

Results over Ocean of the SAR Mode Processing in Sentinel-3A Products

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SAR Workshop
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La Rochelle

Introduction

- Objective of this talk
 - Show results on SAR processing from S3 L2 operational products (PDGS)
 - Improvements that have been achieved in the operational processors
 - Focus on the assets of the SAR mode
- Work done in the frame of the Mission Performance Centre (MPC) activities which is in charge of the maintenance and evolution of the processors used in the S3A ground segment (PDGS)
- More results on S3 data product quality in the SAR Workshop and OSTST sessions
 - Absolute Calibration by Bonnefond et al
 - Radiometer by Frery et al
 - Wind & Wave Products by Abdalla et al
 - Global Assessment by Scharroo et al

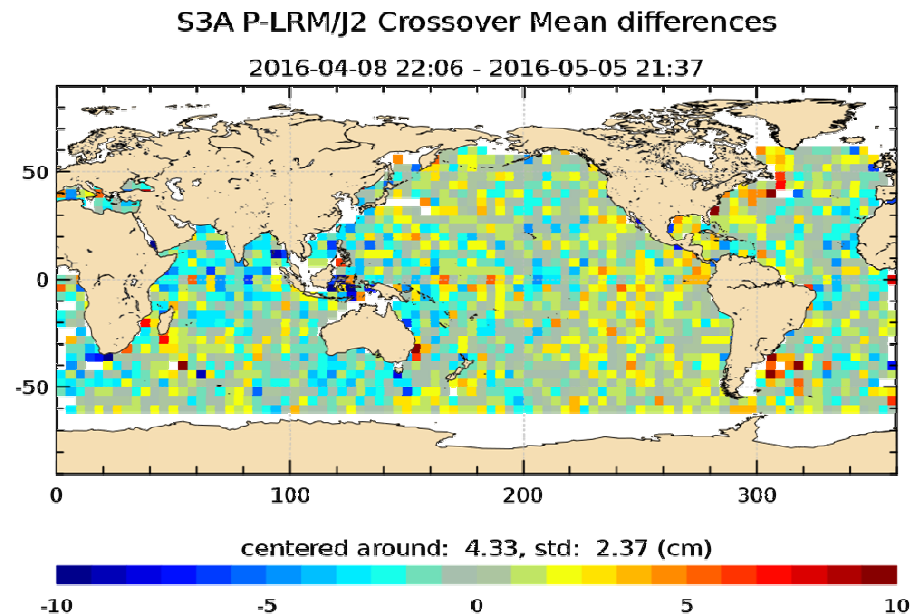
Introduction

Data sets

- L2 NRT Marine products delivered to MPC and S3VT users since 15 June
 - SAMOSA 2.3 retracker implemented today which was the initial retracker version before ESA CP4O project conclusions
 - SAMOSA 2.5 retracker is the version recommended by the CP4O project
- In house CLS ground processor version (Level 1 and Level 2) used to generate the next version of products (that you do not have yet in hands)
- S3PP L2 products generated by CNES since SRAL switch-on for the commissioning phase, used as a reference (results from Raynal et al)

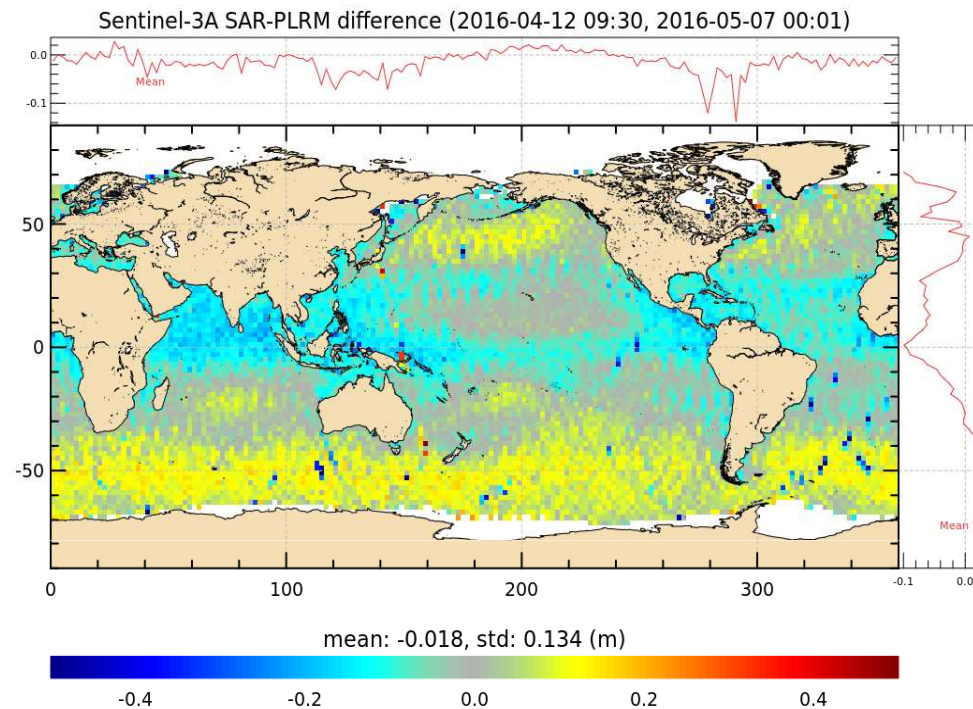
SAR assessment is based on comparisons with PLRM observations

- PLRM fully in line with S3PP PLRM and Jason-2 observations (see Boy and Donlon)
- Offers the capability to detect small magnitude signal

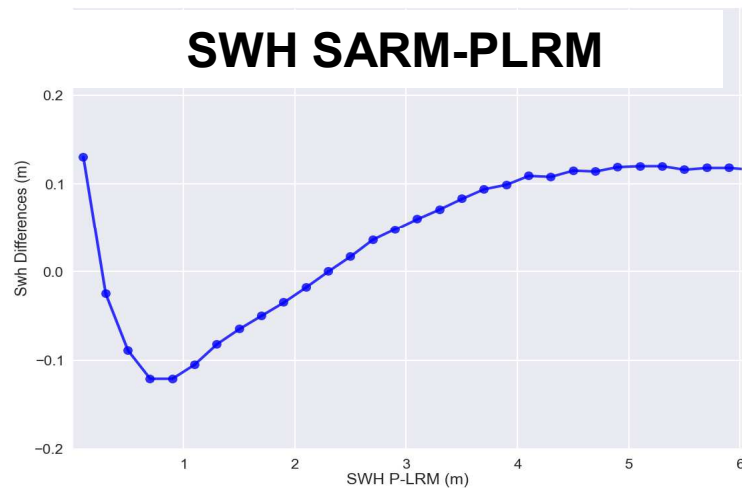
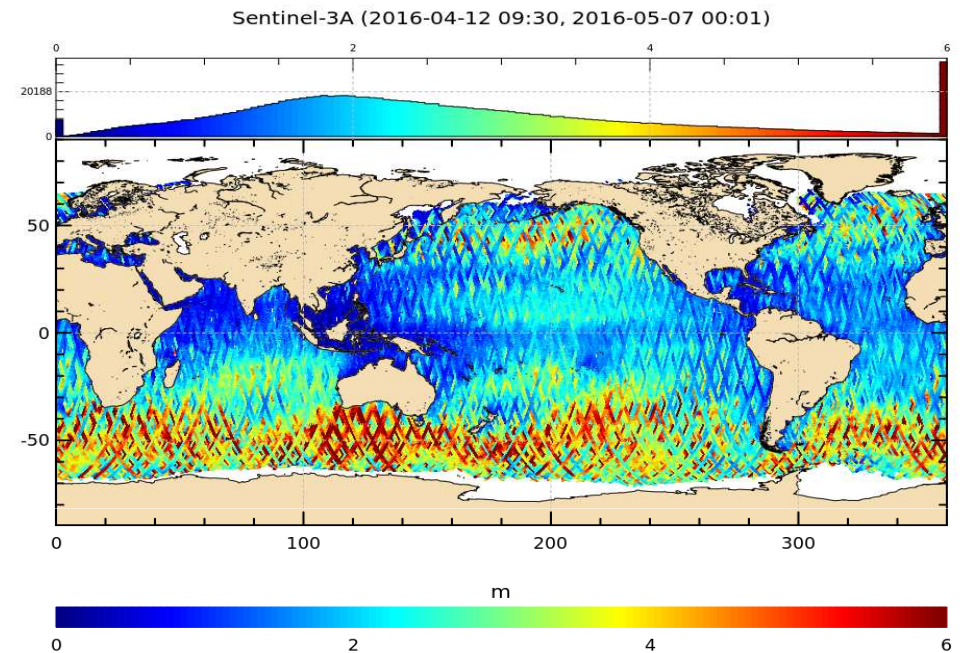


SAR Performance in L2 Products

Ku-band SWH



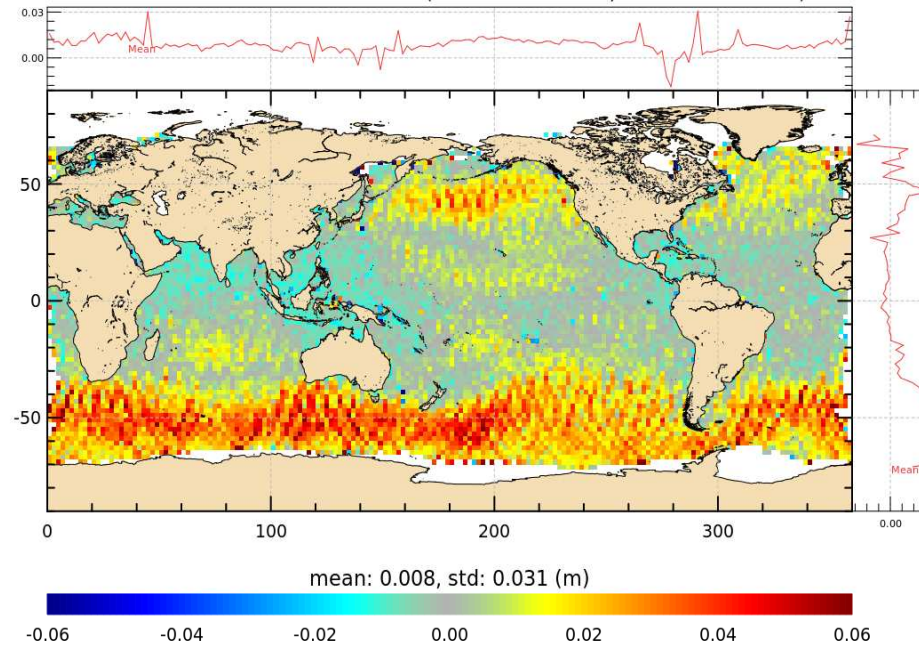
Ku-band SWH



SAMOSA 2.3 retracker does not take into account the SRAL full PTR
⇒ expected biases on SAR SWH
⇒ will be corrected with the implementation of SAMOSA 2.5 retracker

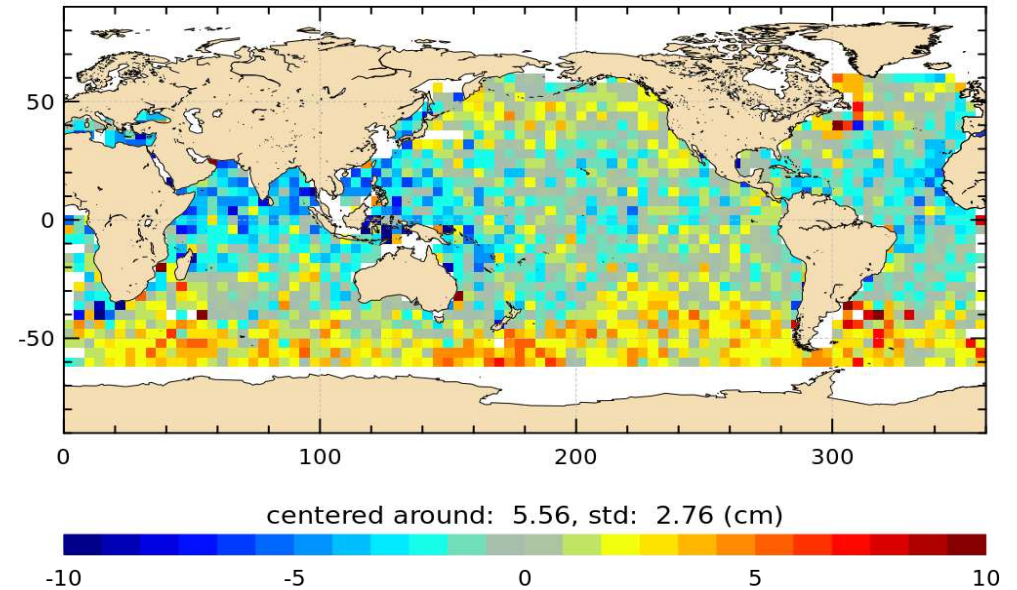
Ku-band SLA using wet tropospheric correction from ECMWF

Sentinel-3A SAR-PLRM difference (2016-04-12 09:30, 2016-05-07 00:01)



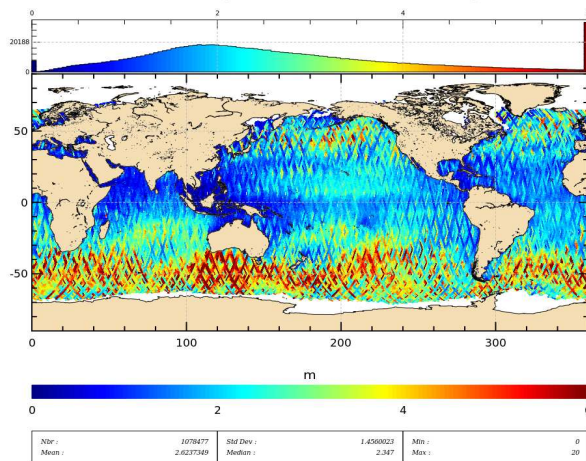
S3A/J2 Crossover Mean differences

2016-04-08 22:06 - 2016-05-05 21:37

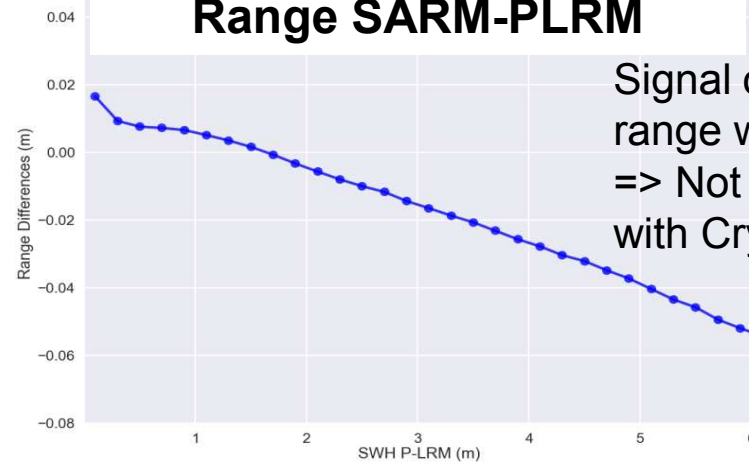


Ku-band SWH

Sentinel-3A (2016-04-12 09:30, 2016-05-07 00:01)

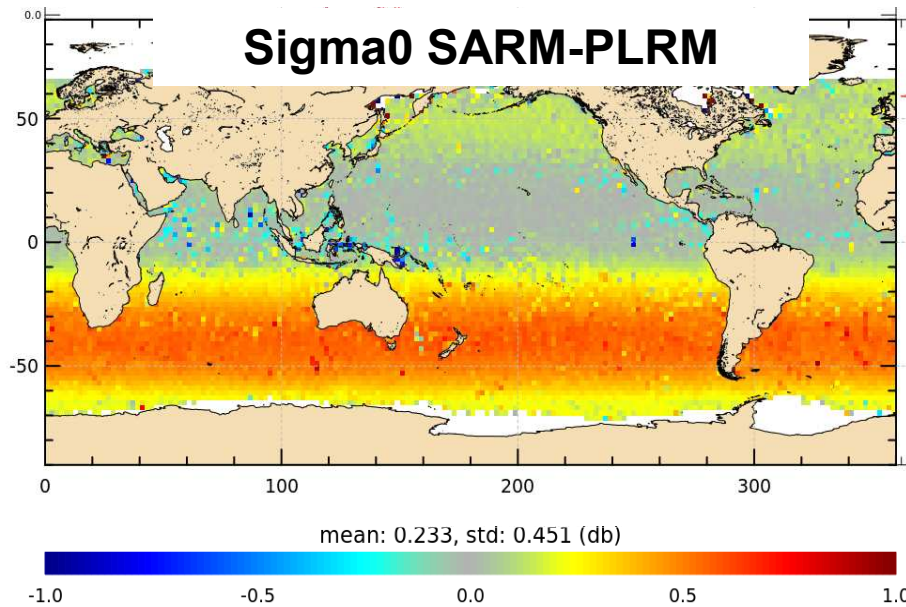


Range SARM-PLRM

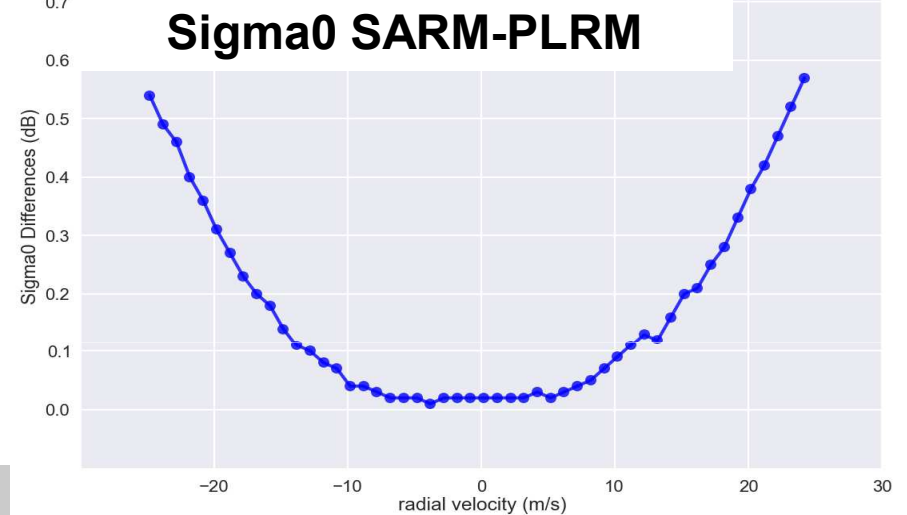


Signal of 1% SWH detected on SAR range when compared to PLRM
=> Not expected from experiments done with Cryosat-2

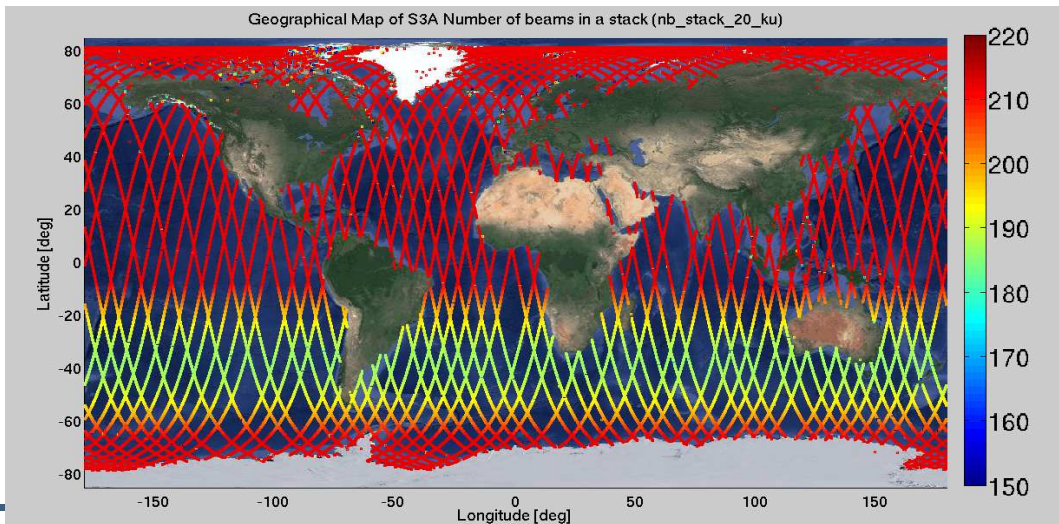
SAR Performance in L2 Products



Absolute bias reduced to zero for the lowest radial velocities when aligning the SAR and PLRM sigma0

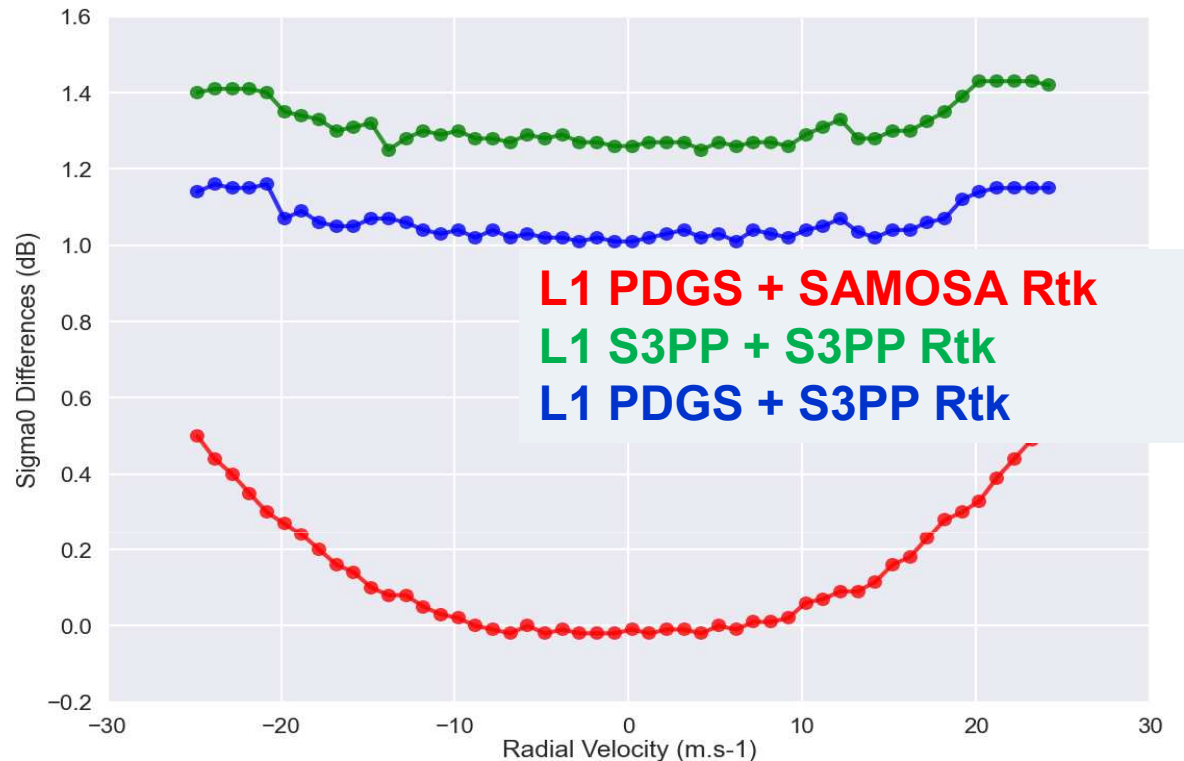


Error of 0.5 dB on the SARM sigma0 in regions correlated with the radial velocity. The pattern is related to the number of beams used in the stacking (varies with radial velocity).



Future Products

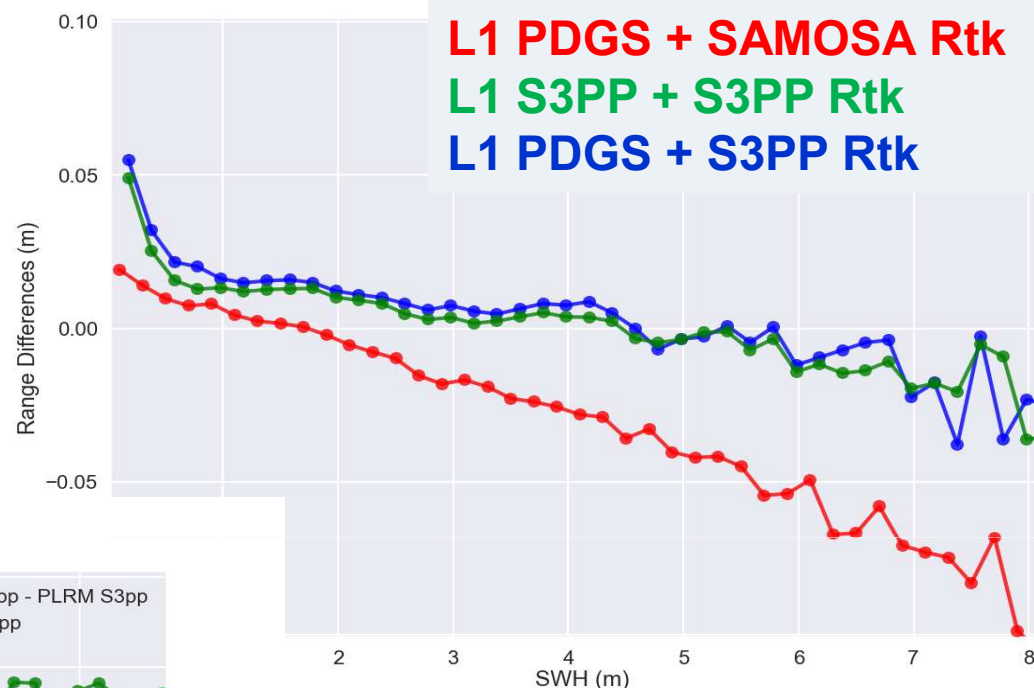
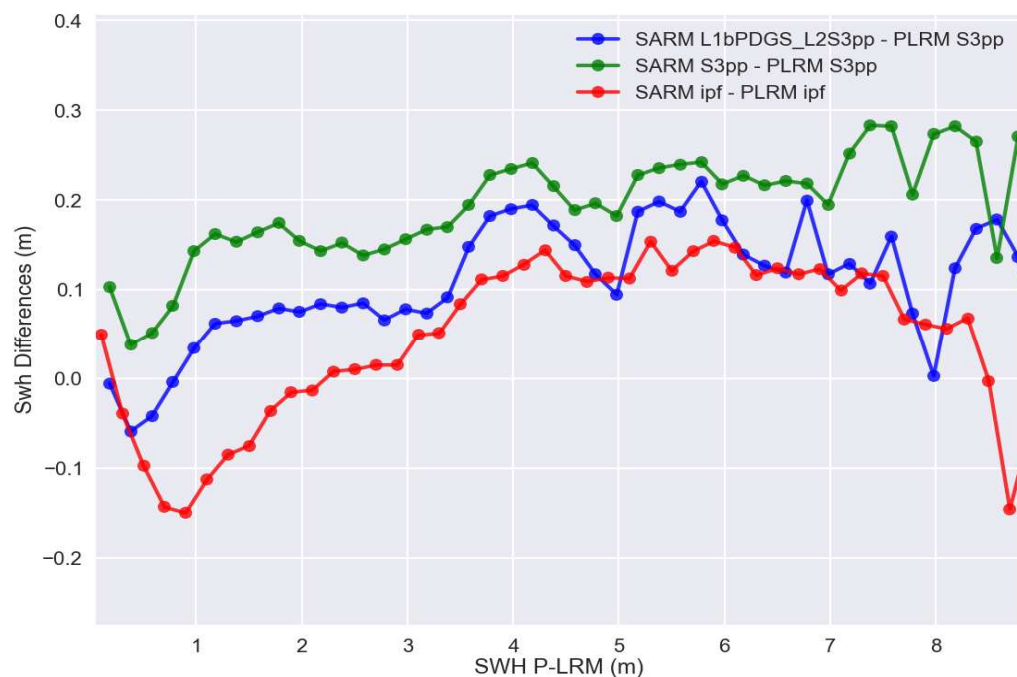
Test done with CNES support :
Apply S3PP retracker instead of
SAMOSA 2.3 retracker to S3 L1
products generated by the ground
segment



When applying the S3PP retracker, most of the error correlated with radial velocity disappears
⇒ 0.15 dB residual error for speed > 18 m/s, also observed with S3PP L1 processing
⇒ this test means that **the error on sigma0 may come from the inconsistency between L1 and SAMOSA retracker**
⇒ the error is not due to the L1 SAR processing

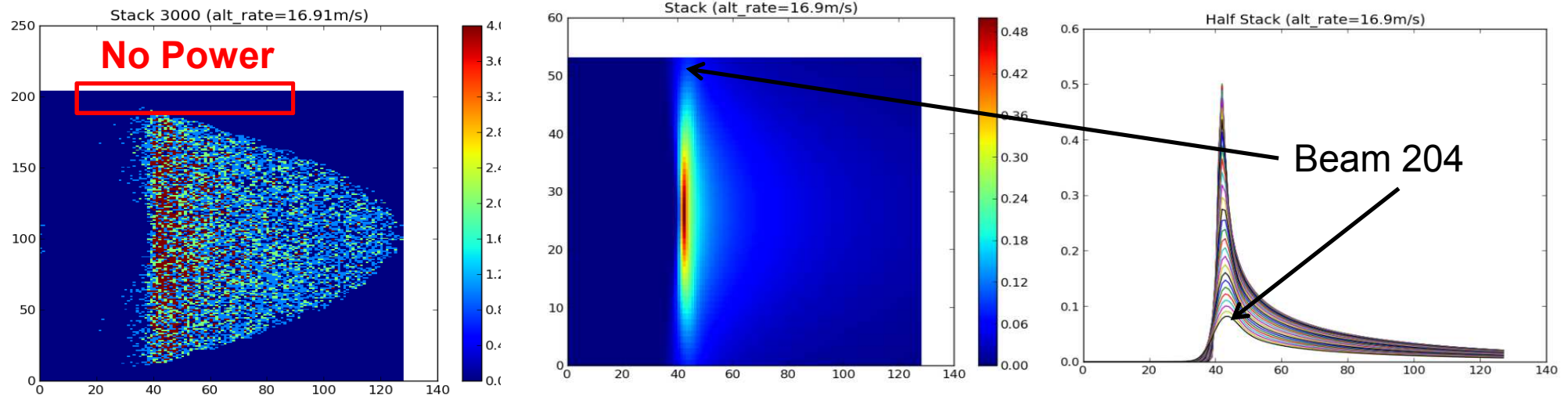
Future Products

Same conclusions for SWH and sigma0: aligned with S3PP when using the S3PP retracker on the L1 generated by the ground segment.



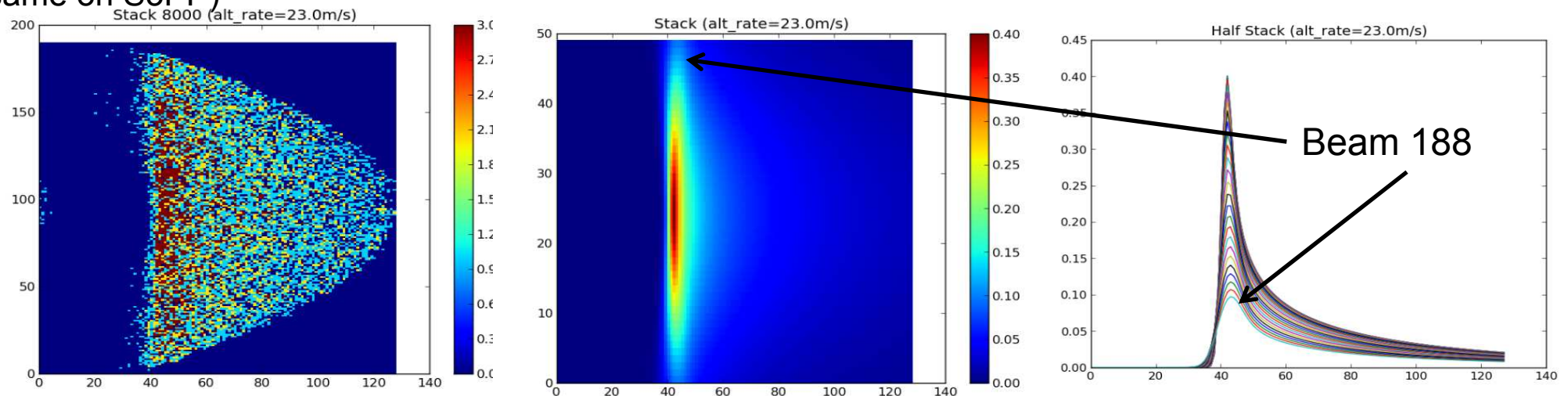
**Experiment fully validates the
operationnal Level 1 processing.
=> Focus on SAMOSA retracker**

SAMOSa Model analysis

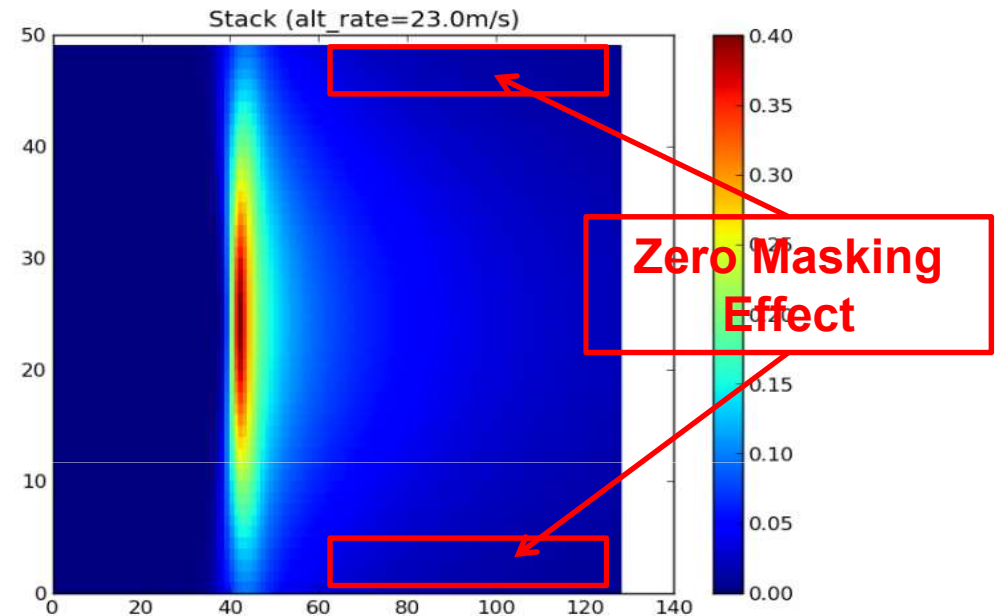
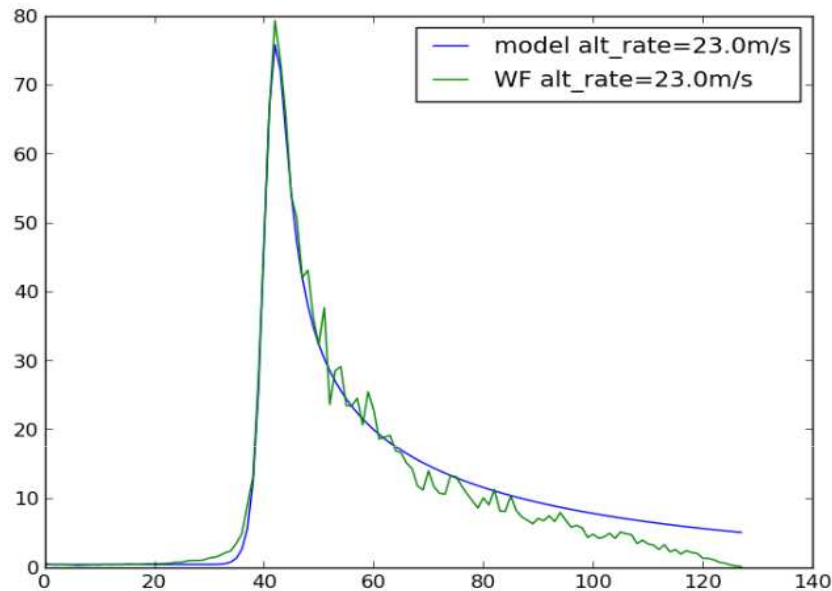


Energy of S3 stacks is always limited to 180 beams, behaves differently from Cryosat (same on S3PP)

SAMOSa 2.3 model still shows significant energy for beams with higher incidence angle (> 180) while S3 observations exhibit no energy.
=> Need to use beams only up to 180 in the model



Future Products



Even with 180 beams, the model still exhibits too much energy compared to measured echoes.

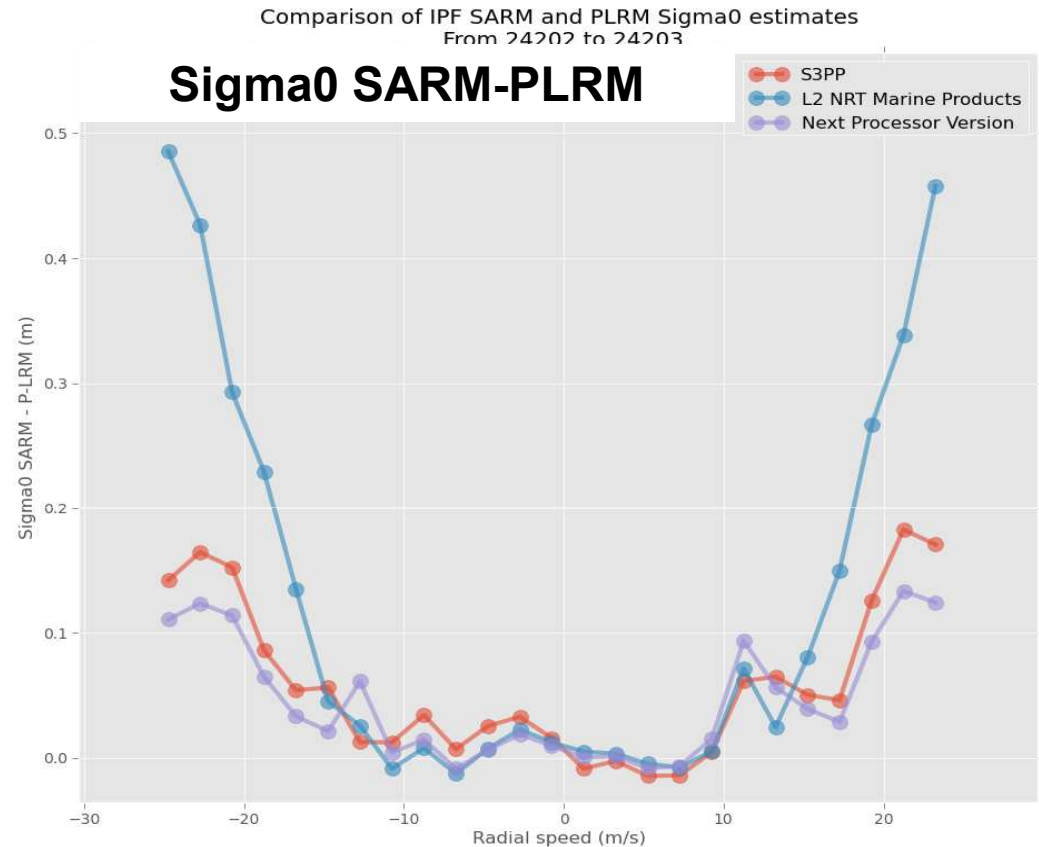
Behavior explained by 0 masking effect which is not taken into account in SAMOSA 2.3 retracker (it will be accounted for in SAMOSA 2.5)

Pragmatic approach to reduce this effect => reduce the number of beams below 180 in input of the retracker to mitigate this effect in the model.

Future Products

Bias on sigma0 is decreased when:

- reducing the number of beams to **175** in input of SAMOSA 2.3 model (consistency between stacking and retracker)
- removing sigma0 scale factor accounted for twice (both in L1 and L2 processings)



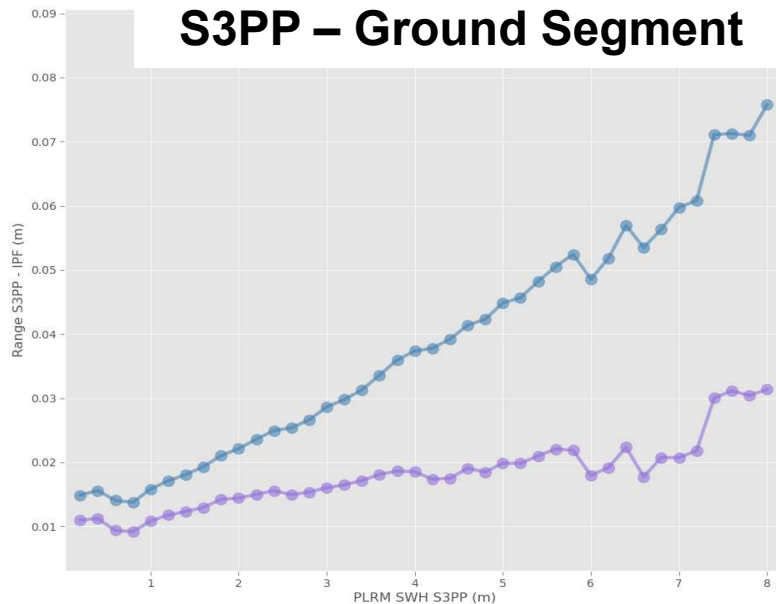
**Residual signal of 0.15 dB on SARM sigma0 observed on both processings: S3 operational processor and S3PP.
Not expected and further work is needed to progress on this topic.**

Future Products

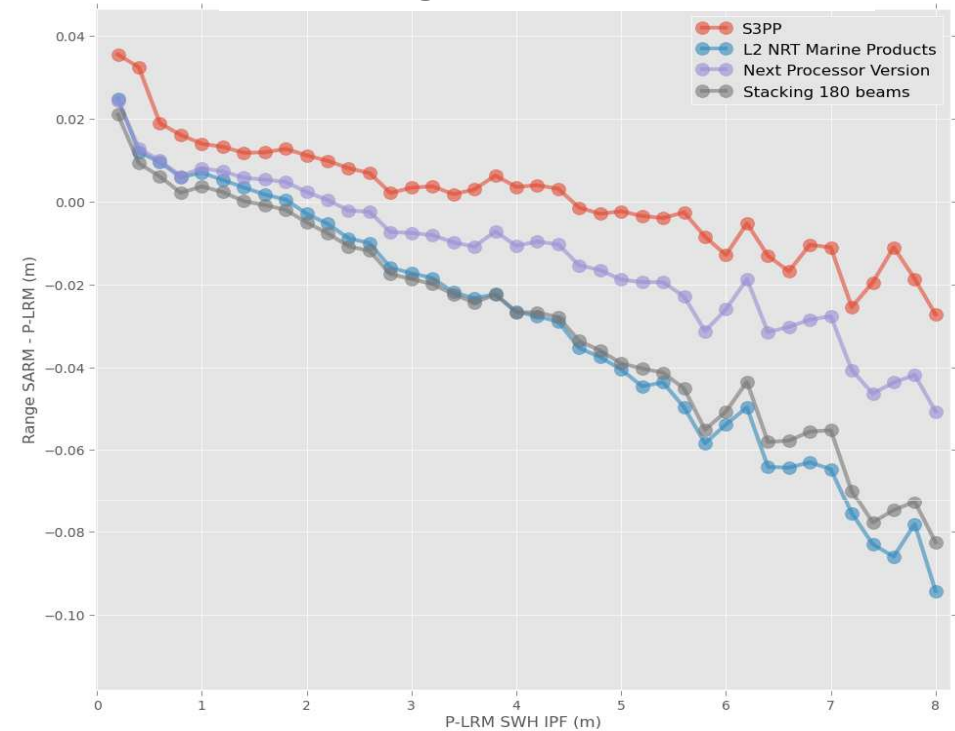
When reducing the number of beams from **180** to **175** in the stacking, the error on the range wrt to PLRM is divided by 2.

Reducing the number of beams does not degrade the range precision (5 cm @ 20 Hz in both cases).

**Range SARM
S3PP – Ground Segment**



Range SARM-PLRM



Residual signal of 0.5%SWH on SARM range observed on S3 operational processor.

Difference with S3PP:

- mean bias of 1 cm
- residual signal of 0.2%SWH

Future Products

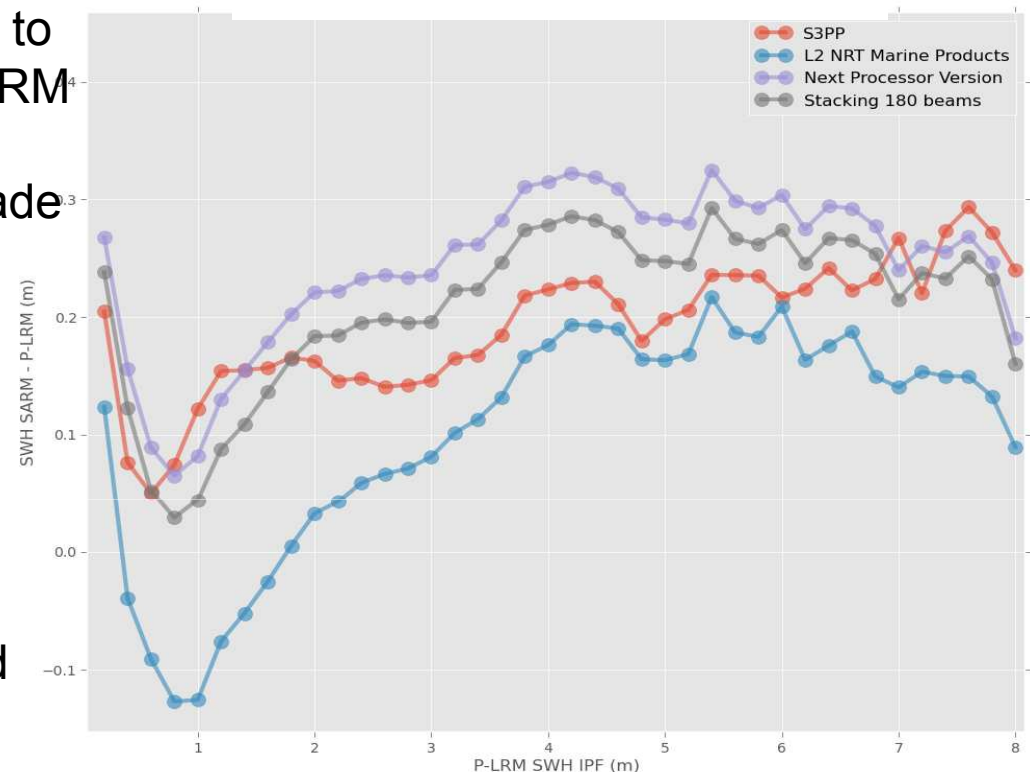
When reducing the number of beams from **180** to **175** in the stacking, the bias on SWH wrt to PLRM is increased by 5 cm.

Reducing the number of beams does not degrade the range precision (40 cm @ 20 Hz in both cases).

Stacking with 175 beams has been implemented in the ground segment processors (Next product version).

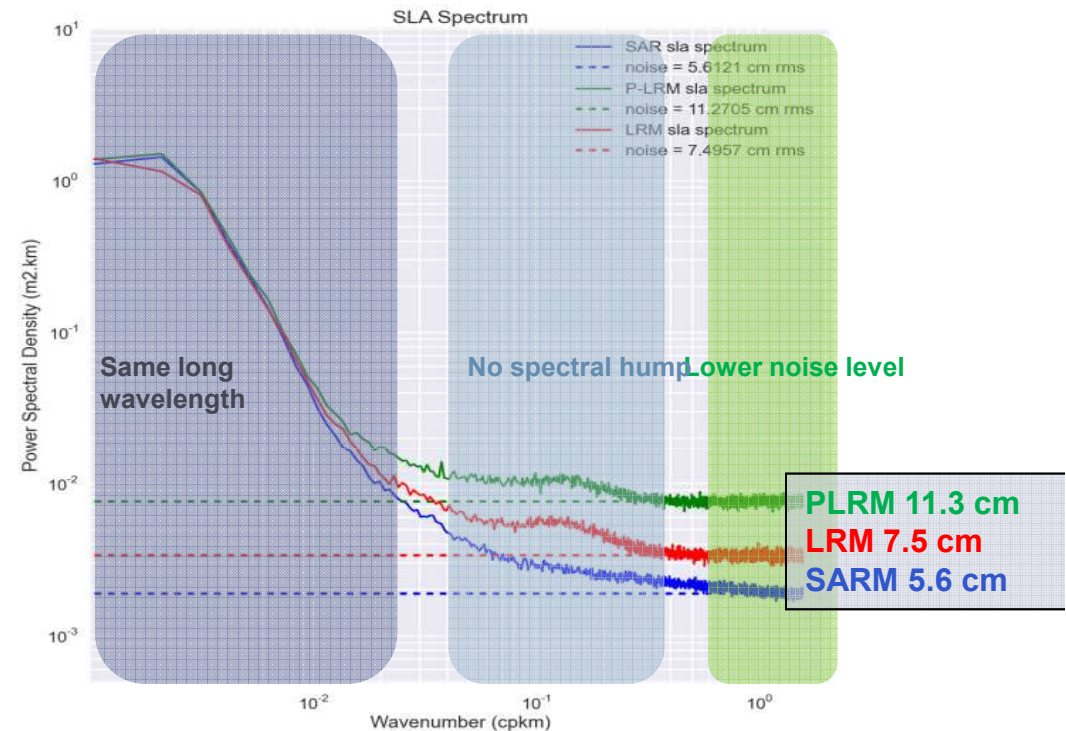
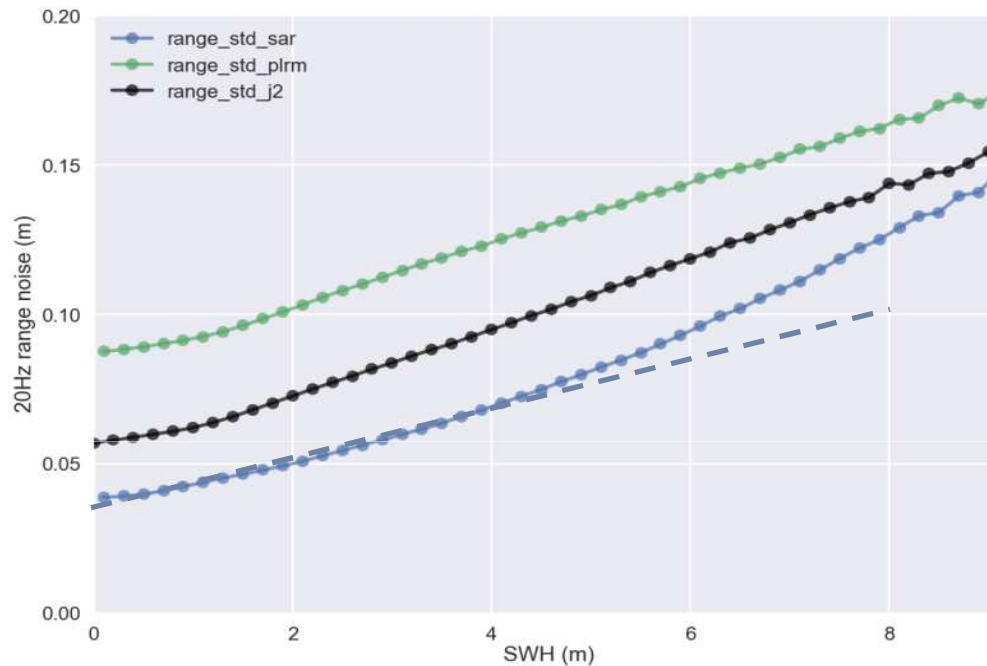
The absolute bias on SWH will be further tuned when switching to SAMOSA 2.5 model.

SWH SARM-PLRM



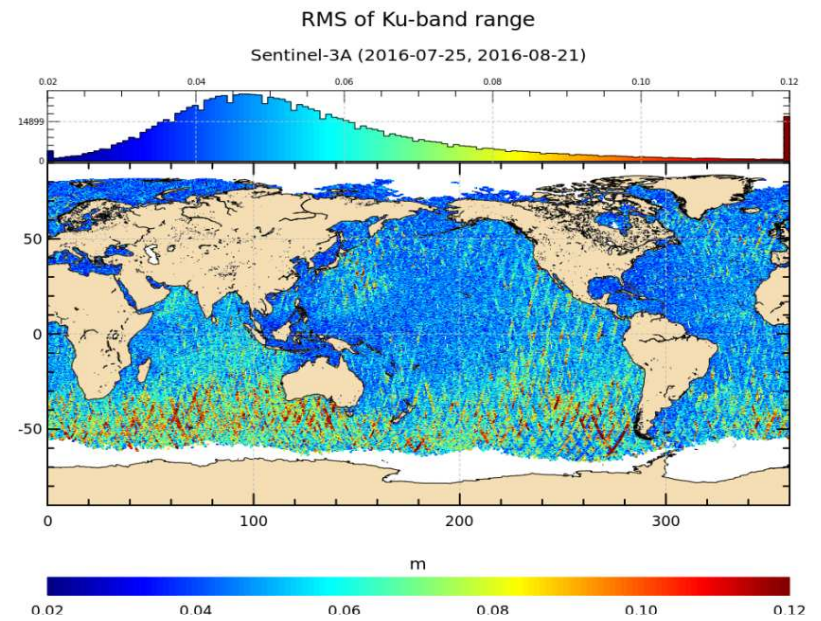
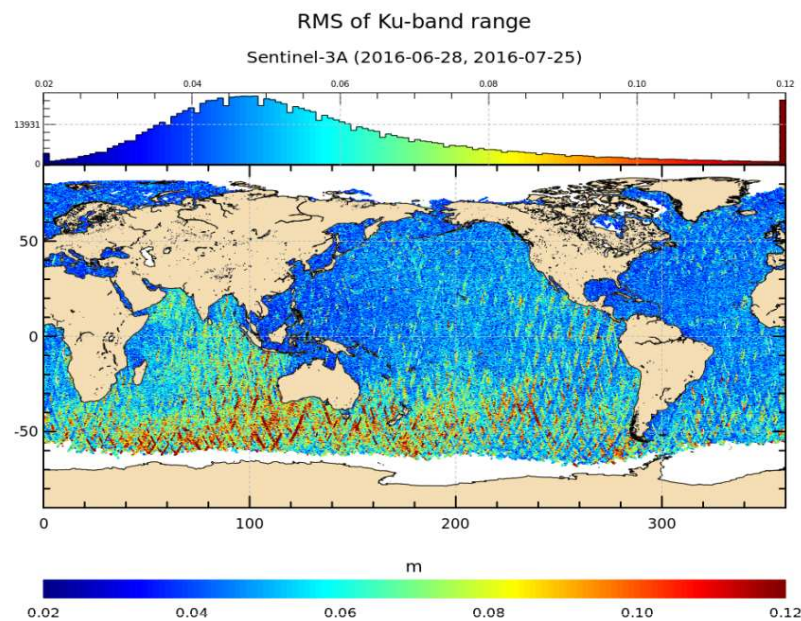
**Residual bias of 30 cm on SARM SWH observed on S3 operational processor and error correlated to SWH for SWH < 3 m.
Difference with S3PP close to 10 cm.**

SAR Assets

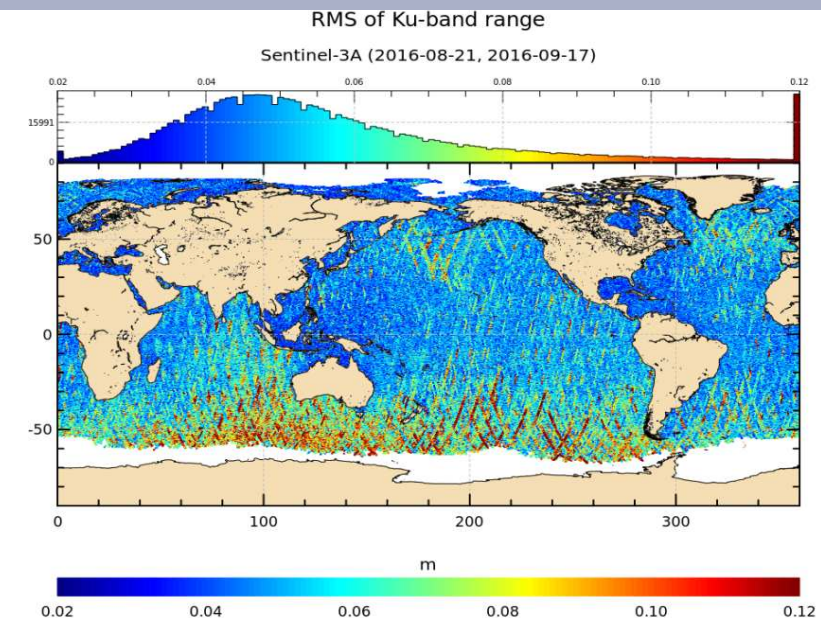
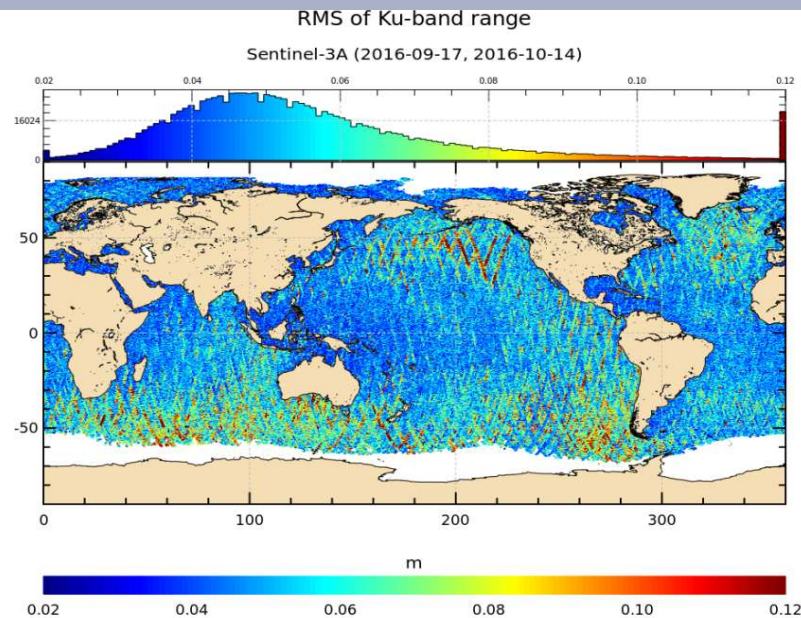


- Precision of the retracked range parameter is in line with the expectations.
 - 5 cm 20Hz range noise for SWH = 2 m
 - No bump for wavelength between 5 and 30 km
 - Long wavelength are consistent between SARM , LRM and P-LRM

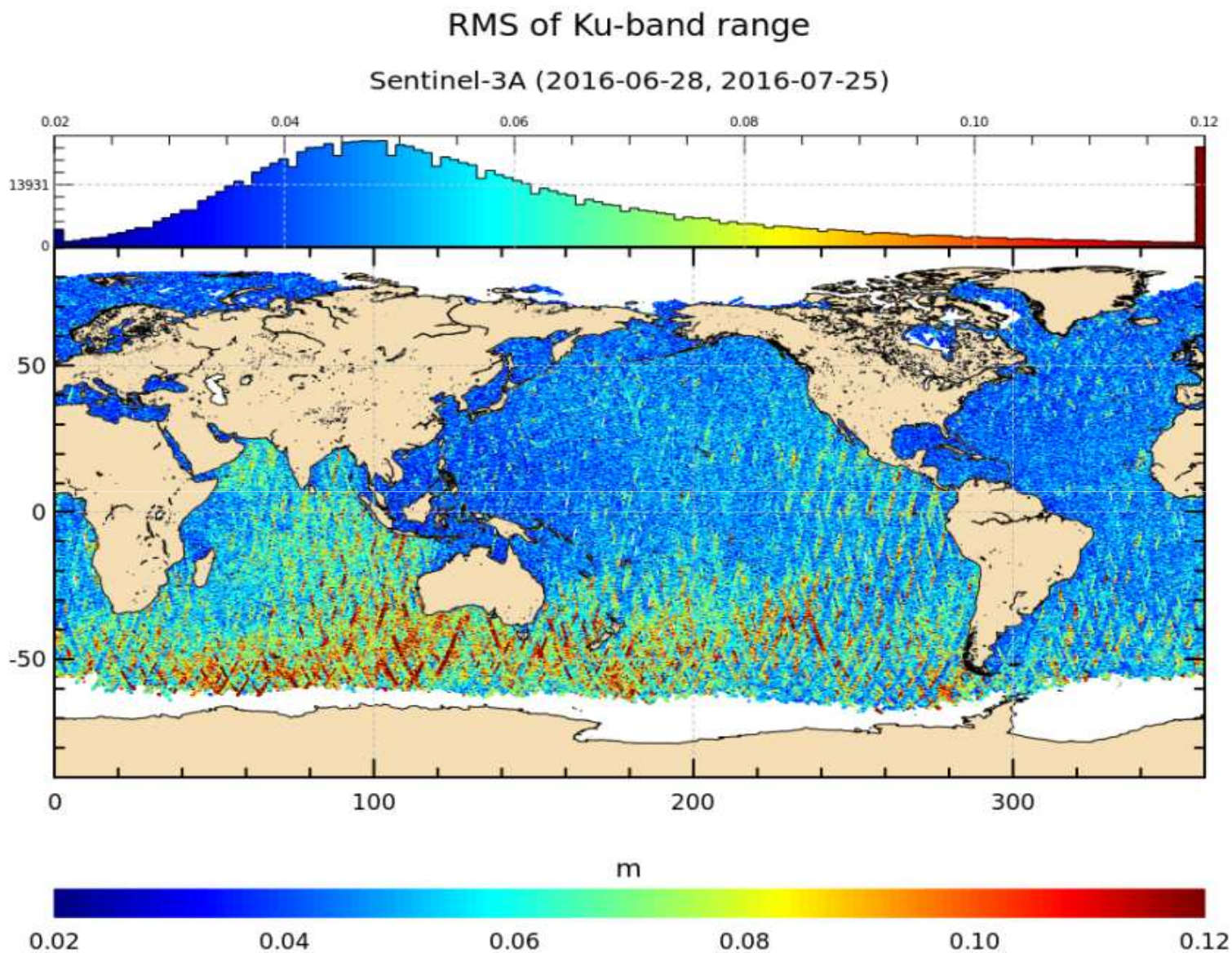
SAR Assets



Swell events signature is observed on SARM 20 Hz range noise



2016, L



Swell events signature is observed on SARM 20 Hz range noise => see more details in Moreau et al (OSTST - Error Session)

Conclusions

- Operational SAR processing very close to S3PP processing
 - Level 1 give similar performances
 - Still some weaknesses with SAMOSA 2.3 retracker partially solved in the next ground processor version
 - Processor version delivered to ESA on 14 Oct, waiting for the installation on ESA and EUMETSAT processing centres, reprocessing already started.
- SAR processing will be improved wrt long wavelength biases:
 - SAR sigma0 residual bias 0.1-0.2 dB
 - SAR Range very close to PLRM (0.5% SWH)
 - SAR SWH still suffer from biases (over estimation wrt PLRM)
- Further improvements expected from SAMOSA 2.5 retracker that will be implemented in the ground segment early next year (recom from CP40 project)
 - More complete model compared to SAMOSA 2.3
 - Takes into account the PTR
 - Corrects for 0 masking effect
- SAR observations are sensitive to the swell (increase of 20 Hz noise)
 - Studies to be done to check potential biases on SARM parameters in case of swell