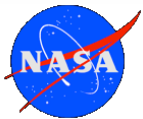


SWOT ST

September 17th , 2023

SWOT 1-day Nadir altimeter & radiometer products and performance



CNES and CLS Calval Team

CNES : François Bignalet-Cazalet, Claire Maraldi, Sophie Le Gac, Matthias Raynal, Nicolas Picot

CLS : Hélène Roinard, Marta Alves, Fanny Piras, Marie-Laure Denneulin



Nadir Altimeter L2 products (L2_NALT)

- OGDR (real-time latency) → **Available from Apr, 1st 2023 to July, 10th**
 - OPR “reduced” → SSHA and limited among of variables
 - OPN “native” → all variables @ 1 Hz and 20 Hz

- IGDR (short time critical) → **Reprocessing available from Apr, 1st 2023 to July, 10th**
 - IPR “reduced”
 - IPN “native”
 - IPS “sensor” → also include waveforms

- GDR (no time critical) → **Available in 2023, from beginning of mission**

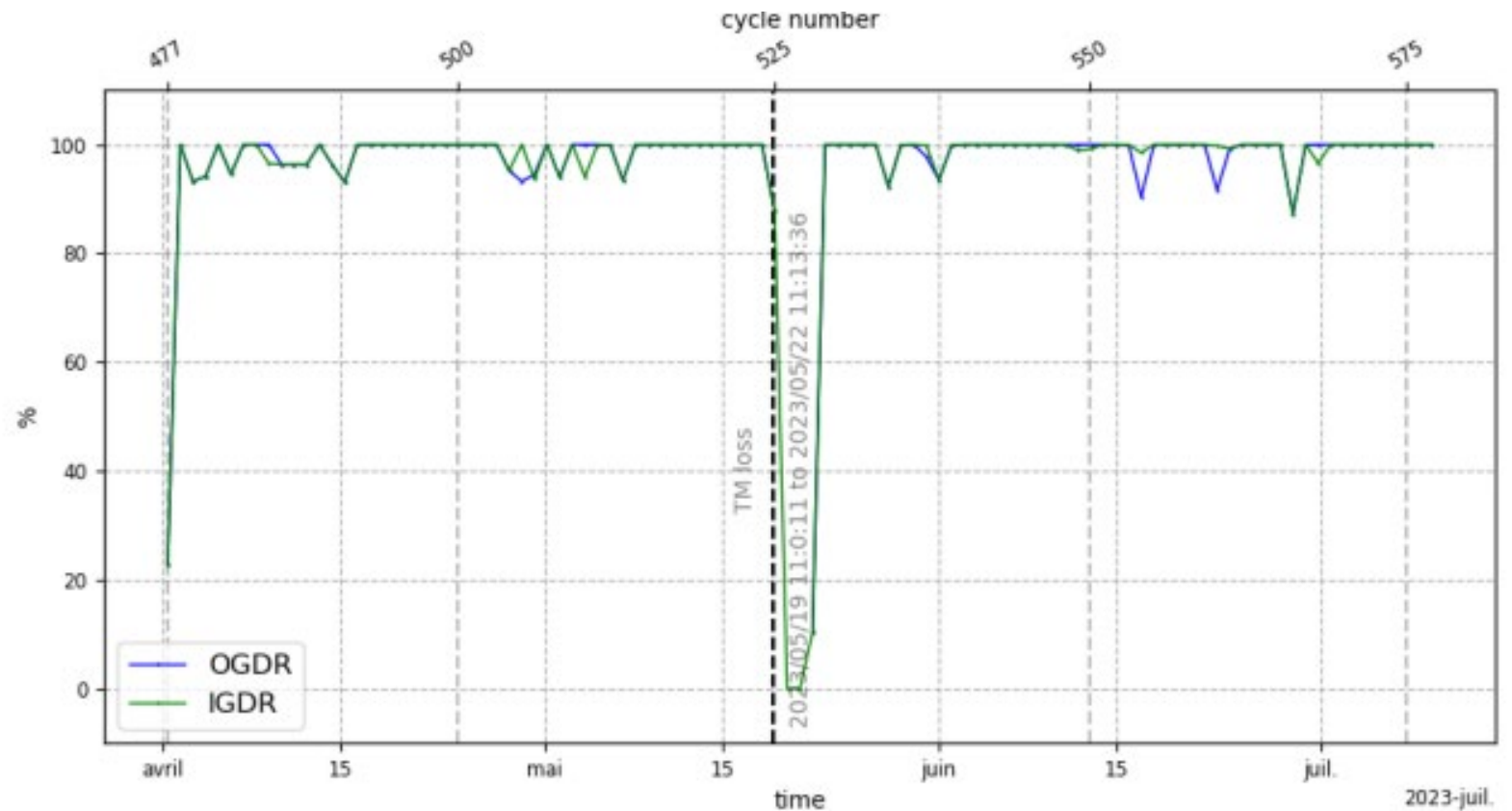
- 1/ Performances over ocean
-
-
-
- 2/ Performances over hydrological targets
-
- 3/ POD performances
-
-
-
- 4/ Conclusion
-

Coverage over ocean

Availability since POS-3C switch-on
~90% (most event related to SWOT SSR issues)

Availability since 1 Apr
~95%

Percentage of available measurements over ocean

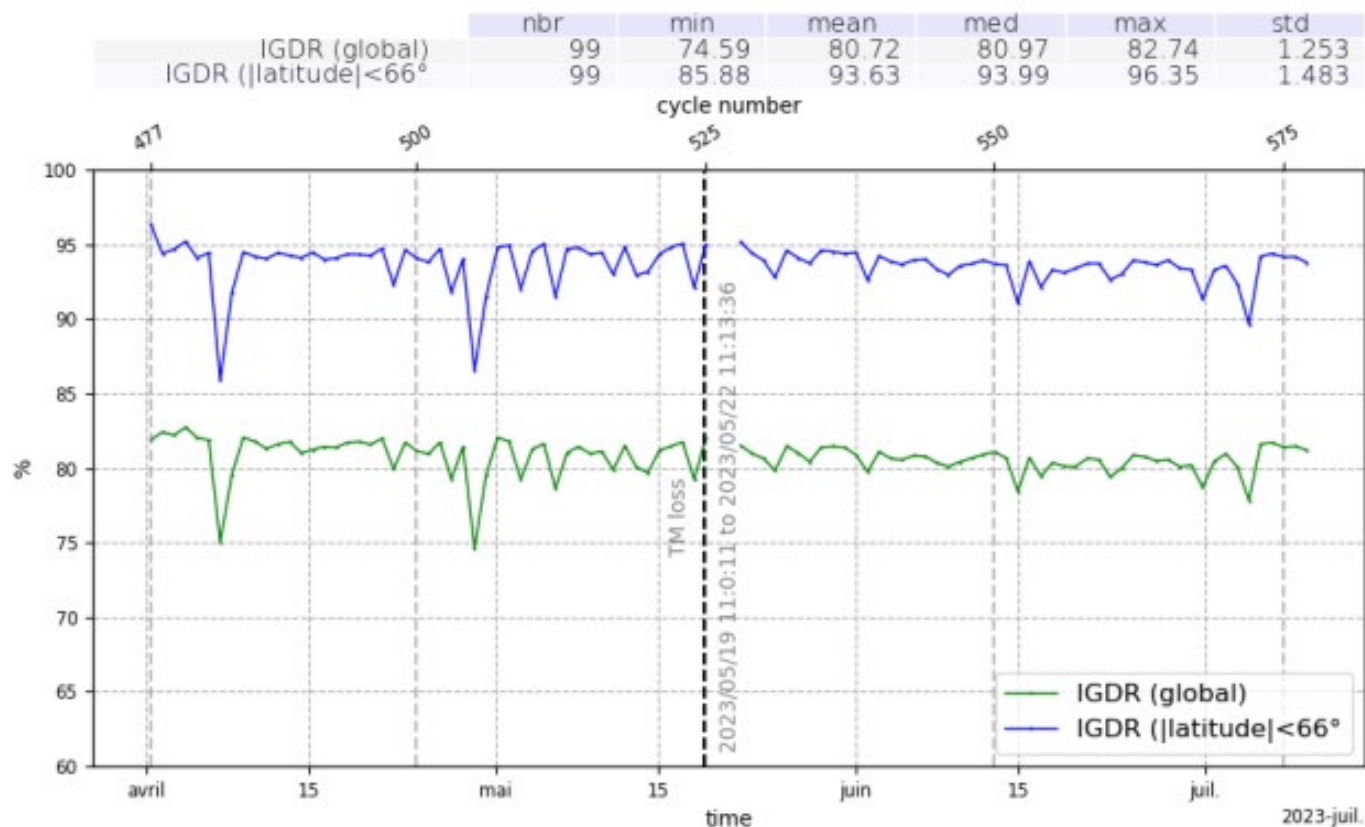


Validity over ocean

Valid measurement over ocean

- ~81% are valid (sea-ice surfaces included)
- ~94% for $|\text{latitude}| < 66^\circ \rightarrow$ similar to S6A-MF

Percentage of valid measurements over ocean

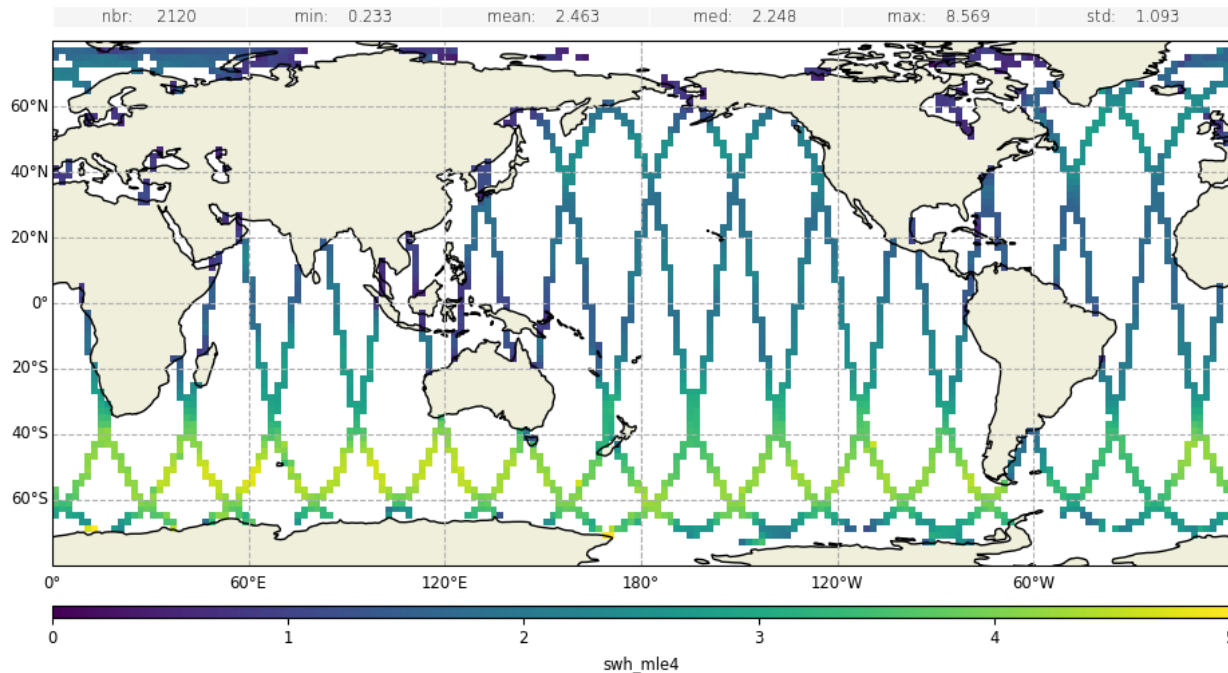


SWH

Expected SWH patterns and range of values

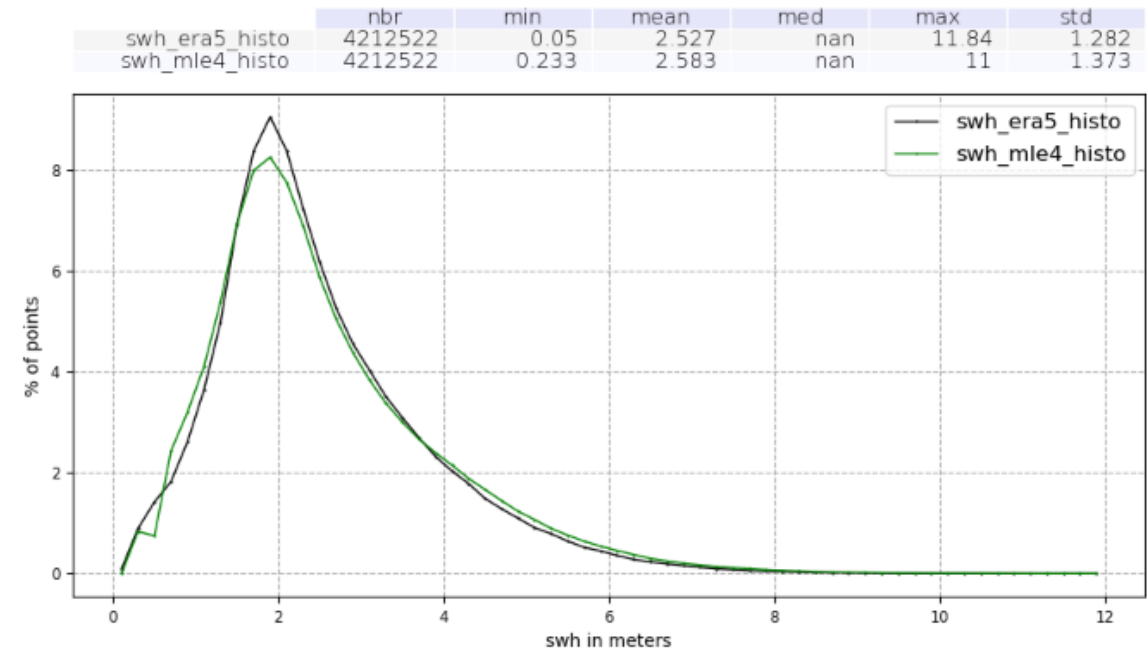
Map of SWH values

mean of swh_mle4 [m]
 Cycle 477 to 578
 2023-03-31 21:33 to 2023-07-10 05:47



Histogram of SWH values

swh histograms (IGDR)
 (selection on valid ssha with MLE4 outputs and radiometer WTC points)
 2023-03-31 21:33 to 2023-07-10 05:47



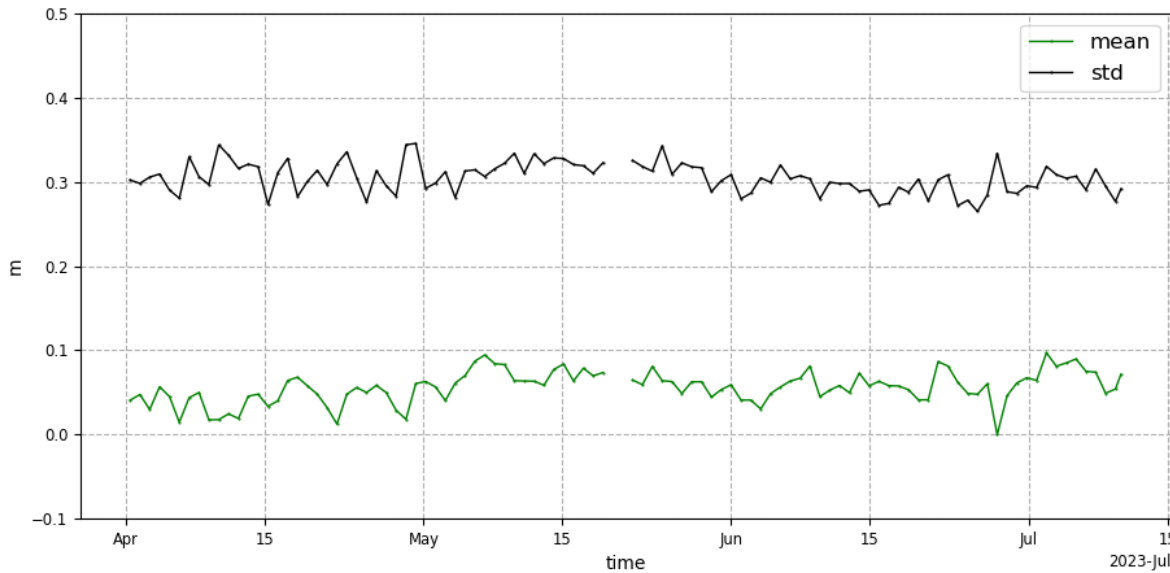
SWH

SWH comparison with ERA5 :

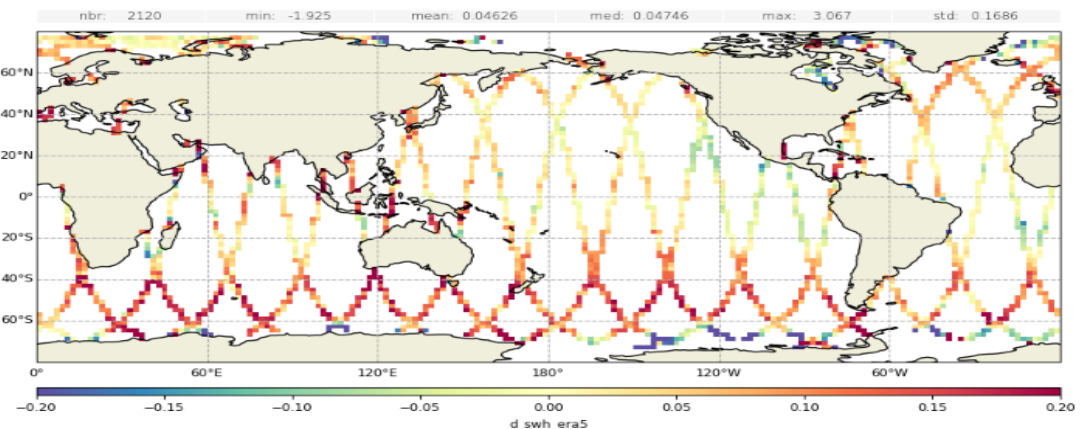
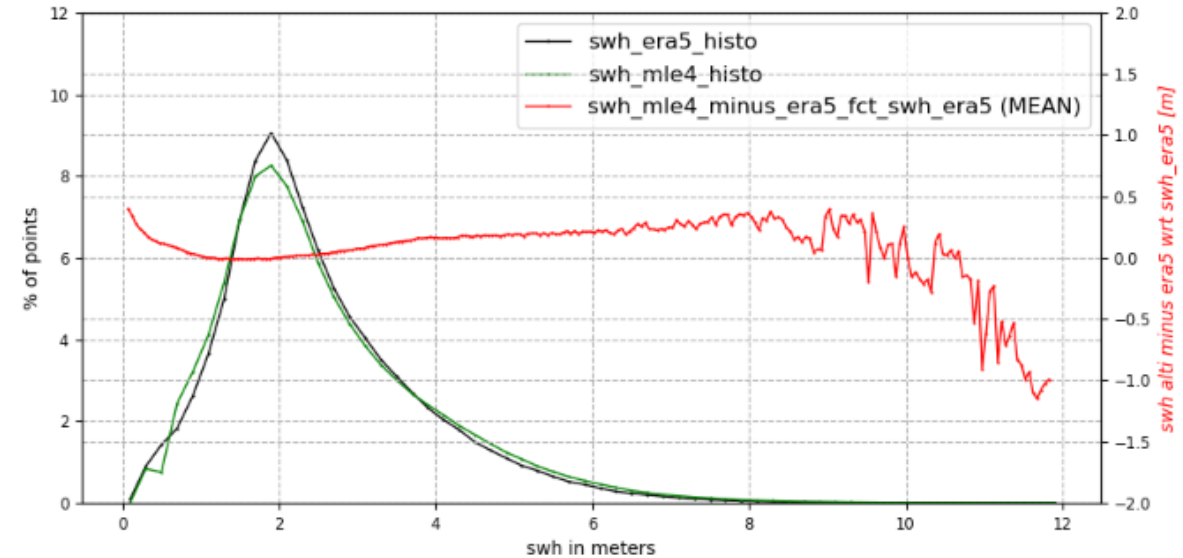
- No clear geographical pattern
- Slight dependence wrt ERA5 SWH, to be monitored in GDR

Time serie of SWH compared to ERA5 (mean and std)

| | nbr | min | mean | med | max | std |
|------|-----|------------|---------|---------|---------|---------|
| mean | 100 | -0.0004291 | 0.05593 | 0.05782 | 0.09695 | 0.01897 |
| std | 100 | 0.265 | 0.3052 | 0.3054 | 0.3458 | 0.01831 |



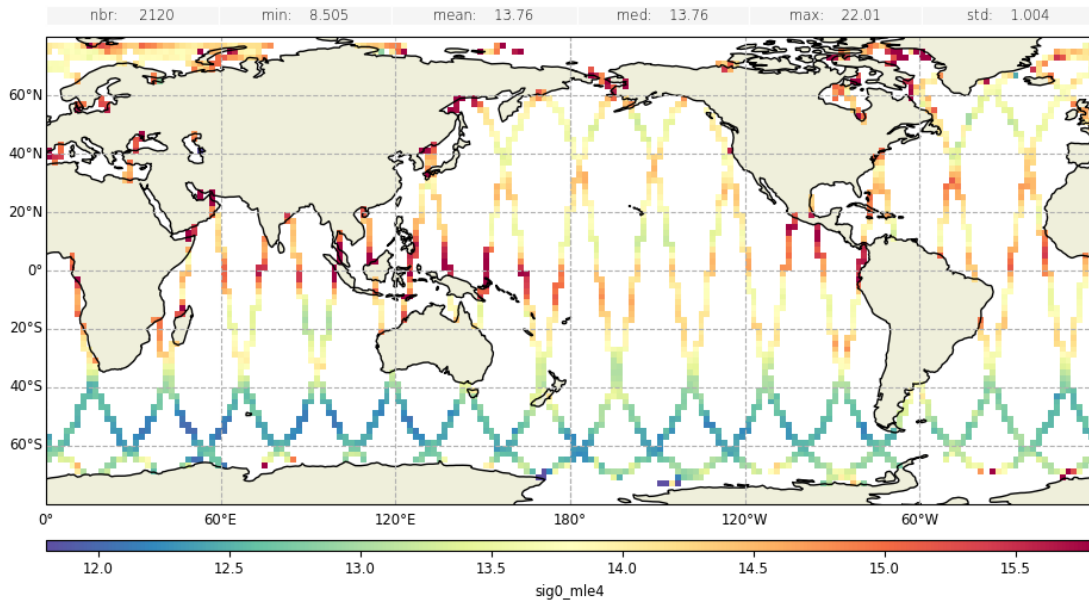
SWH compared to ERA5 : Dependence wrt SWH and map



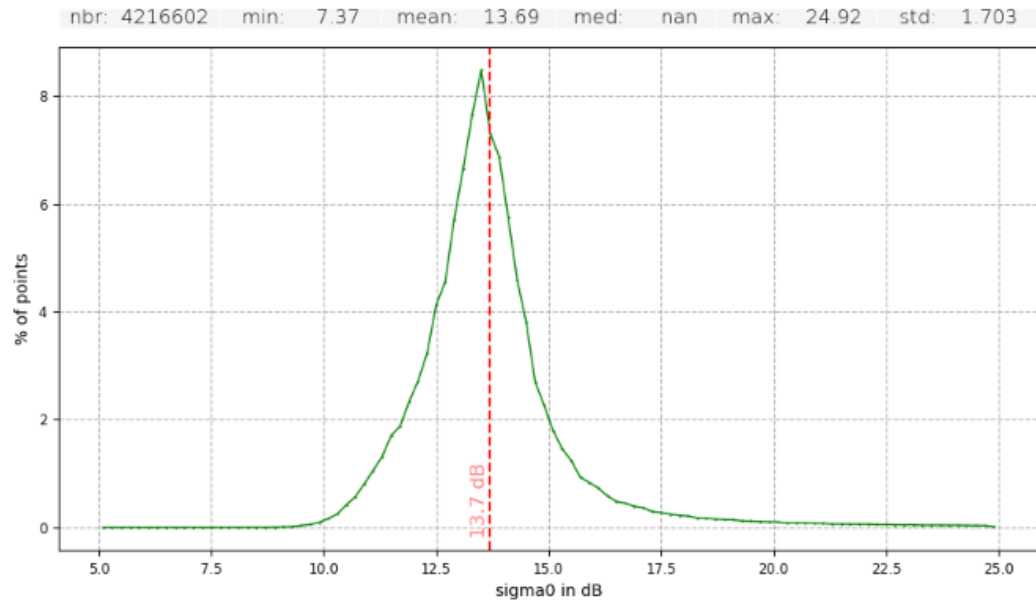
Sigma0

Expected Sigma0 patterns
Histogram coherent with other missions

Map of Sigma0 values



Histogram of Sigma0 values

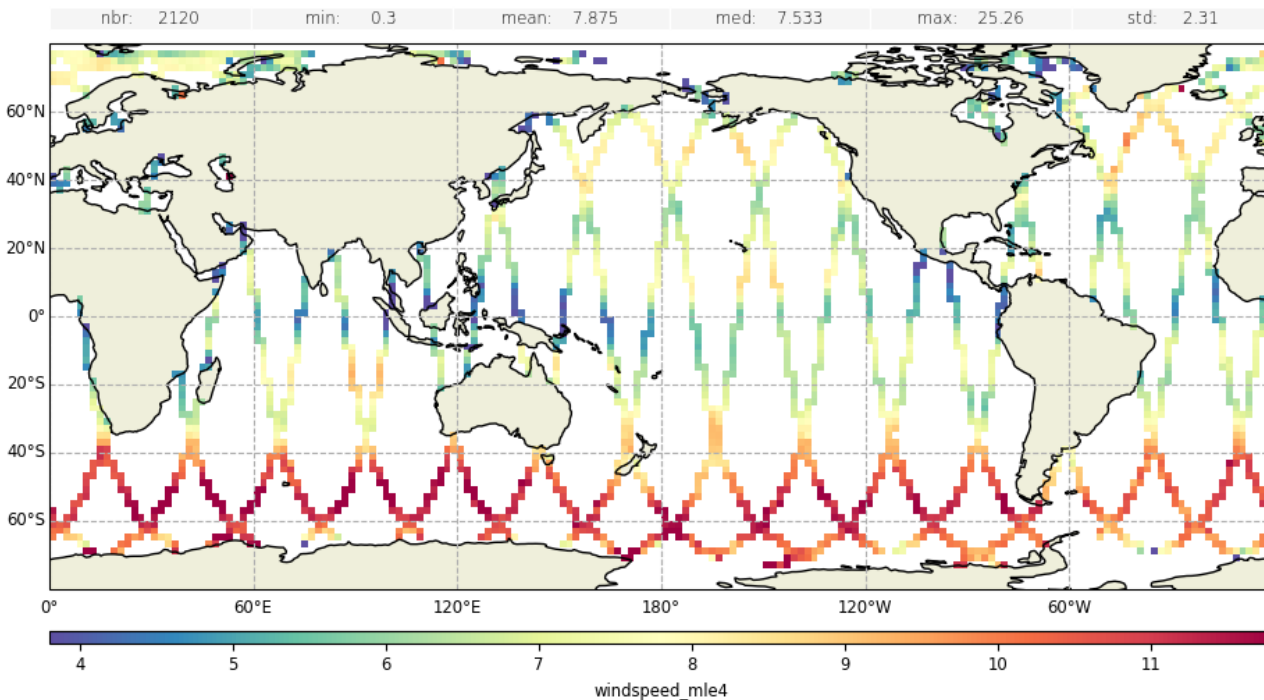


Wind Speed

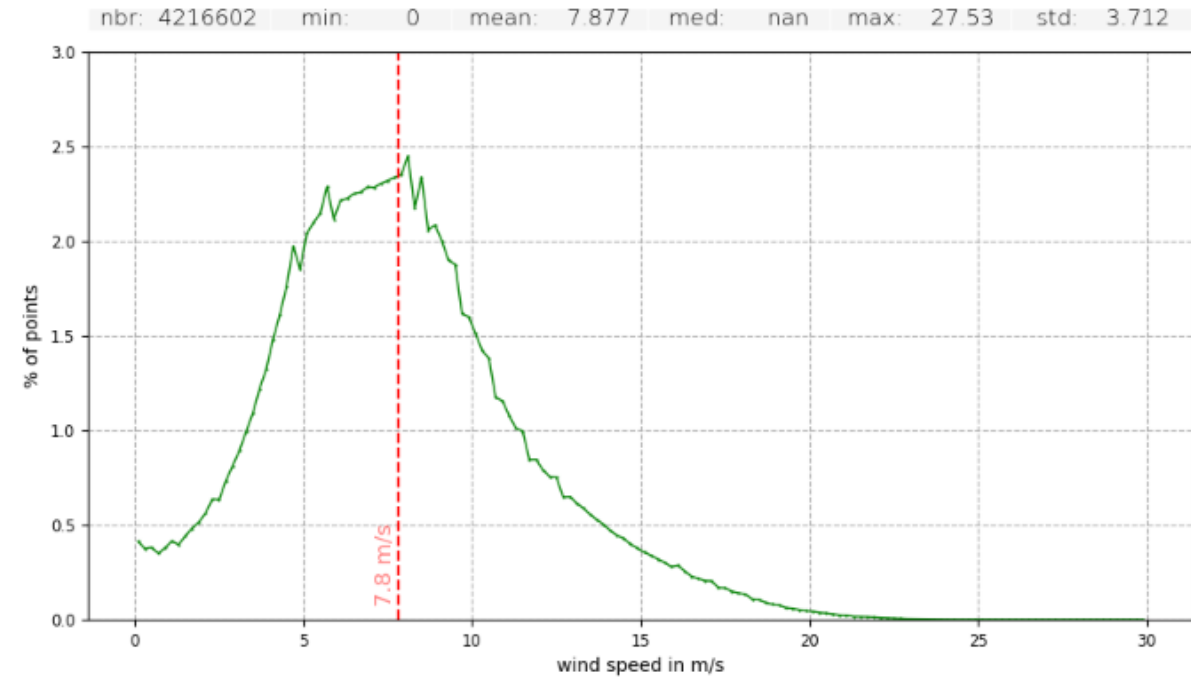
Expected WS patterns

Histogram coherent with other missions

Map of WS values



Histogram of WS values



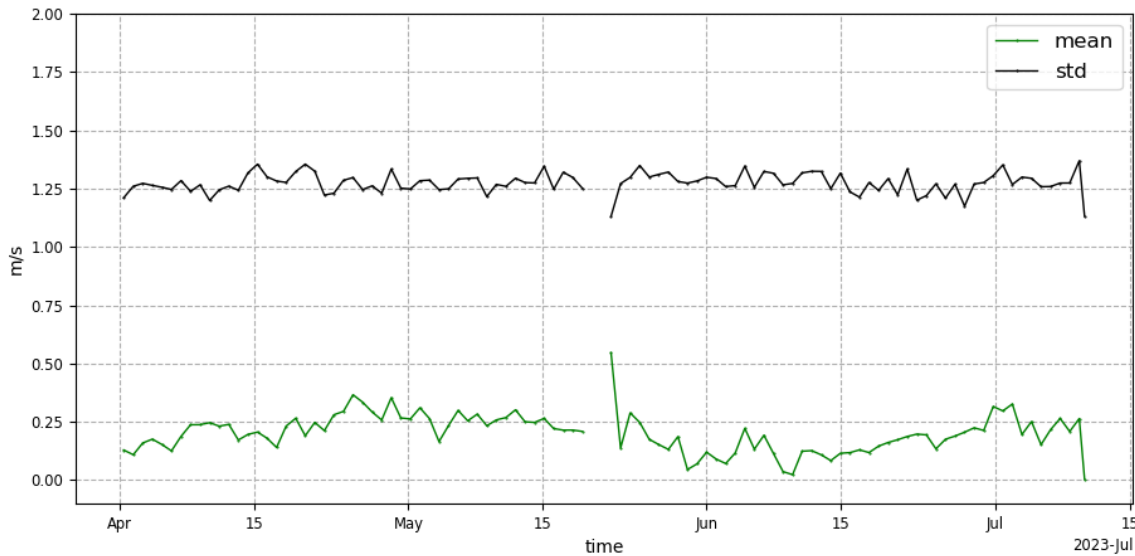
Wind Speed

WS difference wrt ERA5 :

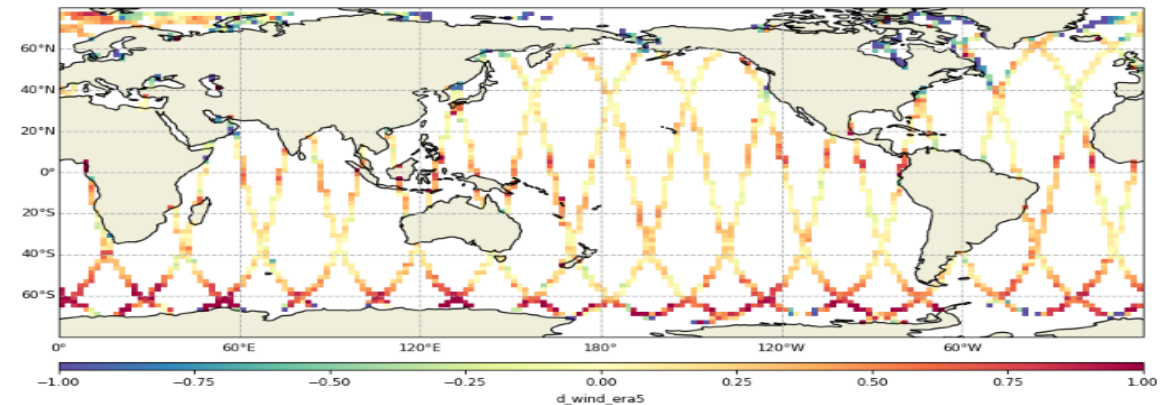
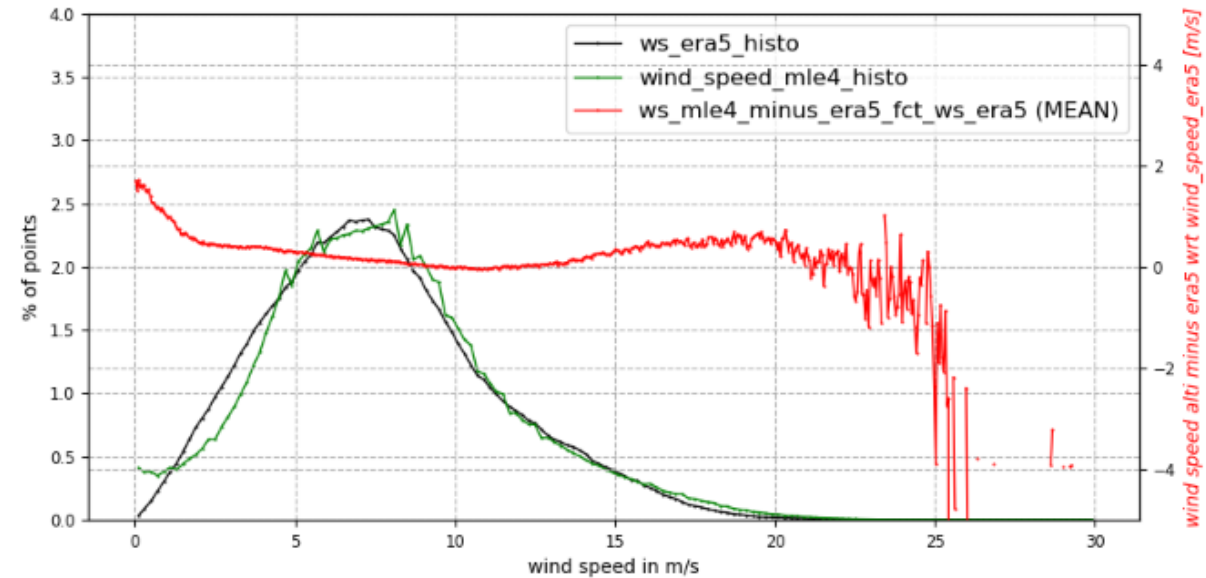
- No clear geographical pattern
- Slight dependence wrt ERA5 WS, to be monitored in GDR

Time serie of WS compared to ERA5 (mean and std)

| | nbr | min | mean | med | max | std |
|------|-----|---------|--------|--------|-------|---------|
| mean | 100 | 0.00443 | 0.2023 | 0.2061 | 0.546 | 0.08188 |
| std | 100 | 1.132 | 1.275 | 1.274 | 1.37 | 0.04344 |



WS compared to ERA5 : Dependence wrt WS and map



Wet Tropo Correction

WPD Side 2 – Side 1: bias about -1,4 mm
variability ~1,3 cm

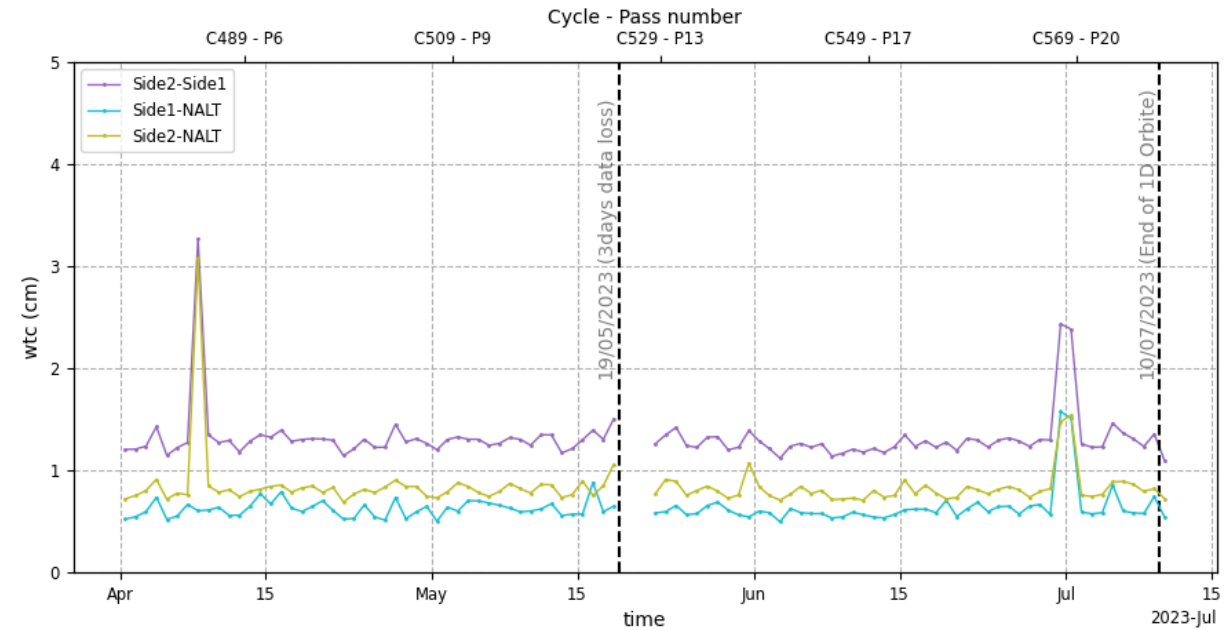
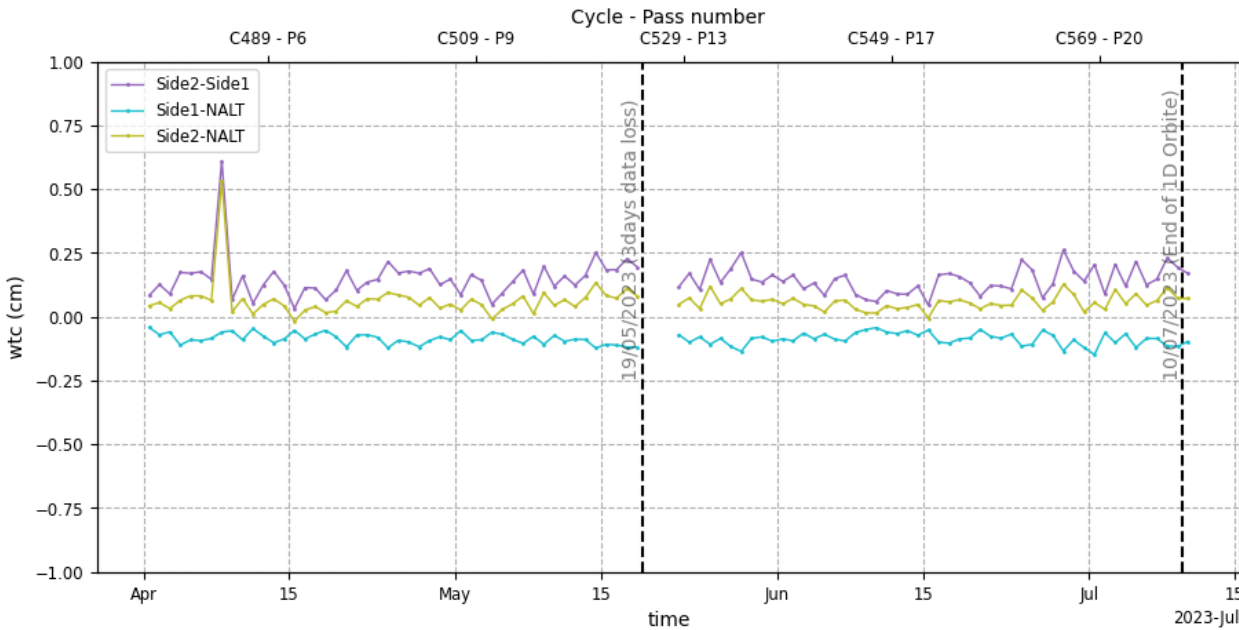
Good coherence between Side 1, Side 2 and Nadir-interpolated WPD

mean per day : wtc

| | nbr | min | mean | med | max | std |
|-------------|-----|----------|----------|----------|----------|---------|
| Side2-Side1 | 98 | 0.0319 | 0.1467 | 0.1405 | 0.6111 | 0.06808 |
| Side1-NALT | 98 | -0.1484 | -0.08663 | -0.08727 | -0.04235 | 0.02274 |
| Side2-NALT | 98 | -0.01795 | 0.06082 | 0.05523 | 0.5337 | 0.05601 |

std per day : wtc

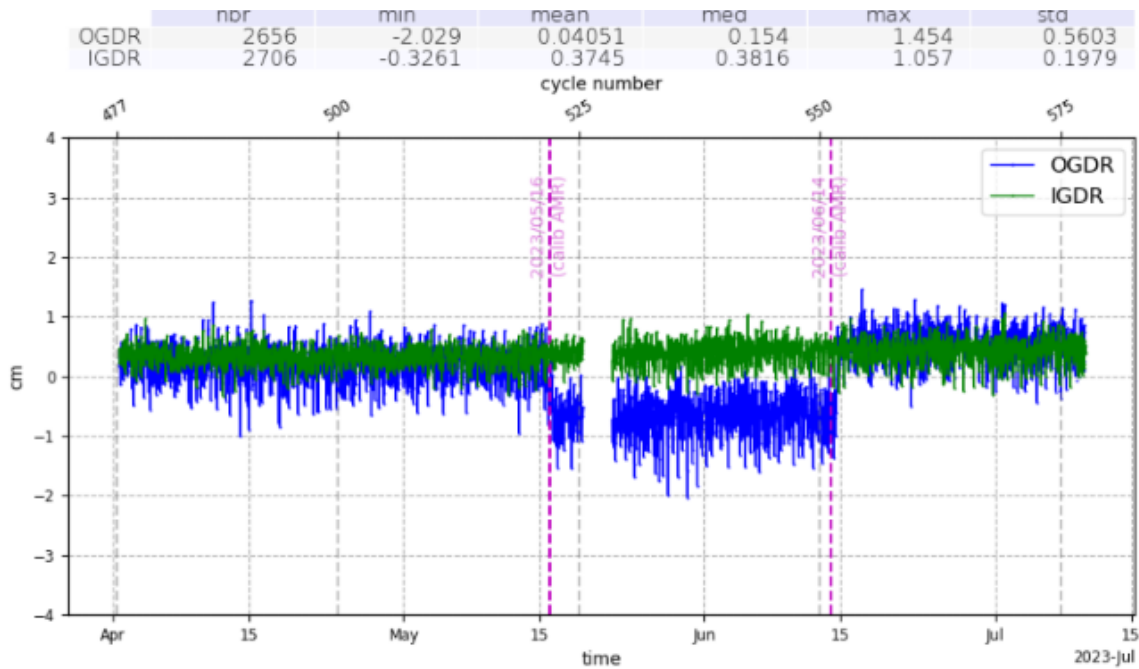
| | nbr | min | mean | med | max | std |
|-------------|-----|--------|--------|--------|-------|--------|
| Side2-Side1 | 98 | 1.087 | 1.312 | 1.276 | 3.26 | 0.265 |
| Side1-NALT | 98 | 0.4908 | 0.6265 | 0.5931 | 1.57 | 0.149 |
| Side2-NALT | 98 | 0.683 | 0.8349 | 0.7892 | 3.071 | 0.2565 |



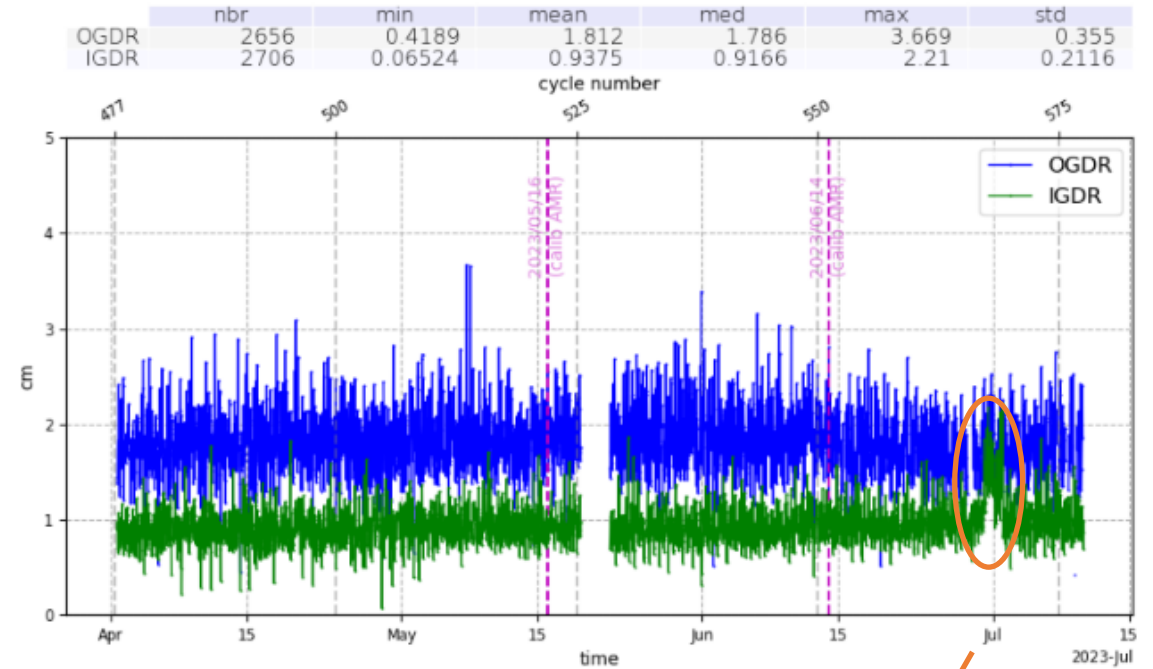
Wet Tropo Correction

Nadir WPD bias with model to ~3 mm, std < 1cm

Time serie of WPD AMR-ECMWF (mean)



Time serie of WPD AMR-ECMWF (std)

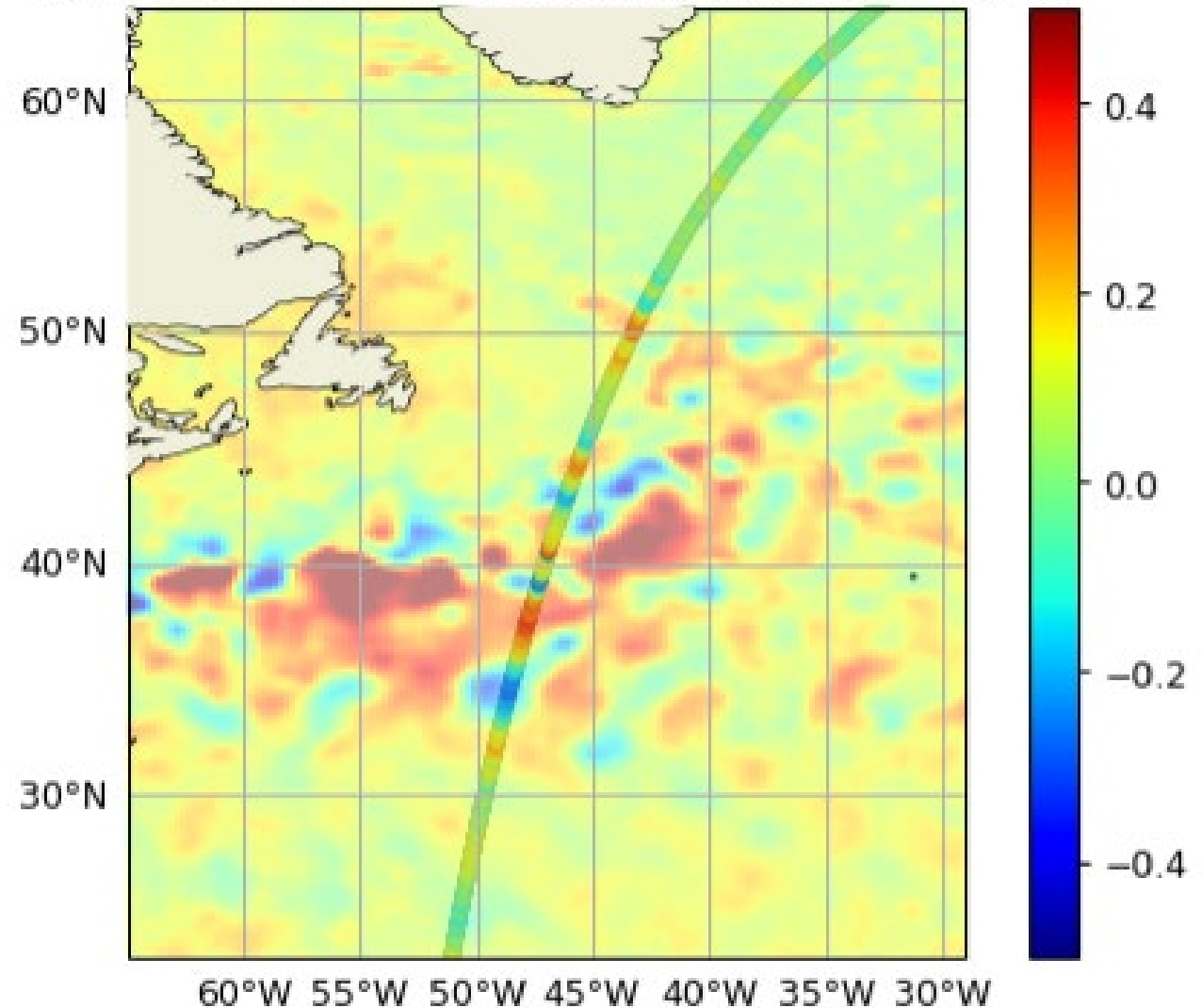


On-ground processing anomaly, will be corrected in GDR

SSHA

- Very good small-scales behavior since the switch-on of POS-3C

SWOT POS-3C & CMEMS L4 ssha(m) 19/01/2023



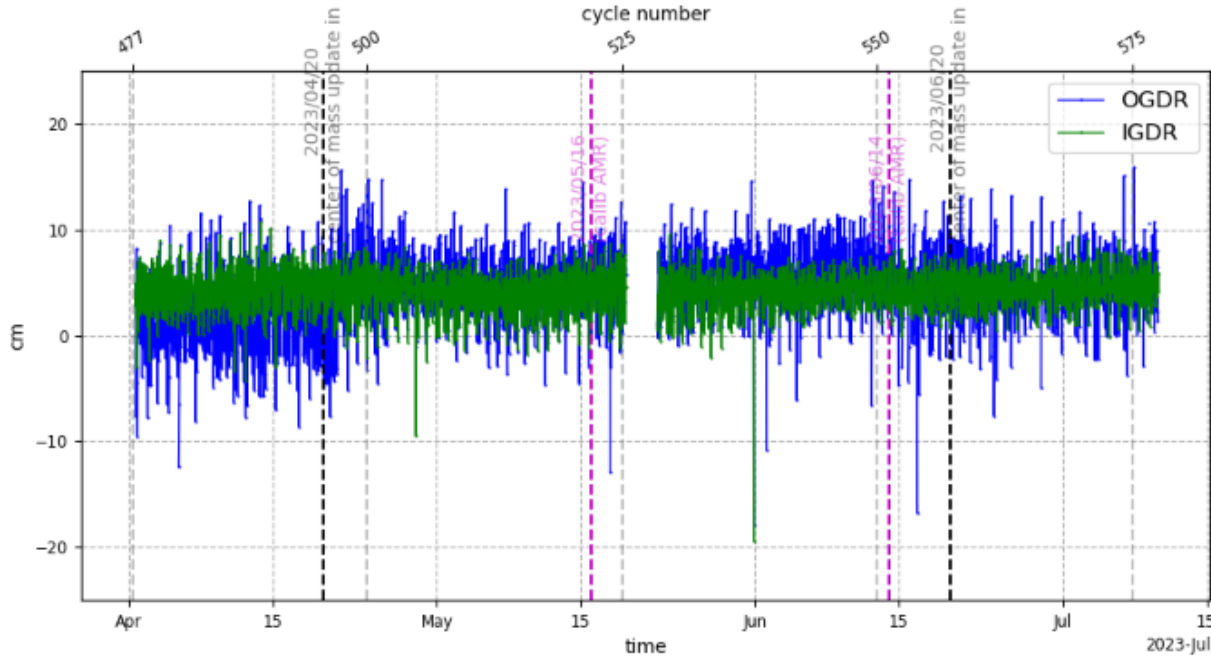
Crédit : M. Raynal

SSHA

- Along track mean stabilised in reprocessed IGDR. (since 20 April in OGDR)
- Along track std after 1 Apr = 9,4 cm (in line with J3)

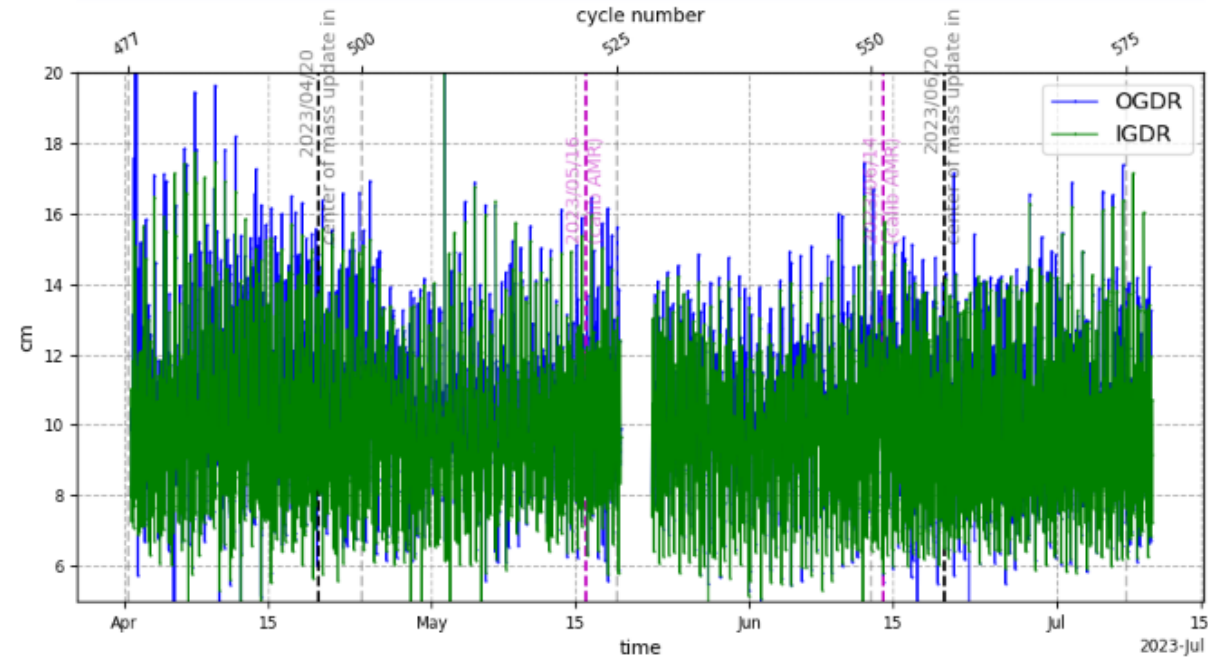
Time serie of mean ML4 SLA

| | nbr | min | mean | med | max | std |
|------|------|--------|-------|-------|-------|-------|
| OGDR | 2656 | -17.88 | 4.276 | 4.557 | 15.91 | 3.666 |
| IGDR | 2706 | -19.46 | 4.239 | 4.386 | 10.7 | 1.986 |



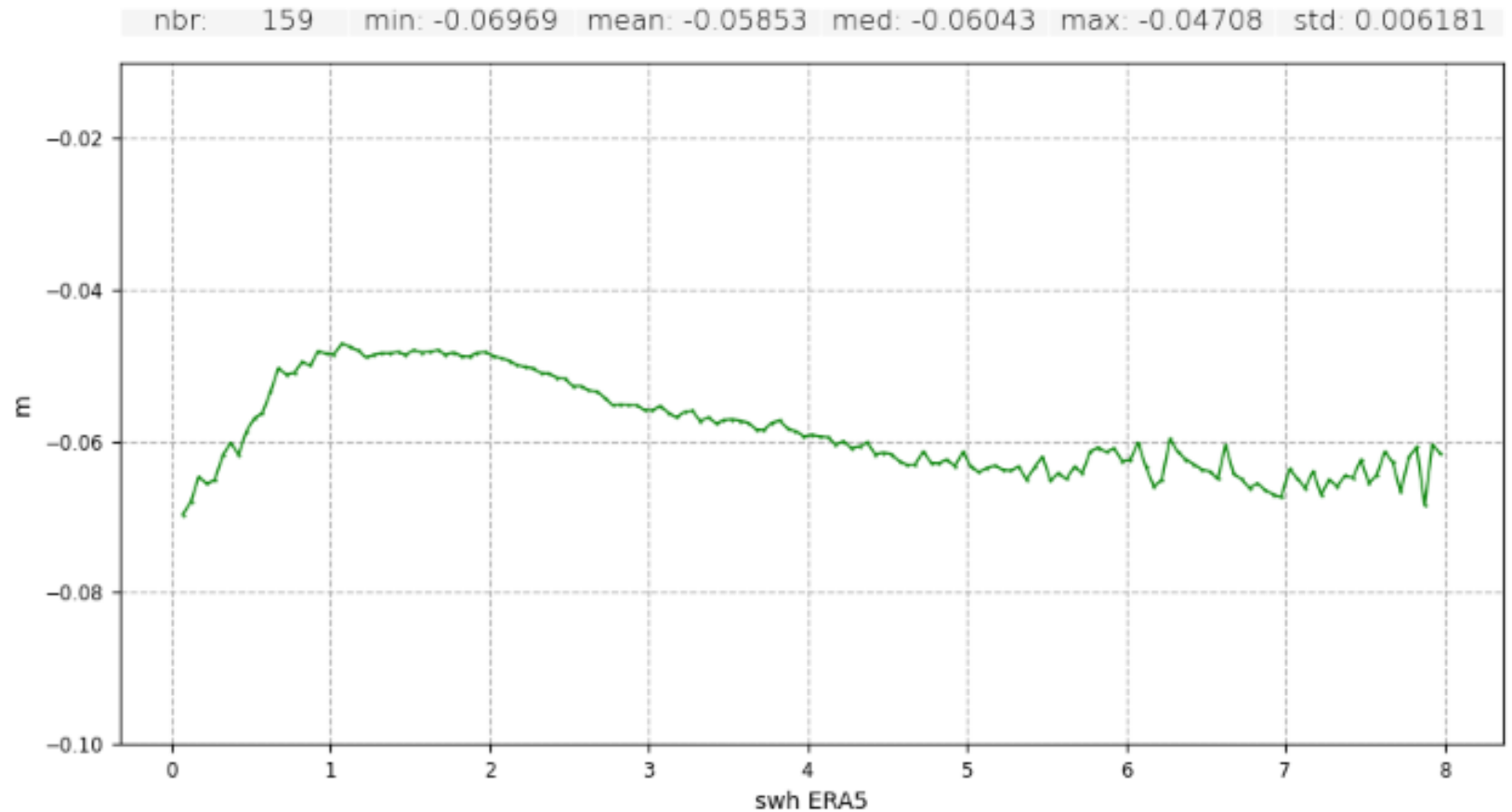
Time serie of STD ML4 SLA

| | nbr | min | mean | med | max | std |
|------|------|-------|-------|-------|-------|-------|
| OGDR | 2656 | 3.459 | 10.27 | 9.97 | 20.88 | 2.384 |
| IGDR | 2706 | 1.437 | 9.704 | 9.382 | 20.38 | 2.245 |



SSHA

(Swot Nadir SSHA – CMEMS SSHA) as a function of SWH



Small wave / latitude dependence to be confirmed in GDR

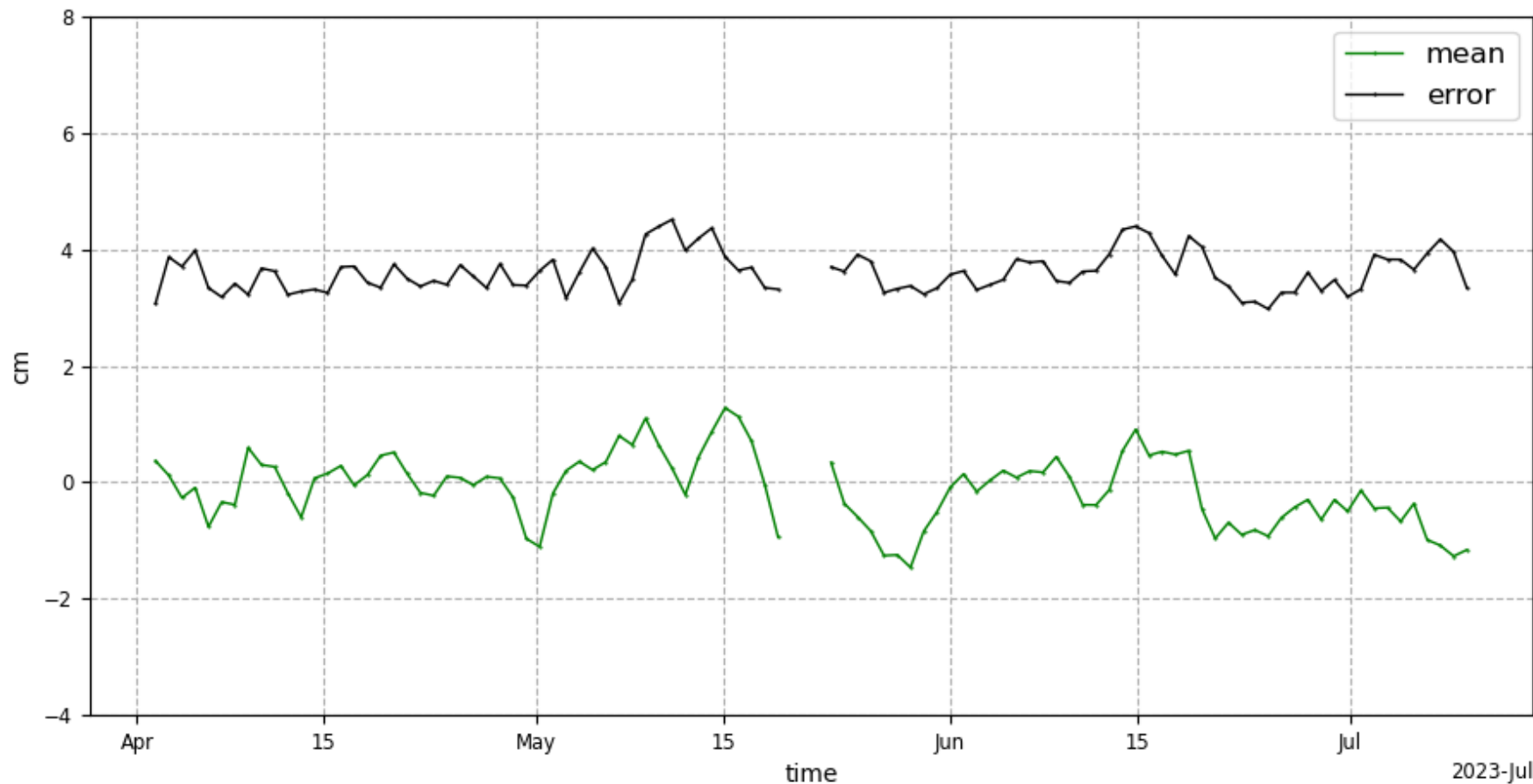
SSHA SWOT/SWOT Xovers

SWOT/SWOT monomission crossovers (DeltaT_3days) sla_mle4_L2_IGDR

Mean ~ 1 mm

Error ~3,6 cm (std ~ 5,1 cm)

| | nbr | min | mean | med | max | std |
|-------|-----|--------|---------|----------|-------|--------|
| mean | 97 | -1.465 | -0.1186 | -0.08727 | 1.278 | 0.5911 |
| error | 97 | 2.978 | 3.612 | 3.605 | 4.516 | 0.3451 |



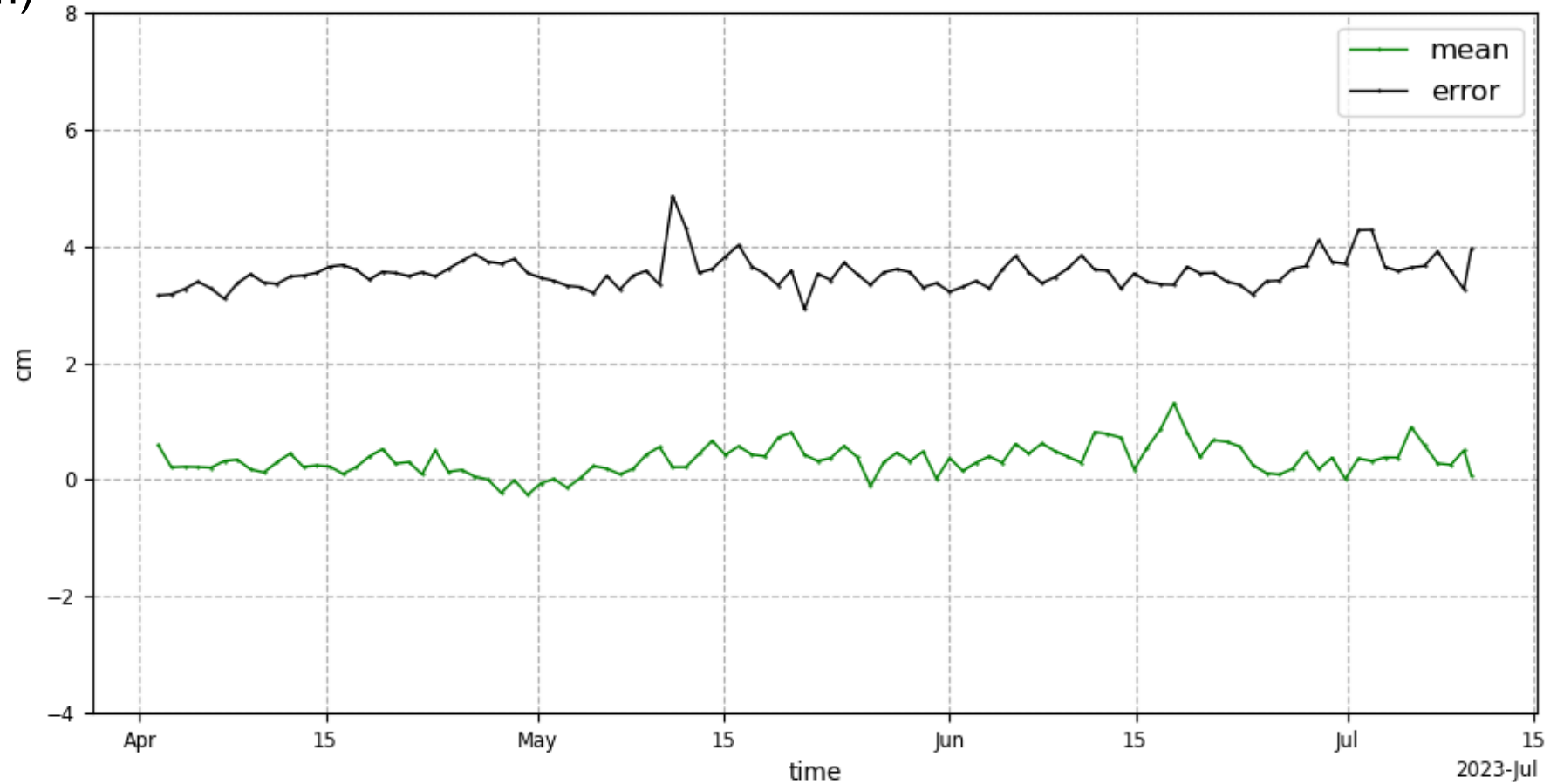
SSHA SWOT/S6_LR Xovers

SWOT/S6A_LR crossovers (DeltaT_3days) sla_mle4_L2_IGDR

Mean ~ 3 mm

Error = 3,5 cm (std ~5,0 cm)

| | nbr | min | mean | med | max | std |
|-------|-----|--------|--------|--------|-------|--------|
| mean | 101 | -0.263 | 0.3408 | 0.3178 | 1.312 | 0.2574 |
| error | 101 | 2.92 | 3.546 | 3.536 | 4.862 | 0.2732 |

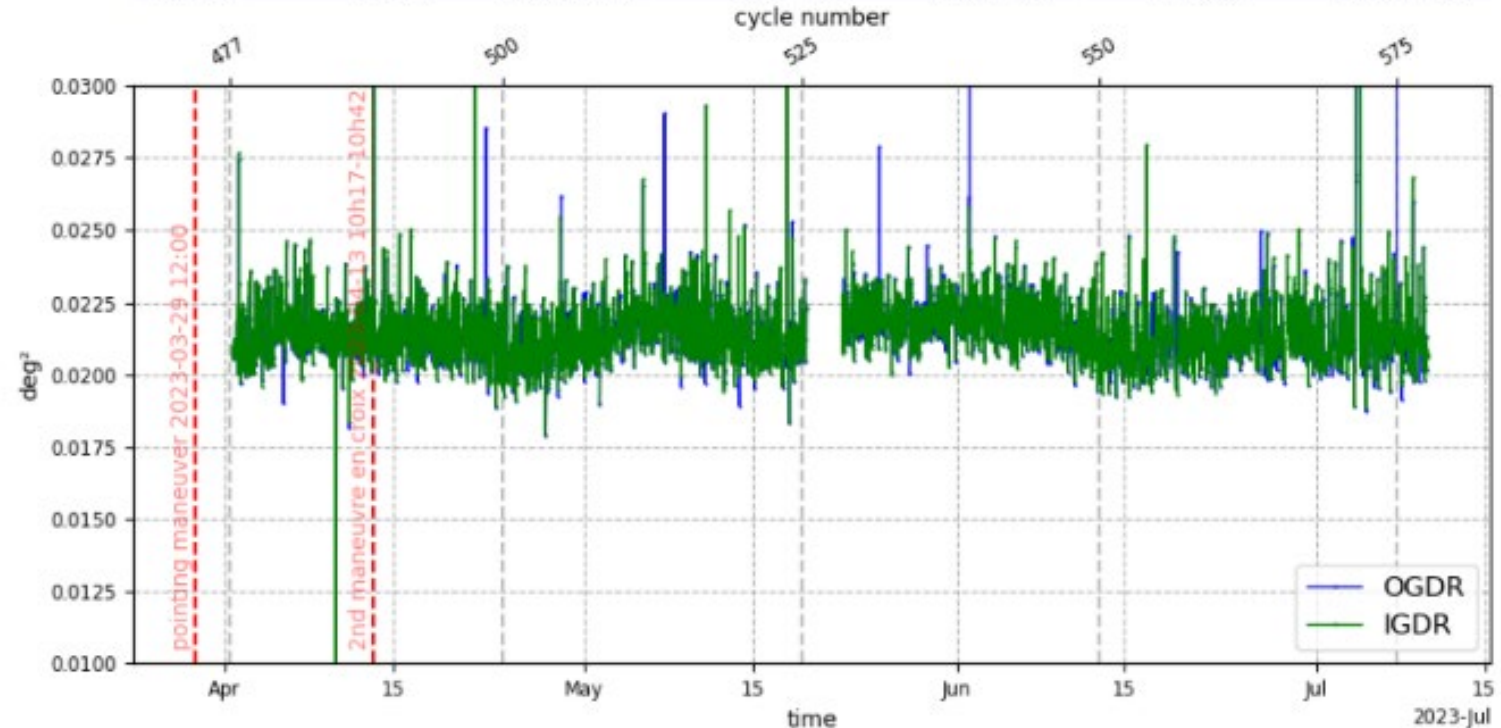


Mispointing

- From 1 Apr onwards, mispointing is stable, small evolutions observed are similar to the one on JA3 and likely due to the surface (SWH, roughness, ...)
- WF estimated mispointing is $\sim 0,145^\circ$, within requirements

Mispointing time serie

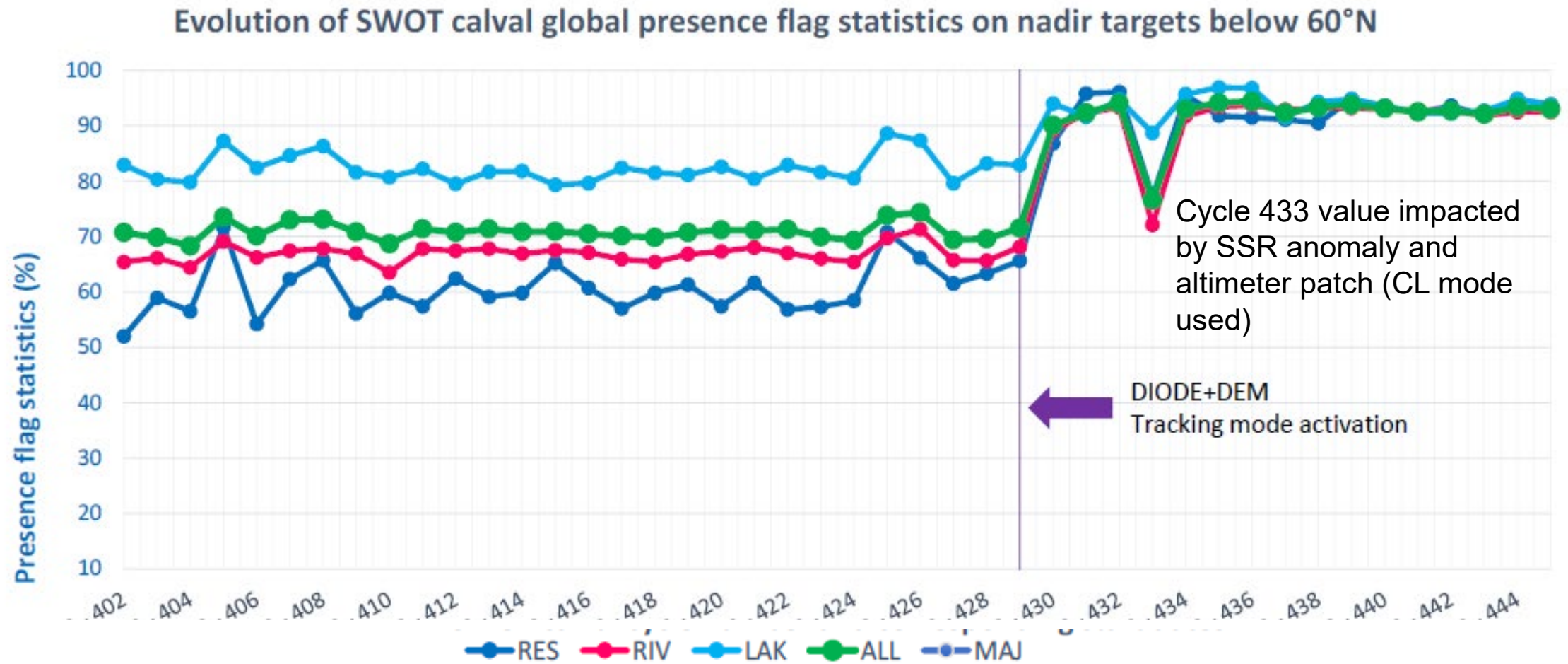
| | nbr | min | mean | med | max | std |
|------|------|----------|---------|---------|---------|----------|
| OGDR | 2656 | 0.006905 | 0.02156 | 0.02135 | 0.06937 | 0.002065 |
| IGDR | 2706 | 0.006886 | 0.02156 | 0.02138 | 0.06687 | 0.001788 |



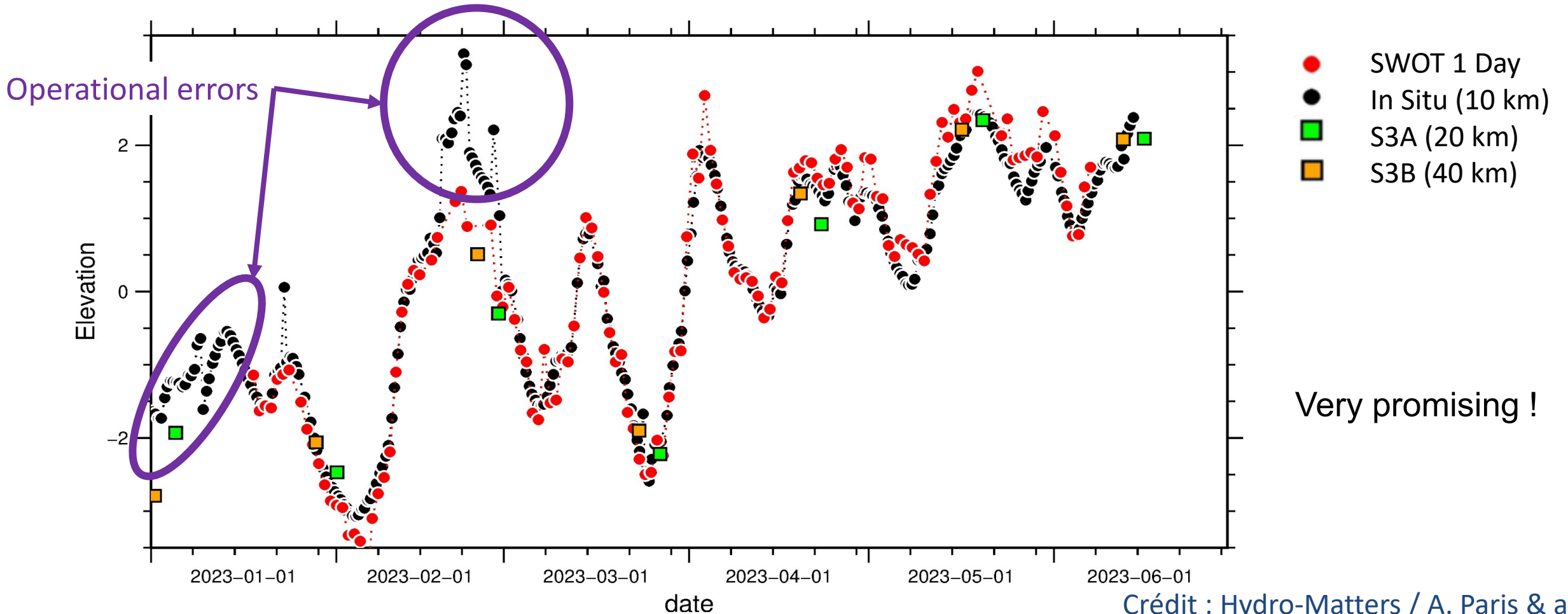
- . 1/ Performance over ocean
- . .
- . .
- . .
- 2/ Performance over hydrological targets
- .
- 3/ POD performances
- .
- . .
- . .
- . 4/ Conclusion
- . .

Availability

- Stable at ~94% (below 60°N) from DIODE+DEM mode activation



Içana river, 1000 km upstream Rio Negro from Manaus



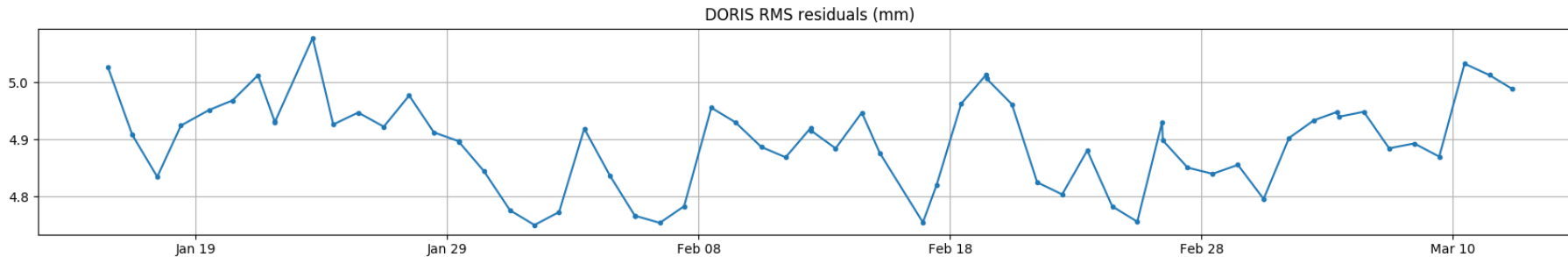
Crédit : Hydro-Matters / A. Paris & al

- 1/ Performance over ocean
-
-
-
- 2/ Performance over hydrological targets
-
- 3/ POD performances
-
-
-
- 4/ Conclusion
-

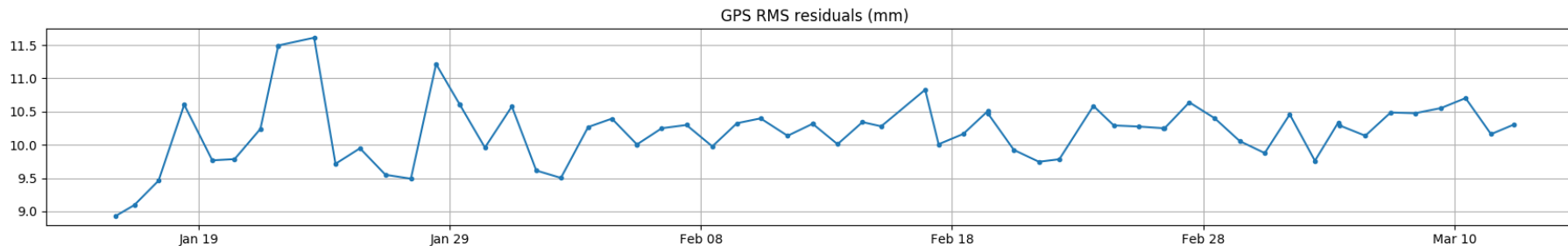
- NAV (DORIS) used for OGDR
- MOE used for IGDR
 - MOE DORIS from Jan, 20th onwards
 - MOE DORIS+GPS from Feb, 19th onwards
- POE in preparation for GDR :
 - POE-F DORIS+GPS orbit solutions,
 - Reduced-dynamic parameterization
 - SLR is saved for independent validations.

- POE evaluation from A. Couhert et al.

- RMS of daily DORIS Doppler post-fit residuals: ~4,8 – 5 mm suggesting a stronger sensitivity to SAA than for Jason-3.

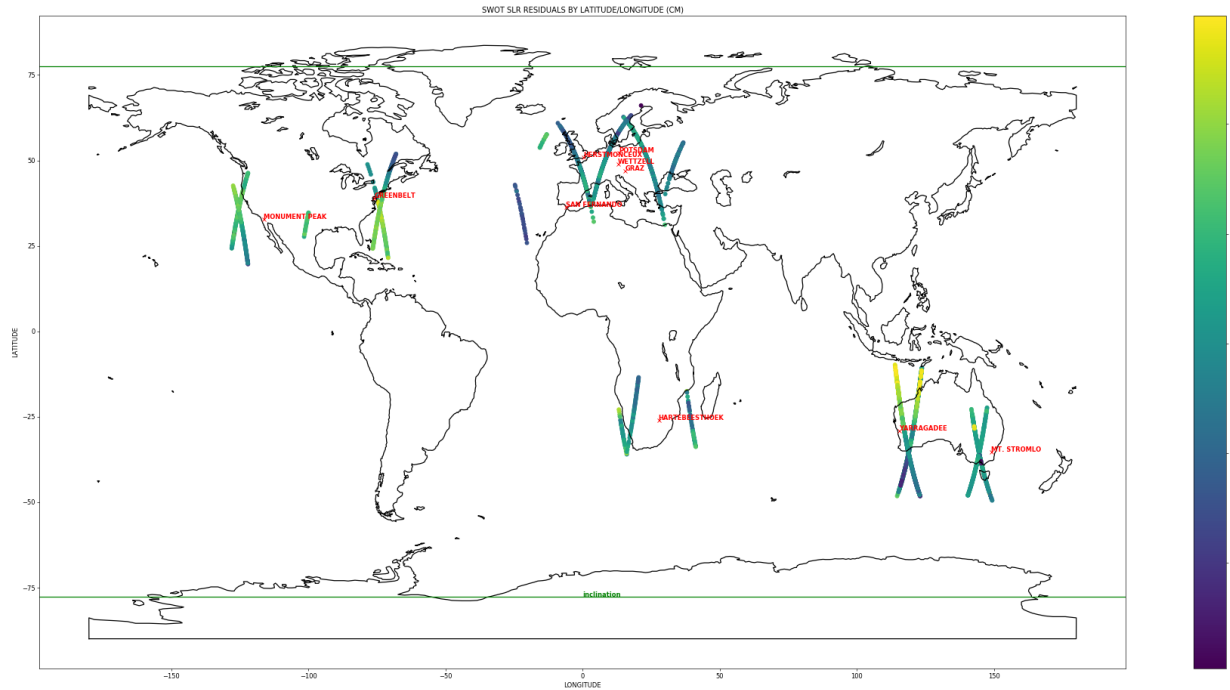


- RMS of daily GPS phase (LC) post-fit residuals: Slightly higher than for Jason-3 but with a pre-flight phase map (solar array perturbations).

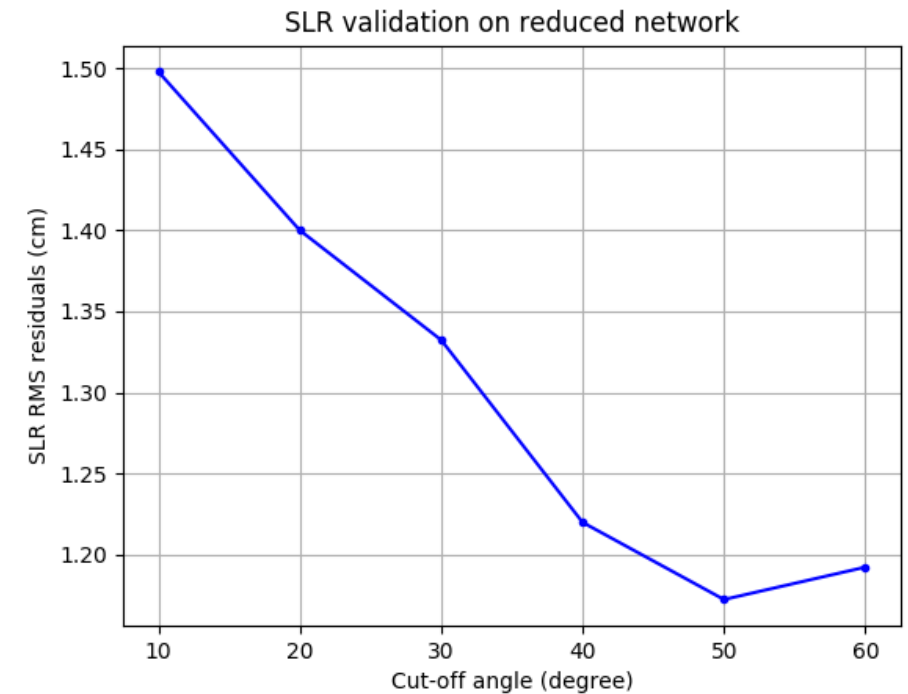


- DORIS-only w.r.t. GPS-based dynamic orbit solutions: Sub-centimeter agreement in the radial direction: ~5 mm RMS.

- POE evaluation from A. Couhert et al.
 - Independent orbit validation owing to SLR observations : Subset of highest quality ILRS stations already validating radial POD accuracies of < 1.5 cm (RMS) , below requirements



Subset of highest quality ILRS stations



RMS of SLR residuals vs. elevation angle

- . 1/ Performance over ocean
- . .
- . .
- . .
- . 2/ Performance over hydrological targets
- . .
- . ● 3/ POD performances
- . .
- . .
- . .
- . 4/ Conclusion
- . .

Conclusion

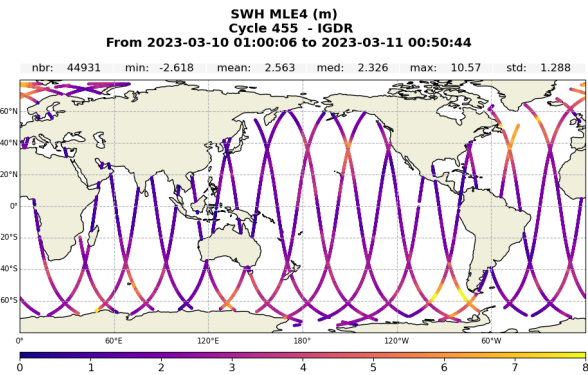
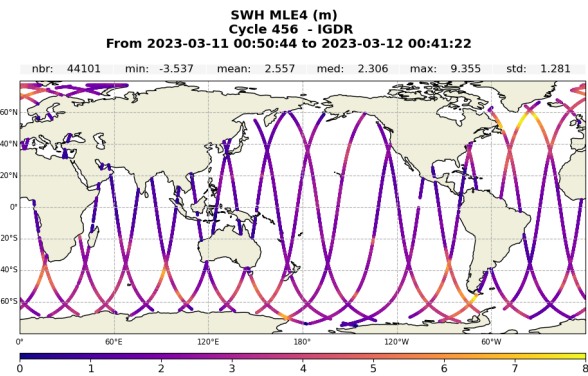
- ❖ Nadir products show very good quality over ocean and hydro
- ❖ Requirements are met
- ❖ Waiting for GDR to confirm the behavior and the final performance
- ❖ Expecting interesting results looking D Day minus D-1 Day

Backup Slides

Nadir Altimetry calibration and validation status

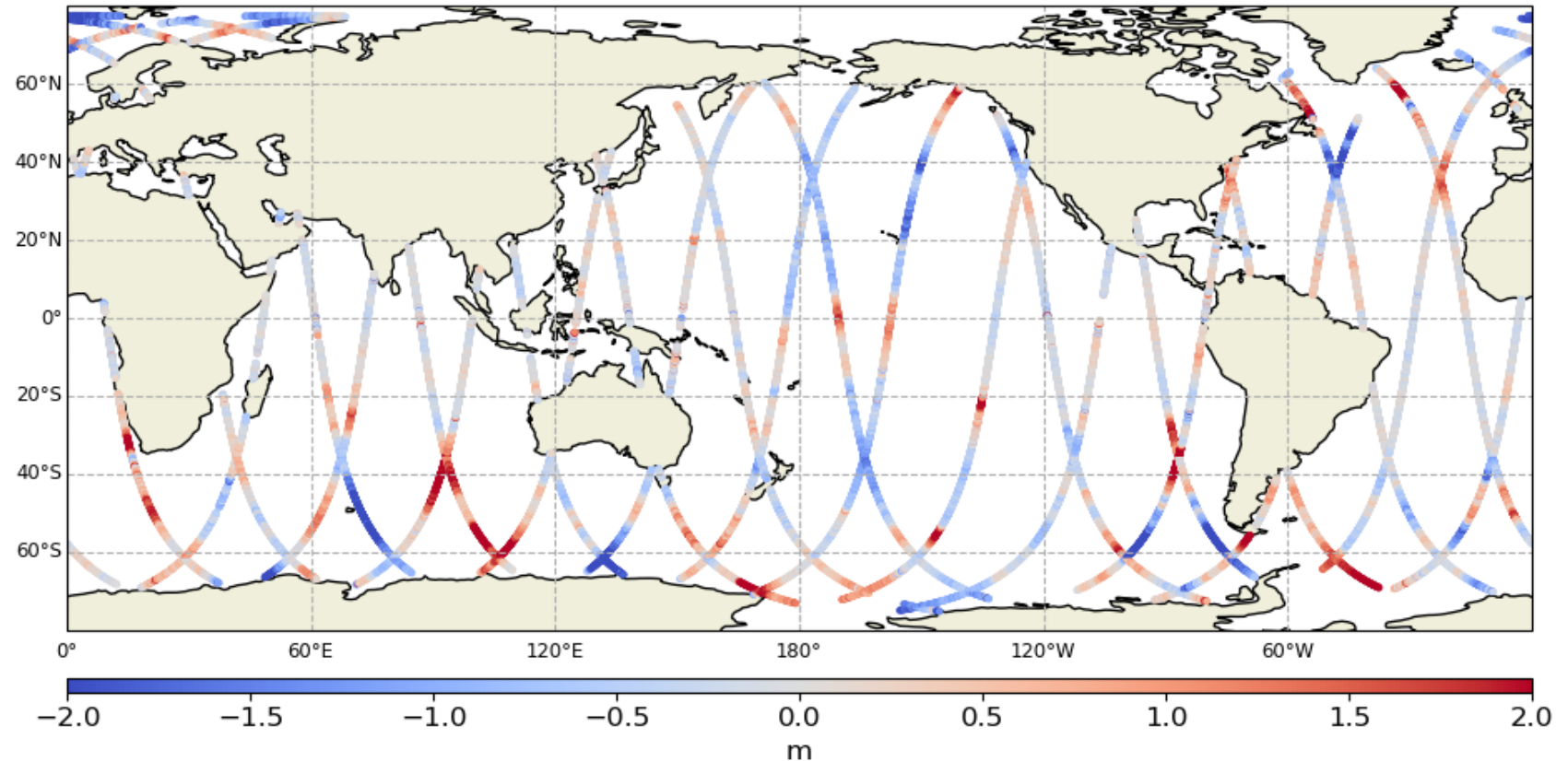
SWH

Difference between Day and Day-1 :
Coherent values with ocean variability



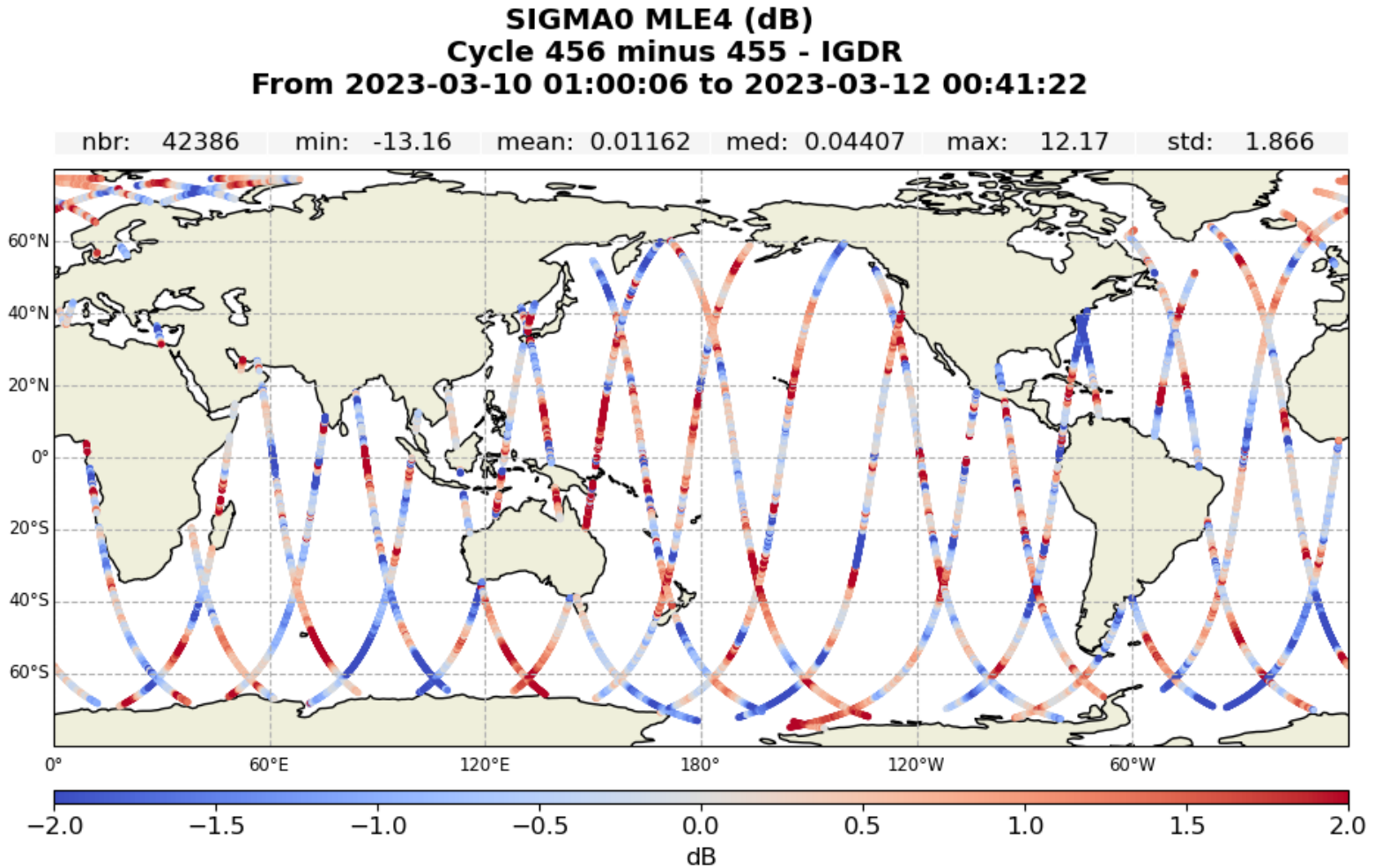
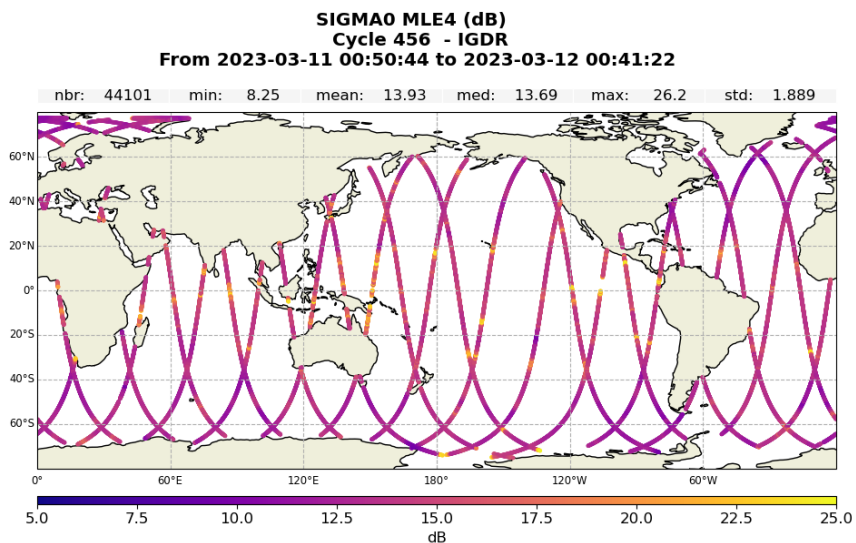
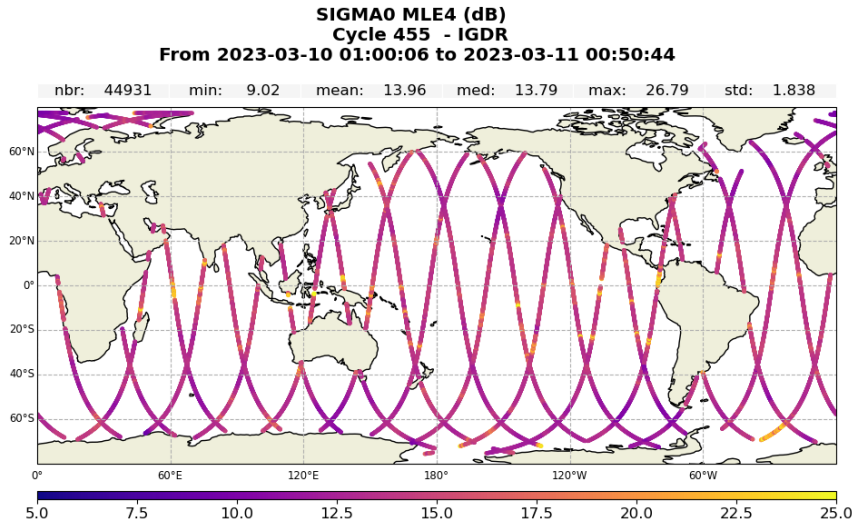
SWH MLE4 (m)
Cycle 456 minus 455 - IGDR
From 2023-03-10 01:00:06 to 2023-03-12 00:41:22

nbr: 42386 min: -5.535 mean: -0.03629 med: -0.05365 max: 4.165 std: 0.8649



Nadir Altimetry calibration and validation status

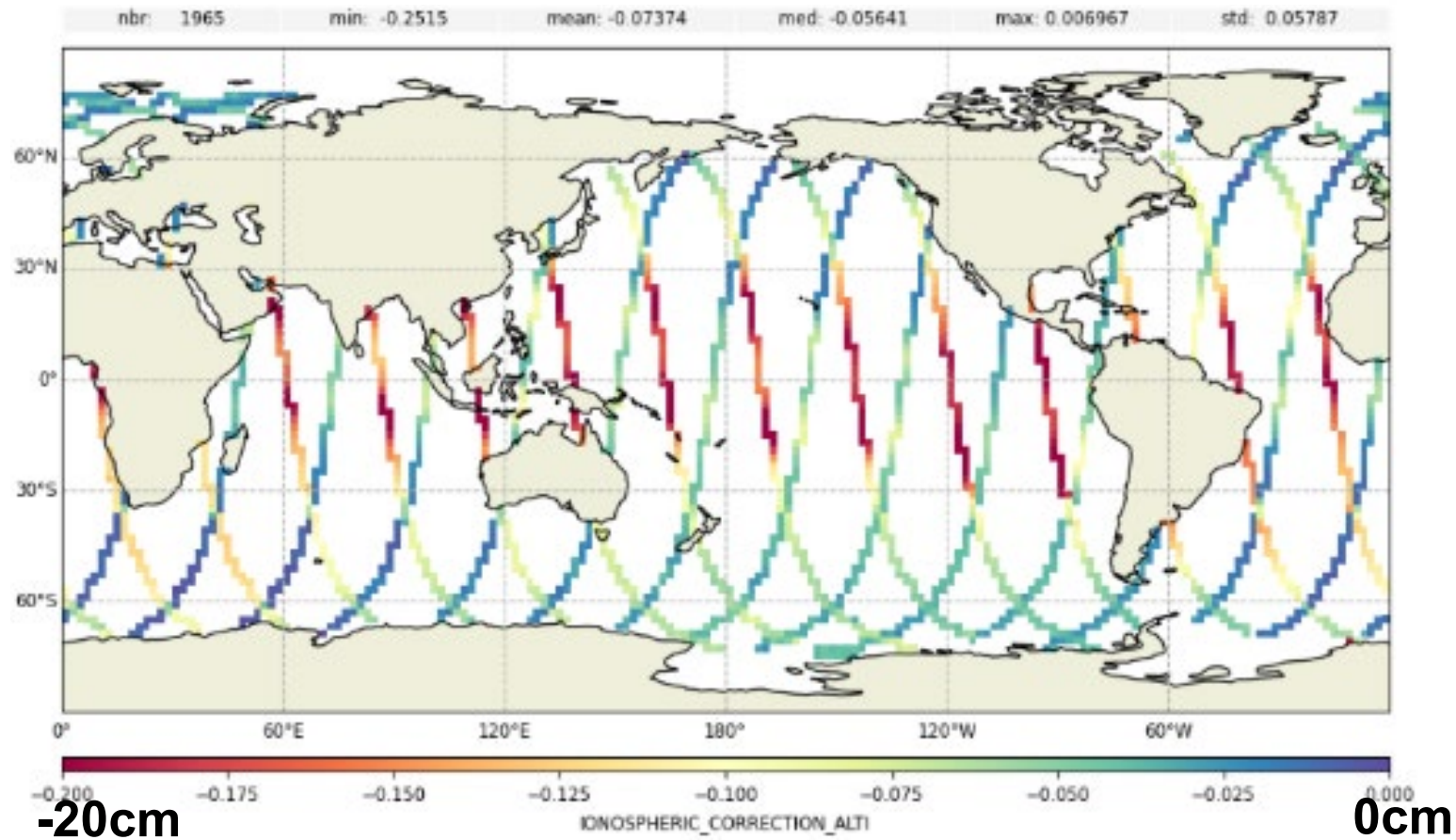
Difference between Day and Day-1



Nadir Altimetry calibration and validation status

Iono Correction

Iono ALTI map



Iono ALTI : expected behavior

Nadir Altimetry calibration and validation status

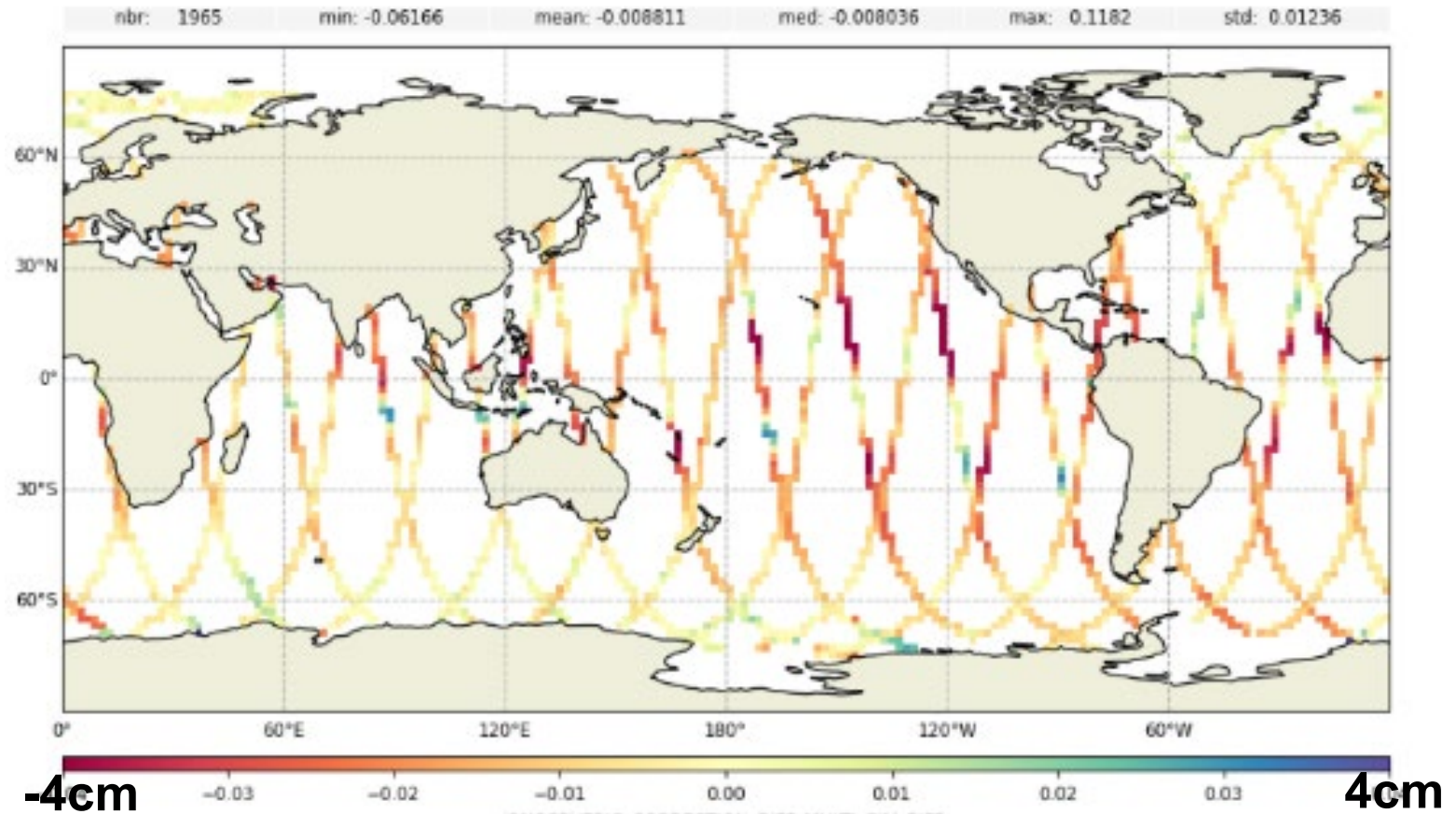
Iono Correction

Iono GIM-ALTI map

Iono GIM – ALTI

- mean : -1cm
- Std : 2cm

Probably linked to the method used for the scaling of GIM → impact on Karin ionospheric correction quality

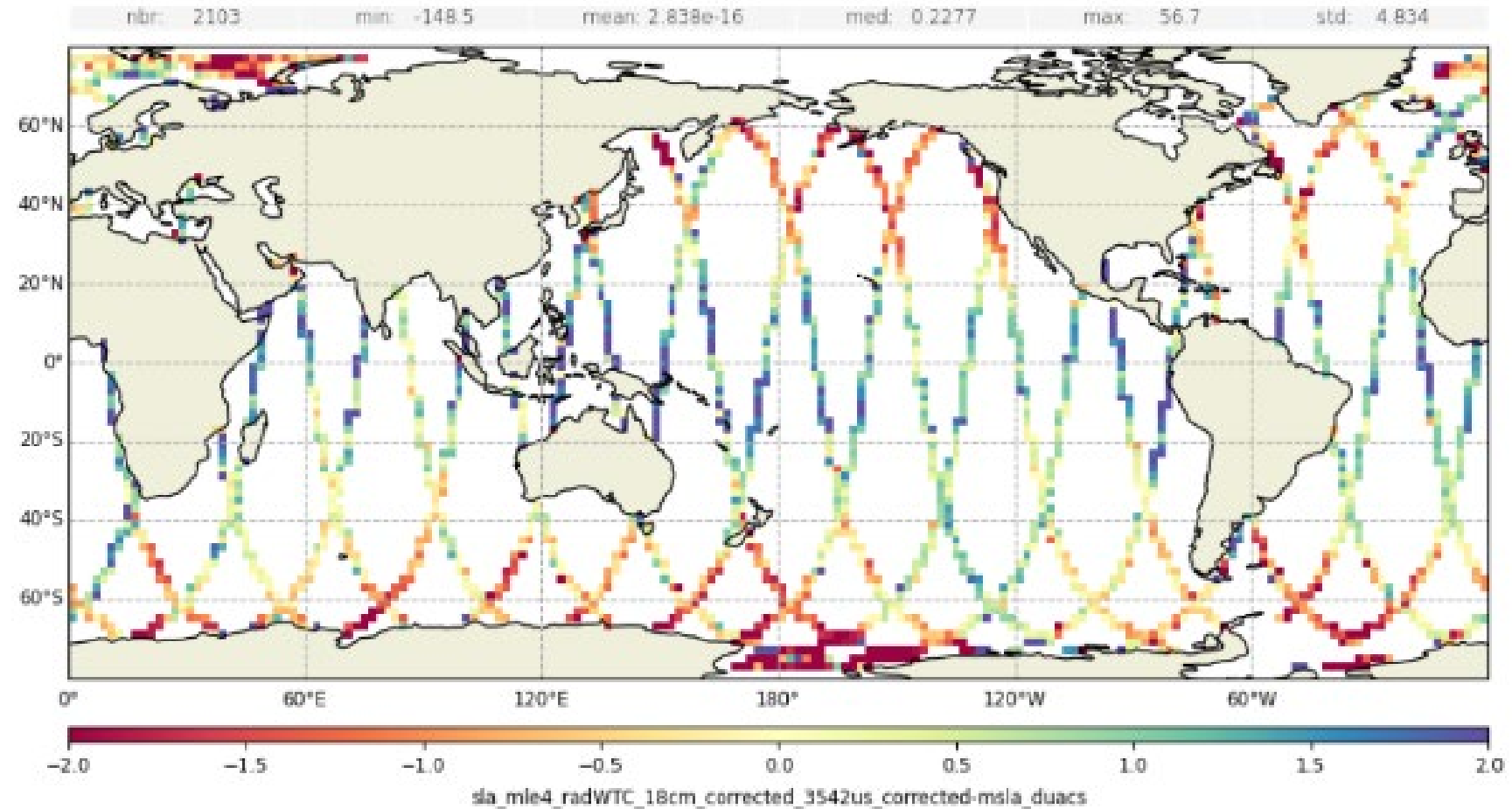


Nadir Altimetry calibration and validation status

SSHA

Map of Swot Nadir SSHA – CMEMS SSHA (before CoG update)

Small wave / latitude
dependence to investigate

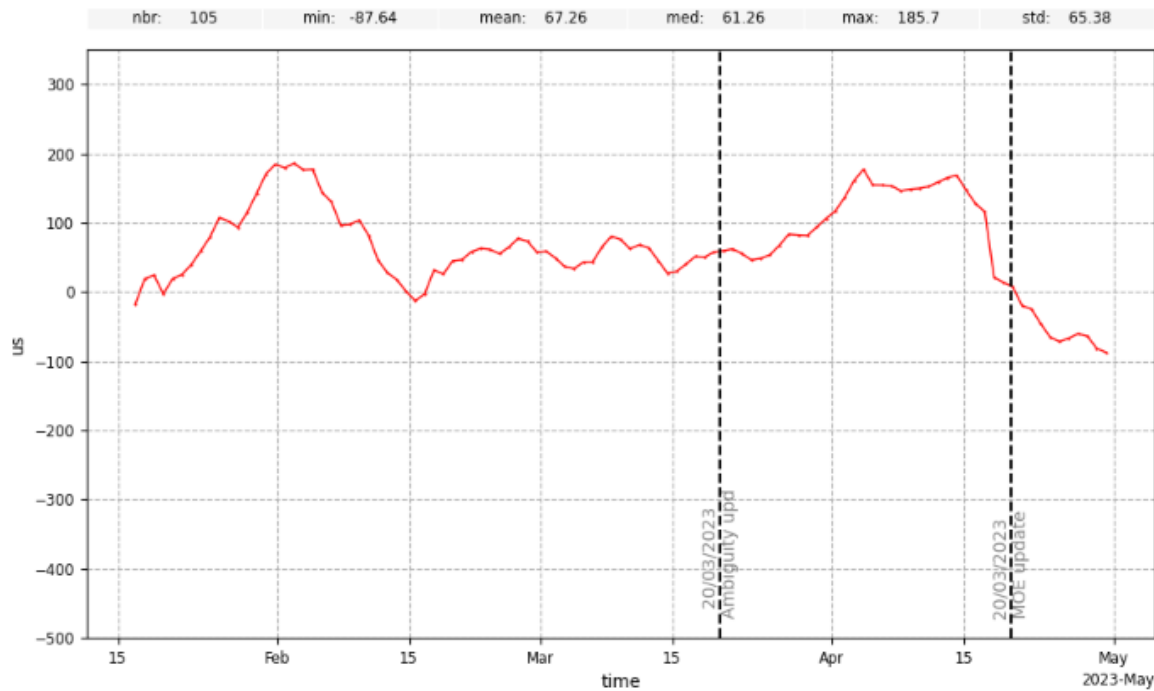


Nadir Altimetry calibration and validation status

Pseudo datation bias

❖ Same order as J3 & S6

Swot Nadir pseudo datation bias (us)



J3 & S6 pseudo datation bias (same scale)

| | nbr | min | mean | med | max | std |
|--------|-----|--------|--------|--------|--------|-------|
| J3 | 256 | -451 | -6.273 | -12.5 | 276 | 104.2 |
| S6A LR | 80 | -224.4 | -23.53 | -21.15 | 312 | 106.8 |
| S6A LR | 1 | -67.13 | -67.13 | -67.13 | -67.13 | 0 |
| S6A HR | 80 | -202 | 27.57 | 32.24 | 326 | 102.7 |

