New stacking method for removing the SAR sensitivity to swell

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Acknowledgments to my co-authors :

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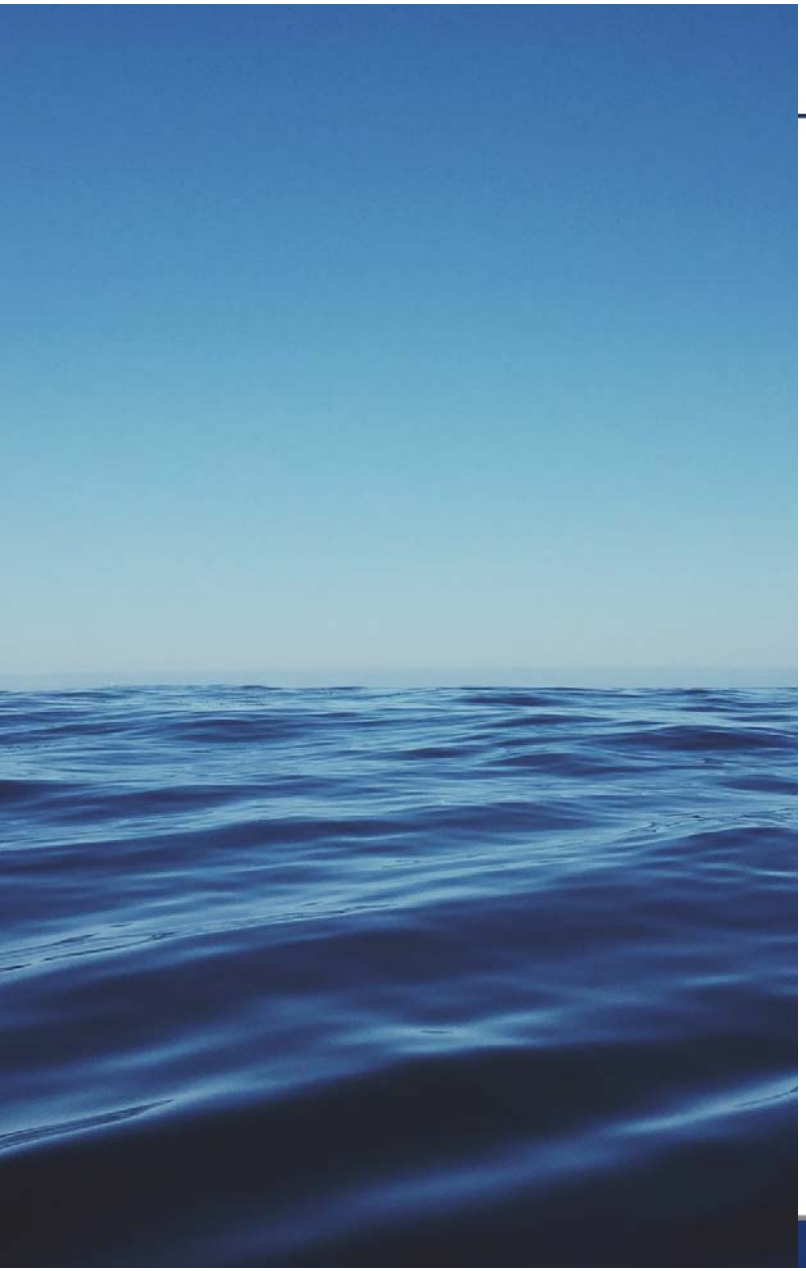
Pierre Femenias (ESRIN)

Nicolas Picot



Frame of the study

CNES collaborates with ESTEC and ESRIN to design, develop, and assess new L1 and L2 algorithms to improve the SARM performances on Sentinel-3/Sentinel-6 missions.

Technical support from CLS team

Few examples of studies:

- ❖SWH bias investigation
- ❖Hamming / 0padding benefits depending on surface type
- ❖Focused SAR processing
- ❖SAR echo model accounting for mean square slope
- ❖**New stacking process**

Is it really new?

« Yes » because different from the operationnal process implemented in the Sentinel-3 PDGS

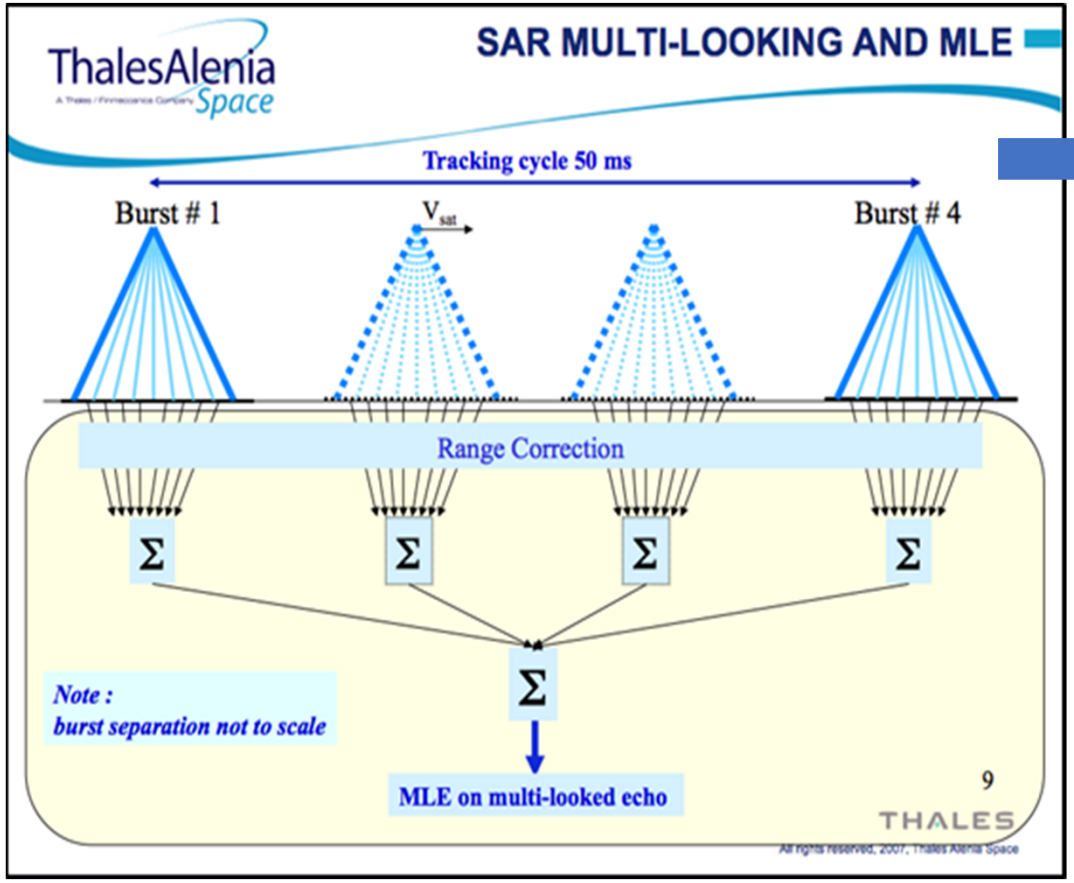
« Not really » because:

- already implemented and used by **Thales Alenia Space** during the Cryosat-2 in-flight assessment *[Phalippou and Demeester, 2011]*
- part of the science processors planned on **Sentinel-6** (as experimental)

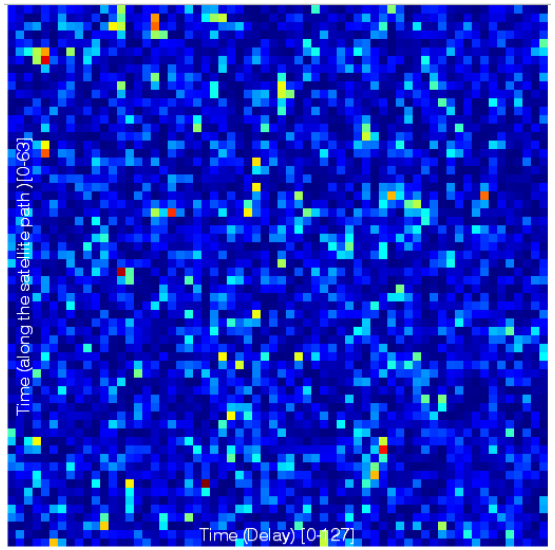
LR-RMC

Low Resolution** with **Range Migration Correction

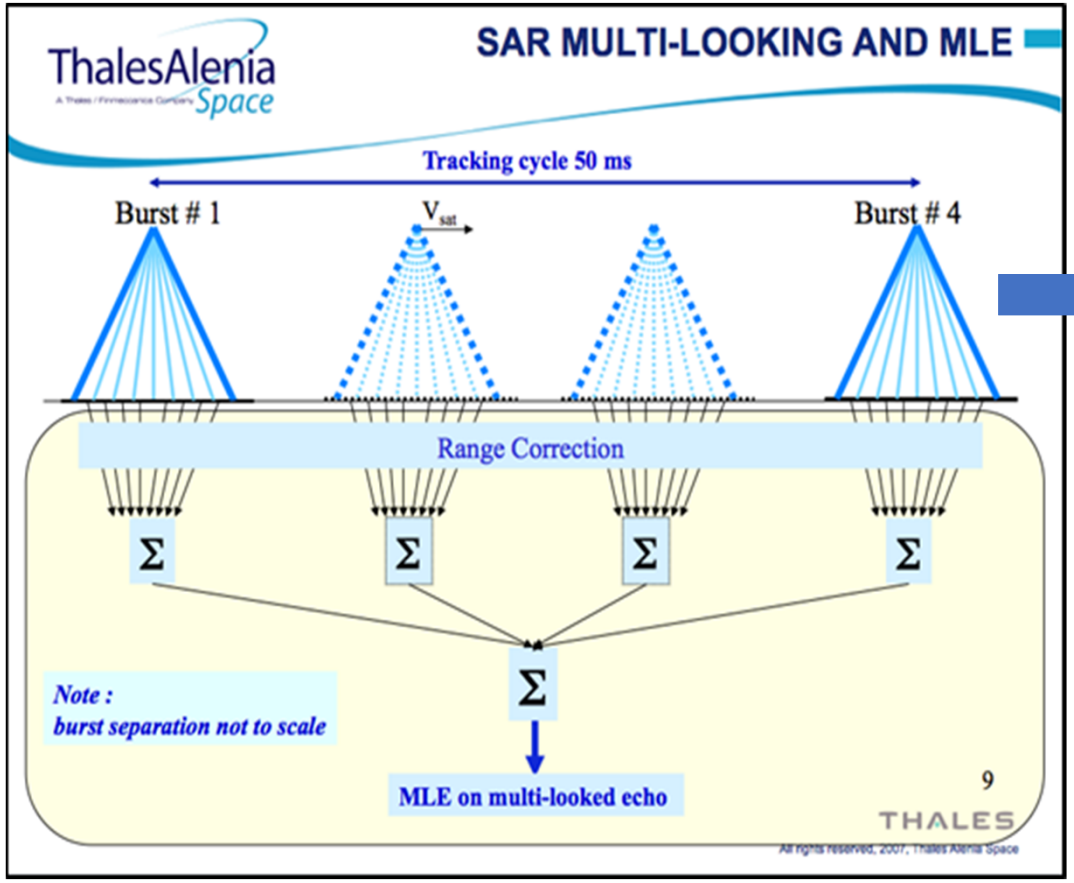
LR-RMC Processing Scheme



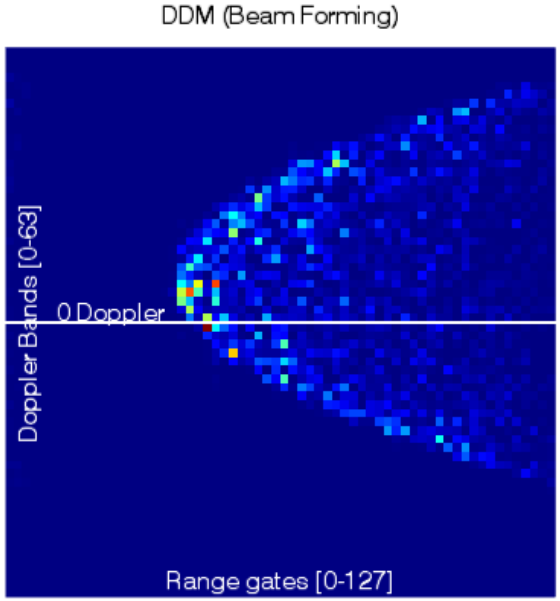
SAR Raw data



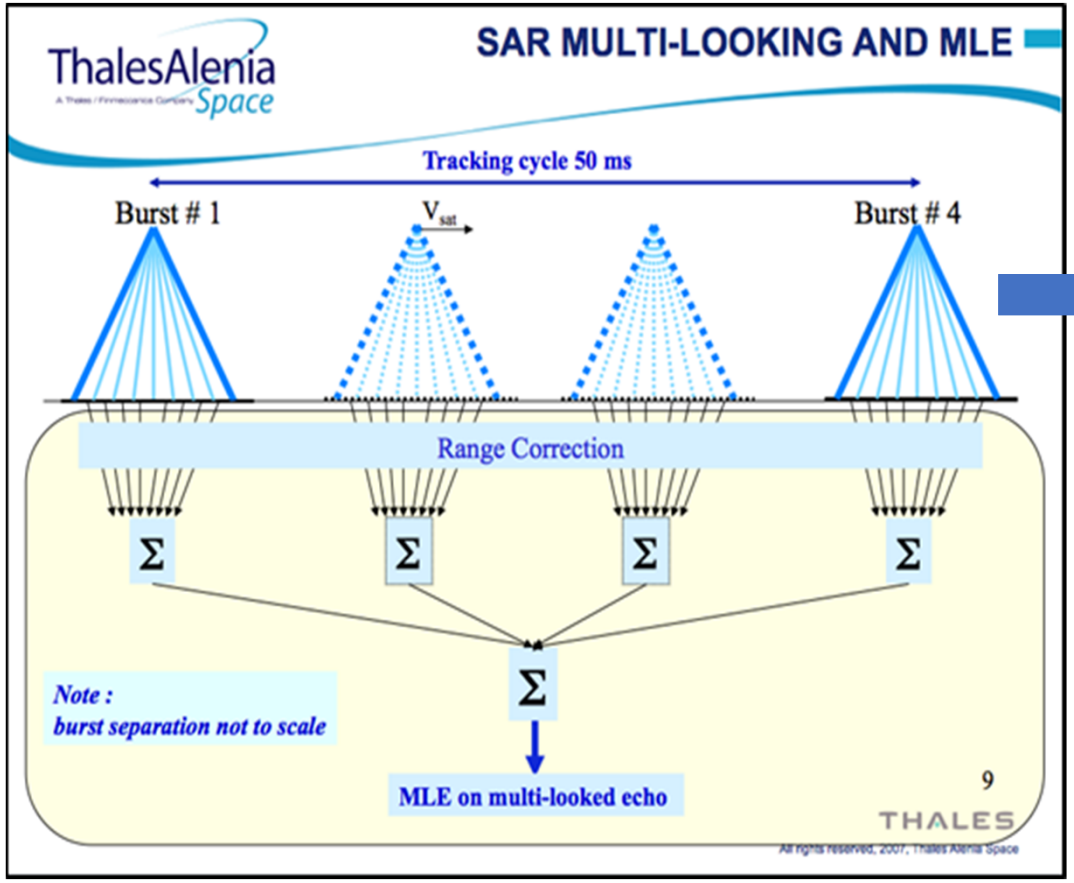
LR-RMC Processing Scheme



Beam Forming
(Unfocused SAR, AT FFT)



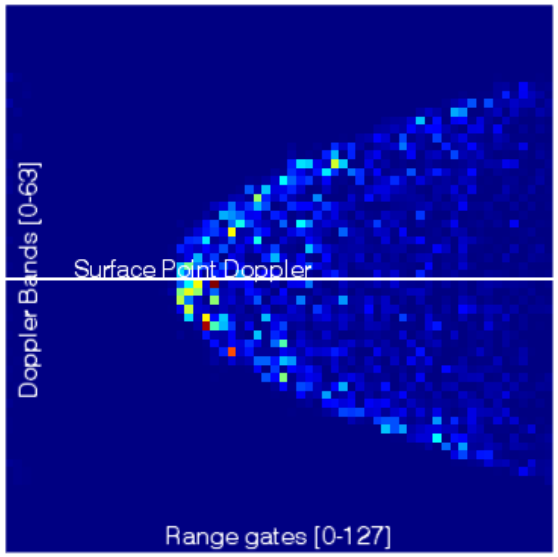
LR-RMC Processing Scheme



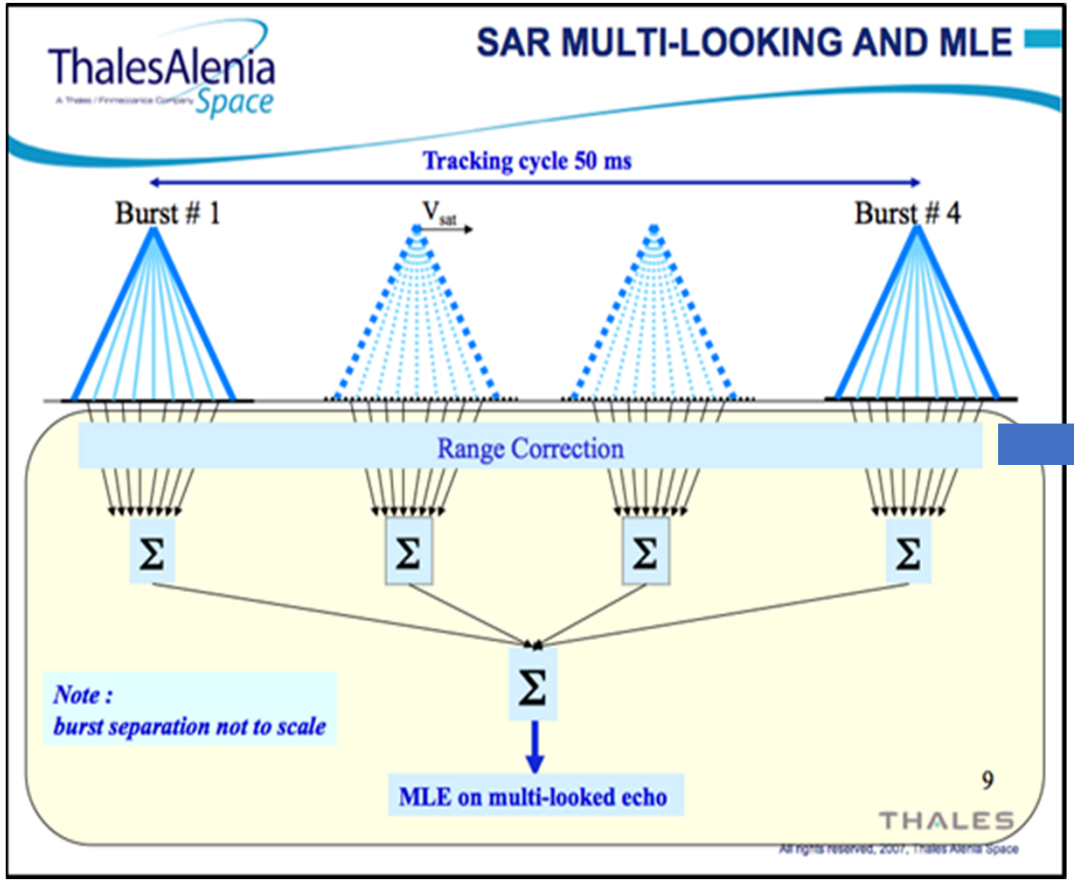
Beam Steering

On nadir location

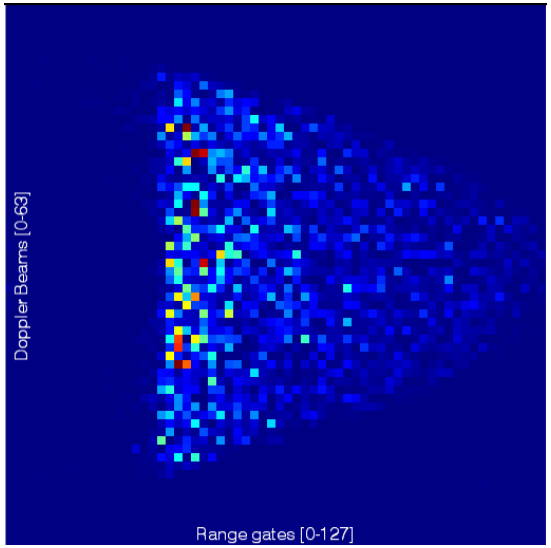
DDM (Beam Steering)



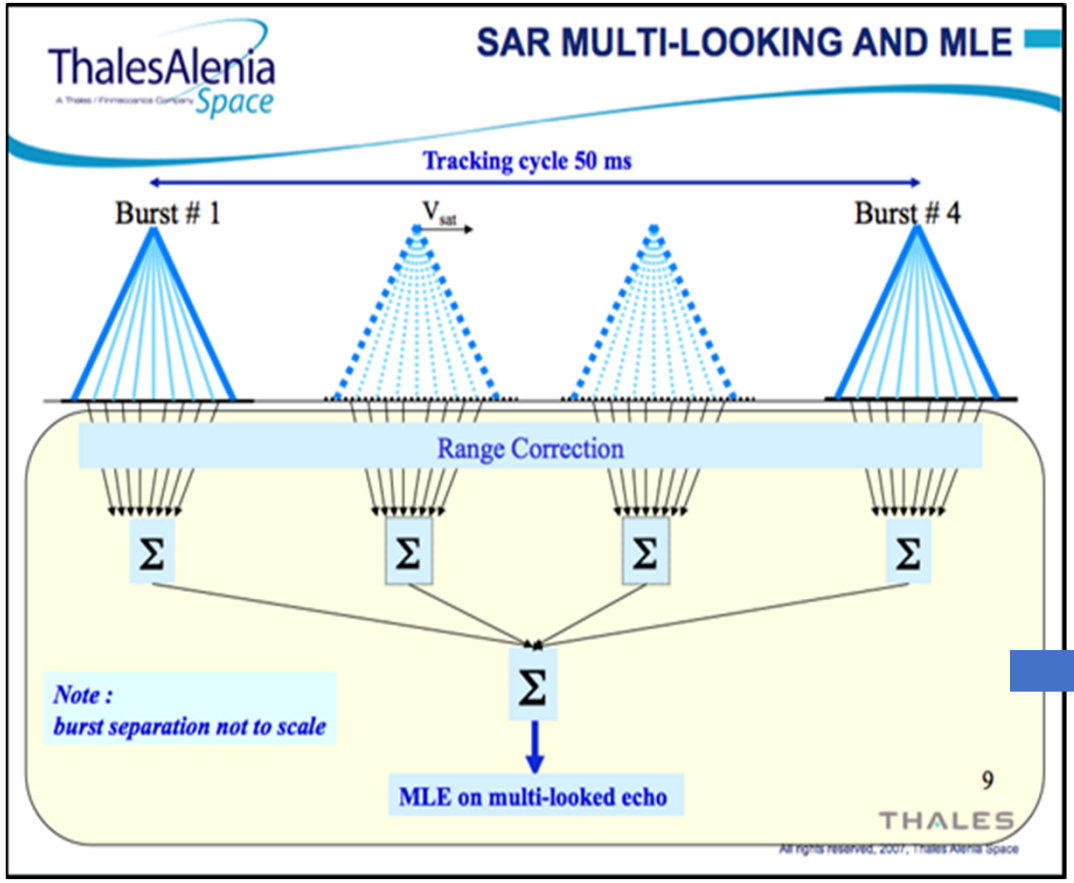
LR-RMC Processing Scheme



Range Migration Correction

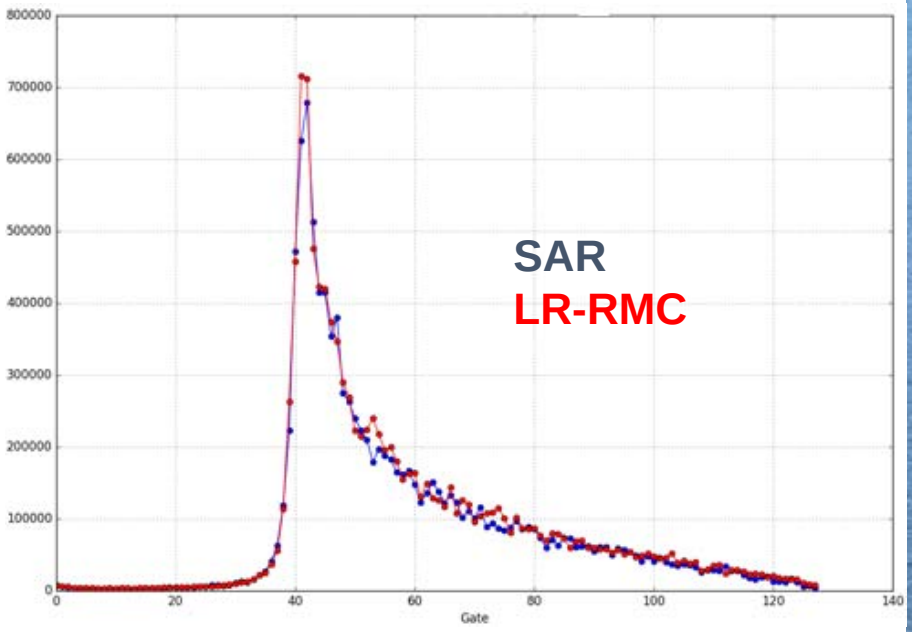


LR-RMC Processing Scheme

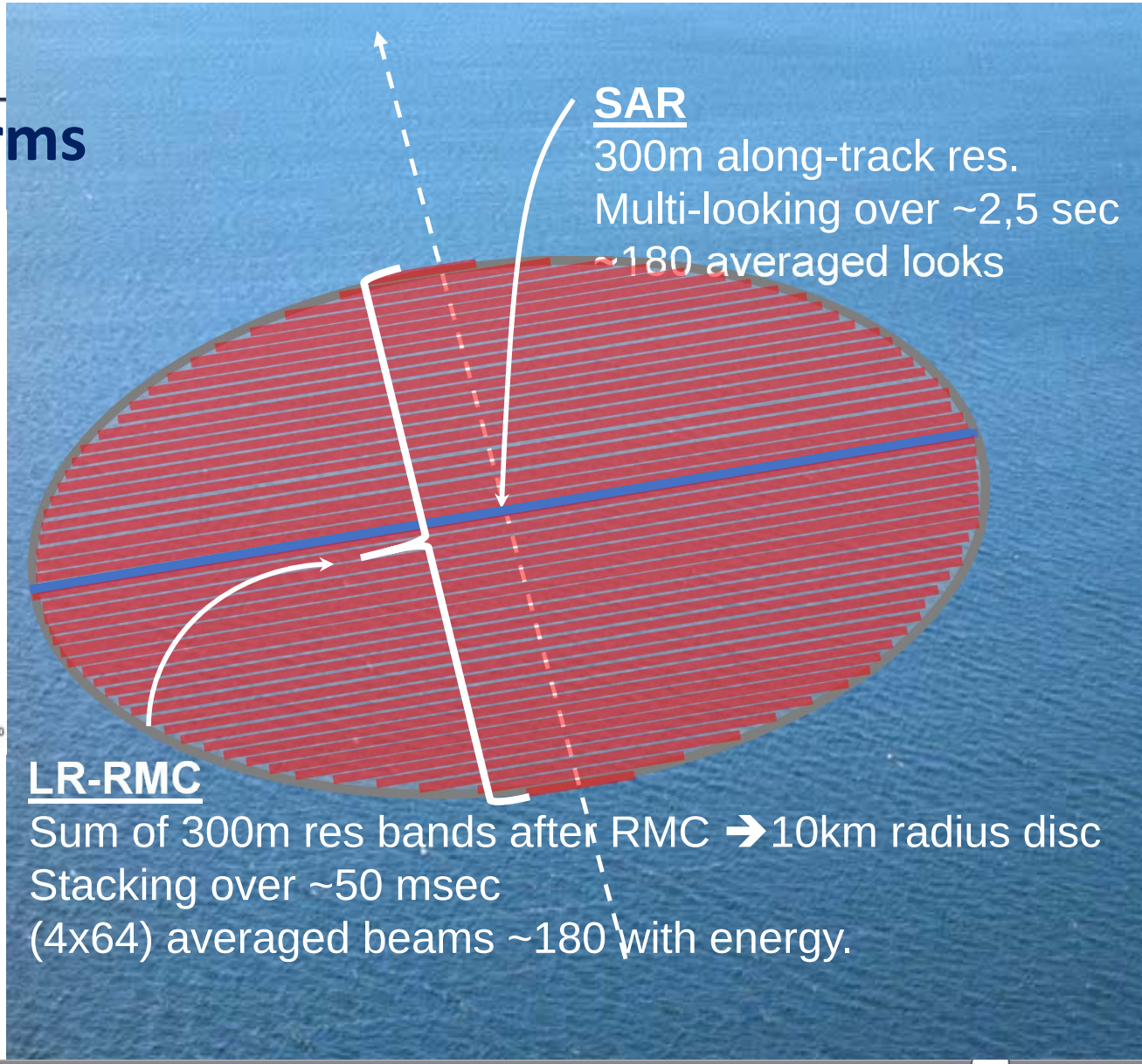


Stacking
within the tracking cycle
(4 bursts)

LR-RMC vs SAR waveforms



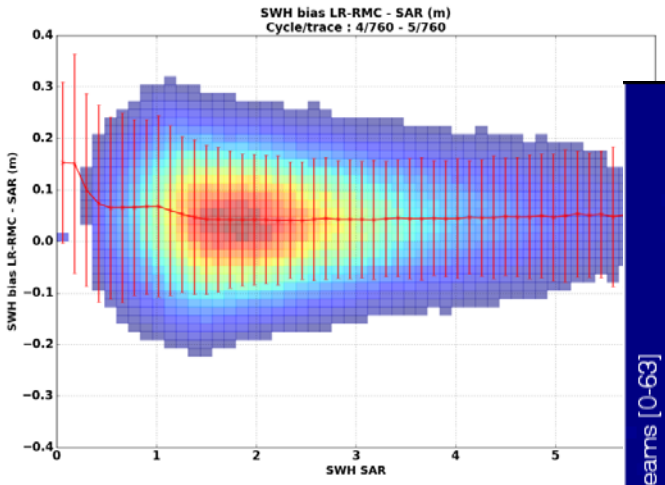
- Similar shapes (thanks to RMC)
- Nadir look/beam are the same
- Same level of SNR
- But different on-ground resolution and ML/Stacking duration

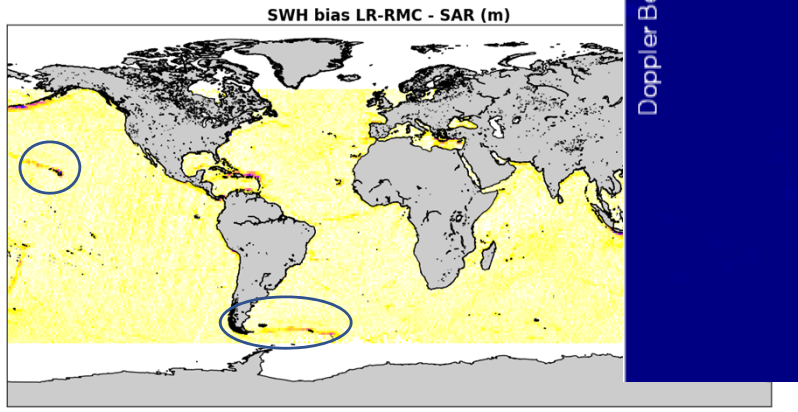


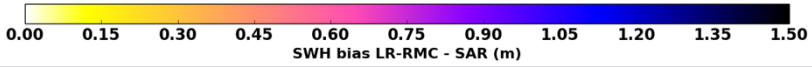
LR-RMC Performance Assessment

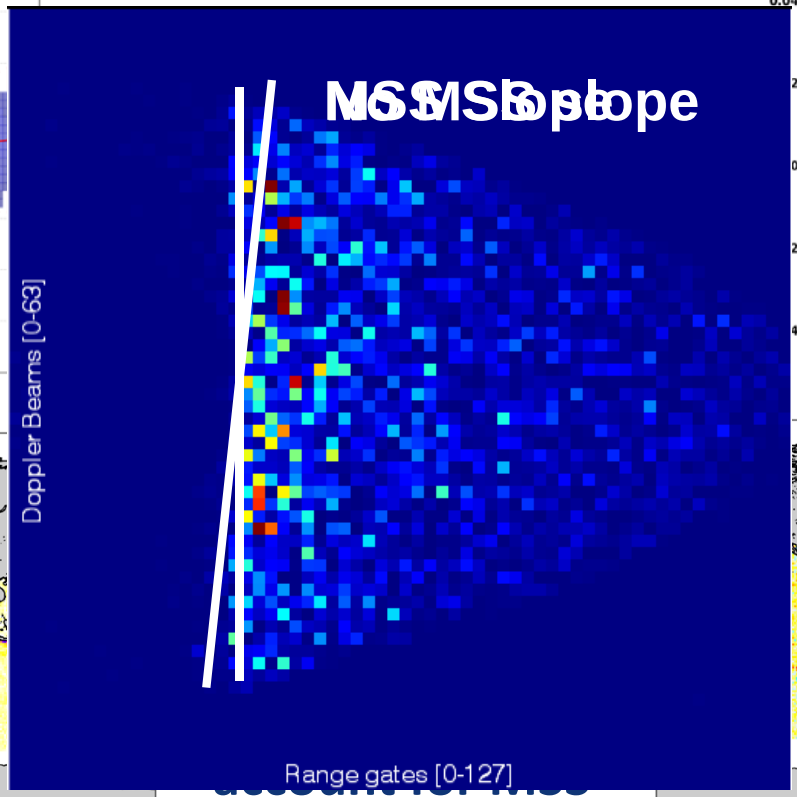
Accuracy wrt SAR

SWH

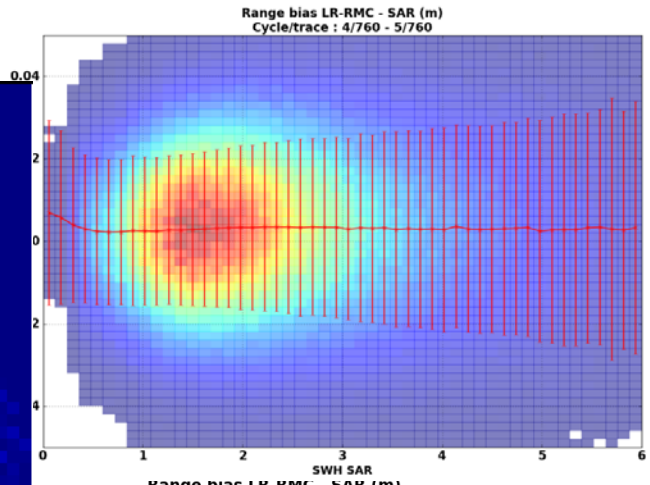


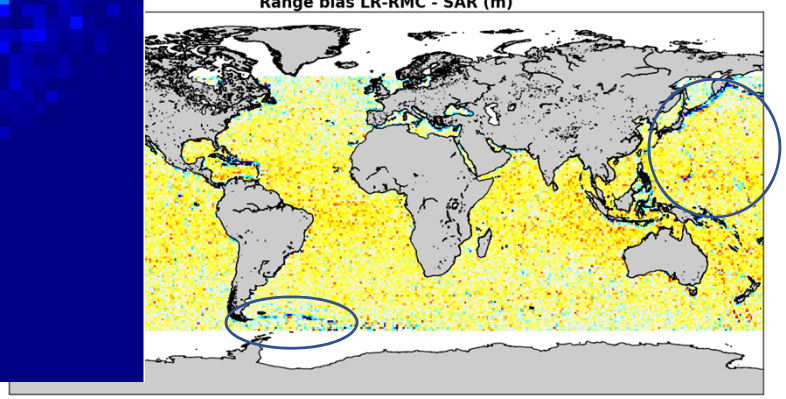


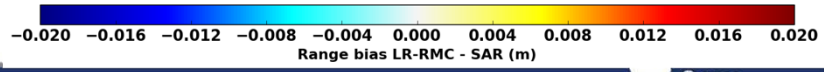




Range



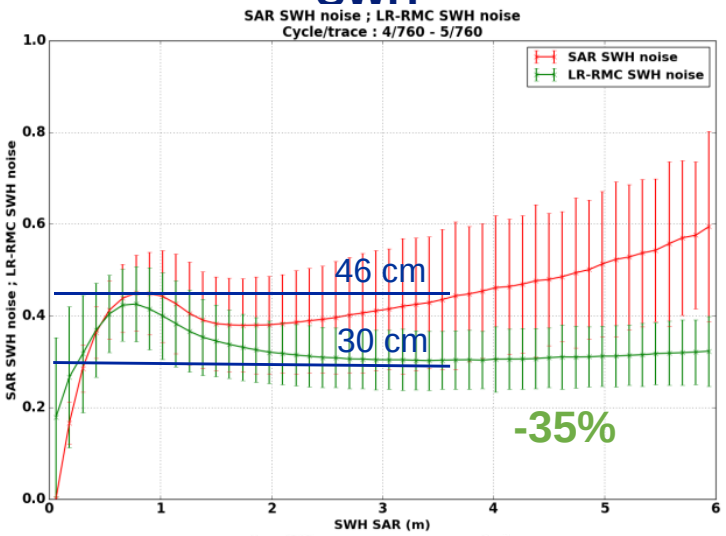




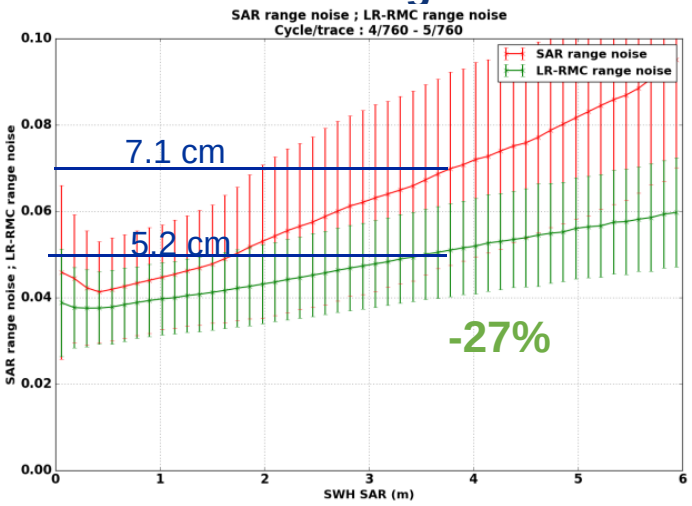
LR-RMC Performance Assessment

Precision wrt SAR

SWH

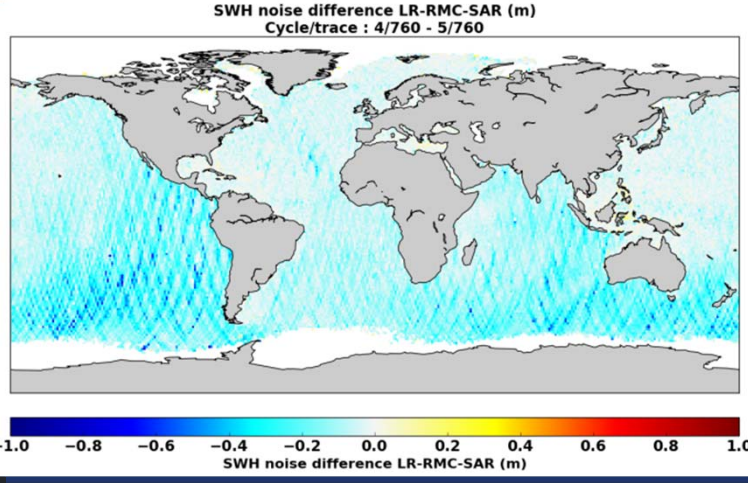


Range



Large noise reduction

Range STD = 9mm@1HZ (SWH=2m)



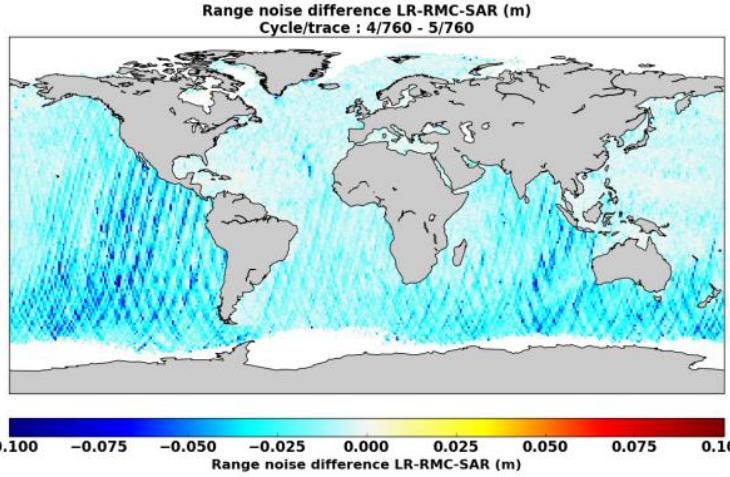
Noise difference map

→

High reduction for specific sea conditions

→

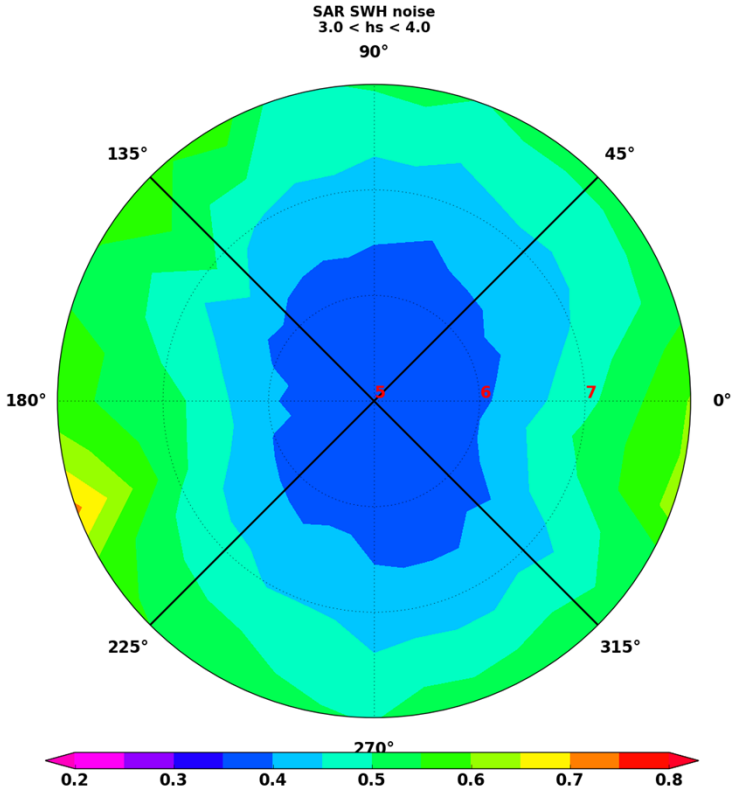
Swell conditions?



LR-RMC Performance Assessment

Current SAR processing : Swell sensitivity

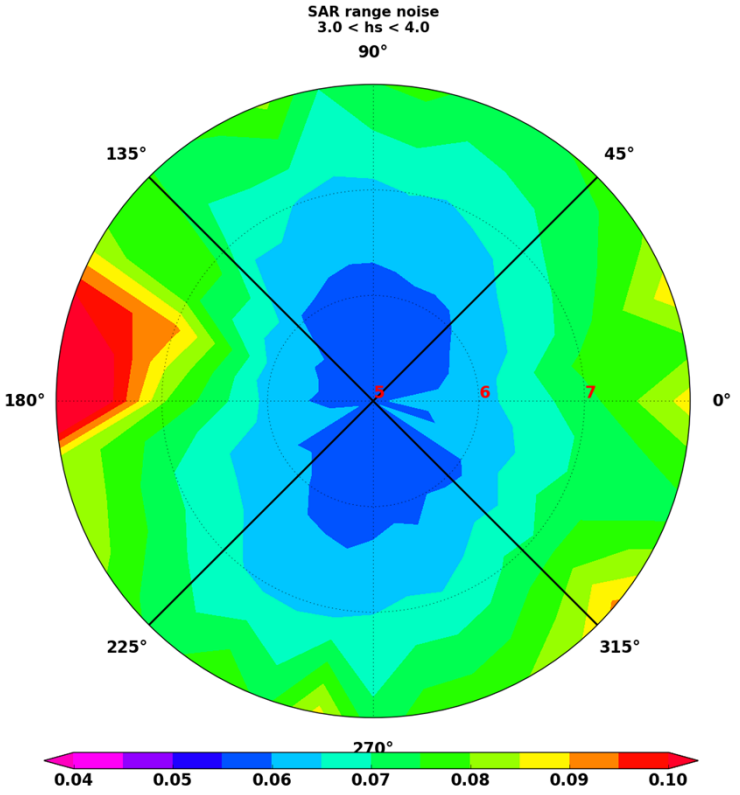
SWH/Range noise (m) against mean swell period (radial distance, in seconds)
and azimuth angle (angle between track and mean swell direction **from WW3**) for 3 m < SWH < 4m



High noise degradation in case of colinear swell

OSTST 2016
(Moreau, Aouf)

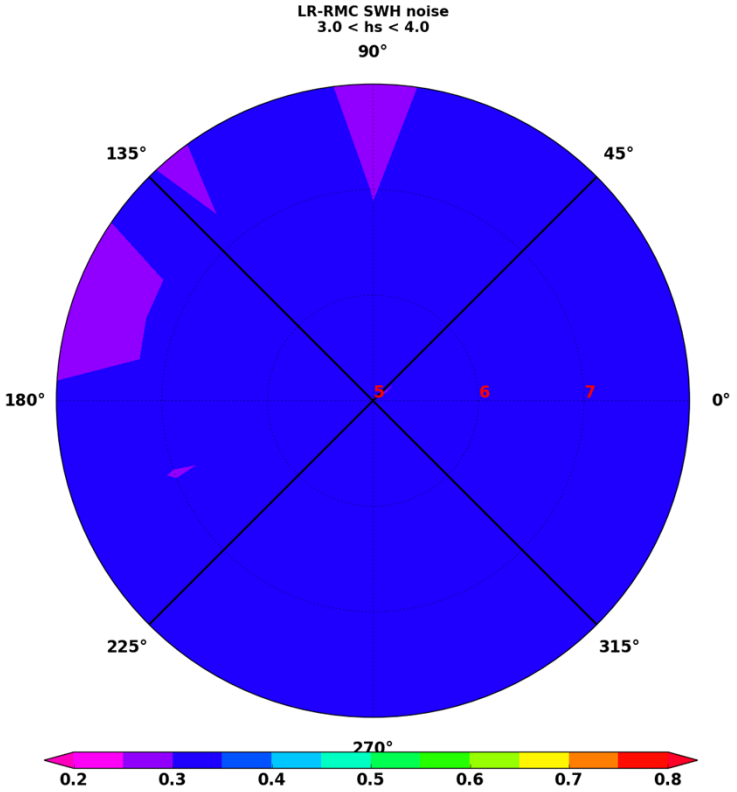
Approach angle
0 & 180 : colinear
90 & 270 : perpendicular



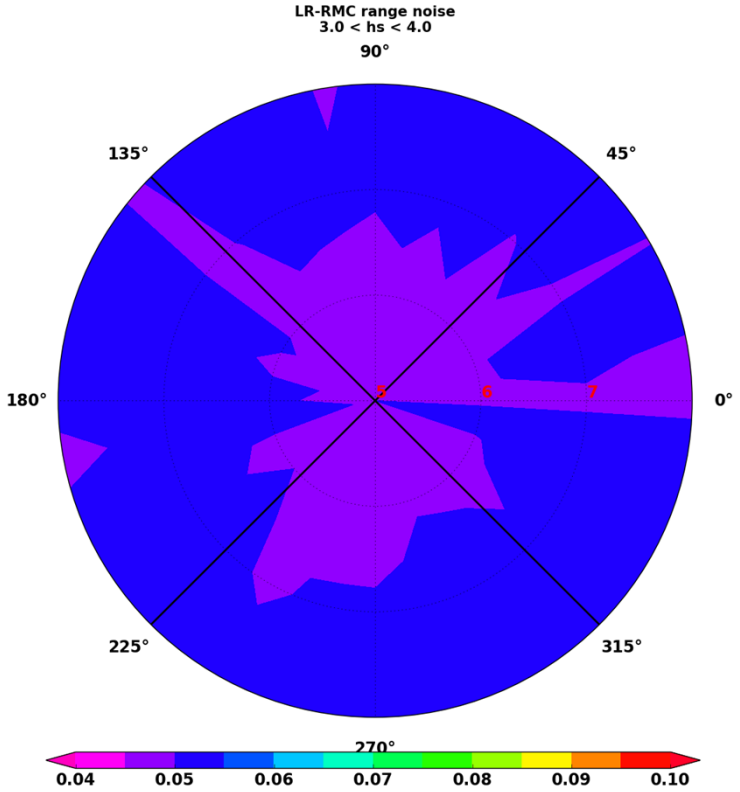
LR-RMC Performance Assessment

LR-RMC Swell sensitivity

SWH/Range noise (m) against mean swell period (radial distance, in seconds)
and azimuth angle (angle between track and mean swell direction) for 3 m < SWH < 4m



No Swell sensitivity in LR-RMC

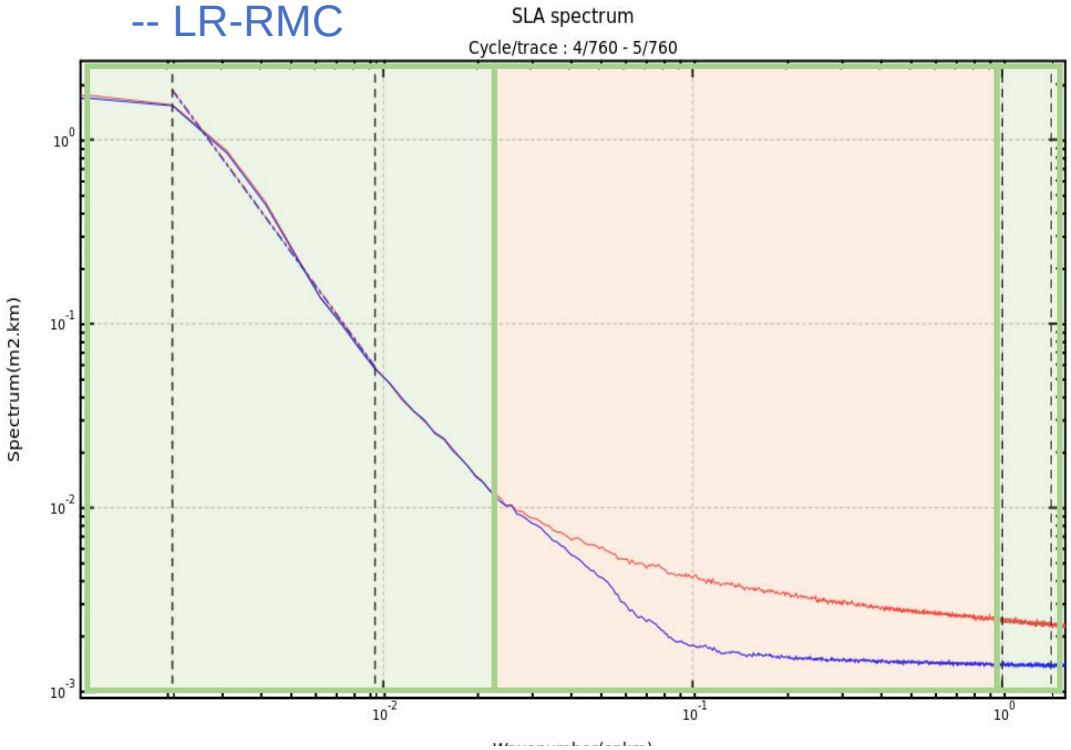


Approach angle
0 & 180 : perpendicular
90 & 270 : parallel

LR-RMC Performance Assessment

Spectral analysis

-- SAR
-- LR-RMC



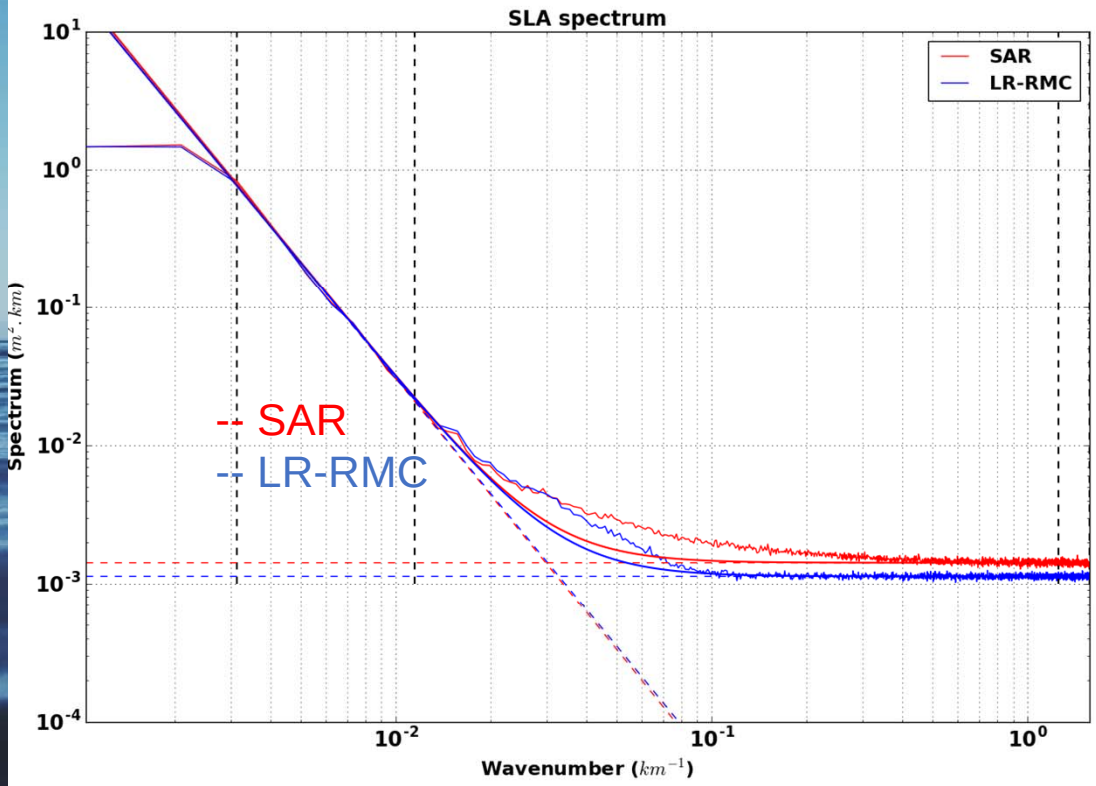
Global analysis:

- Large noise reduction on HF content
- Same behavior on large scales
- SARM exibits a red noise for scales lower than 50km, linked to swell conditions
- Despite a low filtering effect à20km, LR-RMC spectra is cleaner

See CALVAL Session (Wed, 11:15):
Sentinel-3A STM Mission Performance after 1 year in orbit (Sylvie Labroue *et al.)*

LR-RMC Performance Assessment

Spectral analysis



Analysis for low swell conditions:

With low T02 and SWH selection, SAR spectrum goes closer to LR-RMC spectrum

Conclusions

LR-RMC offers a major improvement over open ocean:

- No bias at global scales
- 10%-40% noise reduction on Range and SWH
- Stable performances whatever swell conditions

Workplan (2018) :

- Improvement of RMC accounting for the mean sea surface slope

(or) Estimation of the MSS slope directly from the retracking

- Developement of a weighted retracking (MLE)
- Characterization of the SLA spectra errors (in space and time)
- One year Sentinel-3 reprocessing campaign using LR-RMC as baseline

Goal:

To propose end-2018 an operationnal implementation of LR-RMC processing as a complementary solution of the current SAR processing for ocean application.

Thank you for your attention