Service
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Jason-1 GDR
Quality Assessment Report

Cycle 535

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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 V9.4. Since GDR version "c" products, DORIS TEC data are no longer computed. They are replaced by GIM model ionosphere correction. The results presented in this report have been performed with GDR products in version C. Note that they include some modifications for the geodetic phase of the mission (see chapter Jason-1 on geodetic orbit).

2.2. Jason-1 on geodetic orbit

Since May 2012, Jason-1 is on a geodetic orbit. To distiguish this geodetic phase from the previous repeat ground-track, numbering of the geodetic orbit period starts with cycle 500. Furthermore from cycle 500 onwards, the orbit standard is switched to POE standard D and the mean sea surface available in the GDRs is CNES-CLS-2011. The repeat period of the geodetic orbit is 406 days, but GDRs are distributed using the 10.9 days sub-cycle. Therefore Jason-1 GDRs during the geodetic phase contain 280 tracks per cycle. For more information about the Jason-1 geodetic mission, see the technical note issued by E. Bronner and G. Dibarboure [3].

Note that in this report, on figures showing cycle per cycle monitoring, the x-axis was shifted for the geodetic period by 119 cycles, in order to prevent a (artificial) gap between the last cycle on the repeat ground-track (cycle 374) and the first cycle on the geodetic orbit (cycle 500).

2.3. 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 6.26 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 5.23 cm rms.

The standard deviation of Sea Level Anomalies (SLA) relative to the mean sea surface is 11.05 cm. When using a selection to remove shallow waters (1000 m), areas of high ocean variability and high latitudes ($> |50|$ deg) it lowers to 9.90 cm .

– Performances from crossover differences are detailed in the dedicated **section Crossover statistics**.
– Detailed CALVAL results are presented in **section 3**.
– Note that since cycle 262, Jason-1 is on its new interleaved ground-track.
– Note that since May 2012 (cycle 500), Jason-1 is on a geodetic orbit.

2.4. Missing measurements

This cycle has no missing pass. Missing measurements relative to a nominal ground track are plotted on **section Missing measurements**.

2.5. 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.

2.6. Impact of product version "c"

2.6.1. Editing procedure

For GDR version "c" the same editing criteria and thresholds like in GDR version "b" are used. Thus the MLE4 retracking algorithm, based on a second-order altimeter echo model and more robust for large off-nadir angles (up to 0.8 degrees), is used. For product version "a" (CMA version 6.3), the maximum threshold on square off-nadir angle proposed in Jason-1 User Handbook document was set to 0.16 deg^2. Since GDR version "b", this threshold is too restrictive and has to be set to 0.64 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 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 dB
- Number measurements of Ku sigma0 $\geq$ 10

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

- -0.2 $deg^2 \leq$ square of off-nadir angle from waveforms (off_nadir_angle_ku_wvf) $\leq$ 0.16 deg^2
- sigma0_rms_ku $<$ 0.22 dB (optional criterion)

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

- -0.2 $deg^2 \leq$ square of off-nadir angle from waveforms (off_nadir_angle_ku_wvf) $\leq$ 0.64 deg^2
- and sigma0_rms_ku $\leq$ 1.0 dB
- and 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.

2.6.2. Orbit

The orbit of GDRs "c" uses EIGEN-GL04S gravity field and ITRF2005, instead of EIGEN-CG03C and ITRF2000 for GDRs "b". The change of ITRF induces a North/South bias when comparing with GDRs "b". From May 2012 onwards (cycle 500), during the geodetic phase of Jason-1, the orbit solution available in GDRs uses EIGEN_GRGS_RL02bis_Mean_Field gravity field and ITRF2008.

2.6.3. Sea state bias

The sea state bias (SSB) model on the GDRs "c" products has been empirically derived from MLE4-retracked altimeter data (cycles 1 to 111, GDRs "b"). Users need to be aware that the SSB model on the GDRs "c" will shift the globally averaged SSH lower by 3-4 cm relative to GDRs "b" (when using SSB from the GDR "b" product).

2.6.4. Altimeter instrument correction tables

The altimeter instrument correction tables have been updated using a new version of the altimeter simulator. This allows the Jason-1 and Jason-2 altimeter correction tables to be aligned with each other. As a result, altimeter range, SWH, and sigma0 measurements reported on GDRs "c" products are slightly different than the corresponding measurements on GDRs "b", even though identical retracking algorithms (MLE4) were used to generate both products. For more details, see Jason-1 User Handbook.

2.6.5. Jason-1 Radiometer wet troposphere correction

Version "c" GDRs contain the recalibrated JMR data and some improved algorithms to derive JMR brightness temperatures. Time-variable calibration coefficients with new coefficients once per cycle were implemented. There was also a correction of the scale error.

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.

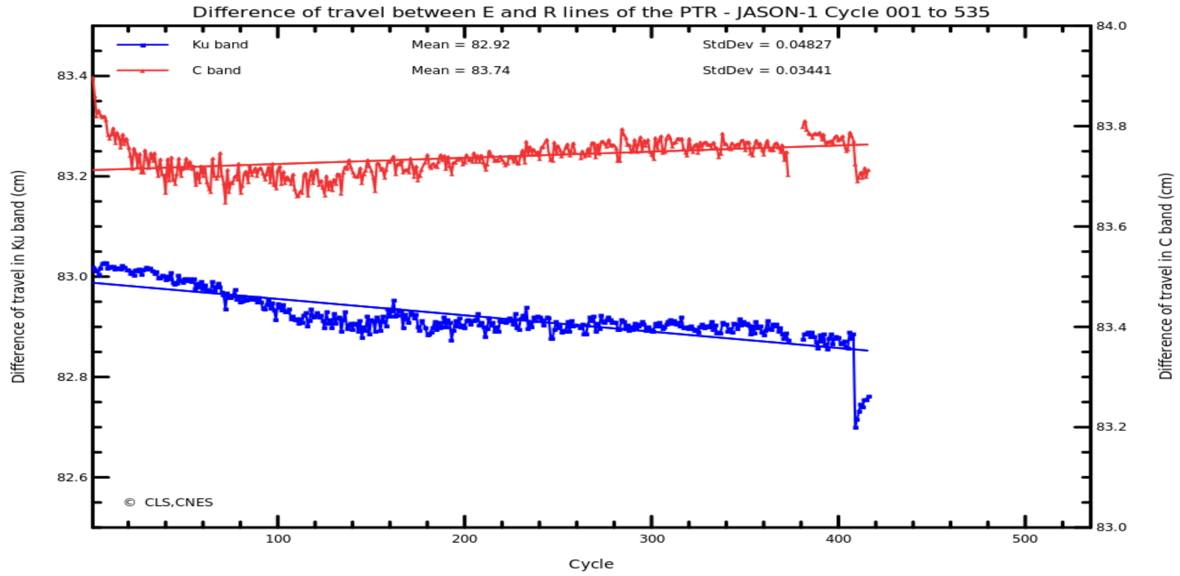
3.2. Poseidon-2 altimeter status

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 :

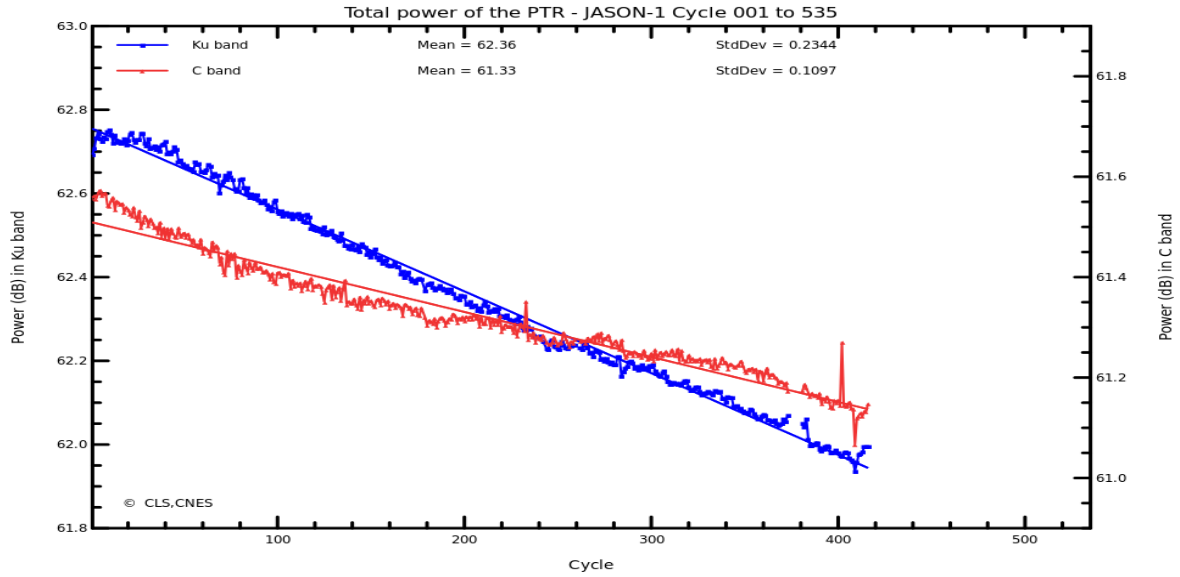
- the internal path delay
- the total power of the PTR

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.
The gap observed on the difference of travel of the PTR (Point Target Response) since the last incident (28/02/2013) seems to be linked to the thermal evolution of the LNA (Low Noise Amplifier) temperatures from 30˚C to 35˚C. Poseidon-2 instrument is also a little less stable since this event. But it is important to note that all these variations are accounted for in the altimeter range value provided in the products.

3.2.1. Monitoring of the internal path delay



3.2.2. Monitoring of the total power in the PTR

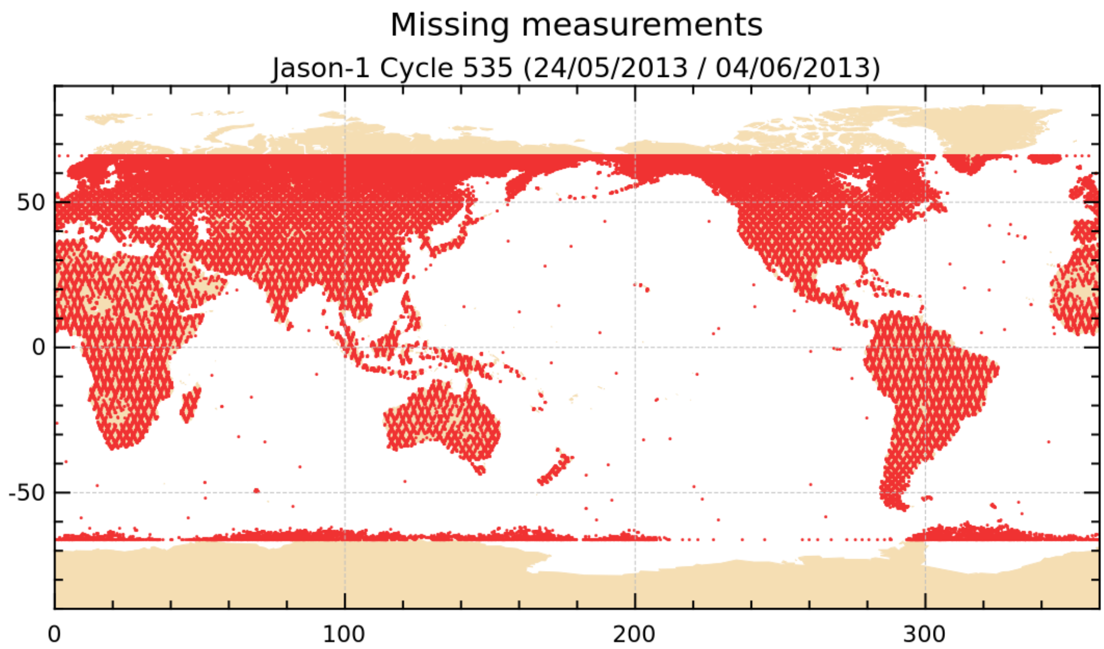


4. CALVAL main results

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.



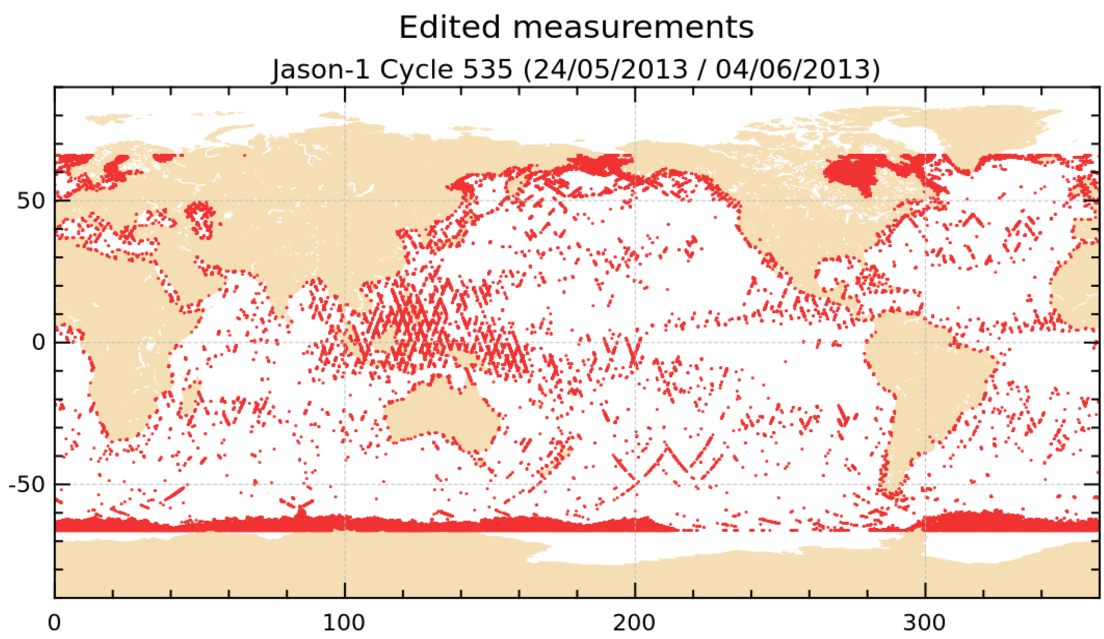
4.2. Edited measurements

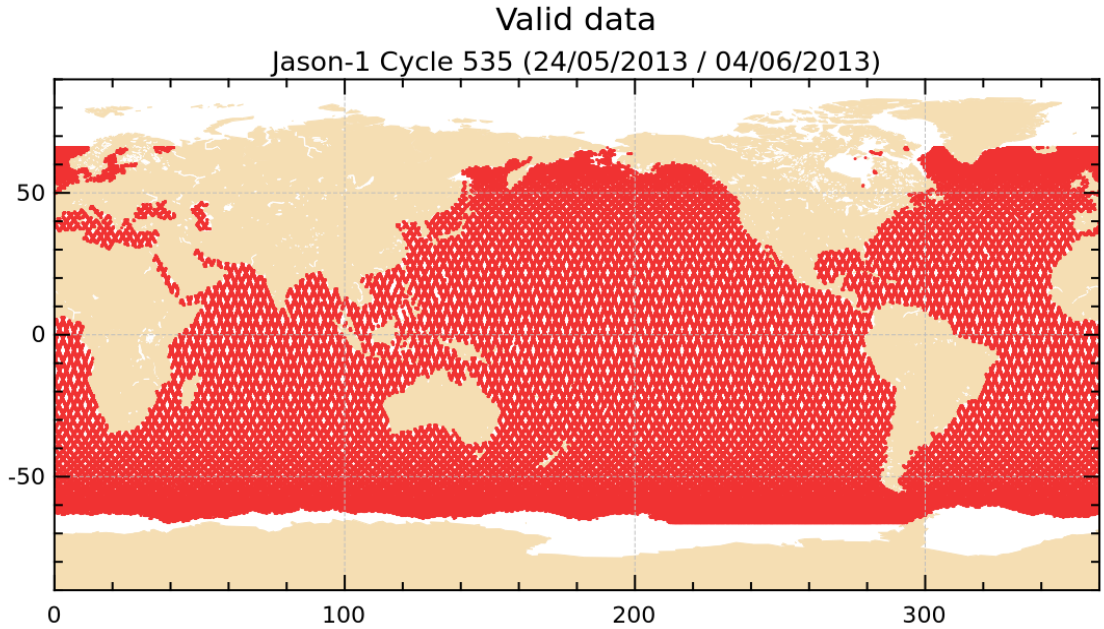
Editing criteria are defined for the GDR product in Aviso and PODAAC User Handbook [3].
The editing criteria are defined as minimum and maximum thresholds for various parameters. Measurements are edited if at least one parameter does not lie within those thresholds. These thresholds are expected to remain constant throughout the Jason-1 mission, so that monitoring the number of edited measurements allows a survey of data quality.
In the following, only measurements over ocean are kept. This is done by applying an ocean-land mask, instead of using the altimeter state flag (alt_state_flag) or the radiometer state flag (rad_state_flag). 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.
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 ice flag (8.72 % of points removed).
Since GDR version C, an ice flag similar to ERS ice flag is available in the products, and therefore used for the editing. It takes into account the difference between (dual frequency) radiometer and ecmwf model wet troposphere correction. It has the advantage to better detect sea ice in the Hudson Bay.

Parameters	Min threshold	Max threshold	Unit	Nb removed	% removed	% mean removed
Sea surface height	-130.000	100.000	m	4697	0.79	0.87
Sea level anomaly	-2.000	2.000	m	5333	0.90	1.07
Nb measurements of range	10.000	_	_	6852	1.16	1.22
Std. deviation of range	0.000	0.200	m	8138	1.38	1.40
Square off nadir angle	-0.200	0.640	deg^2	3000	0.51	0.58
Dry tropospheric correction	-2.500	-1.900	m	0	0.00	0.00
Combined atmospheric correction	-2.000	2.000	m	0	0.00	0.00
JMR wet tropospheric correction	-0.500	-0.001	m	61	0.01	0.10
Ionospheric correction	-0.400	0.040	m	6538	1.11	1.20
Significant wave height	0.000	11.000	m	3397	0.57	0.65
Sea State Bias	-0.500	0.000	m	2920	0.49	0.56
Backscatter coefficient	7.000	30.000	dB	3186	0.54	0.60
Nb measurements of sigma0	10.000	_	_	6797	1.15	1.21
Std. deviation of sigma0	0.000	1.000	dB	10033	1.70	1.74
Ocean tide	-5.000	5.000	m	293	0.05	0.06
Equilibrium tide	-0.500	0.500	m	0	0.00	0.00
Earth tide	-1.000	1.000	m	0	0.00	0.00
Pole tide	-15.000	15.000	m	0	0.00	0.00
Altimeter wind speed	0.000	30.000	$m.s^{-1}$	6247	1.06	1.02
Global statistics of edited measurements by thresholds	_	_	_	17734	3.00	3.05

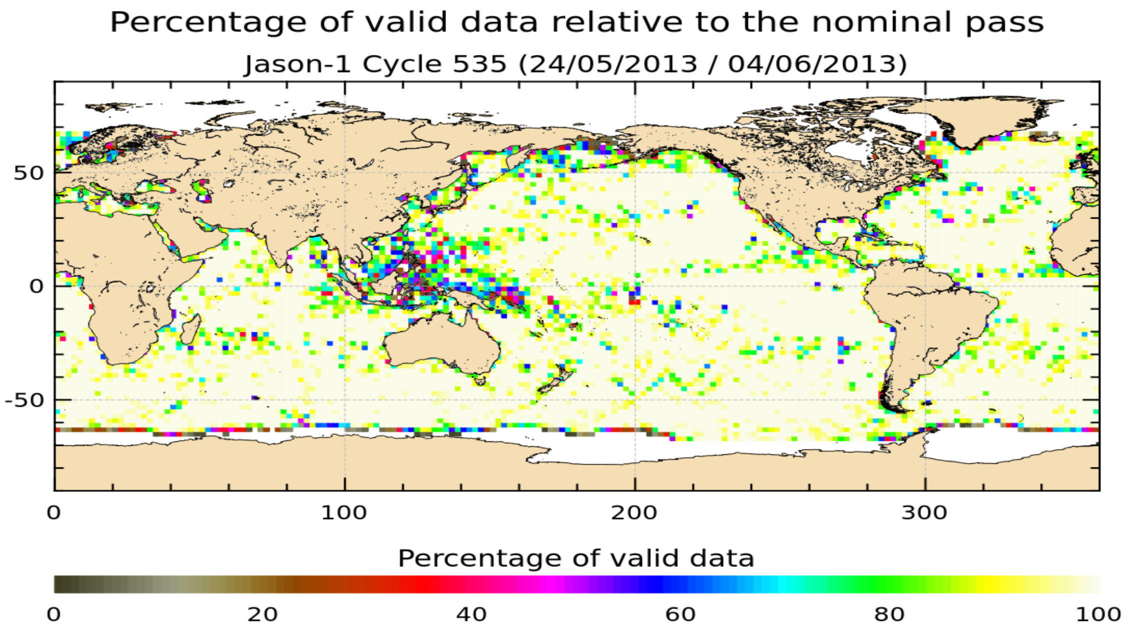
4.2.1. Figures

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





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

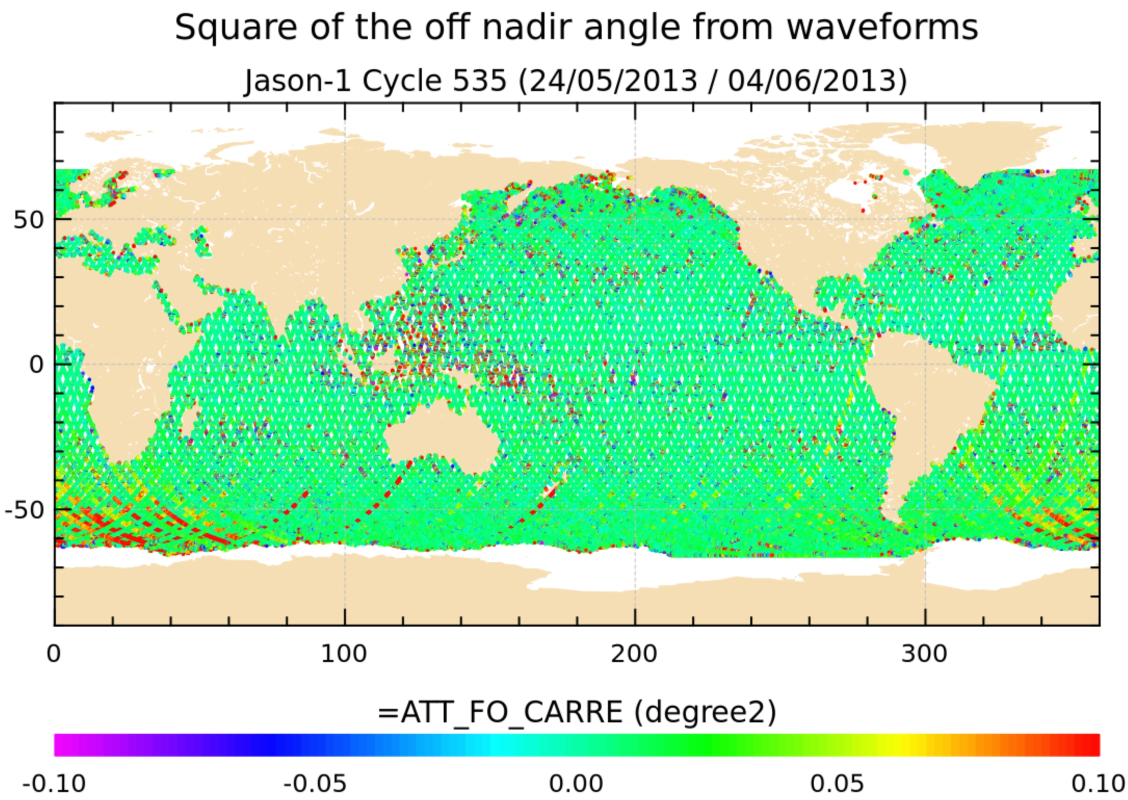


4.2.2. Comments

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.

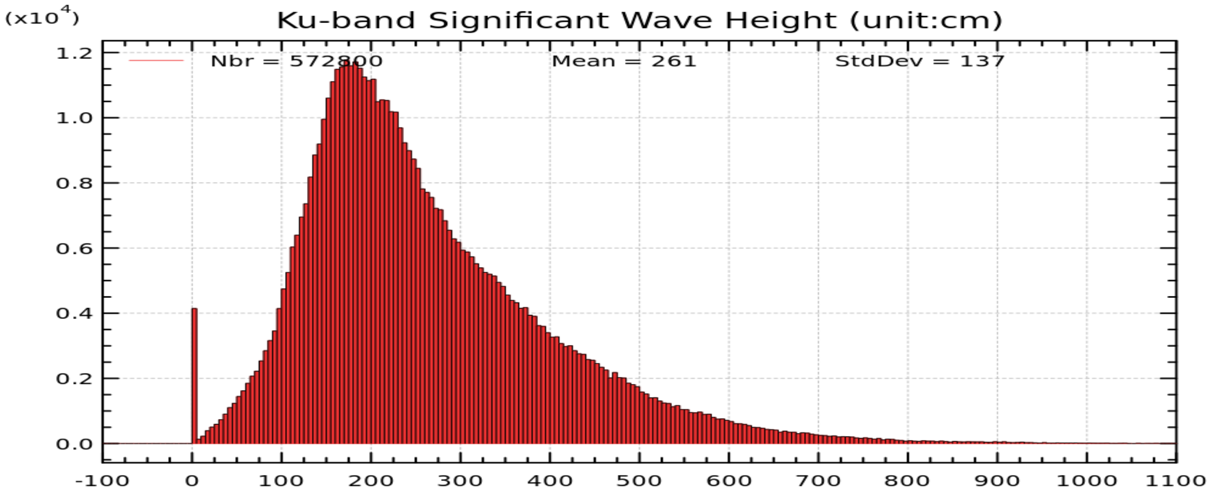
4.2.3. Apparent squared mispointing

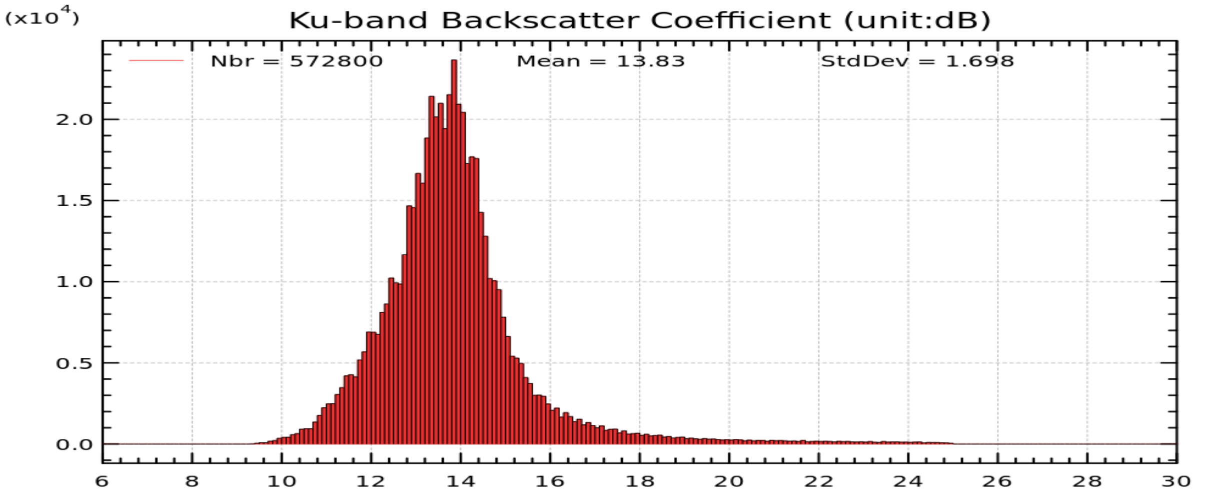
Apparent squared mispointing is for this cycle higher than usual on some part of passes (see figure below), but still within thresholds.

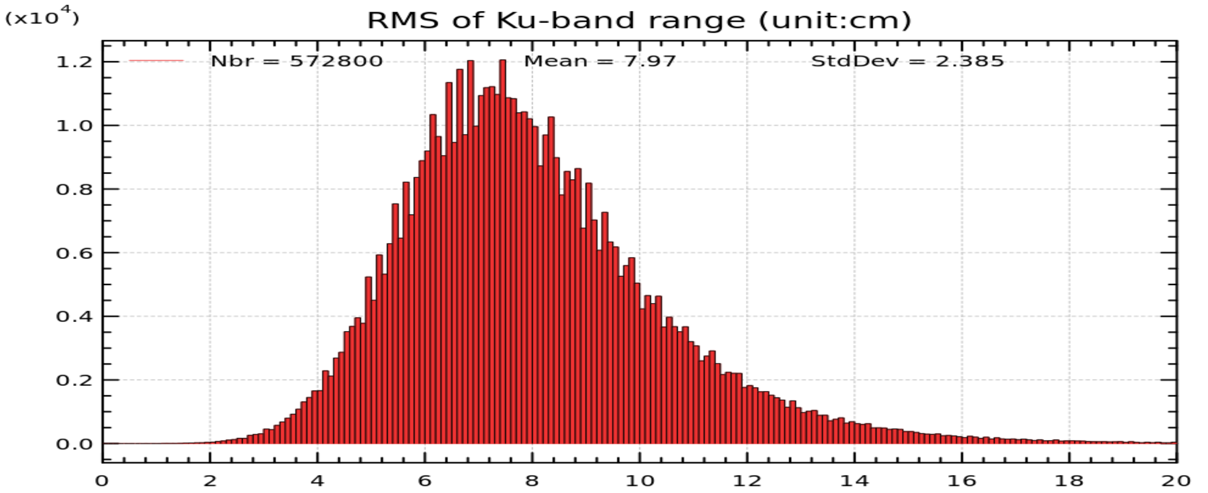


4.3. Altimeter parameters

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.





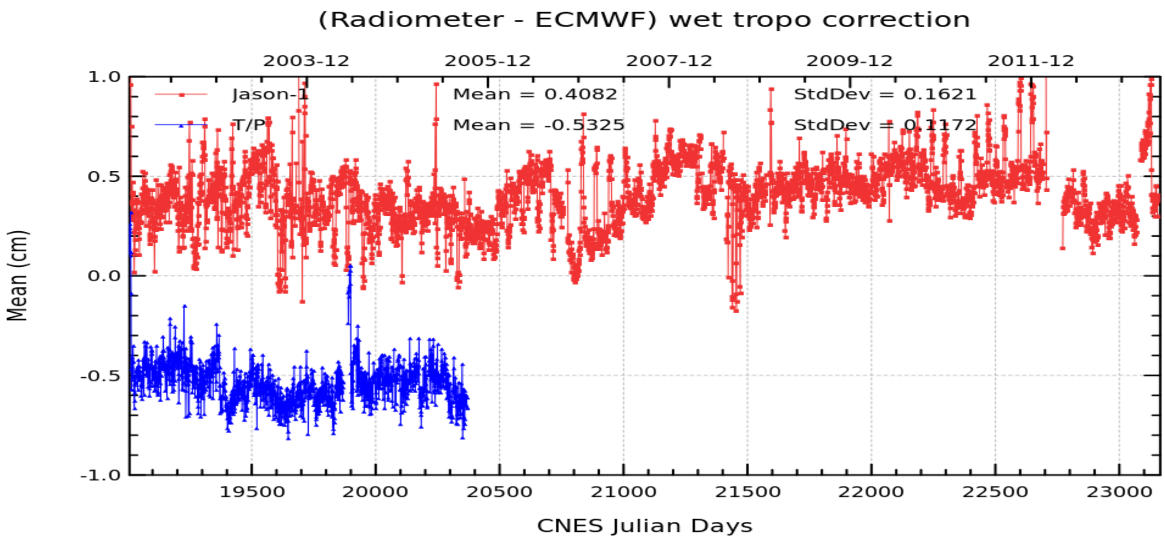


4.4. Radiometer parameters

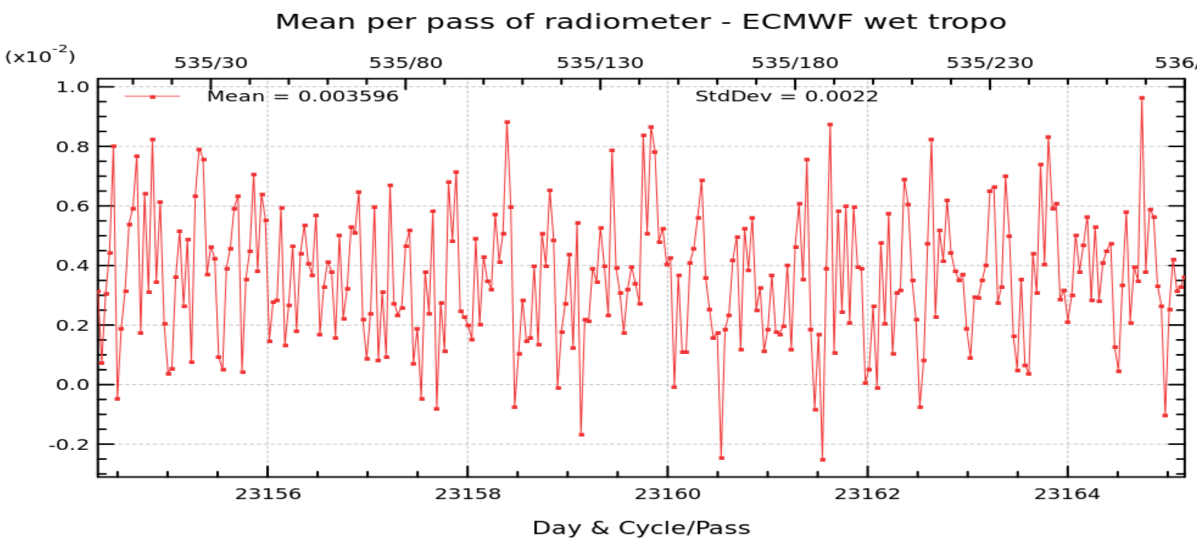
Daily mean of (Radiometer - ECMWF) wet troposphere corrections is plotted below for Jason-1 and T/P. Note that the TMR correction has been corrected for the drift (Sharroo R. et al., 2004 [5]). Moreover the 60-day signal due to TOPEX yaw maneuvers has been partially removed. Since 9th october 2005 scientific mission of TOPEX has stopped.
JMR wet troposphere correction in GDR version "a" used to show a 60-day signal due to Jason-1 yaw maneuvers, as well as jumps. These anomalies were corrected in the GDR version "b" and "c". Nevertheless this long term monitoring still exhibited abnormal variations :

– The 60-day signals due to Jason-1 yaw maneuvers is sometimes still visible.
– After safehold modes (e.g. cycle 243/244), JMR shows thermal instabilities, leading to oscillations in JMR-ECMWF wet troposphere correction differences.

Note that after Jason-1 move to geodetic orbit, from May 2012 to 18 March 2013 (cycle 500 to cycle 528), the JMR was recalibrated. The JMR was recalibrated again from cycle 528 onwards (after safe hold mode in march 2013).

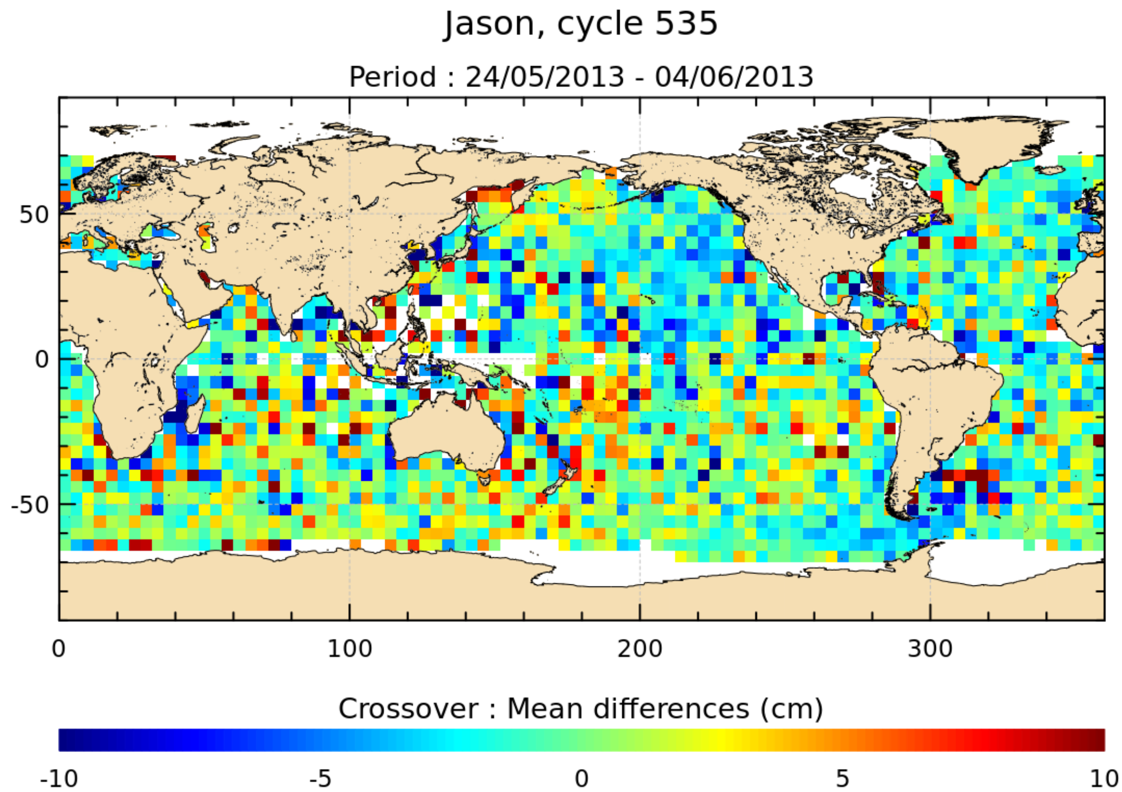


The figure below shows the mean of wet troposphere correction (radiometer - ECMWF) difference by pass.



4.5. Crossover statistics

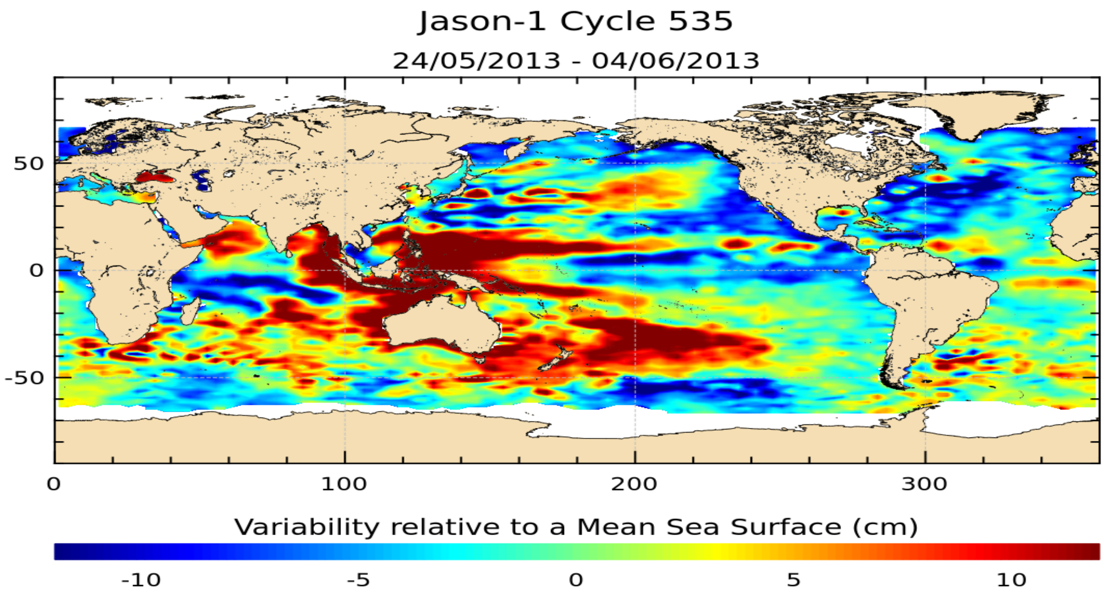
SSH crossover statistics are computed from the valid data set. They are used to estimate the data quality and to monitor the system performances.
After data editing and using the standard Jason-1 algorithms, the crossover standard deviation is about 5.23 cm rms, when using a selection to remove shallow 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.

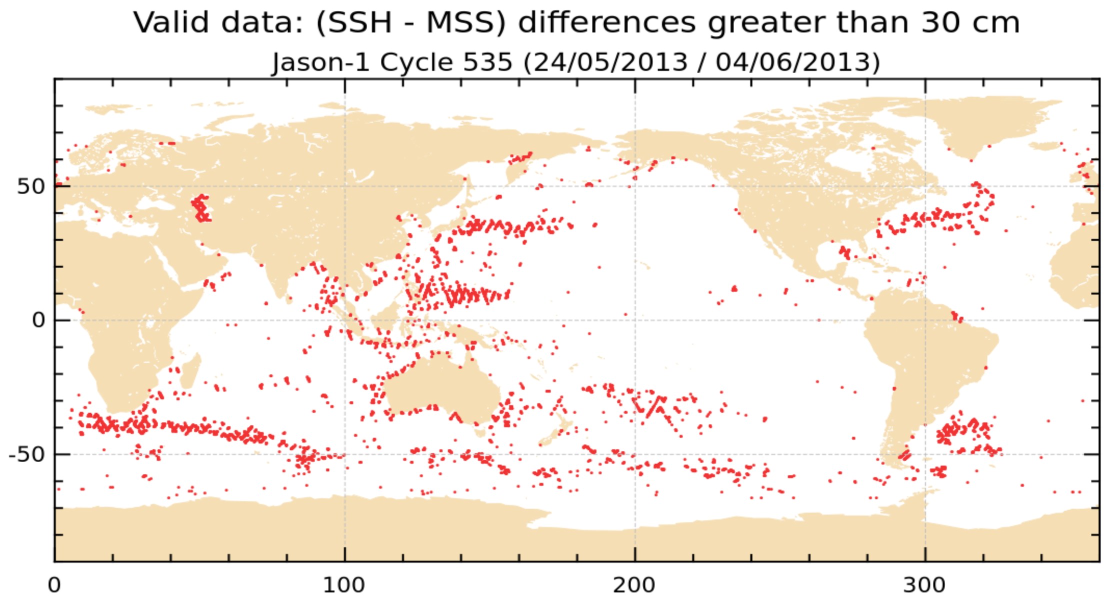


4.6. SSH variability

4.6.1. Jason-1 Sea Level Anomalies

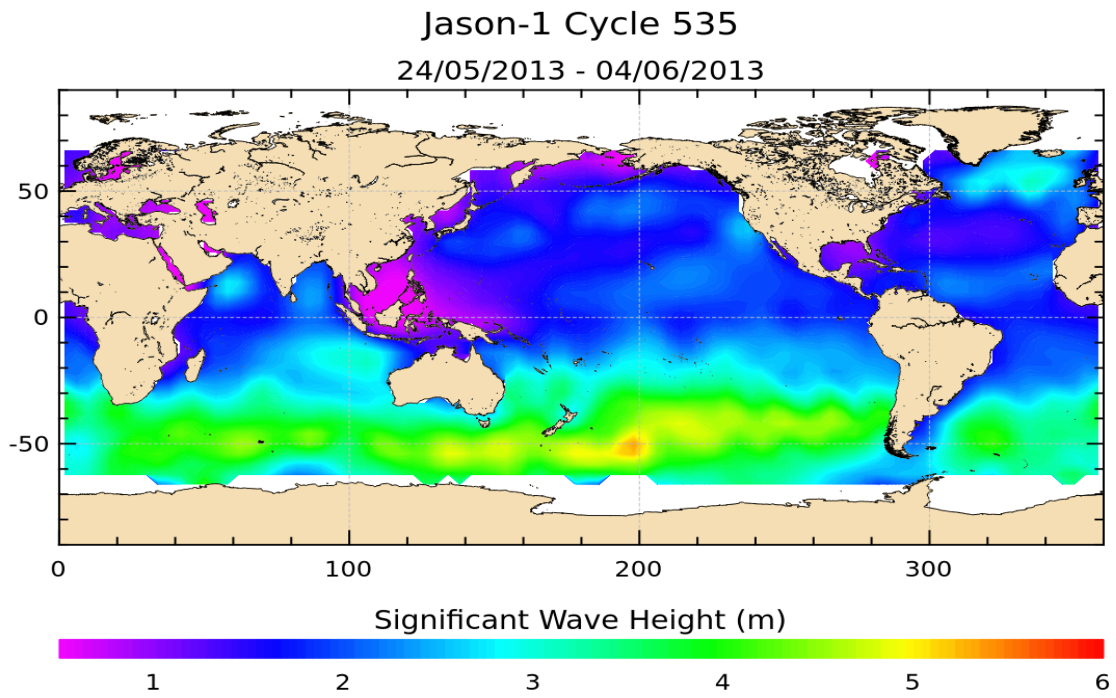
Since May 2012, Jason-1 is on a geodetic orbit. Therefore repeat-track analysis of Sea Level Anomalies (SLA) relative to the previous cycle and relative to a mean profile are no longer possible. The following two maps respectively show the map of Jason-1 SLA relative to the MSS and differences higher 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.

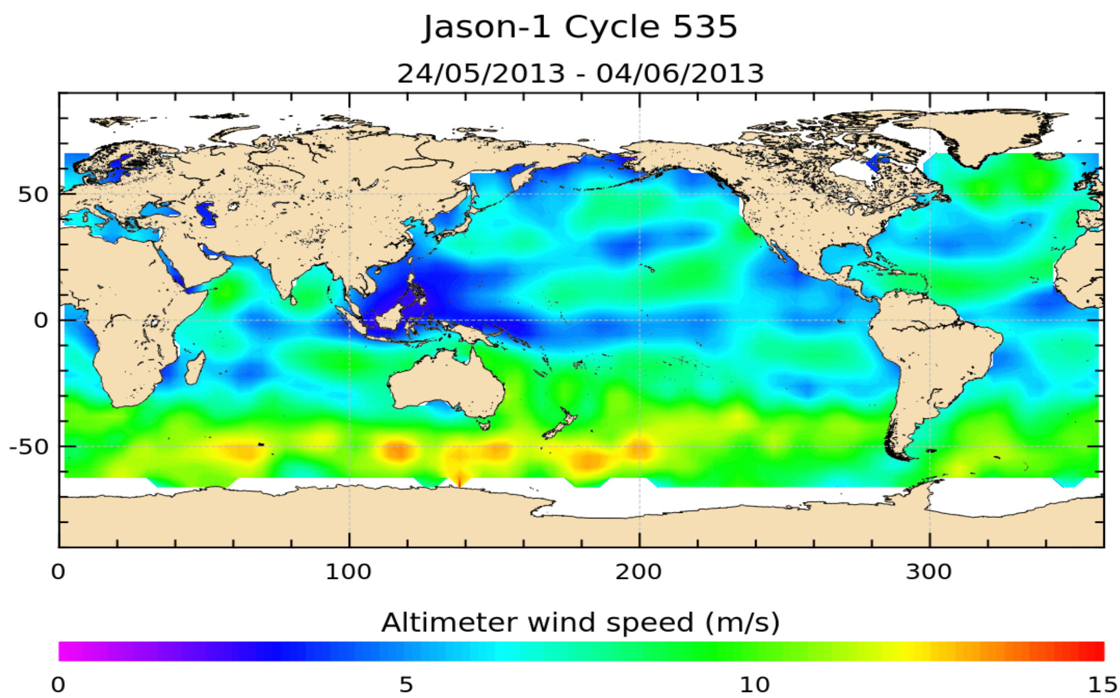




4.7. Wind and wave maps

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





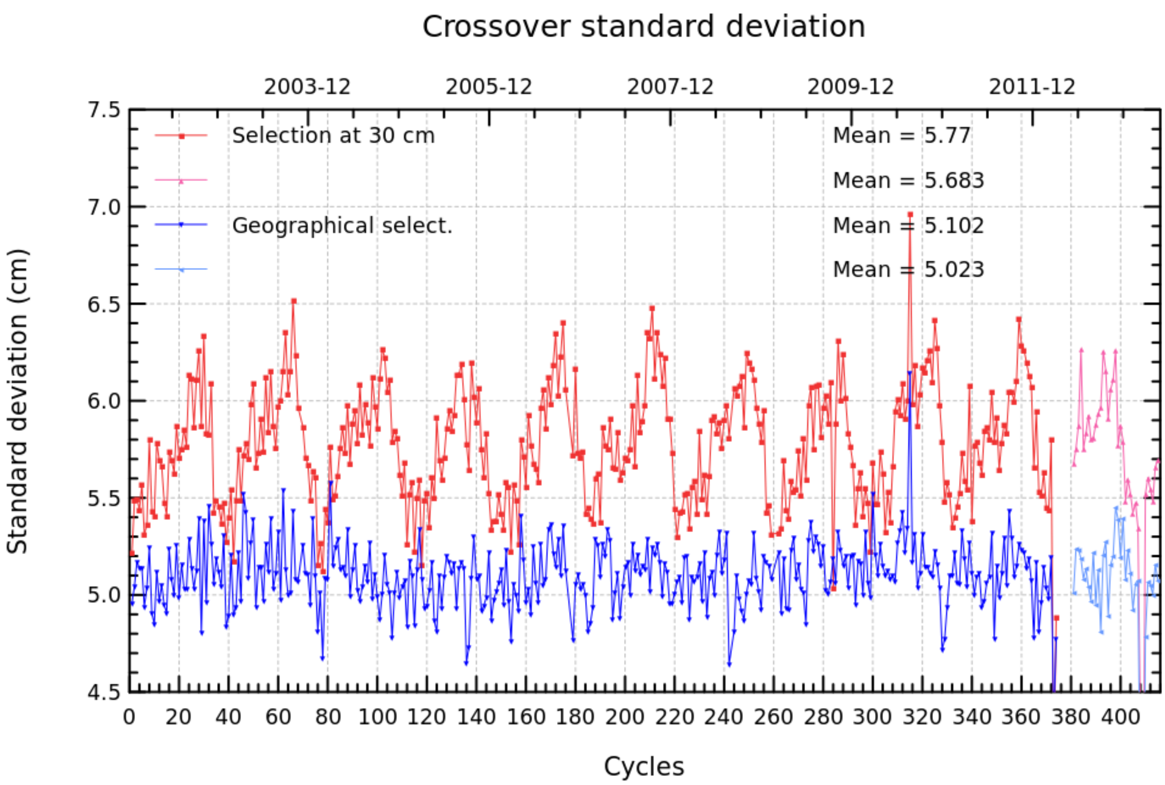
5. Jason-1 long term performance monitoring

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

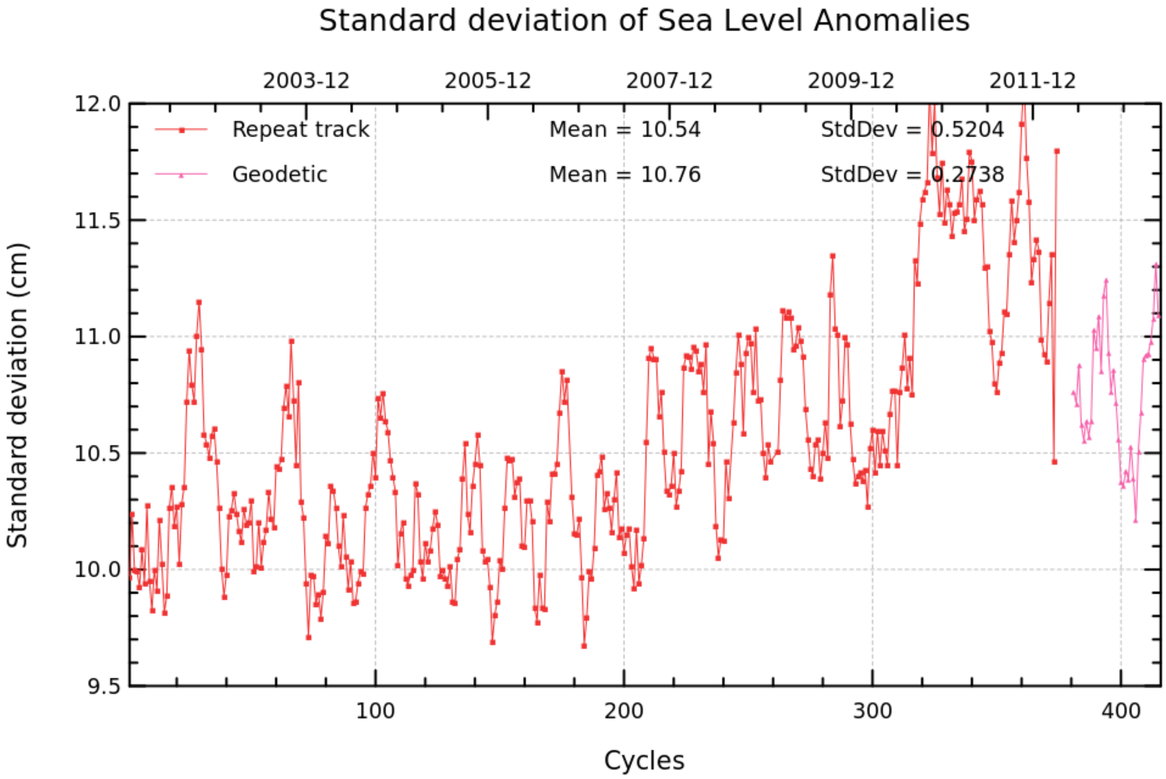
This parameter is plotted as a function of time in a one cycle per cycle basis in the figure below. It is computed after data editing and using 2 additional selection criteria :

- 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.



5.2. RMS of Sea Level Anomaly

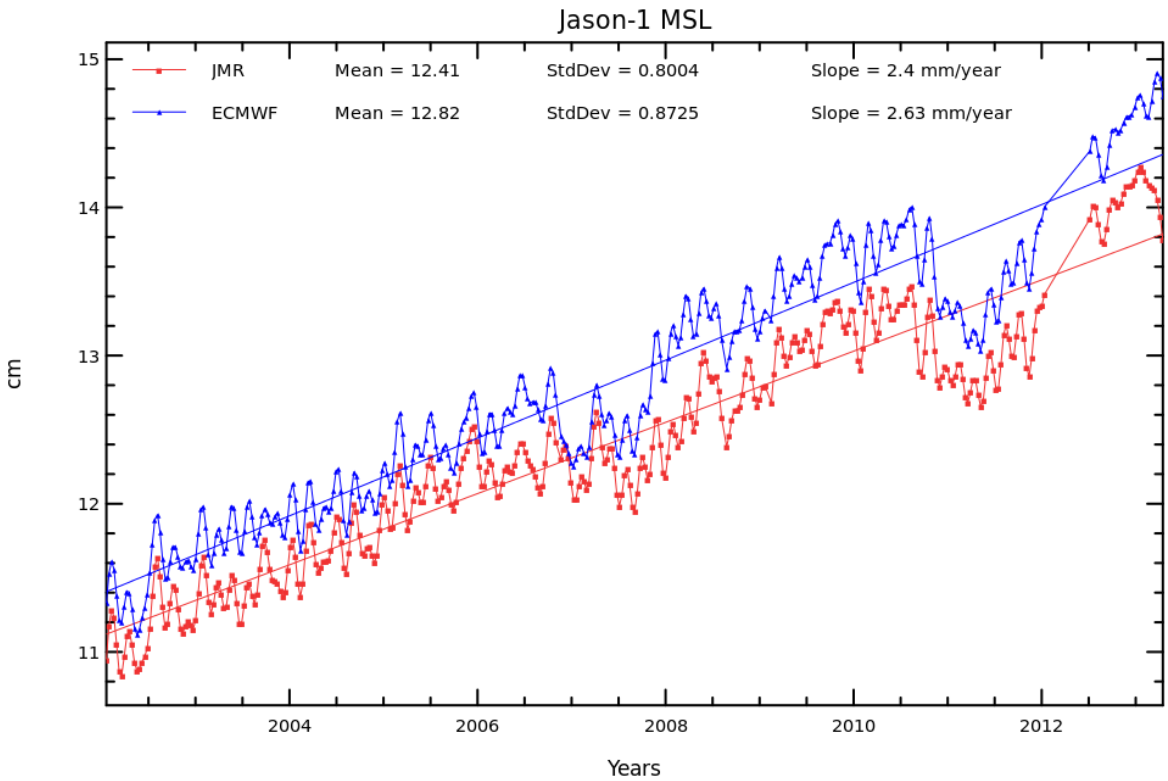
Sea Level Anomalies relative to a mean profile are computed using repeat-track analysis for each Jason-1 cycle. To monitor Jason-1 performances and ocean signals, the cycle per cycle standard deviation of the SLA is plotted as a function of time.
From May 2012 onwards, when Jason-1 moved to a geodetic ground track, repeat-track analysis are no longer possible. During geodetic period, Sea Level Anomalies are therefore computed relative to the mean sea surface. The use of CNES-CLS-2011 mean sea surface from May 2012 onwards, reduces the standard deviation of SLA (which was increased since Jason-1 moved to the interleaved repeat ground-track in February 2009).



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 are obtained after annual and semi-annual signals reduction. MSL estimations are computed with JMR or ECMWF wet troposphere correction so as to compare both solutions. Indeed wet troposphere correction is a main source of error for the MSL calculation. From now on, the whole time series are available in version C. Users are strongly advised to refer to the estimated MSL provided on the AVISO website (http ://www.aviso.oceanobs.com/msl). Details of the way MSL trends are computed are described in [8].
The mean difference of almost 4 mm between both MSL comes from the mean difference of both wet troposphere corrections, which is also close to 4 mm.



Références

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