Towards Jason-3 vaveforms processing:

Assessment of the Numerical Retracking performances.

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OSTST – Constance Lake – Germany - 27-31 Oct, 2014

Introduction

Numerical Retracking: Originally developed by CNES in the frame of SAR altimeter data processing.

→ a better use of the altimeter PTR **to improve the radar echo modeling.**

For Jason-3:

Even if the Jason-3 altimeter POS3B perfectly **fulfils all its requirements** , the "numerical retracking" has been considered as a **very performing solution** to prevent **any degradations** on altimetry products due to a potential ageing of components.

This presentation aims at :

- Presenting the numerical retracking techniques
- Demonstrating the numerical retracking solution is an interesting alternative to the current MLE4/3 widely used on all missions.
- Validating the numerical retracking on Jason-2 mission

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Reminder of the MLE4 Retracking

MLE4 Retracking:

Baseline for all current altimetry missions:

- Based on the use of **Hayne model**
- Most Likelihood Estimator (MLE)
- **E, SWH, Pu and Mispointing** estimations (4 parameters)

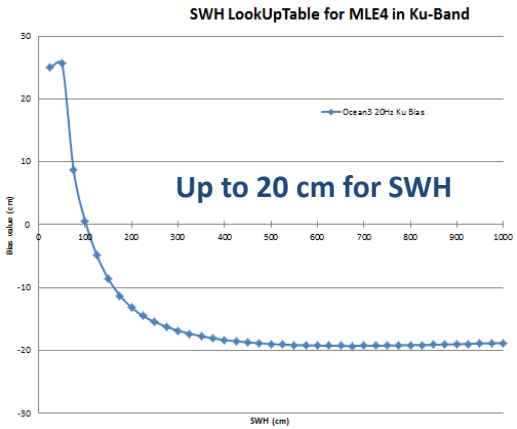
Hayne Model:

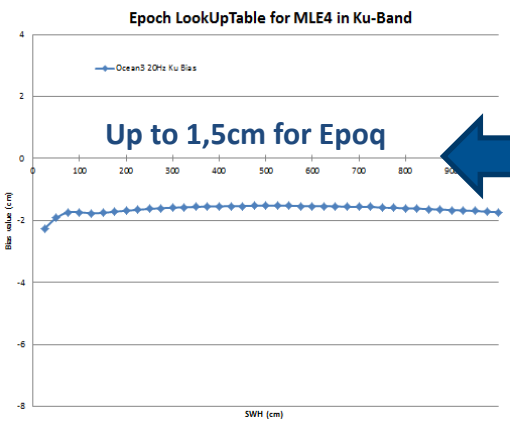
Analytical Radar Echo Model and derivatives

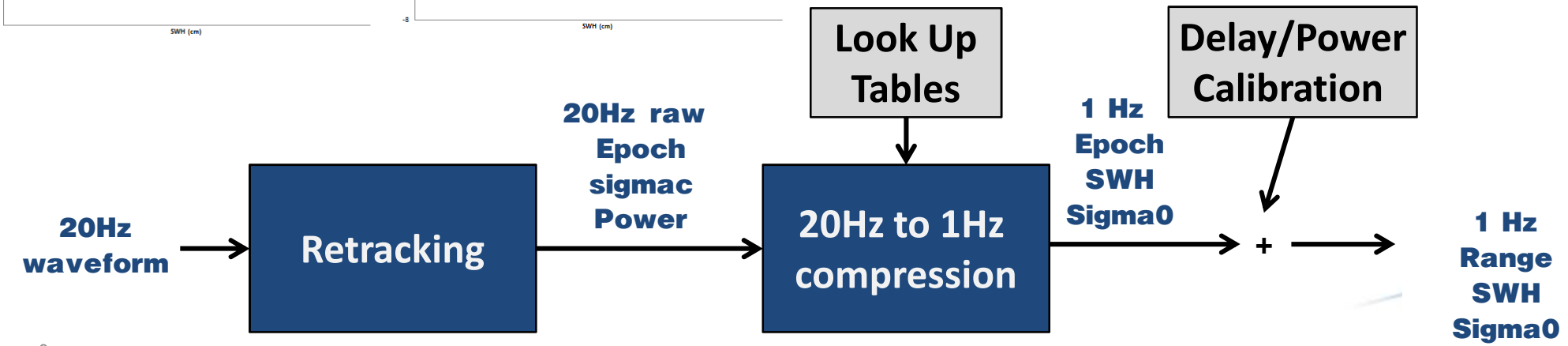
- Most commonly used model
- **Instrument PTR (sinc function) is approx. by a gaussian function.**

Look Up Tables:

- **To correct for the PTR gaussian approx**
- **Offline** computed, using an altimeter simulator taking into account the real instrument PTR
- **Updated** depending on the instrument ageing (**side lobes PTR changes**)







MLE4: Advantages/Drawbacks

Advantages:

- Continuity between past and current missions ?
- **Analytical model → fast computation**

Drawbacks:

- PTR approximation
- Use of LUT computed from **one reference PTR**
- **Any deviations from the reference PTR will generate errors**
- **LUT approach is efficient only if the PTR side lobes are stable**

What if the altimeters would present a stronger ageing or higher characteristics variability?

- The current **MLE4 retracking would not have the capability to account for instrument characteristics variations**.
- To prevent this situation, we need a **new retracking solution accounting for the real instrument PTR**

MLE4 Numerical Retracking (MLE4Num)

MLE4 Numerical Retracking:

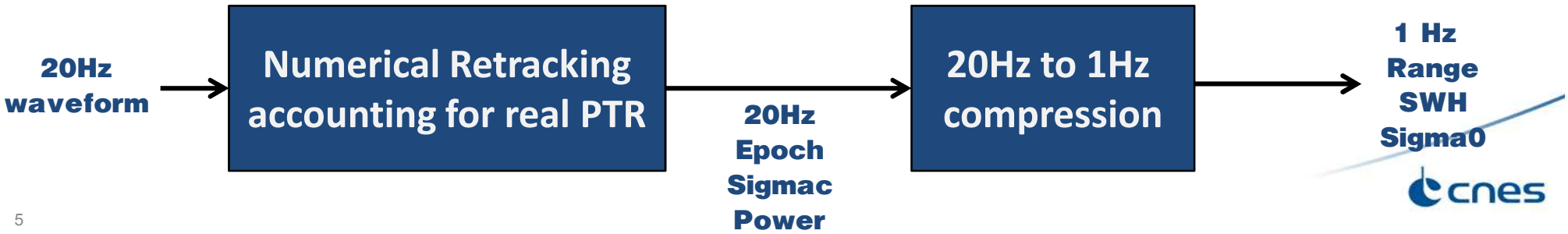
- Based on the use of **a numerical model**
- Most Likelihood Estimator (MLE)
- **E, SWH, Pu and Mispointing** estimations (4 parameters)

Numerical Model:

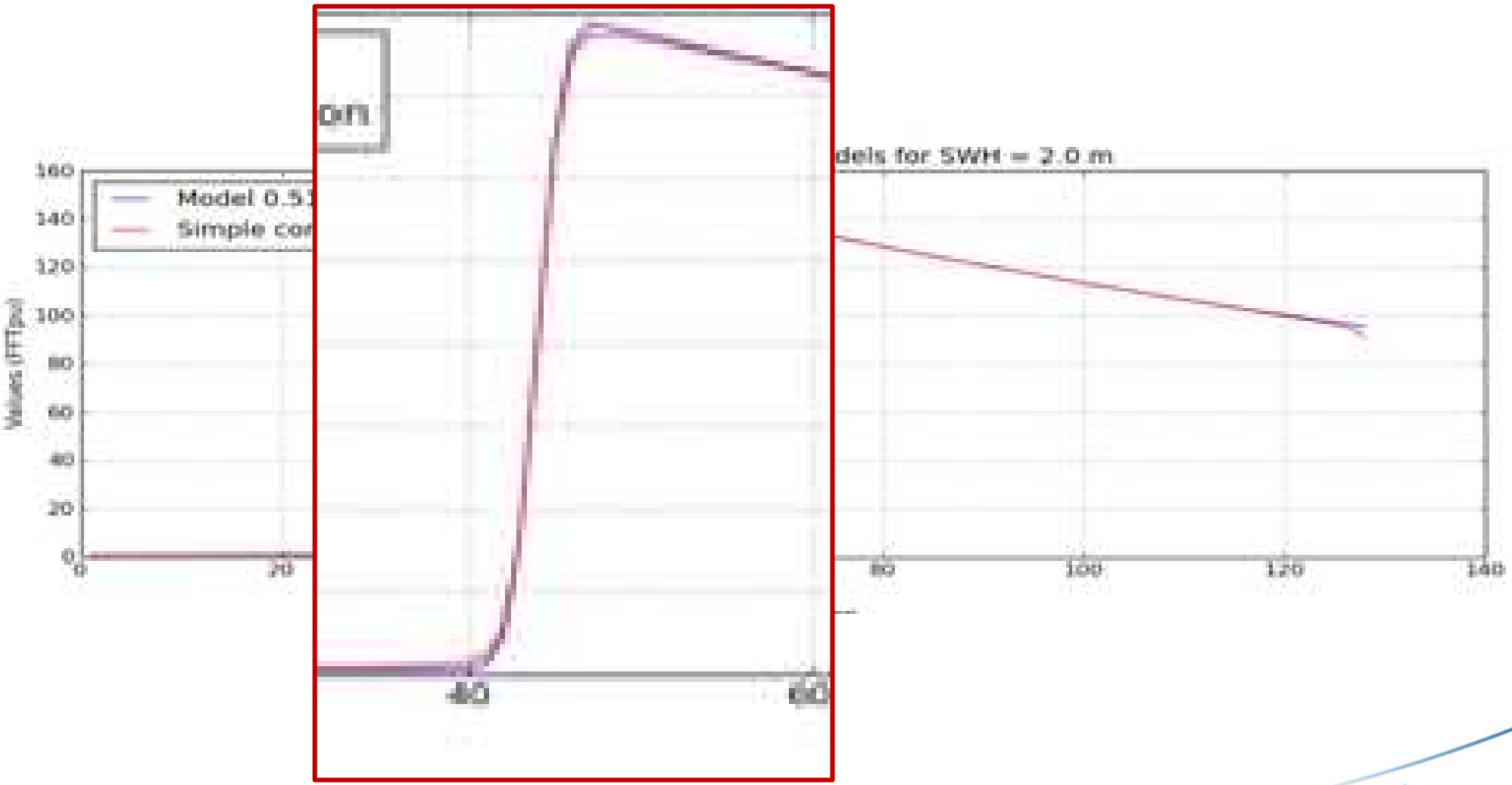
- Starts from Hayne model but without gaussian PTR (sigmap = 0).
  Then, Real time convolution with the instrument PTR (measured from inflight calibrations)
- Derivatives are computed numerically:
  → F'(x) = [F(x + dx) – f(x)]/dx

- All **instrument characteristics** are directly taking into account **inside the model**
  → **PTR evolutions is included in the echoes retracking «on the flow».**

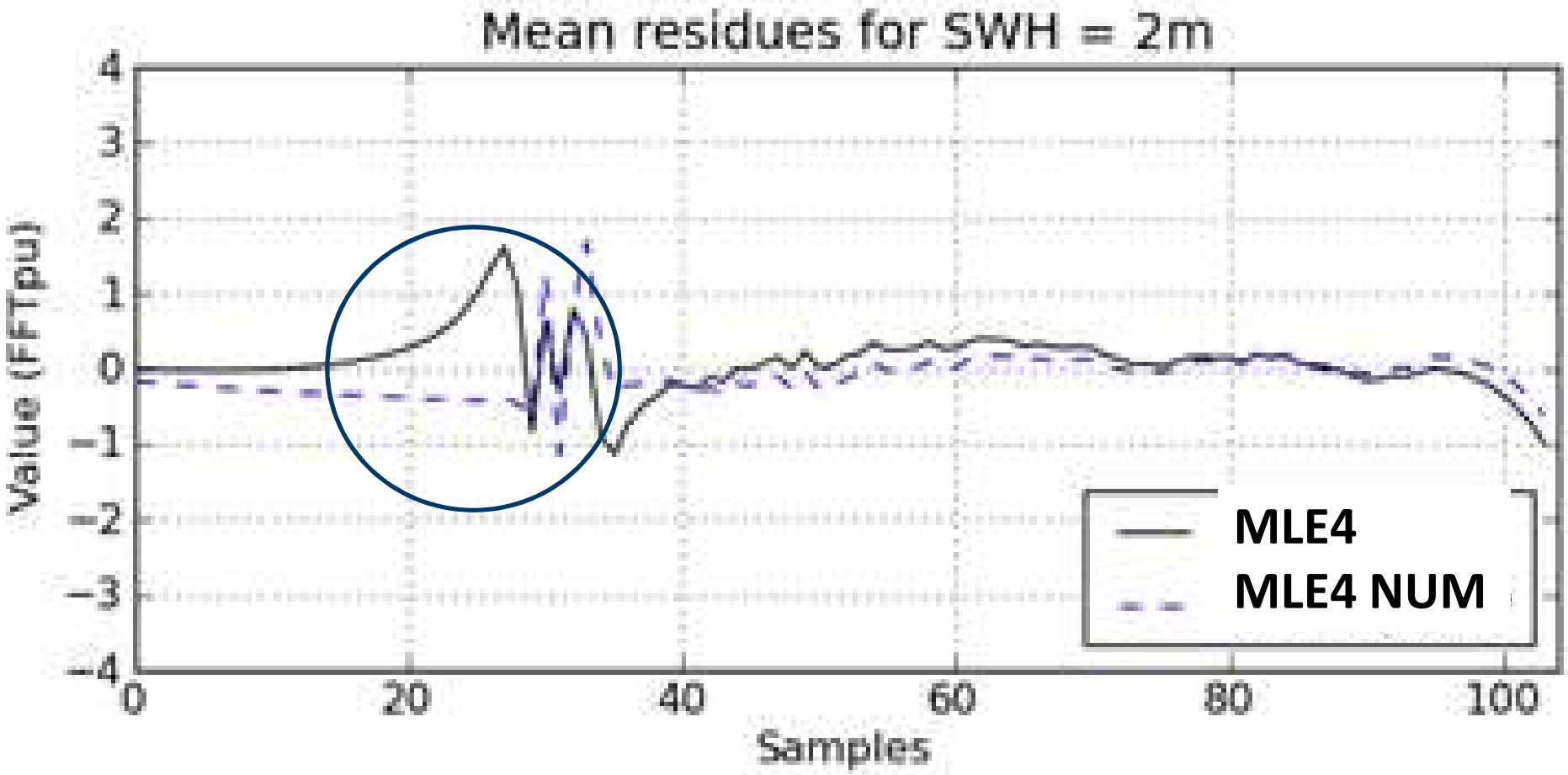
- BUT results **SHOULD/MUST be at least equivalent** to MLE4
  → Validation using **Jason-2 data** (cycle 35)



Numerical vs Hayne's model

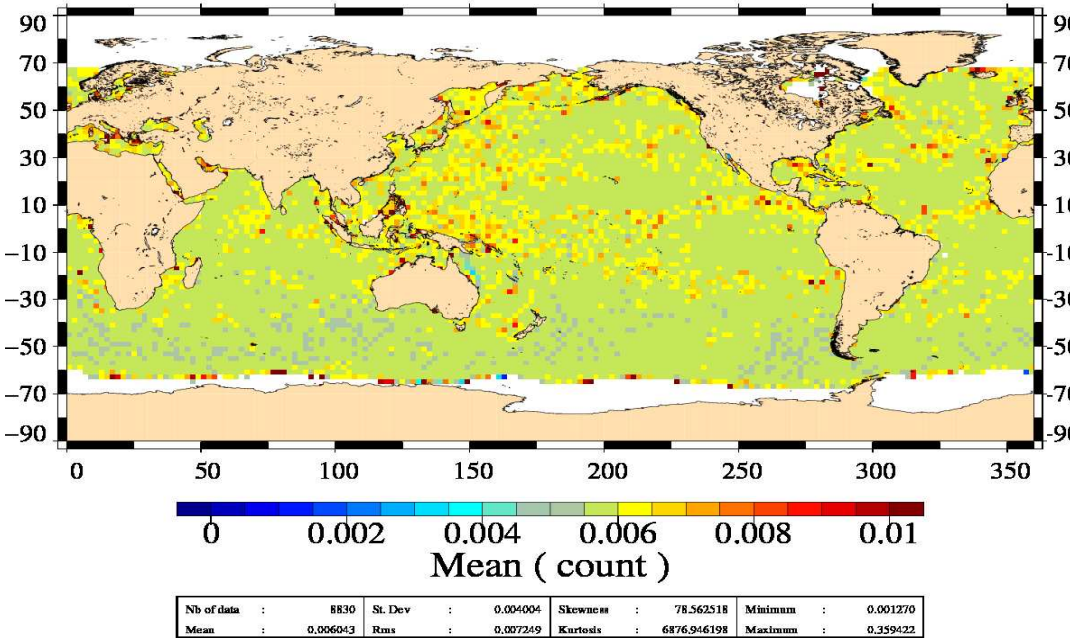


Performances on Jason-2 data
Waveform Residuals

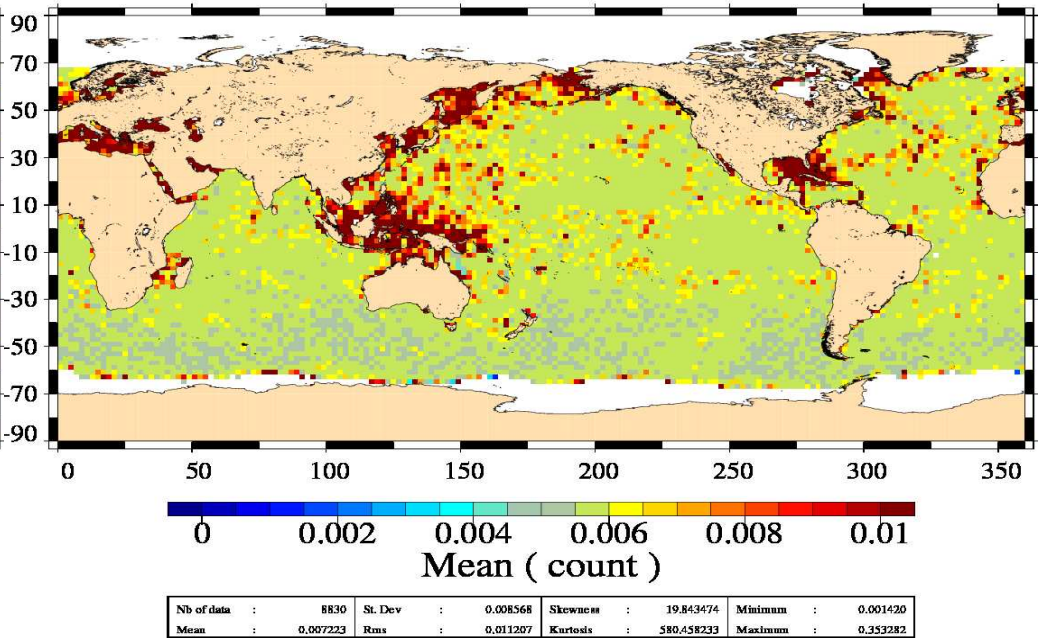


Performances on Jason-2 data
MQE: Difference between model and echo

MQE
NumMLE4

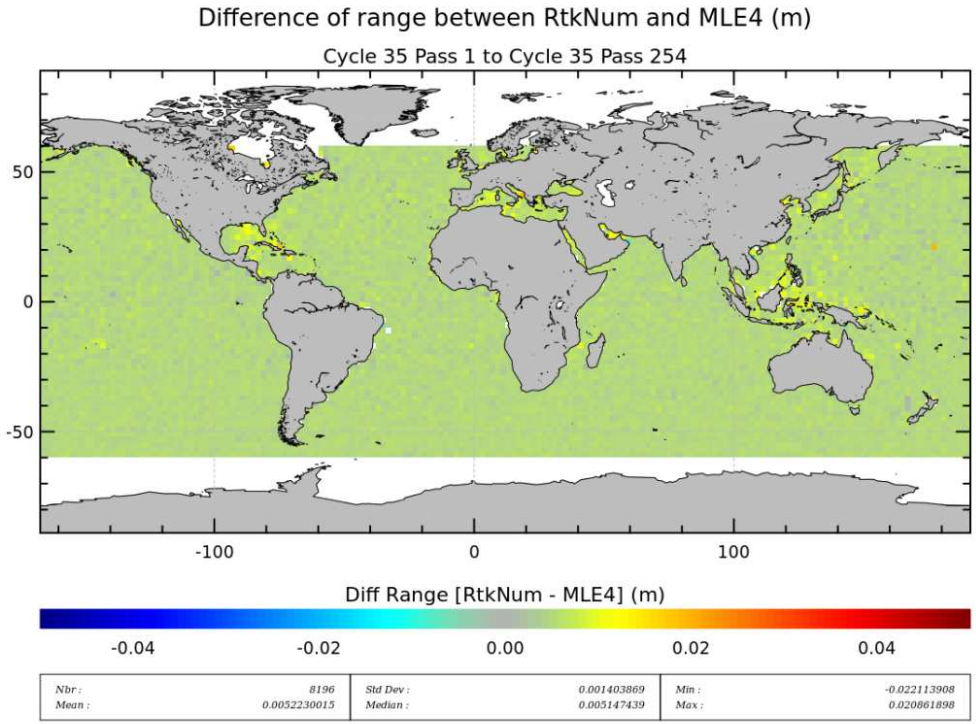


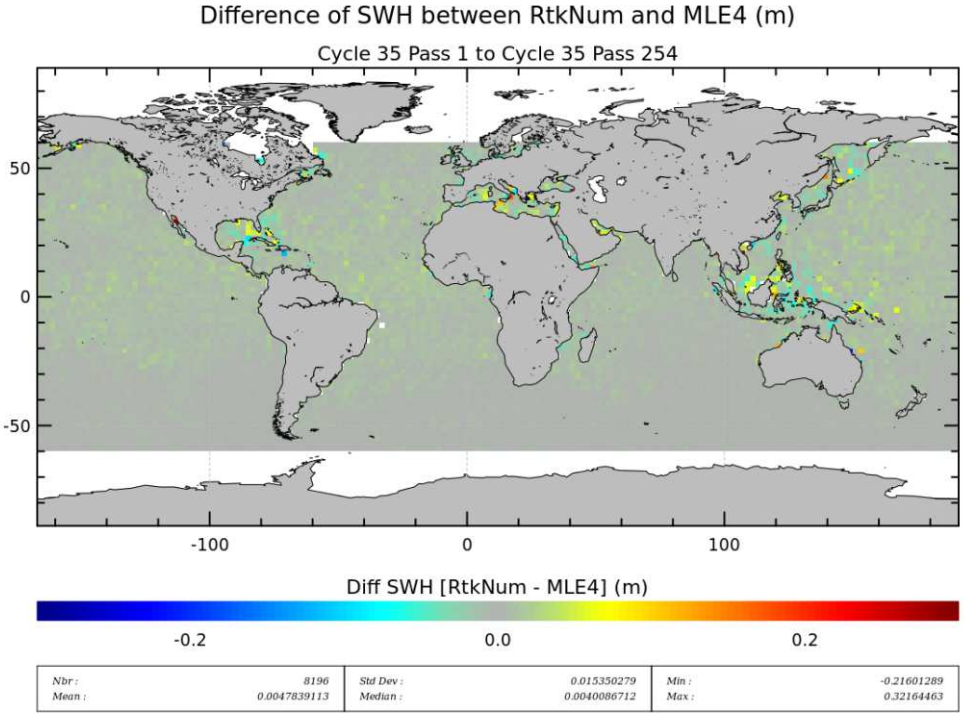
MQE
MLE4



- MQE : **MQE reduced everywhere**
- MQE much more homogeneous wrt SWH

Performances on Jason-2 data
SLA and SWH Analysis

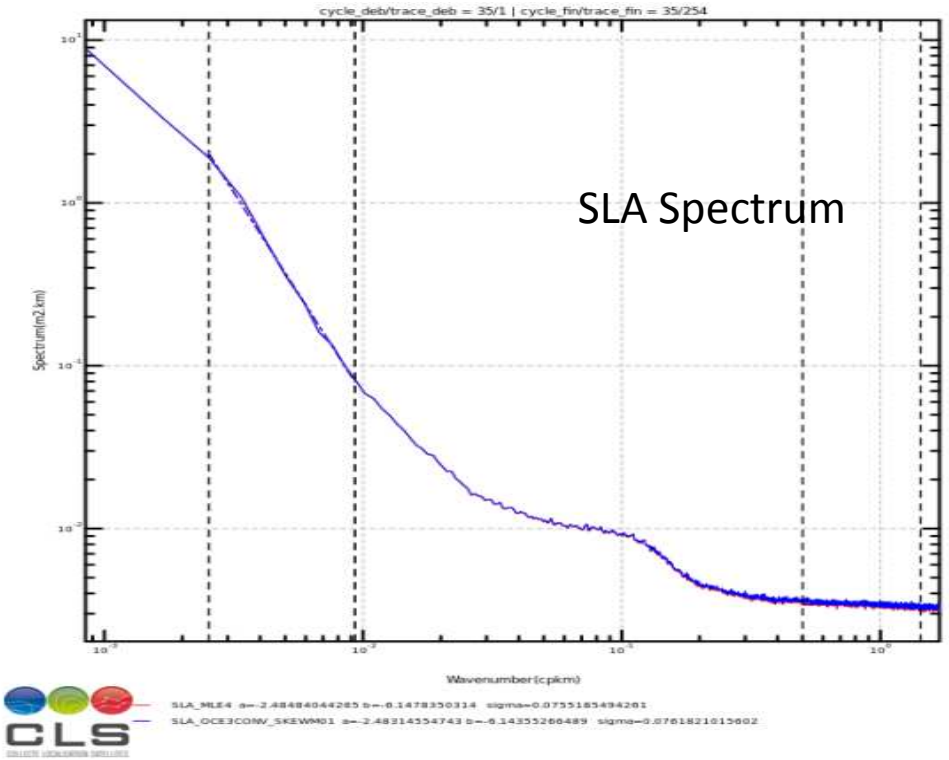


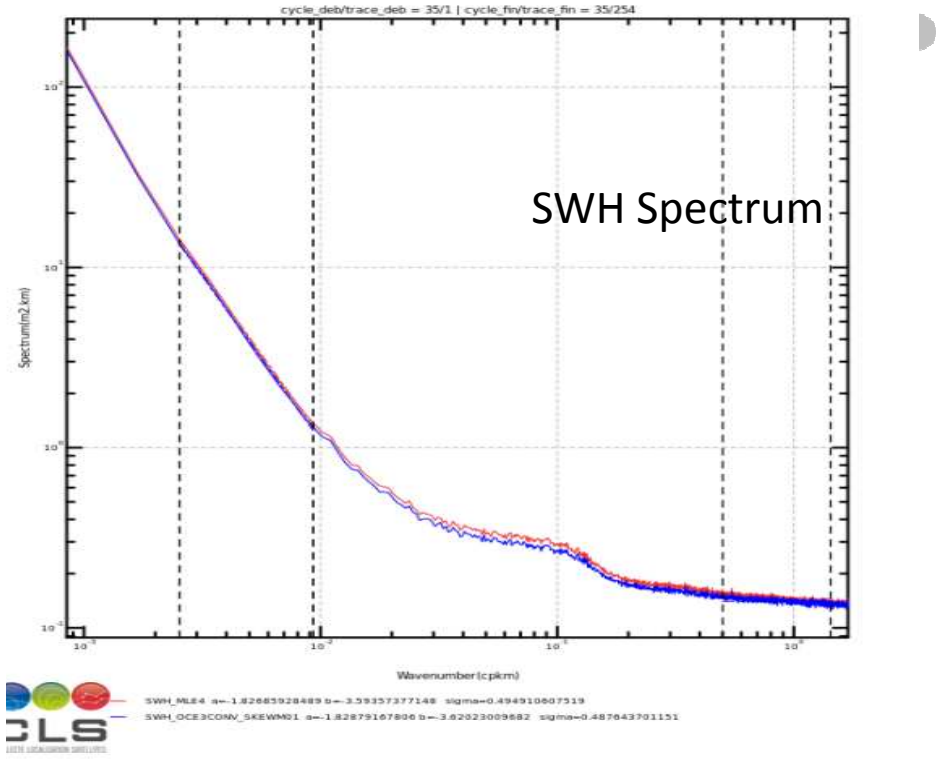


- **Excellent agreement** between MLE4num and MLE4 **Range and SWH** estimates

- **Same excellent agreement for Sigma0** and Mispointing values (not shown)

Performances on Jason-2 data
SLA and SWH Analysis





- Same SLA spectral content
- Small hump reduction on the SWH Spectrum

Continuity between past and current missions ? … YES!

Conclusions

- **MLE4Num** allows to take into account **the instrument features directly inside the echo model.**

- **MLE4Num is robust to any strong instrument ageing** (which is not the case of the MLE4) → **data quality continuity**

- **For Jason-2** (stable instrument), **MLE4num** provides the **same data quality** than the operational MLE4 Retracking → **missions continuity**

For JASON-3 mission:

MLE4 remains the retracking reference solution over ocean in the product.

In parallel, the **MLE4Num will be activated within a prototype** to generate **demonstrative SIGDR products** containing **both MLE4 and MLE4Num.**

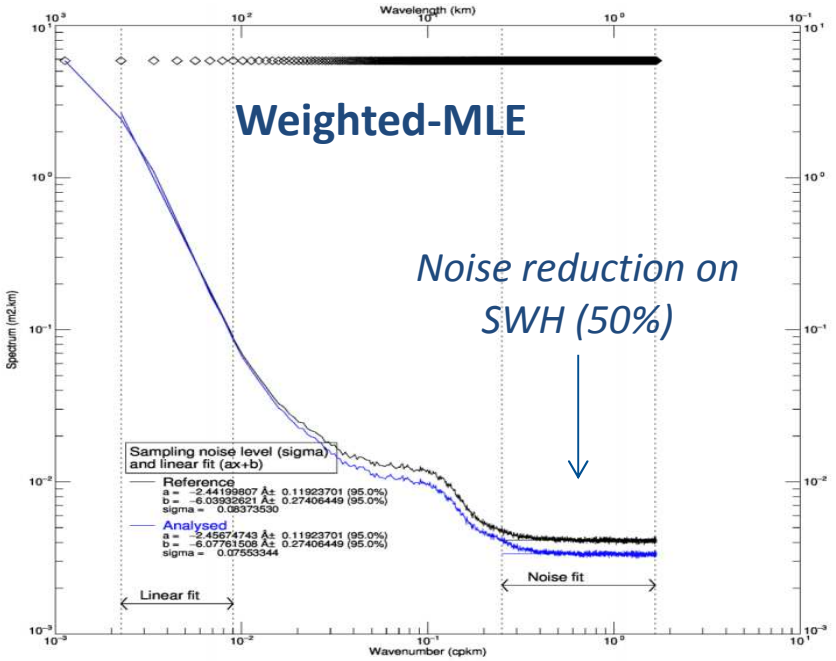
MLE4Num status to be done on J3 (and J1, J2, …) data at the **end of inflight assessment.**

Perspectives

The Numerical model offers a **more precise modeling** of the radar echo:

→ **New opportunities** not possible with Hayne's model

- Weighted-MLE Retracking
- DCORE Retracking
- Kalman Retracking
- Topex waveforms retracking
- SAR-LRM continuity



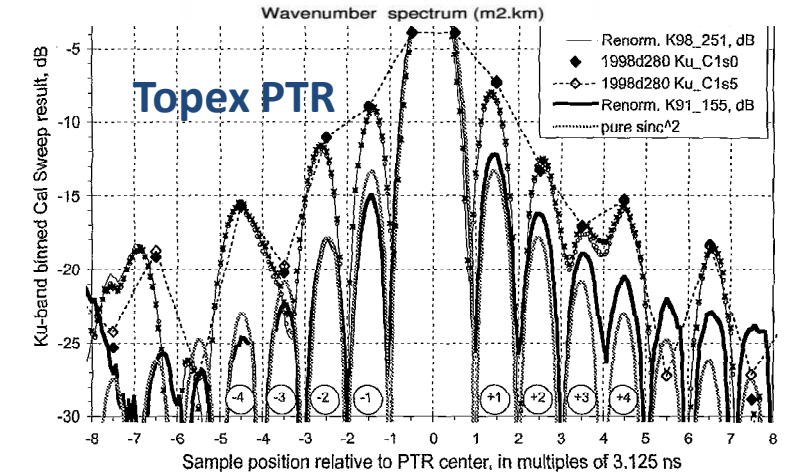
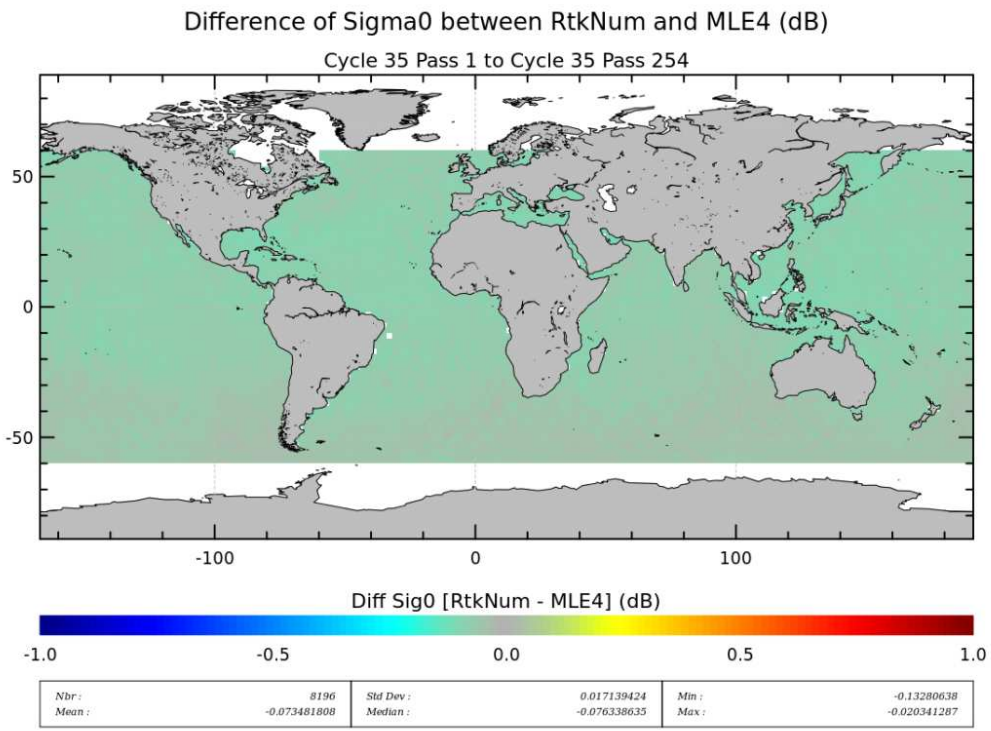
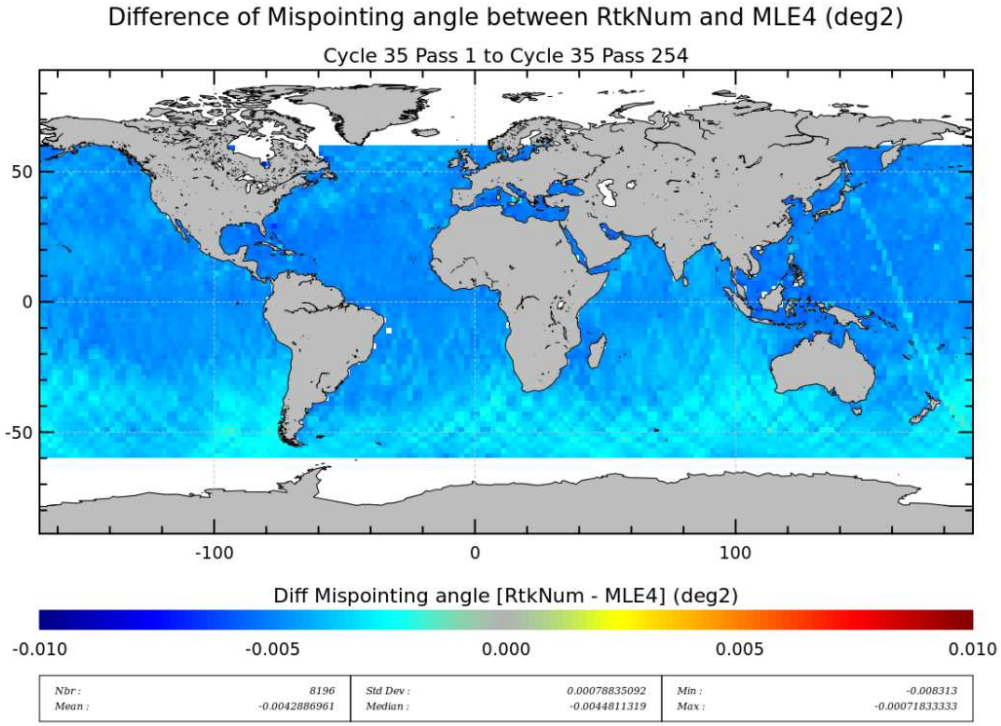


Figure 3-19 TOPEX Ku-Band Cal Sweep PTR Comparisons (labels shown for first four sidelobes each side of central peak)

Annex:
Performances on Jason-2 data :
Sigma0 and ksi differences





- High level of agreement between MLE4num and MLE4 sigma0 and ksi estimates

Jason-CS: ESA / CNES processing