



# Jason-1 GDR Quality Assessment Report

## Cycle 144

**03-12-2005 / 13-12-2005**

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## **1 Introduction. Document overview**

The purpose of this document is to report the major features of the data quality from the Jason-1 mission. The document is associated with data dissemination on a cycle per cycle basis. This document reports results from Jason-1 GDRs.

The objectives of this document are:

- To provide a data quality assessment
- To provide users with necessary information for data processing
- To report any change likely to impact data quality at any level, from instrument status to software configuration
- To present the major useful results for the current cycle

It is divided into the following topics:

- General quality assessment and cycle overview**
- Poseidon-2 altimeter and sensor**
- CALVAL main results**
- Jason-1 Long term performance monitoring**
- Mean Sea Level (MSL)**
- Particular investigations**

## 2 General quality assessment and cycle overview

### 2.1 Software version

This cycle has been produced with the CMA Reference Software V7.1\_05. The content of this science software version is described by N.Picot (electronic communication, October 21, 2005) [1]. The main impacts of these evolutions are described in section [Impact of CMA version 7.1 for the SSH calculation](#) (page 3).

### 2.2 Cycle quality and performances

Data quality for this cycle is nominal.

Analysis of crossovers and sea surface variability indicate that system performances are close to usual values that are obtained from the TOPEX/POSEIDON data. For this cycle, the crossover standard deviation is 6.82 cm rms. When using a selection to remove shallow waters (1000 m), areas of high ocean variability and high latitudes ( $> |50|$  deg.) it decreases down to 5.26 cm rms. The standard deviation of Sea Level Anomalies (SLA) relative to a 7-year mean (based on T/P data) is 10.23 cm. When using a selection to remove shallow waters (1000 m), areas of high ocean variability and high latitudes ( $> |50|$  deg) it lowers to 9.31 cm .

- Performances from crossover differences are detailed in the dedicated [section Crossover statistics](#).
- Detailed CALVAL results are presented in [section 3](#).

### 2.3 Missing measurements

This cycle has no missing pass. Missing measurements relative to a nominal ground track are plotted on [section Missing measurements](#).

### 2.4 End of scientific mission for TOPEX/Poseidon

Since cycle 139, there are no results from intercalibration between Jason-1 and TOPEX/Poseidon data. During TOPEX/Poseidon cycle 481, on 9th October 2005, the pitch reaction wheel showed an anomalous behavior, followed by stalling. Despite of several attempts to restart the wheel, it continues to stop working after a short warm-up phase. In consequence the TOPEX/Poseidon satellite is currently in a sun-pointing safe mode on two-wheel control.

## 2.5 Impact of product version "b" (CMA version 7.1) for the SSH calculation

### 2.5.1 Editing procedure

The new MLE4 retracking algorithm based on a second-order altimeter echo model is more robust for large off-nadir angles (up to 0.8 degrees). For product version "a" (previous CMA version 6.3), the maximum threshold on square off-nadir angle proposed in Jason-1 User Handbook document was set to  $0.16 \text{ deg}^2$ . Henceforth, this threshold is too restrictive and has to be set to  $0.64 \text{ deg}^2$ .

However, this editing criteria had the side effect of removing some bad measurements impacted by rain cells, sigma0 blooms or ice. With the new threshold ( $0.64 \text{ deg}^2$ ), these measurements are not rejected any more even though the estimated SSH is not accurate for such waveforms.

Therefore 2 new criteria have to be added to check for data quality:

- Standard deviation on Ku sigma0  $\leq 1 \text{ dB}$
- Number measurements of Ku sigma0  $\geq 10$

The Jason-1 User Handbook suggests the following editing criteria for the version "a" GDRs:

- $-0.2 \text{ deg}^2 \leq \text{square of off-nadir angle from waveforms (off\_nadir\_angle\_ku\_wvf)} \leq 0.16 \text{ deg}^2$
- $\text{sigma0\_rms\_ku} < 0.22 \text{ dB}$  (optional criterion)

For the version "b" GDRs these two edit criteria should be replaced by:

- $-0.2 \text{ deg}^2 \leq \text{square of off-nadir angle from waveforms (off\_nadir\_angle\_ku\_wvf)} \leq 0.64 \text{ deg}^2$
- and  $\text{sigma0\_rms\_ku} \leq 1.0 \text{ dB}$
- and  $\text{sig0\_numval\_ku} \geq 10$

With these new criteria, the editing gives similar results for both product versions. Most of anomalous SSH measurements are rejected. Please note that some of them are still not detected, in particular close to sea ice. This is due to the ice flag which is not perfect.

### 2.5.2 Impact on mean SSH

Some evolutions have a direct impact on the SSH estimation. The global bias between version "a" and "b" of the products is 1.9 cm :

$$\overline{SSH_{CMA7.1}} = \overline{SSH_{CMA6.3}} - 1.9\text{cm}$$

This comes from two main components:

- A very slight effect of the MLE4 retracking and of the new instrumental tables (0.1 cm).
- The improved SSB correction is shifted in average by 2.0 cm in comparison with the previous one

$$\overline{SSB_{CMA7.1}} = \overline{SSB_{CMA6.3}} + 2.0\text{cm}$$

For several scientific applications (mean sea level trend, ...), it is important to take this difference in mean SSH into account until all the GDRs cycles are provided with the new ground processing version.

### 2.5.3 Impact on mean SWH and sigma0

MLE4 retracking algorithms has no impact on SWH mean value.

Impact of MLE4 retracking algorithms on sigma0\_ku mean value is 0.1 dB (sigma0\_ku becoming higher). Please note that the rms on 20 Hz Ku sigma0 has increased as a consequence of the MLE4 inversion scheme.

### 2.5.4 Jason-1 Radiometer wet troposphere correction

The Jason-1 Microwave Radiometer (JMR) has been recalibrated using data from repeat cycles 1-115. Version "b" GDRs contain the recalibrated JMR data and some improved algorithms to derive JMR brightness temperatures. The recalibrated JMR data remove the anomalous jumps observed in the JMR path delays on the version "a" GDRs. As a result of this recalibration a bias of approximately 0.9 cm in the JMR wet path delays exists between the version "a" GDRs from cycle 135 and the version "b" GDRs from cycle 136. This bias will then also affect mean SSH at this transition when JMR wet path delays are used to compute SSH.

A JMR replacement product that contains recalibrated JMR wet path delay measurements for cycles that are being reprocessed into version "b" GDRs (e.g. cycles < 136) will be released soon. This replacement product can be used to ensure a stable sea surface height time series for precision applications such as mean sea level monitoring. In the meantime, it is preferable to use the EWCMPF model wet troposphere correction.

## 3 Poseidon-2 altimeter and sensor

### 3.1 Sensor status

A detailed assessment of the Poseidon-2 sensor is made in a separate bulletin to be made available on request.

### 3.2 Poseidon-2 altimeter status

This section presents the general status of the altimeter for main instrumental variations through the Jason-1 mission. Two calibration modes are used to monitor the altimeter internal drifts and compute the altimetric parameters. They are programmed about three times per day, over land. The CAL1 mode measures the Point Target Response (PTR) of the altimeter in Ku and C bands. Among the parameters extracted from the PTR are:

- the internal path delay
- the total power of the PTR

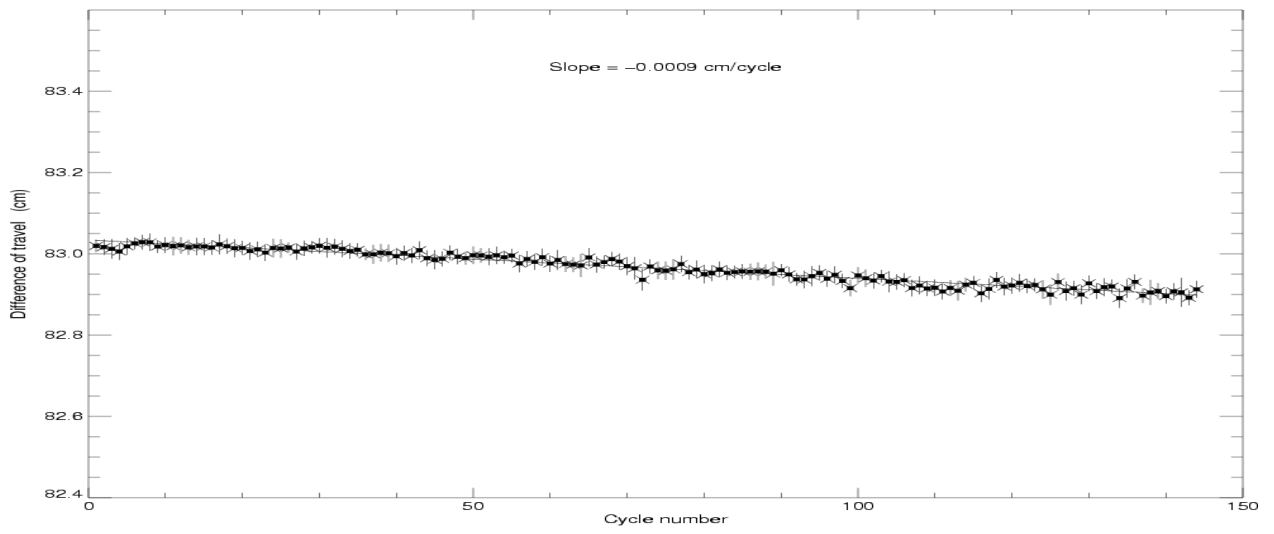
The evolutions of these parameters as a function of time are plotted to monitor the ageing of the altimeter.

Notice that in the Jason-1 products, the range is corrected for the internal path delay and the backscatter coefficient takes into account the total power of the measured PTR.

### 3.2.1 Monitoring of the internal path delay

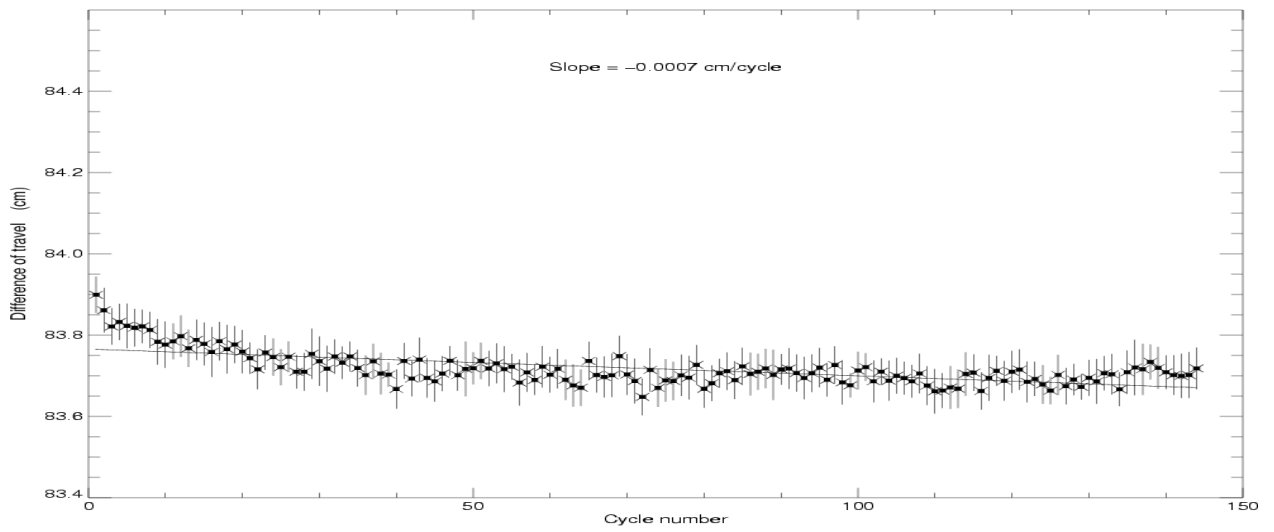
#### POSEIDON2 – Cycle 001 to Cycle 144

Difference of travel between E and R lines of the PTR in Ku band



#### POSEIDON2 – Cycle 144

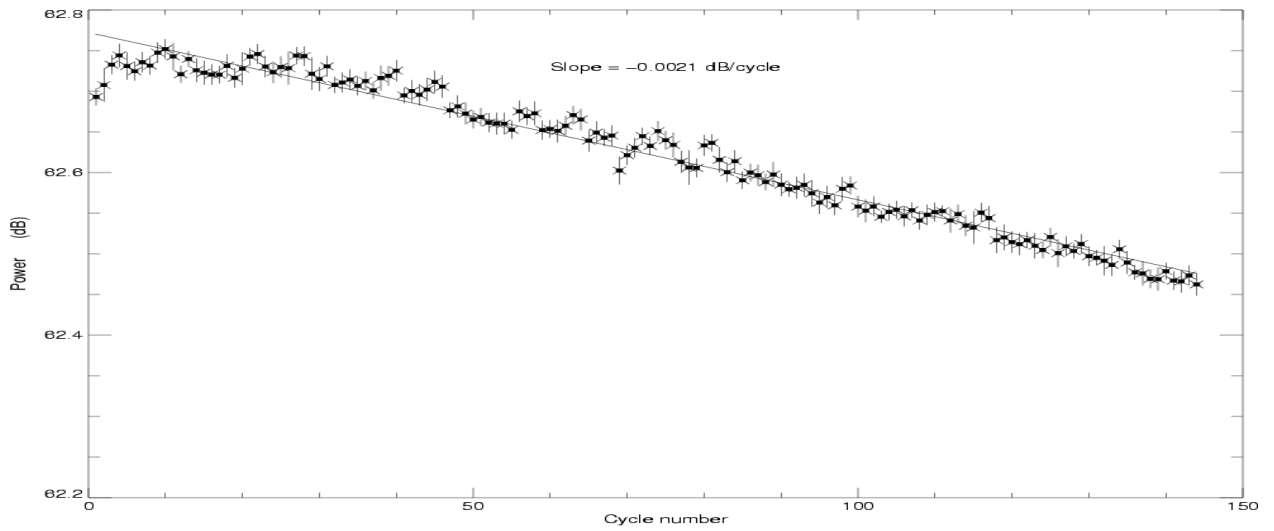
Difference of travel between E and R lines of the PTR in C band



### 3.2.2 Monitoring of the total power in the PTR

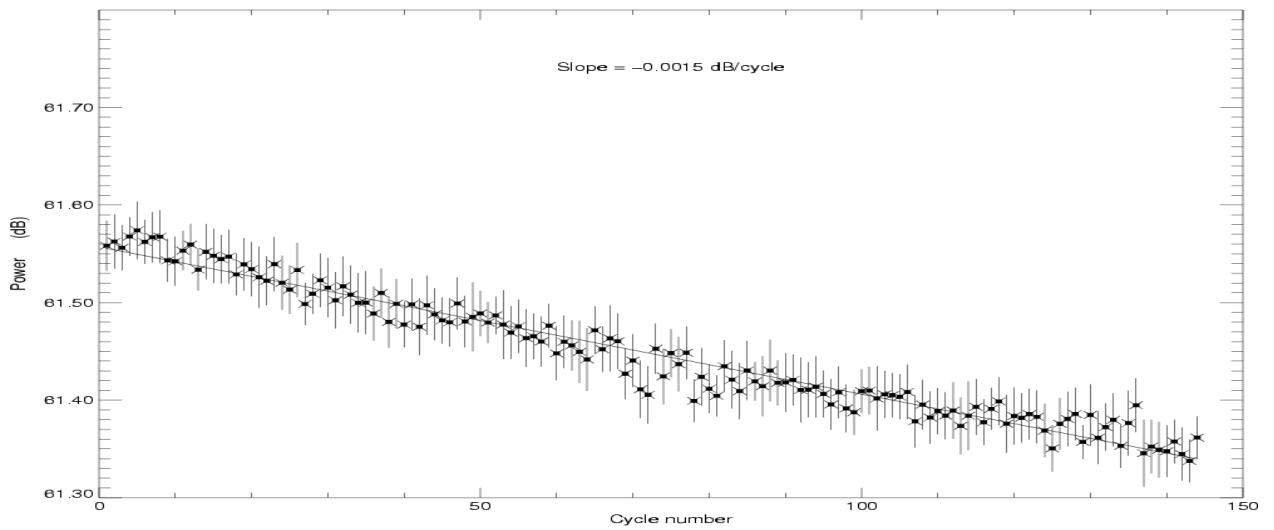
#### POSEIDON2 – Cycle 144

Total power of the PTR in Ku band



#### POSEIDON2 – Cycle 144

Total power of the PTR in C band



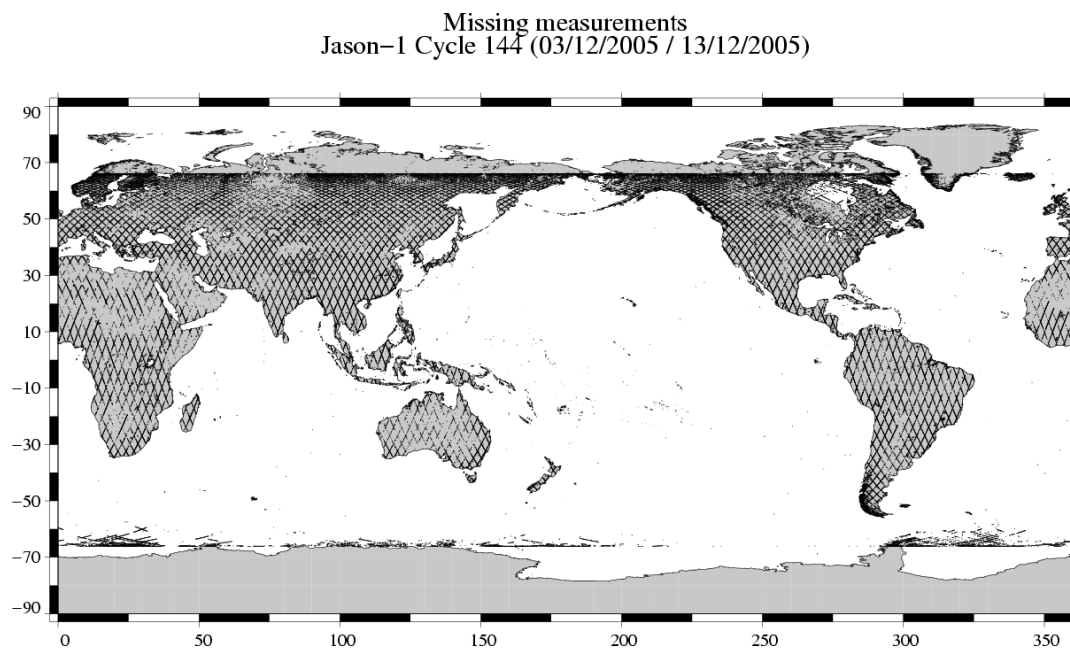


## 4 CALVAL main results

This section presents results that illustrate data quality during this cycle. These verification products are produced operationally so that they allow systematic monitoring of the main relevant parameters.

### 4.1 Missing measurements

The map below illustrates missing 1Hz measurements in the GDRs, with respect to a 1 Hz sampling of a nominal repeat track.



## 4.2 Edited measurements

Editing criteria are defined for the GDR product in Aviso and PODAAC User Handbook [2].

The editing criteria are defined as minimum and maximum thresholds for various parameters. Measurements are edited if at least one parameter does not lie within those thresholds. These thresholds are expected to remain constant throughout the Jason-1 mission, so that monitoring the number of edited measurements allows a survey of data quality.

In the following, the altimeter state flag (`alt_state_flag`) is used instead of the radiometer state flag (`rad_state_flag`). Indeed, this allows to keep more data near the coasts and then to detect potential anomalies in these areas. Furthermore, there is no impact on global performance estimations since the more significant results are derived from analyses in open ocean areas.

The rain flag is not used for data selection since it is not yet tuned.

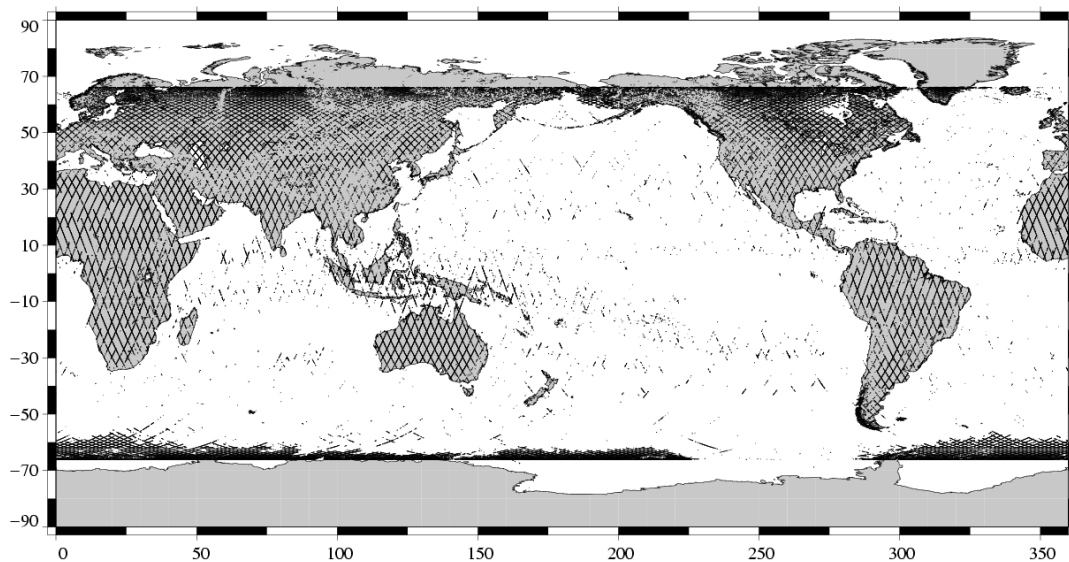
The number and percentage of points removed by each criterion is given on the following table. Note that these statistics are obtained with measurements already edited for altimeter land flag (16.81 % of points removed) and ice flag ( 9.84 % of points removed).

Parameters	Min threshold	Max threshold	Unit	Nb removed	% removed	% mean removed
Sea surface height	-130.000	100.000	<i>m</i>	8362	1.56	1.66
Sea level anomaly	-2.000	2.000	<i>m</i>	10122	1.89	2.25
Nb measurements of range	10.000	-	-	10428	1.95	2.08
Std. deviation of range	0.000	0.200	<i>m</i>	10298	1.93	2.13
Square off nadir angle	-0.200	0.640	<i>deg</i> <sup>2</sup>	5081	0.95	1.75
Dry tropospheric correction	-2.500	-1.900	<i>m</i>	0	0.00	0.007
Combined atmospheric correction	-2.000	2.000	<i>m</i>	10	0.00	0.005
JMR wet tropospheric correction	-0.500	-0.001	<i>m</i>	819	0.15	0.20
Ionospheric correction	-0.400	0.040	<i>m</i>	9499	1.78	1.85
Significant wave height	0.000	11.000	<i>m</i>	5503	1.03	1.32
Sea State Bias	-0.500	0.000	<i>m</i>	4911	0.92	1.35
Backscatter coefficient	7.000	30.000	<i>dB</i>	5489	1.03	1.13
Nb measurements of sigma0	10.000	-	-	10359	1.94	-
Std. deviation of sigma0	0.000	1.000	<i>dB</i>	11395	2.13	-
Ocean tide	-5.000	5.000	<i>m</i>	3066	0.57	0.85
Equilibrium tide	-0.500	0.500	<i>m</i>	0	0.00	0.00
Earth tide	-1.000	1.000	<i>m</i>	0	0.00	0.00
Pole tide	-15.000	15.000	<i>m</i>	0	0.00	1.61
Altimeter wind speed	0.000	30.000	<i>m.s</i> <sup>-</sup>	6881	1.29	3.70
Global statistics of edited measurements by thresholds	-	-	-	20156	3.77	3.70

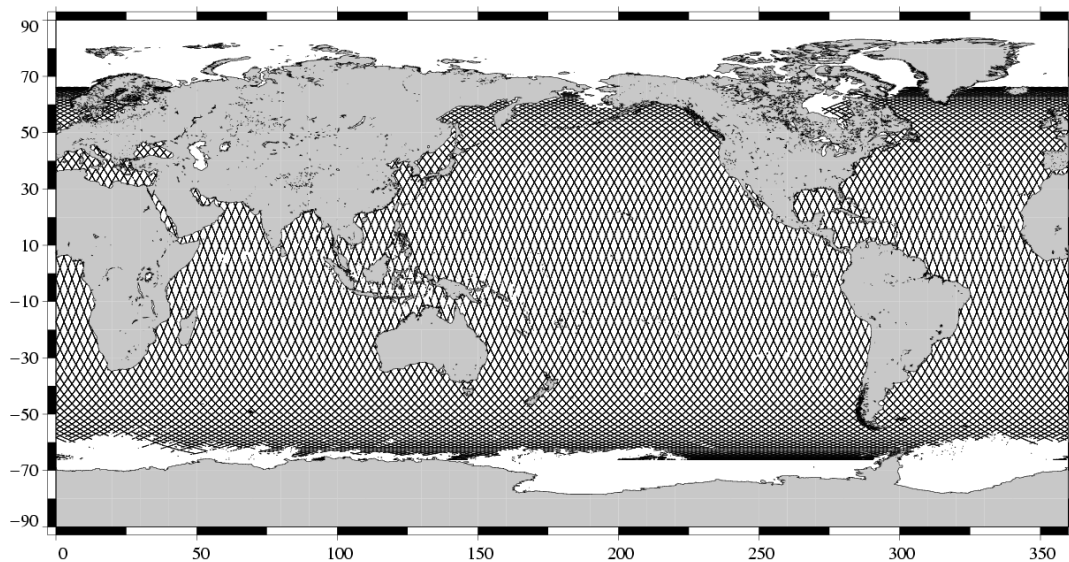
### 4.2.1 Figures

The following two maps are complementary: they show respectively the removed and selected measurements in the editing procedure.

Edited measurements  
Jason-1 Cycle 144 (03/12/2005 / 13/12/2005)

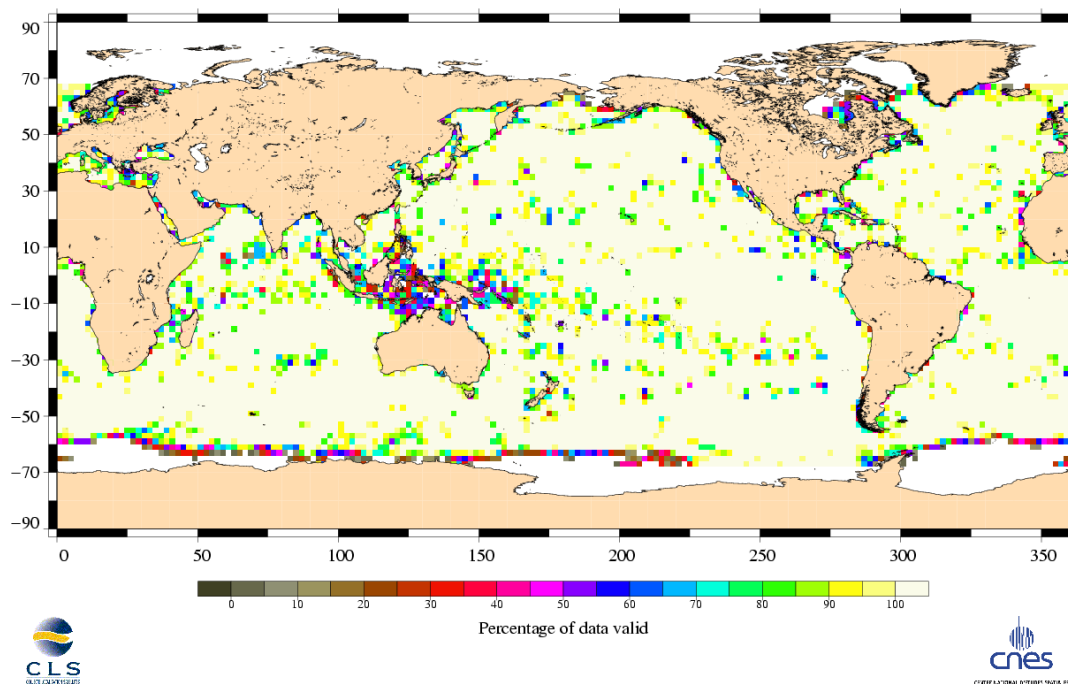


Valid data  
Jason-1 Cycle 144 (03/12/2005 / 13/12/2005)



The next map shows the percentage of valid measurements by sample.

Percentage of valid data relative to the nominal pass  
Jason-1 Cycle 144 (03/12/2005 / 13/12/2005)

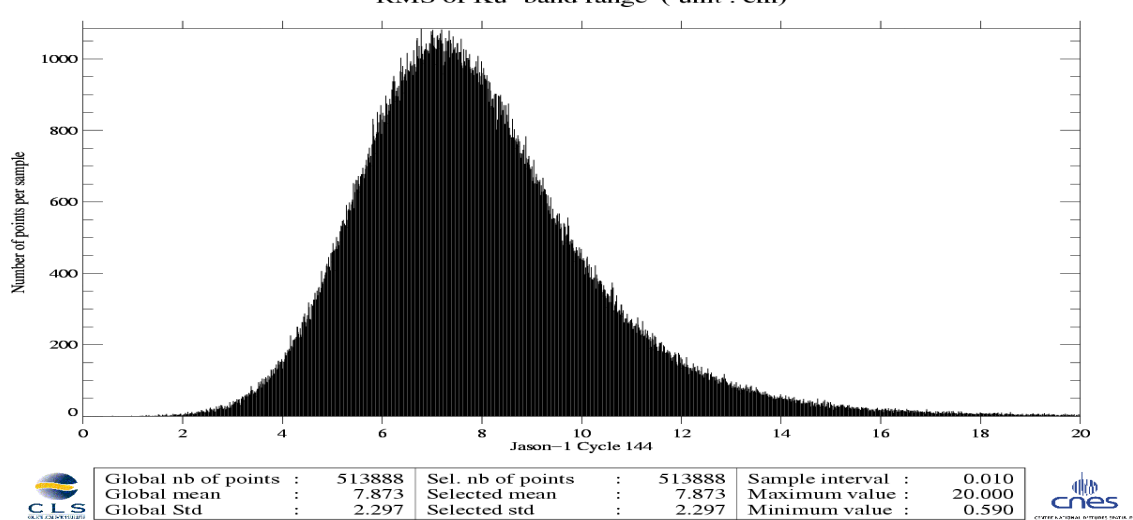
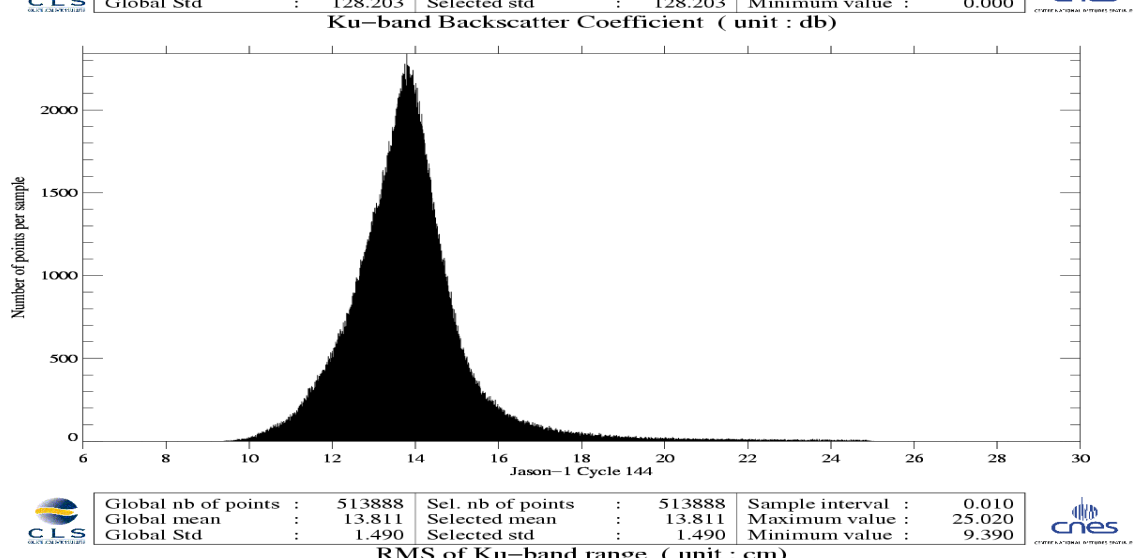
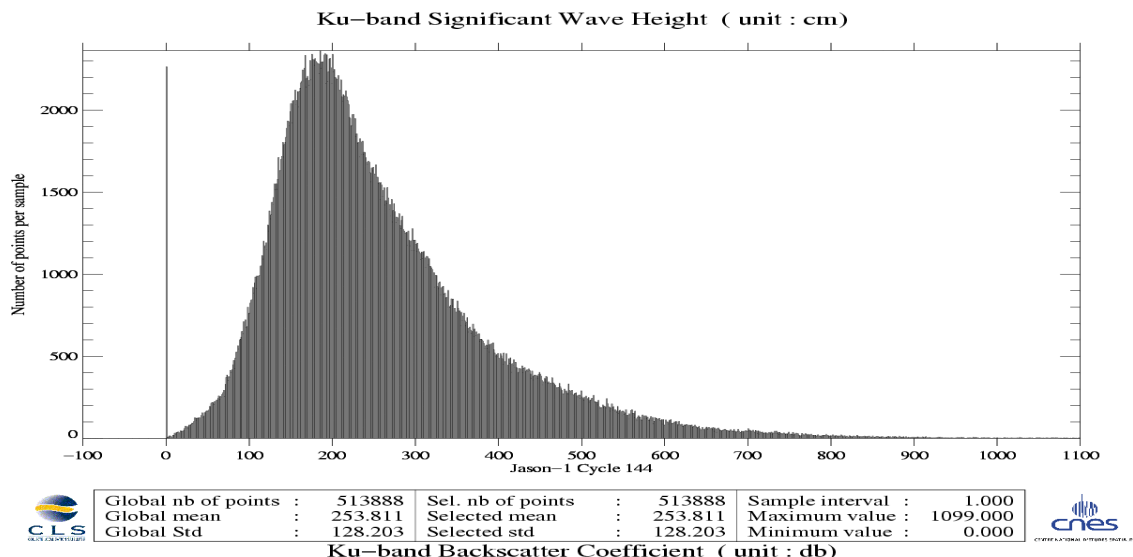


#### 4.2.2 Comments

Wet zones appear in the plot of removed data, as it was also the case for Topex and Poseidon altimeters: measurements may be corrupted by rain. Compared with the usual maps obtained for Topex, there are less removed data in these zones and in the areas of strong sea states.

### 4.3 Altimeter parameters

In order to assess and to monitor altimeter parameter measurements, histograms of Jason-1 Ku-band Significant Wave Height (SWH), Backscatter coefficient (Sigma0) and RMS of altimeter range are computed for the valid data set previously defined.

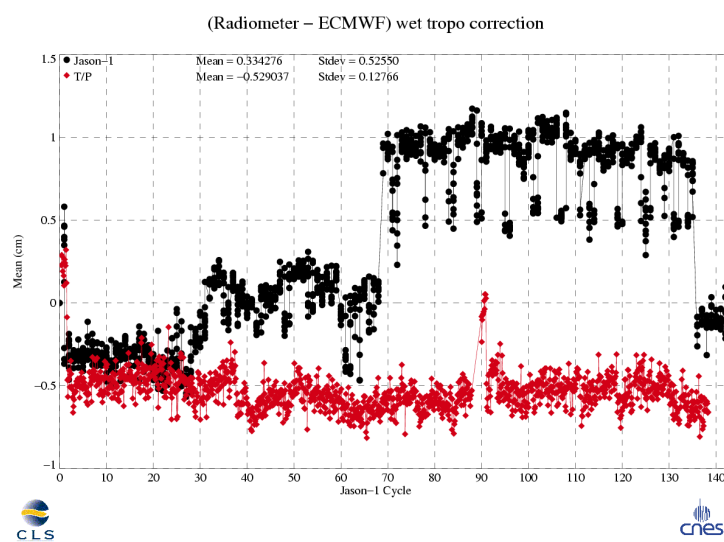


#### 4.4 Radiometer parameters

Daily mean of (Radiometer - ECMWF) wet troposphere corrections is plotted below for Jason-1 and T/P. Note that the TMR correction has been corrected for the drift (Sharroo R. et al., 2004 [4]). Moreover the 60-day signal due to TOPEX yaw maneuvers has been partially removed. Since 9th october 2005 scientific mission of TOPEX has stopped. This long term monitoring exhibits the following abnormal variations:

- A 60-day signals is observed due to Jason-1 yaw maneuvers.
- A significant decrease of about 4 mm is observed from cycle 27 to 32.
- A jump of about 9 mm is observed at cycle 69. This jump occurs after the safehold mode on this cycle.

These jumps have been corrected in CMA version 7.1. This explains the jump observed from cycle 136 onwards.



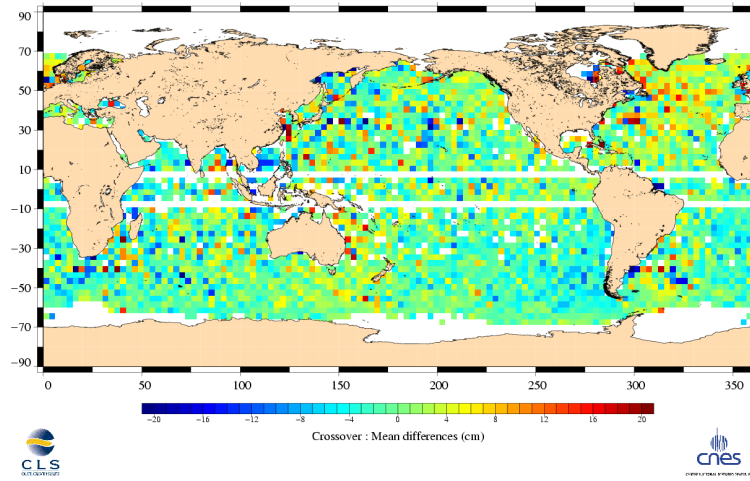
#### 4.5 Crossover statistics

SSH crossover statistics are computed from the valid data set. They are used to estimate the data quality and to monitor the system performances.

After data editing and using the standard Jason-1 algorithms, the crossover standard deviation is about 5.26 cm rms, when using a selection to remove shallow waters (1000 m), areas of high ocean variability and high latitudes ( $> |50|$  deg.).

The map of the mean differences at crossovers (4 by 4 degrees by bins) is plotted below.

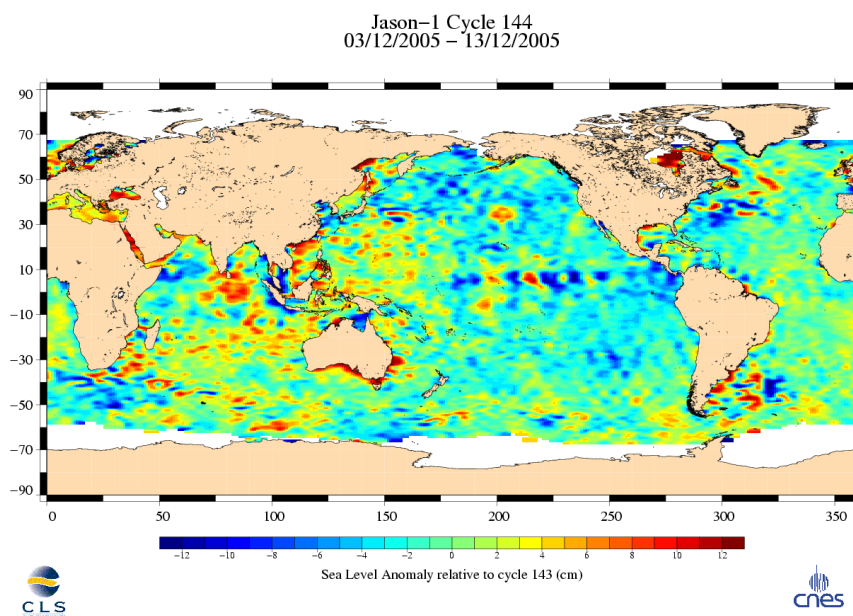
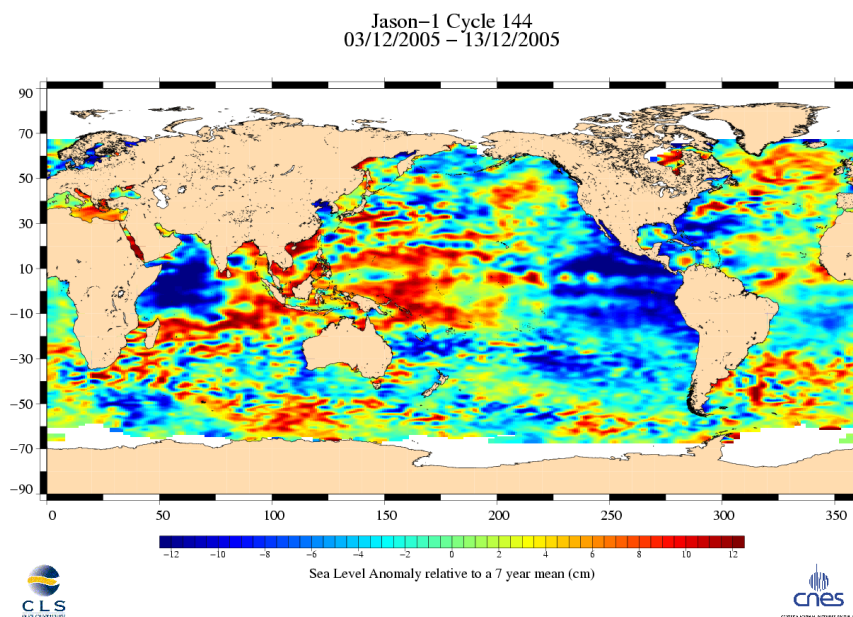
Jason, cycle 144  
Period : 03/12/2005 – 13/12/2005



## 4.6 SSH variability

### 4.6.1 Jason-1 Sea Level Anomalies

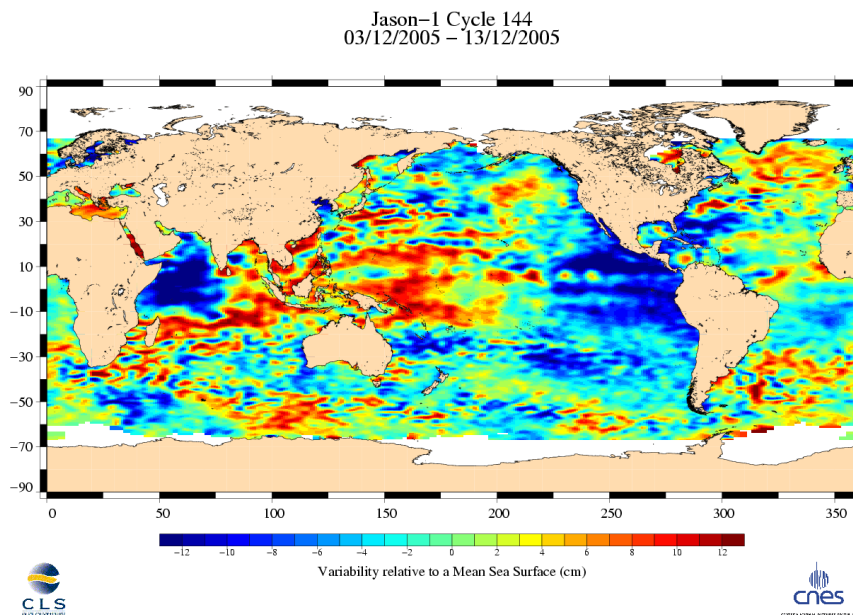
Repeat-track analysis is routinely used to compute Sea Level Anomalies (SLA) relative to the previous cycle and relative to a mean profile. SLA relative to a 7-year mean (based on TOPEX/Poseidon data) shows general oceanic features in good agreement with what is observed with TOPEX/Poseidon. The SSH differences relative to the previous cycle 143 are plotted on the bottom figure. The differences seem homogeneous and do not exhibit any particular trackiness pattern, showing the good quality of the orbit calculation in the Jason-1 GDRs.



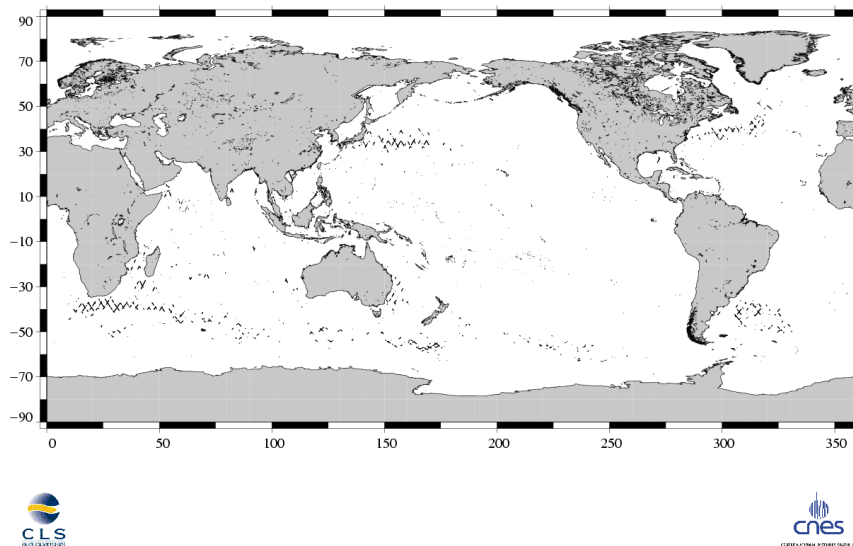


## 4.6.2 Comparison to a Mean Sea Surface

The following two maps respectively show the map of Jason-1 SLA relative to the MSS and differences higher than a 30 cm threshold (after centering the data). The latter figure shows that apart from isolated measurements that should be removed after refining the editing thresholds, higher differences are located in high ocean variability areas, as expected.



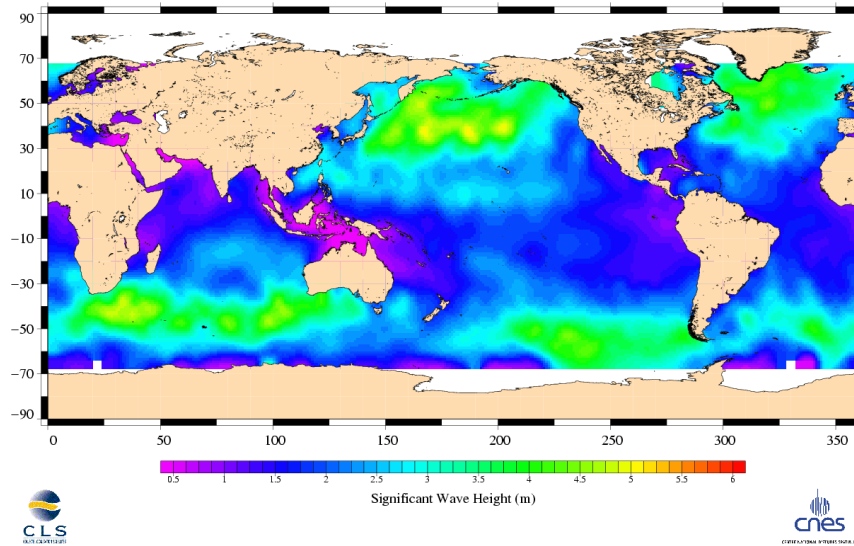
(SSH – MSS) differences greater than 30 cm  
Jason / Cycle 144



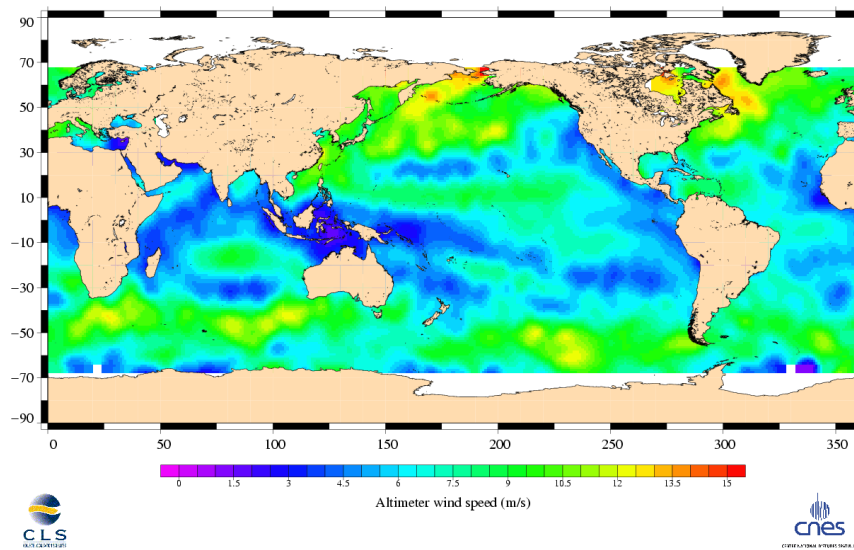
## 4.7 Wind and wave maps

These two figures show wind and wave estimations derived from 10 days of altimeter measurements.

Jason-1 Cycle 144  
03/12/2005 - 13/12/2005



Jason-1 Cycle 144  
03/12/2005 - 13/12/2005



## 5 Jason-1 long term performance monitoring

Statistics of SSH variability are computed after crossover and repeat-track analyses. This allows to estimate how Jason-1 data fulfill the mission objectives in terms of performances.

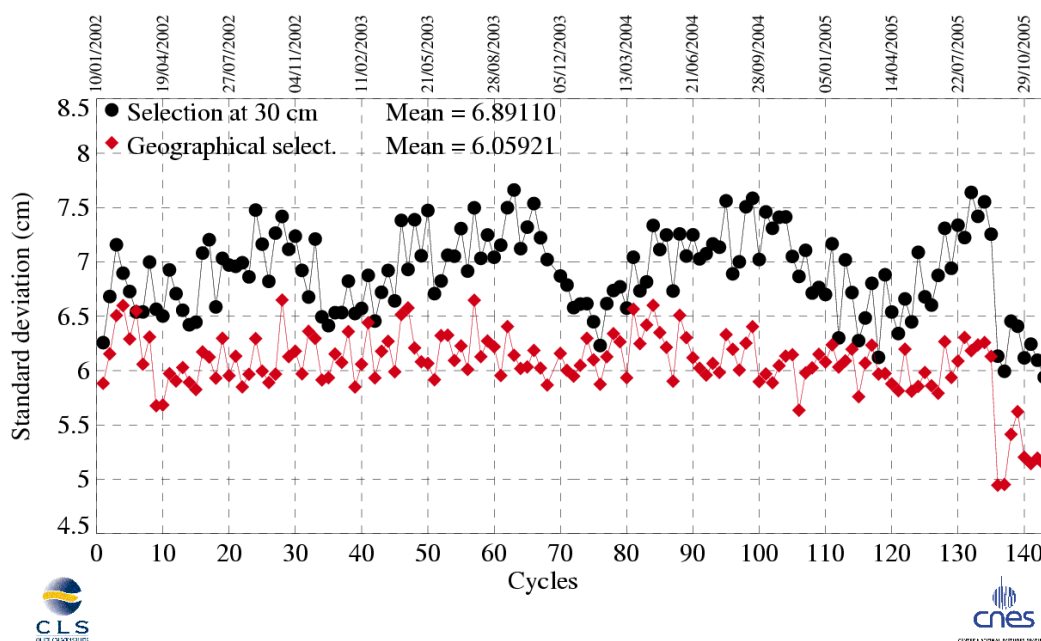
### 5.1 Standard deviation of the differences at crossovers

This parameter is plotted as a function of time in a one cycle per cycle basis in the figure below. It is computed after data editing and using 2 additional selection criteria:

- Selecting crossover differences lower than 30 cm to avoid contamination by remaining spurious data.
- Removing shallow waters (1000 m), areas of high ocean variability and high latitudes ( $> |50|$  deg.) to avoid ice coverage effects.

From cycle 136 onwards, GDRs have been processed with CMA version 7.1. Performances are better for these cycles due to these evolutions: new retracking, new orbit, new atmospheric corrections, new tidal model, ...

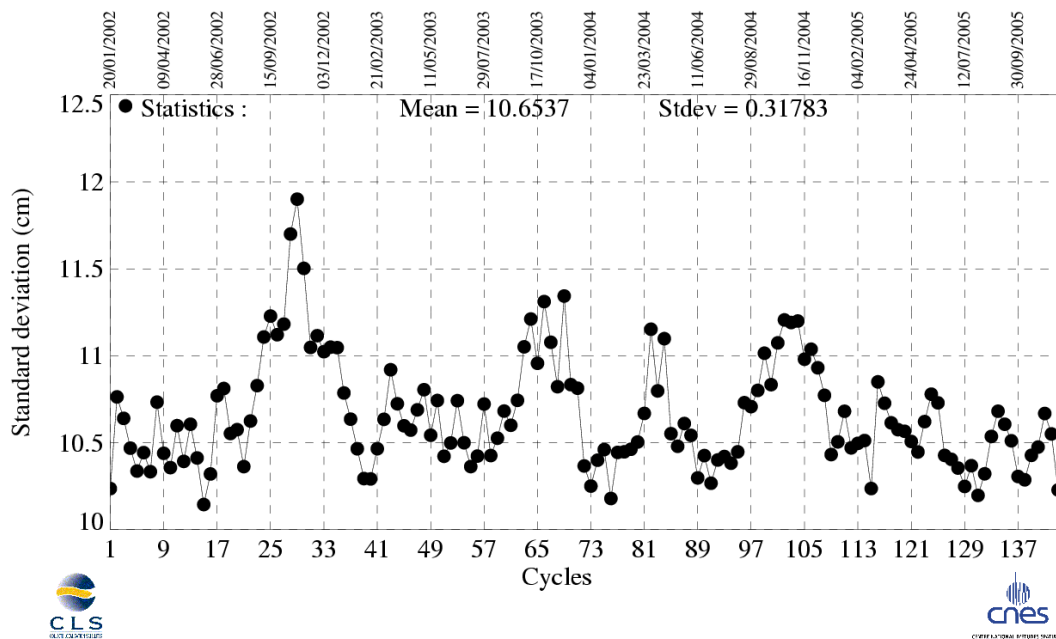
Crossover standard deviation



## 5.2 RMS of Sea Level Anomaly

Sea Level Anomalies relative to a mean profile are computed using repeat-track analysis for each Jason-1 cycle. To monitor Jason-1 performances and ocean signals, the cycle per cycle standard deviation of the SLA is plotted as a function of time.

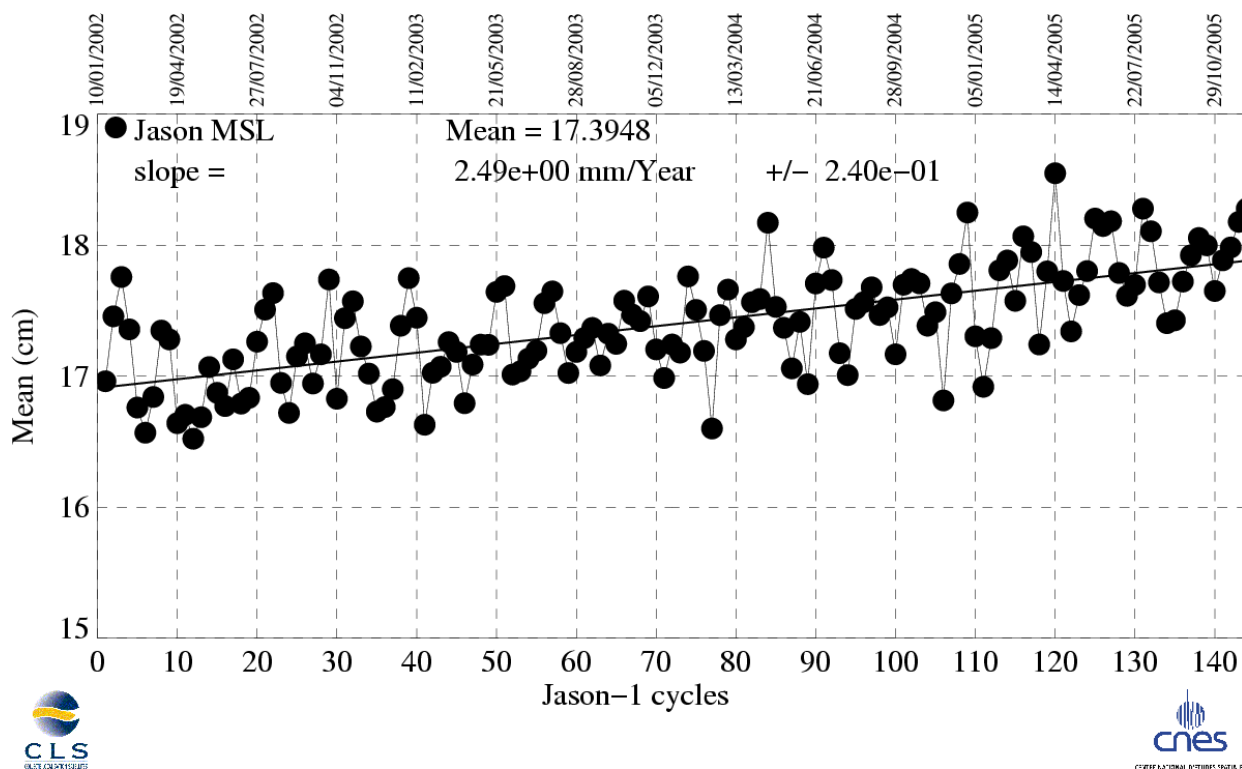
### Standard deviation of Sea Level Anomalies



## 6 Mean Sea Level estimations (MSL)

### 6.1 Jason-1 MSL

MSL estimations are performed in a cycle basis averaging Sea Level Anomalies relative to a mean profile. The value for each cycle is calculated from averaging over 2 by 3 degree bins, then weighting by latitude to take into account the relative geographical area represented by the bin. Results plotted on the following figure is obtained after annual, semi-annual and 60-day signals reduction. Moreover the JMR correction has been replaced by the ECMWF model wet troposphere correction in order to remove the effect of the JMR slopes.



## 7 Particular investigations

No particular investigations have been performed on this cycle.

## References

- [1] Picot N., October 21, 2005: New Jason-1 operational production chain. *Electronic communication*.
- [2] Aviso and PODAAC User Handbook, April 2003: IGDR and GDR Jason User Products, *SMM-MU-M5-OP-13184-CN*.
- [3] Gaspar, P., S. Labroue & F. Ogor, October 2002: Improving nonparametric estimates of the sea state bias in radar altimeter measurements of sea level *J. Atmos. Oceanic Technol.*, **19**, 1690-1707.
- [4] R. Sharroo, J.L. Lillibridge, W.H.F. Smith January-June 2004: Cross-Calibration and Long-Term Monitoring of the Microwave Radiometers of ERS, TOPEX, GFO, Jason, and Envisat. *Marine GEODESY*,**27**, 279-297.
- [5] O.Z.Zanife, P.Vincent, L.Amarouche, J.P.Dumont, P.Thibaut, and S.Labroue, December 2003: Comparison of the Ku-Band Range Noise Level and the relative Sea State Bias of the Jason-1, TOPEX and POSEIDON-1 Radar altimeters *Marine GEODESY*,**26**, 201-238.
- [6] J. Dorandeu, M. Ablain, Y. Faugere, F. Mertz & B. Soussi, 2004: Jason-1 global statistical evaluation and performance assessment. Calibration and cross-calibration results. *Marine GEODESY*,**27**, 345-372.