SWOT-Nadir validation and cross calibration activities

Executive Summary - Annual Report 2025

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Change Log

Version	Date	Changes
1.0	February 12, 2026	First version
1.1	February 18, 2026	Add L1/L2 Library Table + Fixes on editing figures
1.2	February 27, 2026	CNES review taken into account
1.3	March 20, 2026	Executive summary
1.4	April 28, 2026	Xover Multimission minor changes

Acronyms

AMR Advanced Microwave Radiometer
CLS Collecte Localisation Satellites
CMEMS Copernicus Marine Service
CNES Centre National d'Etudes Spatiales
CNG Consigne Numerique de Gain (= Automatic Gain Control)
C2N Cryosat-2
DAC Dynamical Atmospheric Correction
DEM Digital Elevation Model
DV Default Value
DIODE Détermination Immédiate d'Orbite par Doris Embarqué
DORIS Doppler Orbitography and Radiopositioning Integrated by Satellite
DUACS Data Unification and Altimeter Combination System
ECMWF European Centre for Medium-range Weather Forecasting
FES Finite Element Solution
GDR Geophysical Data Record
GIM Global Ionosphere Maps
GMSL Global Mean Sea Level
GOT Global Ocean Tide
GPS Global Positioning System
IGDR Interim Geophysical Data Record
JPL Jet Propulsion Laboratory (Nasa)
L2P Along-track Sea Level Anomalies Level-2+
MLE Maximum Likelyhood Estimator
MOE Medium Orbit Ephemeris
MQE Mean Quadratic Error
MSS Mean Sea Surface
OGDR Operational Geophysical Data Record
PLTM PayLoad TeleMetry
POE Precise Orbit Ephemeris
POS-3C POSEIDON-3C
SALP Service d'Altimétrie et de Localisation Précise
Sigma0 Backscatter coefficient
SHM Safe Hold Mode
SSH Sea Surface Height
SSHA Sea Surface Height Anomalies
SLA Sea Level Anomaly
SLR Satellite Laser Ranging
SSR Solid State Recorder
SSB Sea State Bias
STD Standard Deviation
SWOT Surface Water Ocean Topography
SWH Significant Wave Height
TM TeleMetry
WTC Wet Tropospheric Correction

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1 Executive Summary

1.1 Data Availability

The behaviour of SWOT Nadir over ocean is excellent. In average, for GDR, SWOT Nadir provides 99.039% of measurements over the last year and 98.11% since the beginning of the Science Phase. For IGDR, SWOT Nadir provides 98.811% of measurements over the last year and 97.958% since the beginning of the Science Phase.

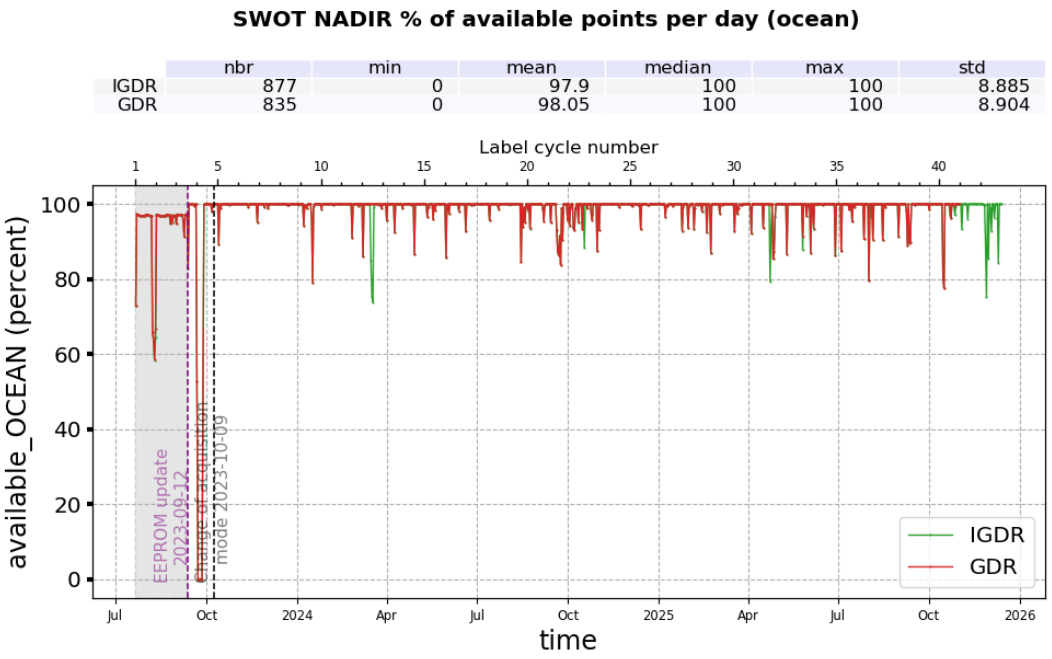

Figure 1: SWOT Nadir data availability over ocean (per day)

1.2 Data Validity

The average of total valid measurements over ocean is 82.244% (see Figure 2).
EEPROM update on 12 Sep. 2023 (C003) has a slight impact on edited data because more data near ice lands are available.
Over the last year, in average 15.006% of data were edited by ice over ocean. Over the studied period, no

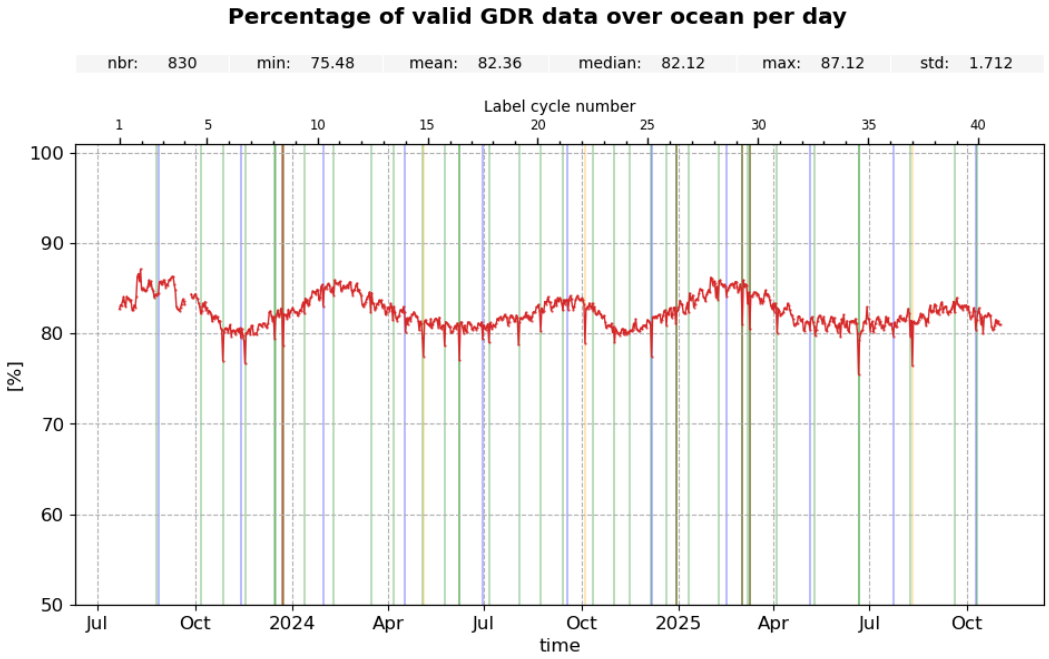

Figure 2: SWOT Nadir ocean data editing average by day.

anomalous trend is detected, only the annual seasonal signal is visible mainly due to ice coverage annual variations in north and south hemispheres.
After quality flag analysis, instrumental parameters have also been analyzed from comparison with thresholds.
The average of total edited measurements following threshold criterion is around 2.75% (Figure 3). Note that all outliers are on maneuver slots (colored lines).

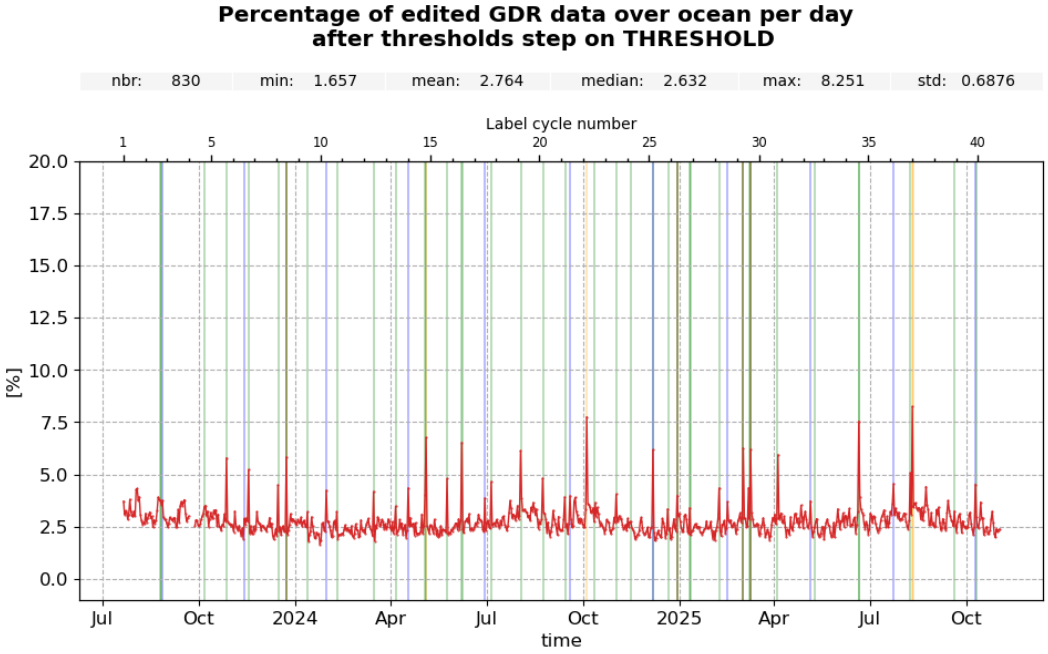

Figure 3: SWOT Nadir data editing by thresholds over ocean average by day.

1.3 Sea Wave Height

SWOT Nadir SWH is centered around 2.604 m for MLE4 (figure 4, top left) and is stable over last year. The average std over the last year is 1.359 m (figure 4, top right). The period of the signal for the std which is also slightly present for the mean, reflects the seasonal variability of wave intensity. Over the last year, the mean and std of the differences with ERA5 model are stable and are respectively in average 12.9 cm and 30.8 cm.

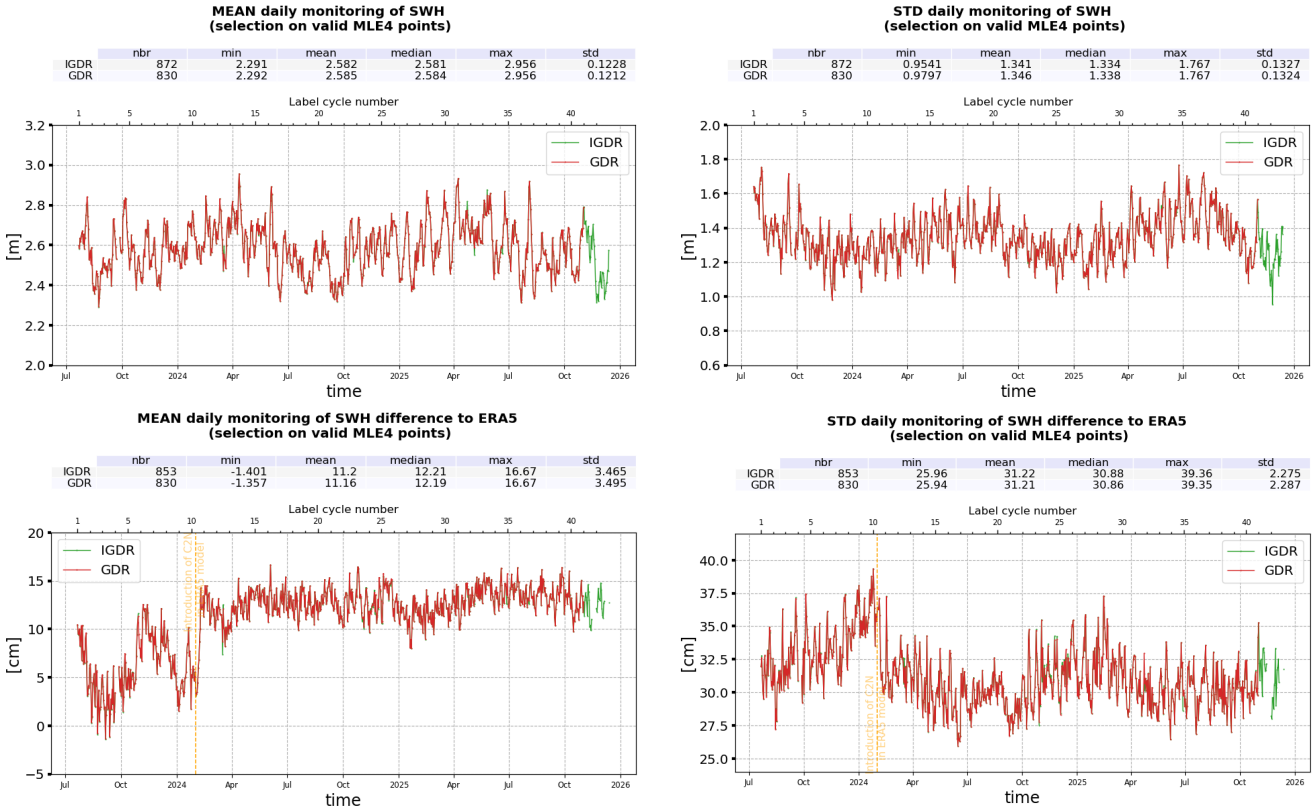

Figure 4: Monitoring of significant wave height

1.4 Wind Speed

Since GDR-S 2.01, calibration bias is fitted to SWOT Nadir data. As a consequence, wind speed estimations are now aligned with ERA5 model. It was not the case in the GDR-F v1.04 version. This explains the jump in IGDR data during cycle 032 (GDR-F –> GDR-S2) in Figure 5 and Figure 6.
Over the last year, the averaged wind speed value is 7.736 m/s for MLE4 (figure 5).

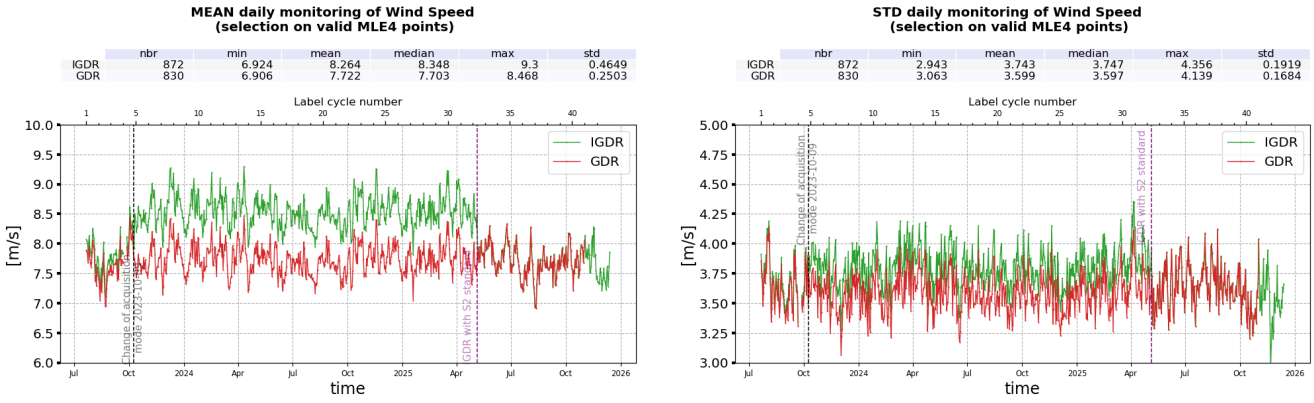

Figure 5: Monitoring of altimeter wind speed

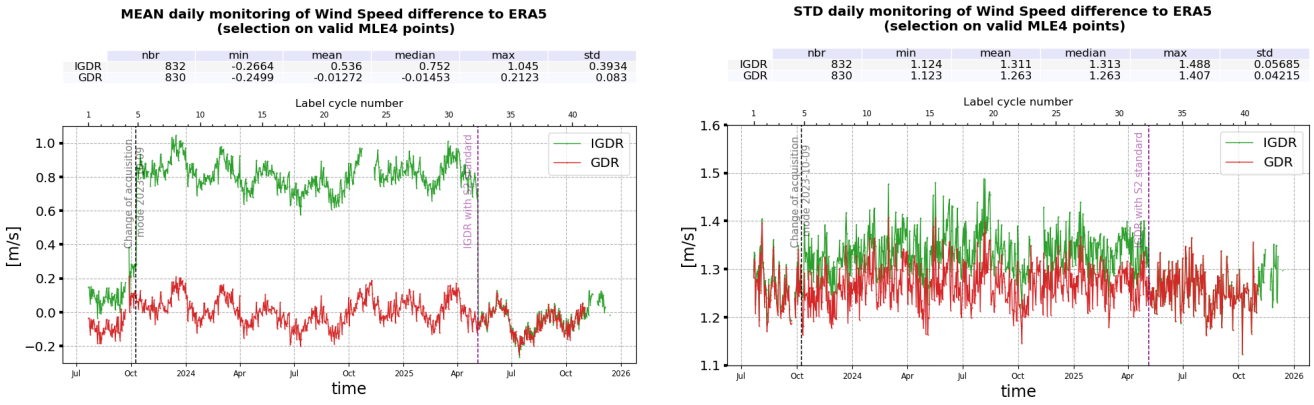

Figure 6: Monitoring of altimeter wind speed difference to ERA5 model

1.5 Sea Level Anomalies

The periodic signal reflects the seasonal cycle of SLA over ocean.
SWOT Nadir SLA shows a good stability over the last year with an averaged value of 6.5 cm over the last year (figure 7, left).
SWOT Nadir shows a good stability in terms of SLA standard deviation with an averaged value of 10.2 cm over the last year (figure 7, right). There is a peak in Figure 7 (right) observed between October 10th and 20th is attributed solely to high latitudes (>60°N).

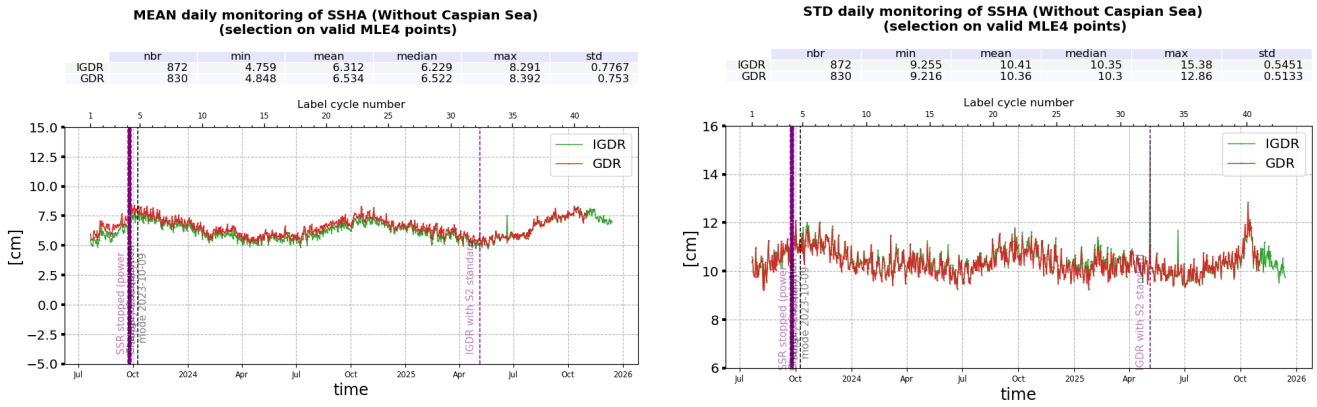

Figure 7: Daily monitoring of along-track SLA

1.6 Performances at crossover points

1.6.1 Monomission crossovers

Mean of Sea Surface Height (SSH) differences at crossovers is almost null showing the stability of measurements for this diagnostic. After data editing, applying additional geographical selection and SWOT Nadir standards, the crossover mean over the last year is about -0 cm in MLE4.
In the map in Figure 8 (right), we detect a geographical pattern (East/West in Pacific Ocean and North/South in Atlantic Ocean). This pattern was studied and was coming from the Orbital Solution POE-F. It will be corrected in 2026 with the Orbital Solution POE-G.

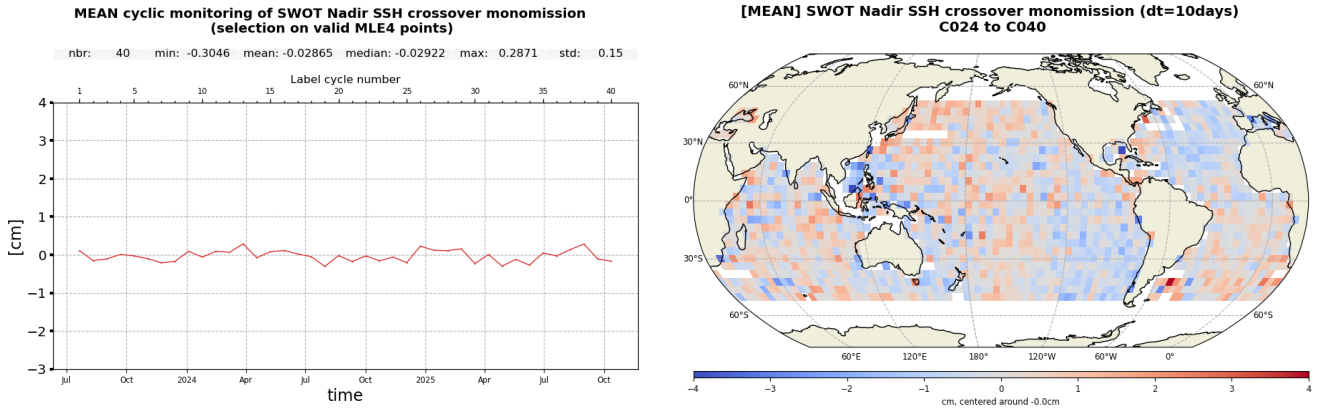

Figure 8: Mean SSH difference at crossovers

The daily standard deviation or variance of SSH crossovers differences are plotted in figure 9 after applying

geographical criteria (bathymetry, latitude, oceanic variability).
This metric allows to estimate the system noise by dividing by $\sqrt{2}$ (which leads to 3.54 cm).
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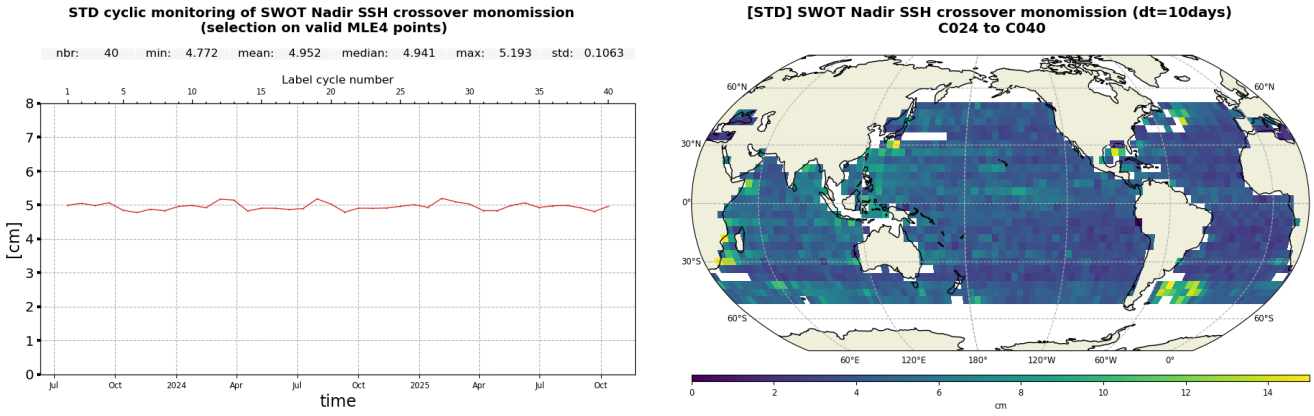

Figure 9: Std SSH difference at crossovers

1.6.2 Multimission crossovers

There is a jump in mean SLA differences at SWOT Nadir/Sentinel-6A-MF crossovers in the Figure 10 due to S6A standard change (F09 –> G01). The jump value is lower than 1 cm. It is consistent with the SLA bias value of 7.3 mm between F09 and G01 standard, described in the S6A G01 Reprocessing Calval Assessment [1]. Before and after the jump, mean SLA differences are quite stable. and around 1.015 cm in average. Figure 11 shows seasonal differences.

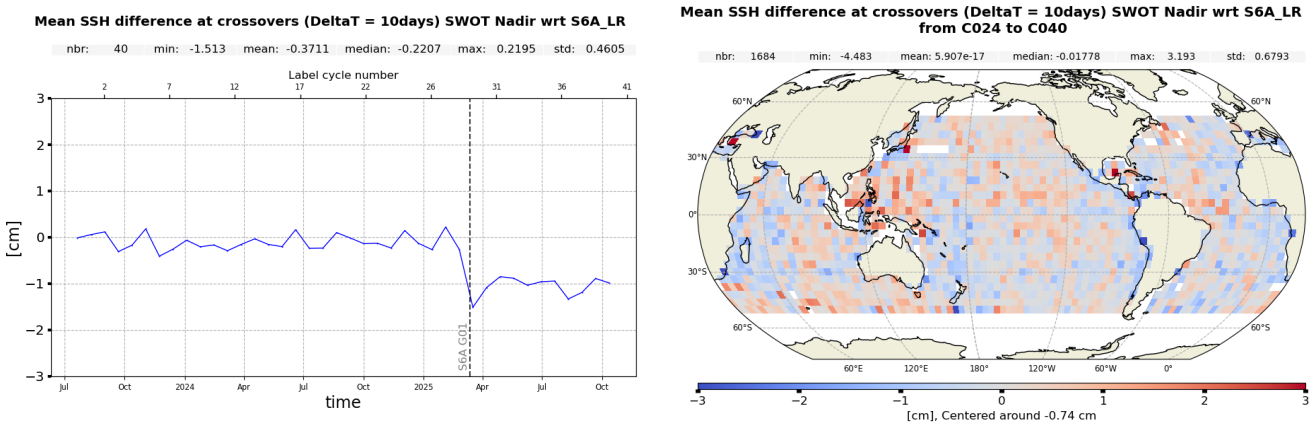

Figure 10: Mean SSH difference at crossovers between SWOT Nadir MLE4 and Sentinel-6 MF LR MLE4

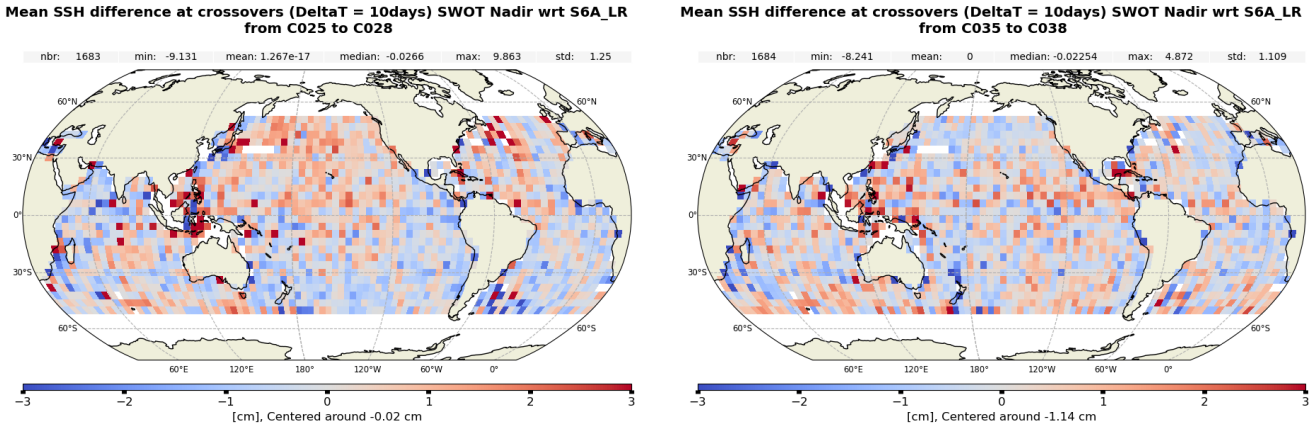

Figure 11: Mean SSH difference at crossovers between SWOT Nadir MLE4 and Sentinel-6 MF LR MLE4 for a winter cycle (left) and a summer cycle (right)

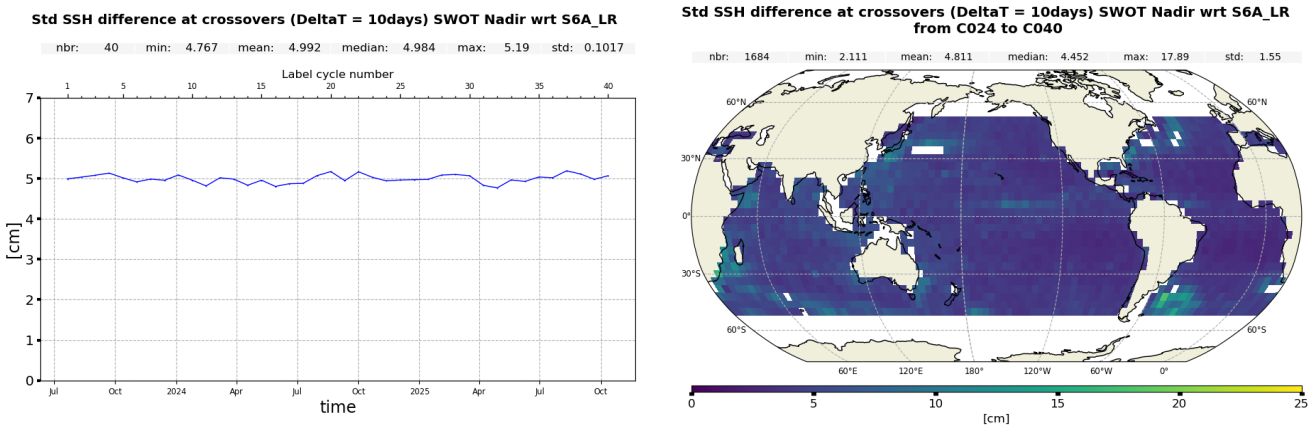

Figure 12: STD Daily monitoring of SSH difference at crossovers between SWOT Nadir MLE4 and Sentinel-6 MF LR MLE4

1.7 Known issues

- The current interpolation of radiometer data on the nadir track currently requires the two AMR sides to be defined and valid. The L2_NALT flag (rad_wet_tropo_cor_interp_qual) informs users of this degraded radiometer interpolation. In a future release, we plan to revisit the radiometer interpolation algorithm to mitigate or remove interpolation artifacts altogether.
- Some ionospheric correction measurements are lost due to a bad behaviour of the filtering process in rare cases. An ongoing study aims to explain this unexpected phenomenon.
- A longitudinal centimetric pattern is visible in SSH difference at crossovers mono and multi-mission. This have been attributed to SWOT POE-F and shall be corrected in the coming SWOT POE-G orbit files.

2 References

References

[1] Courcol B. Sentinel-6 MF : G01 Reprocessing Calval Assessment at https://user.eumetsat.int/s3/ope-eup-strapi-media/Sentinel_6_MF_G01_Reprocessing_Calval_Assessment_7e75a56d93.pdf