CryoSat-2 SAR Mode Over Ocean: One Year of Data Quality Assessment

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Introduction

CNES has performed **the reprocessing of one year of Cryosat-2 data** using the Cryosat Processing Prototype (CPP):

→ Full LRM and SARM coverage (No SARin)

→ Period from May, 2012 to April, 2013

→ All surfaces (ocean, inland waters, ice sheets)

→ Level2 products are available: same NetCDF format than J2 GDR products and close content (SLA, SWH, Sigma0, Geo Corr…)

→ Those products are available on ftp server

The scope of this talk is to present **the data quality assessment of CRYOSAT-2 SAR data over ocean. Here are the diagnostics performed:**

→ Cross comparison with Jason-2 (analysis at crossover points)

→ Comparison between SAR and RDSAR (pseud-LRM) measurements

→ Analysis of LRM to SAR/RDSAR continuity

→ Spectral analysis

Few words about the processing

From FBR to Level2 for SARM and LRM

- LRM:

Processing inherited from Jason-2.
MLE4 retracking using Brown model.

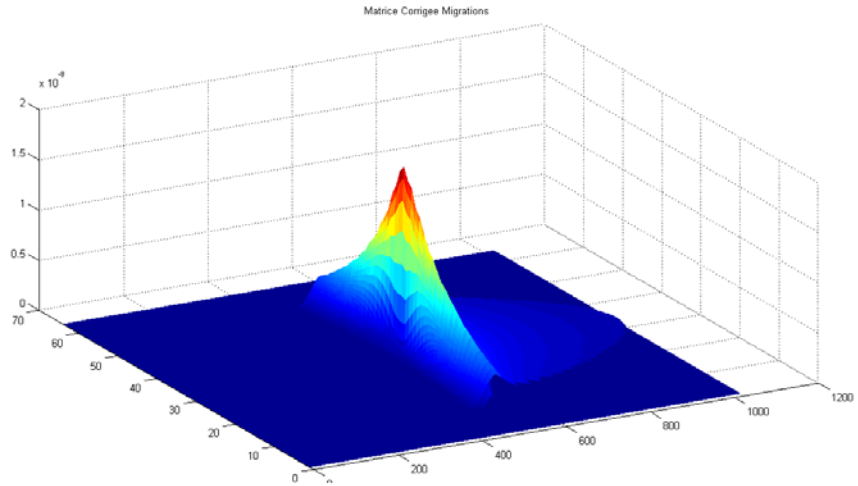
- SARM:

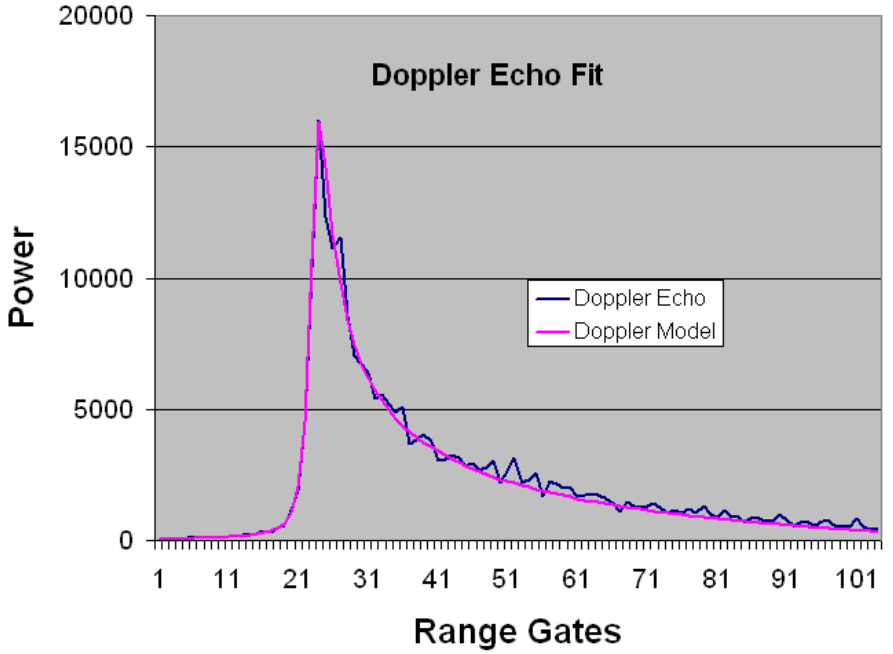
Use of a Doppler model built with a numerical approach (numerical computation of the radar echo shape).
The retracking is inherited from Jason-2 MLE3:

- Model derivatives are numerically computed
- Use of mispointing angle given by the StarTrackers as an input (required because of the Doppler echo model sensitivity to mispointing variation).

- RDSAR (pseudo-LRM):

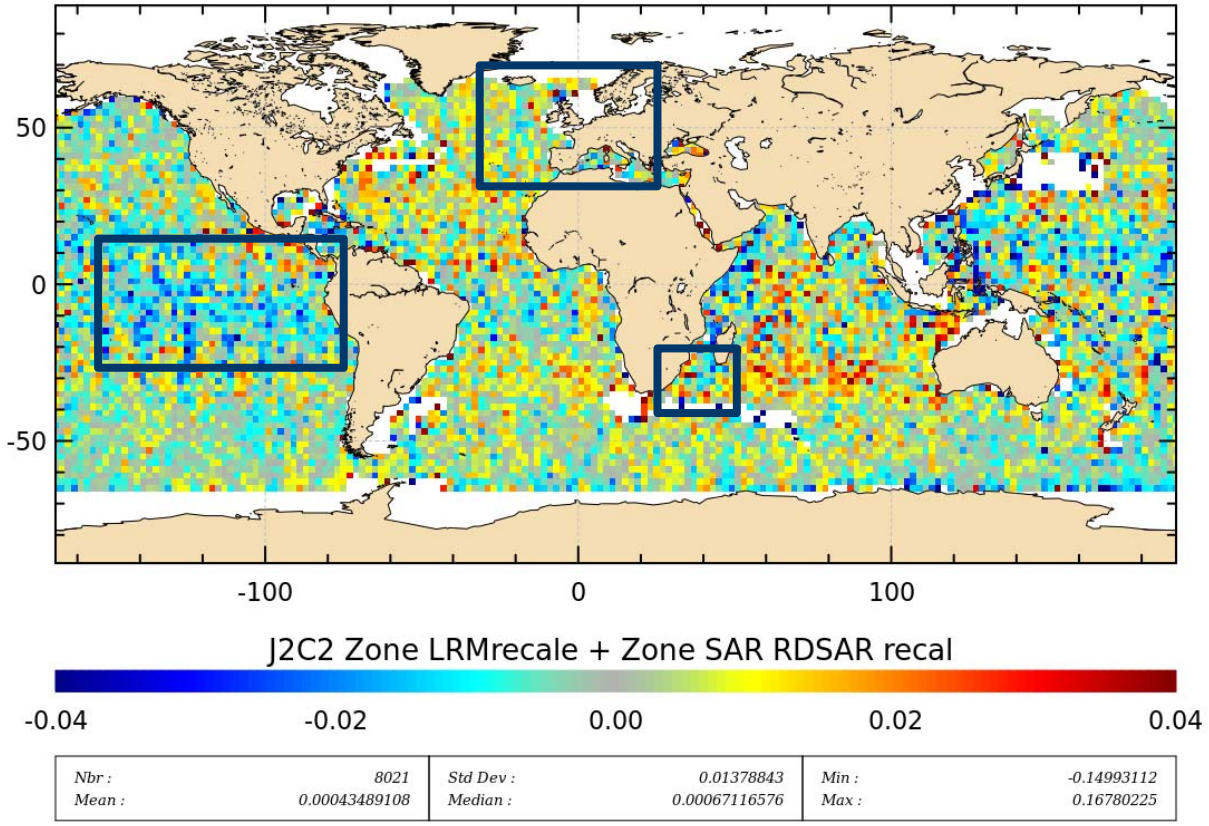
Low resolution reference built from SAR measurements to calibrate this new mode. Processed as a LRM measurements.





RDSAR reference assessment

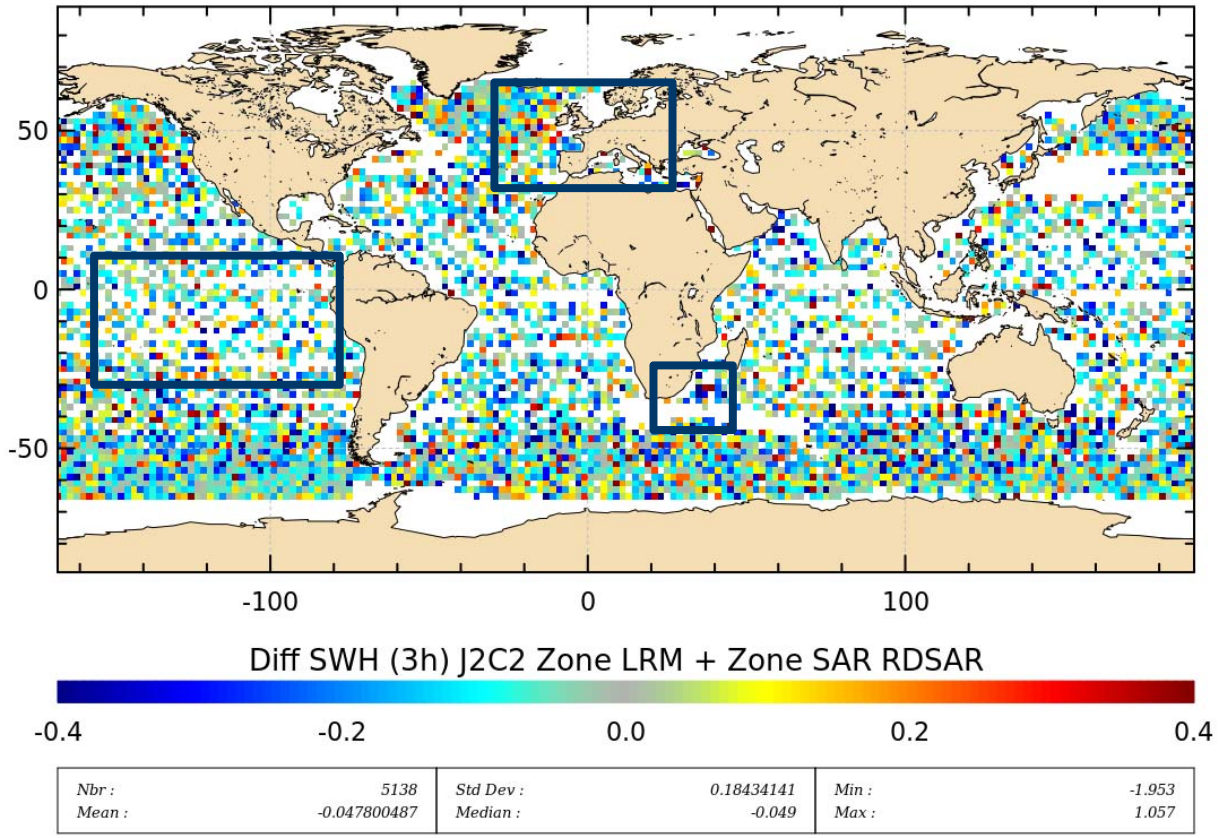
Xover points analysis between LRM/RDSAR and Jason-2:
Sea Level Anomalies



- **Very good agreement between CY2 and J2 SLA**
- **RDSAR provides SLA with the same accuracy than LRM compared to Jason-2 mission.**

RDSAR reference assessment

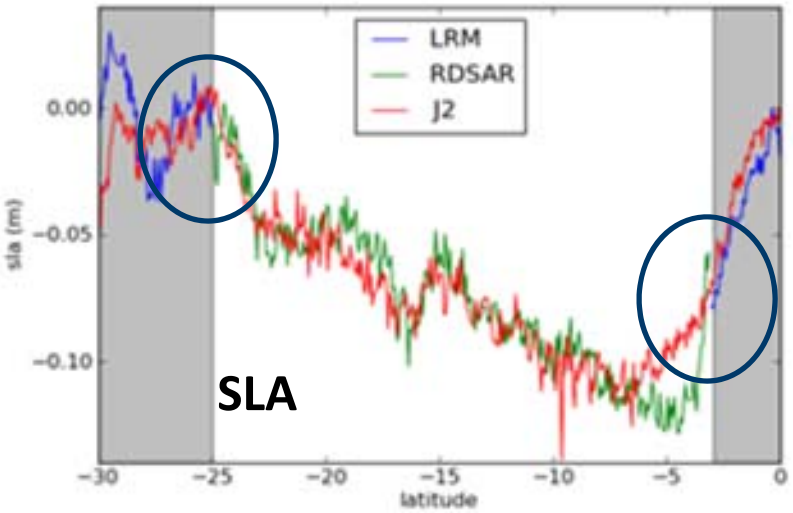
Xover points analysis between LRM/RDSAR and Jason-2:
SeaWaveHeight

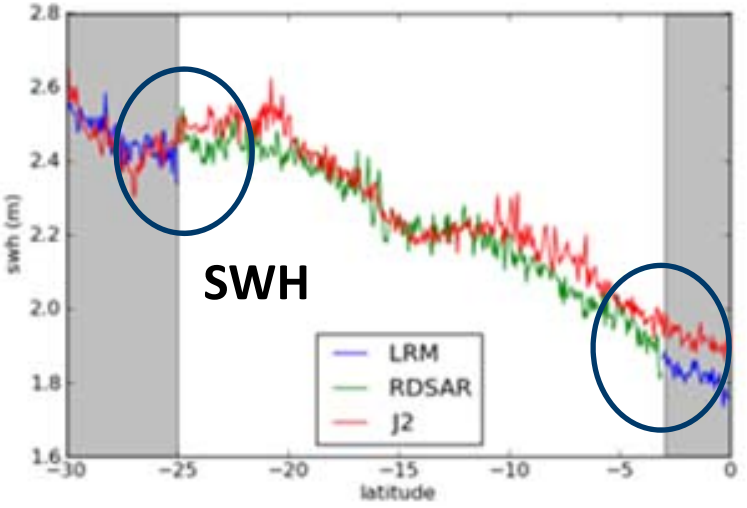


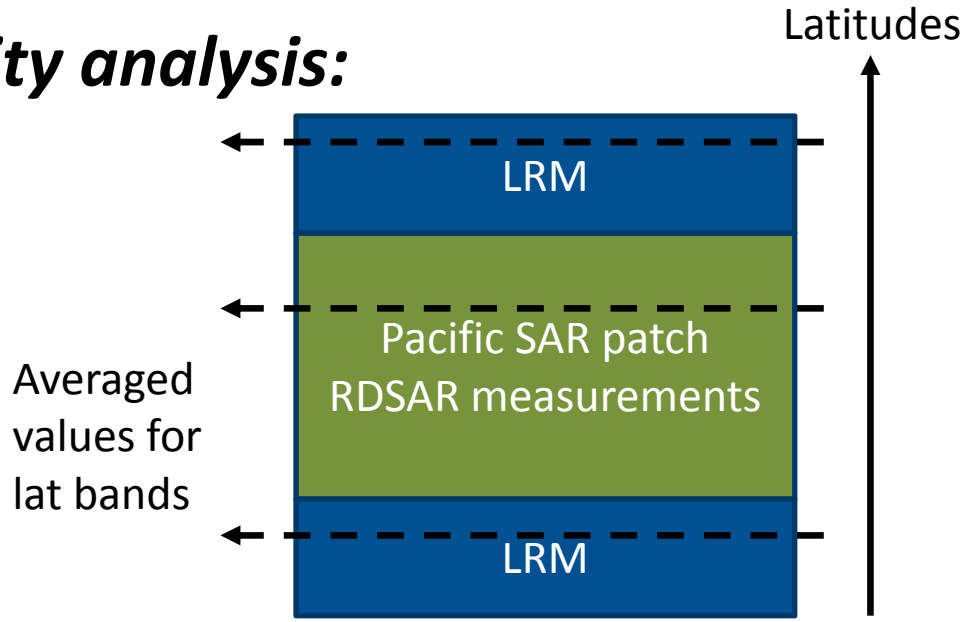
- **Very good agreement between CY2 LRM/RDSAR and J2 SWH**
- **RDSAR provides SWH with the same accuracy than LRM**

RDSAR reference assessment

LRM to RDSAR continuity analysis:



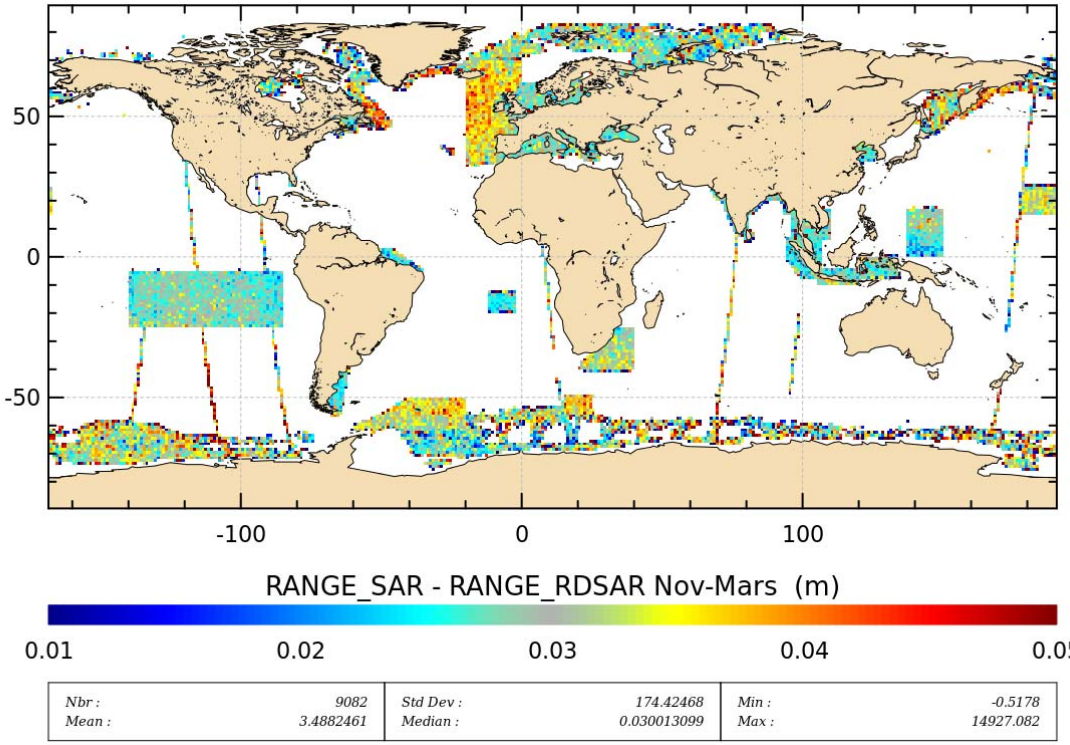




- Very good LRM-RDSAR continuity
- Very good agreement between RDSAR and J2
- ***Good confidence in the RDSAR reference to calibrate SAR results.***

Comparison between SAR and RDSAR

Range differences

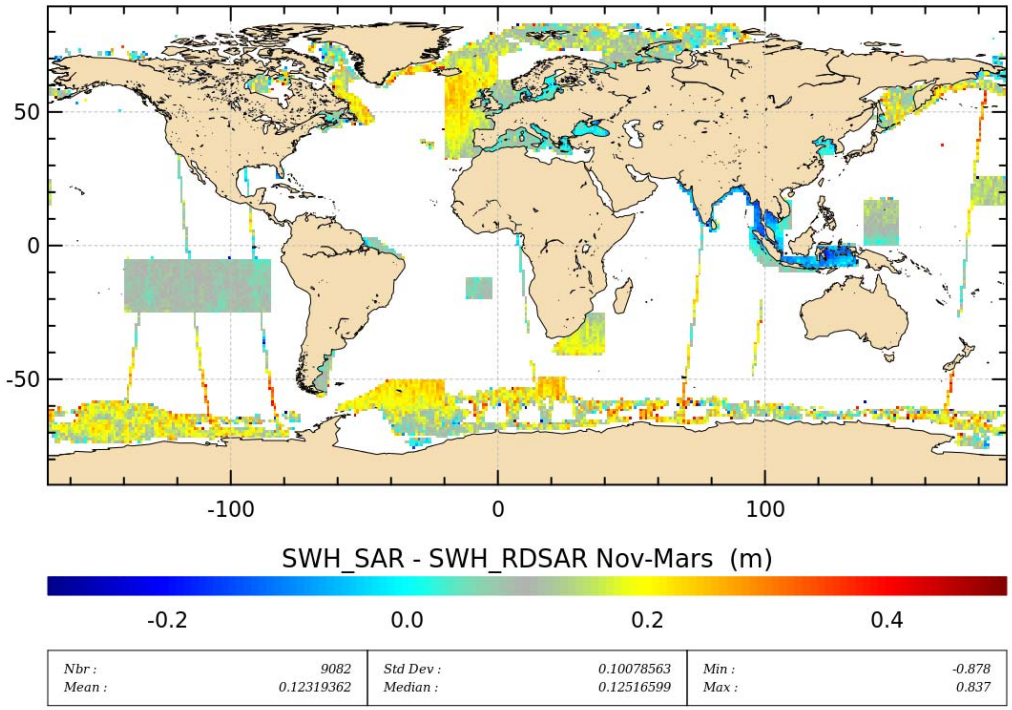


- 3 cm bias between SAR and RDSAR
- Stronger SLA differences in North Atlantic
- which dependencies?

- **But differences scales are only about +/- 1.5cm**

Comparison between SAR and RDSAR

SWH differences:

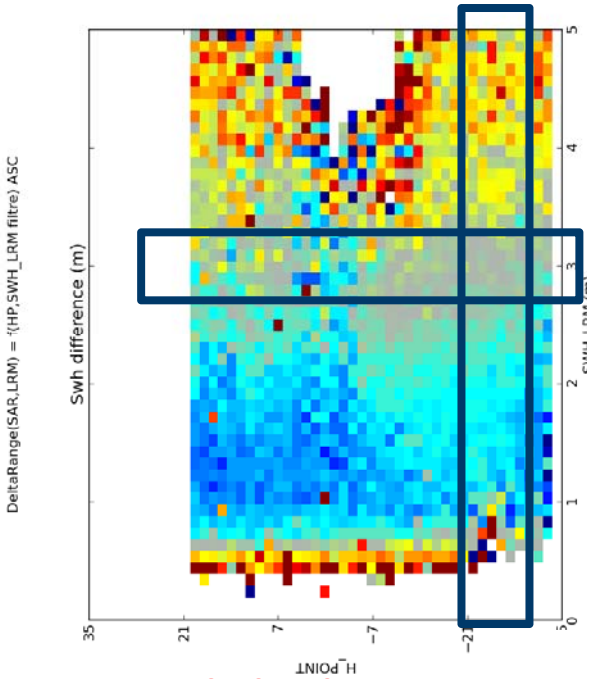


- 10 cm SWH differences in Pacific area
- Stronger SWH differences in North Atlantic (20cm)
- which dependencies?

Comparison between SAR and RDSAR

Range Differences Dependencies Analysis:

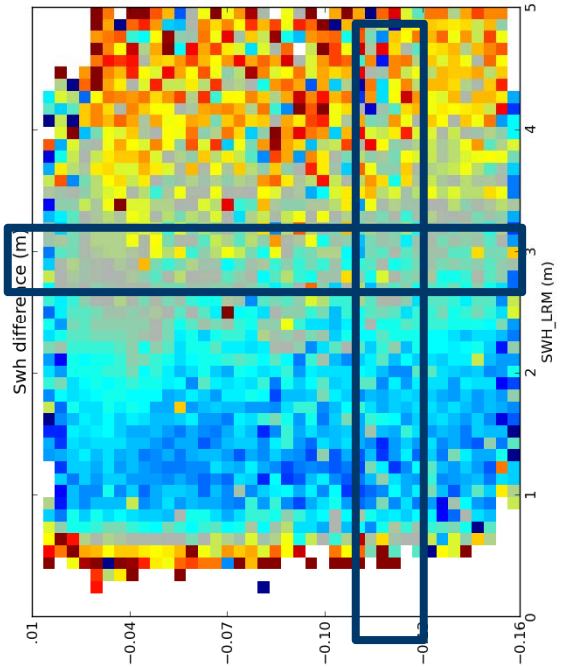
Method: differences are sorted by SWH values (y-axis) and by radial velocity (x-axis/left) or roll angle (x-axis/right)



Radial velocity

No radial velocity and roll angle dependencies

1%SWH dependency

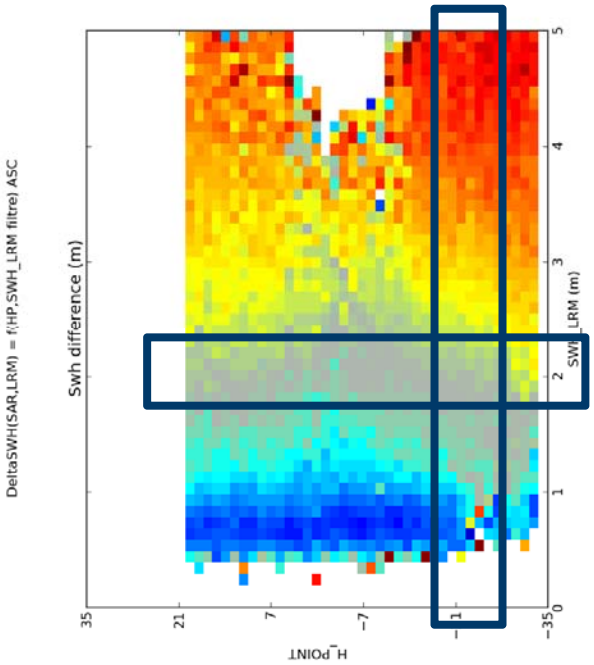


Roll angle

Comparison between SAR and RDSAR

SWH Differences Dependencies Analysis:

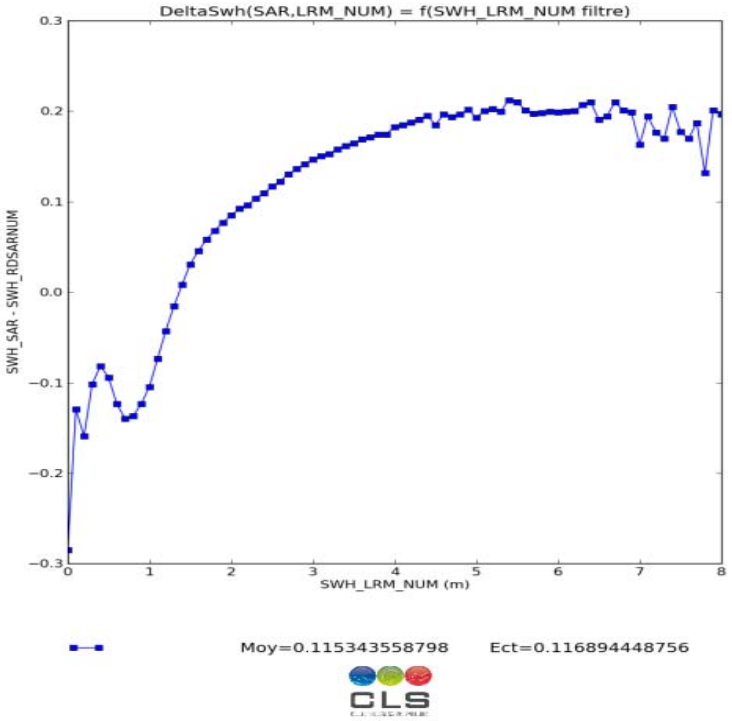
Method: differences are sorted by SWH values (x-axis) and radial velocity (y-axis/left) or crosstrack mispointing (y-axis/right)



Radial velocity

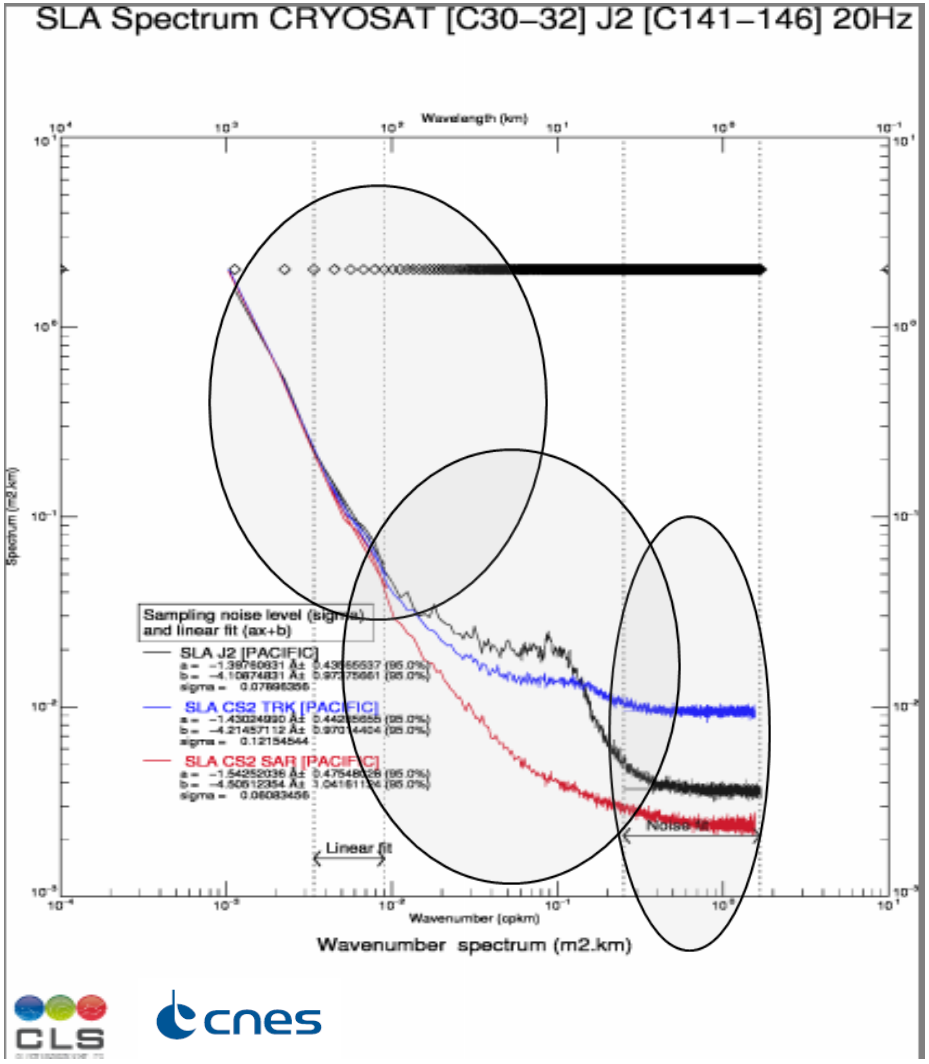
No major radial velocity and roll angle dependencies

SWH dependency



SLA Spectral analysis

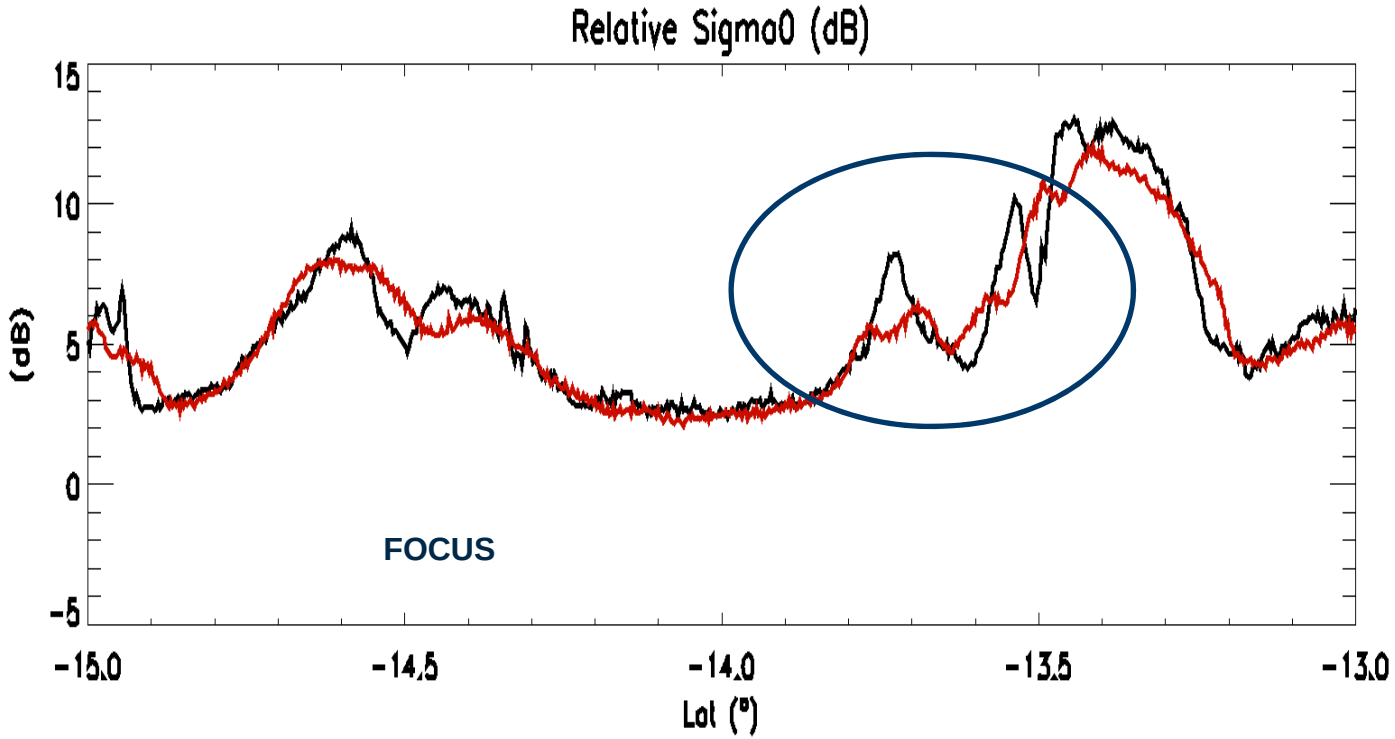
SLA SPECTRAL ANALYSIS:



- All spectra are superimposed for wavelength larger than 100 km. SARM processing is not affected by any error in the medium/large mesoscale band.
- A white noise plateau is visible on all spectra for wavelengths ranging from 600 m to approximately 3 km. The blue spectrum (Cryosat, pseudo-LRM) is largely higher than Jason-2 (sqrt3 as expected) . The SAR spectrum (red) exhibits a white noise plateau lower than Jason-2's (by approximately 30%).
- For wavelengths ranging from 7 to 100 km: although the black (LRM) and blue (pseudo-LRM) spectra exhibit a spectral "bump", the red spectrum (SARM) does not

SARM provides with more trustworthy SLA dataset to observe scales ranging from 10 to 100km.

SAR and RDSAR Sigma0



- **SAR Mode (black) measures small scales signal**, not seen by the conventional approch (red ie RDSAR)

Conclusion

- **RDSAR measurements have been fully validated** using Xover analysis with Jason-2 and also by analysing the LRM to RDSAR continuity.

- **SARM clearly presents advantages regards to the conventional mode:**
  - SARM SLA noise is 30% lower than in LRM
  - SARM provides with more trustworthy SLA dataset to observe scales ranging from 10 to 100km
  - SARM allows to catch small scales sigma0 features never seen by the conventional altimetry

→ ***« Observing Coastal dynamics with SAR Altimetry » by C. Dufau, CLS (today at 10:50)***

- **Yet a good continuity between SARM and CY2/J2 Low Resolution Mode.**

For all those reasons, the user community asked for 100% SARM coverage on Sentinel-3 mission.

What do we need to take a step forward?

What do we need to keep on consolidating our knowledge of SAR techniques in preparation of Sentinel-3 and Jason-CS missions?

- **Independent assessment from the scientist** (deep ocean, coastal areas, inland waters). CPP SAR/LRM products are available on a ftp server. **We need your feebacks!**

  ftp.cy2_sar_l2.oceanobs.com (Contacts: N. Picot an F. Boy)

- A new mode mask on Cryosat-2 mission to look at new regions, high waves, …
- Initiatives to estimate the Doppler Sea State Bias.
- Cross comparison between different processing techniques (SAMOSA, CPP, Halimi, others…). Planed in the on-going CP40 ESA project.

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