Lessons learned from Sentinel SARM missions in preparation of Jason-CS

M. Raynal, E. Cadier, S. Labroue, T. Moreau, P. Rieu (CLS)
P. Féménias, F. Bordes (ESA)
F. Boy, N. Picot (CNES)

SENTINEL 3 Mission Performance Centre

CLS COLLECTE LOCALISATION SATELLITES

esa European Space Agency

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Context

- ❑ SARM was recommended to be activated for the first time at global scale by the scientific community and the Copernicus Services:
  Now Sentinel-3A and -3B operate in SARM at global scales, since
  3.5 and 1.5 years respectively :

- ➢ Successful missions for the Copernicus services:
- Excellent data availability
- Excellent data quality and consistency with other altimeters at long wavelengths

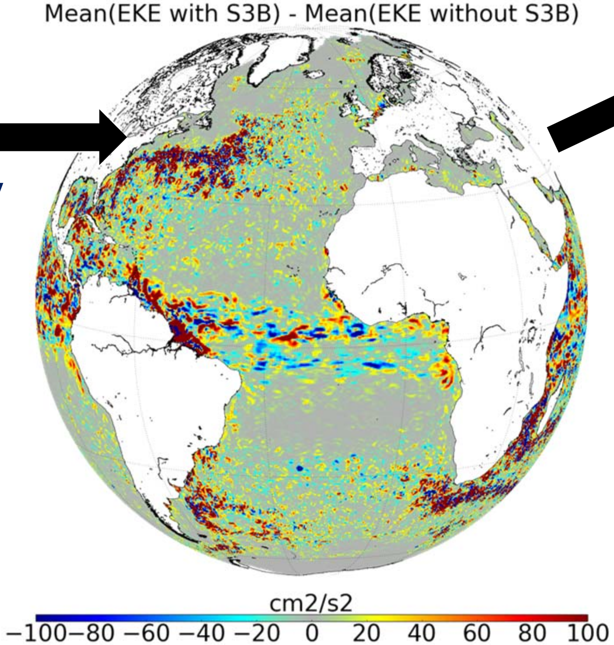
Courtesy: Yannice Faugere

S3B Impact study on L4 products over 1 month (March):

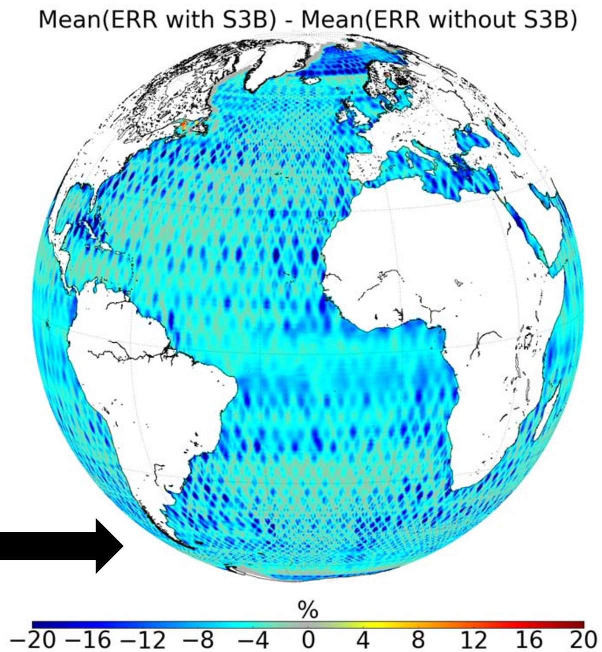
- **Global EKE increase**
  - 150 cm²/s² in high variability areas
  - Decrease near equator : planetary wave

➔ Additional eddies observed when Sentinel-3B is used

➔ Other eddies characteristics changes (amplitude; shape, position)



Sentinel-3B contributes to reduce the mesoscale mapping errors



- **Formal mapping error reduced by ~5%** (locally up to 20%; max at Jason-3 inter-track positions

Impact of Sentinel in CMEMS wave service

Courtesy: Lotfi Aouf

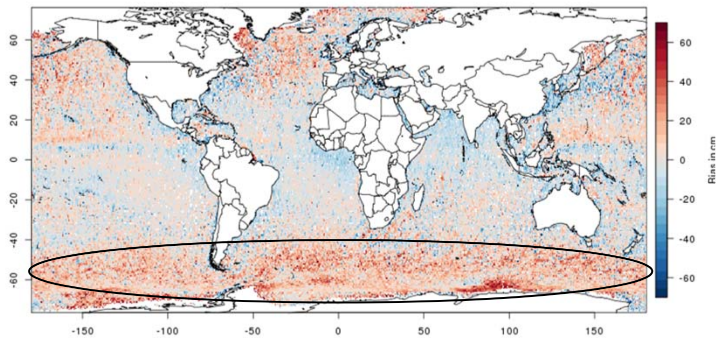
Improvements induced by the assimilation of S3A & S3B altimeters in the global wave height model

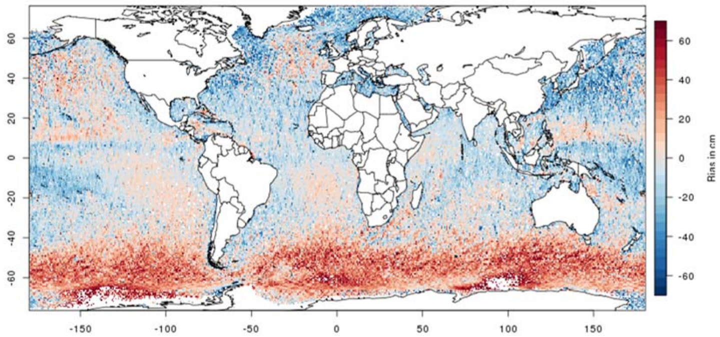
Validation with Jason-3 and Saral/altiKa over Jan-Feb-March 2019

Assimilation of S3A & S3B

Bias (max 50 cm)

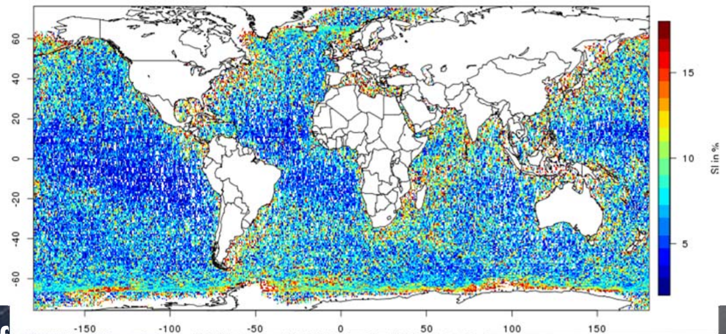
Without S3A –B assimilation

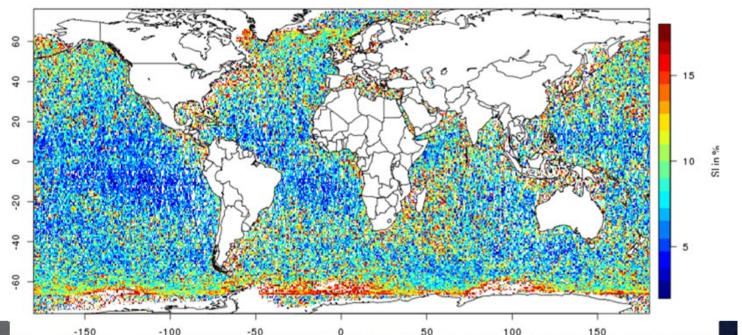




Overall good performance

Scatter index maps in %





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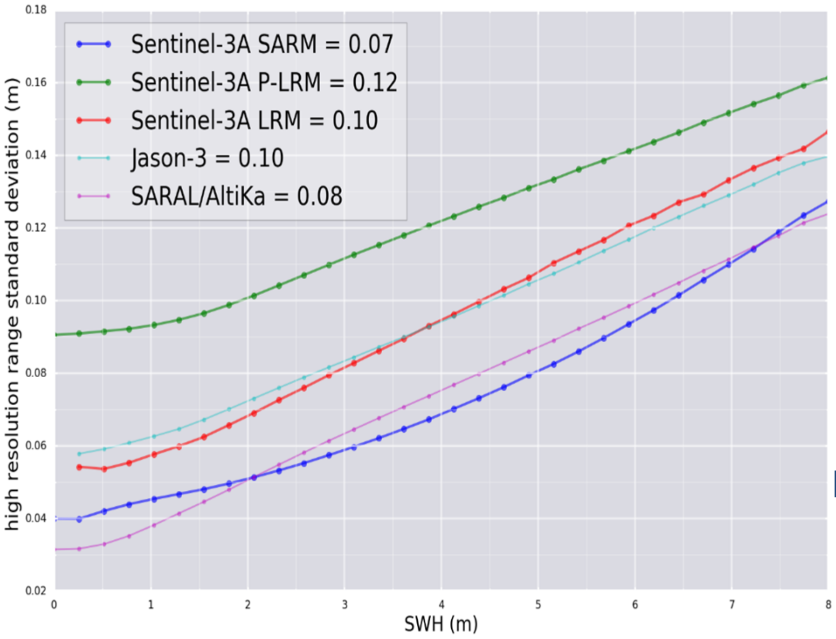
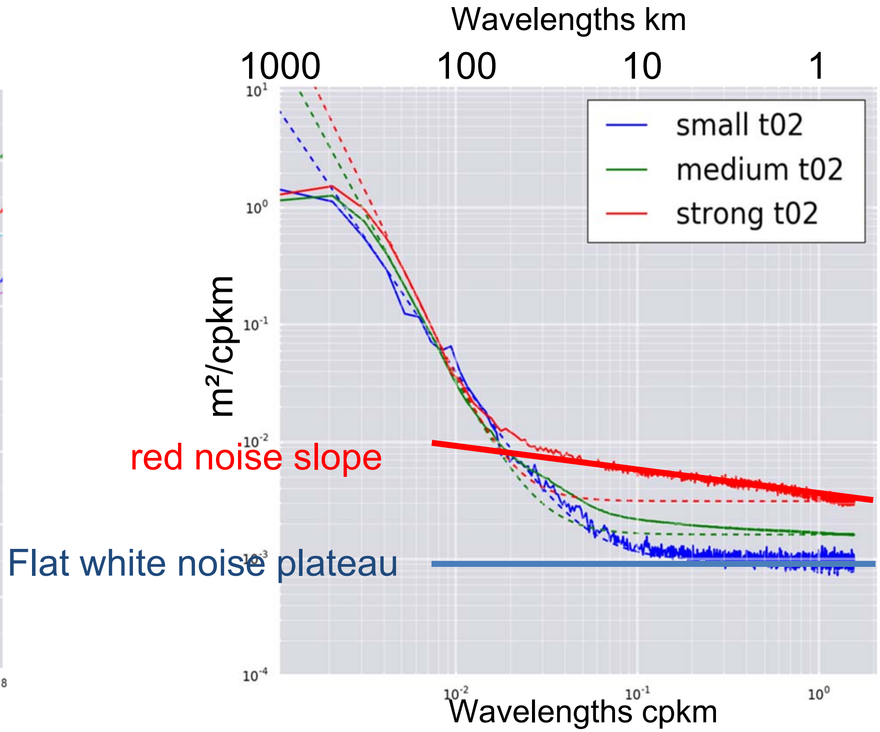
This presentation aims at summarizing / reviewing the remaining limitations to to fully exploit the potential offered by SARM technique.

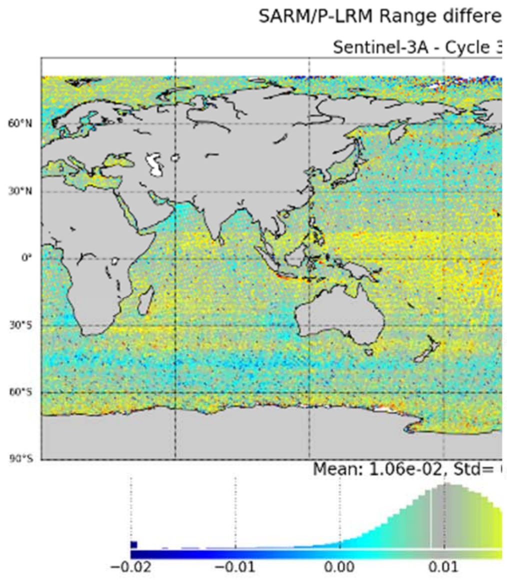
Range and SWH : short wavelength (< 10 km) errors

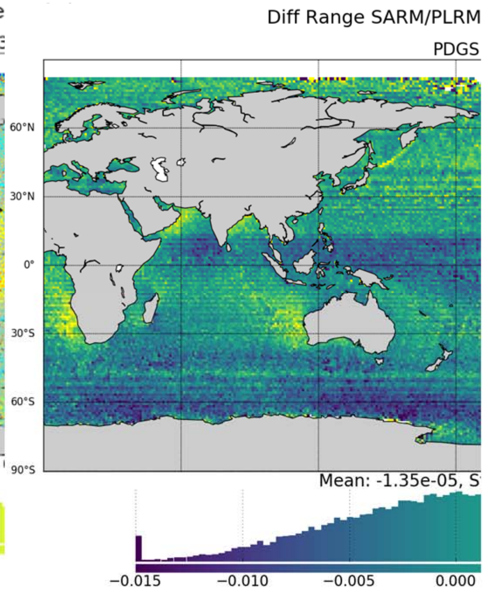


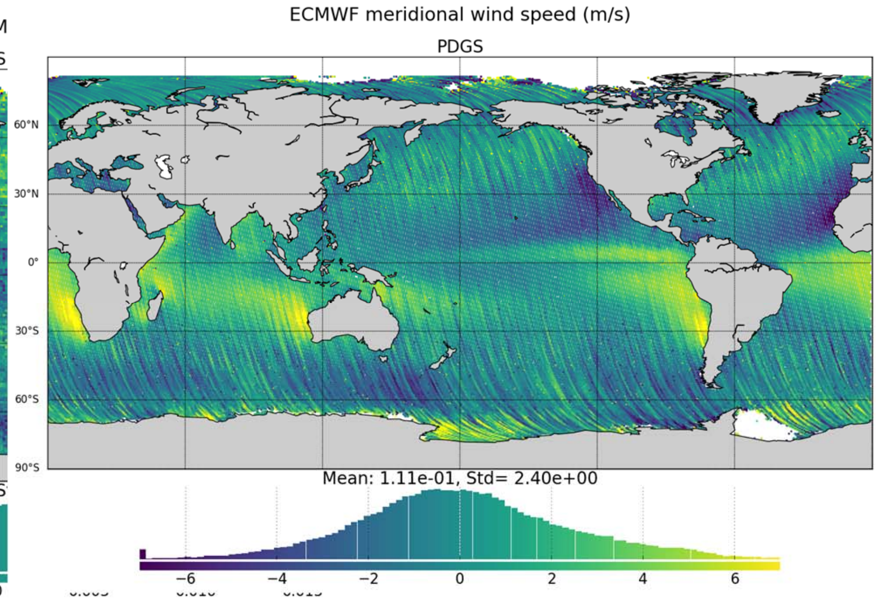


- Although the SARM noise floor (instrumental + processing) is lower than for conventional altimetry, it is affected by swell waves (depends on swell period and direction) ➔ See P. Rieu's presentation based on S3A-B tandem phase results

Range : Long wavelengths errors

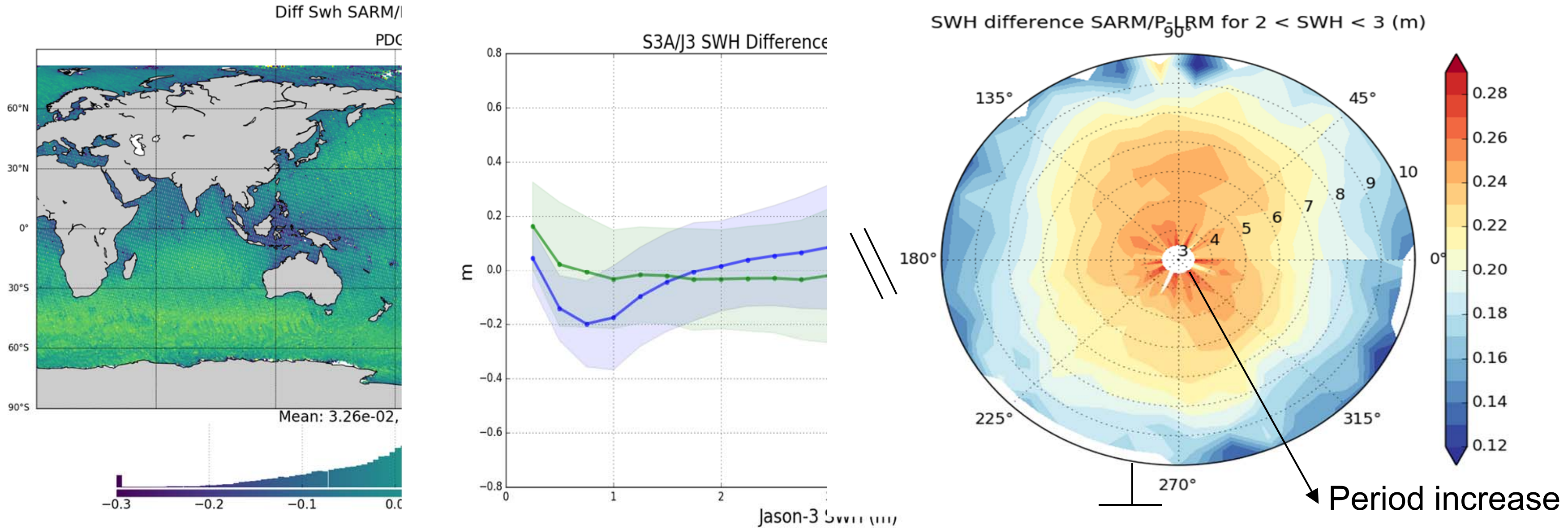






- ❑ Patterns are related to meridional wind speed component

SWH : Long wavelengths errors

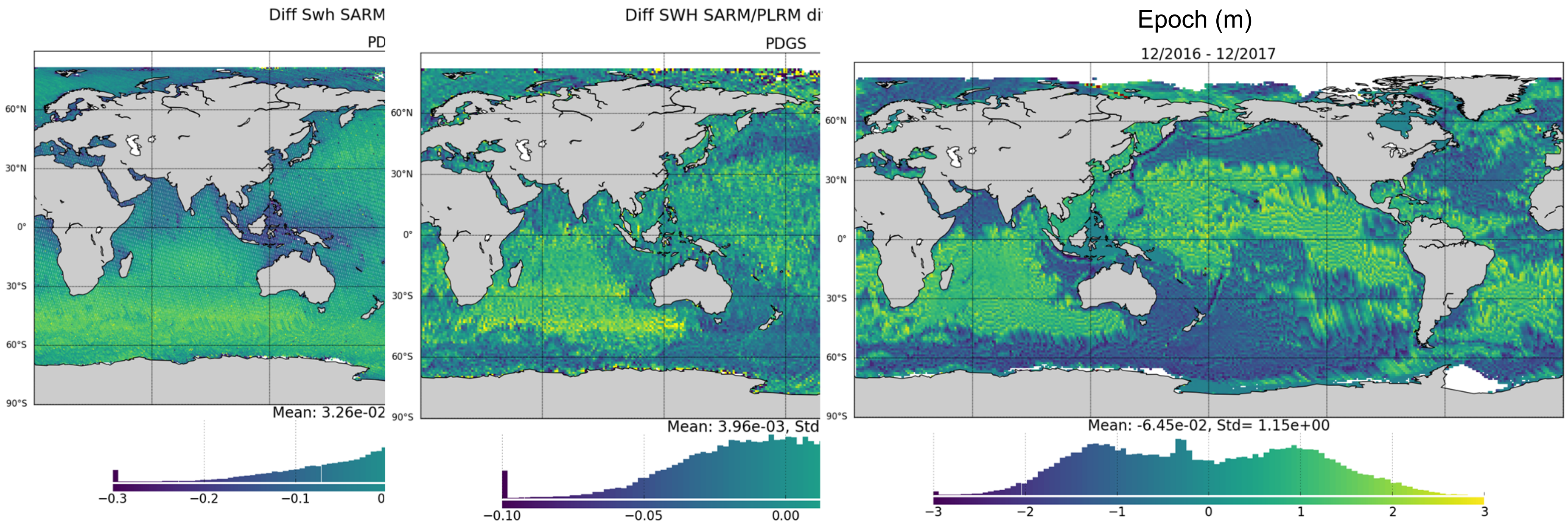


- ❑ SARM SWH are biased wrt to conventional altimetry ➔ this bias depends on wave height, wave period and wave direction

➔ This result is observed using different SARM model approaches (analytic / numerical) for different satellites S3A, S3B and Cryosat-2

➔ Ongoing studies / first results show that this effect could be related to wave orbital velocity (C. Buchhaupt / A. Egido / A. Laiba results)

SWH : Long wavelengths errors

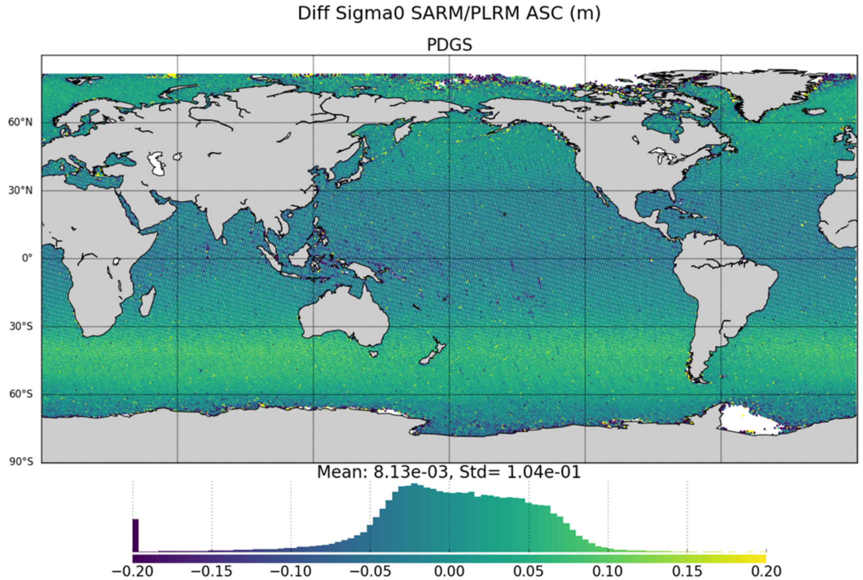


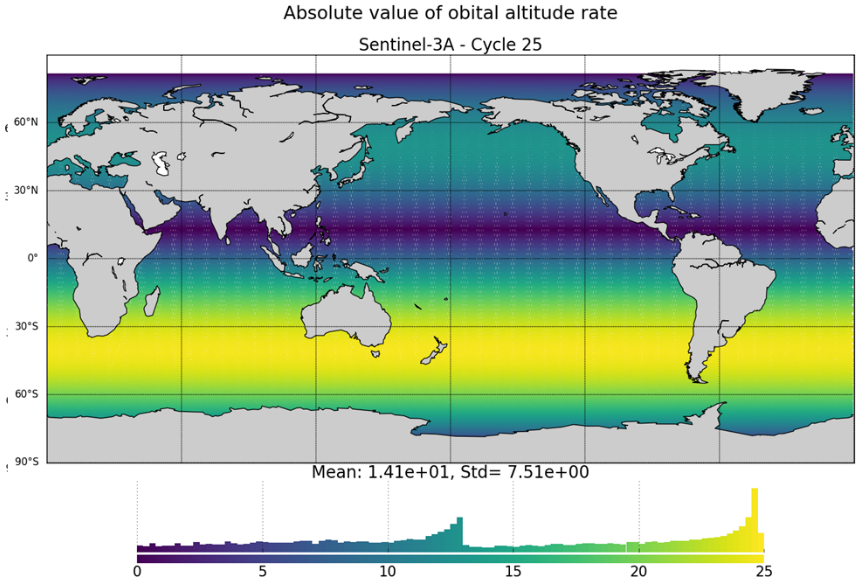
❑ Other effect to explain slight differences observed between ASC and DSC passes ?

EPOCH LR-RMC ASC (dB)

➔ Effect of the waveform centering: solution based on SARM model 0-masking is under investigation

Sigma0 : Long wavelengths errors

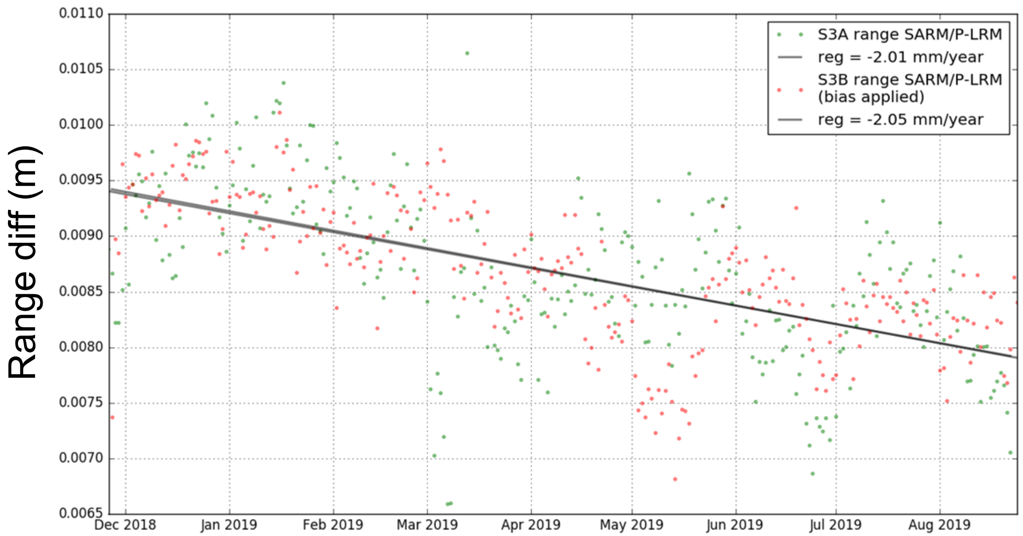




- ❑ Small bias between SARM and P-LRM sigma0 related with satellite radial velocity

This 0.1 dB error impacts wind speed estimation by 30 cm/s
(0.03 dB ➔ 10 cm/s on wind speed from Ablain et al. 2012)

Climate scales errors



- The SARM /P-LRM range comparisons (without SSB correction) clearly highlight variations as function of time:
  - This variation is not related to the PTR shape evolution (shown by J. Poisson et al.) as its effect has similar magnitude on SARM and P-LRM ranges and cancels out in the difference
  - This variation is also observed on other retracker (S3PP dataset)
  - This variation is also observed in Sentinel-3B (while SRAL-B is in different regime) thus is instrument independant

Sentinel-3 SARM errors : Summary

- ❑ Sentinel-3A & 3B instruments and derived datasets meet the requirements and fully contribute to the ocean monitoring in the Copernicus services.

- ❑ Summary of the SARM residual small errors observed with respect to conventional altimetry
  ➔ it should be investigated to improve:

- Our understanding of the SARM sensitivity to geophysical effects.
- Data quality to prepare for Jason-CS and future missions

Param	Error	Amplitude	Wavelength
Range & SWH	Swell impact (T02, Dir)	~several cm	<= 10 km
Range	Meridional wind speed effect	2 cm	>100 km
SWH	Wave height dependency	10/15 cm	>100 km
SWH	Swell dependency	5/10 cm	>100 km
SWH	waveform centering dependency	10 cm	> 100 km
Sigma0 / WS	Radial velocity dependency	0.1 dB / 30 cm/s	> 100 km
Range	Temporal drift	1 mm/y	> month
?	others	?	?


Thank you for your attention
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