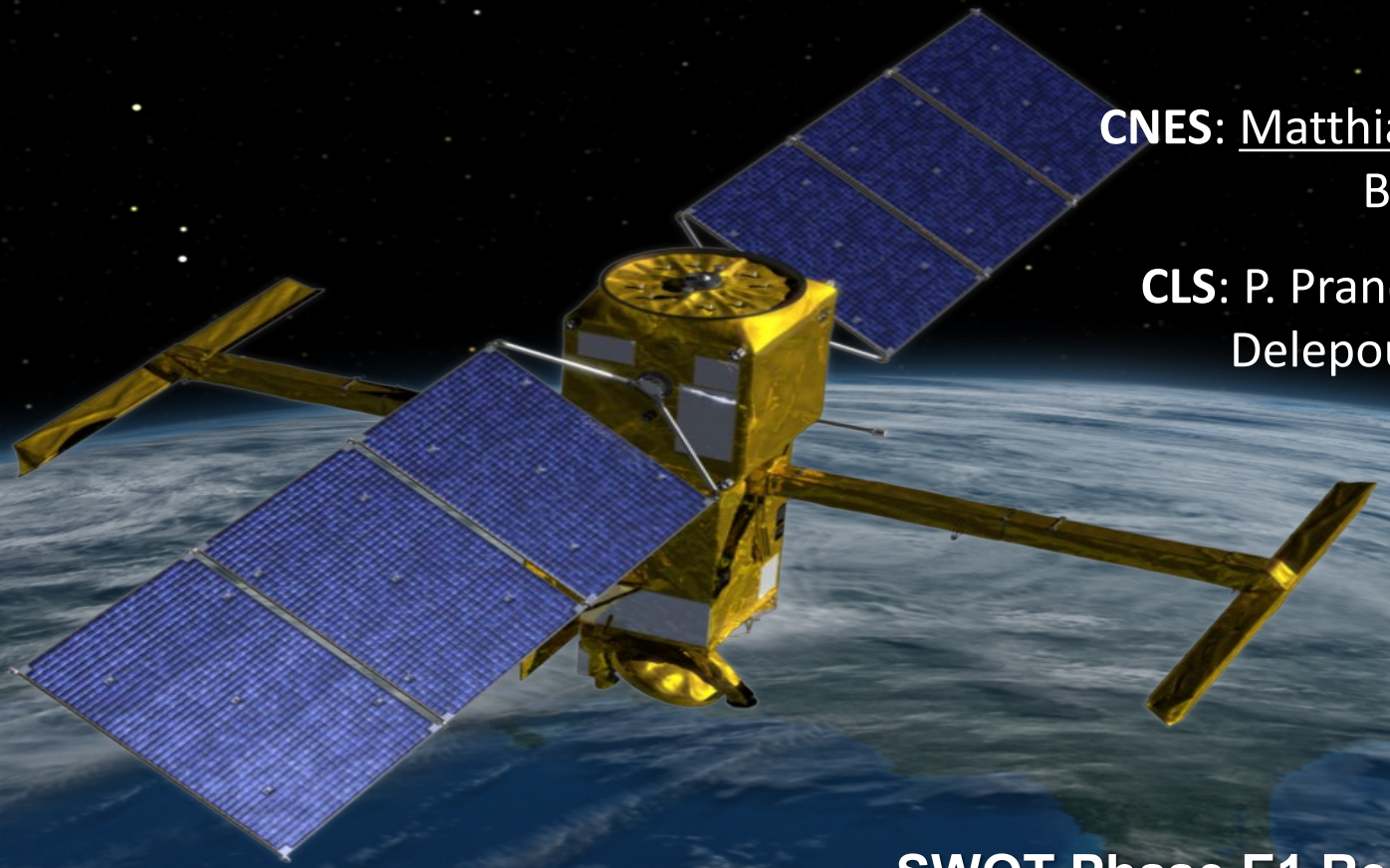


Surface Water and Ocean Topography (SWOT) Mission

September 2023

CNES: Matthias Raynal, G. Dibarboure, A. Bohe, F. Bignalet-Cazalet, N. Picot

CLS: P. Prandi, E. Cadier, F. Nencioli, F. Briol, A. Delepoulle, B. Flamant, M. Denneulin

Fluctus: B. Picard

DATLAS: C. Ubelmann

JPL ADT team

SWOT Phase E1 Results

21-d orbit early CalVal results over Ocean

Overview

- **Some Ocean CalVal results from 1D orbit were presented:**
  - ✓ On Tuesday by A. Bohe for KaRIn L2 LR products
  - ✓ On Wednesday by F. Bignalet-Cazalet on SWOT-nadir IGDR products

- **Overview of early results from 21d orbit and assessment of the continuity with the CalVal orbit.: Do we see any specific changes in terms of data quality ?**

- **Two different orbits, different kind of analyses**
  - ✓ 1D orbit analyses essentially based on the day to day signal evolution
  - ✓ 21D orbit provides a much complete geographical sampling of the open ocean and ease the regional CalVal analyses.

Nadir Altimeter L2 products (L2_NALT) for science orbit

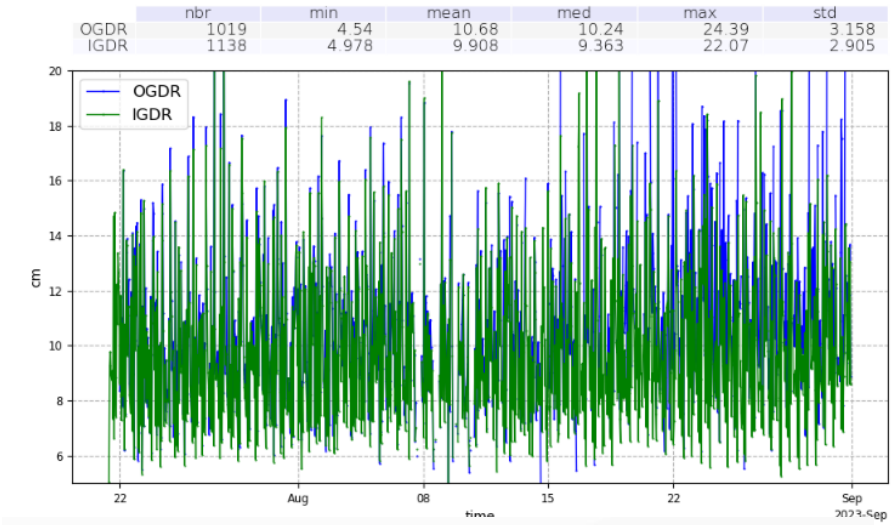
- OGDR (real-time latency) → Available on flow
  - OPR “reduced” → SSHA and limited among of variables
  - OPN “native” → all variables @ 1 Hz and 20 Hz
- IGDR (short time critical) → Available on flow
  - IPR “reduced”
  - IPN “native”
  - IPS “sensor” → also include waveforms
- GDR (no time critical) → Available later in 2023

Nadir preliminary performance over ocean in science orbit

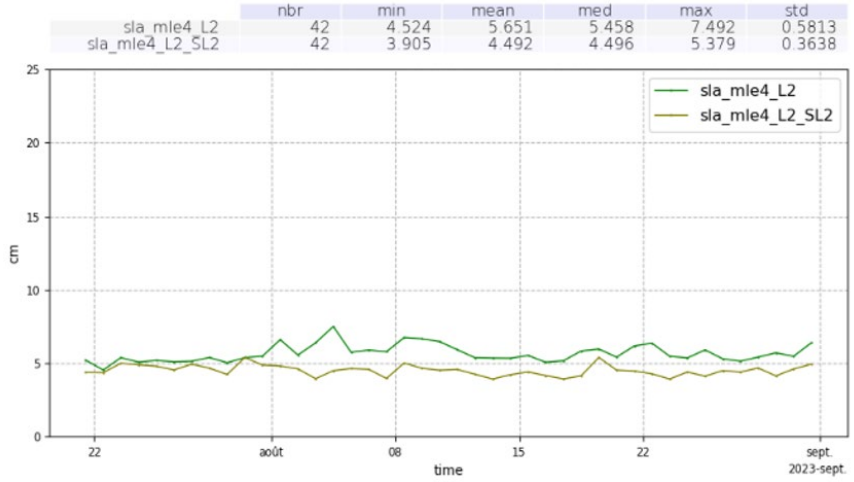
- Very good thermal and stability behavior of POS-3C

- All IGDR metrics are very close to IGDR in Cal/Val orbits
  - STD SLA = 9,9 cm
  - STD (SWOT nadir SLA – DUACS SLA) = 4,4 cm
  - SWOT/SWOT Xovers STD = 5,6 cm
  - SWOT/S6 LR Xovers STD = 5,1 cm

MLE4 SLA STD



SWOT/SWOT Xovers STD



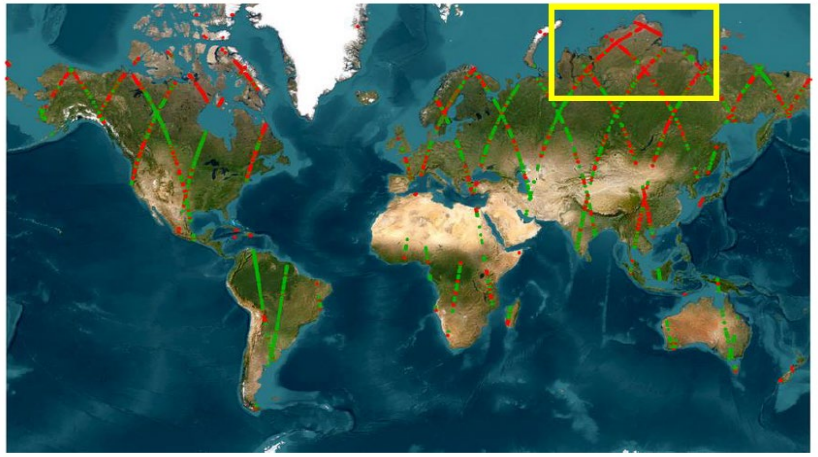
Nadir preliminary performance over hydro targets in science orbit

- POS-3C is in Close-Loop acquisition mode.

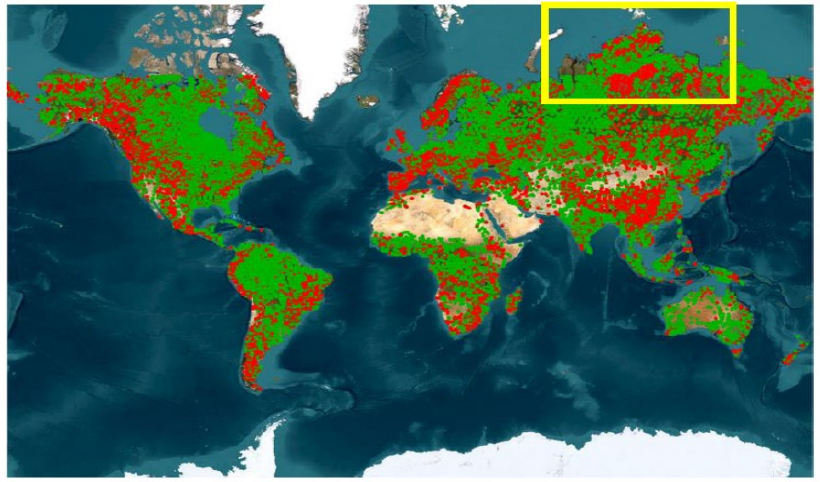
  New DEM for science orbit is upload, it will be activated in coming days.

- Aiready excellent tracking performances observed in CL with more 70% of successful acquisitions over the virtual stations defined.

- Will significantly be improved with OL acquisitions



Cycle N° 427 (Cal/Val phase: 10/02/2023)
% OK: 61,4



Cycle N° 1 (Science phase)
% OK: 71,3

Editing global results over 21d orbit

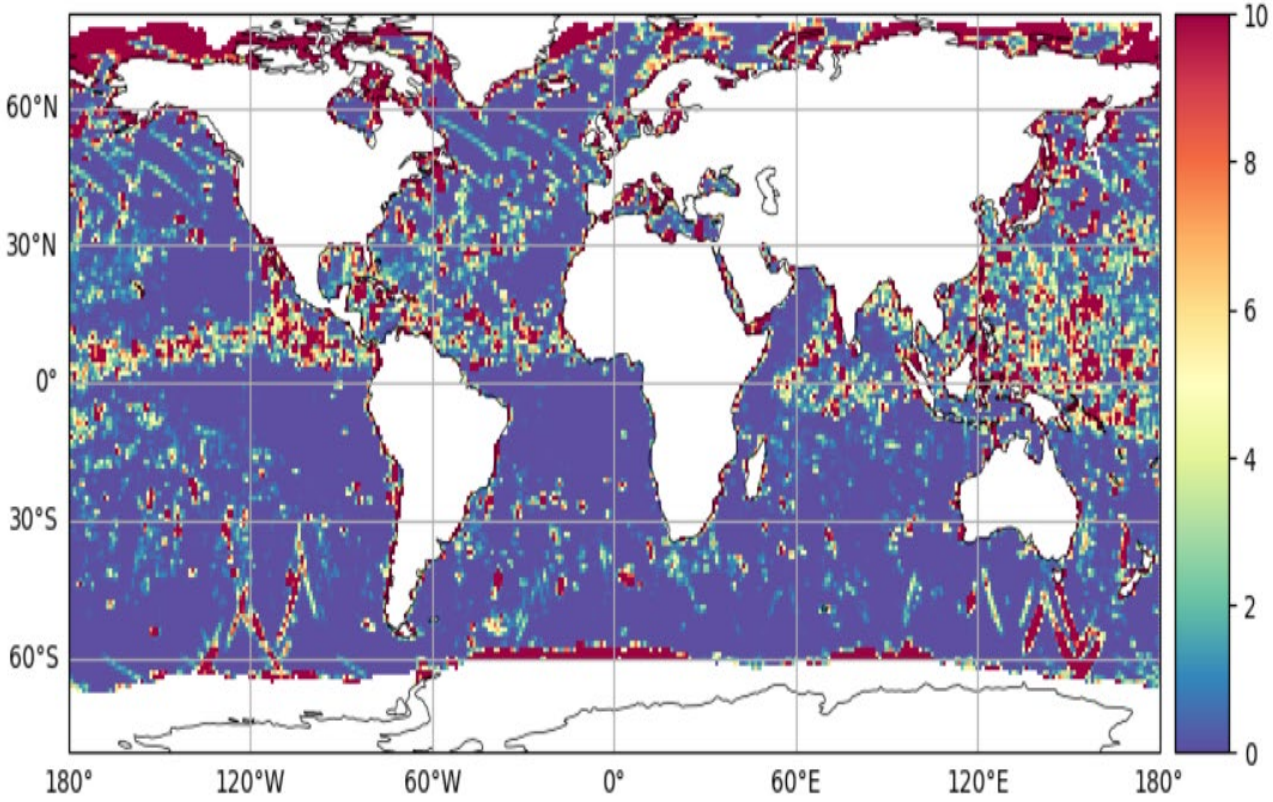
- **Tips:**
  - ✓ Simplest way to select valid measurements is to use ssha_karin(_2)_qual == 0
  - ✓ However some large transects might be edited on « suspect_model_swh_ssb_used » criteria, raised when nadir data is missing or corrupted.
  - ➔ Solution: also includes this byte in the selection.

- **Global percentage of valid data is excellent ~ 96% ➔ close to Jason altimeters metrics (~97%).**

- **Little effect of SWH ➔ KaRIn signal behaves very well over strong sea states,**

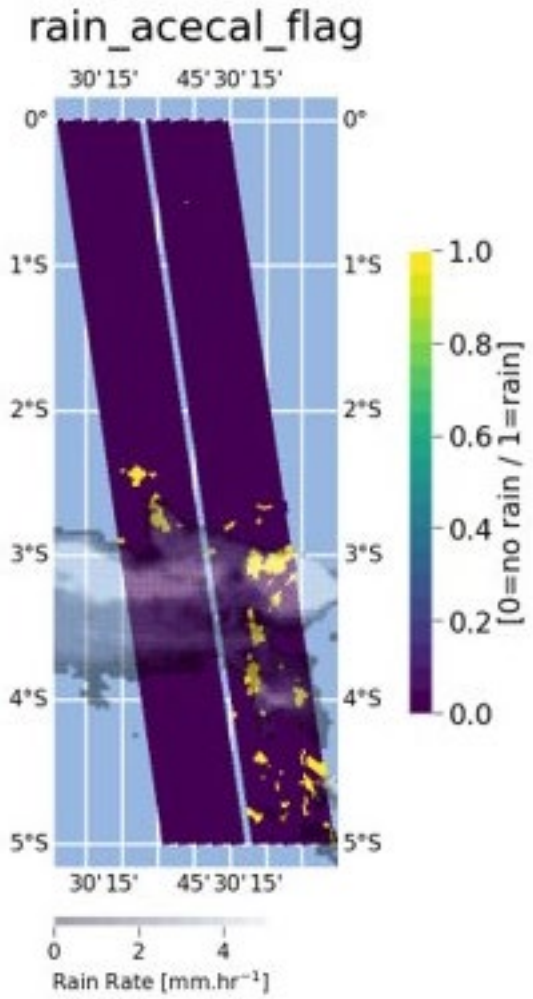
- **Most of the pixels edited are located in heavy rain areas (Ka-band is more rain sensitive than Ku band)**
  - ✓ When SSHA is impacted KaRIn measurements are generally correctly flagged in Ssha_karin_2_qual

- **Further work on the editing strategy is ongoing**
  - ✓ Assess the data quality of measurements flagged as suspect
  - ✓ Use of statistical method

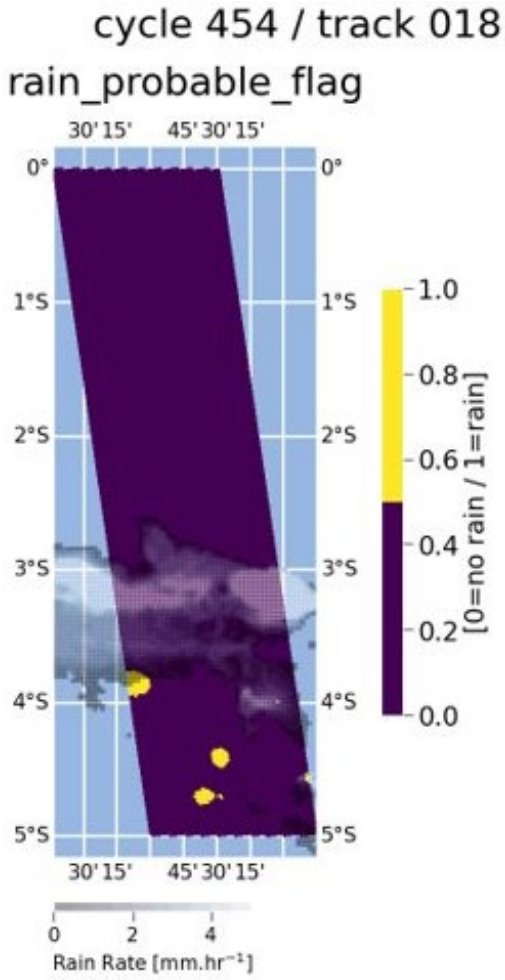


Rain flagging (reminder)

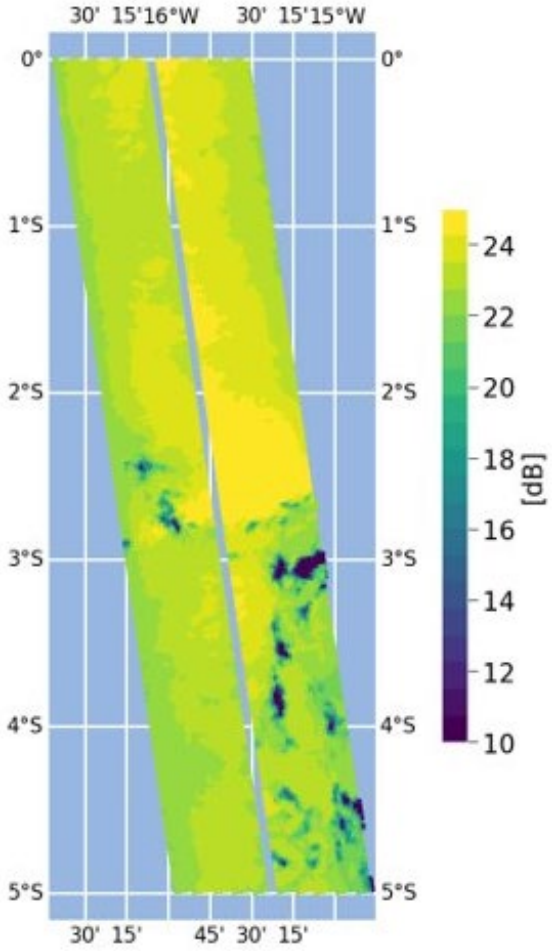
Prototype rain flag



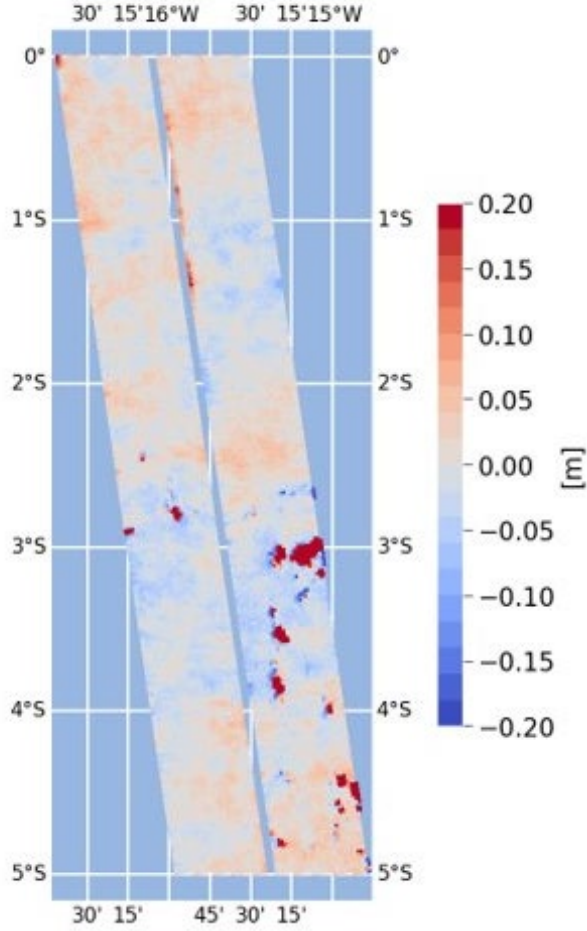
Product rain flag (ECMWF)



KaRIn sigma0

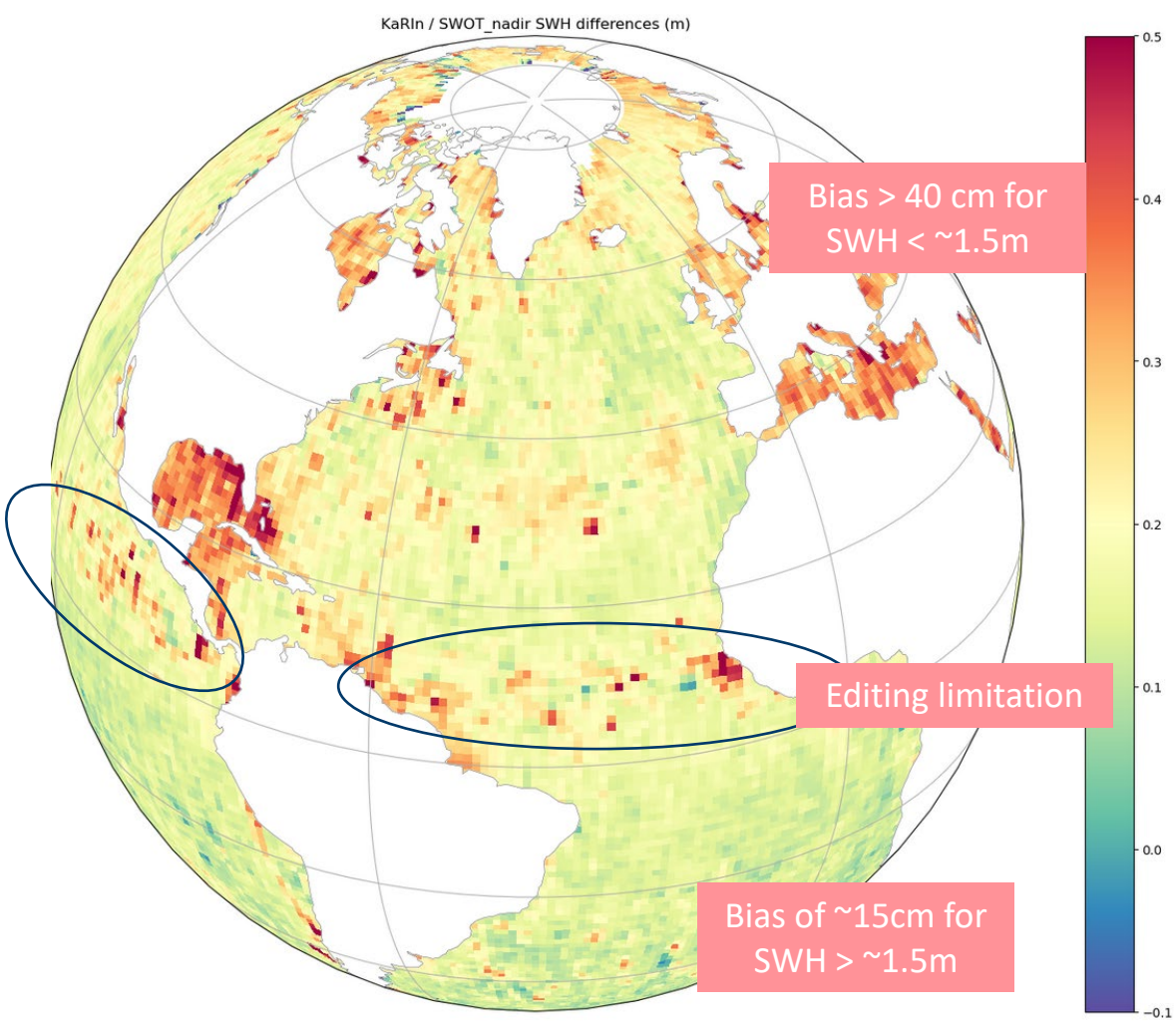


KaRIn ssha



KaRIn & SWOT nadir SWH analysis

Diff KaRIn / SWOT nadir SWH (m)

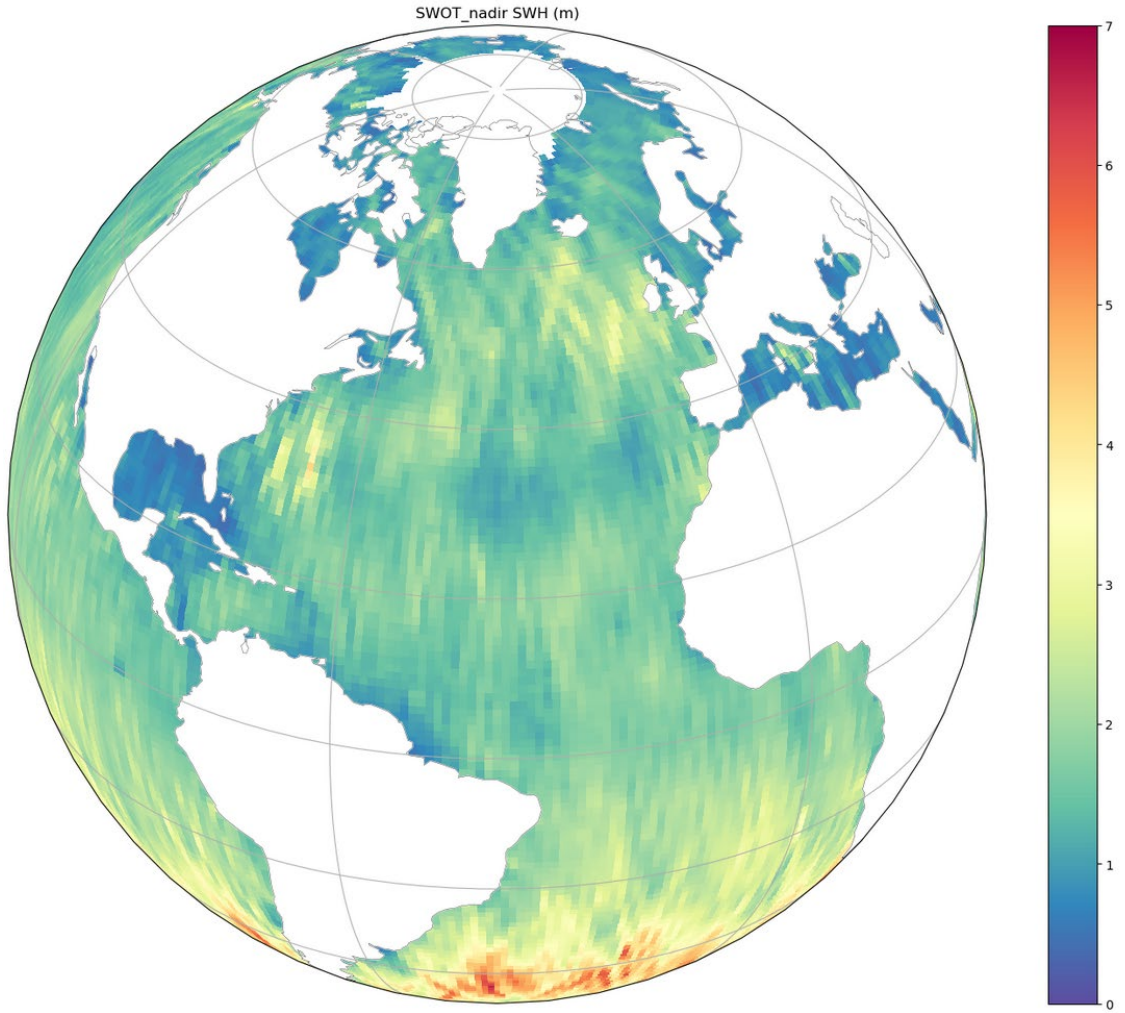


Bias > 40 cm for SWH < ~1.5m

Editing limitation

Bias of ~15cm for SWH > ~1.5m

SWOT nadir SWH (m)



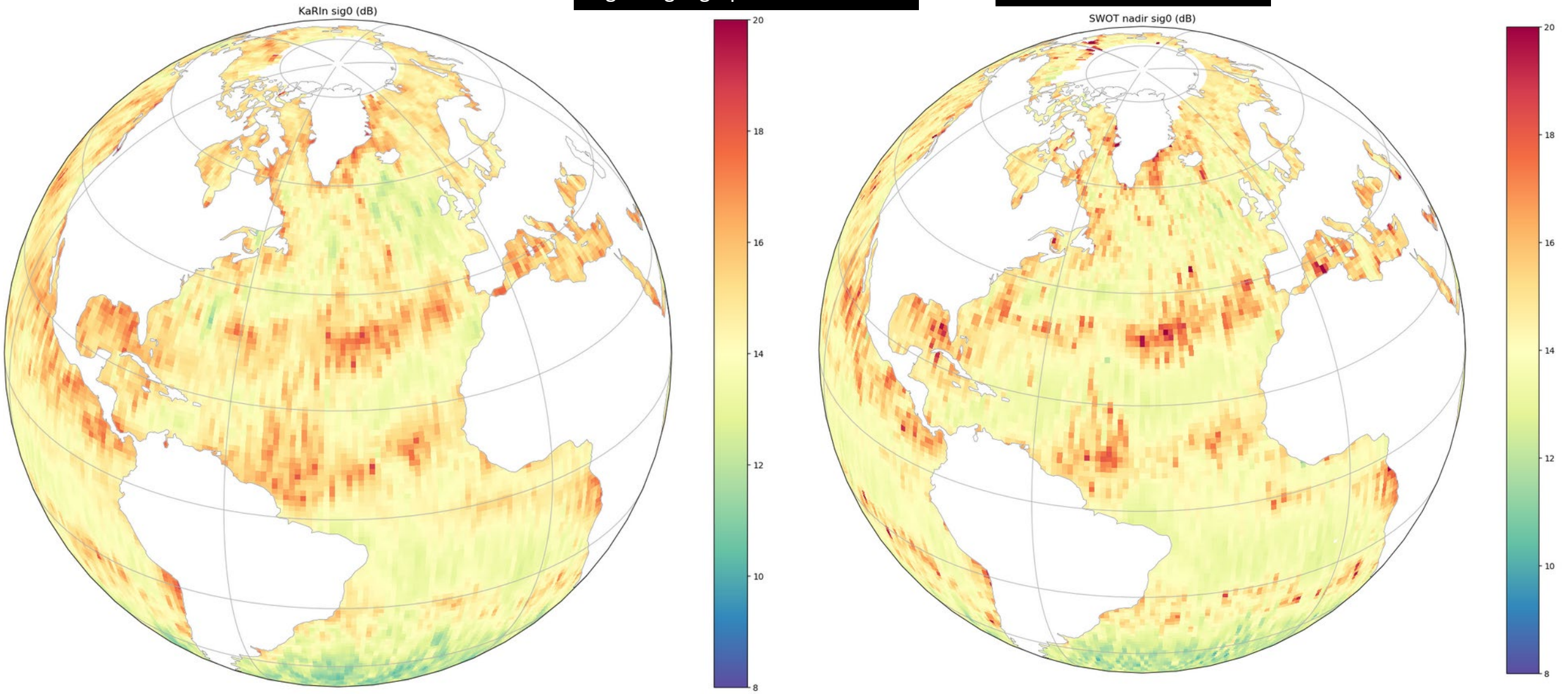
- Improvements expected with future PGE delivery (October) : discussed / presented by A. Bohe in W&W WG

KaRIn & SWOT nadir sigma0 / Wind speed

KaRIn Ka-band (dB)

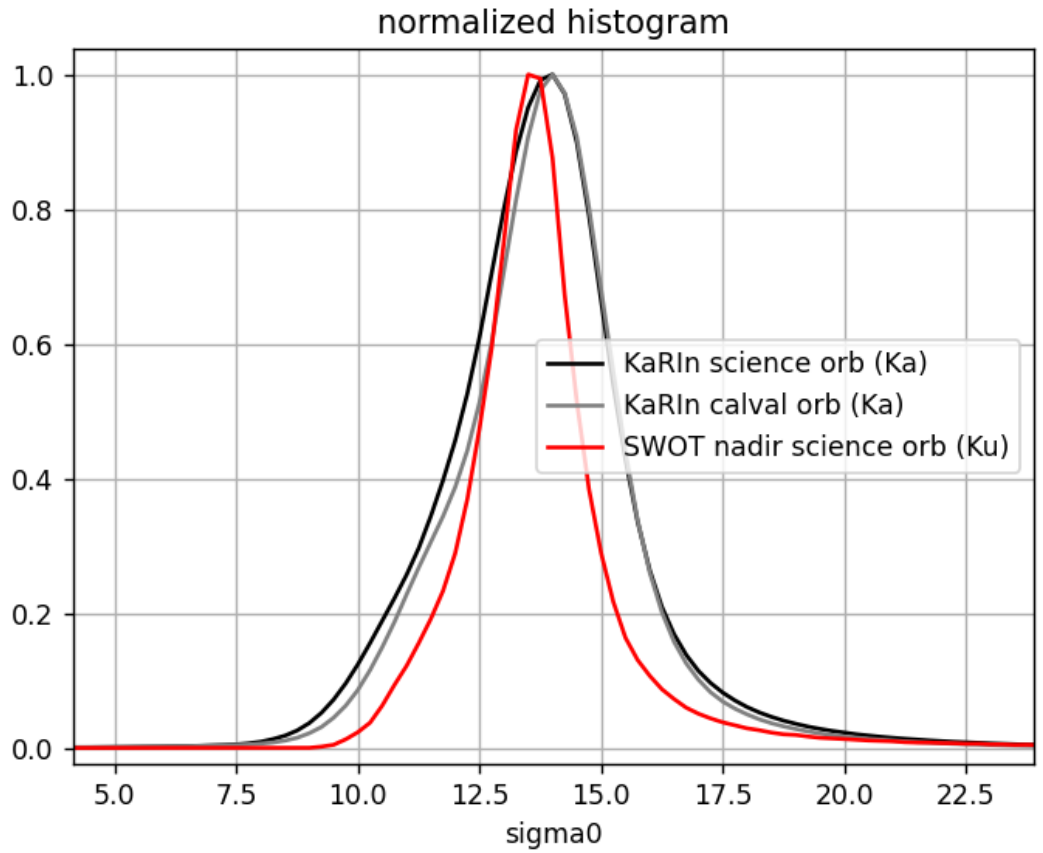
Sigma0 geographical distribution

SWOT nadir Ku-band (dB)

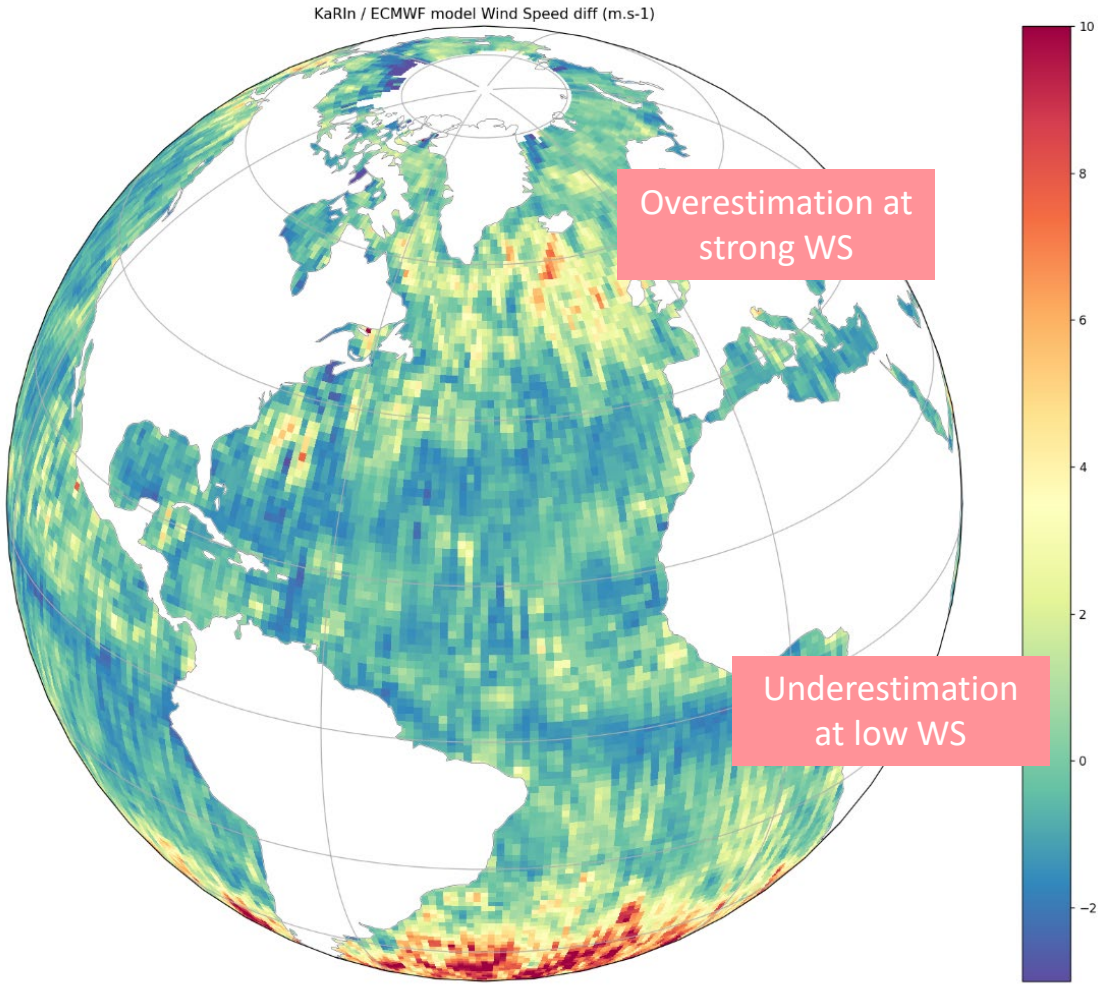


KaRIn & SWOT nadir sigma0 / Wind speed

- Expected wider distribution for Ka band
- Similar behaviour from 1d to 21d orbit



KaRIn / ECMWF Wind Speed differences (m.s-1)



- Pre-launch GMF not accurate enough.
- Improvements expected with future PGE delivery (October) : presented by A. Bohe in W&W WG

AMR analyses

- The two sides are well intercalibrated (below 1 K of biases on the 3 channels)

➔ very small systematic bias on the difference of the WTC (about 0.2 cm)

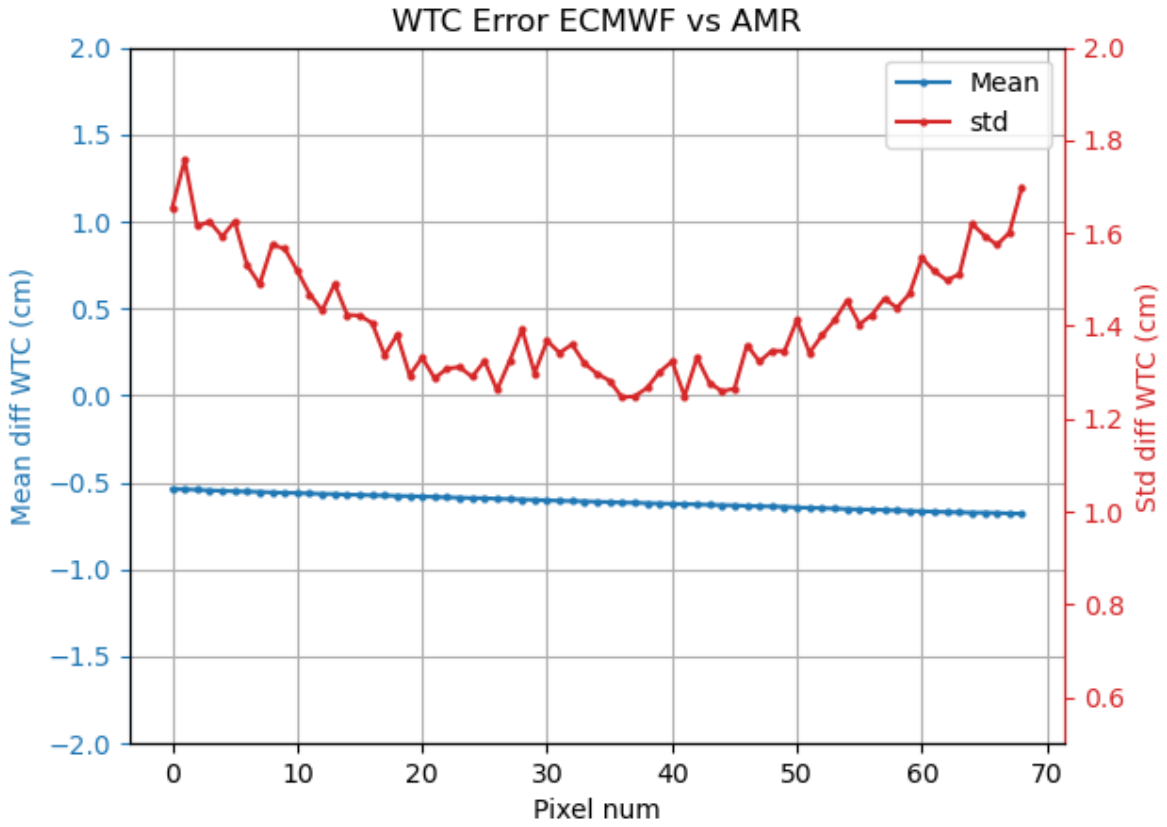
- For about 90% of the AMR-C measurements, no cross-track artificial slope expected for the KaRIn interpolated WTC

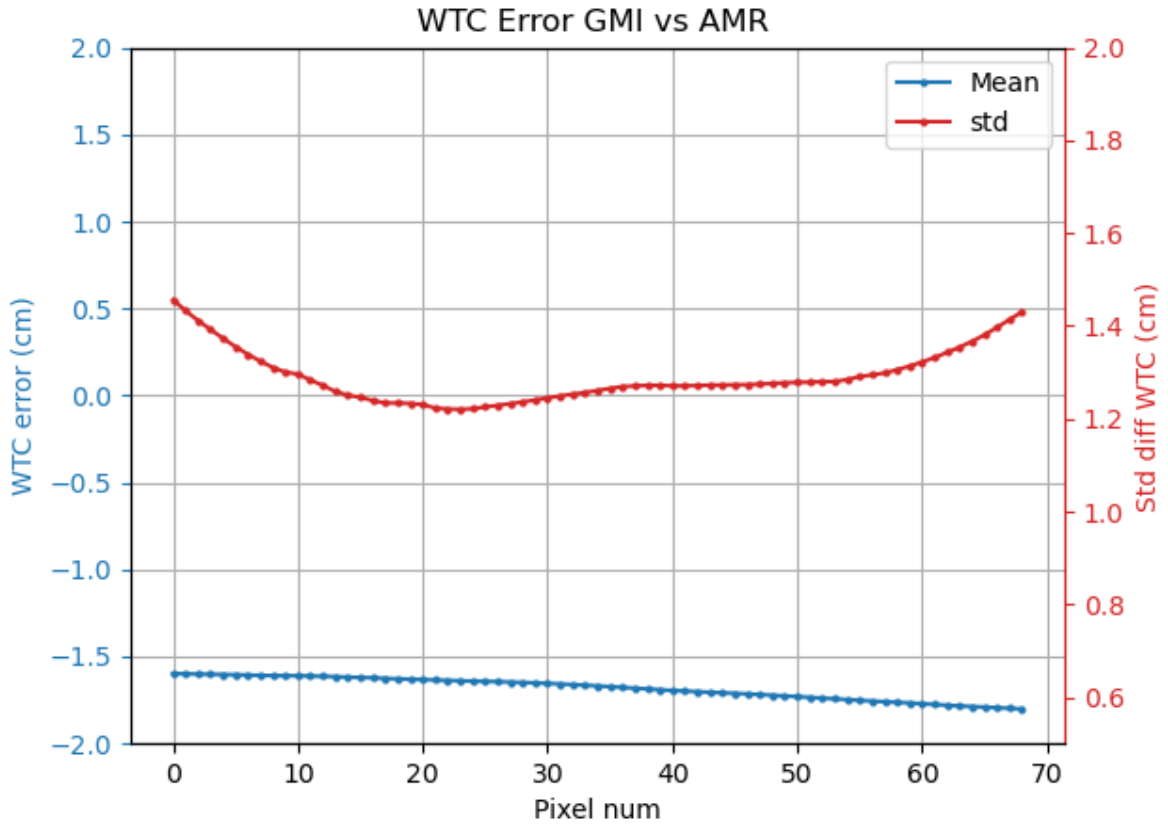
- For about 10% of the open ocean measurements (all sky), a cloudy situation is observed on 1 side only ➔ investigation over the cross-track slope in these specific cases

Nb records = 17 910 524	% of records	DWTC: mean	DWTC: stdev
Side 1 only is contaminated	1.6 %	-0.2 cm	1.4 cm
Side 2 only is contaminated	1.7 %	-0.1 cm	1.6 cm

Nb records = 10 424 087	% of records	ΔWTC: mean	ΔWTC: stdev
Both sides are clear sky	46.5 %	-0.2 cm	1.4 cm
Both sides are cloudy	34.4 %	-0.2 cm	1.6 cm
Side 1 only has LWP > 0	8.1 %	-1.1 cm	1.6 cm
Side 2 only has LWP > 0	11 %	+0.7 cm	1.4 cm
Side 1 only has LWP > 0.01	6.6 %	-1.3 cm	1.7 cm
Side 2 only has LWP > 0.01	8.8 %	+0.8 cm	1.5 cm
Side 1 only has LWP > 0.1	1.8 %	-2.3 cm	2.0 cm
Side 2 only has LWP > 0.1	2.2 %	+1.7 cm	1.9 cm

AMR analyses



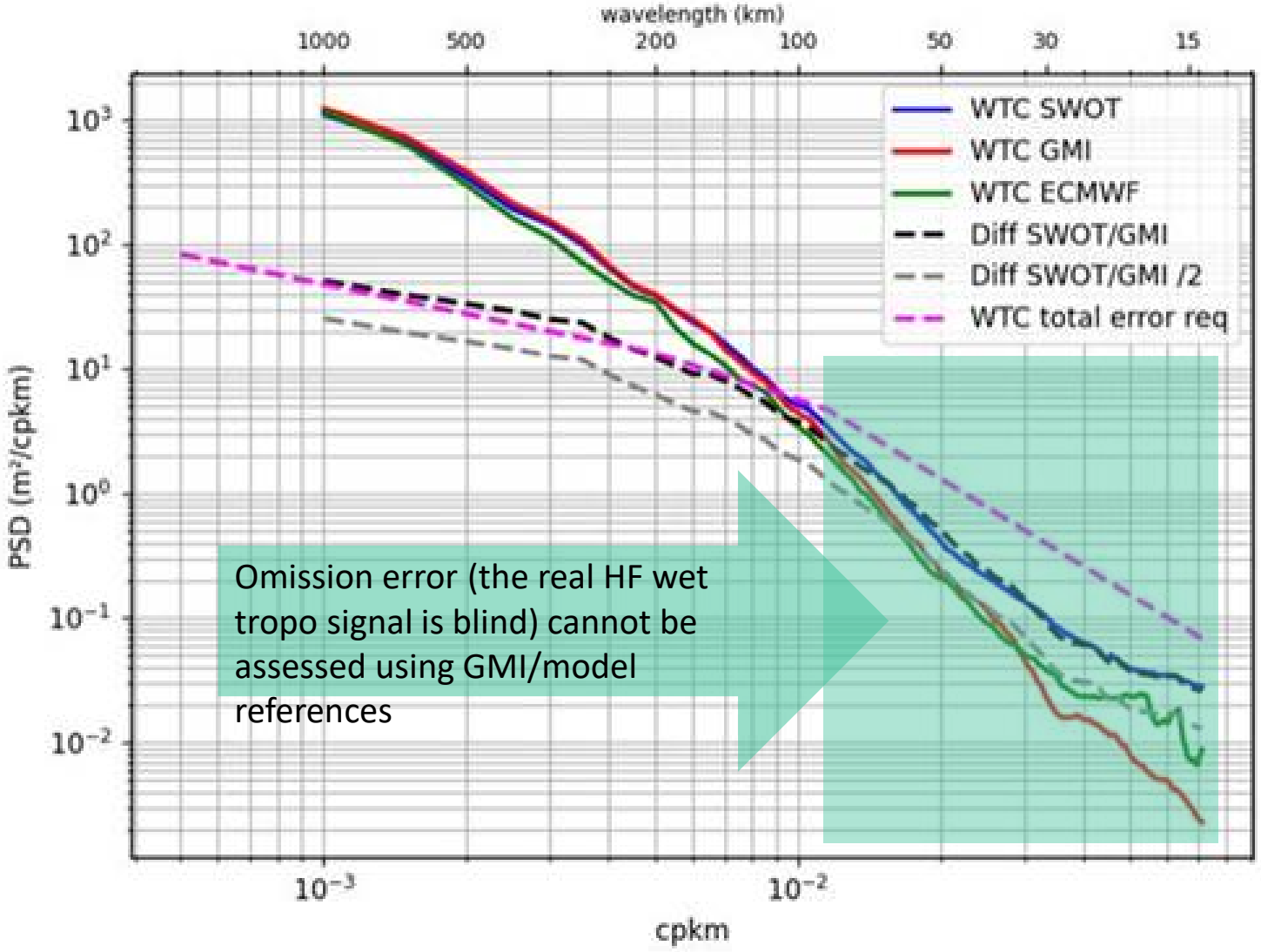


- Very small cross-track bias bias compared to ECMWF & GMI
- Low standard deviation of differences, expected « W » shape observed, with slightly lower errors on the left swath.
- (not shown) SSHA error reduction at KaRIn/KaRIn crossover ~-1.4 cm² (-1.6 cm² for Sentinel-6 MF). To be consolidated with longer time series

AMR analyses

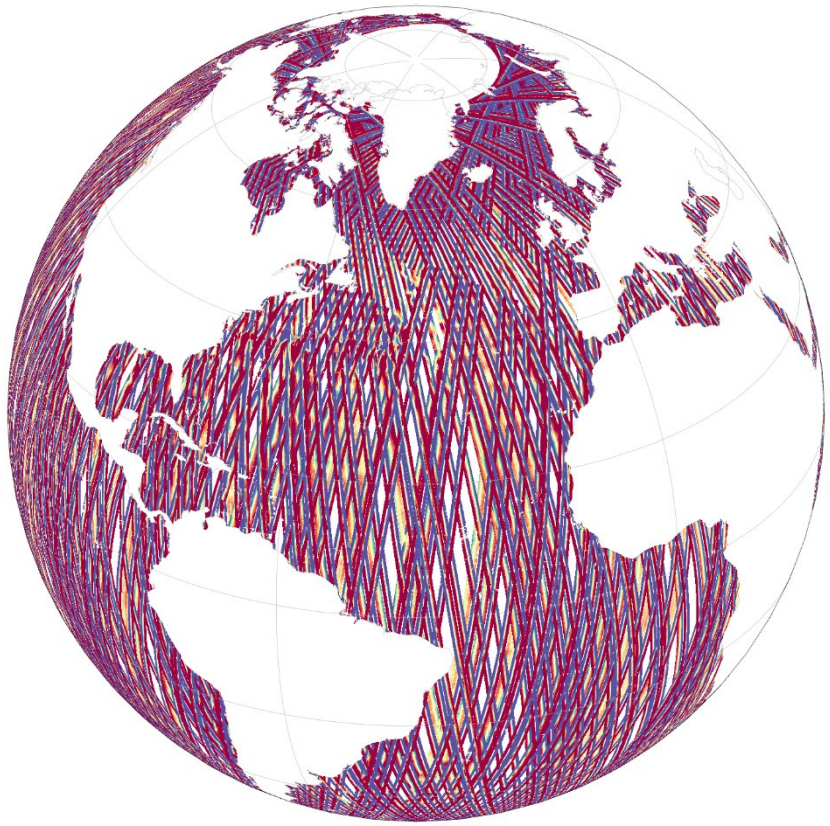
- **Good agreement between the 3 variables above 100 km wavelengths (model has lower energy).**
- **GMI & ECMWF content at HF is lower : explained by the products spatial resolution**
- **Comparison between SWOT WTC vs GMI shows very encouraging results:**
  - ✓ consistent with / below requirements allocation for wavenumbers > 100 km
  - ✓ Below hundred of km: SWOT WTC missed a part of the WTC signal (interpolation + beam resolution). The GMI reference is too smooth to quantify this omission error.

➔ Need higher spatial resolution reference.

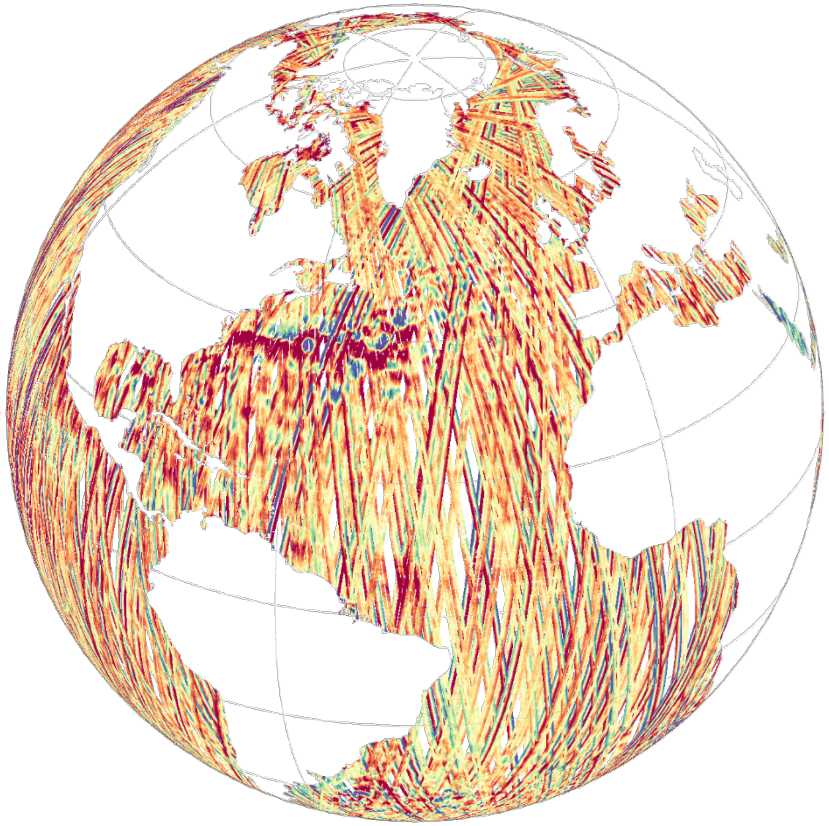


KaRIn SSHA analysis

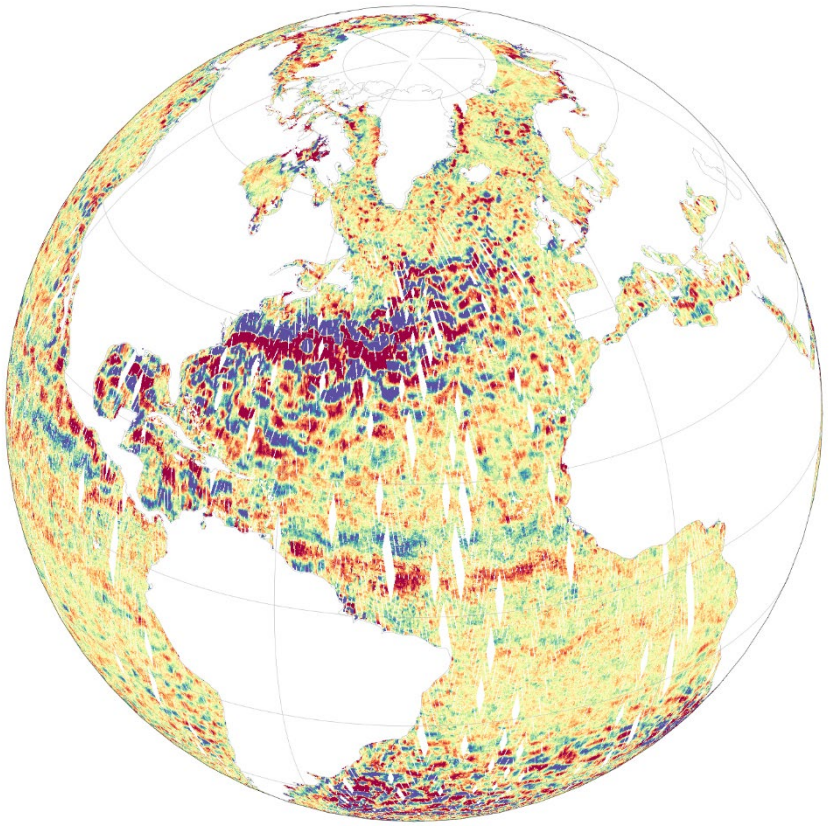
Ssha_karin_2



Ssha_karin_2 + height_cor_xover



Ssha_karin_2 high pass filter (< 1000km)



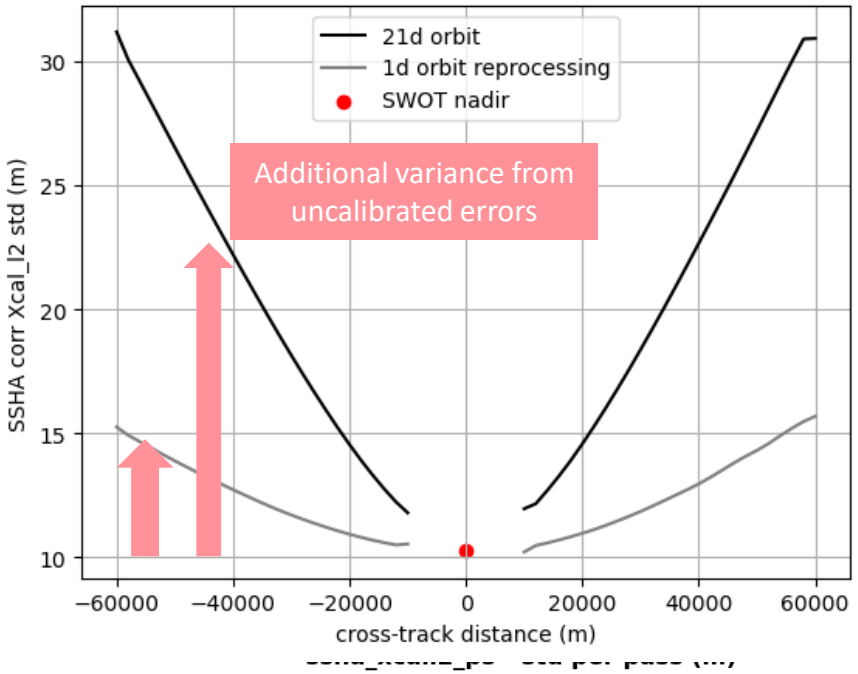
- **REMINDER:**
  - ✓ L2 SSHA long wavelengths are affected by « systematic errors » (e.g. from roll error knowledge)
  - ✓ The « crossover » correction will remove most of this error (see G. Dibarboure presentation)
  - ✓ Below1000 km, these systematic errors are much smaller than the oceanic signal

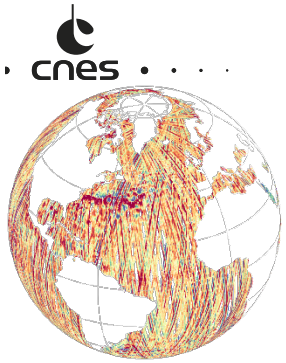
KaRIn SSHA analysis

- Improved performances were expected for 21d orbit (more crossovers, better geographical sampling)

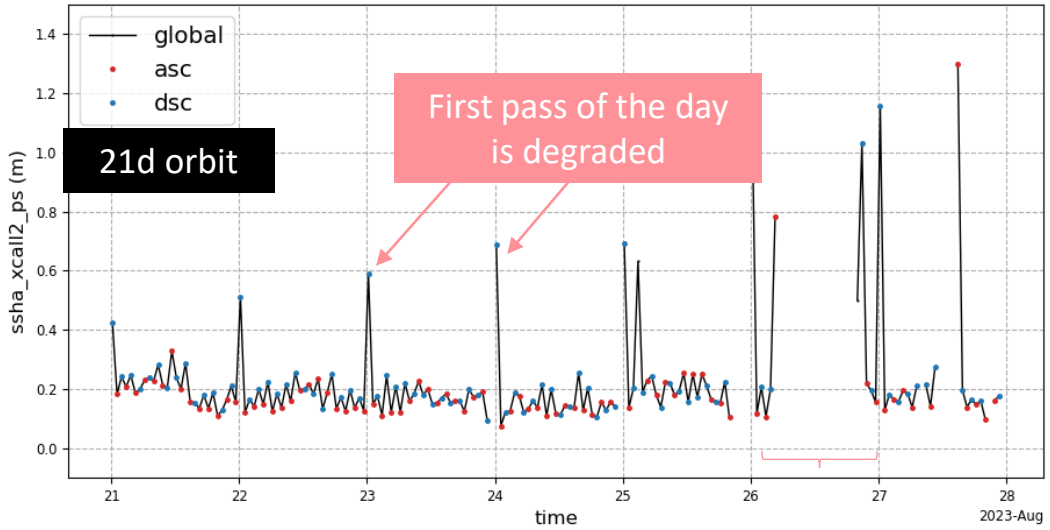
- Corrected SSHA variance is higher than expected:
  - The V4.2 XoverCal is tuned for 1d orbit (implemented in June 2023).
  - Some limitations were found (see G. Dibarboure dedicated presentation)

➔ Correction and deployment of XoverCal V4.3 in October.





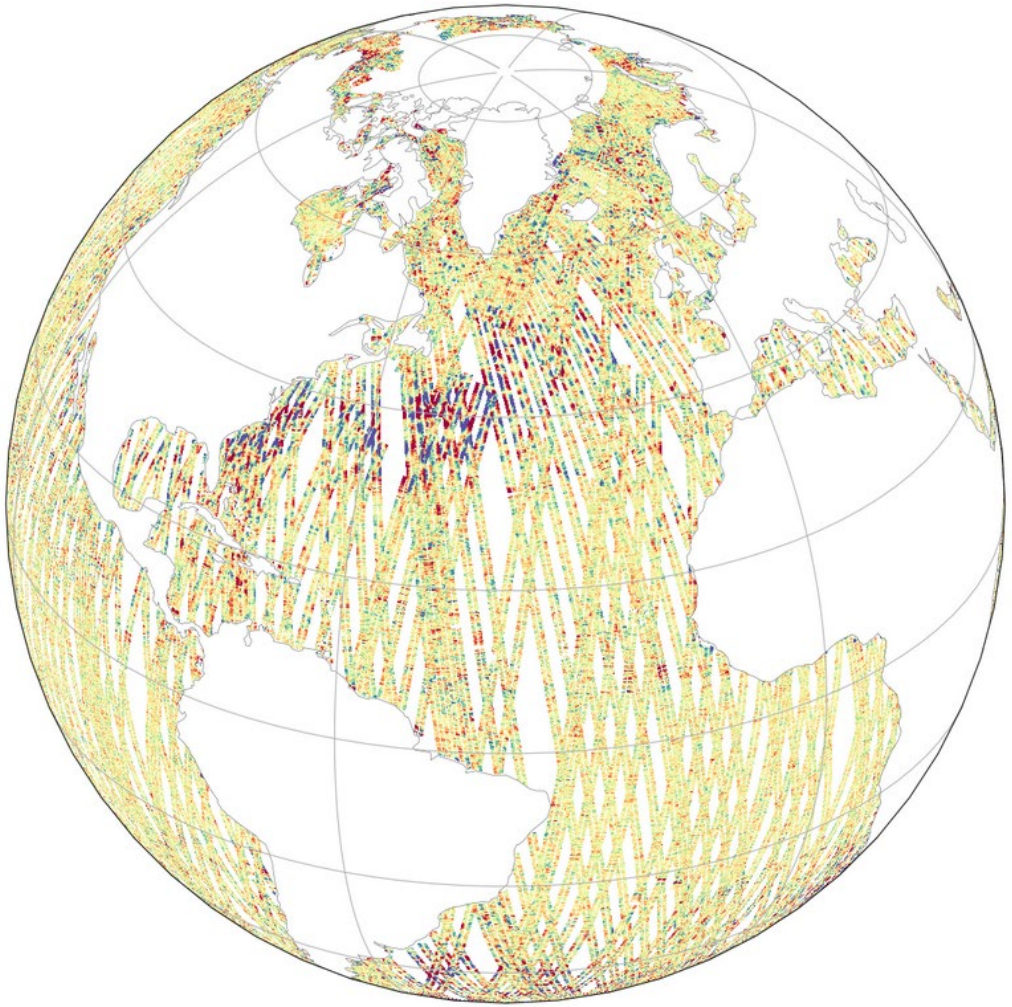
	nbr	min	mean	med	max	std
global	166	0.07548	0.219	0.1787	1.297	0.1796
asc	80	0.07504	0.1834	0.1549	1.297	0.1496
dsc	84	0.0944	0.2445	0.1964	1.156	0.1941



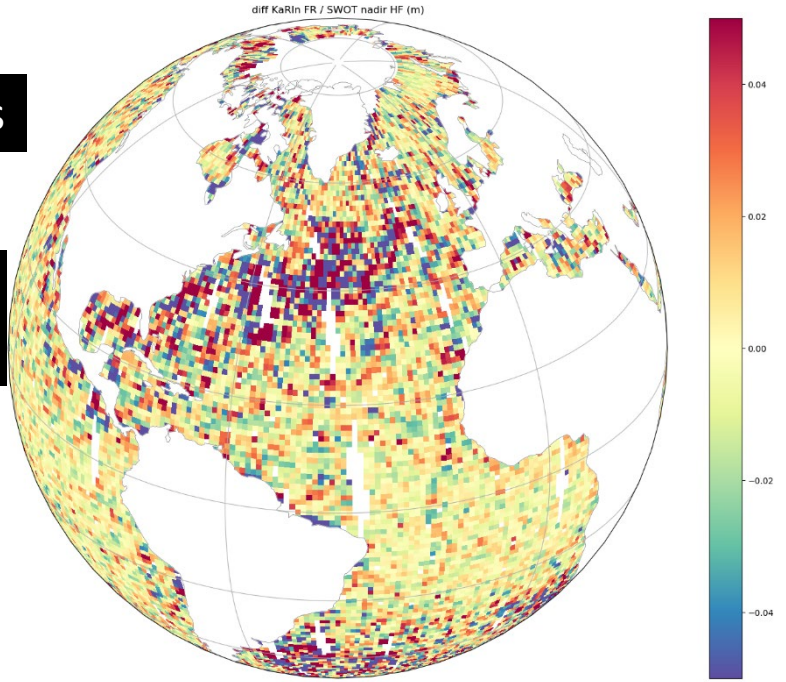
KaRIn SSHA analysis: High pass filtered SSHA

KaRIn / SWOT nadir « HF » (below 1000km) SSHA differences

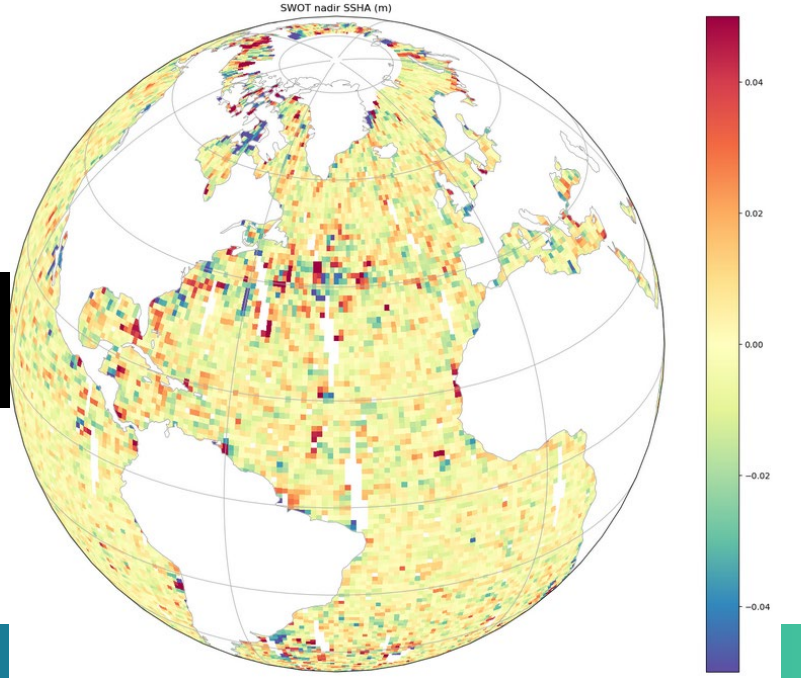
Along-track illustration (no



Far range selection
Geographical binning



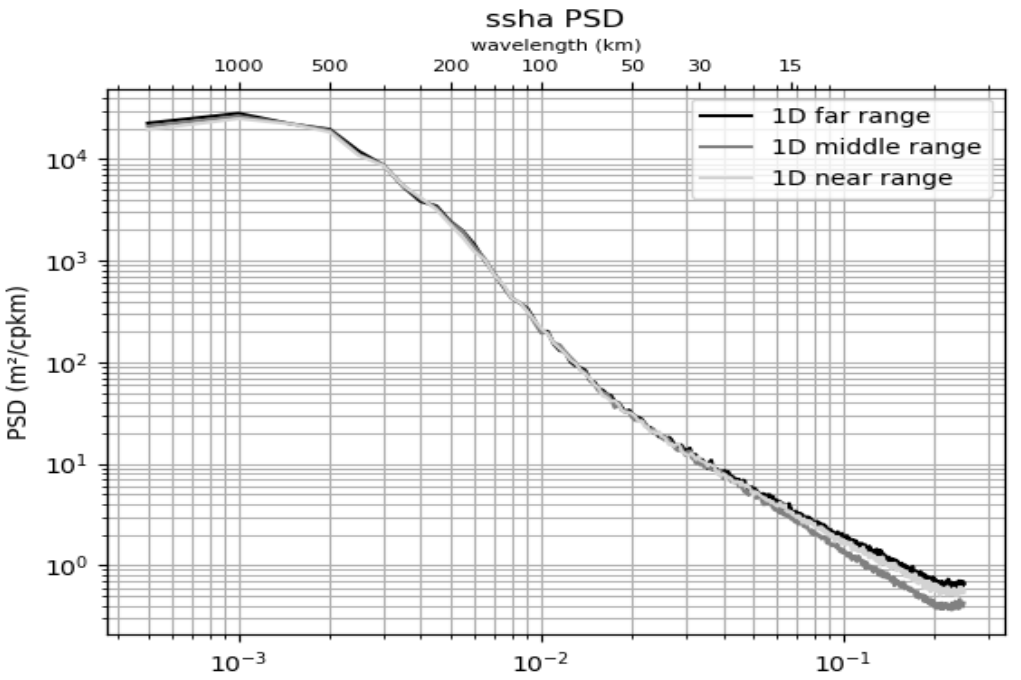
Near range selection
Geographical binning

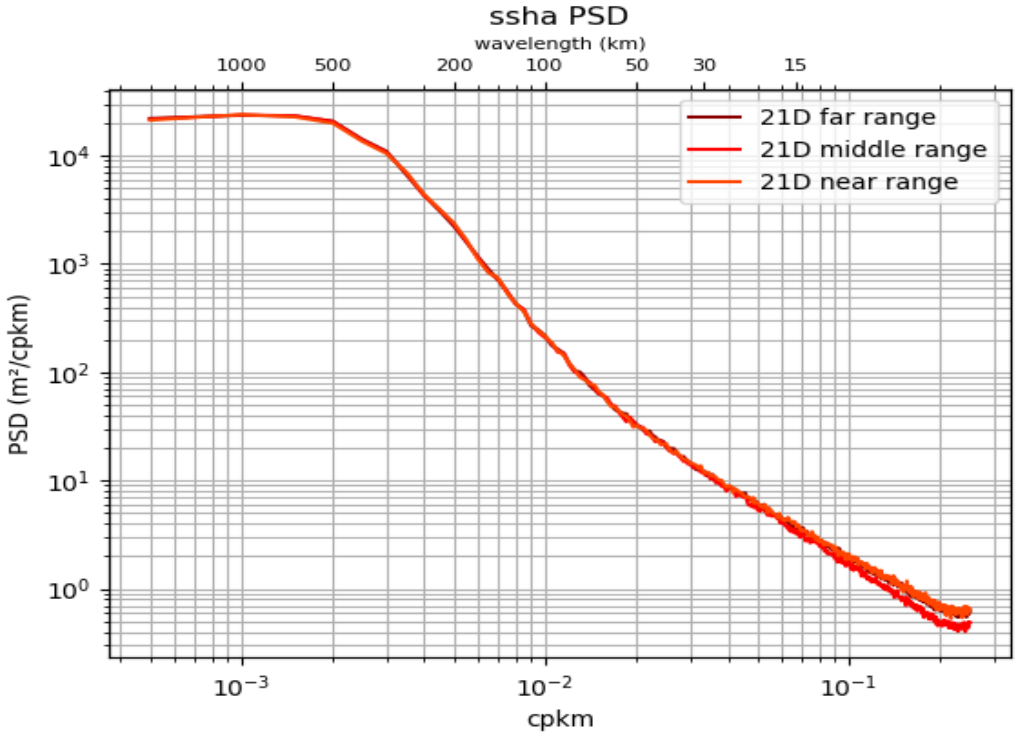


SSHA PSD

- **Very similar spectral behaviour from 1day orbit to 21day orbit**
  - ✓ Ocean & wave conditions sampled are not exactly similar.

- **Small change observed at High frequencies comparing far,near and middle range psds**
  - ✓ Possibly explained by the altitude change
  - ✓ Sampling area
  - ✓ Sea states conditions



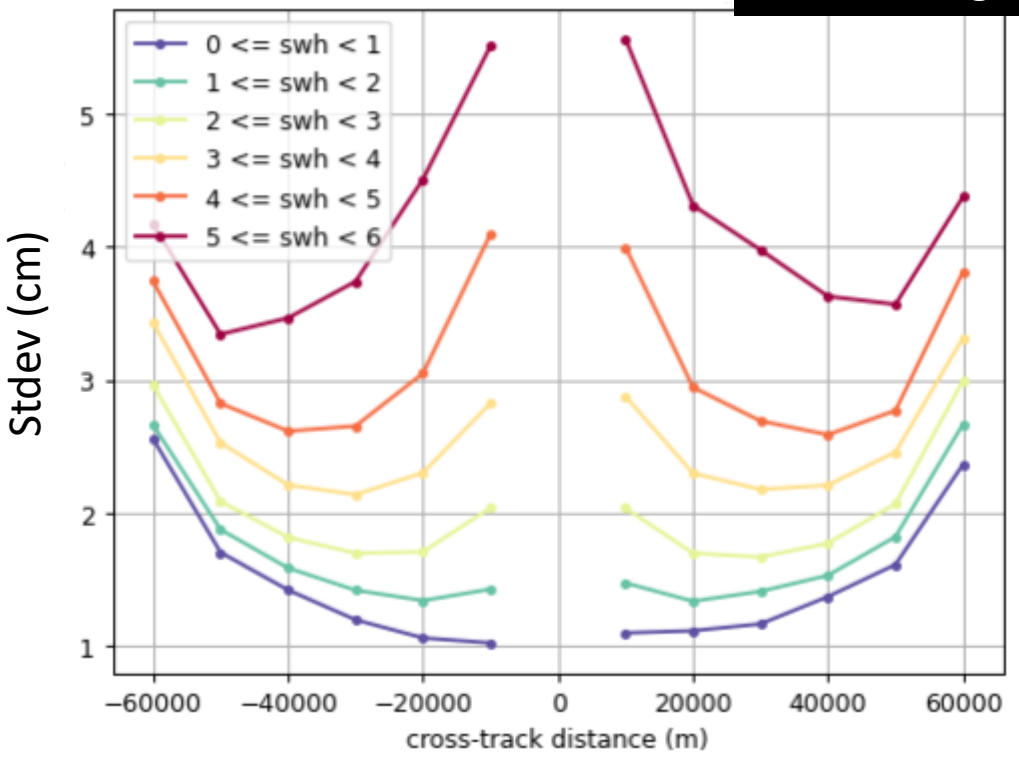


SSHA PSD & HF Signal

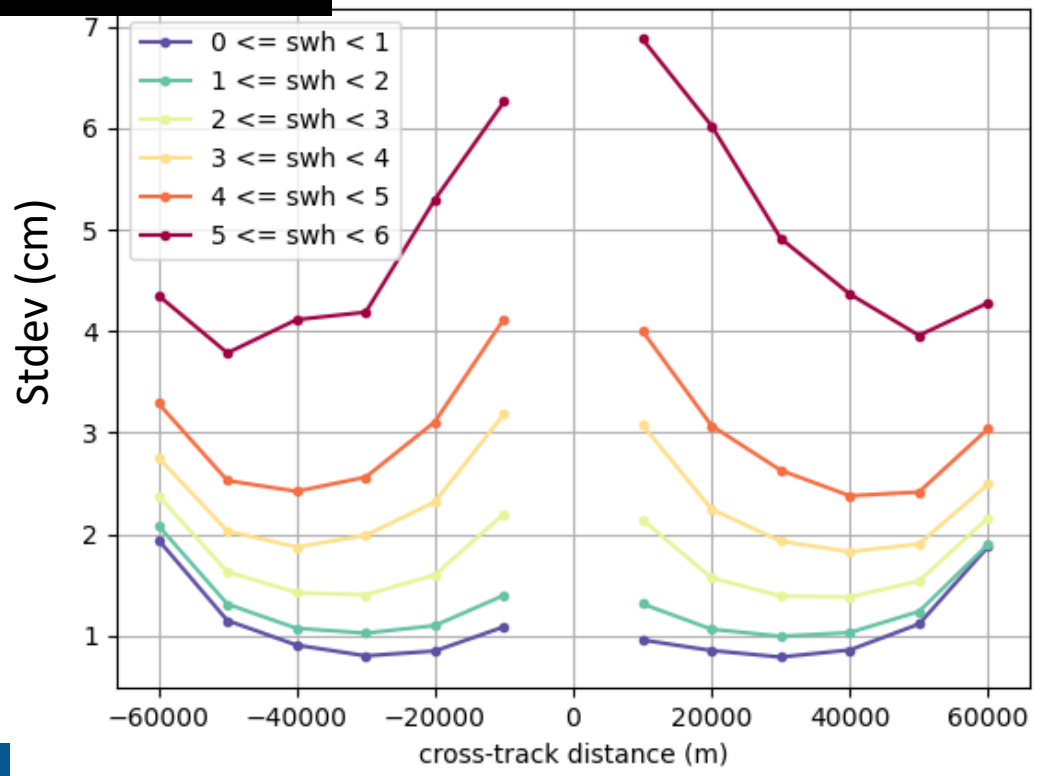
- **HF content estimated from Unsmoothed SSHA (plateau fit & integral)**
- **Slight change in cross-track direction near and far range are more aligned.**
  - ✓ To be assessed with better description of sea state conditions (wave period, direction …)

Variance of the SSHA HF signal
(from L2 Unsmoothed SSHA spectra)
Posting : 250m spatial res: 500m

1d orbit



21d orbit



Conclusions

- **Poseidon-3C and KaRIn behave very well and similarly on both CalVal & Science Orbits**

- **An important work has been achieved to pre-validate the KaRIn products, analyse the KaRIn topography signal. Results presented are just a global overview.**

- **Much remains to be done and it will require**
  - Investigations performed over the two orbit phases
  - The Science Team expertise
  - Extensive use of nadir constellation / other sensors / models / insitu measurement …