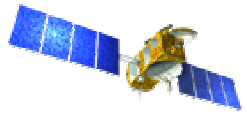

Evaluation of the Jason-1 ground retracking algorithm

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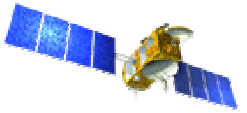
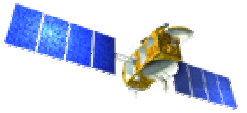


Objective

The objective of this presentation is to give an overview of some of the results that have been obtained with the Jason-1 retracking algorithms and especially with the retracking algorithm used for the GDR 'B'.

Addtionnal results have already been provided during the OSTST in Arles and in St.Petersburg and also in the 2nd and 3rd Marine Geodesy special issues on Jason-1.

Historical reminder of the Jason-1 retracking algorithm



- Since launch, GDRs have been obtained with a retracking algorithm (MLE-3)
  - ✓ solving for 3 parameters (SWH, epoch and amplitude)
  - ✓ using a Hayne's model developed at the first order (valid for ξ<0.3deg)
  - ✓ with a skewness coefficient of 0
  - ✓ corrected with LUT (coherent with the rtk algorithm)

➔ GDR 'A'

- Star tracker system has shown abnormal behavior leading to mispointing angles out of the limit of validity of the model

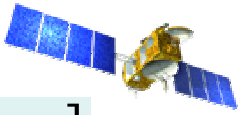
- Development of a second order model valid up to 0.8 deg
  (Amarouche, 2004, Marine Geodesy 2nd issue)

- Impossibility to derive the mispointing angle from the slope of the trailing edge

- Development of a new retracking algorithm (MLE-4)
  - ✓ solving for 4 parameters (SWH, epoch, amplitude + mispointing angle)
  - ✓ using the model developed at the second order (valid for ξ<0.8deg)
  - ✓ with a skewness coefficient of 0.1
  - ✓ corrected with LUT (coherent with the new rtk algorithm)

➔ GDR 'B'

Analytical formulation of the waveform model



- 1st order model (for mispointing angles lower than 0.3 °)

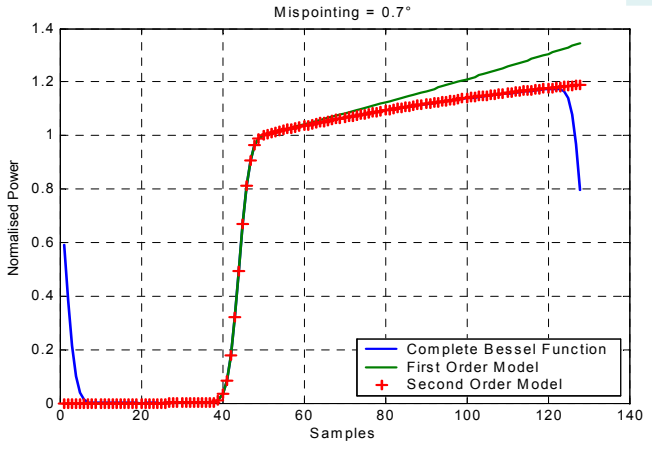
  (Hayne's model)

$$W(t)=A\exp(-v)\left[1+erf(u)\right]$$

With : $u=\frac{t-\tau-\alpha\sigma_c^2}{\sqrt{2}\sigma_c}$ $v=\alpha\left(t-\tau-\frac{\alpha}{2}\sigma_c^2\right)$ $\alpha=\delta-\frac{\beta^2}{4}$

- 2nd order model (for mispointing angles lower than 0.7 °) (Amarouche, 2004, Marine Geodesy 2nd issue)

$$W(t)=A\exp(-v_1)\left[1+erf(u_1)\right]-\frac{A}{2}\exp(-v_2)\left[1+erf(u_2)\right]$$



With :

$u_1=\frac{t-\tau-\alpha_1\sigma_c^2}{\sqrt{2}\sigma_c}$ $v_1=\alpha_1\left(t-\tau-\frac{\alpha_1}{2}\sigma_c^2\right)$ $\alpha_1=\delta-\frac{\beta^2}{8}$

$u_2=\frac{t-\tau-\alpha_2\sigma_c^2}{\sqrt{2}\sigma_c}$ $v_2=\alpha_2\left(t-\tau-\frac{\alpha_2}{2}\sigma_c^2\right)$ $\alpha_2=\delta$

$\delta=\frac{4}{\gamma}\frac{c}{h}\cos(2\xi)$ $\beta=\frac{4}{\gamma}\left[\frac{c}{h}\right]^{1/2}\sin(2\xi)$

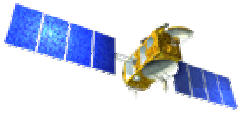
- Consequences on the retracking procedure

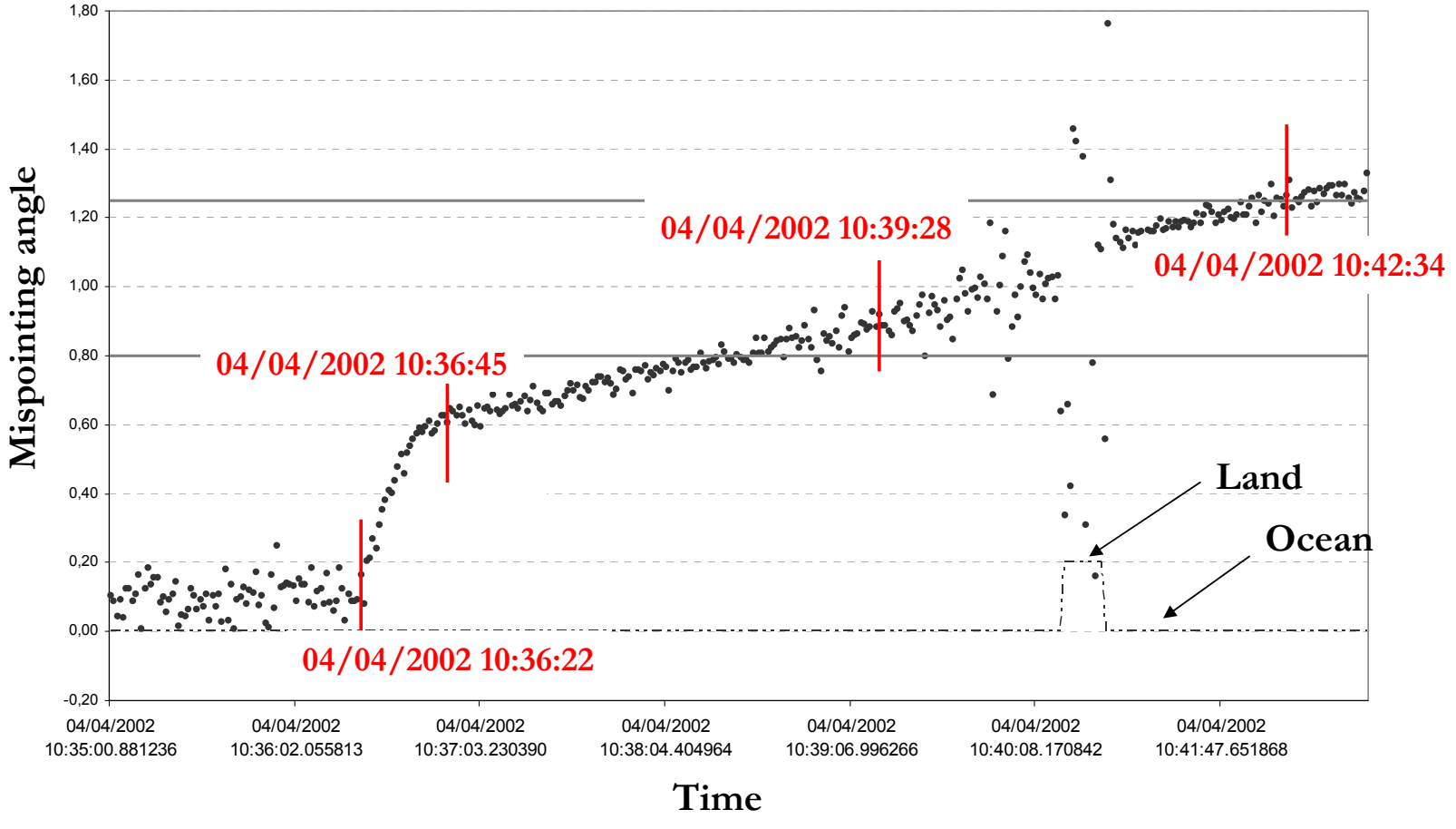
impossibility to derive the mispointing angle from the slope of the trailing edge

$$\xi^2=\frac{1+\frac{\text{Slope}}{\frac{\alpha}{2}}}{2}\cdot\frac{1}{1+\frac{1}{\gamma}}$$

⇒ MLE retracking solving for 4 parameters (range, SWH, σ_0 and $\xi 2$)

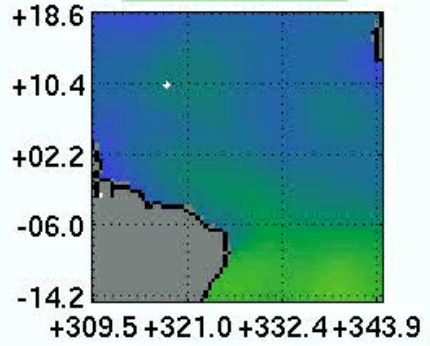
First Star Tracker Incident (Cycle 008 : 04/04/2002)



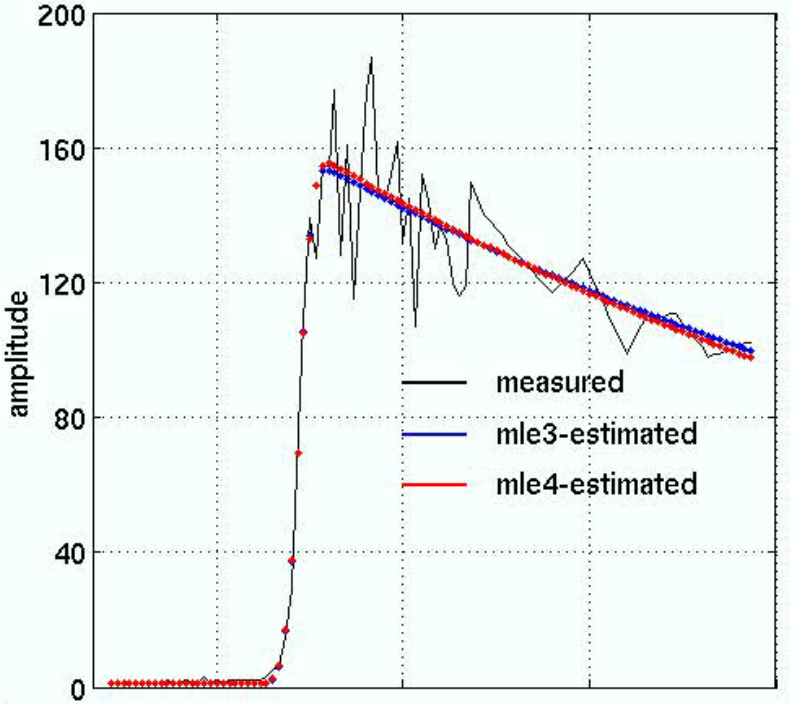


Jason-1 : Cycle 008 / Pass 252 / 10H35m8s => 10H40m13s

Satellite Track

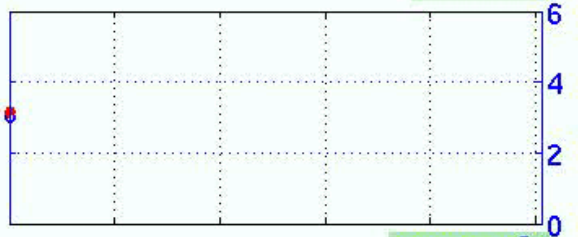


Ku-Band Waveforms



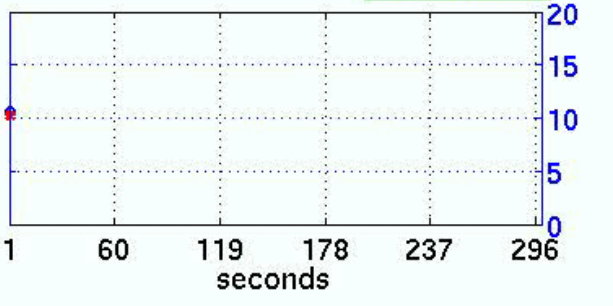
Epoch [m]

SWH [m]

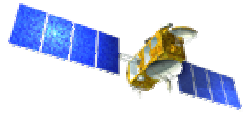


Xi2 [deg^2]

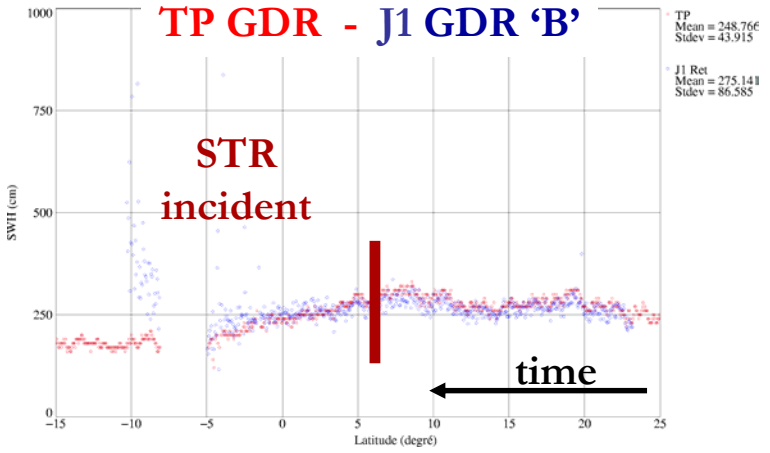
sigma$_0$ [dB]



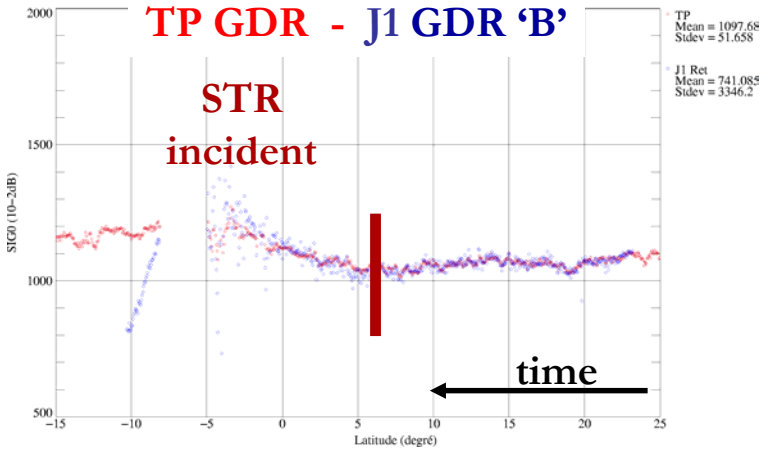
Comparison with Topex data (separated by 73 sec) on 04/04/2002



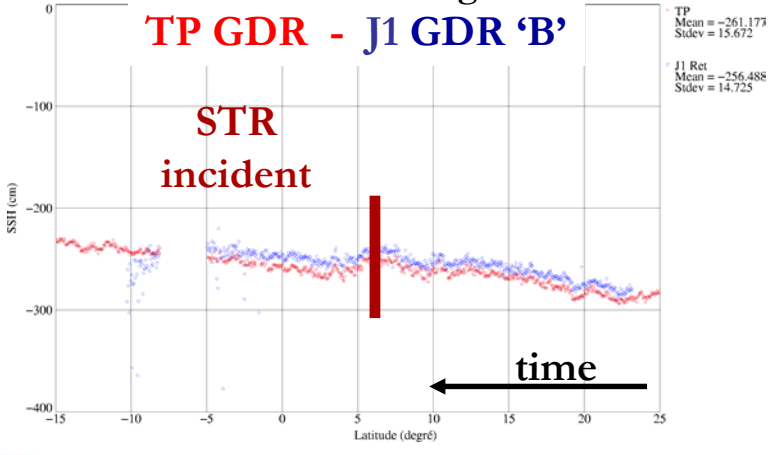
SWH

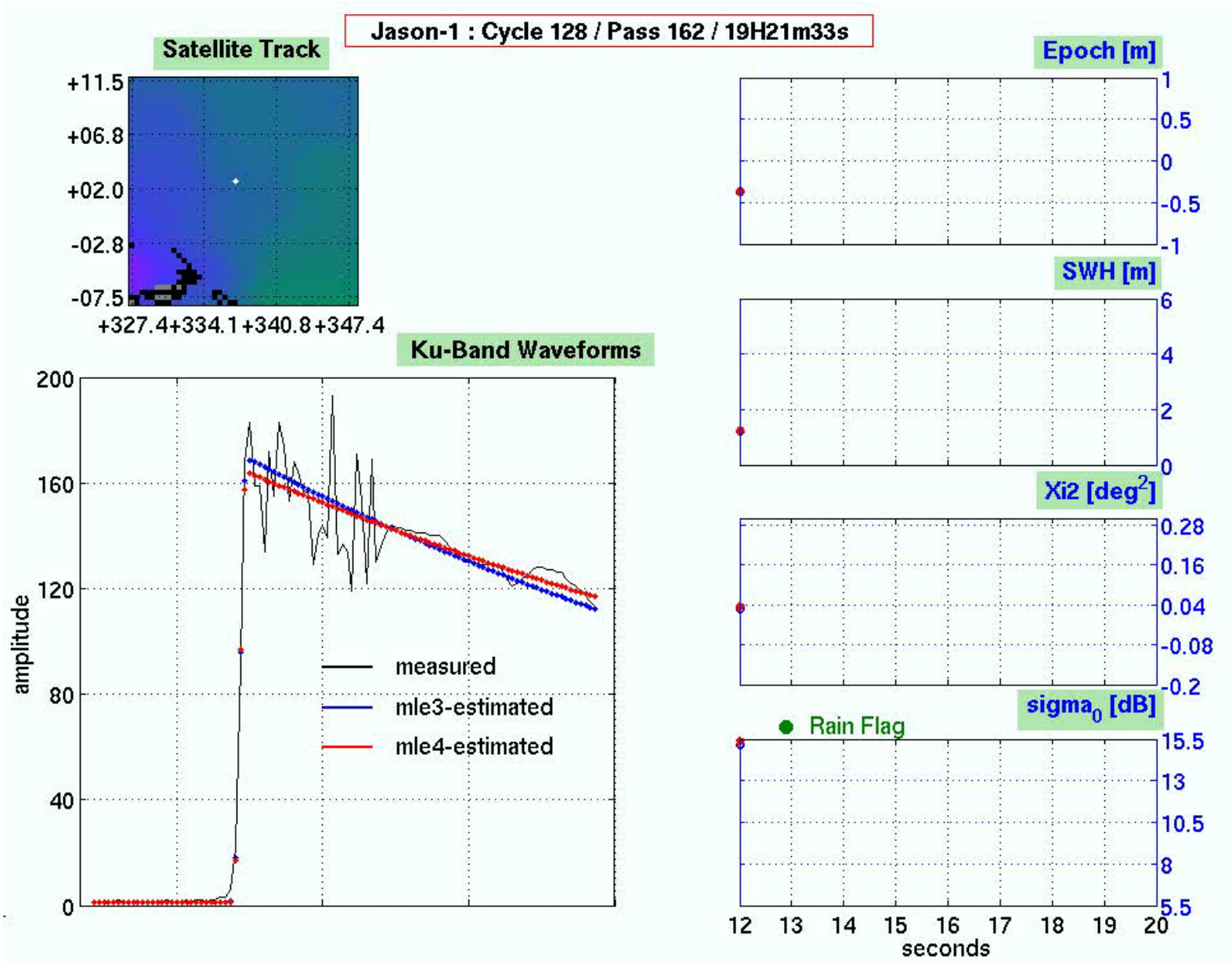


Sigma 0



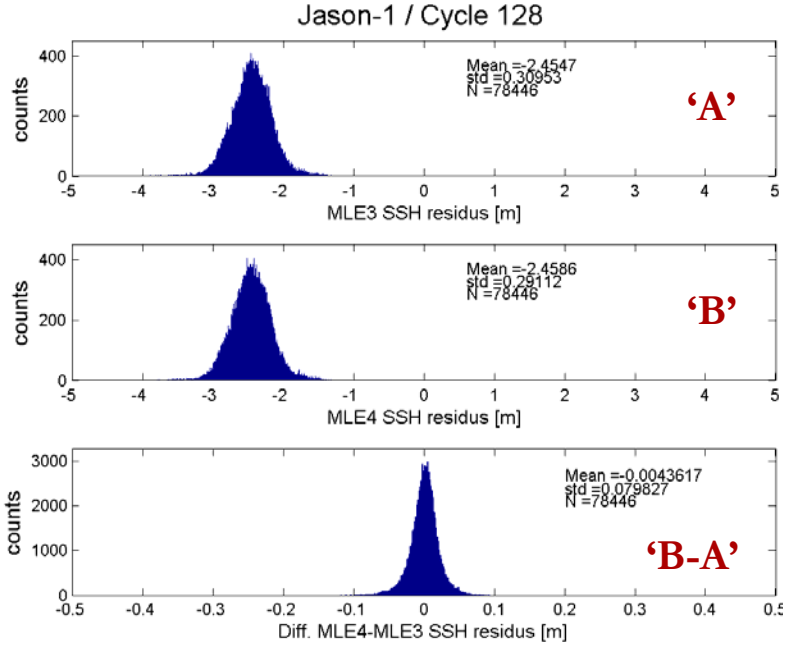
Sea Surface Height



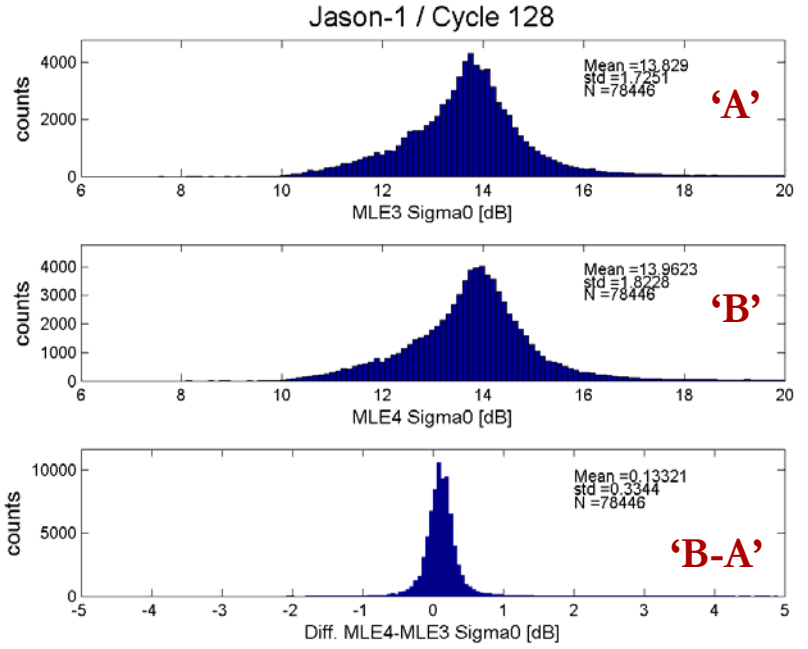

Jason-1 : Cycle 128 / Pass 162 / 19H21m33s
Satellite Track
+11.5
+06.8
+02.0
-02.8
-07.5
+327.4+334.1+340.8+347.4
Ku-Band Waveforms
amplitude
200
160
120
80
40
0
measured
mle3-estimated
mle4-estimated
Epoch [m]
1
0.5
0
-0.5
-1
SWH [m]
6
4
2
0
Xi2 [deg^2]
0.28
0.16
0.04
-0.08
-0.2
sigma$_0$ [dB]
Rain Flag
15.5
13
10.5
8
5.5
12
13
14
15
16
17
18
19
20
seconds

Histograms of the main parameters (Cycle 128)

Res SSH

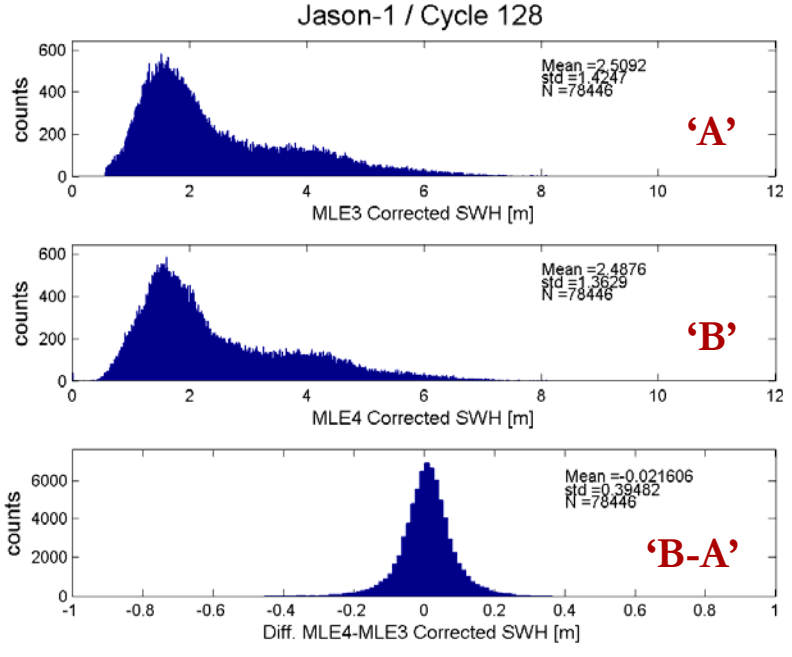


Sigma0

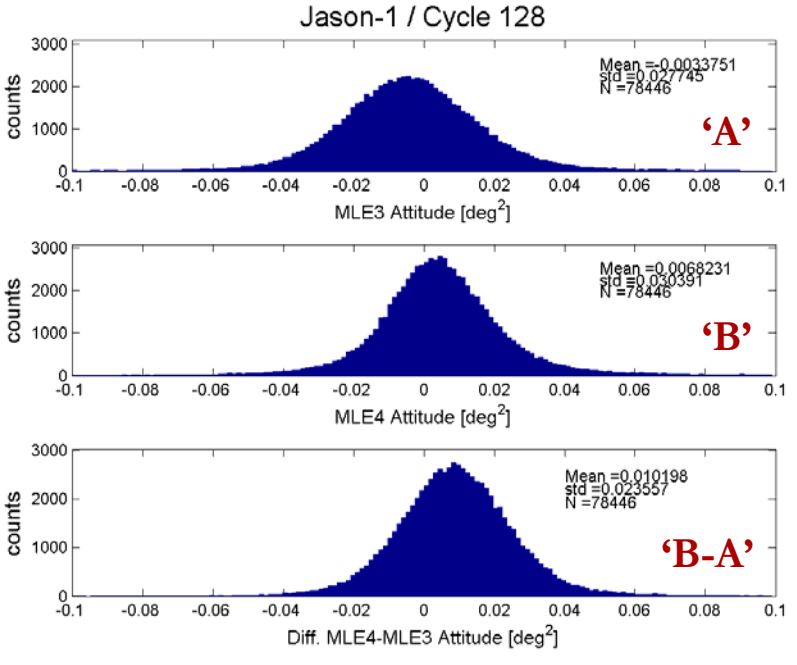


Histograms of the main parameters (Cycle 128)

SWH

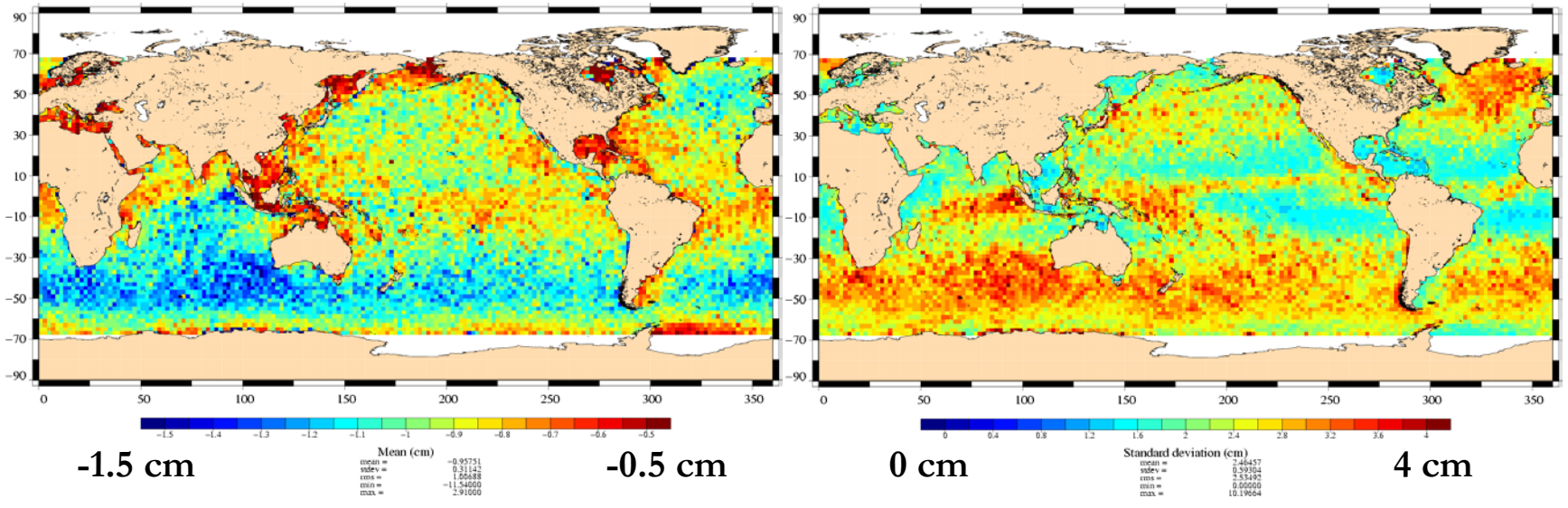


ξ^2



Difference of range without LUT : GDR 'B' – GDR 'A'

Mean Cycles 1-21 Std



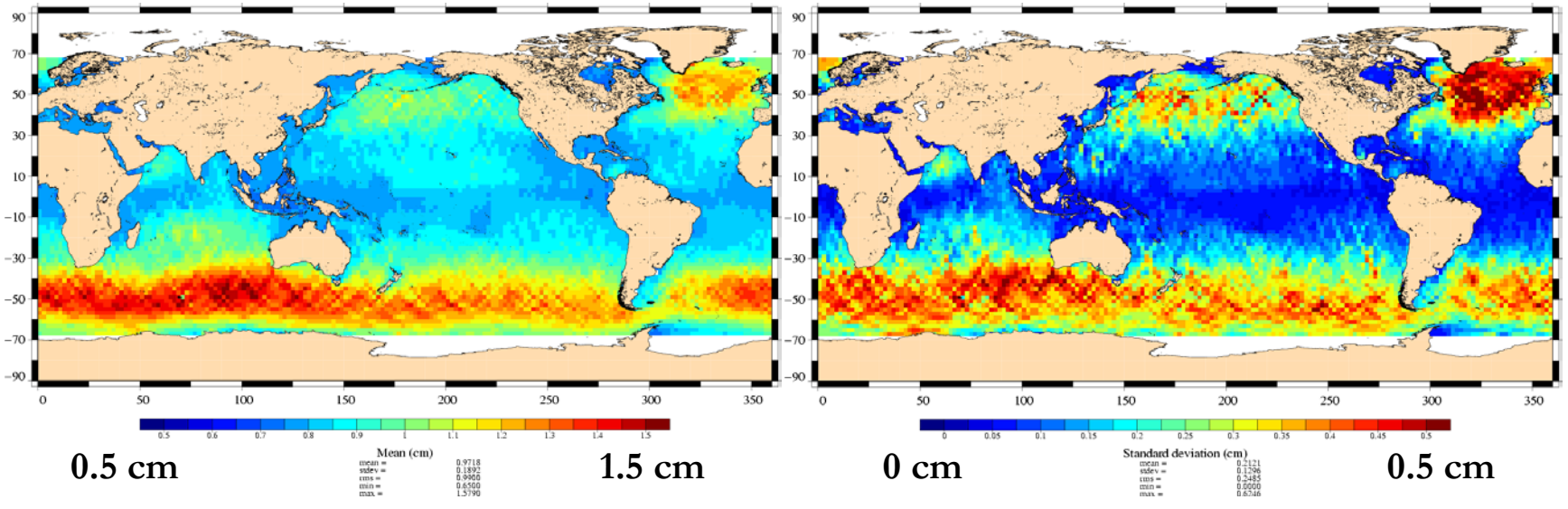
-1.5 cm -0.5 cm 0 cm 4 cm

➔Impact of the Retracking algorithm (weak on mean, significant on Std)

➔Impact of the skewness coefficient (0.3%SWH)

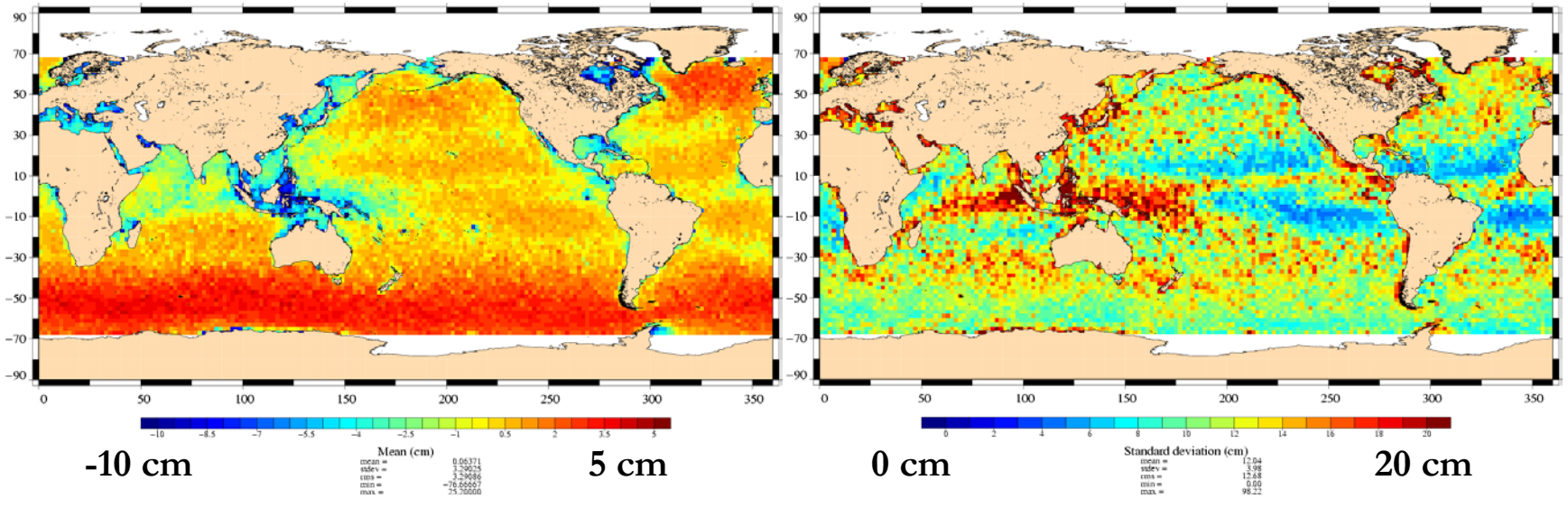
Differences of LUT on range : GDR 'B' – GDR 'A'

Mean Cycles 1-21 Std



Difference of Significant Wave Height : GDR 'B' – GDR 'A'

Mean Cycles 1-21 Std

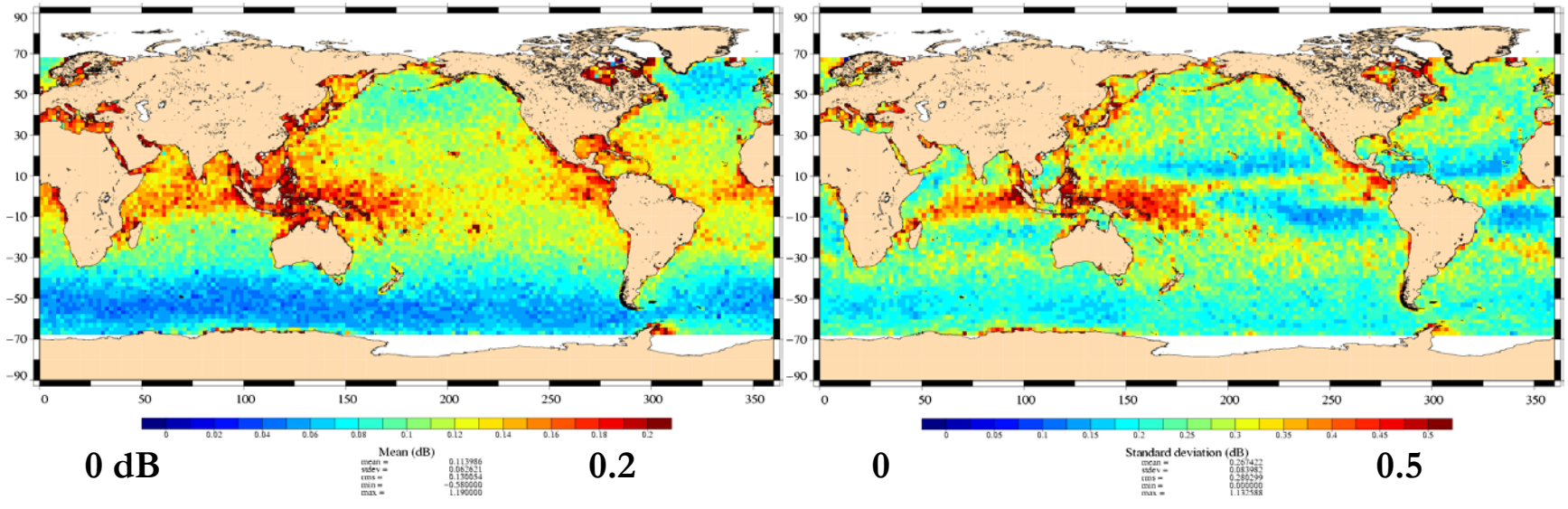


-10 cm 5 cm 0 cm 20 cm

➔ Impact of the LUT : higher values of SWH for GDR 'B' than for GDR 'A'

Difference of Sigma naught : GDR 'B' – GDR 'A'

Mean Cycles 1-21 Std

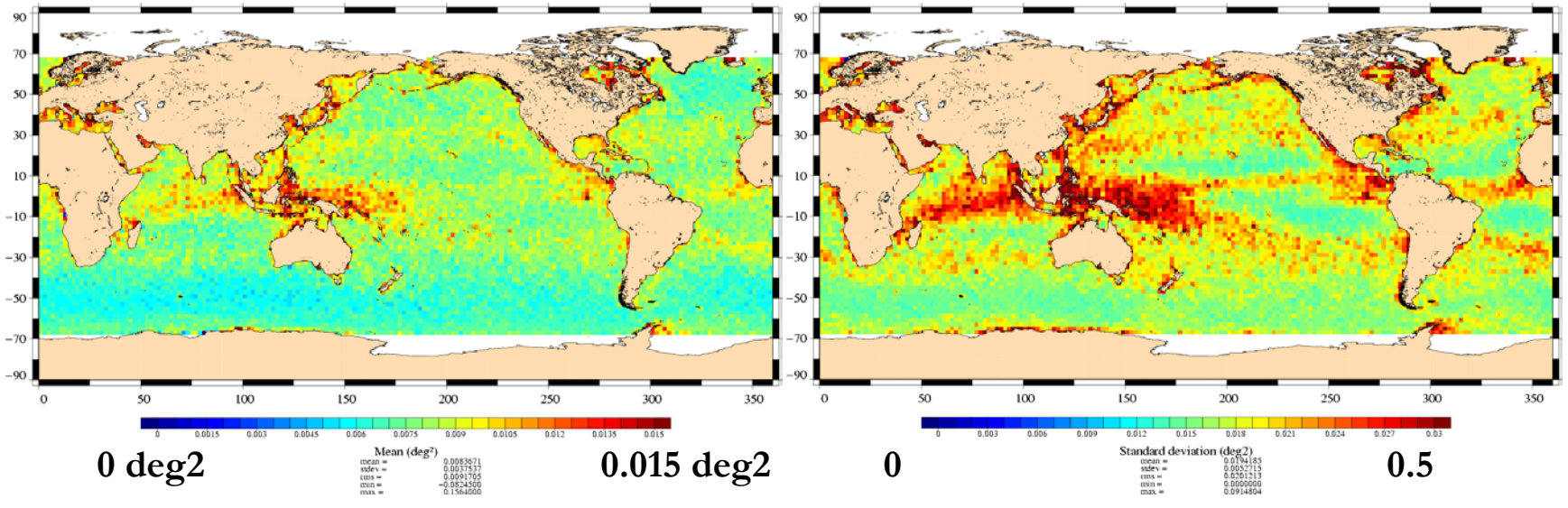


0 dB 0.2 0 0.5

➔ Mean bias equal to 0.1 dB
➔ No impact of the LUT
➔ Very small impact of the retracking

Difference of ATT square : GDR 'B' - GDR 'A'

Mean Cycles 1-21 Std



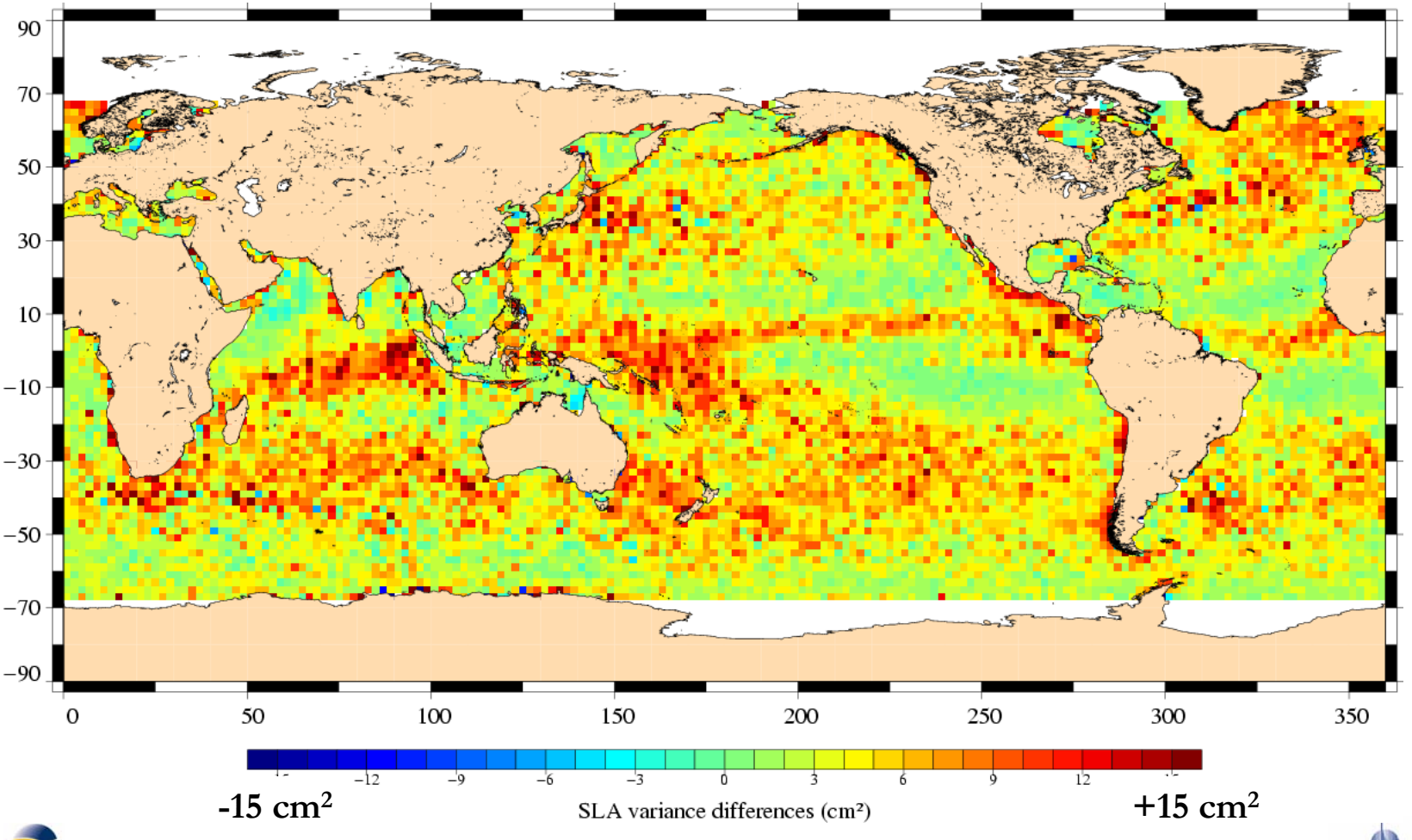
0 deg2 0.015 deg2 0 0.5

➔ Bias on the mean value (from negative to slightly positive)

Variance reduction (between GDR 'B' and GDR 'A')

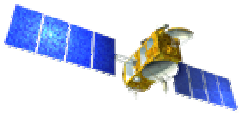
➔ Always positive

SLA variance differences

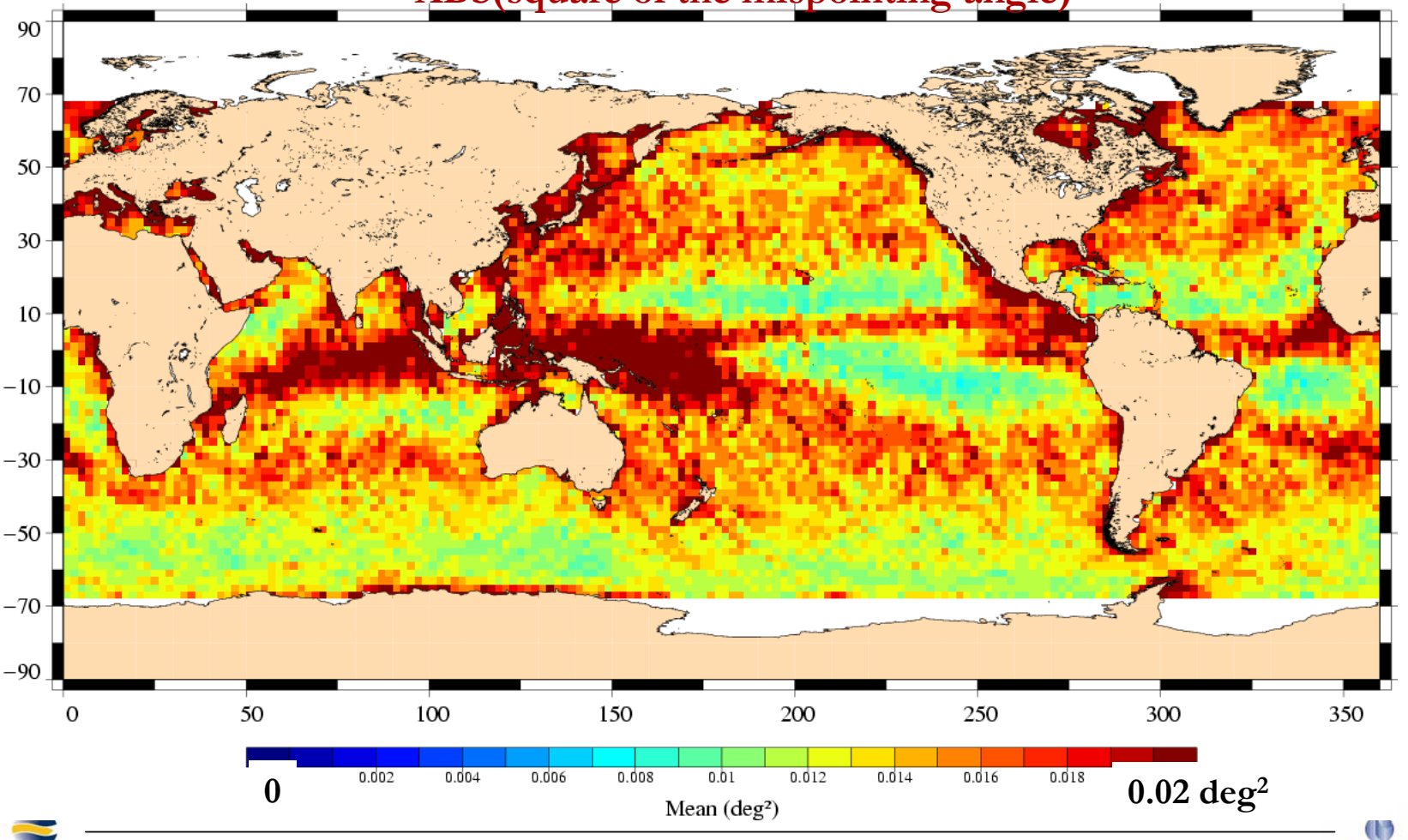


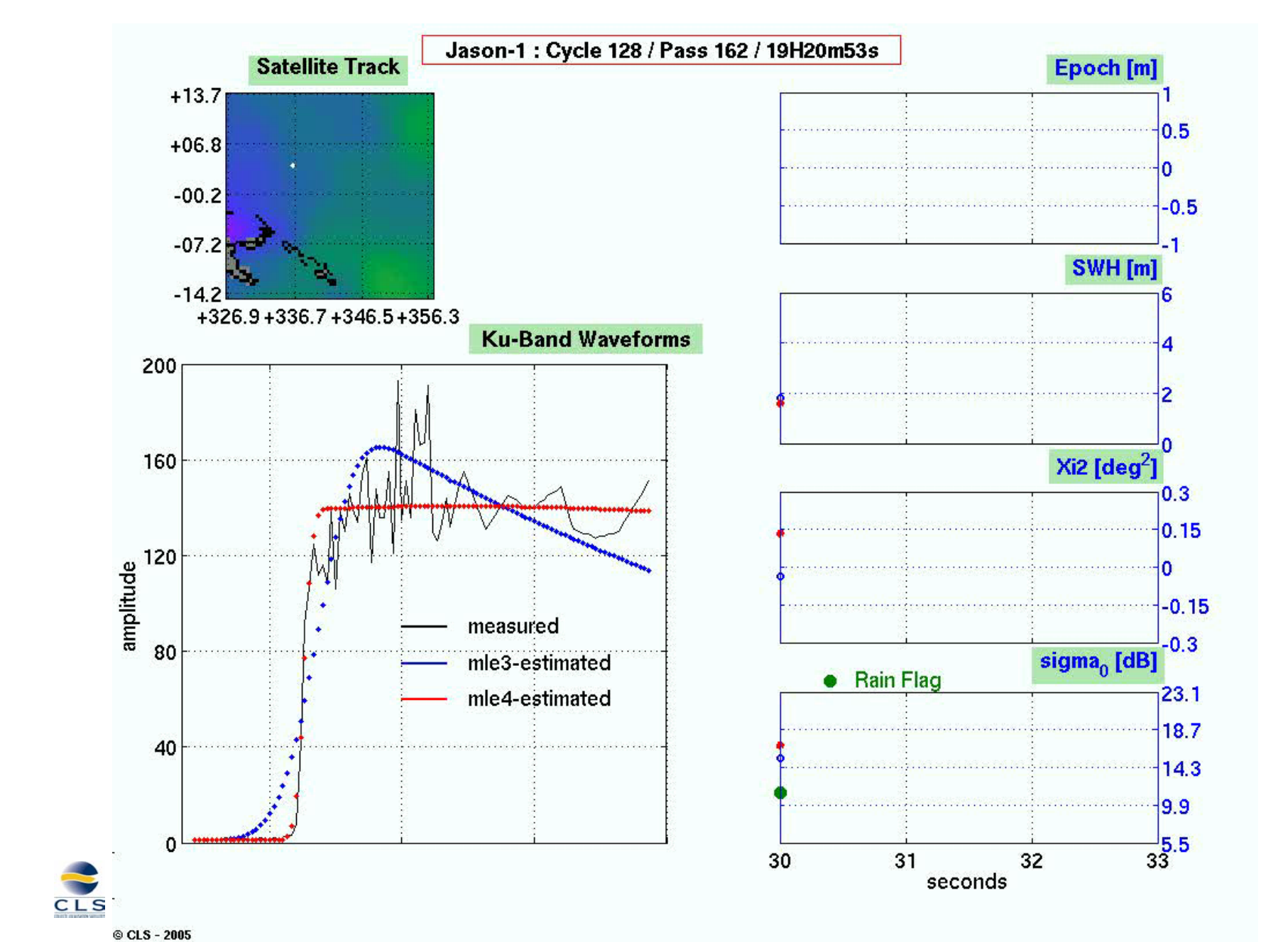
➔ Every where the waveforms differ from the theoretical Hayne's model (especially in the trailing edge of the WF), the MLE-4 retracking algorithm performs better than MLE-3 with reduction of the variance of the SLA.

➔Pseudo mispointing angle different from real mispointing angle

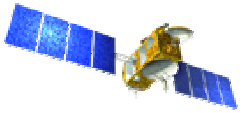


ABS(square of the mispointing angle)

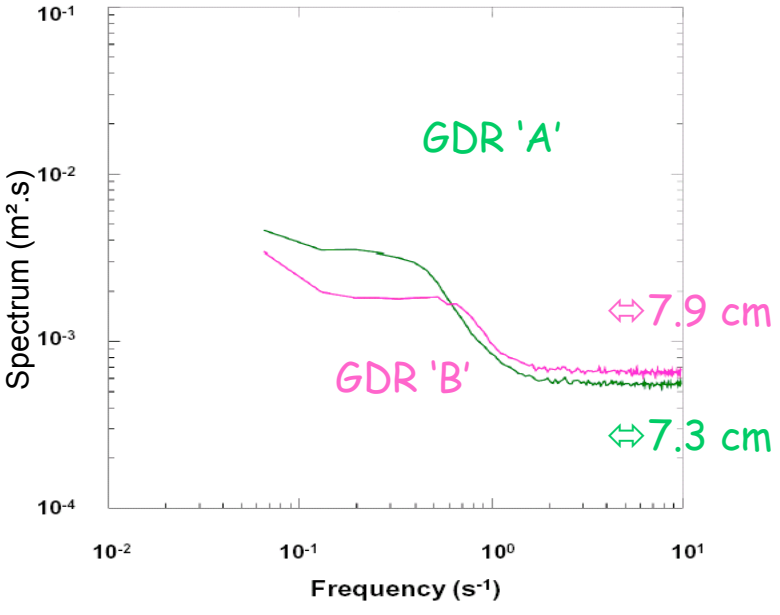



Jason-1 : Cycle 128 / Pass 162 / 19H20m53s
Satellite Track
+13.7
+06.8
-00.2
-07.2
-14.2
+326.9 +336.7 +346.5 +356.3
Ku-Band Waveforms
amplitude
200
160
120
80
40
0
measured
mle3-estimated
mle4-estimated
Epoch [m]
1
0.5
0
-0.5
-1
SWH [m]
6
4
2
0
Xi2 [deg^2]
0.3
0.15
0
-0.15
-0.3
sigma$_0$ [dB]
Rain Flag
23.1
18.7
14.3
9.9
5.5
30
31
32
33
seconds

Jason-1 SSH spectra
(cycle 131)



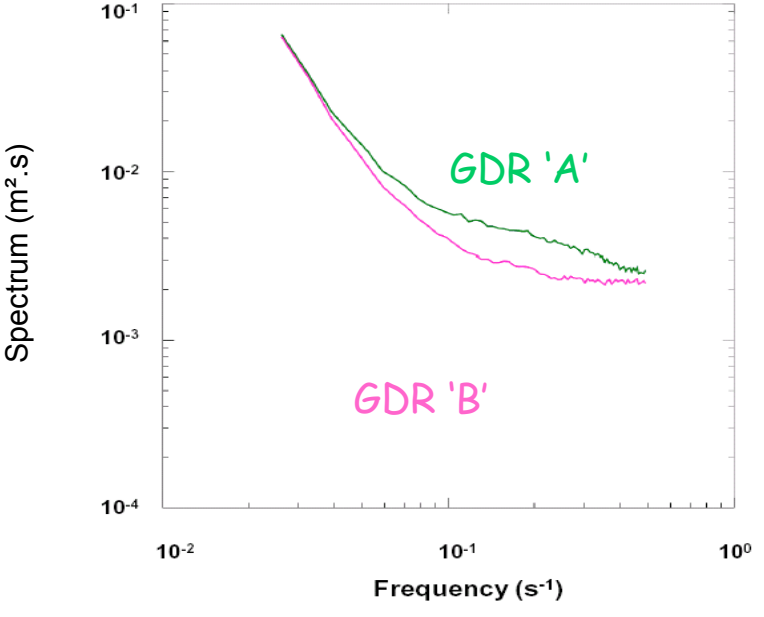
20 Hz



➔ Increase of the 20-Hz noise level

➔ Drop in energy in the range [0.1Hz-1Hz]

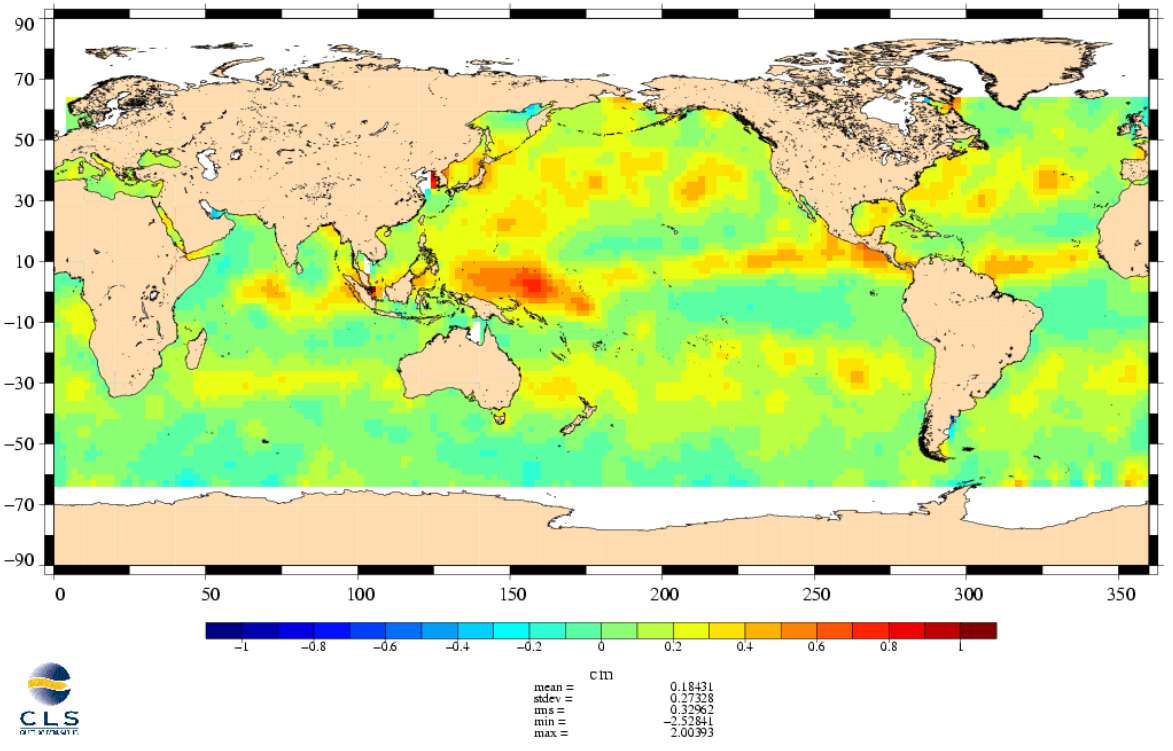
1 Hz



➔ Drop in energy in the range [0.1Hz-1Hz]

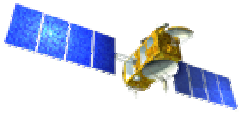
Comparison with Envisat data are developed by Y.Faugère (CalVal and Data consistency session)

Jason-1 high frequency reduction : GDR 'A' – GDR 'B' - cycles 128 - 135



➔ Areas where the high frequency content is decreased : rain areas

See again comparison with Envisat by Y.Faugère (CalVal and Data consistency session)

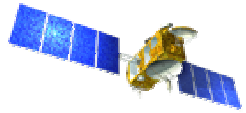


CONCLUSION

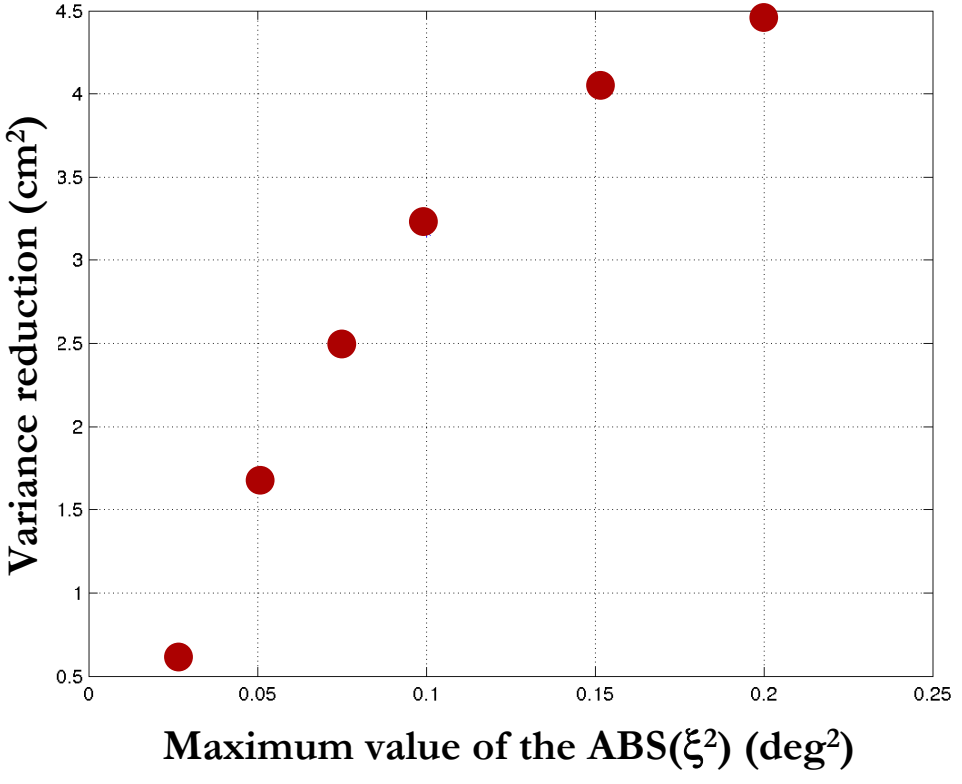
GDR 'B' using MLE-4 with second order model fully validated :

- **On platform sequences with real mispointing (up to 0.8 deg)**
- **On "normal Hayne's echoes" with a slight increase of the 20Hz noise but a drop of the spectrum energy in the range [0.1Hz-1Hz]**
- **On corrupted echoes (rain, sigma blooms, …) (variance reduction)**

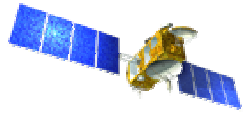
➔ **Envisat retracking algorithm ? What results could be expected ?**



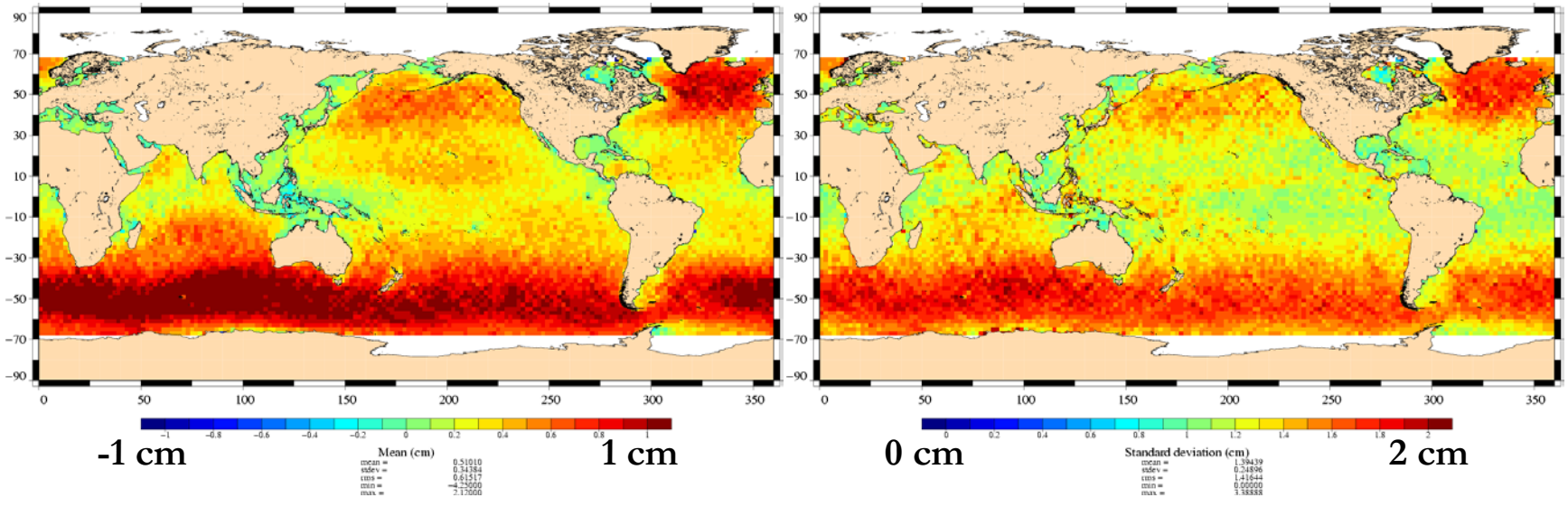
Variance difference 'B'- 'A' as a function of the max value of the mispointing



Difference of standard deviation on range (20 Hz data) : 'B' – 'A'



Mean Cycles 1-21 Std



➔ Correlation with SWH (high waves)

Jason-1 SSH spectrum (cycle 131)

20 Hz

Low ξ^2 ➔ $\xi 2 < 0.025$ deg^2