Numerical Solution for the Retracking Algorithm: Performances on Conventional Altimeter Waveforms

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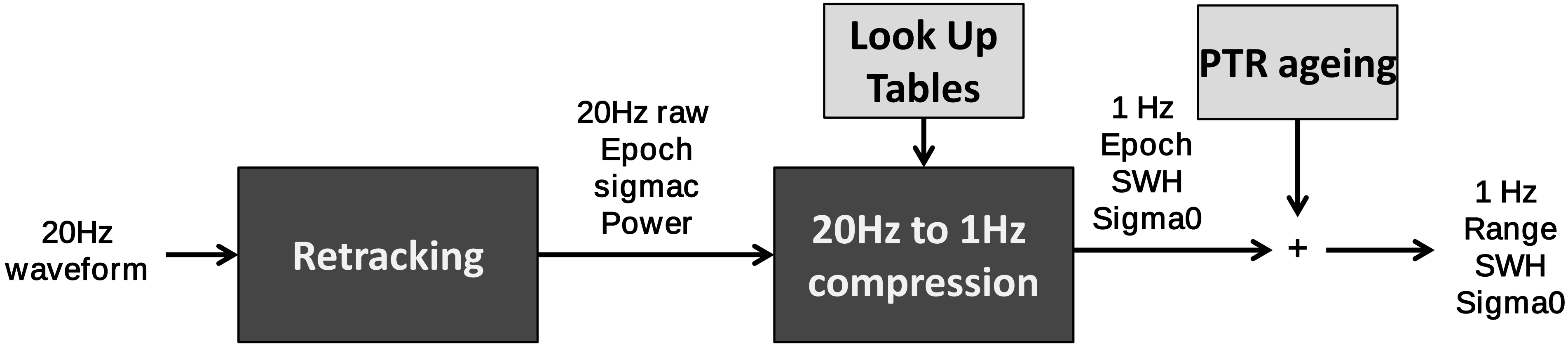
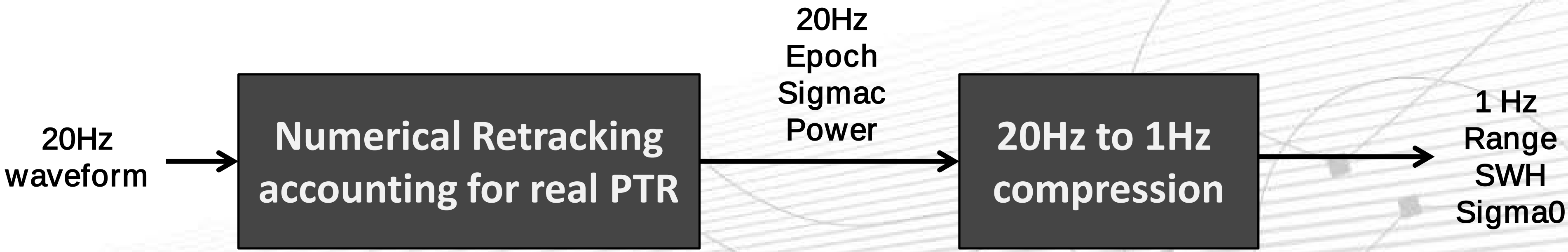
Why to introduce a numerical retracker in LRM ?

- Historically, the altimeter instrumental Point Target Response (**LRM**) has always been approximated by gaussian(s)
  - One gaussian for Poseidon-1/Jason-1/Jason-2
  - One gaussian for for Envisat/RA-2
  - Several gaussians for Topex (E.Rodriguez)
- Mainly because the Hayne model (that is fitted to the measurements) has a simpler formulation when using a gaussian approximation.
- The other reason is that retrackers are iterative fitting methods using analytical derivatives of the model
- With the new **SAR/doppler** instruments, it is much more difficult to derive tracktable analytical SAR echo model with simple derivatives especially if we introduce PTR approximation. Simulated models can also be used (CNES CPP processing)
- Consequently the PTR has to be accounted for in a numerical way without any approximation (derivatives computed numerically from model differentiation)
- We decided to derive a Numerical Retracking algorithm (using real PTR data) but first to validate it on conventionnal echos (Jason-2)
- The aim of this talk is to present the advantages and drawbacks of this new algorithm in order to be confident on the method itself for SAR retrackers.

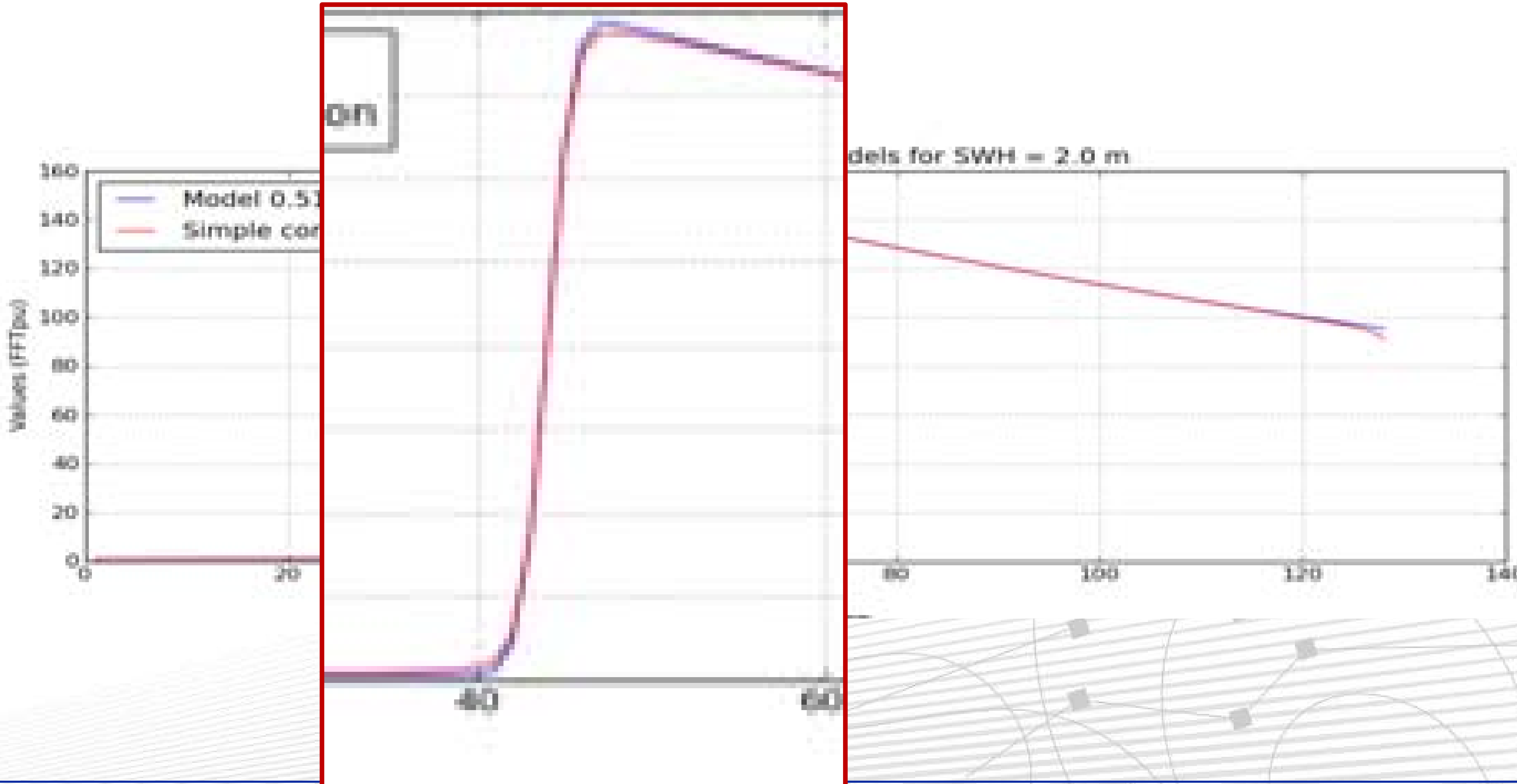
Current waveform processing for Jason



Numerical retracker



Impact of real PTR vs Gaussian on a waveform



Performances on simulated data

Blue : Gaussian Appr.
Red : Real PTR

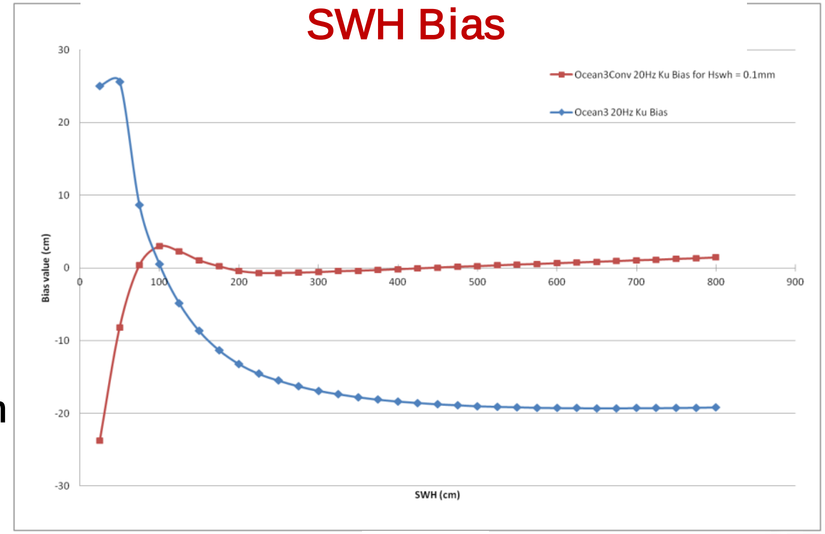
0 cm

-2 cm

SWH

0 cm

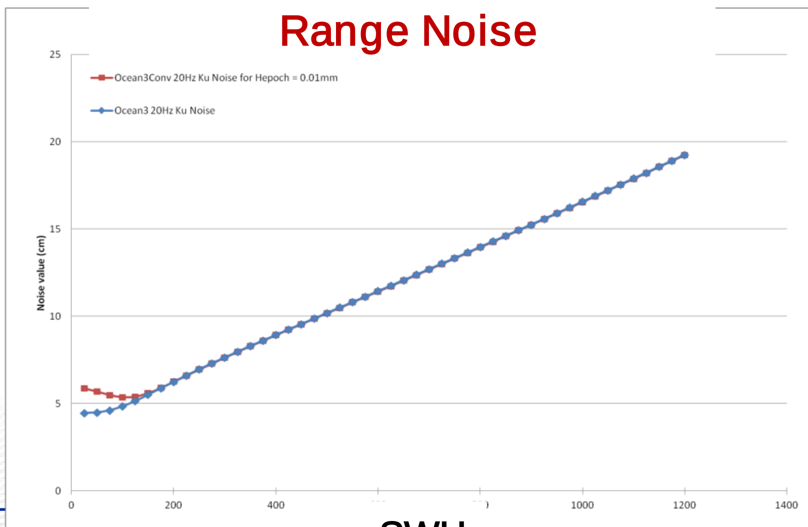
-20 cm



SWH

20 cm

5 cm



SWH

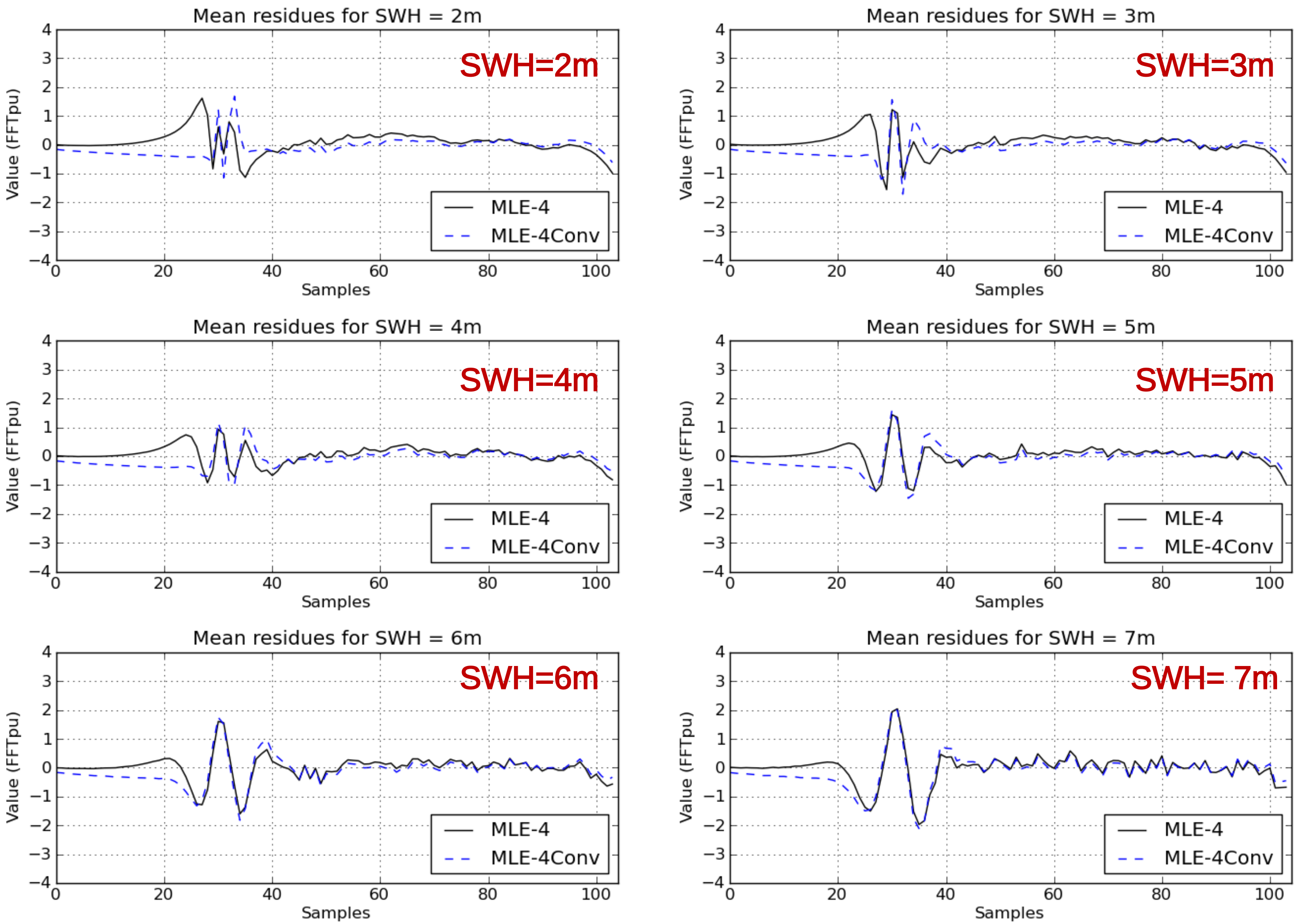
90 cm

30 cm

SWH

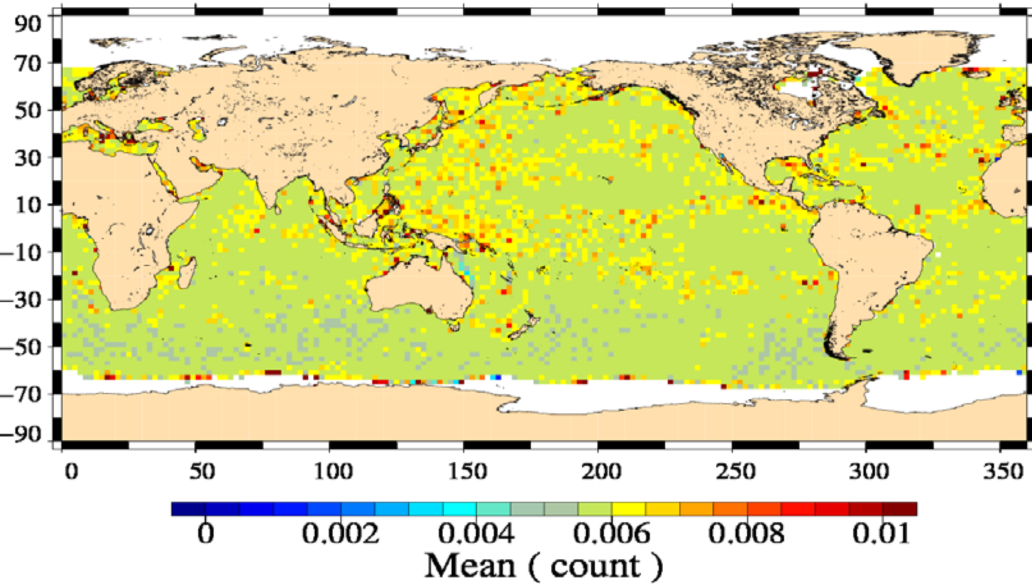
Performances on Jason-2 data : Range (cycle 35)

Waveform Residuals (Skewness -0.1)



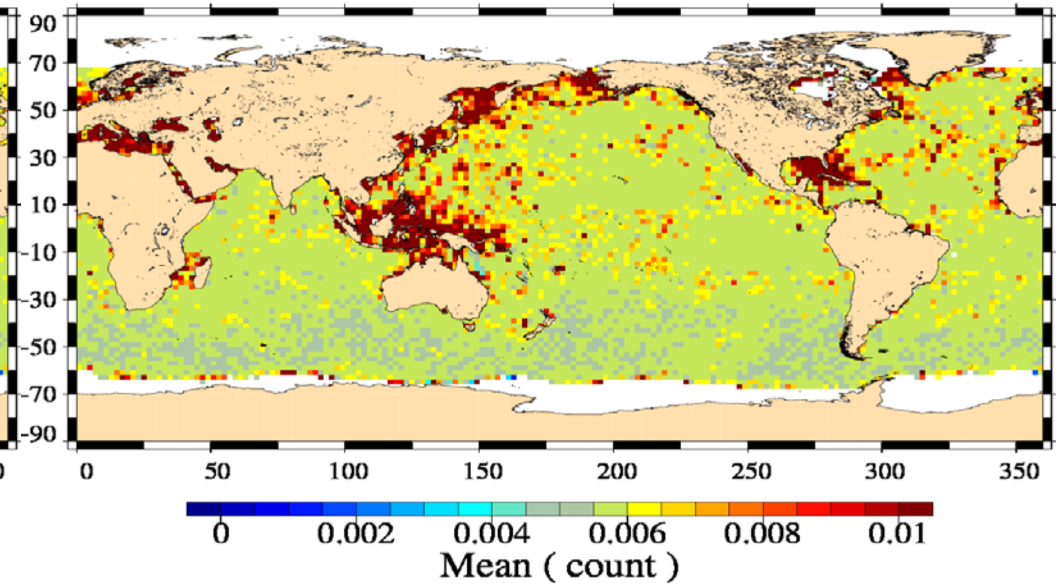
Performances on Jason-2 data : MQE (cycle 35)

MQE
NumMLE4



Nb of data	:	8830	St. Dev	:	0.004004	Skewness	:	78.562518	Minimum	:	0.001270
Mean	:	0.006043	Rms	:	0.007249	Kurtosis	:	6876.946198	Maximum	:	0.359422

MQE
MLE4



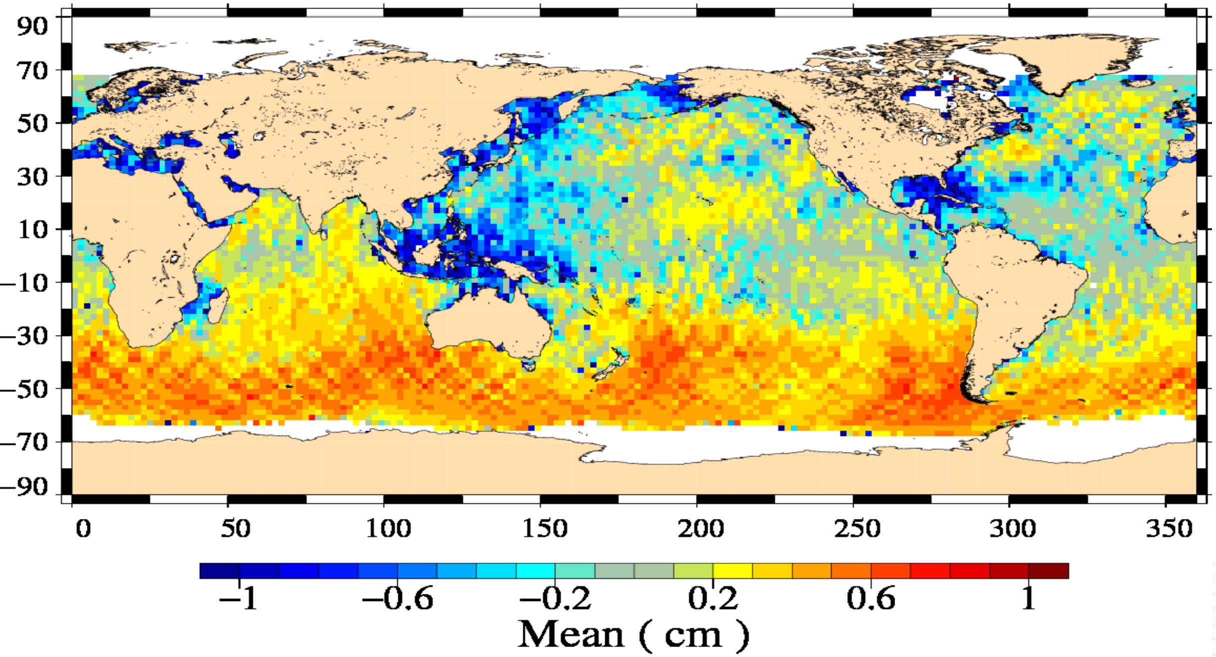
Nb of data	:	8830	St. Dev	:	0.008568	Skewness	:	19.843474	Minimum	:	0.001420
Mean	:	0.007223	Rms	:	0.011207	Kurtosis	:	580.458233	Maximum	:	0.353282

- MQE reduced for small SWH and much more homogeneous for all SWH

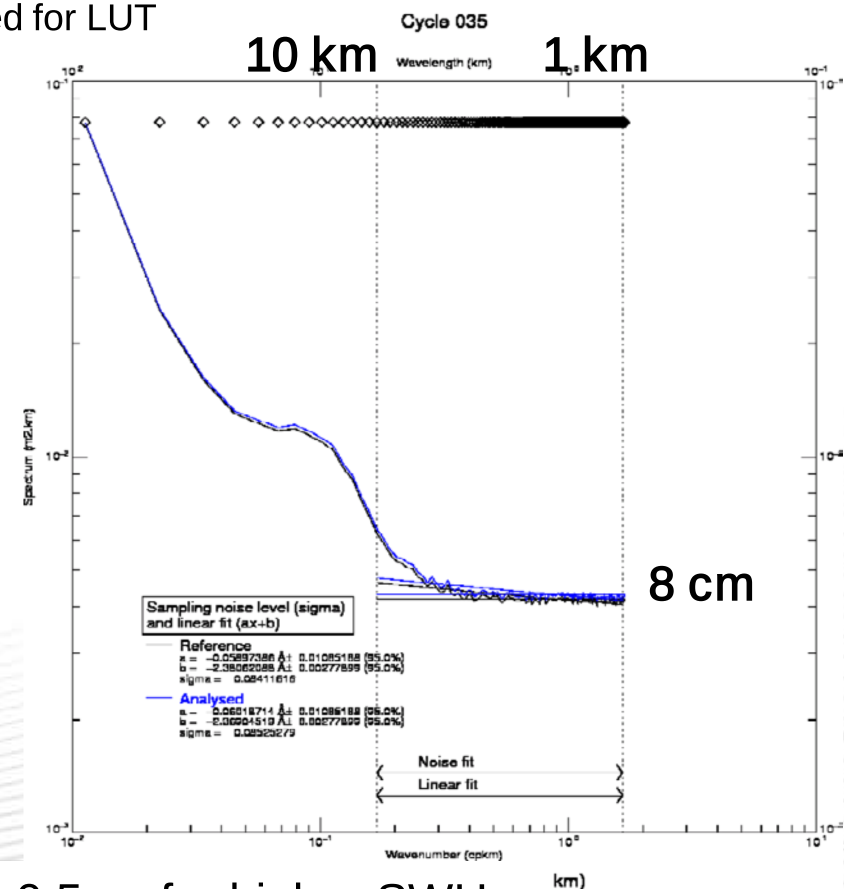
Performances on Jason-2 data : Range (cycle 35)

Difference of Ranges (NumMLE4 – MLE4)

MLE4 not corrected for LUT



Nb of data	:	8830	St. Dev	:	0.64485	Skewness	:	–26.80454	Minimum	:	–37.36833
Mean	:	0.07105	Rms	:	0.64875	Kurtosis	:	1374.53535	Maximum	:	1.73197

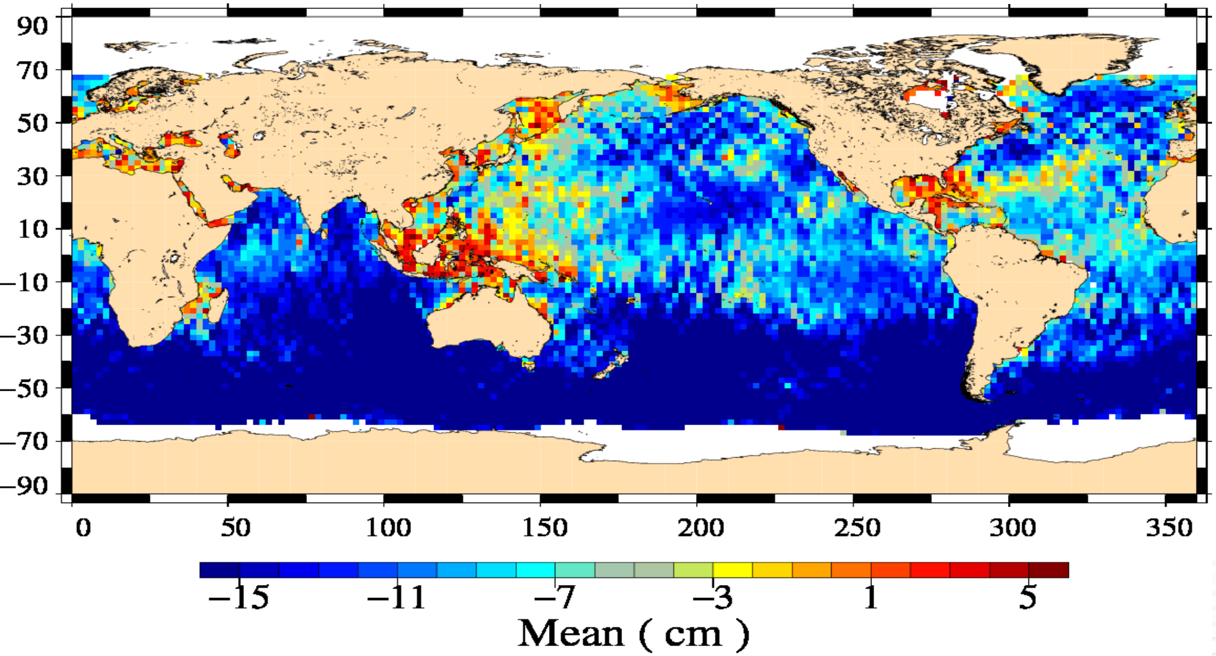


- Dependency with SWH: no difference for SWH=2m; 0.5cm for higher SWH
- No modification of the spectrum of energy (at any wavelength)

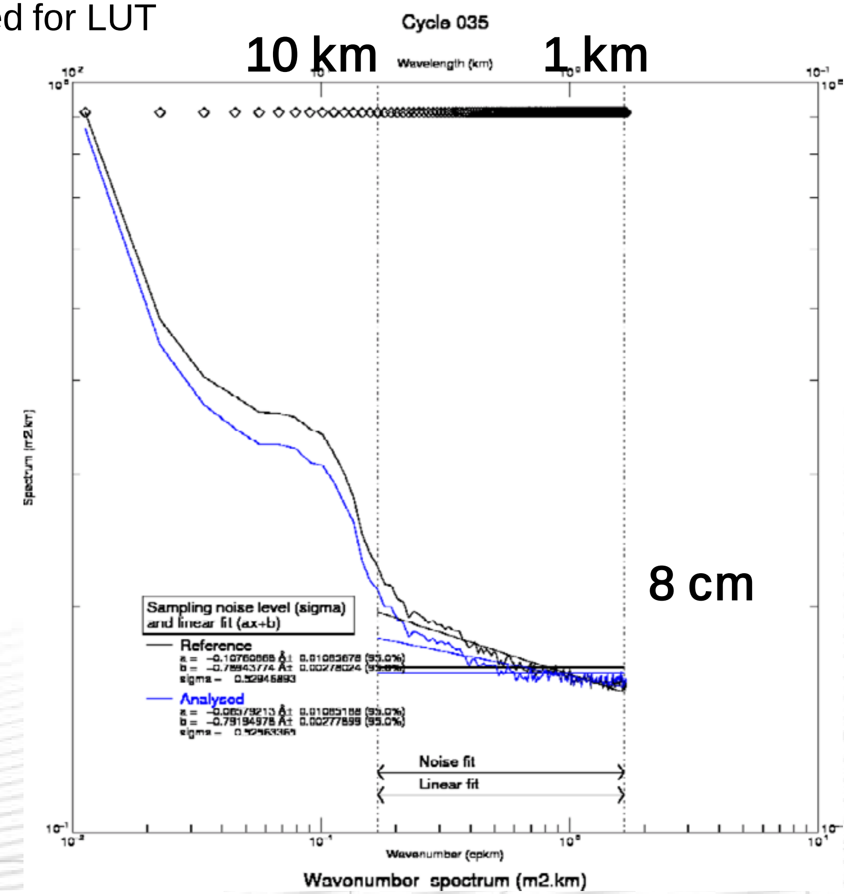
Performances on Jason-2 data : SWH (cycle 35)

Difference of SWH NumMLE4 – MLE4

MLE4 not corrected for LUT

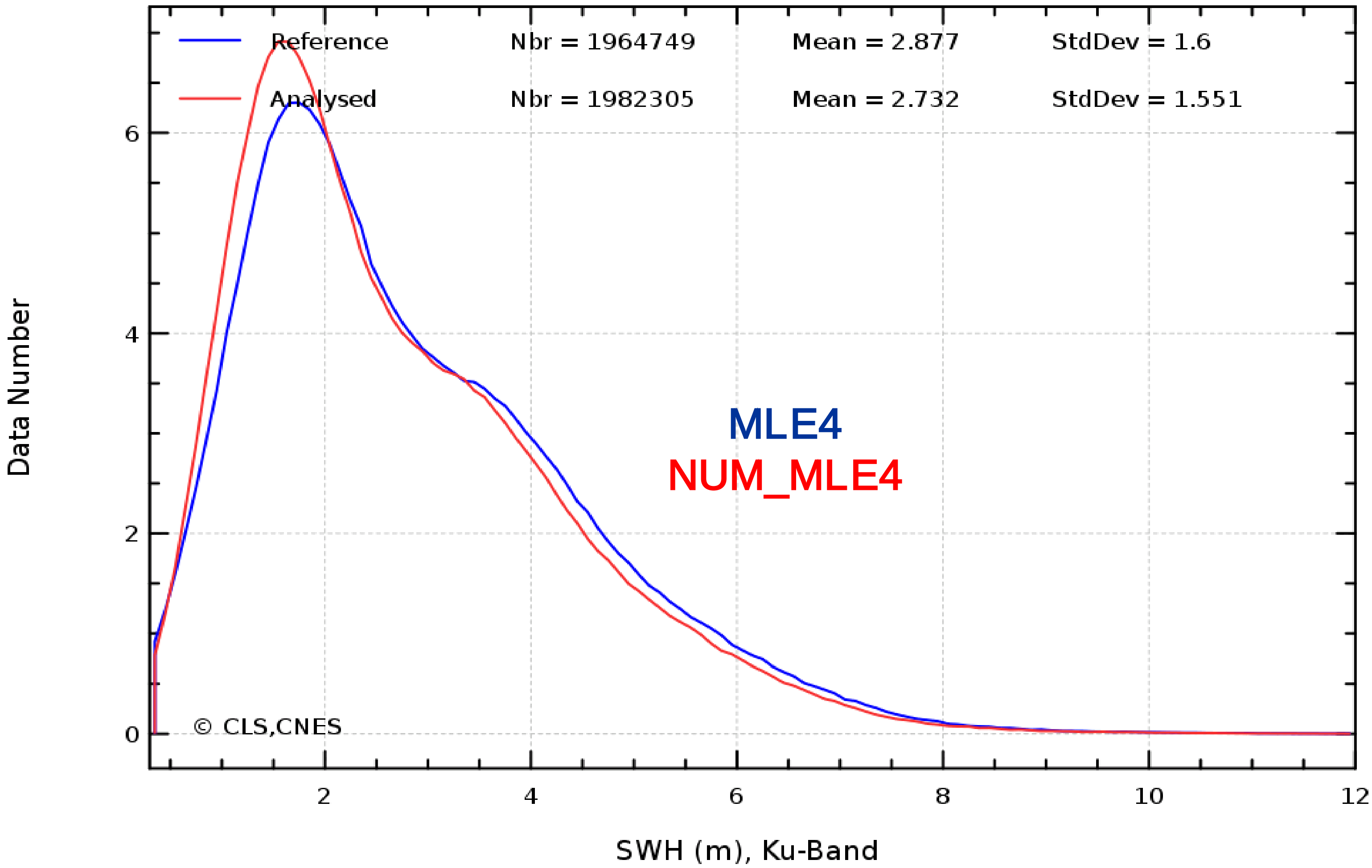


Nb of data	:	8828	St. Dev	:	6.03846	Skewness	:	0.82674	Minimum	:	–42.19342
Mean	:	–11.33476	Rms	:	12.84289	Kurtosis	:	2.04862	Maximum	:	58.35302



- ❑ Strong bias of about 20 cm as expected from simulations

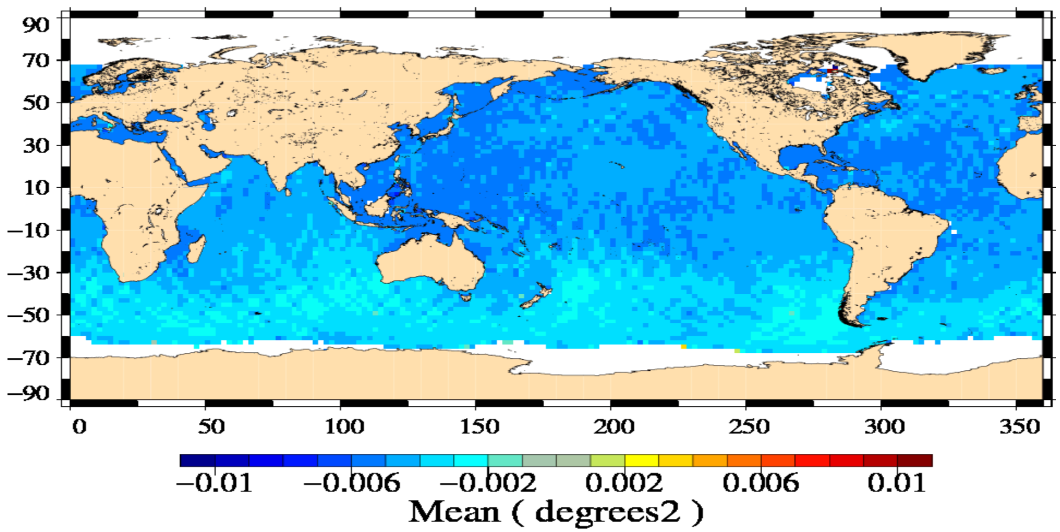
Performances on Jason-2 data : SWH (cycle 35)



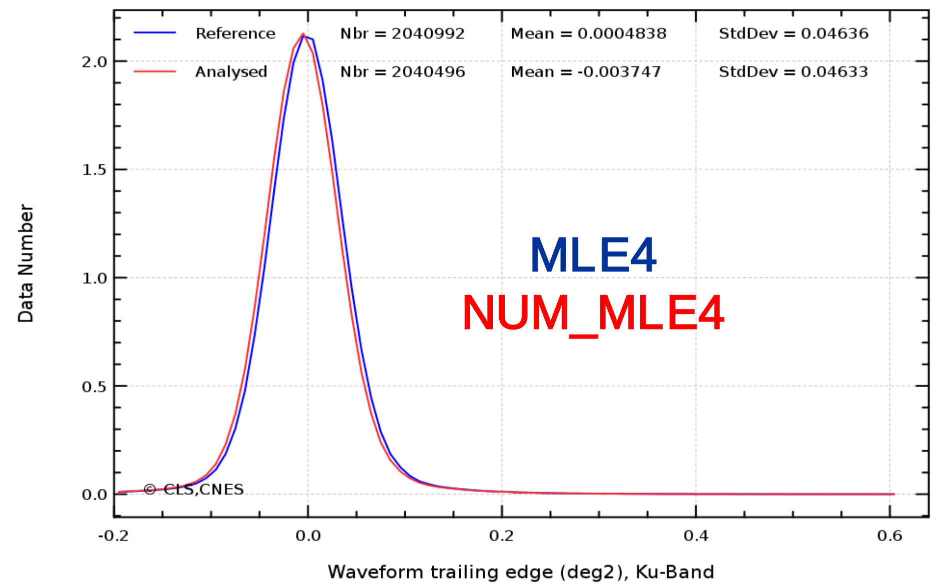
- Small shift of the histogram towards smaller SWH

Performances on Jason-2 data : Slope of Trailing edge (cycle 35)

Difference of ξ^2
NumMLE4 – MLE4



Nb of data	:	8830	St. Dev	:	0.0009386	Skewness	:	5.3556062	Minimum	:	−0.0105093
Mean	:	−0.0043985	Rms	:	0.0044976	Kurtosis	:	110.2482212	Maximum	:	0.0185830



- ❑ No impact on the decay of the trailing edge

Numerical Retracking for TOPEX ?

San Diego
OSTST - 2011

- Numerical Retracking is also very interesting when the PTR is degraded or when the PTR is less stable with time
- This retracker **could be used** to intercompare results with JPL on Topex data
- Very important to consolidate/preserve the instrumental data sets (PTR, filters, etc …) and measurements

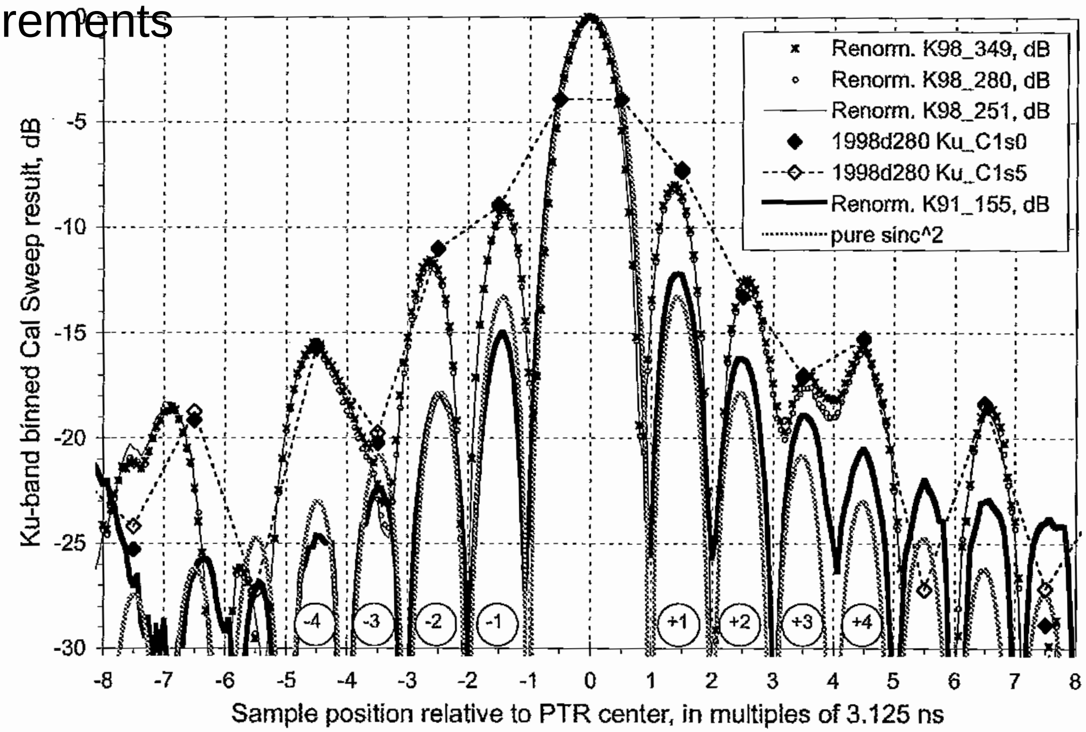


Figure 3-19 TOPEX Ku-Band Cal Sweep PTR Comparisons (labels shown for first four sidelobes each side of central peak)

Conclusions

- Very good performances of the numerical retracker including real PTR values
- Better accounting of the instrument ageing
- CPU much higher than with the current MLE4
- Reduction of biases (especialy on SWH for small SWH) without any degradation of the estimation noise
- Very good estimates **provided at 20Hz**

- **Applicable to other conventional altimeter data (TOPEX, JASON-3, …) and also to SAR data (see F.Boy presentation) using simulated echo models**

- Skewness coefficient probably to be fitted again. Consequences on SSB to be evaluated
- Integration of the real antenna pattern (using a full numerical model)
- Study still on going to improve the retracker itself (LSE/MLE, Quantization noise, …)

Thank you !