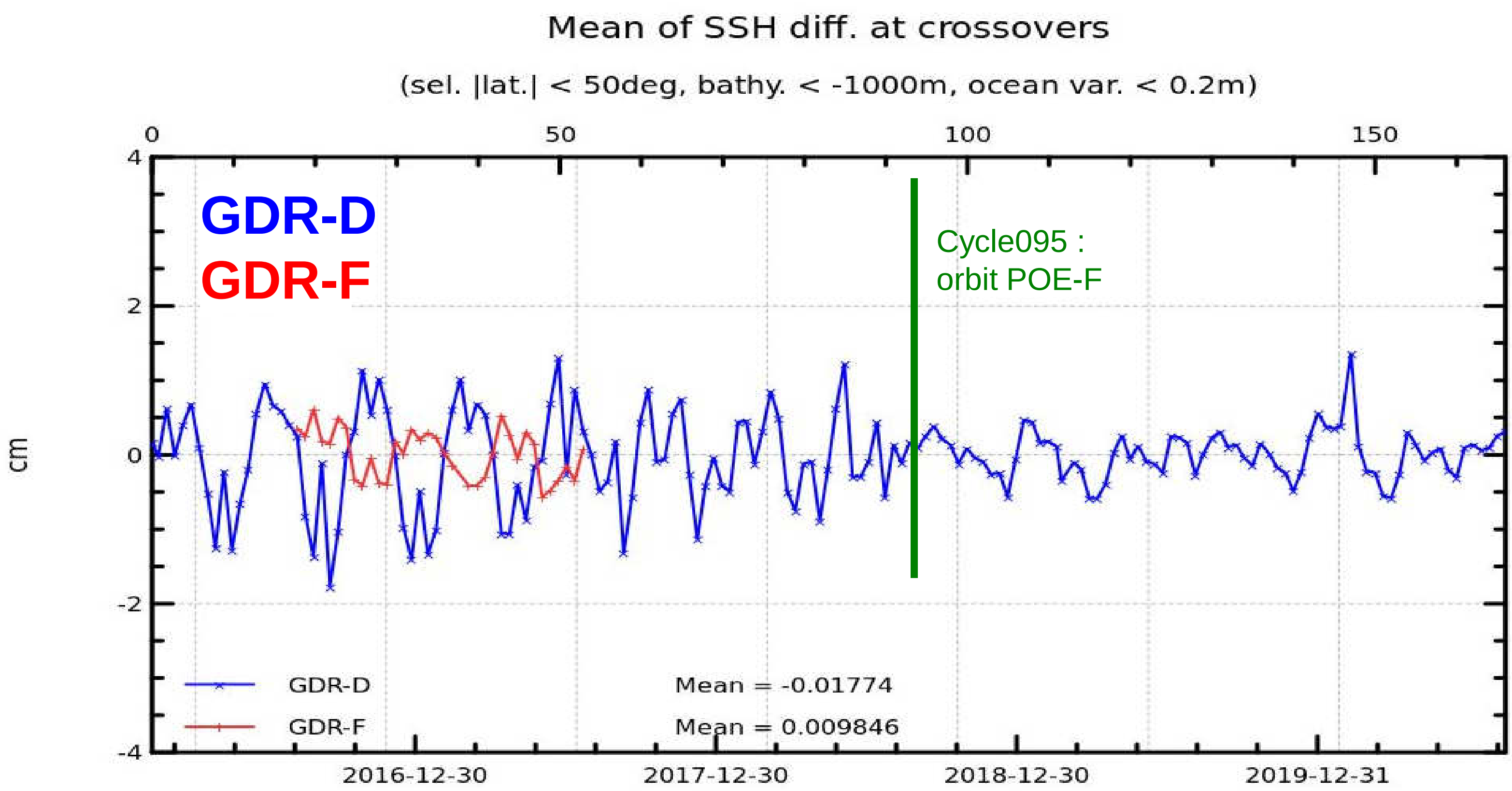


Performances for SLA with MLE4 retracking : GDR-F vs GDR-D

Performance at crossovers

Mean of SSH differences at crossovers

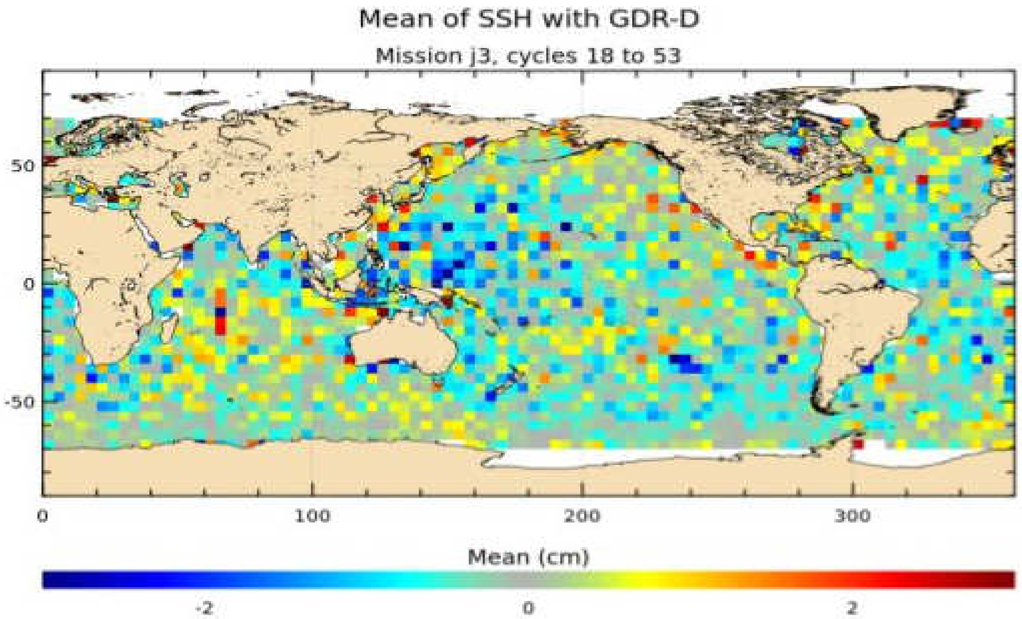
Thanks to POE-F orbit solution, 120days signal at crossovers is reduced and its phase is changed

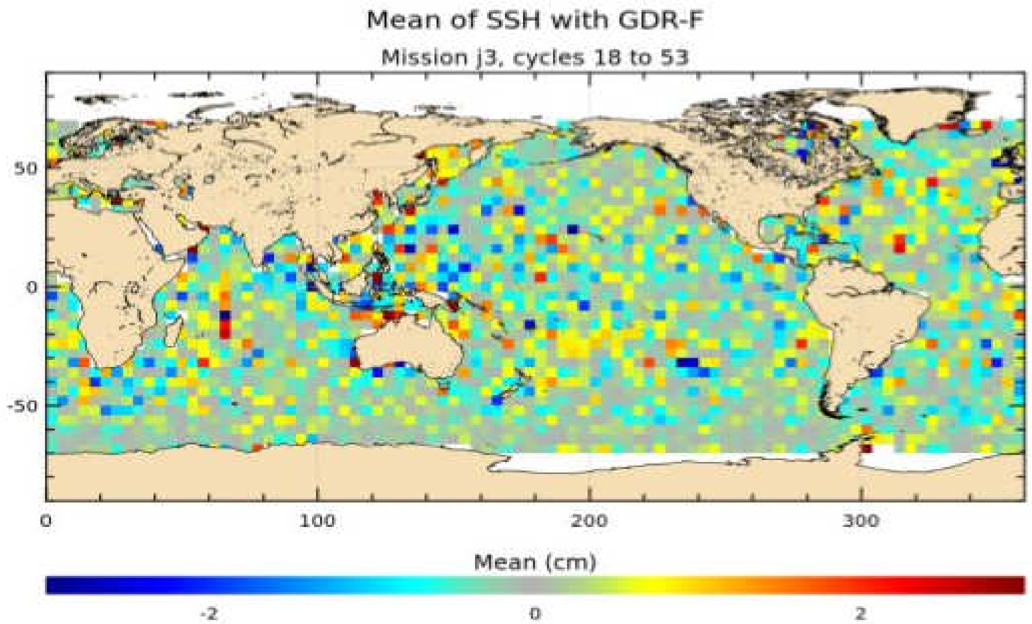


Performance at crossovers

Mean of SSH differences at crossovers

geographically correlated patterns are slightly reduced (linked to 120days signal reduction)

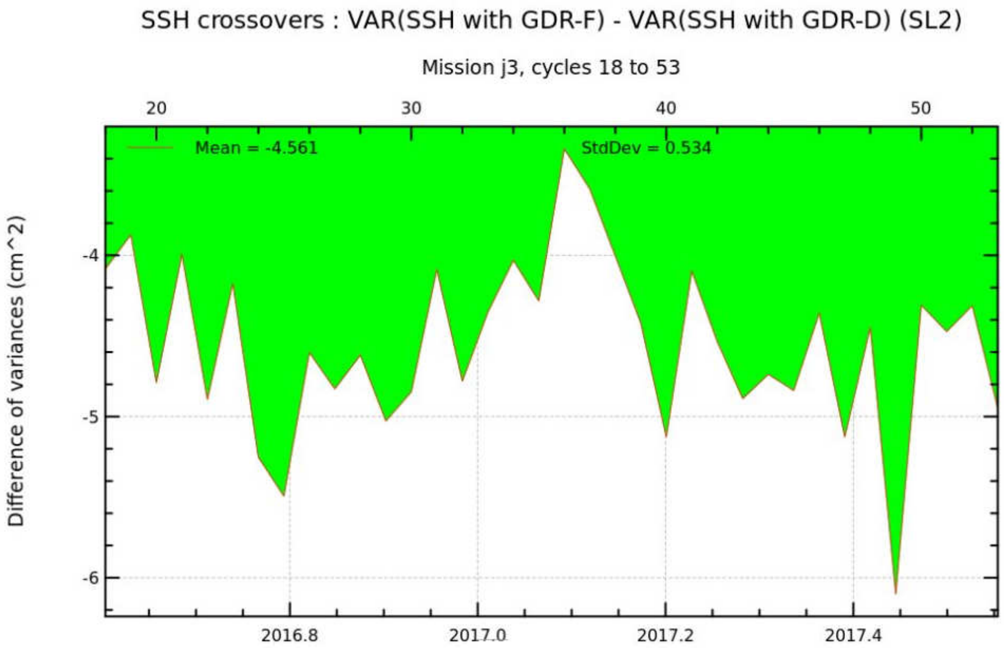


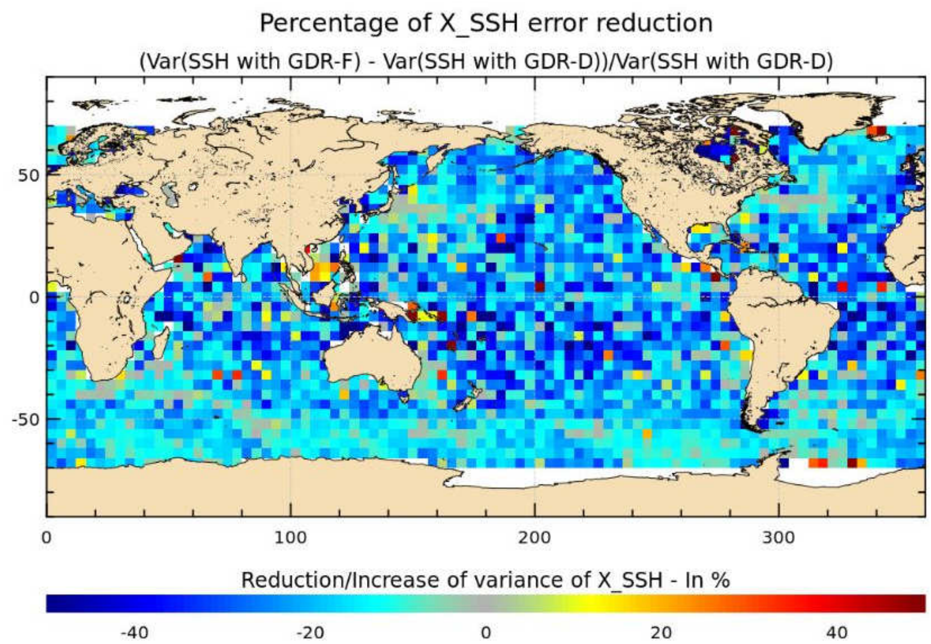


Performance at crossovers

Variance of SSH differences at crossovers

Variance of SSH difference at croosovers is significantly reduced everywhere **: -4,6cm²**
(-1,4cm² using raw ionospheric correction in both cases (not shown here),
and -3,2cm² when adding the ionospheric correction filtering)



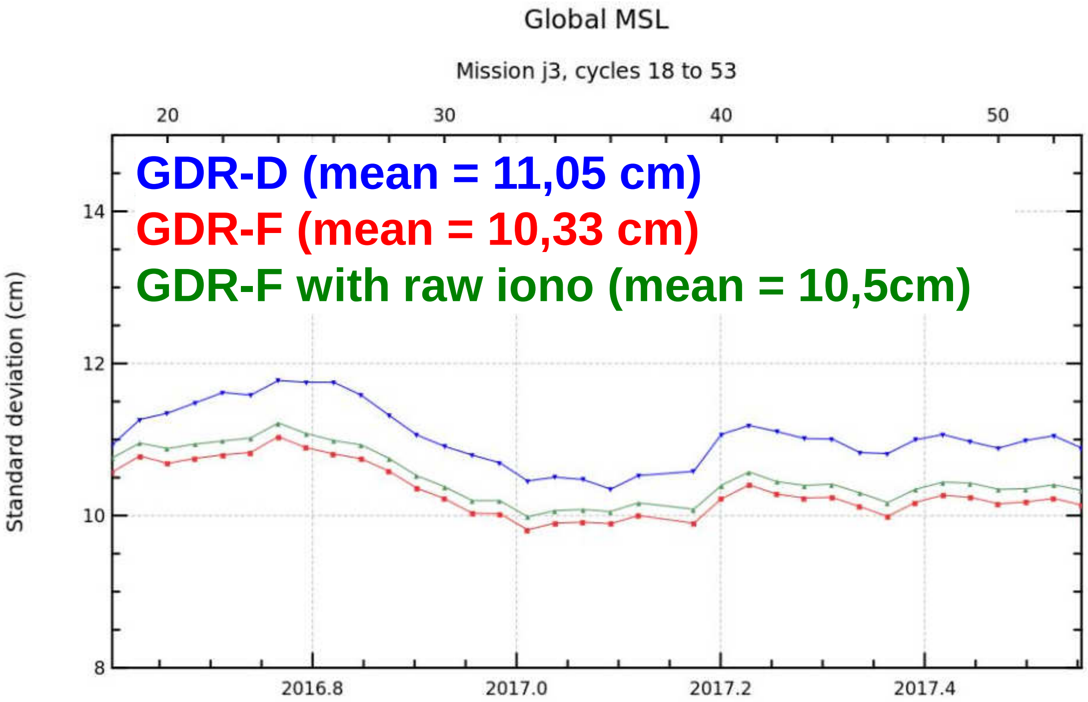


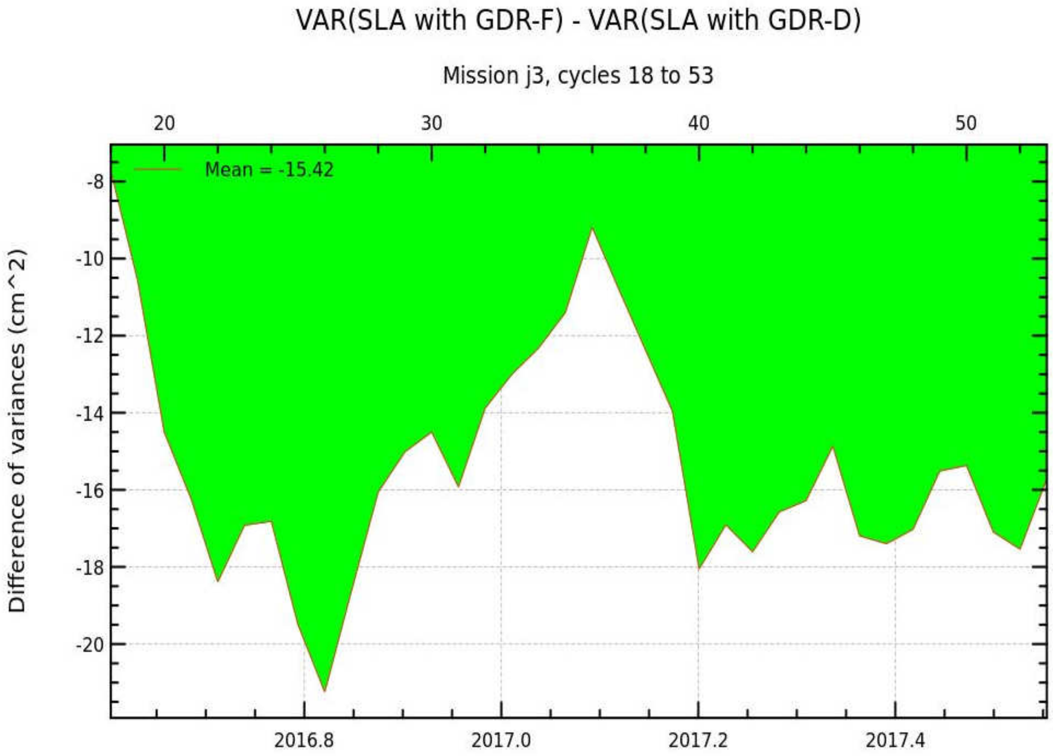
more details in OSTST 2019 poster: JASON-3 MISSION PERFORMANCE TOWARDS GDR-F

Performance of along-track SLA

Global variance of along-track SLA

Global SLA variance is significantly reduced from GDR-D to GDR-F (mainly due to new MSS and ionospheric correction filtering)

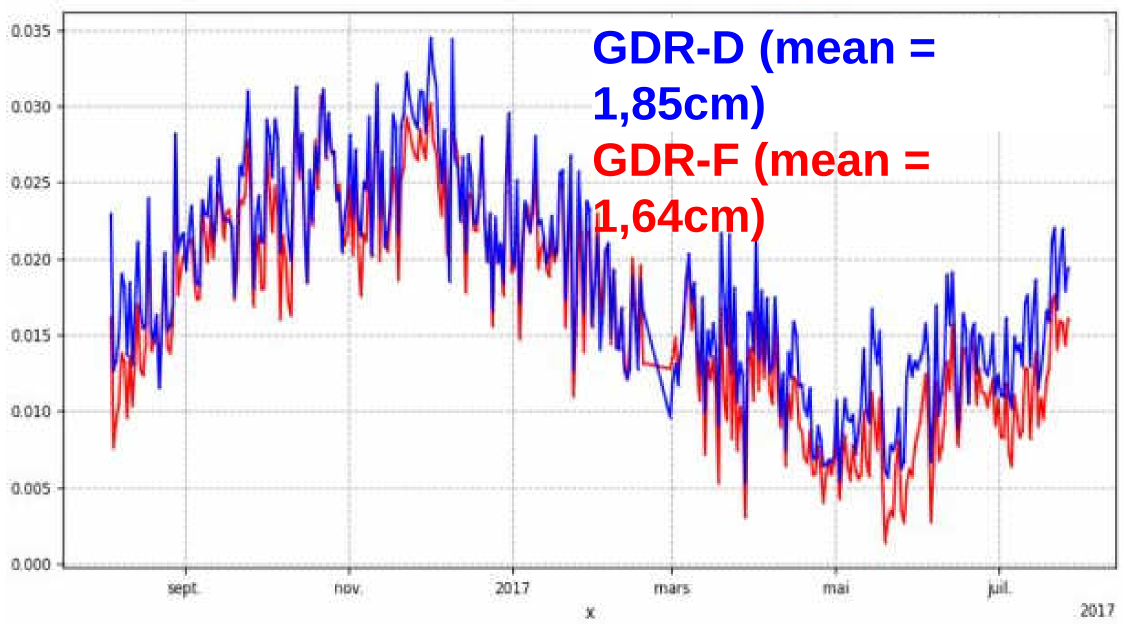


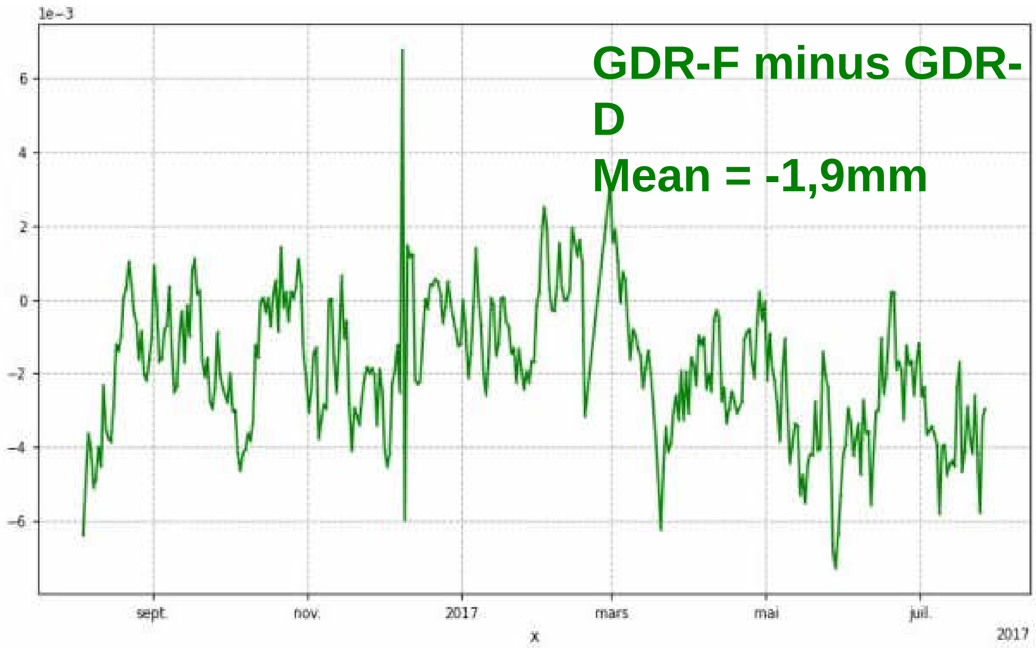


along-track SLA

Global mean of along-track SLA

Taking into account valid points in both GDR-F and GDR-F datasets, global GDR-F SLA is about 1,9mm under GDR-D SLA in average





CLS

SLA global bias

SLA global bias

SLA = orbit - range - ssb - mss - WetTropo – DryTropo – iono – DAC - OceanTide – InternalTide – PoleTide - SolidEarthTide

DAC & DryTropo & SolidEarthTide		**no change from GDR-D to GDR-F**	**Mean difference for GDR-F and GDR-D valid points over cycles 17 to 53**
InternalTide	N/A	New correction	0 in average
PoleTide	WAHR85 With MPL TOPEXlegacy	DESAI2015 with MPL 2017	+0,2mm
OceanTide	GOT4.8	FES14B	0
WetTropo	Radiometer	Radiometer	-6,3mm
Iono	Dual-frequency	Dual-frequency	+3,3mm (raw) (due to SSBs differences) +3,0mm (filtered)
SSB	Non-param	Non-param	Ku: -19,1mm / C: -37,2mm
Range	Ku mle4 C mle3	Ku mle4 C mle3	Ku: -0,8mm C: -0,8mm
orbit	orbit = POE-E until cycle 094, POE-F cycle 095 onwards	POE-F	-0,7mm
MSS	CNES/CLS11	CNES/CLS15	+23,8mm

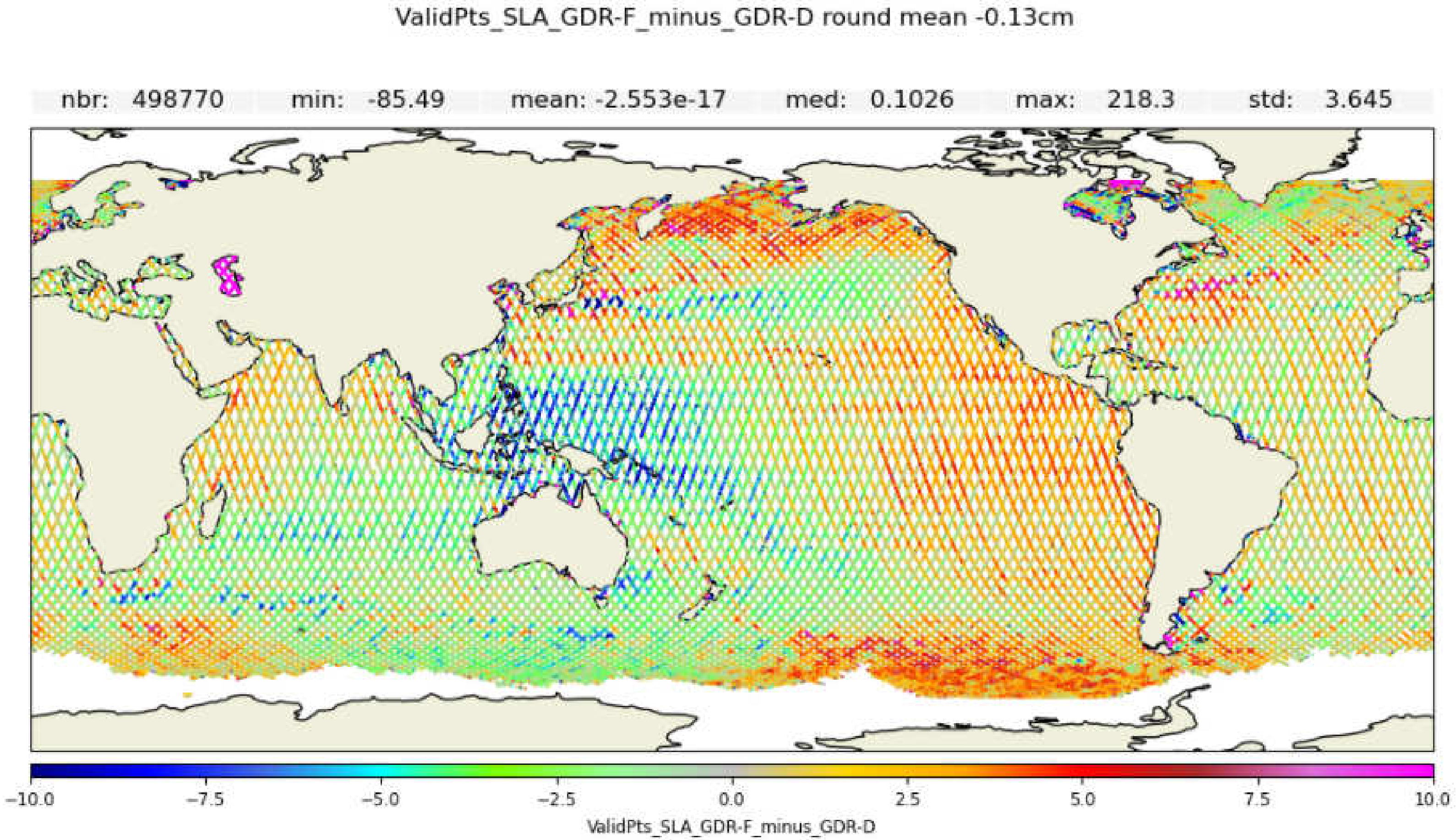
SSHA MLE4 bias ~ -1,9 mm

- +2,4cm due to MSS reference change (over 20 years for GDR-F instead of 7years for GDR-D)
- -1,9cm on SSB solutions from GDR-D to GDR-F

SLA regional bias

SLA regional bias

Difference in regional behaviour for SLA bias:

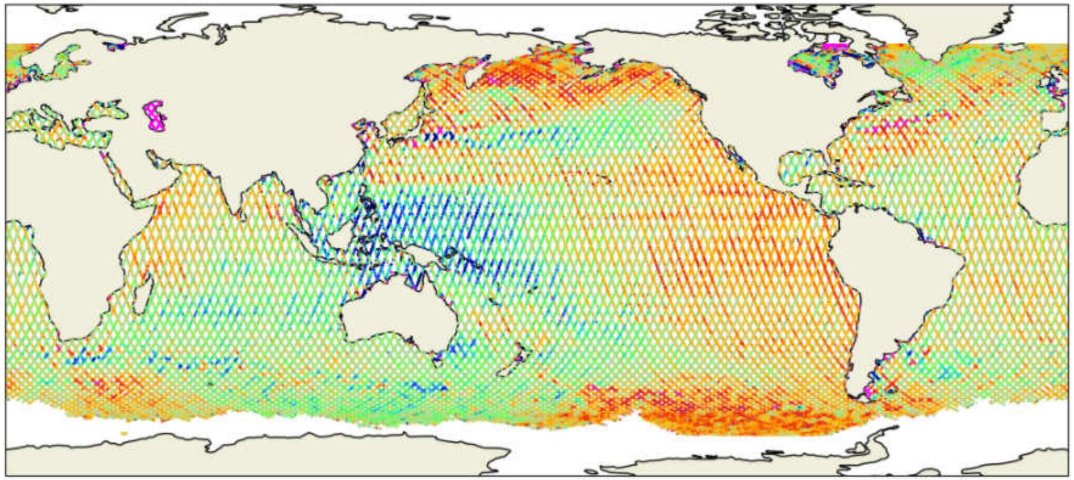


SLA regional bias

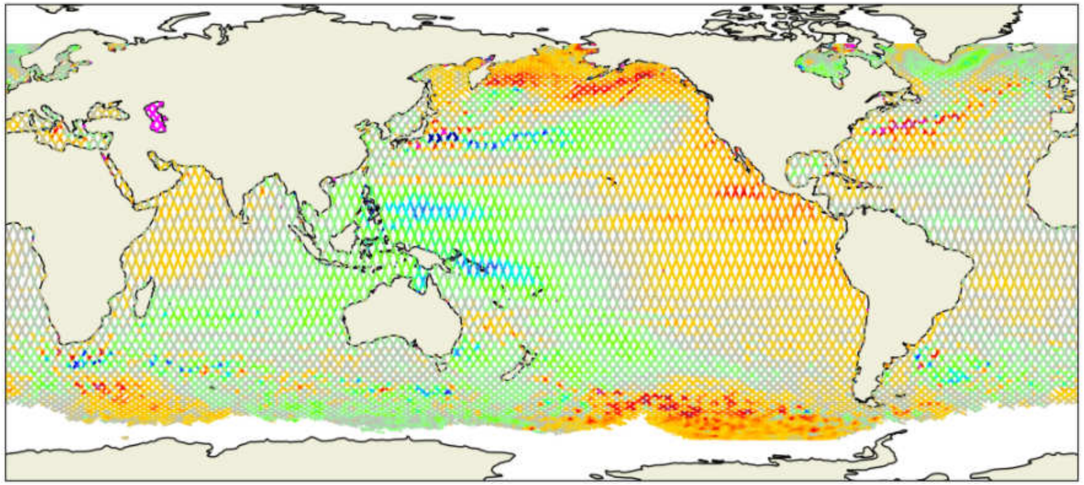
SLA regional bias

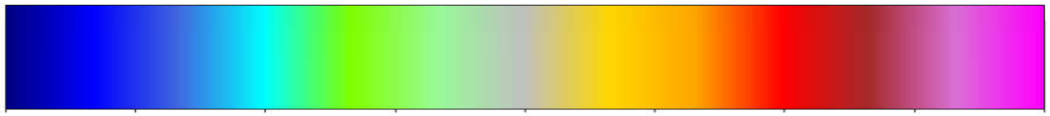
The change of MSS solution explains the main geophysical patches of several centimeters

SLA regional bias over cycle020
centered round -0,13cm



MSS differences over cycle 20
centered round -2,37cm

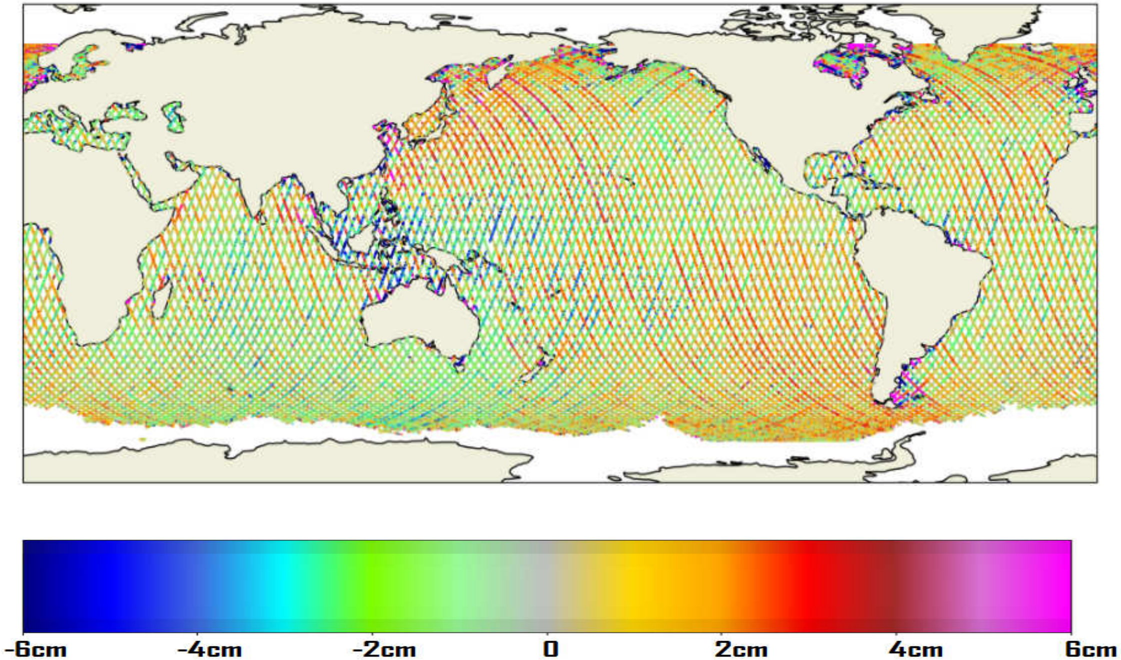




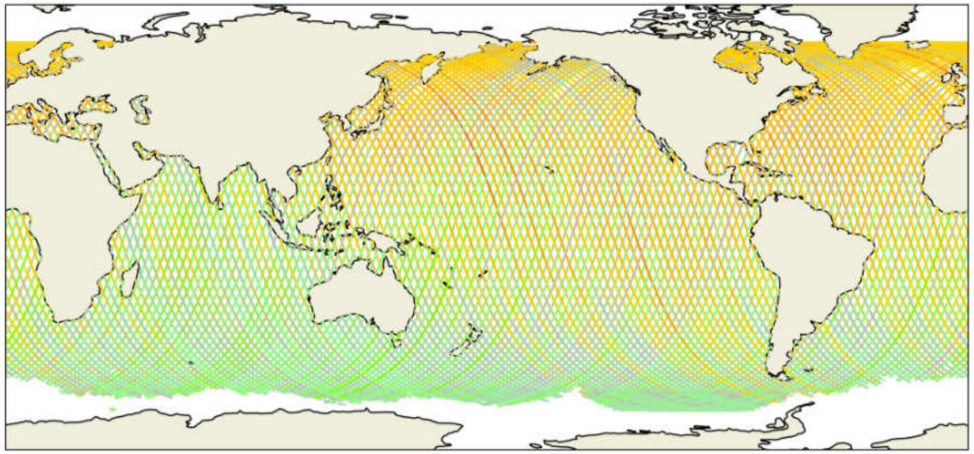
SLA regional bias

SLA regional bias

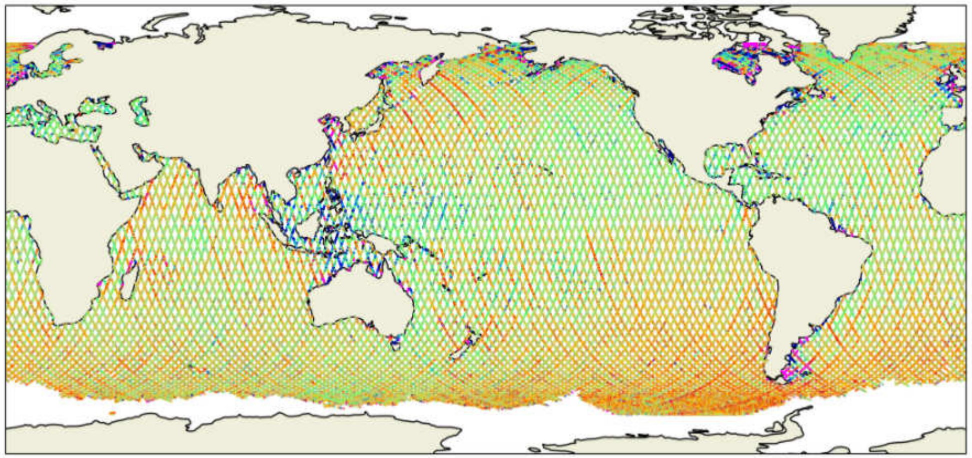
After MSS differences remove
(map centered round 2,24cm):



orbit - range



All range corrections (centered round 2,30cm)

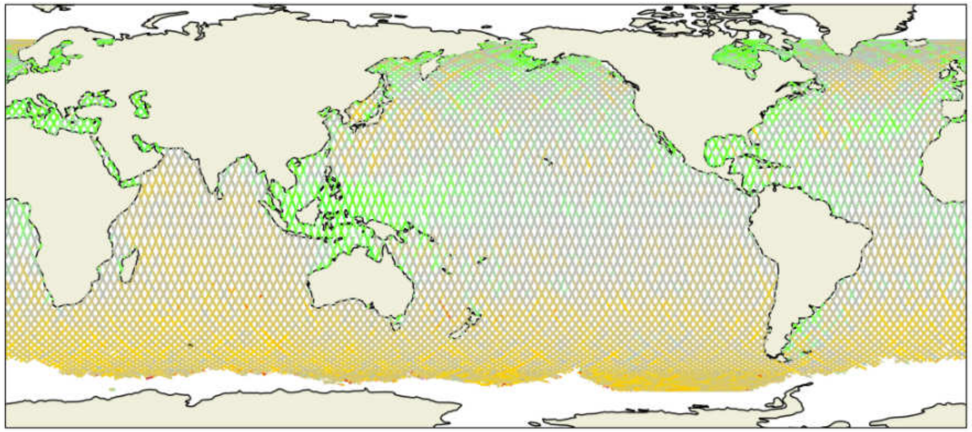


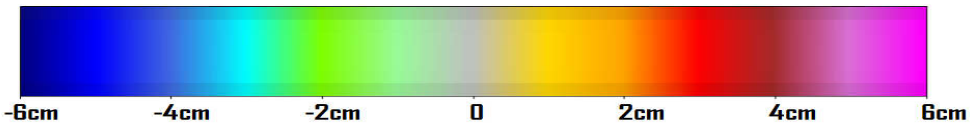
range corrections regional bias

SLA regional bias

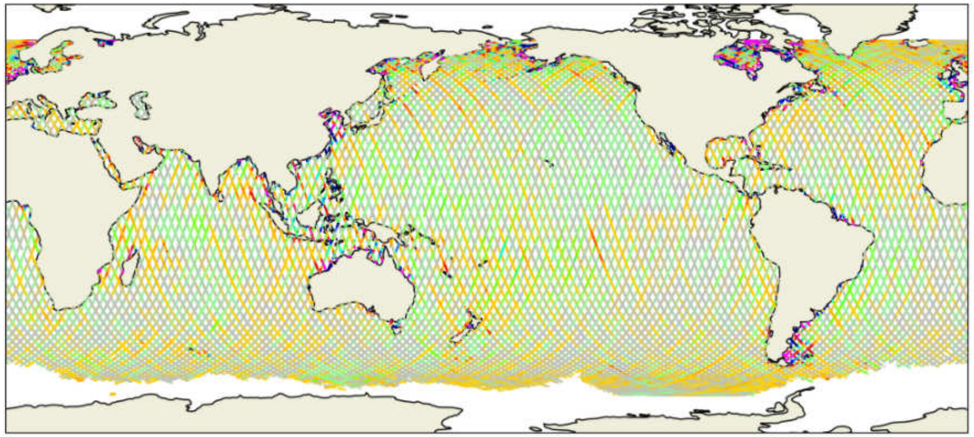
Part of ssb, ocean tide and pole tide contributions in SLA regional bias :

ssb

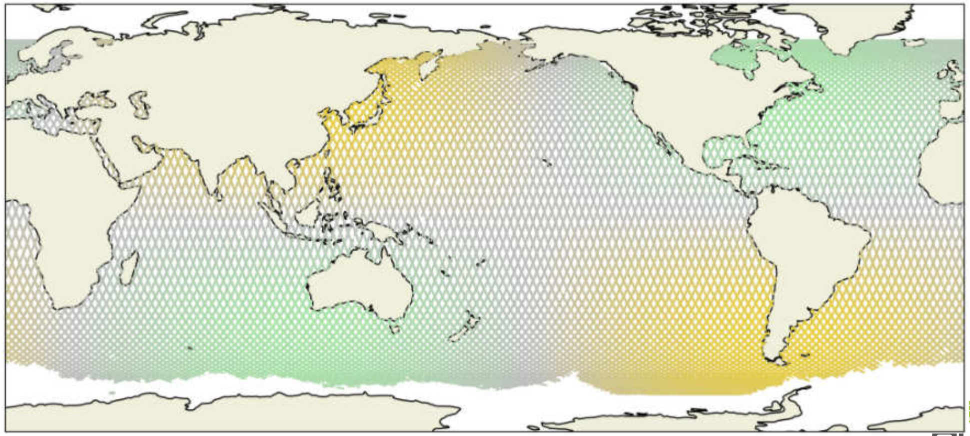




ocean tide

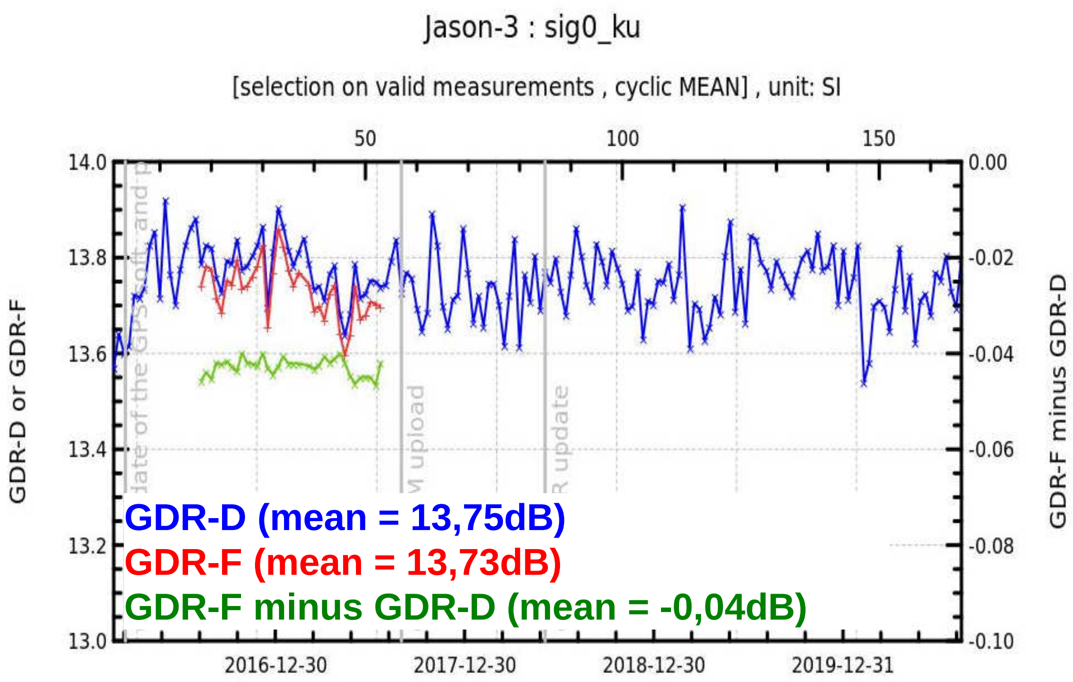


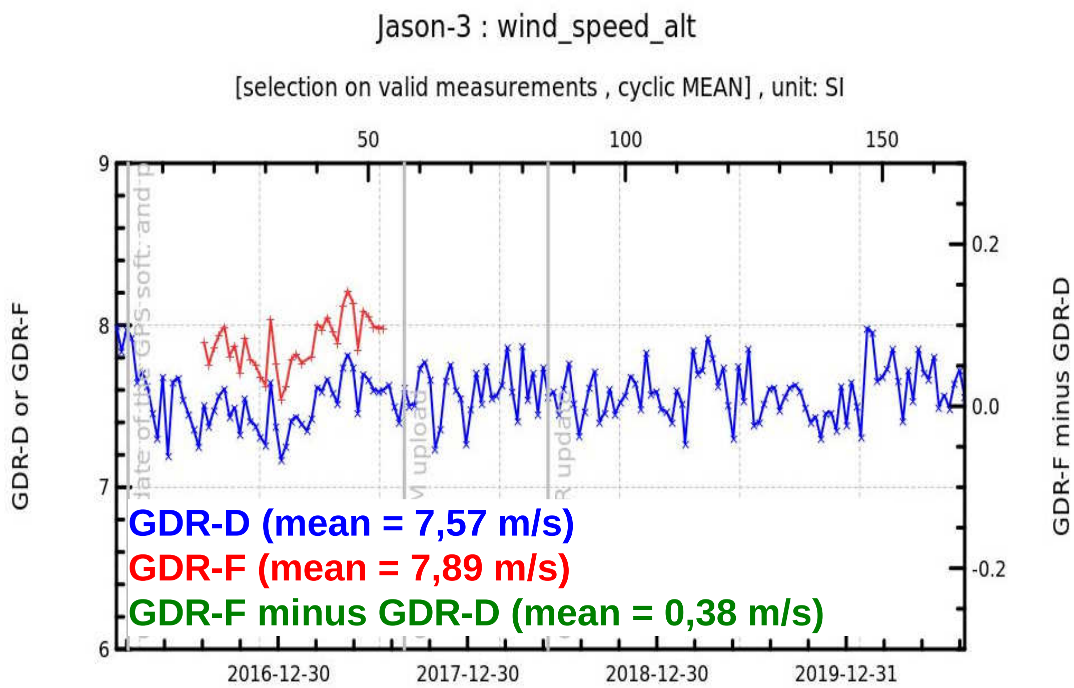
pole tide



swh, mispointing, sigma0 and wind speed

MLE4 bias out of SLA components

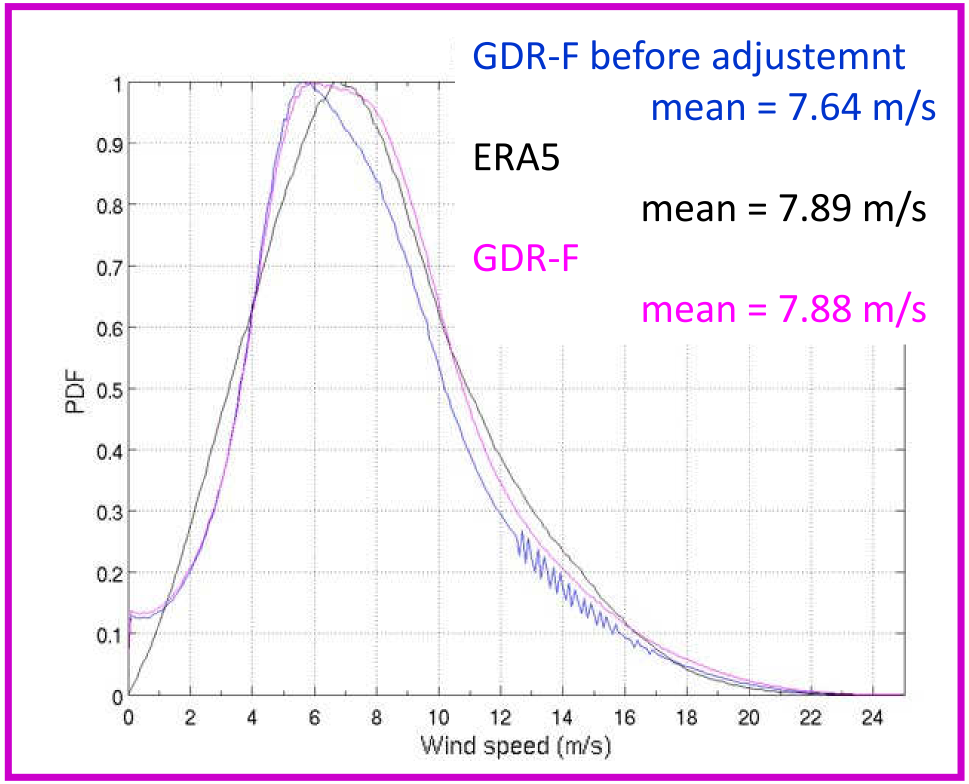


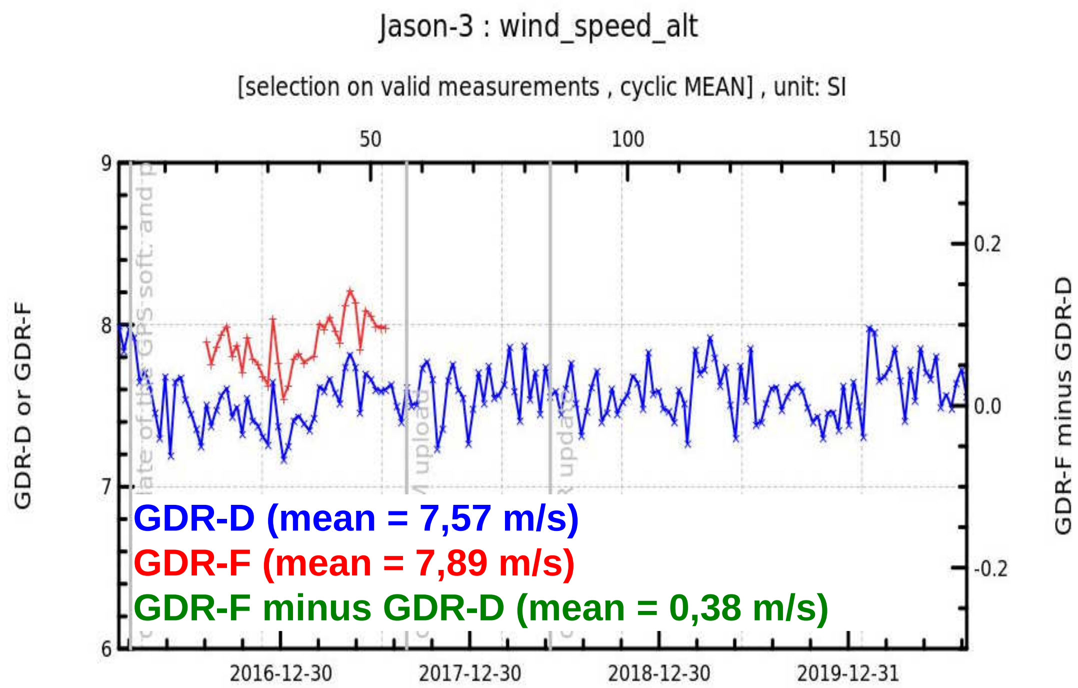


- No impact on swh and square off nadir angle from waveforms
- Sigma0 is slightly lower with valid GDR-F dataset than with valid GDR-D dataset (-0,04dB)
- wind speed values are higher by 0,38m/s

Jason-3 GDR-F wind_speed mle4

MLE4 bias out of SLA components





Wind speed values are higher in GDR-F data so as to be more coherent with ERA5 model distribution

Performance of GDR-F vs GDR-D

Conclusions

There is a global bias of -0,19 cm from GDR-D MLE4 SLA to GDR-F MLE4 SLA.
Regional bias can reach several centimeters mainly due to MSS evolution

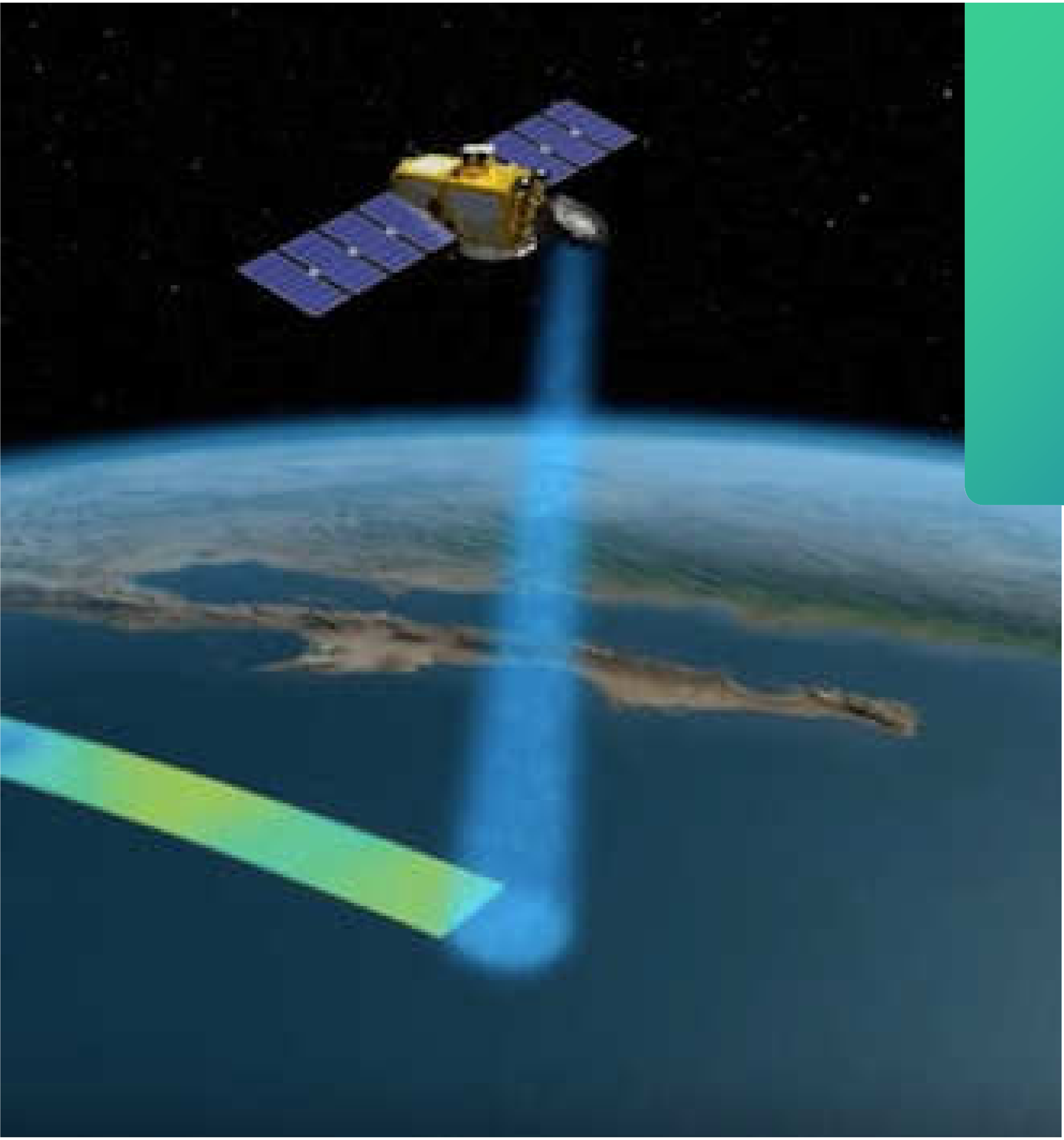
GDR-F SLA MLE4 data are globally more rejected than GDR-D data (using recommended in handbook procedure), due to ionospheric correction filtering near ice

Taking into account valid in both datasets points, performances are better with GDR-F solution than with GDR-D:

- ✓ variance of SSH difference at crossovers is reduced by -4,6cm²
- ✓ Standard deviation of along-track SLA is reduced from 11,05cm to 10,33cm)

See also OSTST2019 poster : "Jason-3 mission performance towards GDR-F"

CLS



Performances for SLA : GDR-F MLE4 vs adaptive

...

Point to point validation procedure

Recommanded editing thresholds from handbook

The following results are obtained following the same validation point procedure for mle4 and adaptive outputs (particularly, same threholds are used, as described in handbook)

Then, filter the data as follows to retain only the most valid data:

Parameter	Validity conditions
data01/ku/range_ocean_numval	10 ≤ x
data01/ku/range_ocean_rms	0 ≤ x (mm) ≤ 200
data01/altitude - data01/ku/range_ocean	-130 000 ≤ x (mm) ≤ 100 000
data01/model_dry_tropo_cor_zero_altitude	-2 500 ≤ x (mm) ≤ - 1 900
data01/rad_wet_tropo_cor	-500 ≤ x (mm) ≤ - 1
data01/iono_cor_alt_filtered	-400 ≤ x (mm) ≤ 40
data01/ku/sea_state_bias	-500 ≤ x (mm) ≤ 0
data01/ocean_tide_fes	-5 000 ≤ x (mm) ≤ 5 000
data01/solid_earth_tide	-1 000 ≤ x (mm) ≤ 1 000
data01/pole_tide	-15000 ≤ x (mm) ≤ 15000
data01/ku/swh_ocean	0 ≤ x (mm) ≤ 11 000
data01/ku/sig0_ocean	7 ≤ x (dB) ≤ 30
data01/wind_speed_alt	-0 ≤ x (m/s) ≤ 30
data01/ku/off_nadir_angle_wf_ocean	-0.2 ≤ x (deg^2) ≤ 0.64
data01/ku/sig0_ocean_rms	x (dB) ≤ 1
data01/ku/sig0_ocean_numval	10 < x

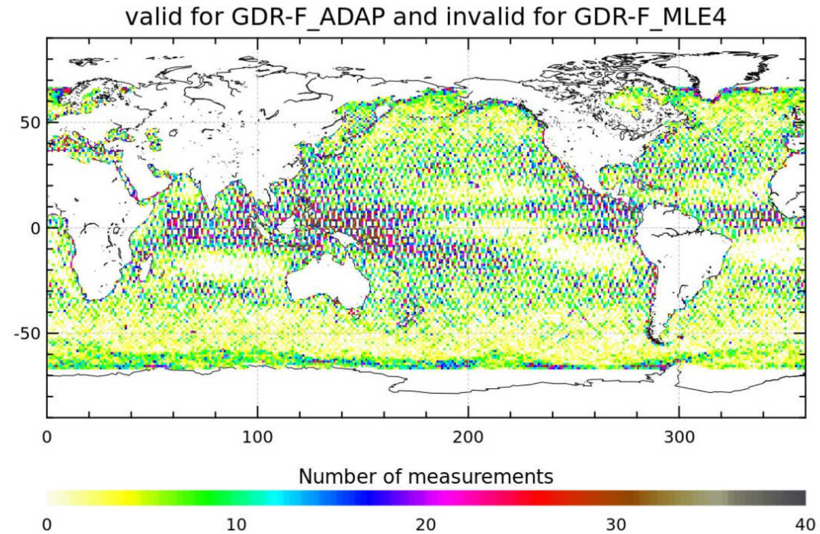
Table 16 : Recommended filtering criteria

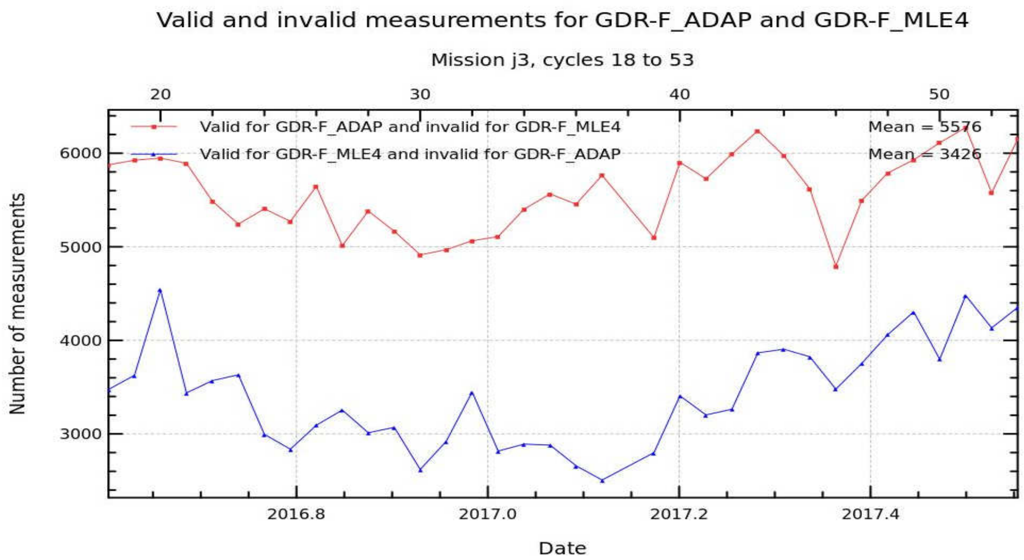
To restrict studies to deep water, apply a limit, e.g., water depth of 1000m or greater, using the bathymetry parameter (ocean depth in meters.)

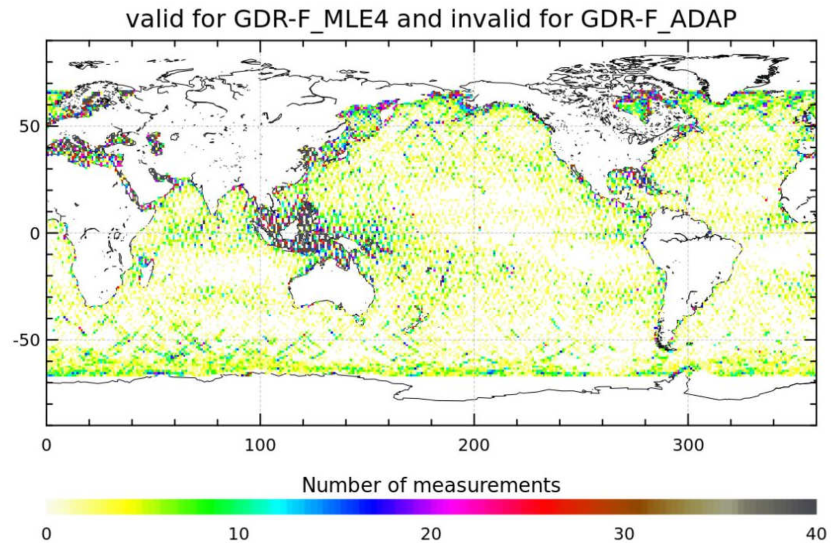
SLA MLE4 vs ADAPTIVE

Measurements quality : editing

- ➔ Globally more points are rejected with MLE4 SLA than with adaptive SLA
- ➔ bottom right: additional valid points with mle4 dataset compared to adaptive
- ➔ top right: additional valid points with adaptive dataset compared to mle4

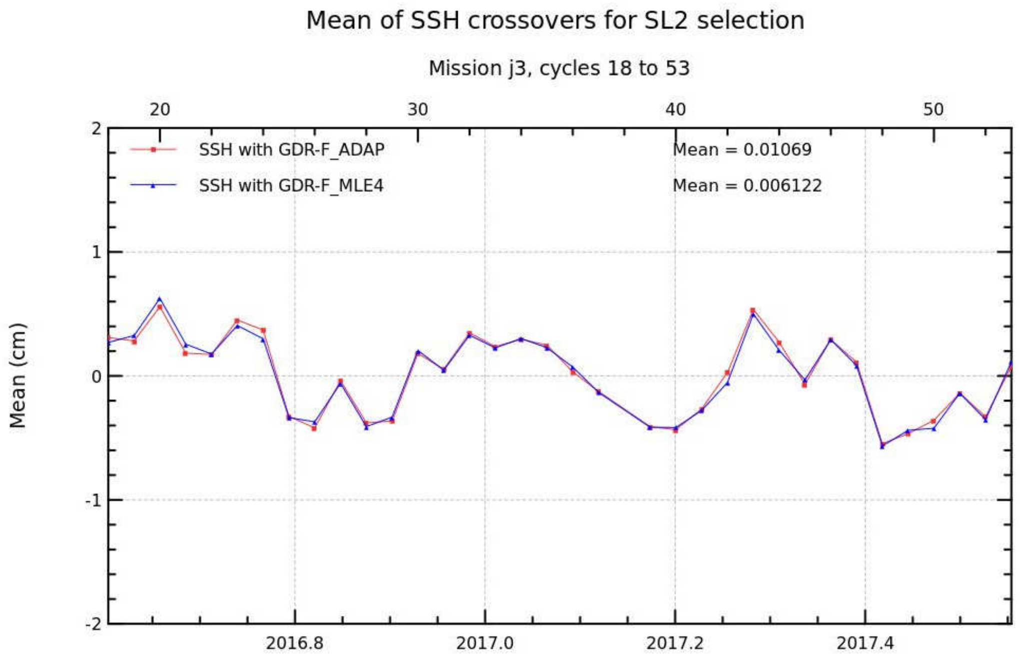


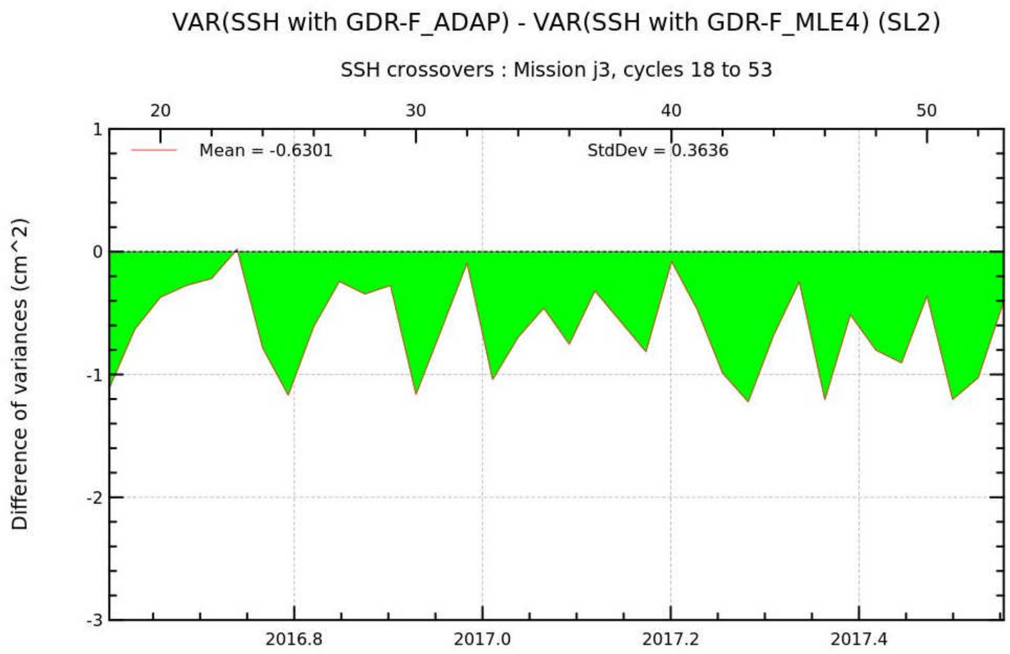




Performance at crossovers

Mean of SSH difference at crossovers and variance difference





No global neither regional (not shown here) impact on mean of SSH difference at crossovers

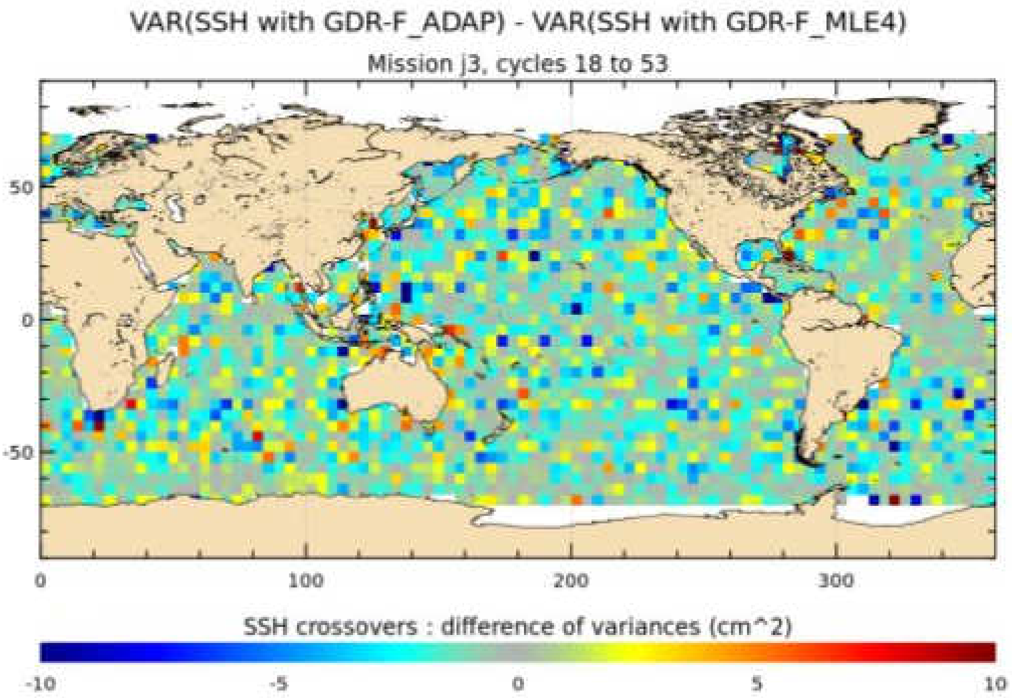
Global variance of SSH difference at crossovers is reduced by 0,63cm² in average with adaptive retracker compared to MLE4

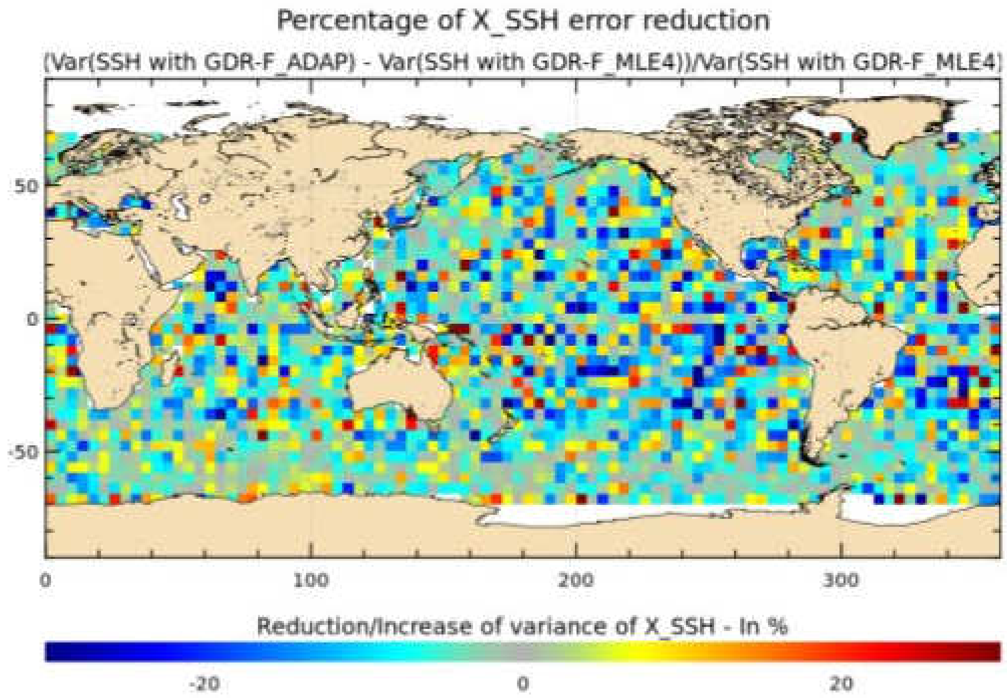
Note that on points that are valid with both solutions are used to compute this analysis

Performance at crossovers

Mean of SSH differences at crossovers

geographic reduction (in blue) of variance of SSH difference at crossovers

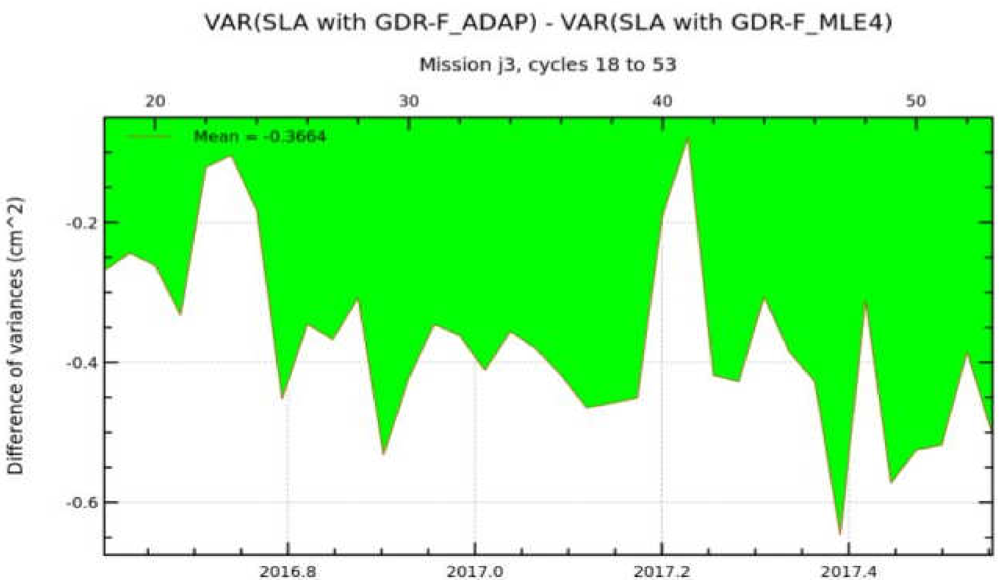


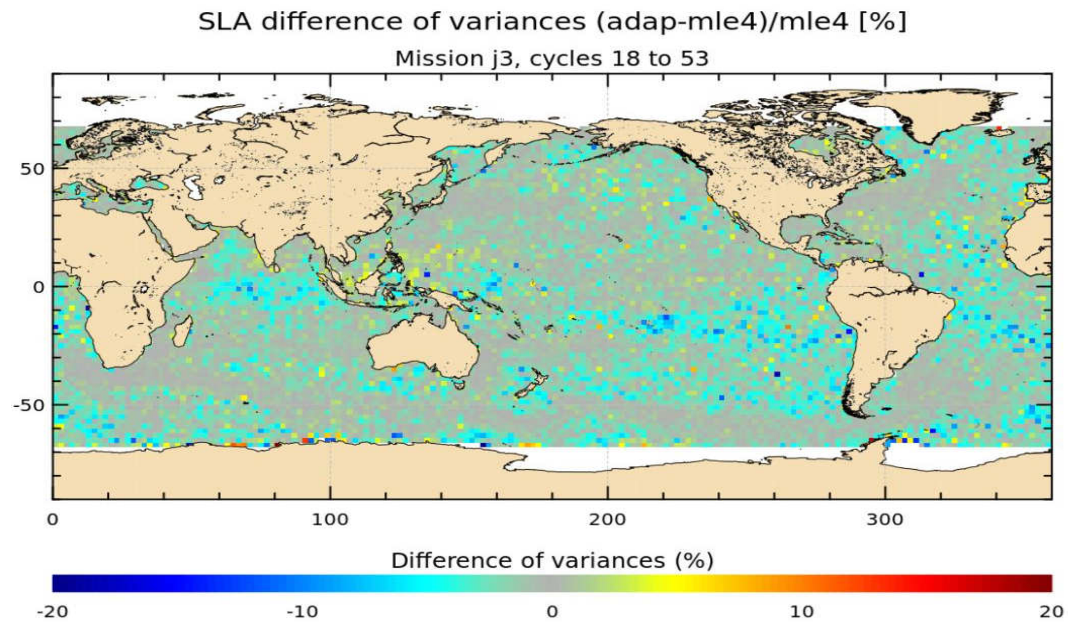


Performance of along-track SLA

Global variance of along-track SLA

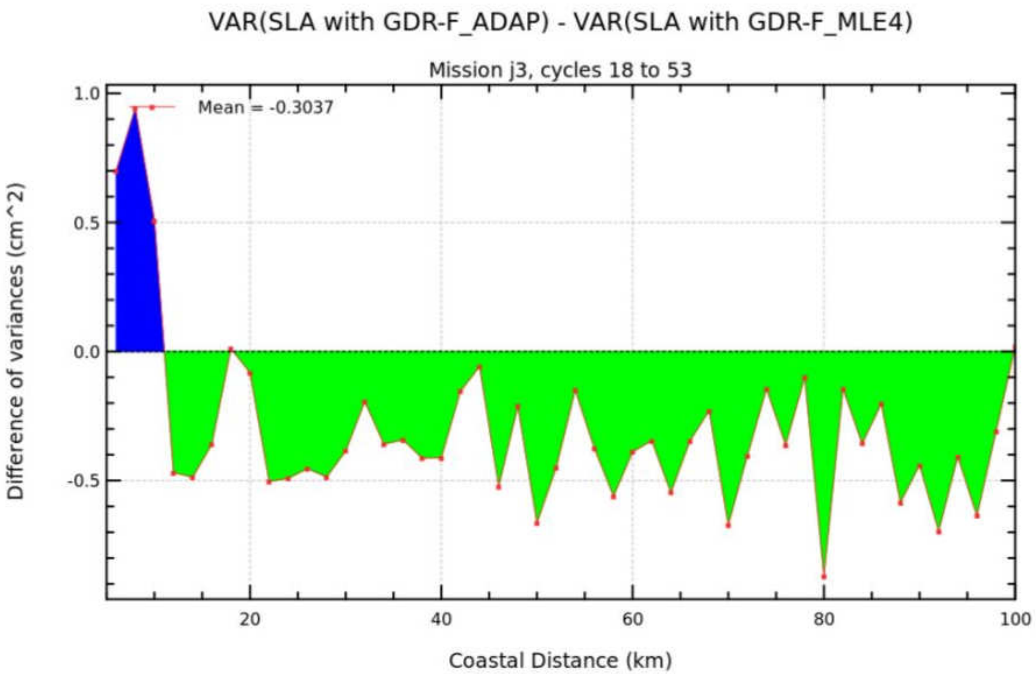
Variance of along track SLA is reduced by 0,37cm² with adaptive compared to MLE4





Performance of along-track SLA

Global variance of along-track SLA



Variance of along track SLA is reduced near everywhere with adaptive compared to MLE4,

But near coasts (in the last 10km), the behavior is different:
Expected differences in retrackers performances in the last 3km that impact 1Hz data until 10km.

SLA MLE4 vs ADAPTIVE

Conclusions

There is a global bias of -2,28cm from MLE4 SLA to adaptive SLA (not shown here)

SLA MLE4 data are globally more rejected than SLA Adaptive data (using recommended in handbook procedure)

Taking into account valid in both datasets points, performances are better with adaptive solution than with MLE4:

- ✓ variance of SSH difference at crossovers is reduced by -0,63cm²
- ✓ variance of along-track SLA is reduced by -0,37cm² (except for coastal distance < 10km)

More about Adaptive retracking : see Thibaut et al. OSTST 2020