# WP 5000
# Assessment of CPP SAR processing

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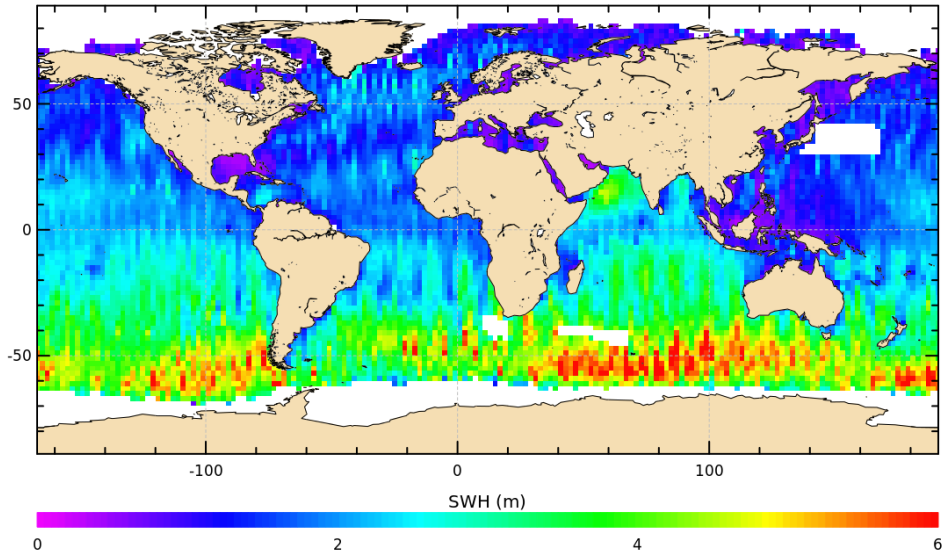
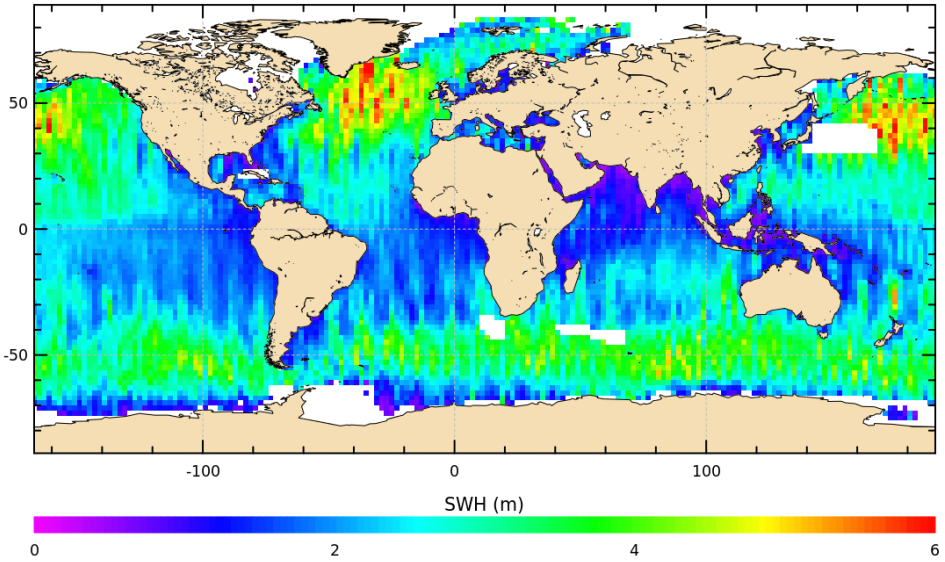
# Validation approach

- CPP SAR processing already presented by F. Boy
- Results have been shown at several OSTST (Venice 2012, Boulder 2013), 3rd Cryosat User Wokshop, Living Planet Symposium 2013
- 2 months selected for covering large range scale of wave and wind conditions




July 2012




January 2013

# Validation approach

- Objectives of this assessment for open ocean
  1. Detect possible correlated errors for large scales beyond 150 km. The objective is to show that SAR processing is as accurate as LRM mode for mesoscale studies and climate applications (regional Mean Sea Level)
  2. Confirm that the SAR processing allows retrieving smallest spatial scales (20-70 km) thanks to 20 Hz noise and footprint reduction in the along track direction

- Validation with Cryosat-2 mission is not that straightforward because of
  - No overlap between LRM and SAR zones
  - SAR sensitivity to several parameters (Waves, Mispointing, Radial velocity)
  - The limited geographic coverage which makes difficult to separate the different effects that have spatial coverage varying in space and time

- Two kind of metrics are presented here
  - Stand alone assessment of SAR data
  - Assessment of long wavelength errors based on comparison with PLRM data colocalised with SAR.

# Stand alone assessment

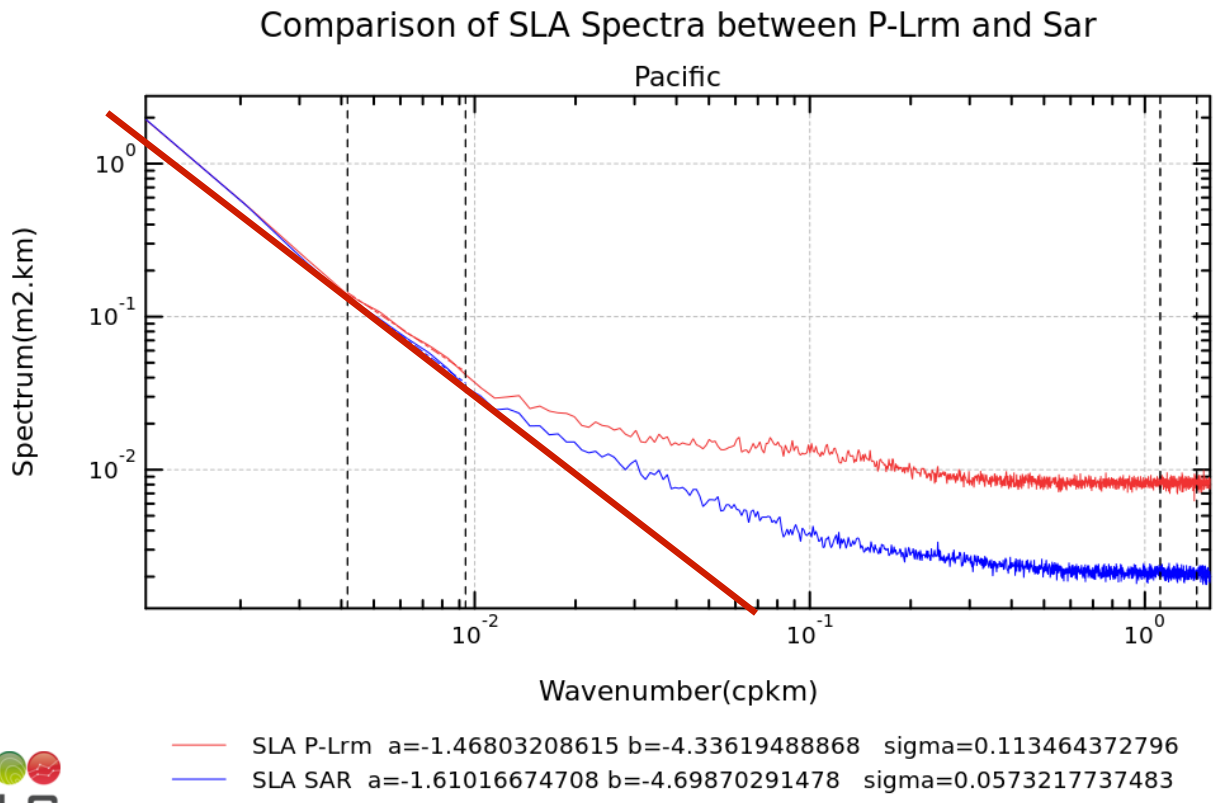
- Spectral analysis is an interesting tool for
  - ✓the assessment of the instrumental noise level given both the shape of the plateau and the white noise level
  - ✓the assessment of the small scale content by comparing the real PSD with the expected oceanic signal
  - ✓ the assessment of the longer wavelength signals (>100 km) where we would expect that all altimeters are super imposed.

- Noise close to 5.7 cm wrt 11.3 cm in PLRM
- PSD overlap for scales > 250 km
- All existing LRM altimeters present high spectral energy ('bump') below 100 km which comes from heteregoneity within the footprint (Dibarboure 2014)

=> this impacts the PSD for scales up to 250 km on the Pacific

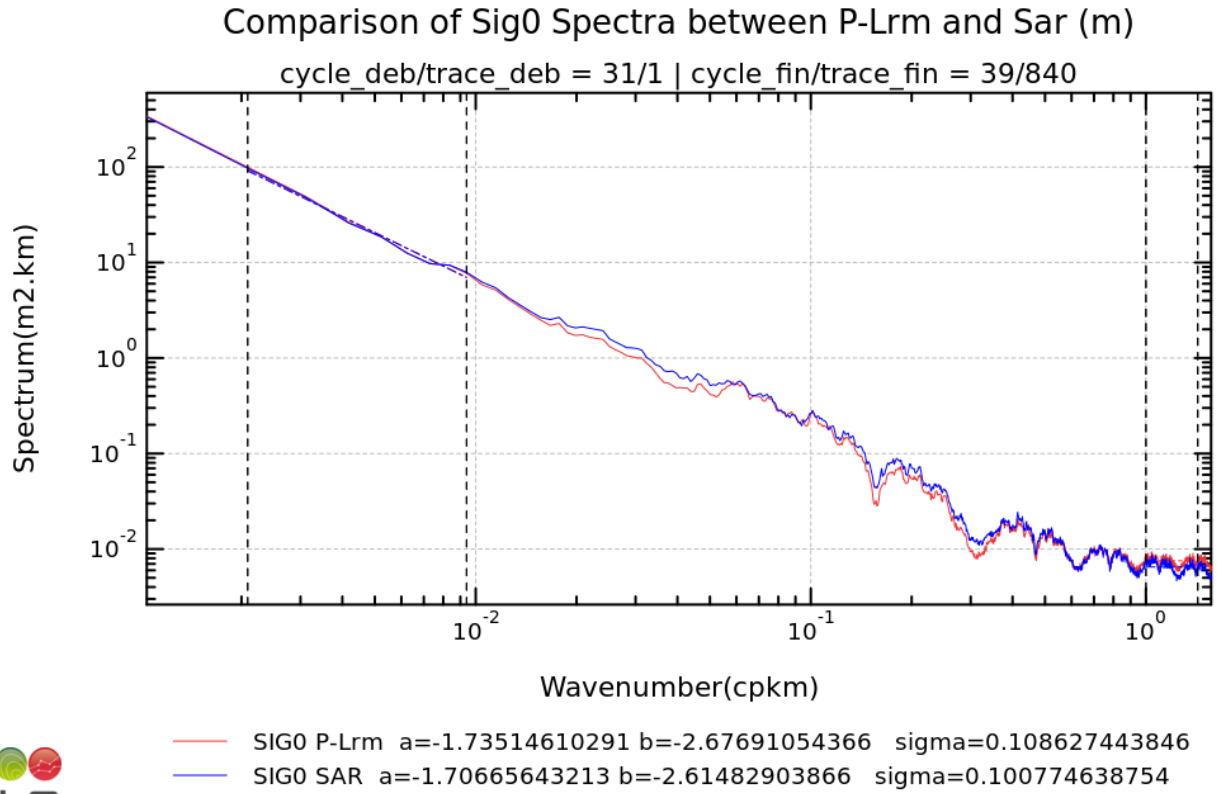
With SAR processing :

- Clean SLA spectrum down to 90 km
- Spatial limit (where error is 50% of the signal energy) is closer to 30 km compared to 70 km with LRM processing



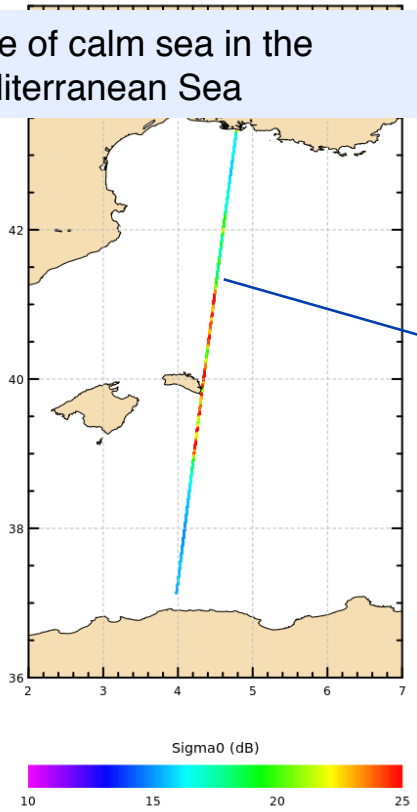
# Stand alone assessment

- Spectral analysis for Sigma0
  - ✓Same noise level at 20 Hz
  - ✓More energy in the SAR PSD between 16-60 km and 2-7 km, which is due to the reduced footprint of 300 m that allows capturing small scale roughness
  - ✓ Large wavelength show no difference

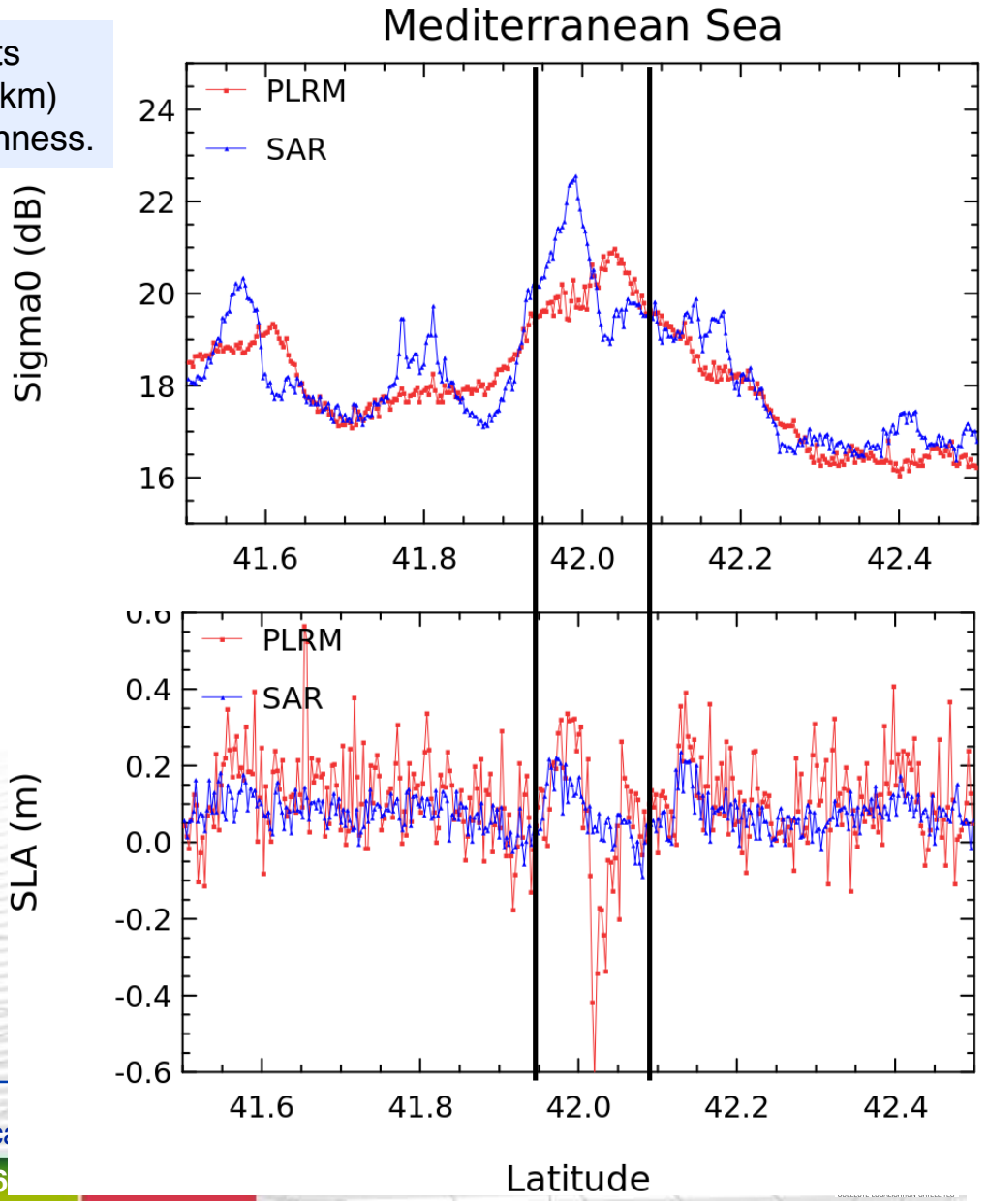


# Stand alone assessment

Case of calm sea in the Mediterranean Sea



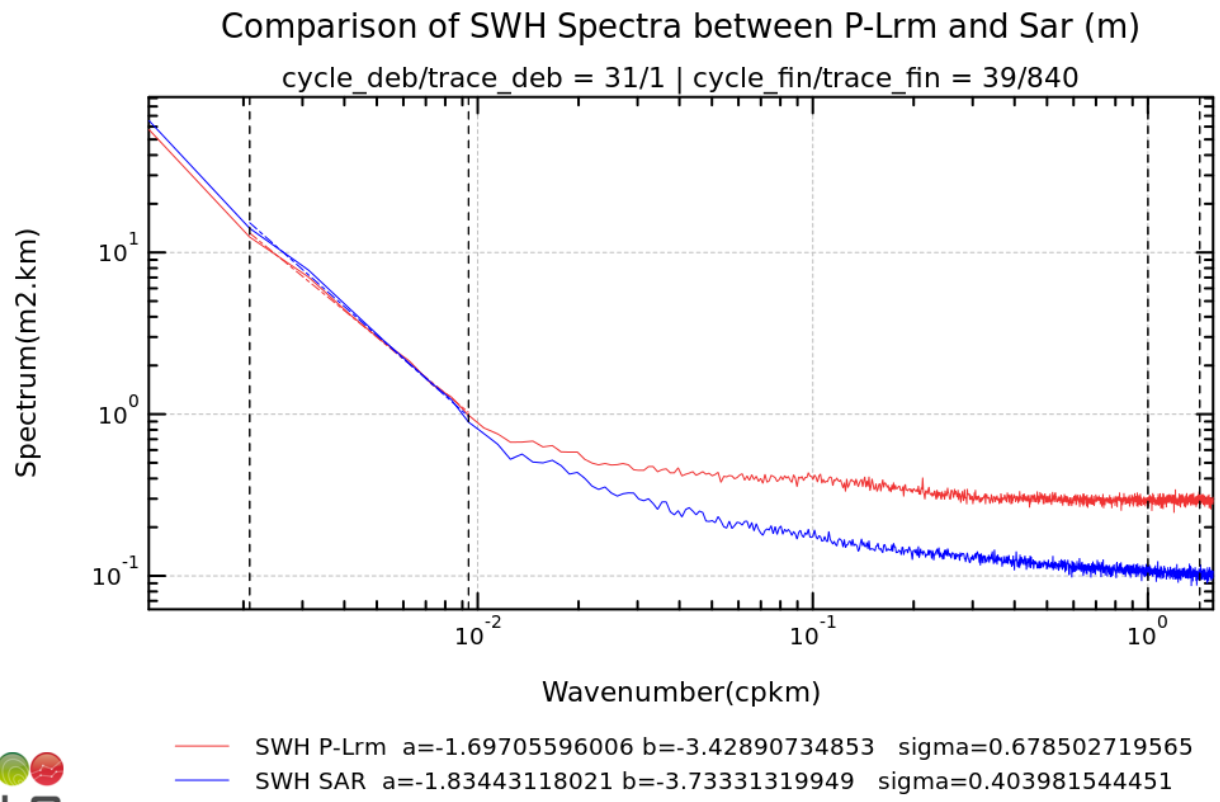

The SAR sigma0 detects small structures (10-20 km) of the sea surface roughness.



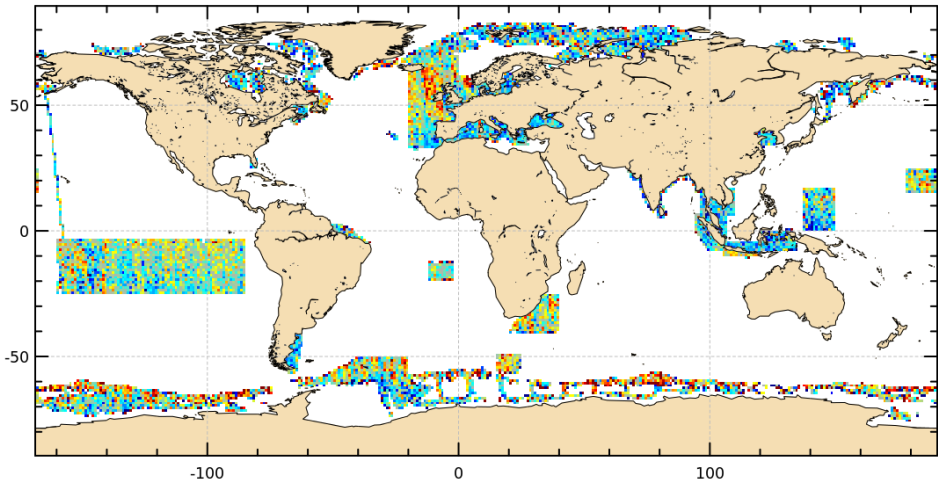

The SAR SLA remains stable compared to PLRM SLA which departs from the mean signal by +/- 30 cm.
The jumps of the PLRM SLA are completely correlated with SARsigma0 => with PLRM processing, the signal is seen on the SLA and the sigma0 remains stable whereas all the roughness is properly retrieved along track by the SAR sigma0 and does not corrupt the SLA measurement.
=> Such an error on the SLA is responsible for the bump on the SLA PSD.

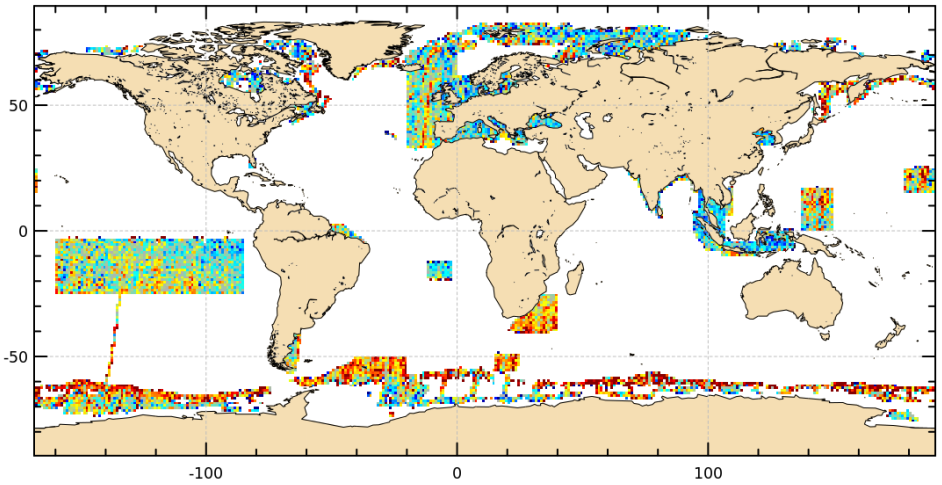
# Stand alone assessment

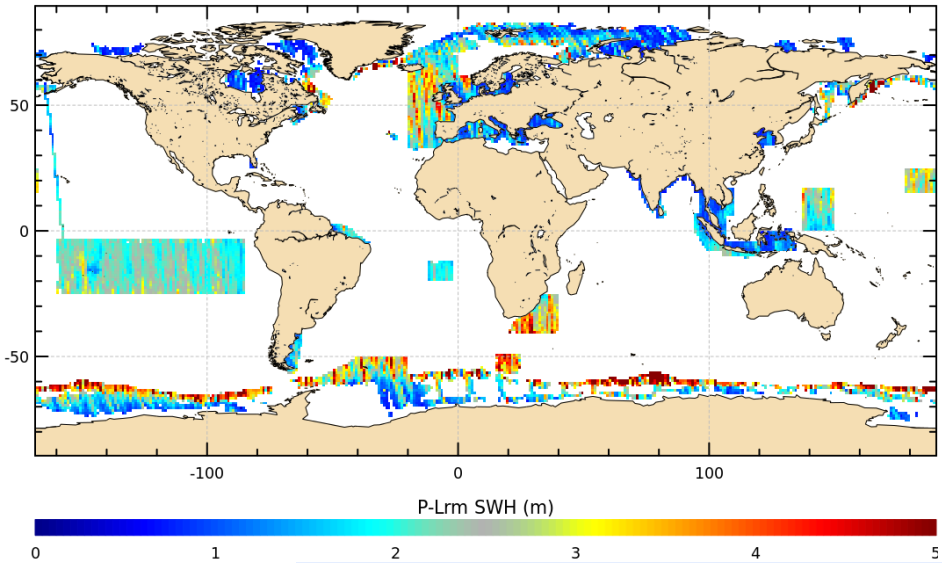
- Spectral analysis for SWH
  - ✓Different noise level at 20 Hz => 40 cm for SAR wrt 68 cm for PLRM (Jason-2 is 54 cm in average)
  - ✓Bump also present on SWH with PLRM, SAR PSD does not exhibit the bump
  - ✓ Large wavelength show no difference

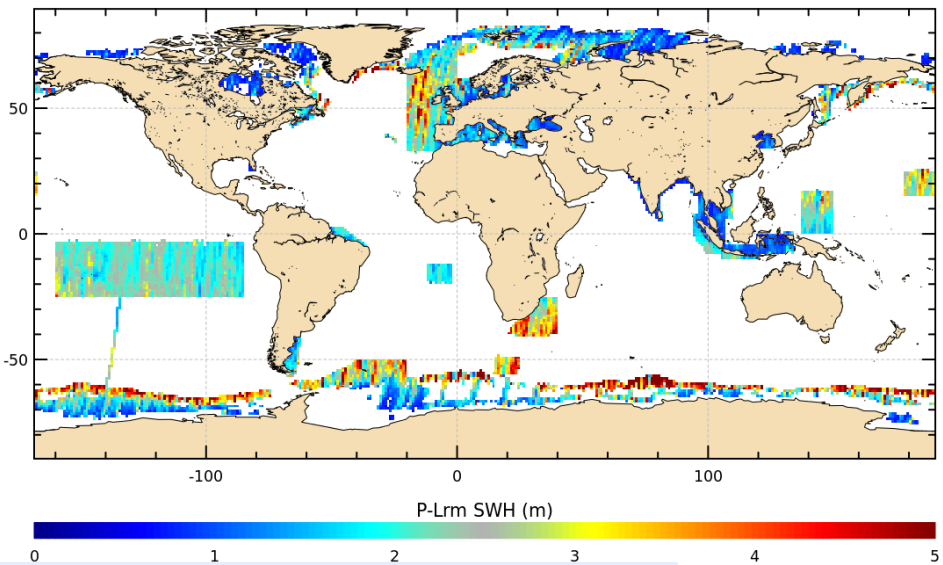


# Long wavelength errors - Range



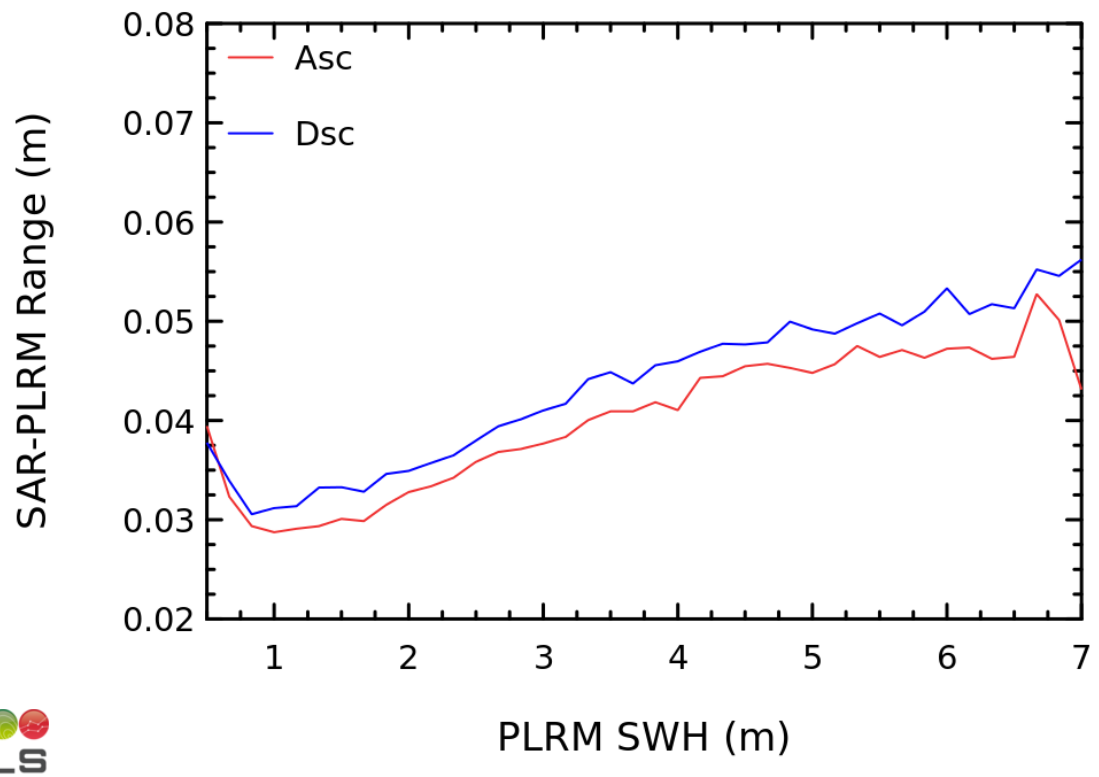




The range difference exhibits very small variations between 3 and 5 cm
The range difference appears to be mainly correlated with SWH

# Long wavelength errors - Range

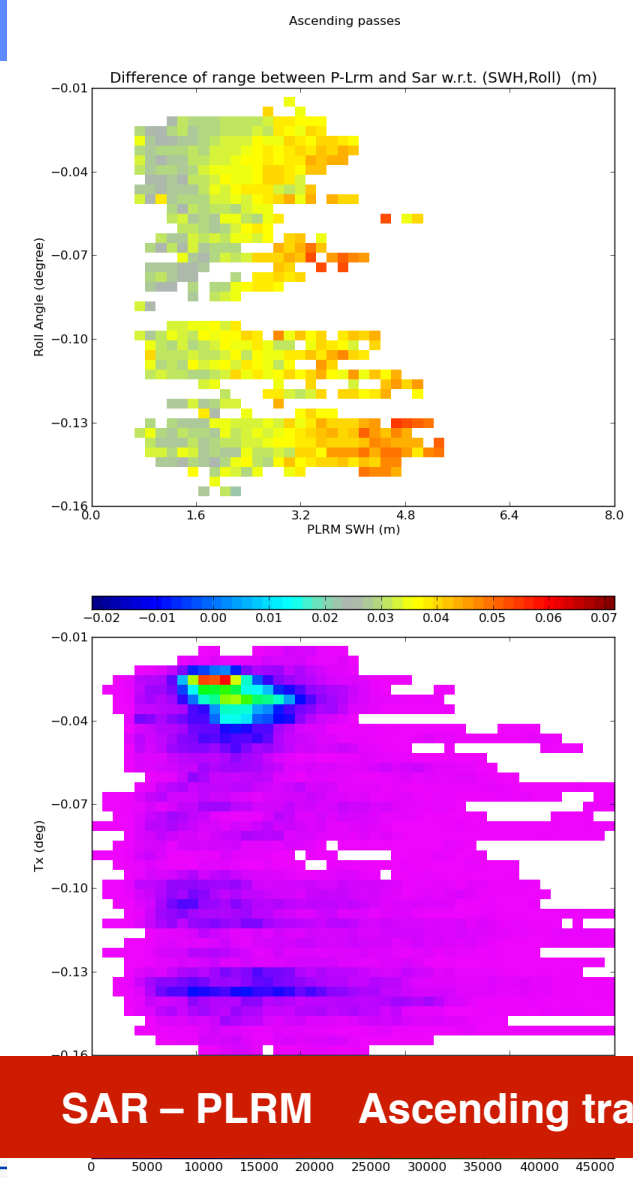


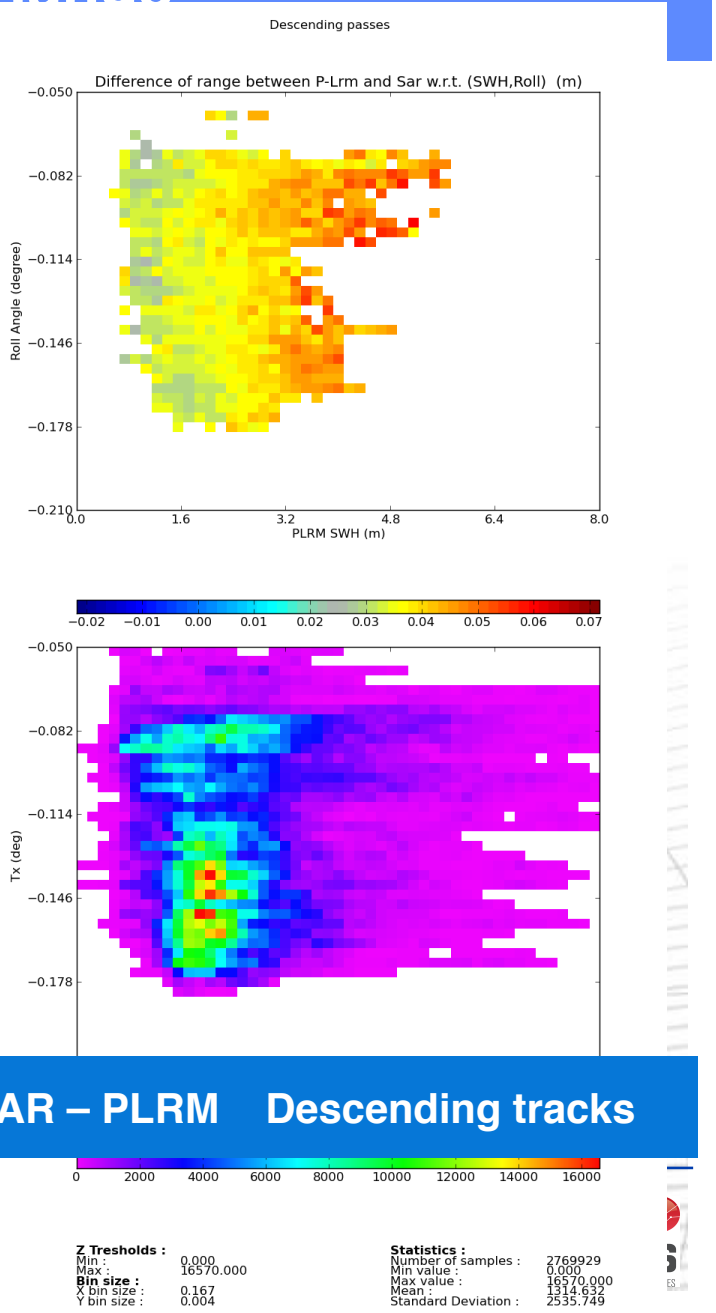

Absolute bias of 3 cm, given by the value at small SWH

Difference of 0.4%SWH => either error in CPP SAR retracking or different SSB behaviour between LRM and SAR modes

Bias of 4 mm between ascending and descending passes, not explained.

# Long wavelength errors - Range



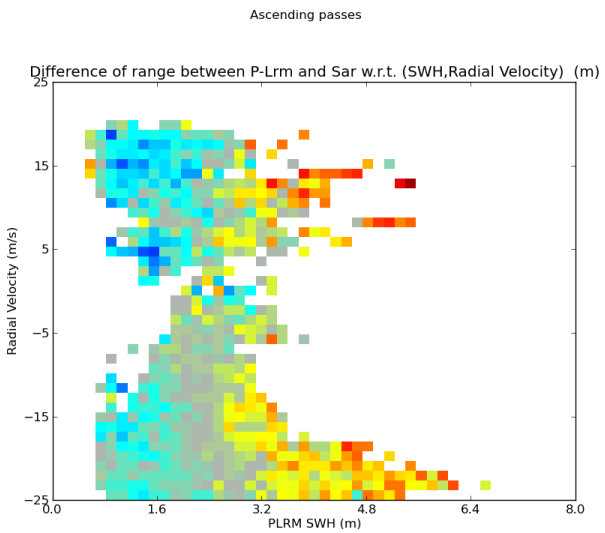




No residual error correlated with roll angle.

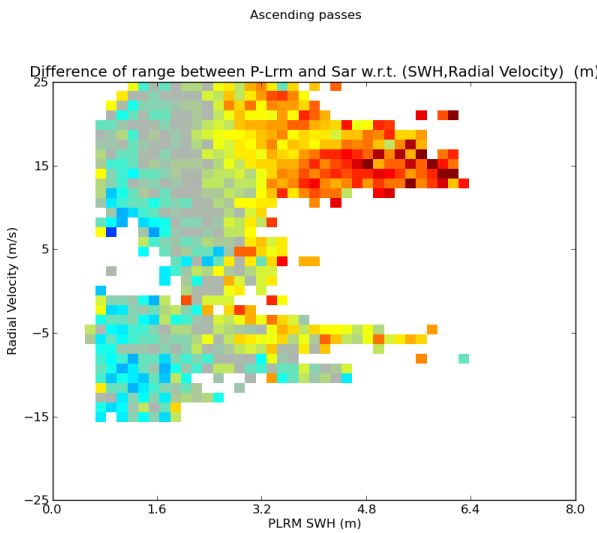
**SAR – PLRM Ascending tracks**

**SAR – PLRM Descending tracks**

# velength errors -




No residual error correlated with radial velocity




**SAR – PLRM Ascending tracks**

**SAR – PLRM Descending tracks**

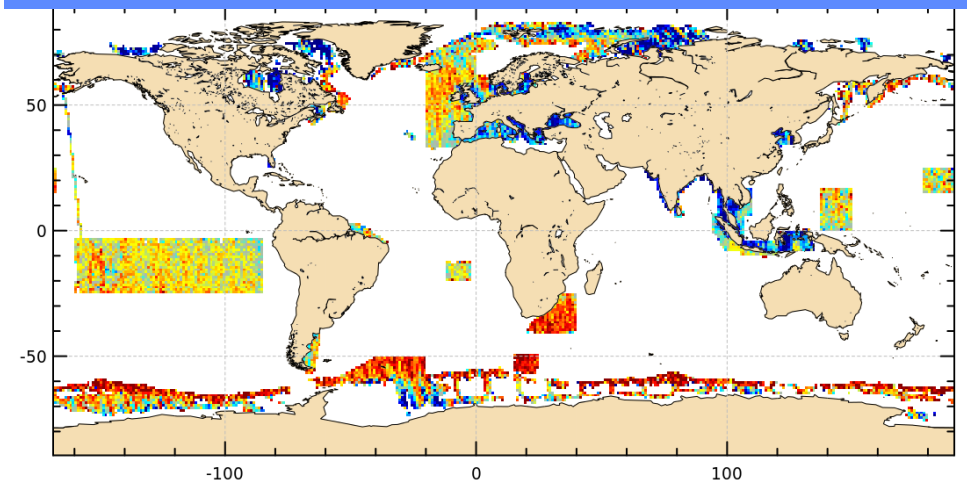
**Z Tresholds :**
Min : 0.000
Max : 16807.000
**Bin size :**
X bin size : 0.167
Y bin size : 1.190

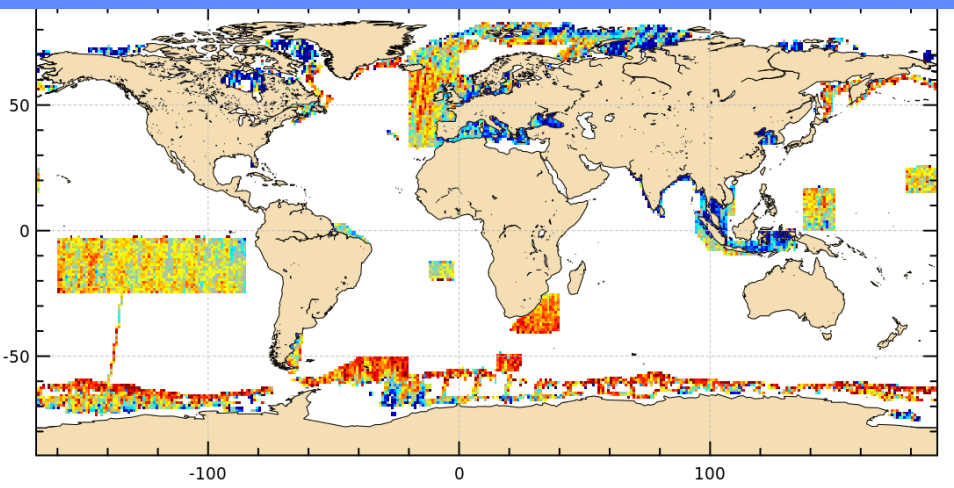
**Statistics :**
Number of samples : 1980881
Min value : 0.000
Max value : 16807.000
Mean : 940.143
Standard Deviation : 2159.176

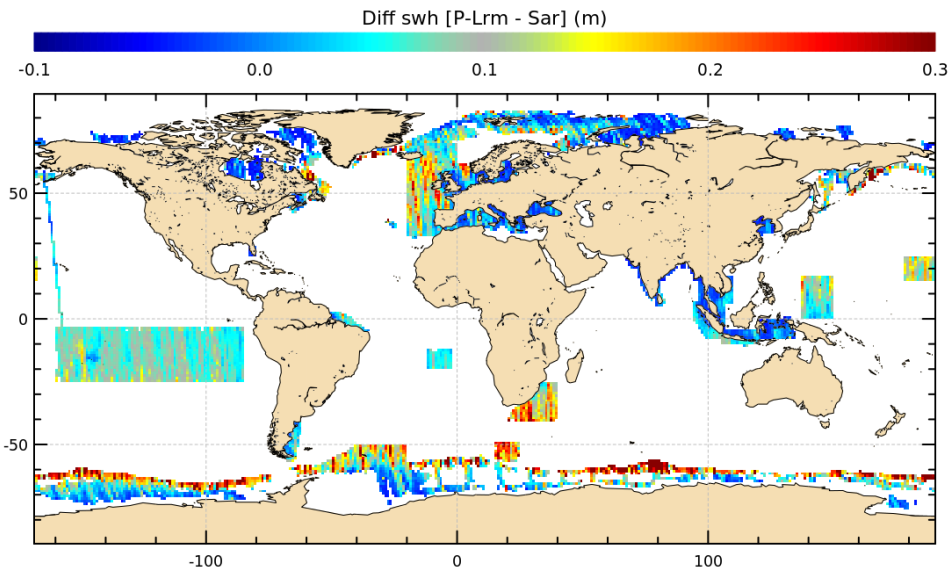
**Z Tresholds :**
Min : 0.000
Max : 16416.000
**Bin size :**
X bin size : 0.167
Y bin size : 1.190

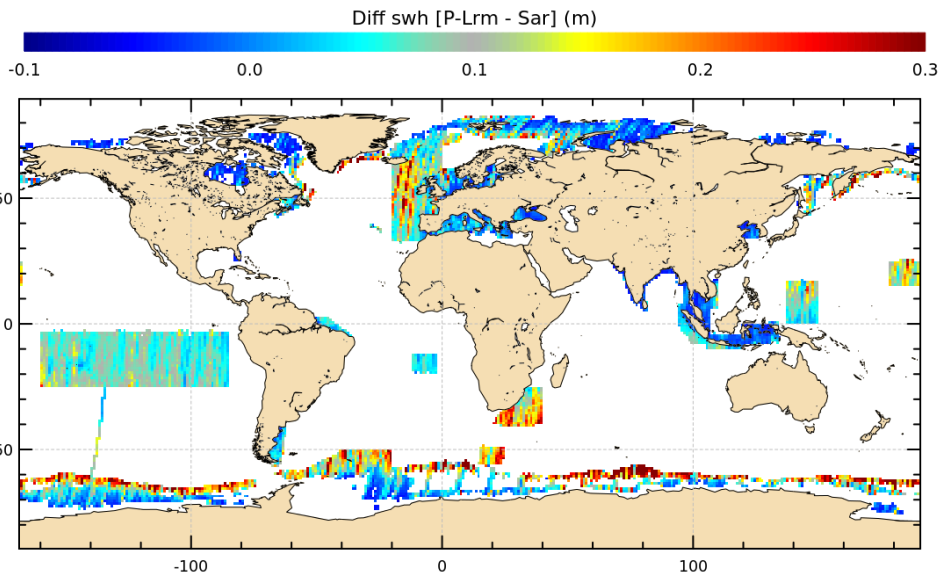
**Statistics :**
Number of samples : 2442988
Min value : 0.000
Max value : 16416.000
Mean : 1159.463
Standard Deviation : 2549.126

# Long wavelength errors - SWH





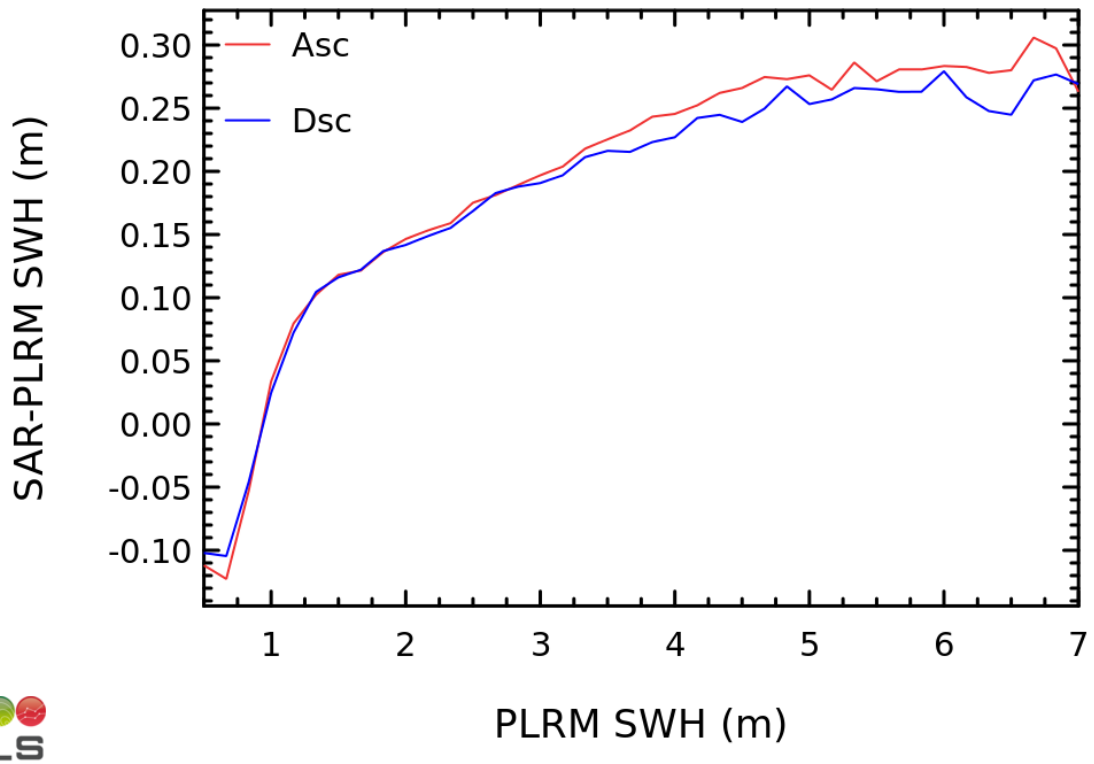





| | | | |
|---|---|---|---|
| Nbr : | 8048 | | 0.351725 |
| Mean : | 2.1714865 | | 10.42535 |

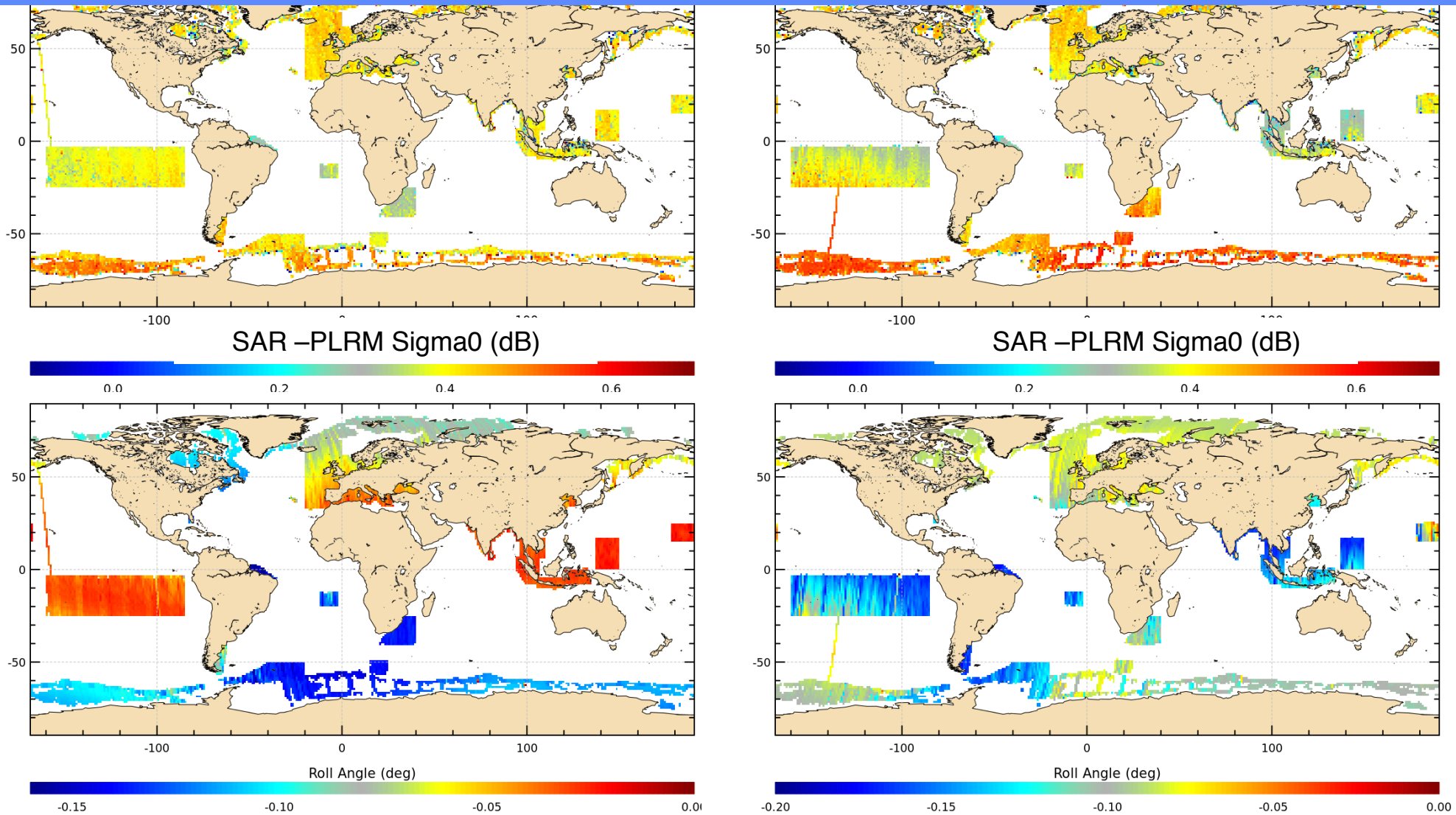
The SWH difference appears to be mainly correlated with SWH

# Long wavelength errors – SWH




Error close to 4% SWH between 1 m and 5 m.
Same error for ascending and descending passes
Assumming that the PLRM SWH are 10 cm too low, SAR SWH are unbiased at SWH=1.25m
Still some larger bias for low SWH (< 1 m)

# Long wavelength errors – Sigma0




Excellent agreement between PLRM and SAR backscatter coefficient => geographic variations of only 0.2 dB magnitude ! Residual difference could be correlated to roll but not a systematic correlation (works in Pacific desc but not for south and north Atlantic…)

# Conclusions

- SAR CPP processing shows improved content for SLA, SWH and Sigma0 at scales below 100 km. The more continuous decay of the SLA PSD should yield better observations to capture oceanic structures below 100 km.
- The Sigma0 provides more short scale content and thus more accurate content due to the 300 m footprint in the along track direction.

- The SLA show neither residual errors correlated to mispointing, nor to radial velocity.
- Only long wavelength error correlated with SWH has been found, which would suggest either an error in the SAR retracking or a different SSB behaviour between LRM and SAR modes with the CPP processing. The impact on this data set is close to 0.4% SWH, providing a SAR SSB higher than the LRM SSB. This effect on SSB should be further confirmed with other SAR retrackings.
- The SWH exhibit residual error correlated with SWH close to 4% SWH.
- The Sigma0 shows negligible bias of 0.2 dB magnitude, possibly correlated with mispointing.
- The absolute biases on SAR parameters are close to 3 cm for range, 5 cm for SWH and 0.4 dB for sigma0.

# If we want to go further…

- SWH retrieval could and shall be further improved (Bias and 20 Hz noise)

- Better understanding of the small scale retrieval and further check the impact of heterogeneity on the SAR processing => SAR data are improved compared to LRM processing but not necessarily completely ‘clean’ of any error