



Envisat GDR Quality Assessment Report

Cycle 033

13-12-2004 / 17-01-2005

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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 ocean Envisat mission. The document is associated with data dissemination on a cycle by cycle basis.

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**
- CALVAL main results**
- Long term performance monitoring**
- Cross Calibration with ERS-2**
- Particular investigations**

2 Cycle overview

2.1 Data and software version

This cycle has been produced with the IPF processing chain V4.58 and the CMA Reference Software V6.3_05.

2.2 Parameters

The parameters used to compute the sea surface height (SSH) for Envisat are:

- Ku range (ocean retracking)
- POE orbit
- Dual frequency ionospheric correction
- MWR derived wet troposphere correction
- ECMWF dry tropospheric correction
- Non parametric sea state bias
- Inverted barometer correction with time varying pressure
- Total geocentric GOT00 ocean tide height
- Geocentric pole tide height
- Solid earth tide height

2.3 Warnings and recommendations

20 passes are missing due to level1 B data unavailability (see [section 3.1](#)).

13 pass have no radiometer correction (see [section 3.3](#)).

23 passes are impacted by the S-Band anomaly (see [section 3.3](#)).

2.4 Platform and instrument events

RA-2 went to RS/WT/INI due RBI (2004/12/27 02:49:10 to 2004/12/27 13:49:30, 380 to 391)

Orbit Maintenance Maneuver (2004/12/17 01:03:48 to 2004/12/17 03:03:52, 91 to 93)

Orbit Maintenance Maneuver (2005/01/05 23:10:28 ro 2005/01/06 01:10:36, 661 to 663)

Orbit Inclination Maneuver (2005/01/07 04:25:17 to 2005/01/07 06:38:53, 696 to 698)

2.5 Cycle quality and performances

Good general results are obtained for this cycle of data.

The crossover standard deviation is 7.48 cm rms when using a selection to remove shallow waters (1000 m), areas of high ocean variability and high latitudes ($> |50|$ deg). The standard deviation of Sea Level Anomalies (SLA) relative to the CLS01V1 Mean Sea Surface is 10.7 cm. When using a selection to remove shallow waters (1000 m), areas of high ocean variability and high latitudes ($> |50|$ deg) it lowers to 9.2 cm .

Detailed CALVAL results are presented in [section 3](#).

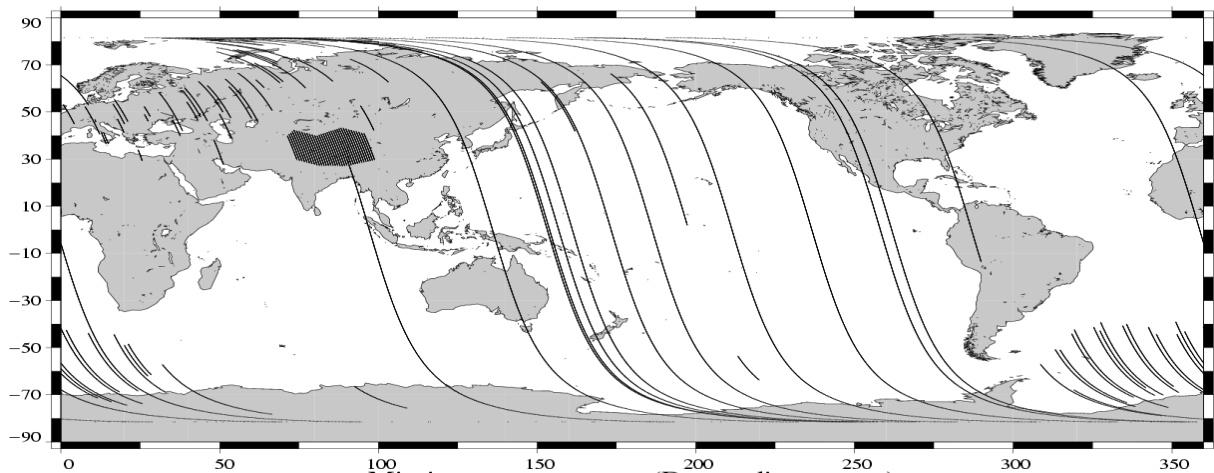
3 CALVAL main results

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.

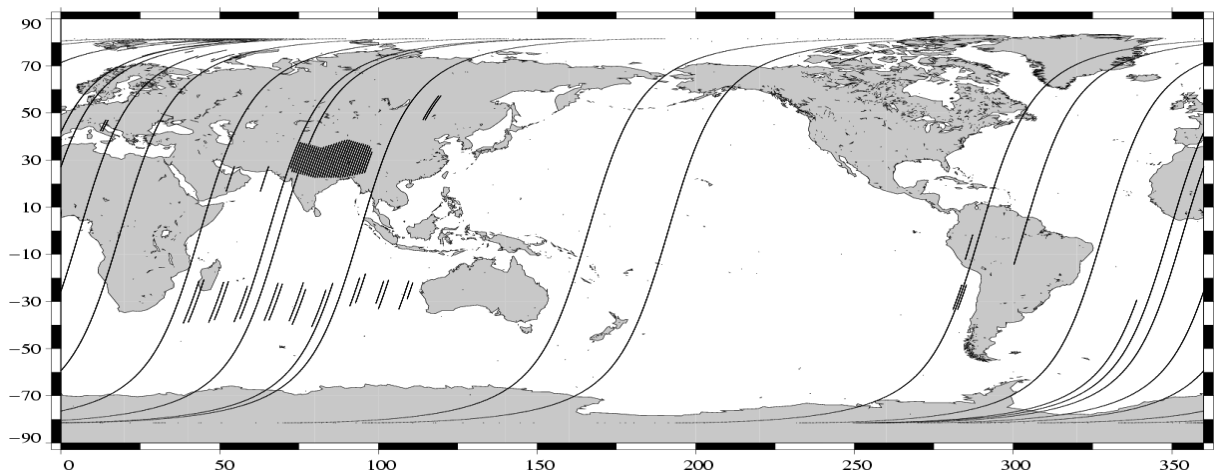
3.1 Missing measurements

2605782 are present, and 109068 (4.0%) are missing. The maps below illustrate missing 1Hz measurements in the GDRs, with respect to a 1 Hz sampling of a nominal repeat track.

Missing measurements (Ascending passes)
Envisat Cycle 033 (13/12/2004 / 17/01/2005)



Missing measurements (Descending passes)
Envisat Cycle 033 (13/12/2004 / 17/01/2005)



12 passes (380-391) are missing due to : "RA-2 went to RS/WT/INI due RBI"
8 passes are missing due to either to LRAC_PDHSs data generation to level1 problems or ingestion pbs on F-PAc side.

3.2 Orbit quality

3.2.1 Manoeuvres

On the 17 december 2004, a one burn in-plane correction manoeuvre took place.

On the 05 january 2005, an in-plane correction manoeuvre (SFCM) took place.

On the 07 december 2005, an orbit inclination correction manoeuvre took place.

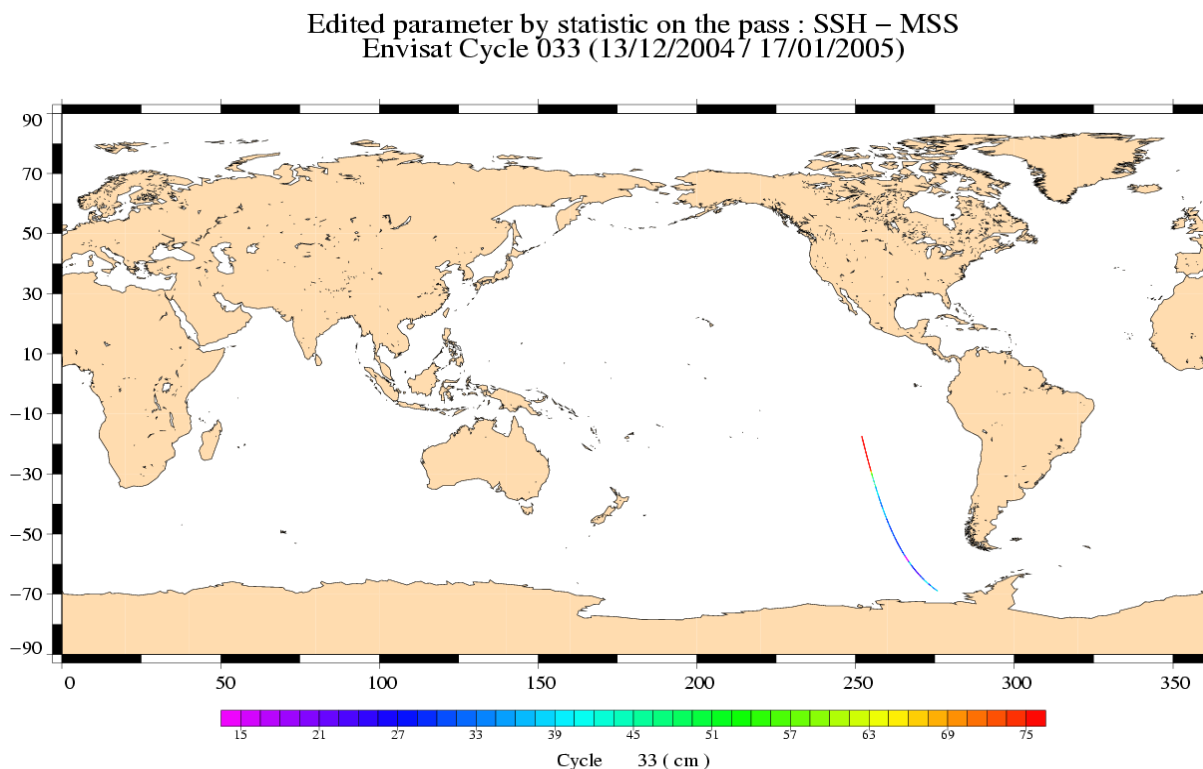
3.2.2 Doris and Laser performances

The next table gives statistics on Doris and Laser residuals:

7-day Period	Number of Doris measurements	Number of Laser measurements	RMS of Laser measurements (cm)
13/12/2004 to 20/12/2004	47823	1207	2.62760
20/12/2004 to 27/12/2004	52629	1058	2.23580
27/12/2004 to 03/01/2005	55260	1015	2.36760
03/01/2005 to 10/01/2005	44901	912	4.55350
10/01/2005 to 17/01/2005	53552	1982	2.15700

3.2.3 Impact on SLA

The SLA is impacted by the 07 december 2005 maneuver. High SSH-MSS values are found on pass 697. Measurements with latitude greater than 10S are missing. The following figure shows this parameter .



Users are advised to remove pass 697 from their dataset.

3.3 Edited measurements

3.3.1 Statistics

Data editing is necessary to remove altimeter measurements having lower accuracy.

First, there is an editing using flags. Compared to the GDR product, two additional flags are computed:

An ice flag to detect sea ice measurements. A measurement is set to ice if, at high latitudes ($> |50|$ deg), one of the following criteria is valid:

- Number of 20Hz measurement < 17
- $|MWR - ECMWF|$ wet tropospheric correction > 10 cm
- Peakiness > 2

A S-band anomaly flag: this flag is set if $|\text{Sigma0(Ku)} - \text{Sigma0(S)}| > 5$ dB

Notice that this flag is set over land and ice, even when no S-band anomaly occurs.

Parameter	Nb rejected	% rejected
Radiometer land flag	933095	40.63
Ice flag	740450	32.24
S-Band anomaly flag	382107	16.64

Then, measurements are edited using thresholds on several parameters. These thresholds are expected to remain constant throughout the Envisat mission, so that monitoring the number of edited measurements allows a survey of data quality.

The next table gives for each tested parameter, minimum and maximum thresholds, the number and the percentage of points removed.

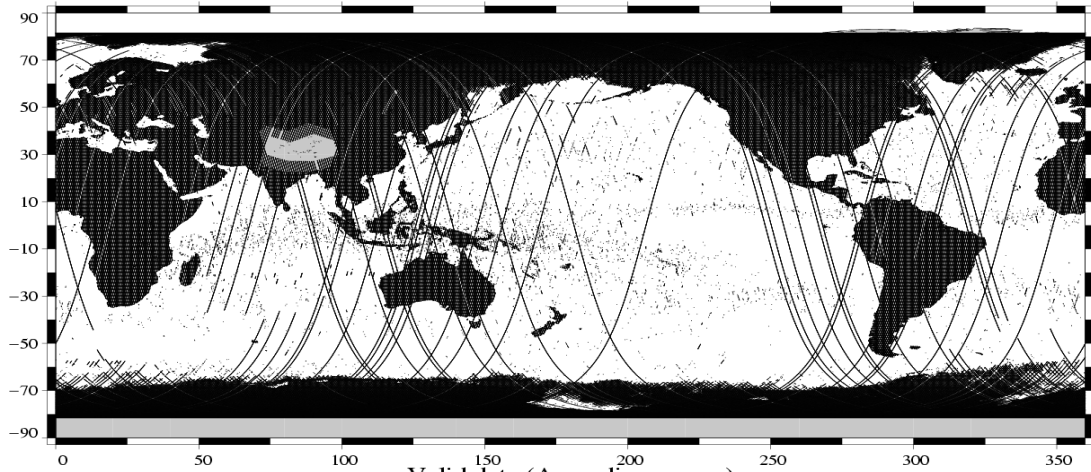
Parameters	Min Thres.	Max Thres.	Nb rejected	% rejected
Sea surface height (m)	-130.000	100.000	864	0.06
Variability relative to MSS (m)	-2.000	2.000	4135	0.31
Number of 18Hz valid points	10.000	-	97	0.01
Std. deviation of 18Hz range (m)	0.000	0.250	13096	0.98
Off nadir angle from waveform (deg ²)	-0.200	0.160	8872	0.66
Dry tropospheric correction (m)	-2.500	-1.900	0	0.00
Invert barometer correction (m)	-2.000	2.000	0	0.00
MWR wet tropospheric correction (m)	-0.500	-0.001	1915	0.14
Dual Ionospheric correction (m)	-0.400	0.040	3192	0.24
Significant wave height (m)	0.000	11.000	1572	0.12
Sea state Bias (m)	-0.500	0.000	1936	0.14
Backscatter coefficient (dB)	7.000	30.000	2709	0.20
GOT00 ocean tide height (m)	-5.000	5.000	1150	0.09
Long period tide height (m)	-0.500	0.500	0	0.00
Earth tide (m)	-1.000	1.000	0	0.00
Pole tide (m)	-5.000	5.000	0	0.00
RA2 wind speed (m/s)	0.000	30.000	0	0.00

A final editing is then performed on corrected sea surface height, using a spline fitting procedure, leading to remove 530 (0.04 %) measurements.

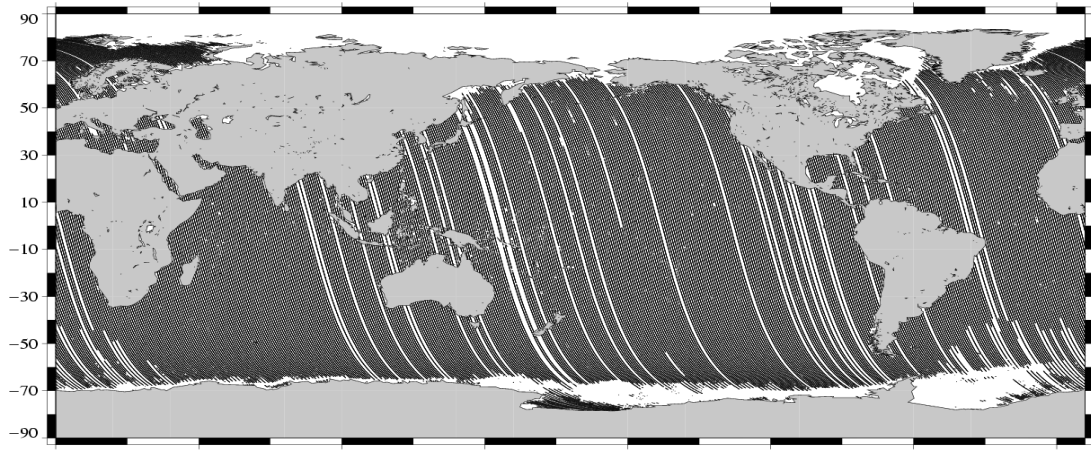
3.3.2 Figures

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

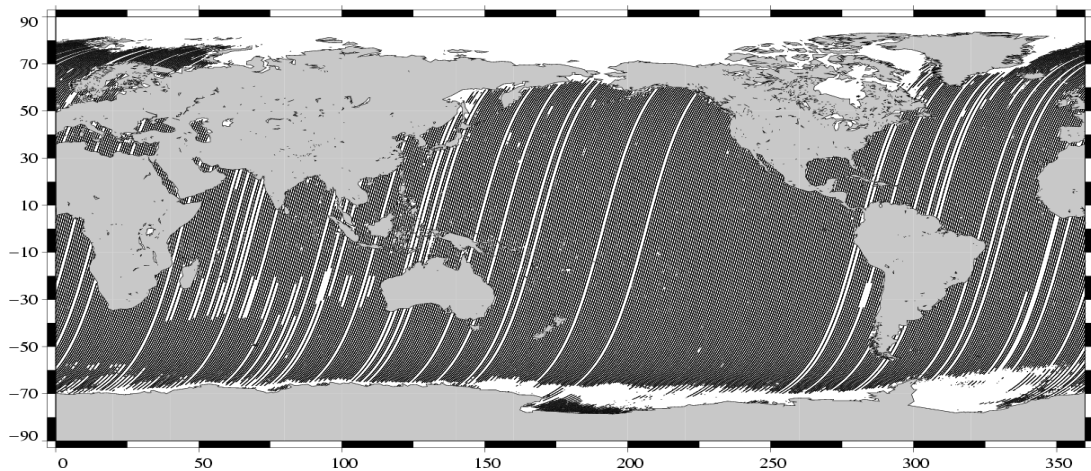
Edited measurements
Envisat Cycle 033 (13/12/2004 / 17/01/2005)



Valid data (Ascending passes)
Envisat Cycle 033 (13/12/2004 / 17/01/2005)



Valid data (Descending passes)
Envisat Cycle 033 (13/12/2004 / 17/01/2005)



3.3.3 Comments

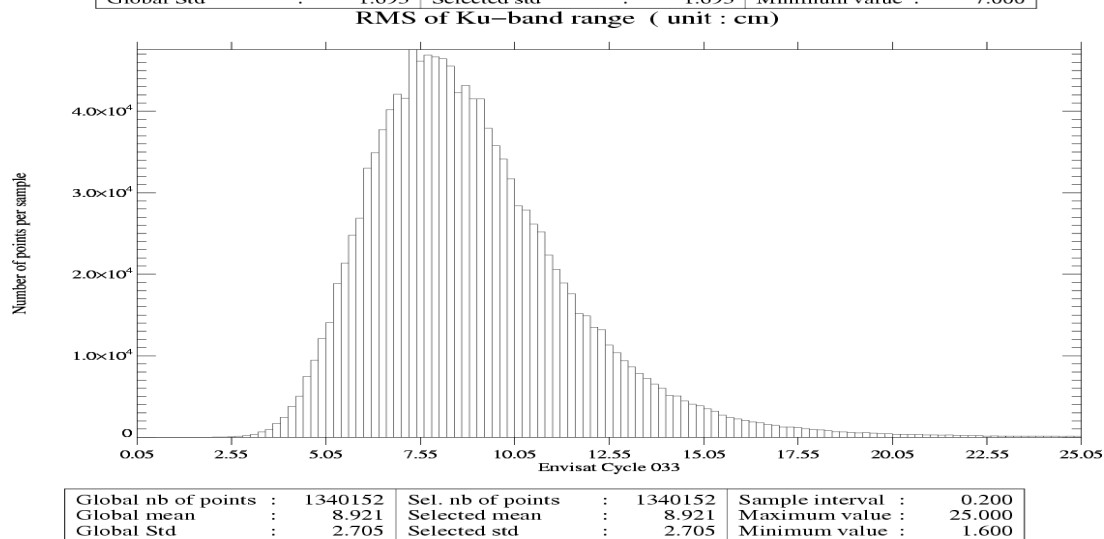
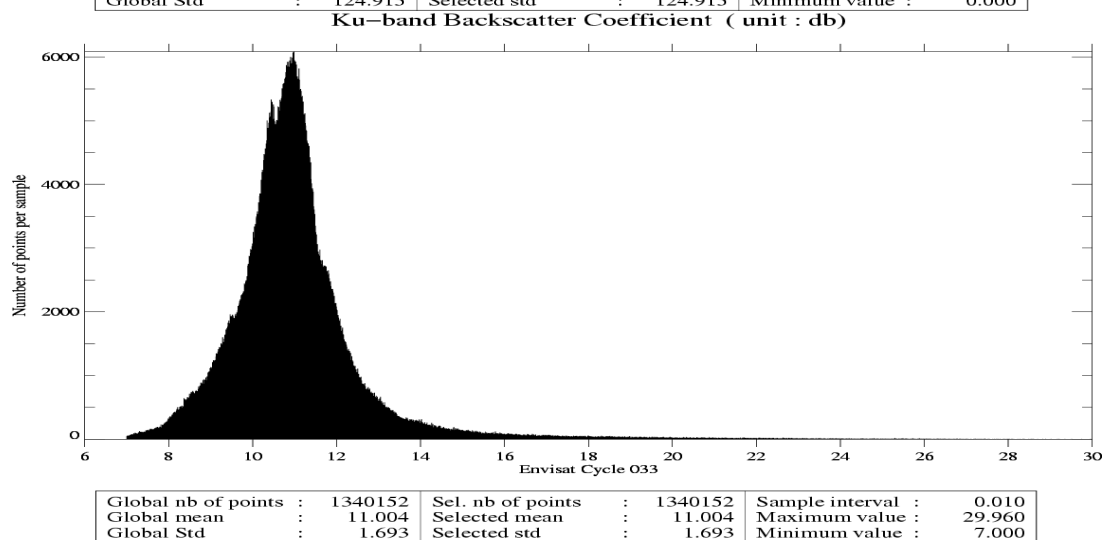
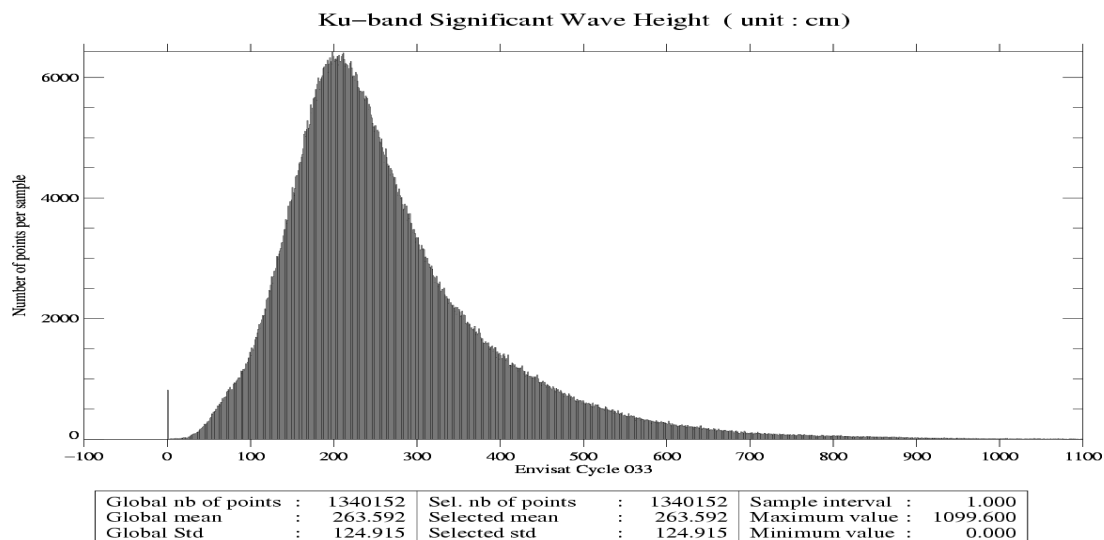
982 passes have been delivered. Among these passes:

- 13 passes are entirely edited on the radiometer land flag (no MWR correction)
- 23 passes (134-137,186-193,218-223,264-265,580-581,697) are edited because of S-Band anomalies. Users are advised not to use the S-Band parameters and the dual ionospheric correction on these passes.

Wet areas appear in the plot of removed data. Similar features are observed with other altimeters (T/P, Jason) mainly due to rain contamination.

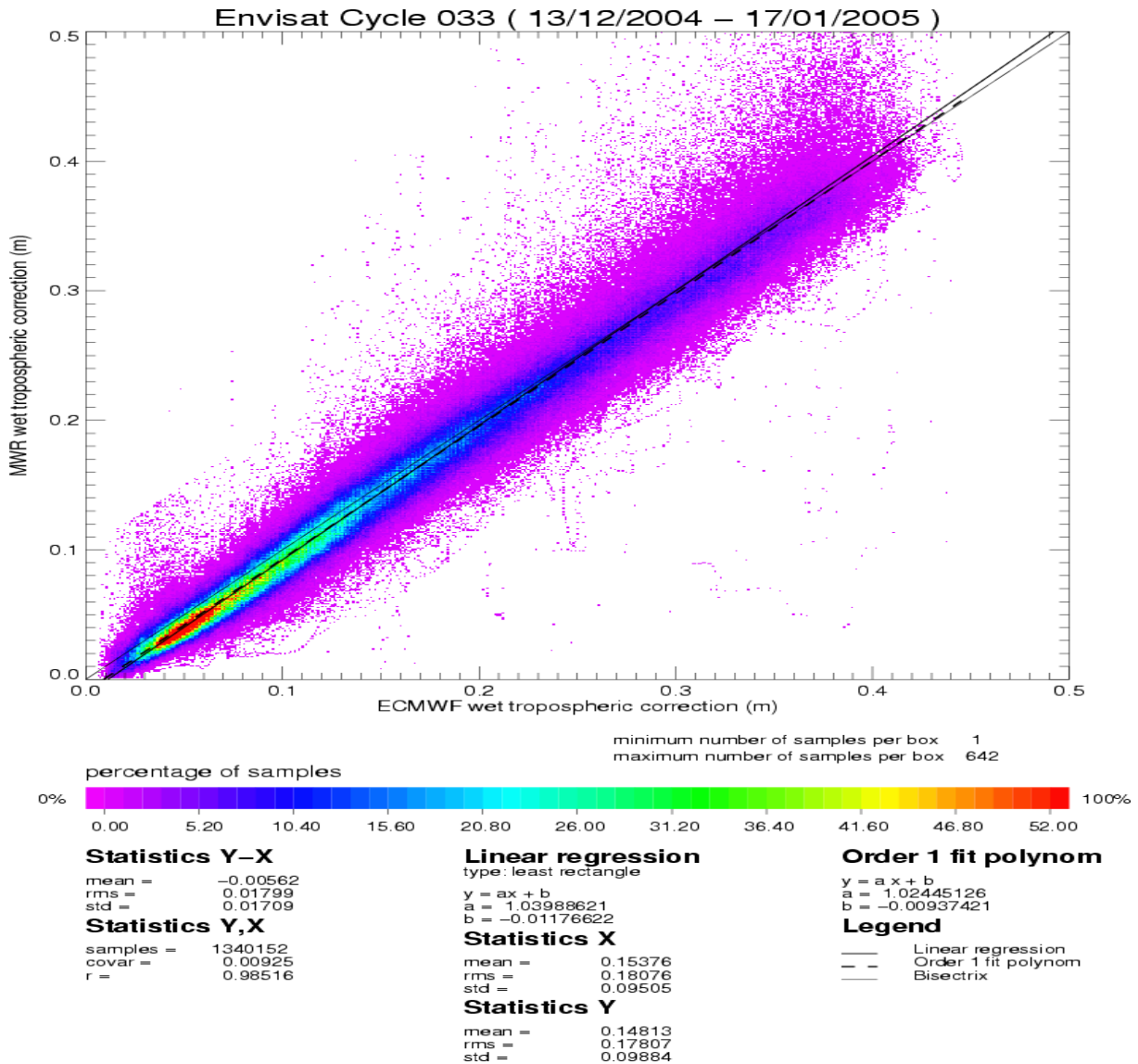
3.4 Altimeter parameters

In order to assess and to monitor altimeter parameter measurements, histograms of Envisat Ku-band Significant Wave Height (SWH), Backscatter coefficient (Sigma0) and RMS of altimeter range are computed.



3.5 Radiometer

In order to assess and to monitor radiometer measurements, a scatter plot between the radiometer wet troposphere correction and the ECMWF model is computed for the valid data set previously defined.

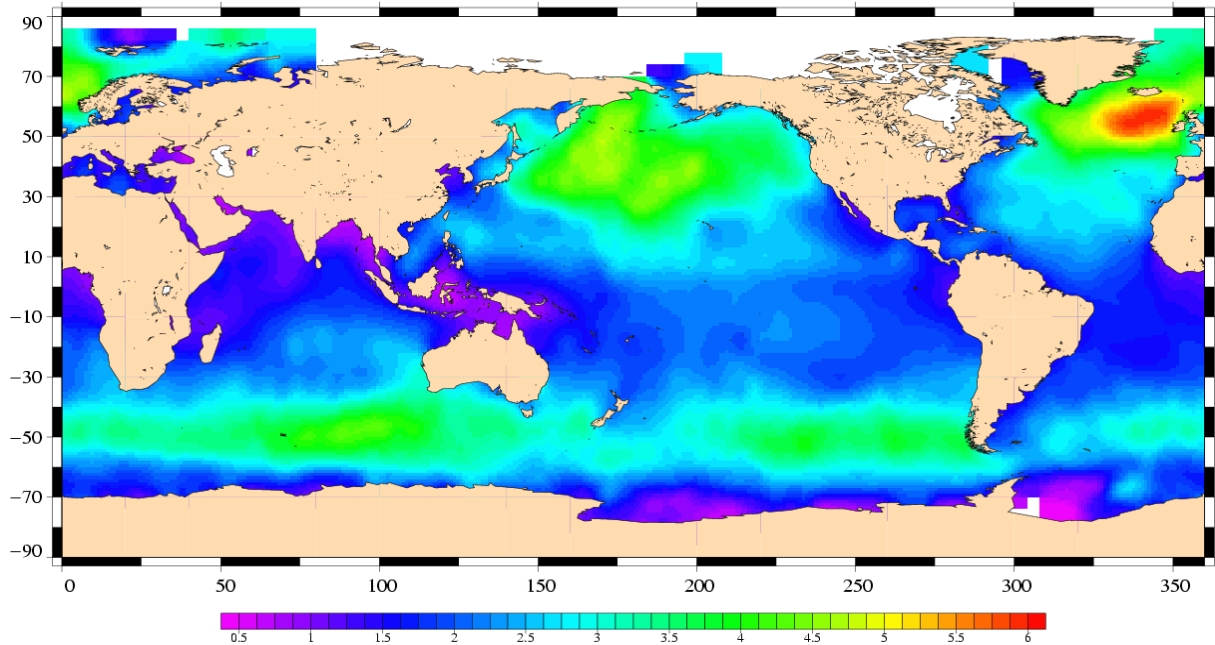


The radiometer-model mean difference is 0.6 cm. A drift on the Envisat 23.8GHz brightness temperature has been detected and has to be monitored on the long term. Note that the neural algorithm is now implemented on Envisat.

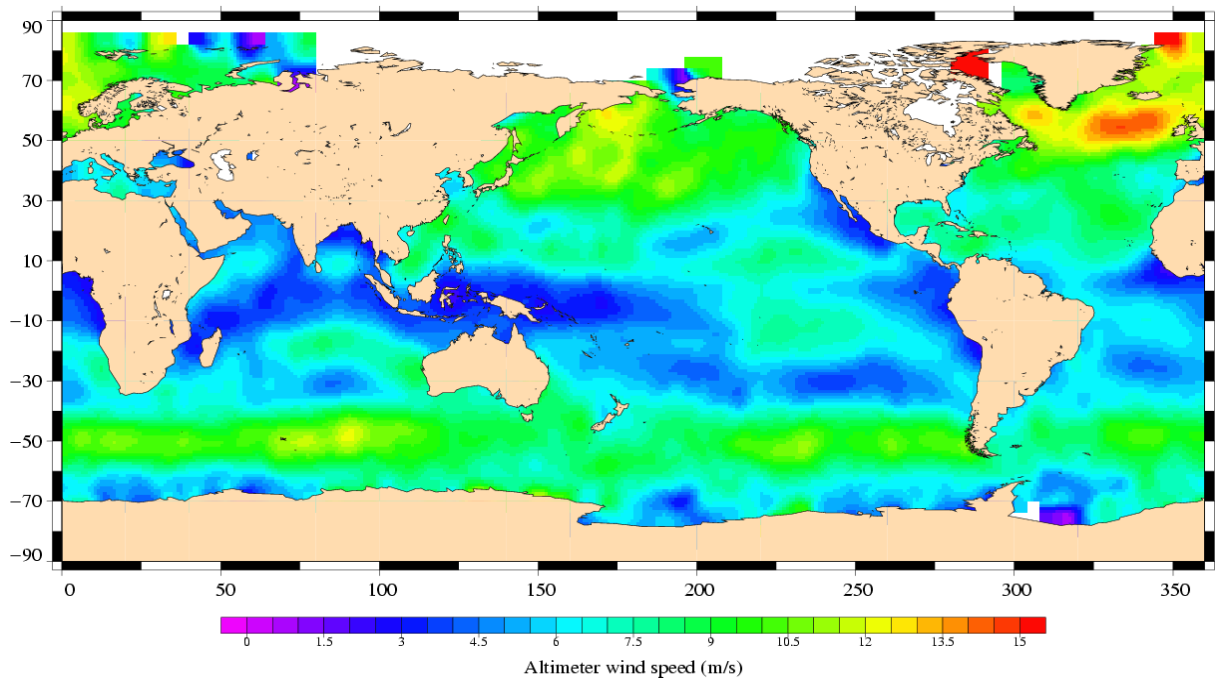
3.6 Wind and wave maps

These two figures show wind and wave estimations derived from 35 days of altimeter measurements.

Envisat Cycle 033
13/12/2004 – 17/01/2005



Significant Wave Height (m)
Envisat Cycle 033
13/12/2004 – 17/01/2005



3.7 Crossover statistics

3.7.1 General comment

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 Envisat algorithms, the crossover standard deviation is about 9.03 cm rms, when using a selection to remove shallow waters (1000 m). When using an additional selection to remove areas of high ocean variability and high latitudes ($> |50|$ deg) it lowers to 7.48 cm rms. This statistic is a stable estimation of the system performance as it is not influenced by sea ice coverage.

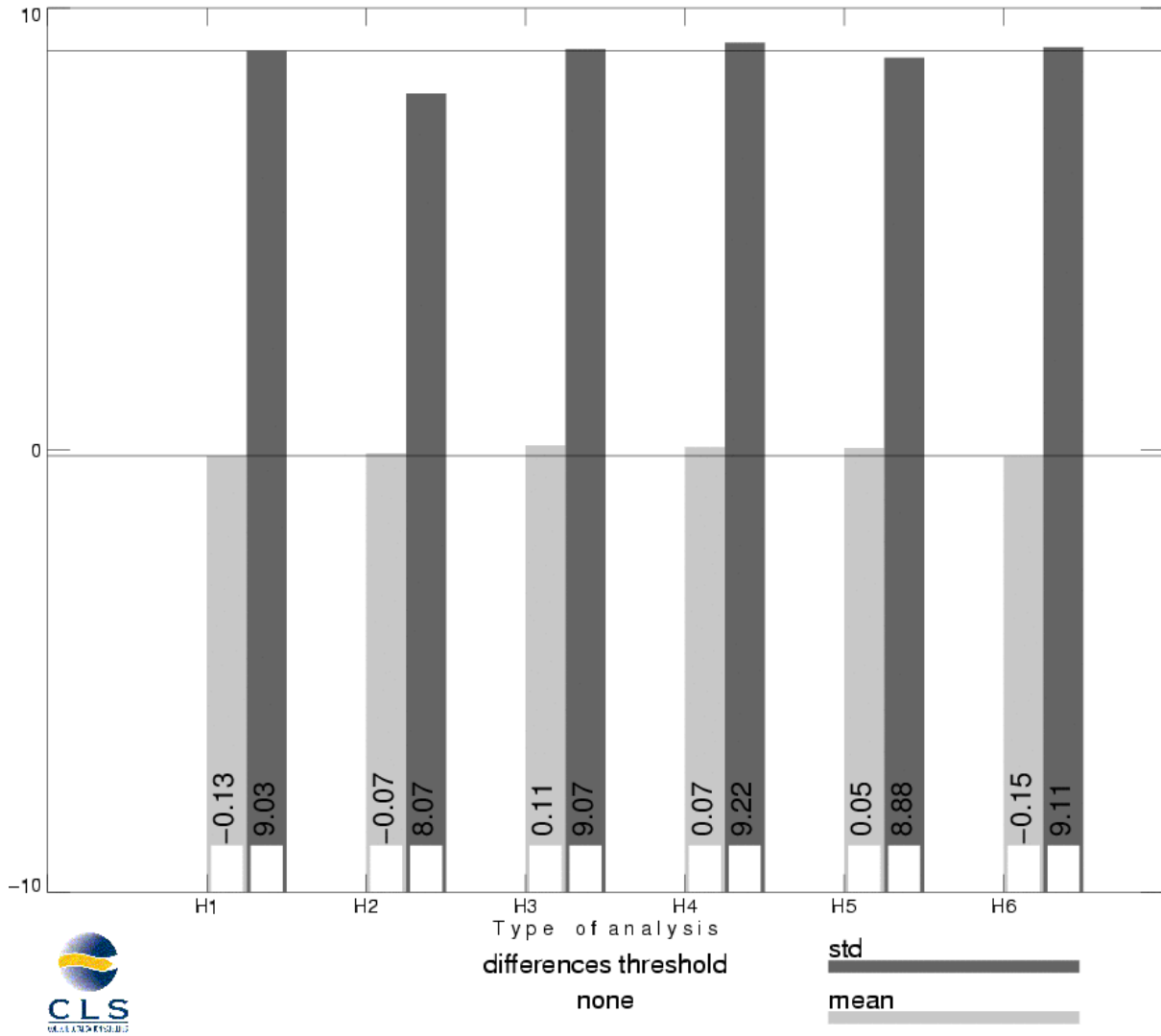
3.7.2 Impact of geophysical corrections

This figure shows the impact of geophysical corrections on crossover mean and rms. A selection is used to remove shallow waters (1000 m).

For this analysis two corrections have been computed: a long wave length and a model ionospheric correction. The long wave length estimation is performed by a global minimization of crossover differences using a (1 and 2 cycles/revolution) sinusoidal model. The model ionospheric correction is computed using the JPL's version of the GPS Ionosphere Maps (JPL GIM) thanks to the procedures provided by Remko Scharro (internet communication to the CCVT community, December 12, 2002).

ENEN – CROSSOVER STATISTICS

Impact of geophysical corrections

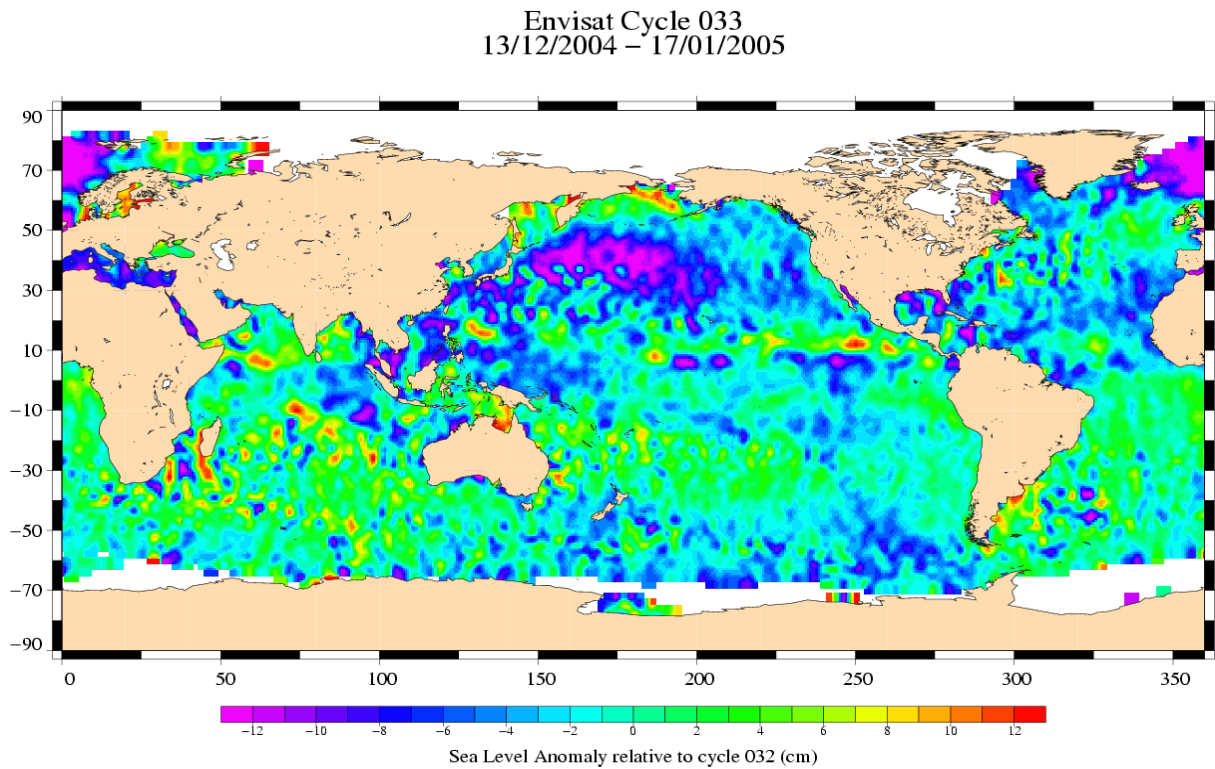


H1 = SSH	H4 = SSH with DORIS ionospheric correction (in product)
H2 = SSH applying a long wave length error (computed)	H5 = SSH with FES02 tide model (in product)
H3 = SSH with GIM ionospheric correction (computed)	H6 = SSH with ECMWF wet tropospheric correction (in product)

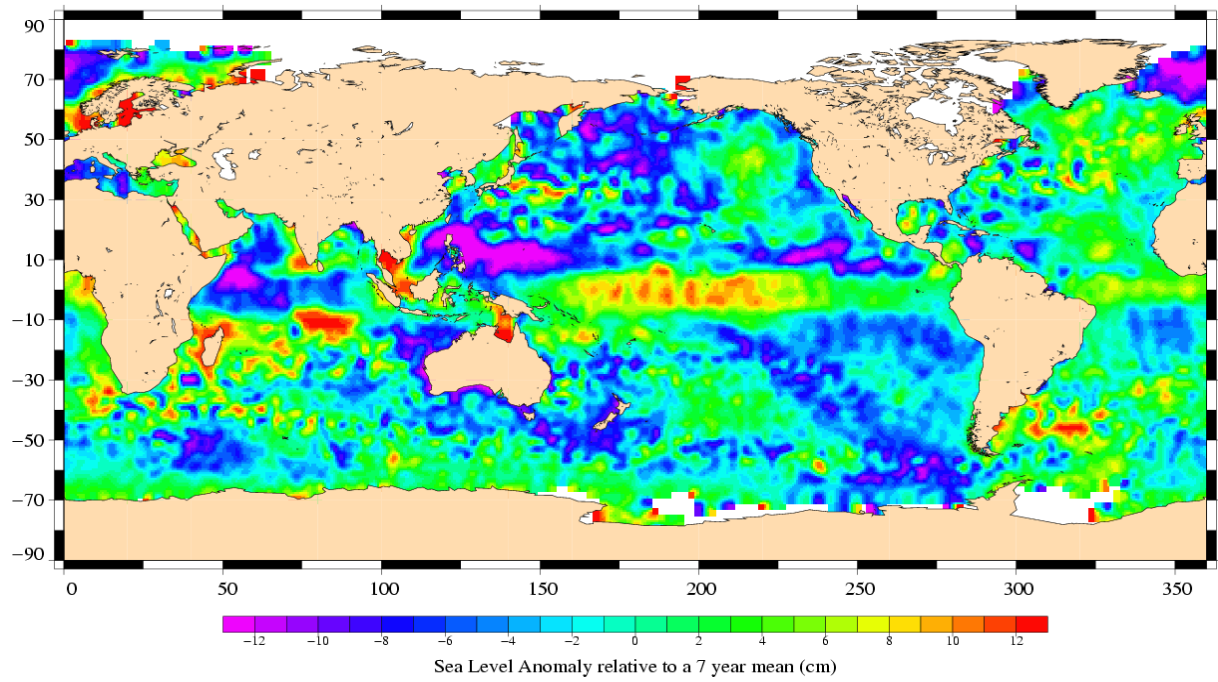
3.8 SSH variability

3.8.1 Sea Level Anomaly

Repeat-track analysis is routinely used to compute Sea Level Anomalies (SLA) relative to the previous cycle and relative to a mean profile. The mean profile has been computed using ERS-1 and ERS-2 data and has been adjusted on the 7 year TP mean profile. In order to see fine features SLA are centered about the mean value.



Envisat Cycle 033
13/12/2004 – 17/01/2005



3.8.2 Comparison to a precise Mean Sea Surface

The MSS from the product is used as a reference to compute SLA. Global statistics of Envisat SSH-MSS are (cm):

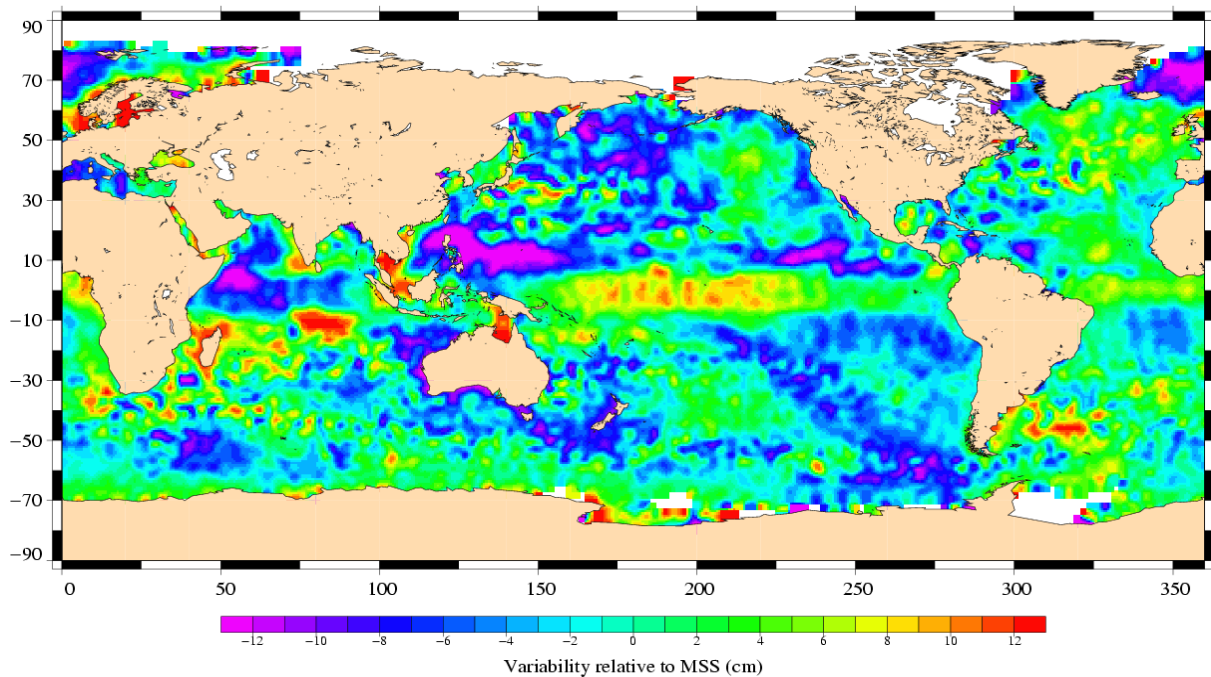
Number	Mean	Std. dev.
1499128	44.06	10.68

When using a selection to remove shallow waters (1000 m), areas of high ocean variability and high latitudes ($> |50|$ deg) statistics are:

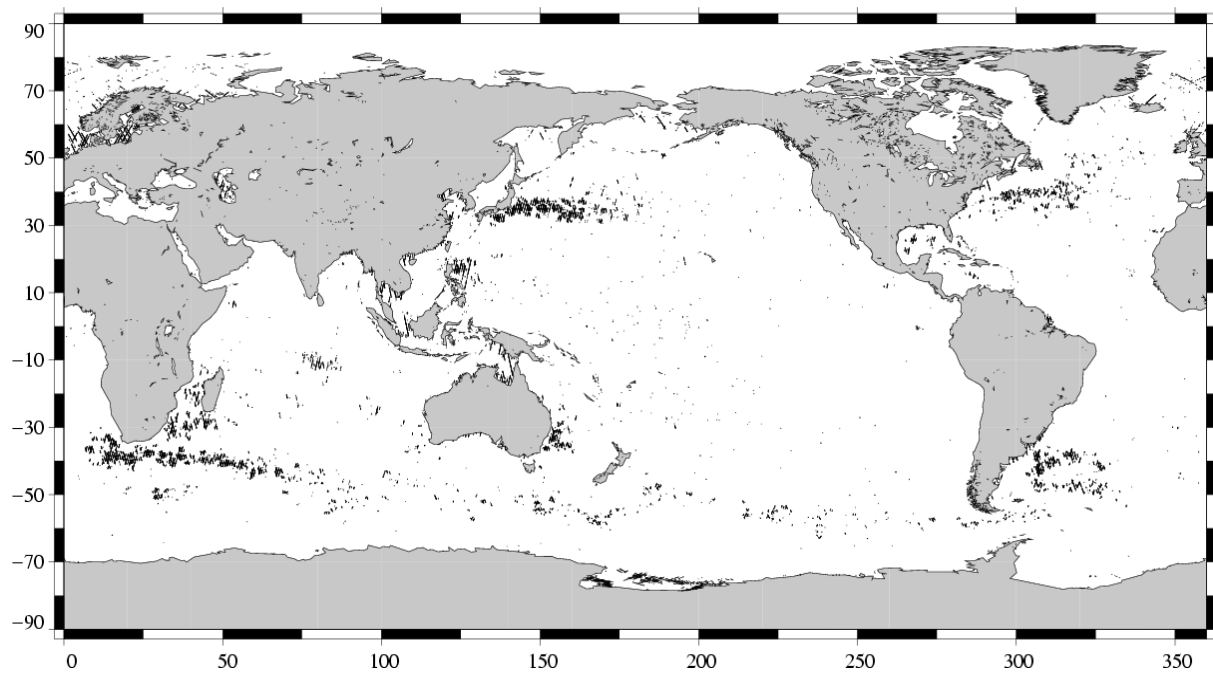
Number	Mean	Std. dev.
911213	44.05	9.25

The two following maps respectively show the map of Envisat SLA relative to the MSS and differences higher than a 30 cm threshold. In order to see fine features SLA are centered about the mean value. The latter figure shows that apart from isolated measurements, higher differences are located in high ocean variability areas, as expected.

Envisat Cycle 033
13/12/2004 – 17/01/2005



(SSH - MSS) centered, differences greater than 30 cm
Envisat / Cycle 033



4 Envisat long term performance monitoring

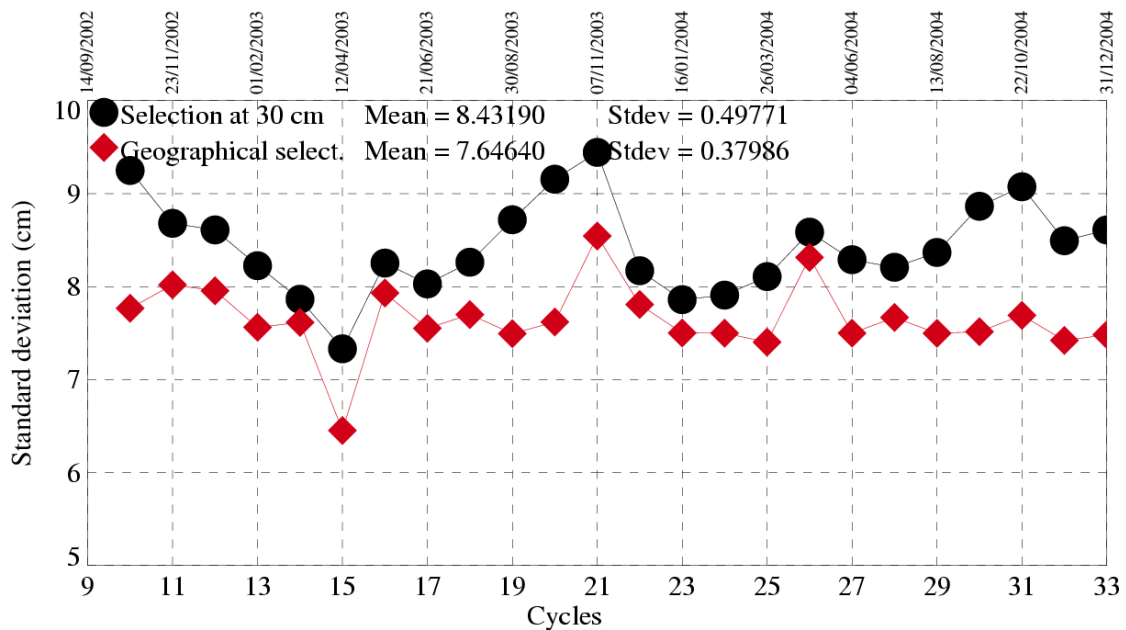
Statistics of SSH variability are computed after crossover and repeat-track analyses. This allows to estimate how Envisat data fulfill the mission objectives in terms of performances.

4.1 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 editing 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.

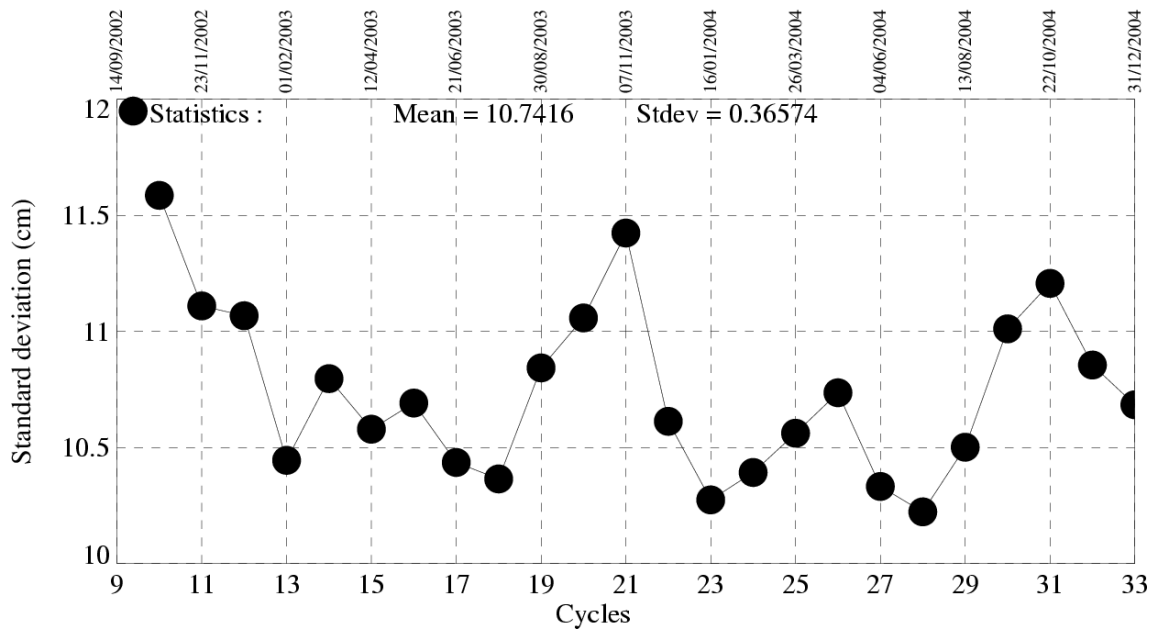
Crossover standard deviation



4.2 RMS of Sea Level Anomaly

Sea Level Anomalies relative to a mean profile are computed using repeat-track analysis for each Envisat cycle. To monitor Envisat 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



5 Cross Calibration with ERS-2

Envisat flies on the same ground track as ERS-2, 30 minutes ahead. This section presents results that illustrate the difference with ERS-2.

A failure of the ERS-2 tape recorder occurred on 22 June 2003. The ERS-2 Low Rate mission continues within the visibility of ESA ground stations over Europe: North Atlantic, Arctic and western North America. Nevertheless, cross calibration with ERS-2 can be performed on this zone. Envisat cycle 033 data are collocated to data from ERS-2 GDR cycle 100 in order to compare the main parameters from repeat-track analysis.

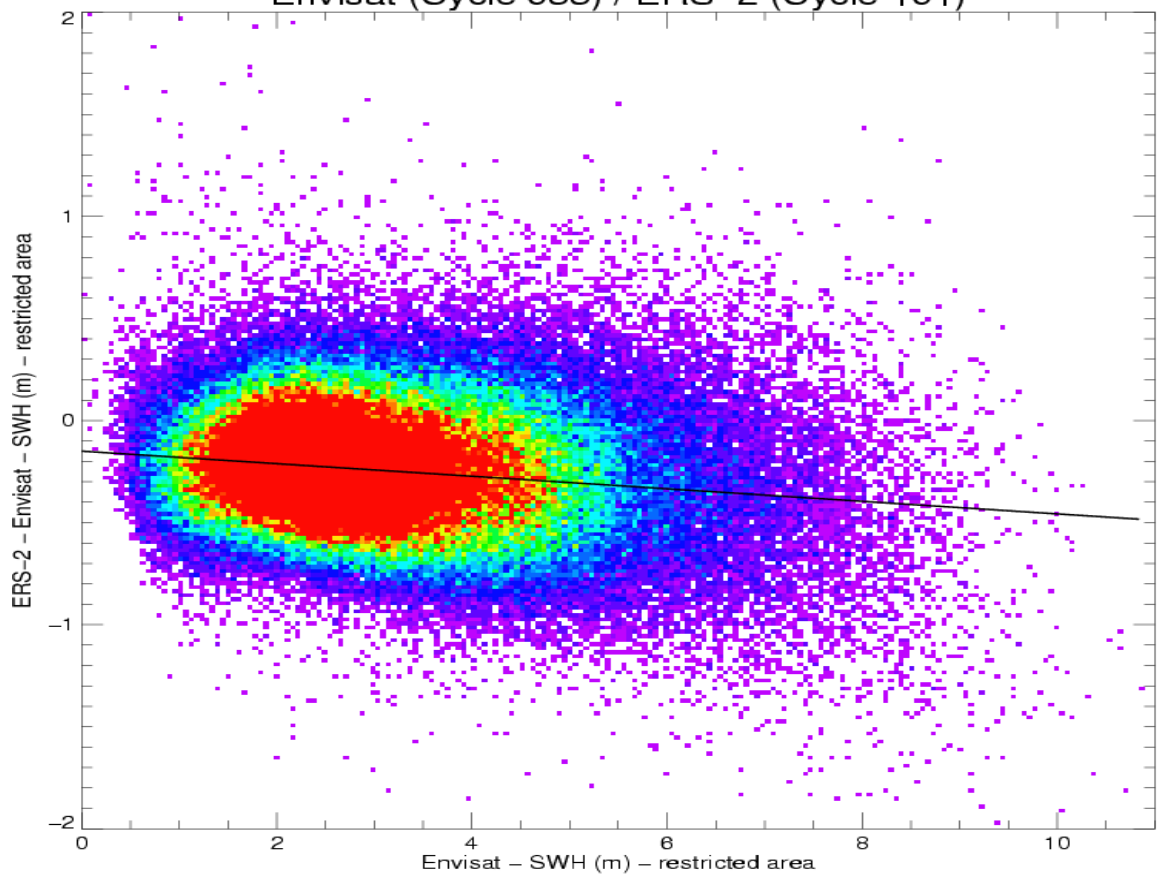
5.1 [ERS-2 - Envisat] Ku SWH differences

Global statistics of [ERS-2 - Envisat] Ku SWH differences are (cm):

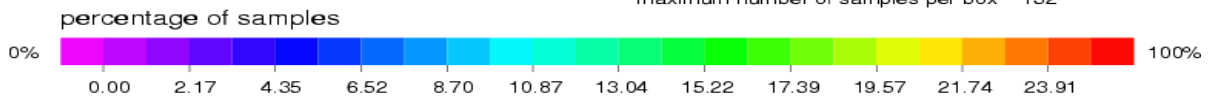
Number	Mean	Std. dev.
166306	-23.83	28.76

The scatter plot between Envisat and ERS-2 Ku SWH measurements is given on the following figure:

Envisat (Cycle 033) / ERS-2 (Cycle 101)



minimum number of samples per box 1
 maximum number of samples per box 132



Order 1 fit polynom

$$y = ax + b$$

$$a = -0.03076864$$

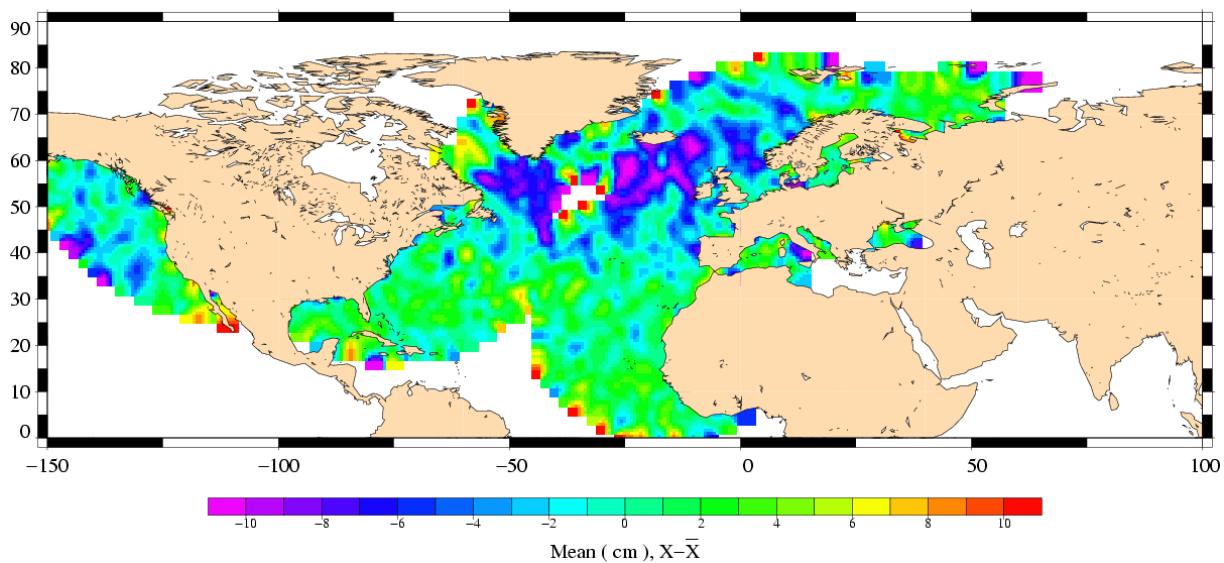
$$b = -0.14978190$$

Legend

— Order 1 fit polynom

These differences are plotted on the following figure (data are centered about the mean value).

SWH differences
ERS-2 (Cycle 101) – Envisat (Cycle 033)

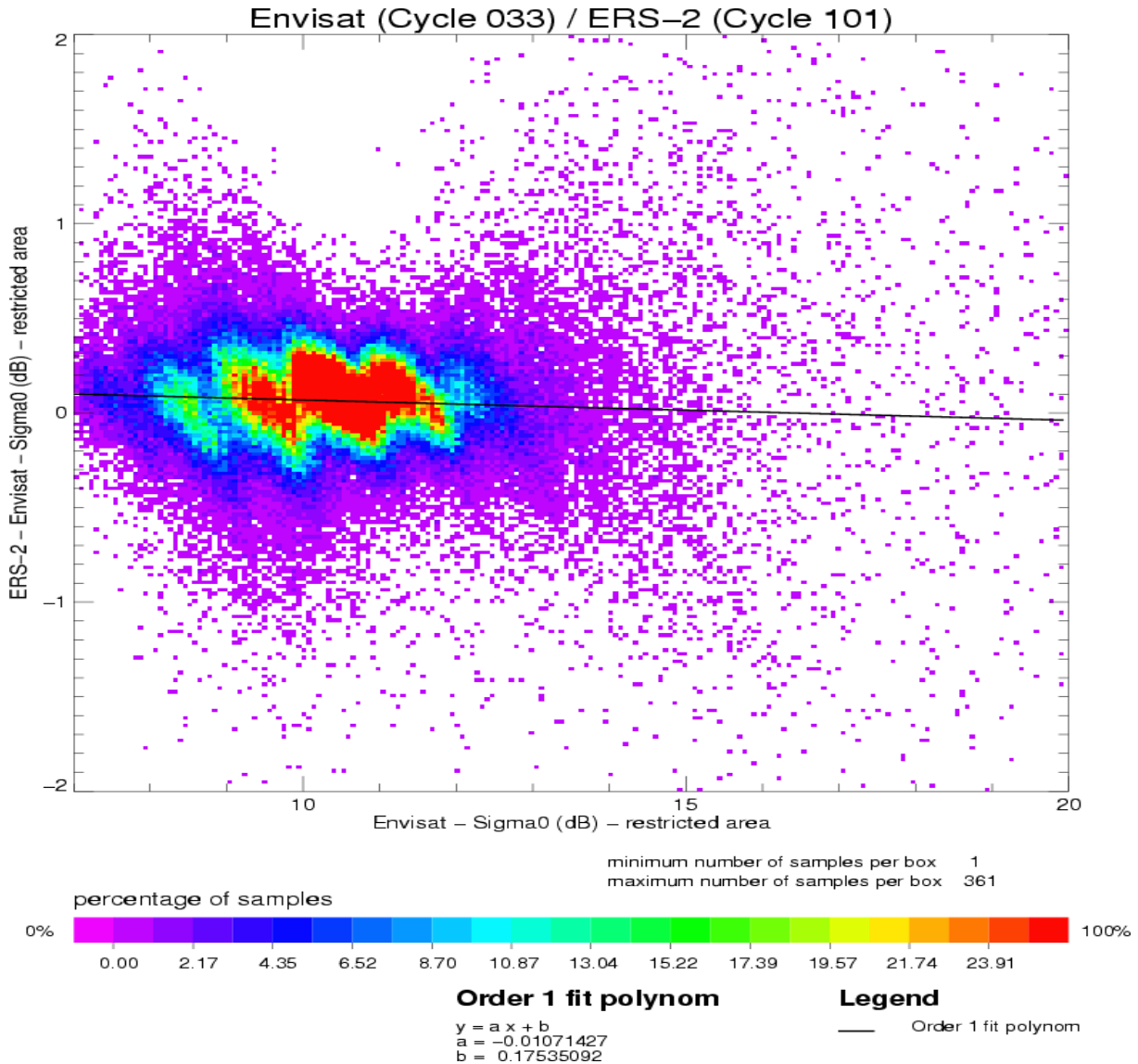


5.2 [ERS-2 - Envisat] Ku Sigma0 differences

Global statistics of [ERS-2 - Envisat] Ku Sigma0 differences are (dB):

Number	Mean	Std. dev.
166306	0.07	0.27

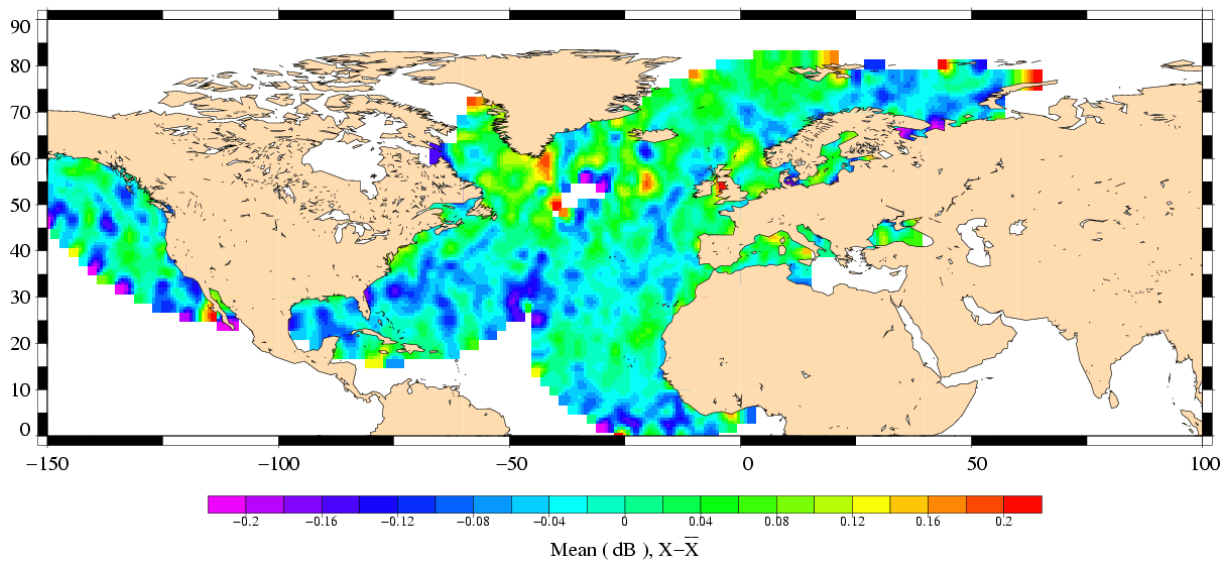
The scatter plot between Envisat and ERS-2 Ku Sigma0 measurements is given on the following figure:



Particular features on the scatter plot mainly come from the shape of ERS-2 histogram.

The differences are plotted on the following figure (data are centered about the mean value).

Sigma0 differences
ERS-2 (Cycle 101) – Envisat (Cycle 033)



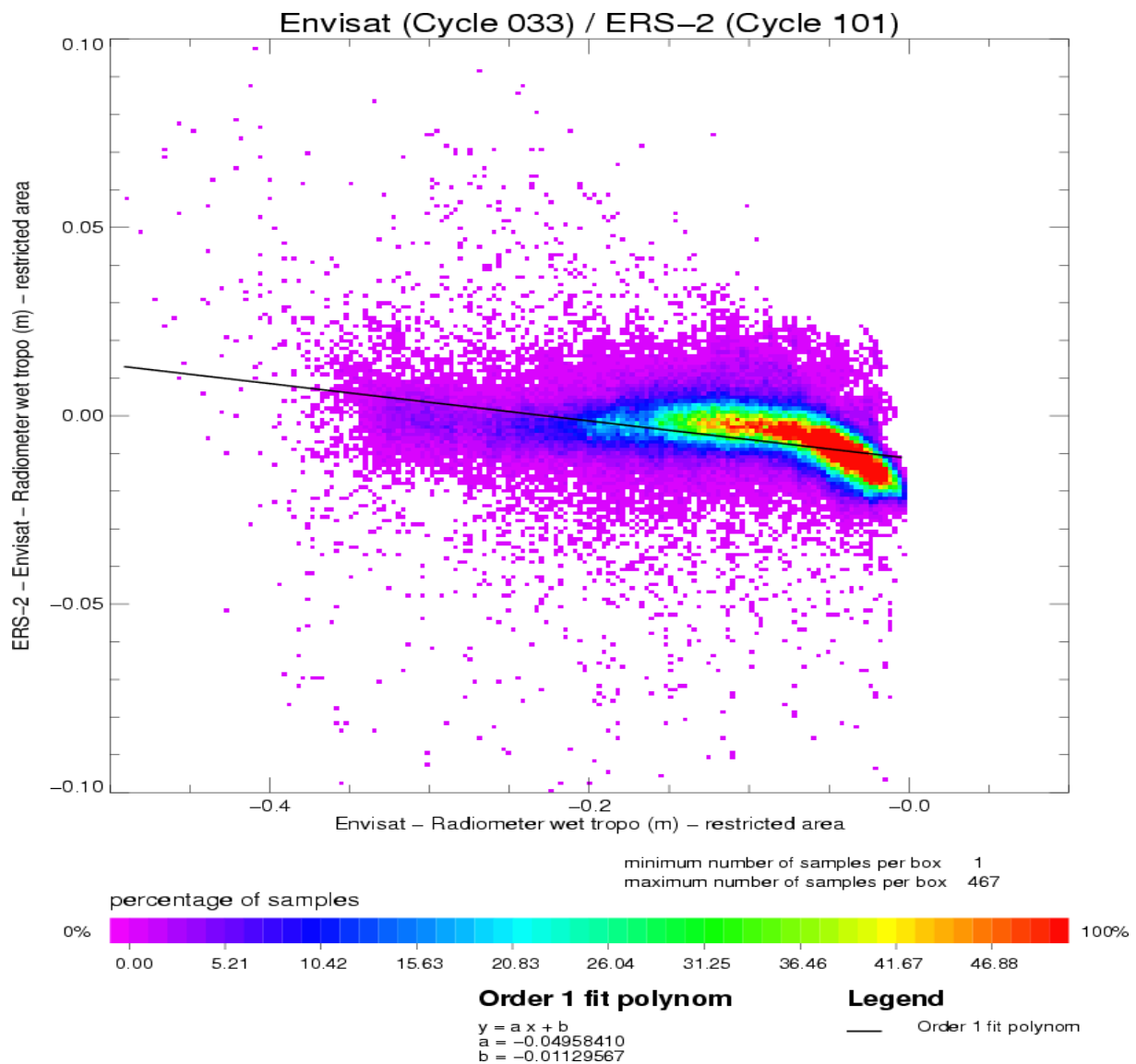
5.3 [ERS-2 - Envisat] radiometer wet troposphere correction differences

The ERS-2 radiometer correction is recomputed to correct the gain drop and the drift of the 24 GHz brightness temperature (Obligis et al., 2003).

Global statistics of [ERS-2 - Envisat] radiometer wet troposphere correction differences are (cm):

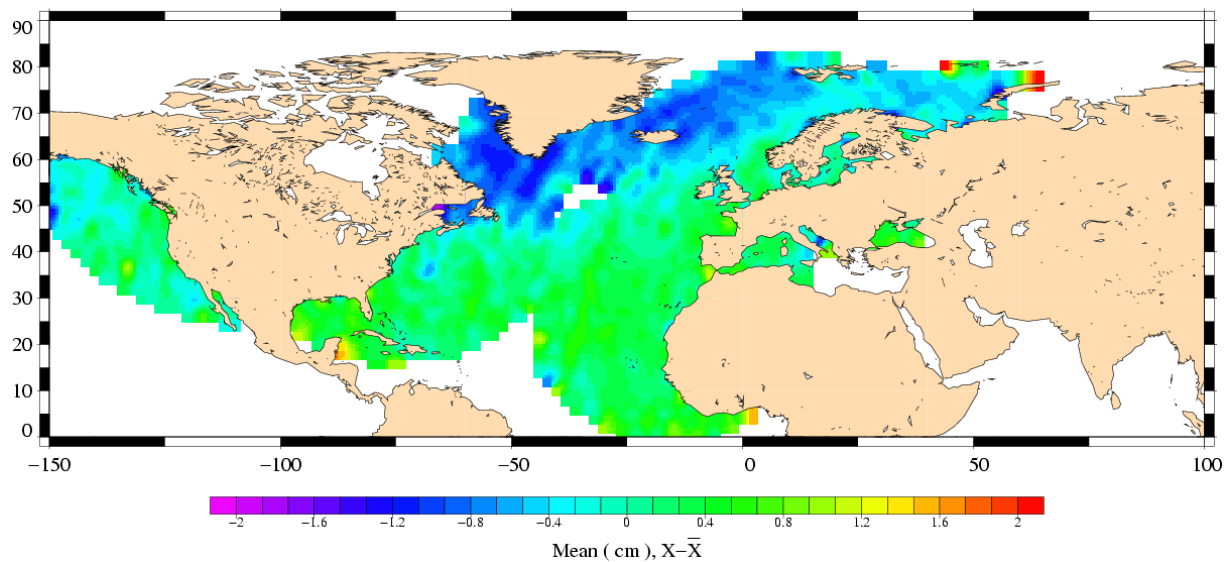
Number	Mean	Std. dev.
166306	-0.58	0.86

The scatter plot between Envisat and ERS-2 radiometer wet troposphere corrections is given on the following figure:



The differences between Envisat and ERS-2 radiometer corrections are plotted on the following figure (data are centered about the mean value).

Radiometer wet tropo correction differences
ERS-2 (Cycle 10I) – Envisat (Cycle 033)



5.4 [ERS-2 - Envisat] SSH differences

In order to compare the ERS-2 SSH with the Envisat SSH, ERS-2 GDRs have been updated with algorithms and corrections similar to Envisat:

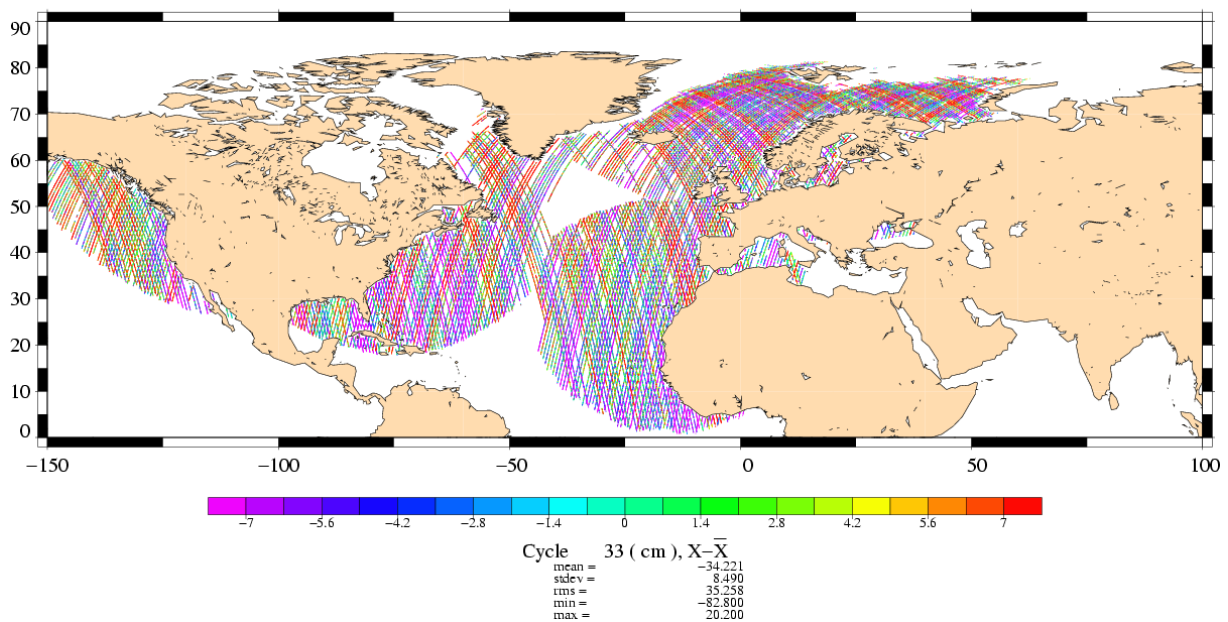
- Range corrected from SPTR, USO, time tag bias
 - ECMWF wet tropospheric correction
 - Model dry tropospheric correction
 - 3-parameters sea state bias
 - Inverted barometer correction with time varying pressure
 - Total geocentric GOT00 ocean tide height
 - Geocentric pole tide height
 - Solid earth tide height
 - GIM ionospheric correction
 - DPAF orbit (No DGME-04 orbit files are available for cycle 100, the initial orbit is then used).
- The correction used for Envisat are those described in [section 2.2](#) except for:
- Total geocentric GOT00 ocean tide height
 - GIM ionospheric correction
 - ECMWF wet tropospheric correction

Global statistics of [ERS-2 - Envisat] SLA differences (cm):

Number	Mean	Std. dev.
166306	-34.22	8.49

These SSH differences are plotted on the following figure.

Corrected SLA (GIM iono, ECMWF (gaussian) wet tropo configuration)
ERS-2 (Cycle 101) – Envisat (Cycle 033)



The main source of differences is the ERS-2 orbit errors.

6 Particular investigations

none