Envisat GDR
Quality Assessment Report

Cycle 031

04-10-2004 / 08-11-2004

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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_03.

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

17 passes are missing due to level1 B data unavailability (see **section 3.1**).

1 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

Collision avoidance Maneuver (2004/10/22 03:20:22 to 2004/10/22 07:00:41, Pass 495-498)

2.5 Cycle quality and performances

Good general results are obtained for this cycle of data.

The crossover standard deviation is 7.69 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 11.2 cm. When using a selection to remove shallow waters (1000 m), areas of high ocean variability and high latitudes ($> |50|$ deg) it lowers to 9.6 cm .

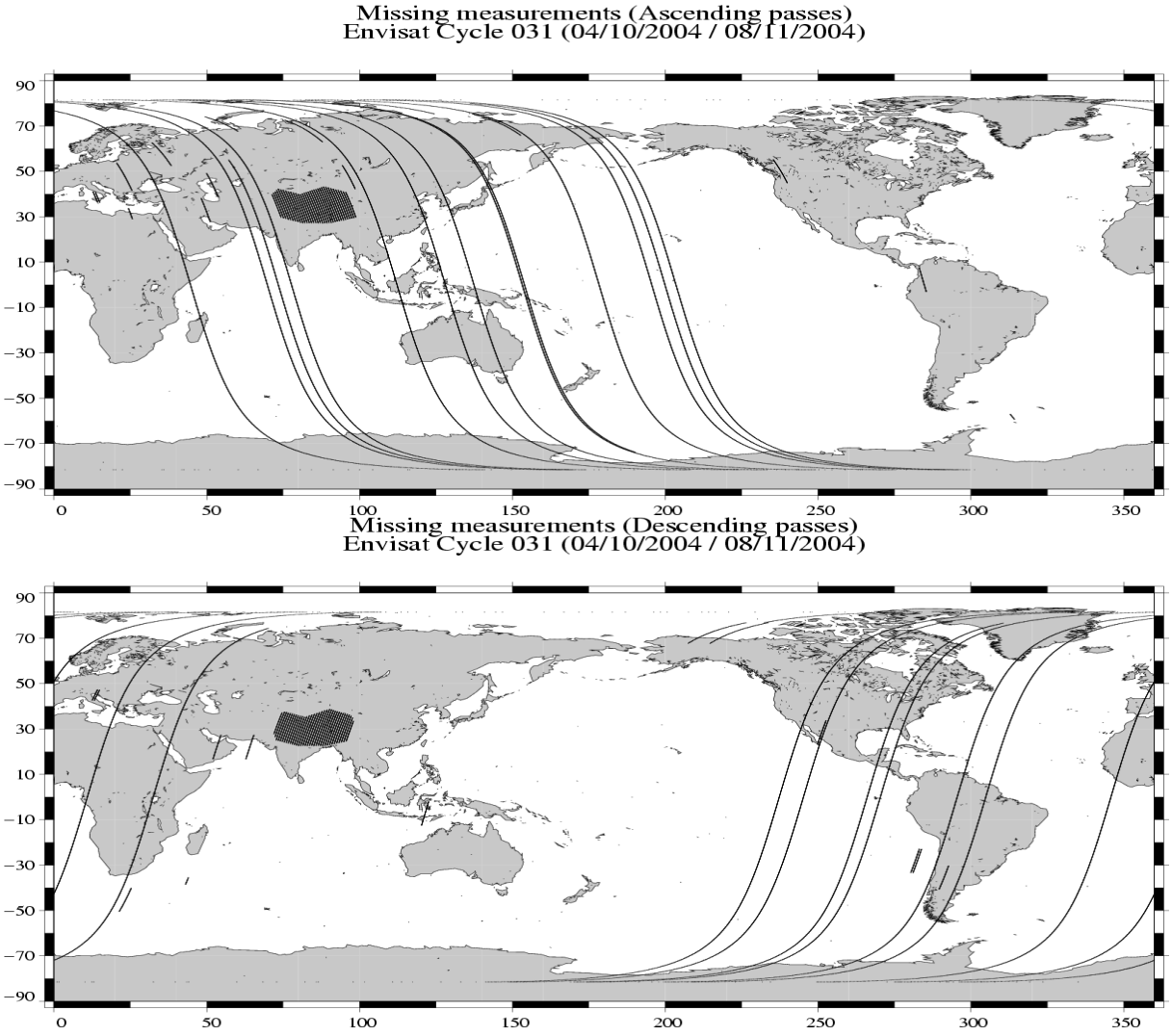
Detailed CALVAL results are presented in **section 3**.

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

2637607 are present, and 77279 (2.8%) are missing. The maps below illustrate missing 1Hz measurements in the GDRs, with respect to a 1 Hz sampling of a nominal repeat track.



17 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 22 October 2004, a 2-burn in-plane collision avoidance manoeuvre was executed as planned.

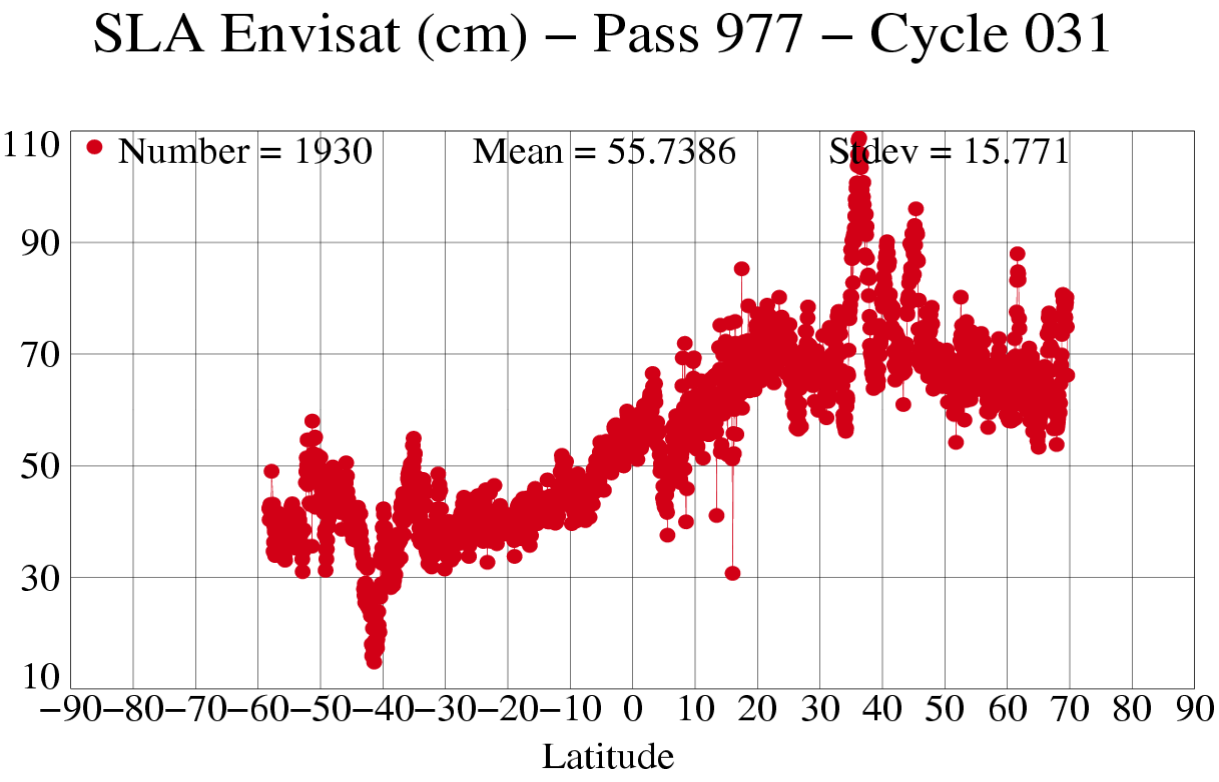
3.2.2 Doris and Laser performances

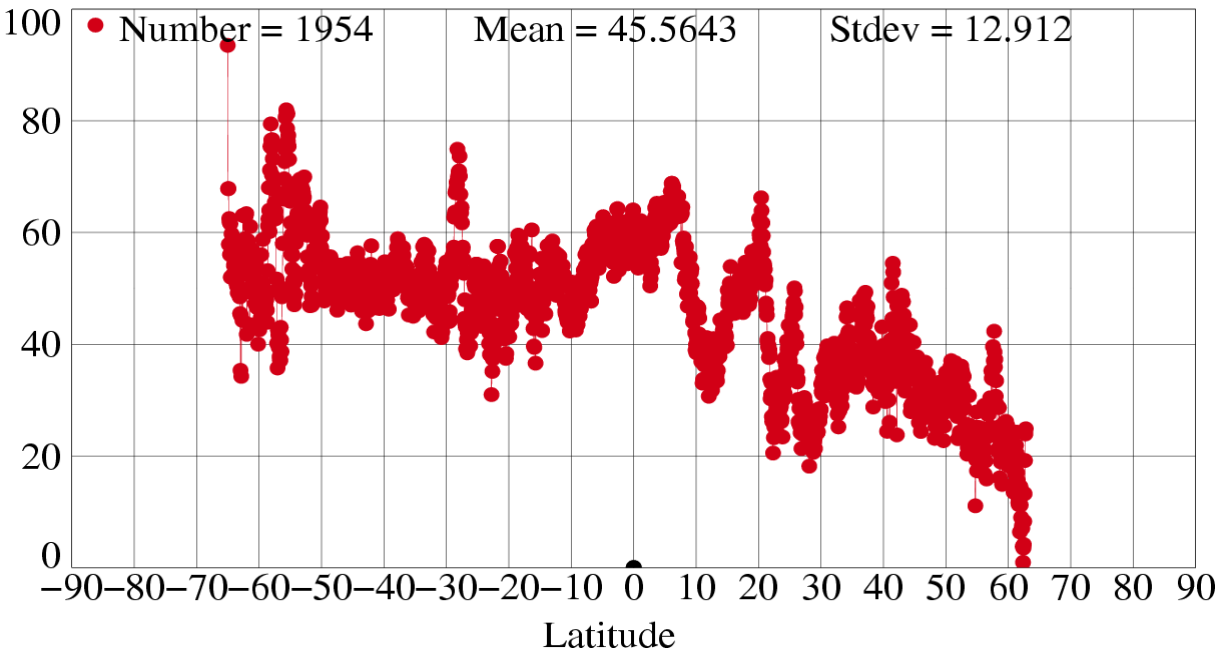
The next table gives statistics on Doris and Laser residuals:

7-day Period	Number of Doris measurements	Number of Laser measurements	RMS of Laser measurements (cm)
04/10/2004 to 11/10/2004	32581	504	1.52630
11/10/2004 to 18/10/2004	35968	863	2.31350
18/10/2004 to 25/10/2004	45854	943	2.64670
25/10/2004 to 01/11/2004	44307	1034	2.39190
01/11/2004 to 08/11/2004	46437	894	4.72200

3.2.3 Impact on SLA

The orbit quality is good for this cycle of data. No Impact is noticed on SLA.
There is a high solar activity at the end of the 5th arc. A specific processing has been implemented for this arc. The SLA is slightly degraded between pass 974 and 1002. It is more strongly degraded on a few passes, 977 and 987 especially. The following figure shows the SLA on these two passes: .





Users are advised to use passes 974 to 1002 with care.

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 $>$ 10cm
- Peakiness $>$ 2

A S-band anomaly flag: this flag is set if |Sigma0(Ku)-Sigma0(S)| $>$ 5dB
Notice that this flag is set over land and ice, even when no S-band anomaly occurs.

Parameter	Nb rejected	% rejected
Radiometer land flag	899968	39.87
Ice flag	774063	34.29
S-Band anomaly flag	398595	17.66

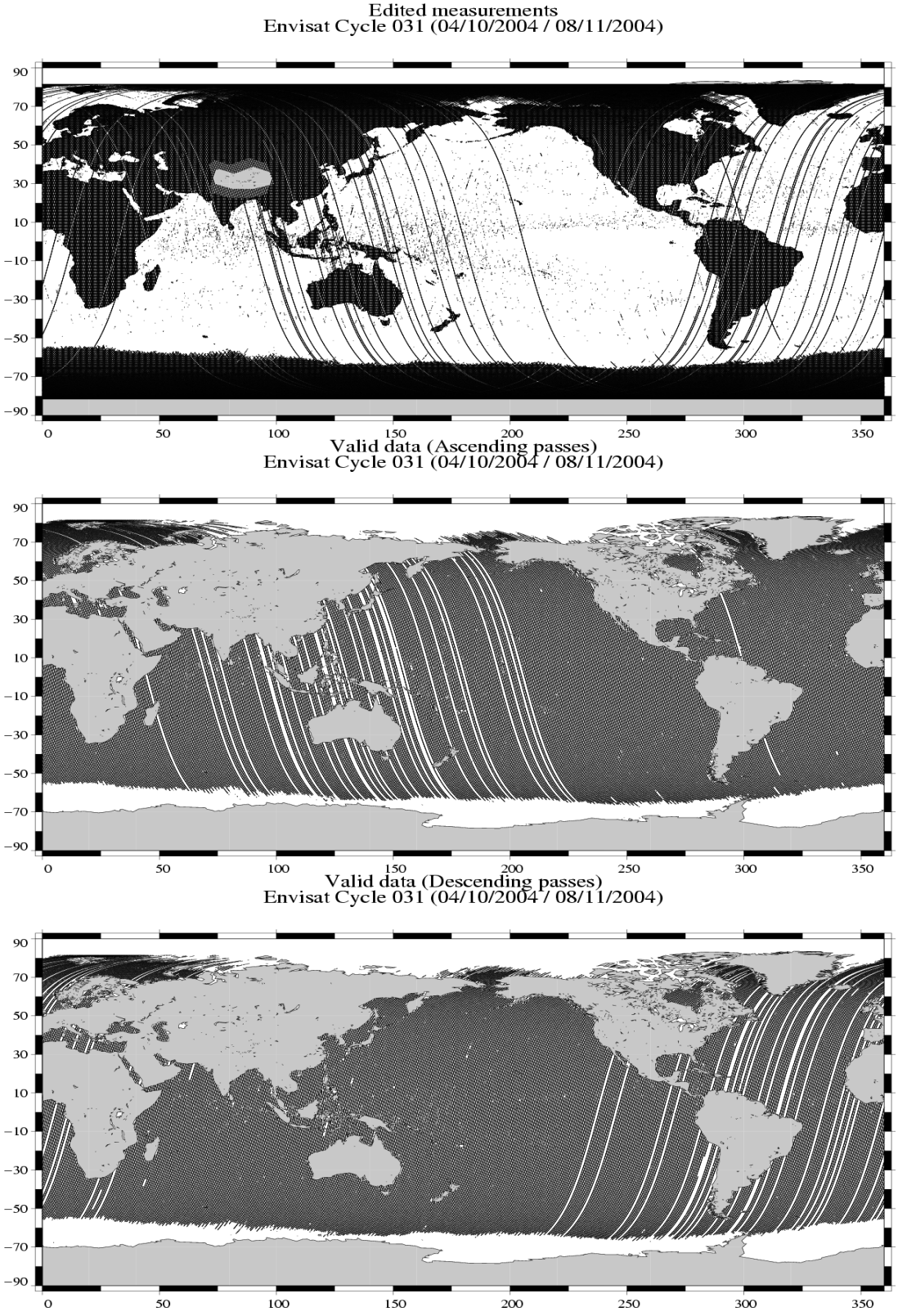
Then, measurements are edited using thresholds on several parameters. These thresholds are expected to remain constant throughout the Envisat mission, so that monitoring the number of edited measurements allows a survey of data quality.
The next table gives for each tested parameter, minimum and maximum 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	941	0.07
Variability relative to MSS (m)	-2.000	2.000	4526	0.34
Number of 18Hz valid points	10.000	-	102	0.01
Std. deviation of 18Hz range (m)	0.000	0.250	13971	1.04
Off nadir angle from waveform (deg2)	-0.200	0.160	9151	0.68
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	1264	0.09
Dual Ionospheric correction (m)	-0.400	0.040	2880	0.22
Significant wave height (m)	0.000	11.000	832	0.06
Sea state Bias (m)	-0.500	0.000	2140	0.16
Backscatter coefficient (dB)	7.000	30.000	1163	0.09
GOT00 ocean tide height (m)	-5.000	5.000	1214	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 519 (0.04 %) measurements.

3.3.2 Figures

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



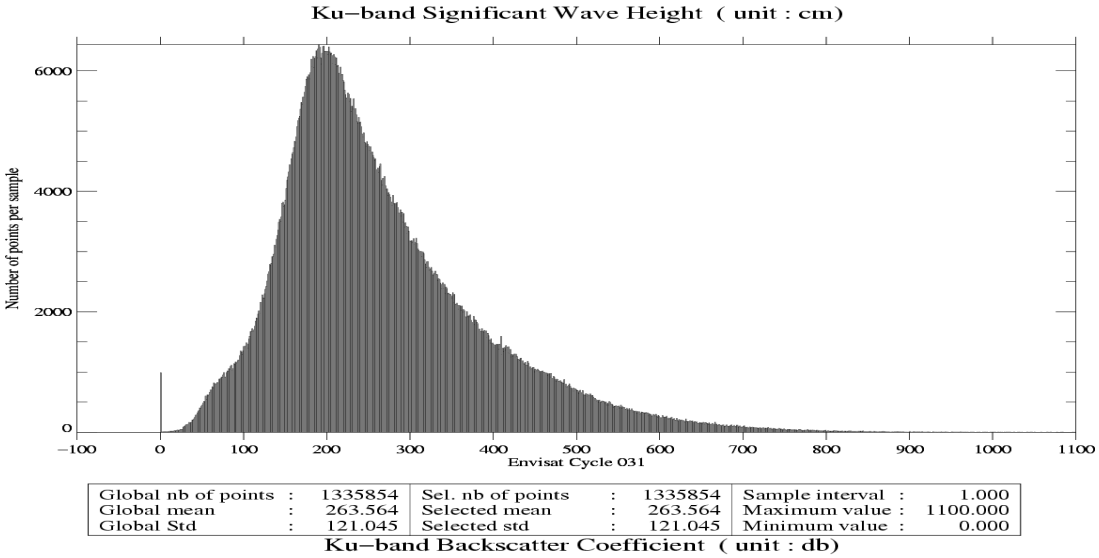
3.3.3 Comments

970 passes have been delivered. Among these passes:
- 1 pass (624) is entirely edited on the radiometer land flag (no MWR correction)
- 37 passes (247-251,532-537,588-595,702-709,728-737) 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.

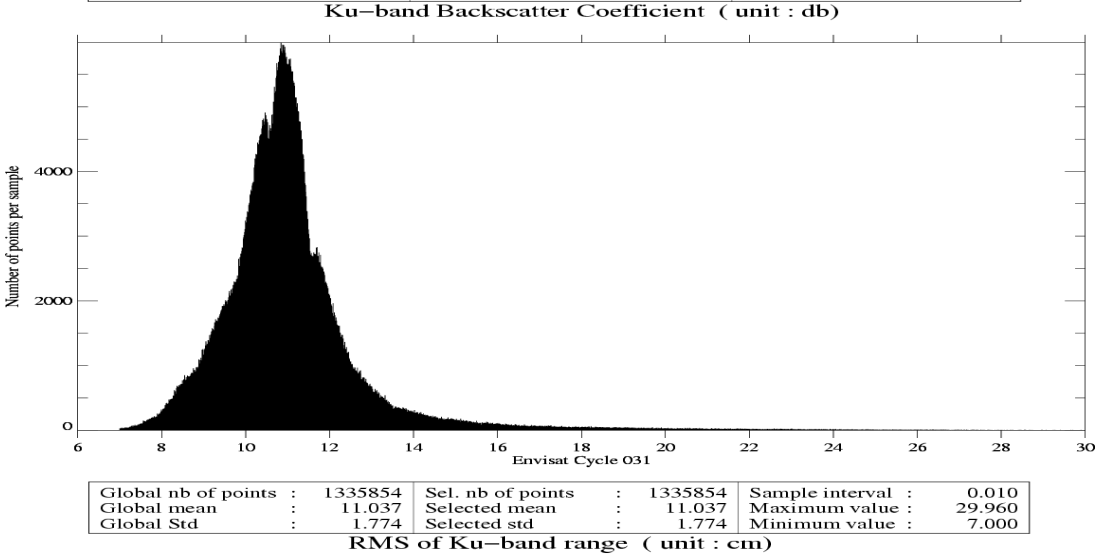
Wet areas appear in the plot of removed data. Similar features are observed with other altimeters (T/P, Jason) mainly due to rain comtamination.

3.4 Altimeter parameters

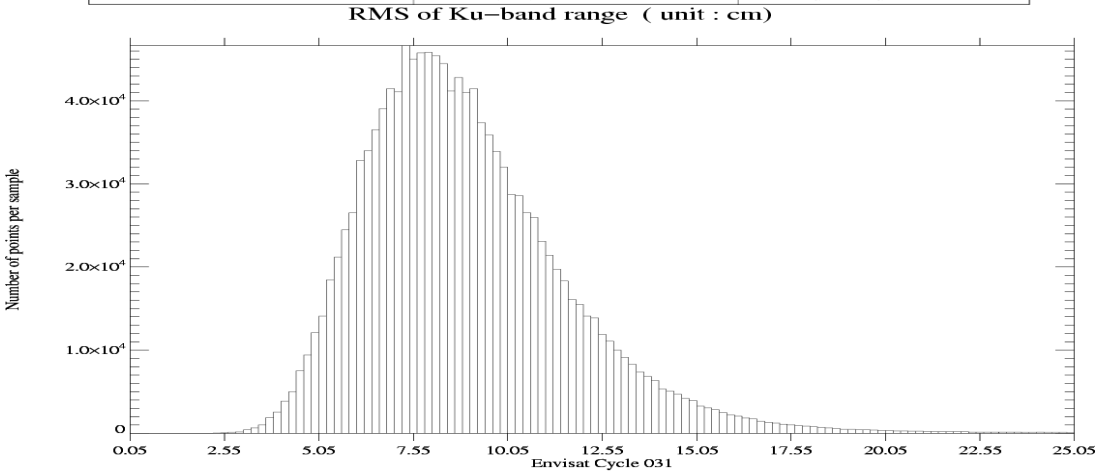
In order to assess and to monitor altimeter parameter measurements, histograms of Envisat Ku-band Significant Wave Height (SWH), Backscatter coefficient (Sigma0) and RMS of altimeter range are computed.



Global nb of points	:	1335854	Sel. nb of points	:	1335854	Sample interval	: 1.000
Global mean	:	263.564	Selected mean	:	263.564	Maximum value	: 1100.000
Global Std	:	121.045	Selected std	:	121.045	Minimum value	: 0.000



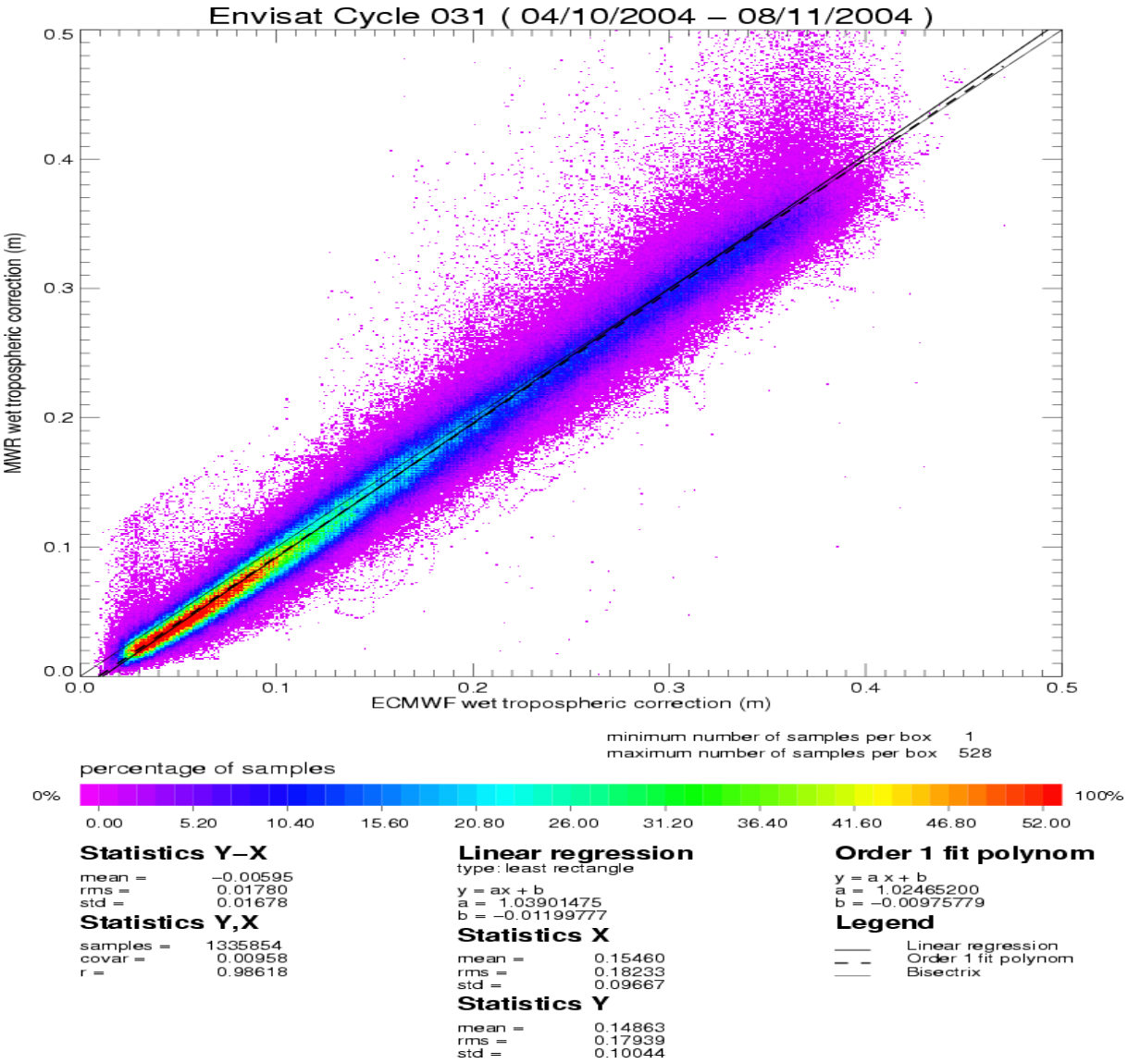
Global nb of points	:	1335854	Sel. nb of points	:	1335854	Sample interval	: 0.010
Global mean	:	11.037	Selected mean	:	11.037	Maximum value	: 29.960
Global Std	:	1.774	Selected std	:	1.774	Minimum value	: 7.000



Global nb of points	:	1335854	Sel. nb of points	:	1335854	Sample interval	: 0.200
Global mean	:	8.942	Selected mean	:	8.942	Maximum value	: 25.000
Global Std	:	2.681	Selected std	:	2.681	Minimum value	: 1.700

3.5 Radiometer

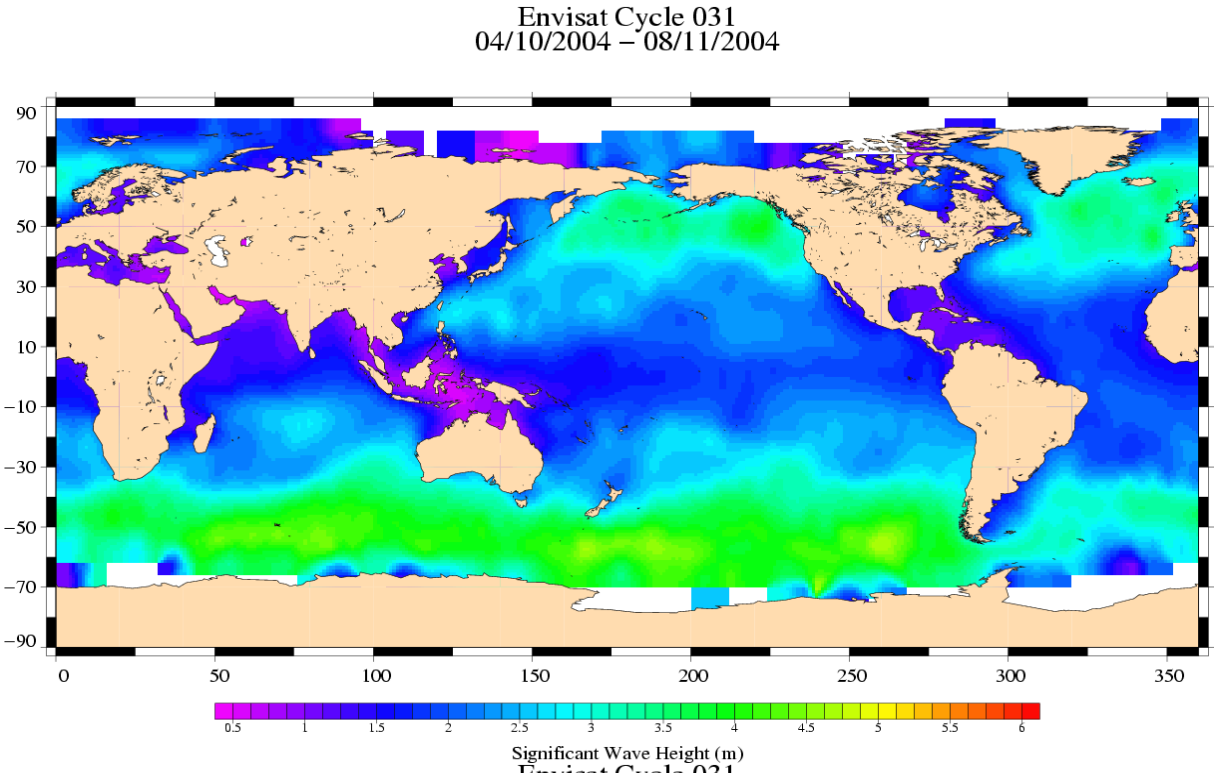
In order to assess and to monitor radiometer measurements, a scatter plot between the radiometer wet troposphere correction and the ECMWF model is computed for the valid data set previously defined.

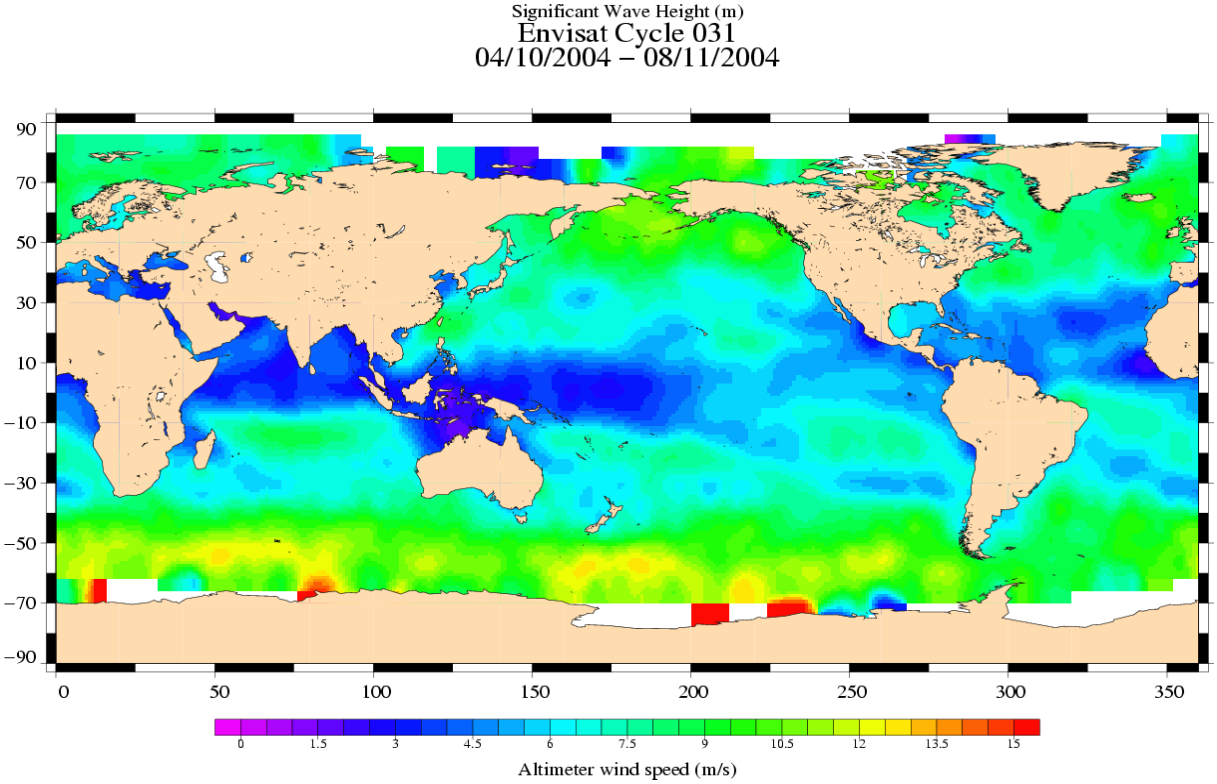


The radiometer-model mean difference is 0.6 cm. A drift on the Envisat 23.8GHz brightness temperature has been detected and has to be monitored on the long term. Note that the neural algorithm is now implemented on Envisat.

3.6 Wind and wave maps

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





3.7 Crossover statistics

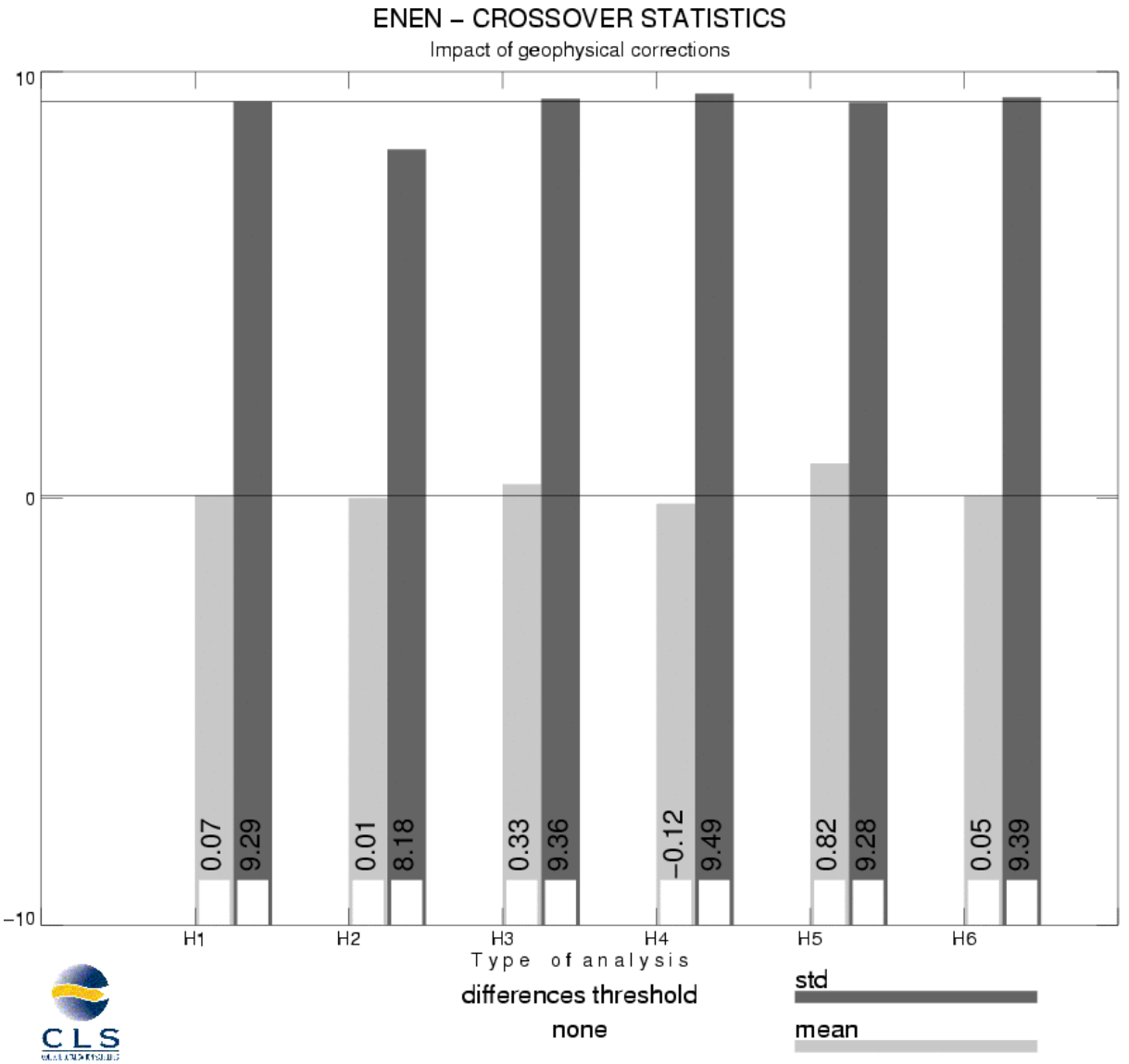
3.7.1 General comment

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 9.29 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 7.69 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).

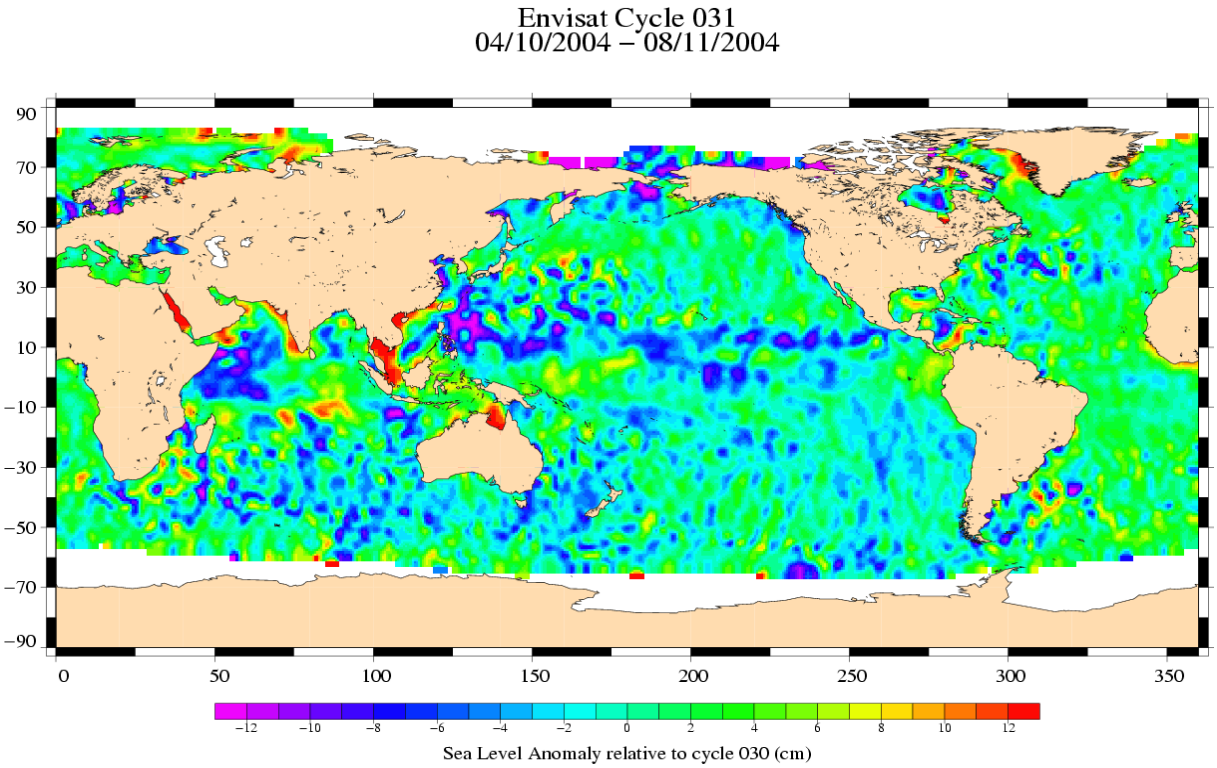
For this analysis two corrections have been computed: a long wave length and a model ionospheric correction. The long wave length estimation is performed by a global minimization of crossover differences using a (1 and 2 cycles/revolution) sinusoidal model. The model ionospheric correction is computed 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
10
0
−10
0.07
9.29
0.01
8.18
0.33
9.36
−0.12
9.49
0.82
9.28
0.05
9.39
H1
H2
H3
H4
H5
H6
Type of analysis
differences threshold
none
std
mean
H1 = SSH
H2 = SSH applying a long wave length error (computed)
H3 = SSH with GIM ionospheric correction (computed)
H4 = SSH with DORIS ionospheric correction (in product)
H5 = SSH with FES02 tide model (in product)
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 ajusted on the 7 year TP mean profile. In order to see fine features SLA are centered about the mean value.



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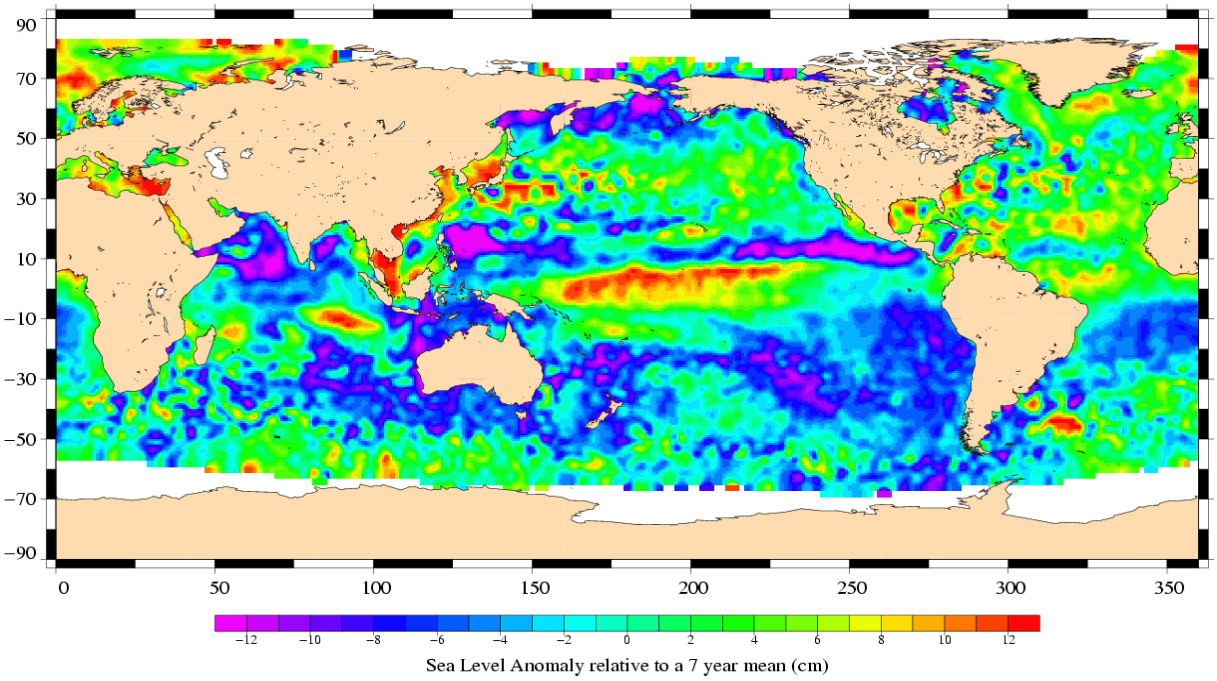


3.8.2 Comparison to a precise Mean Sea Surface

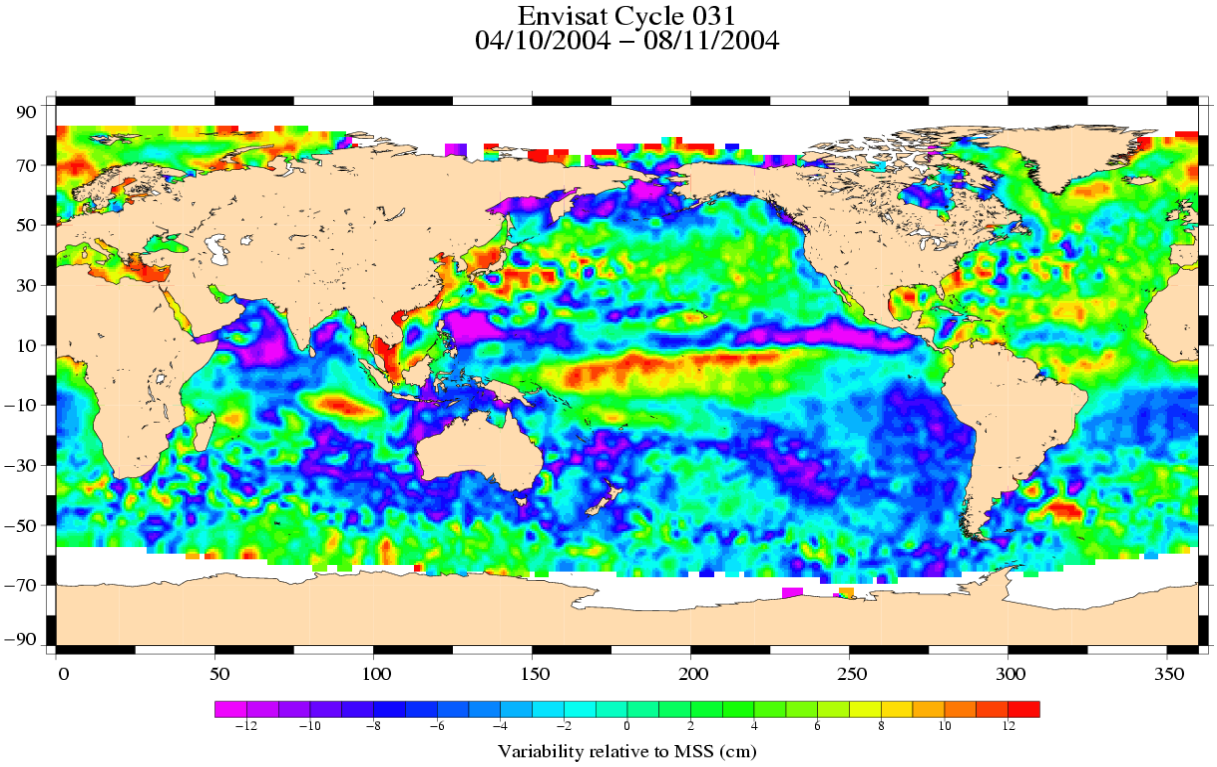
The MSS from the product is used as a reference to compute SLA. Global statistics of Envisat SSH-MSS are (cm):

Number	Mean	Std. dev.
1493888	45.09	11.21

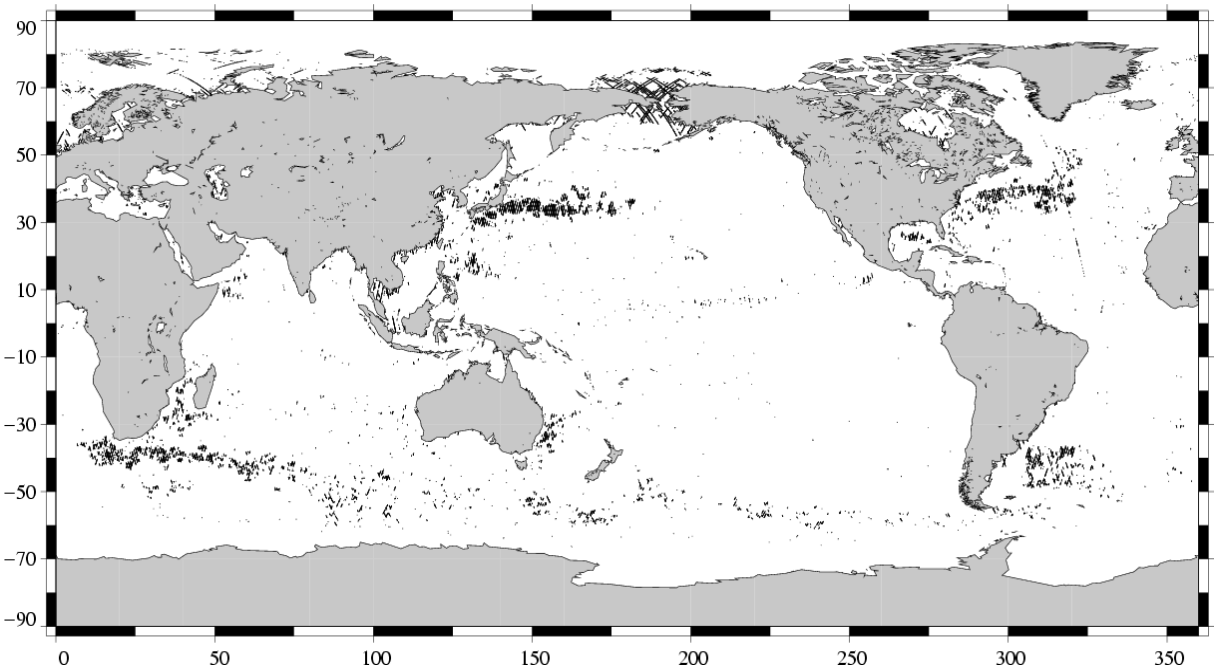
When using a selection to remove shallow waters (1000 m), areas of high ocean variability and high latitudes ($> |50|$ deg) statistics are:

Number	Mean	Std. dev.
933143	44.69	9.57

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.



(SSH − MSS) centered, differences greater than 30 cm
Envisat / Cycle 031



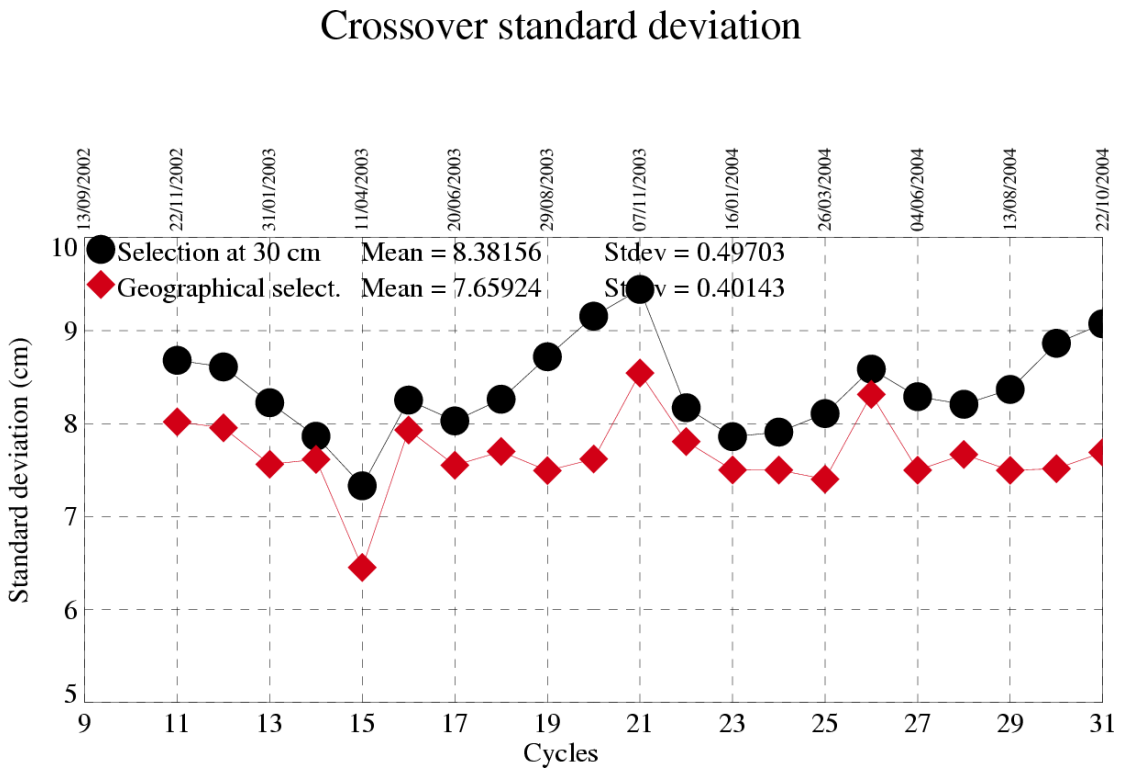
4 Envisat long term performance monitoring

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

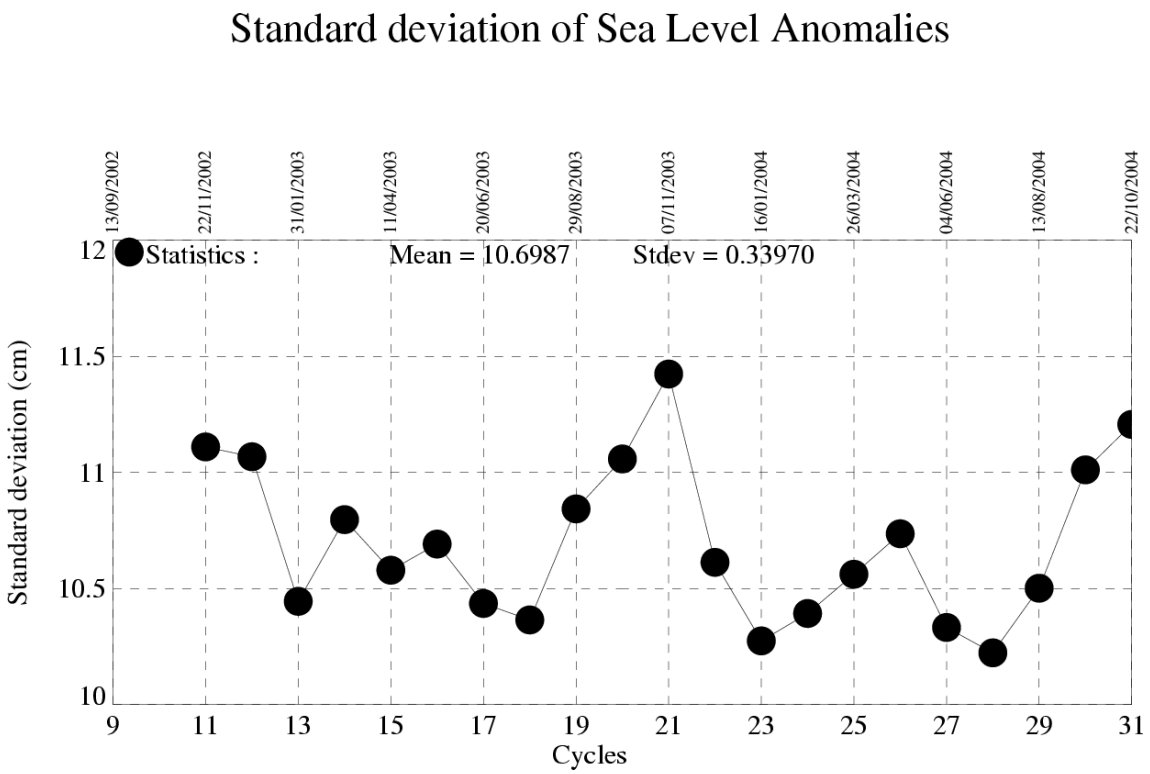
This parameter is plotted as a function of time in a one cycle per cycle basis in the figure below. It is computed after data editing and using 2 aditing selection criteria:

- 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.



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.



5 Cross Calibration with ERS-2

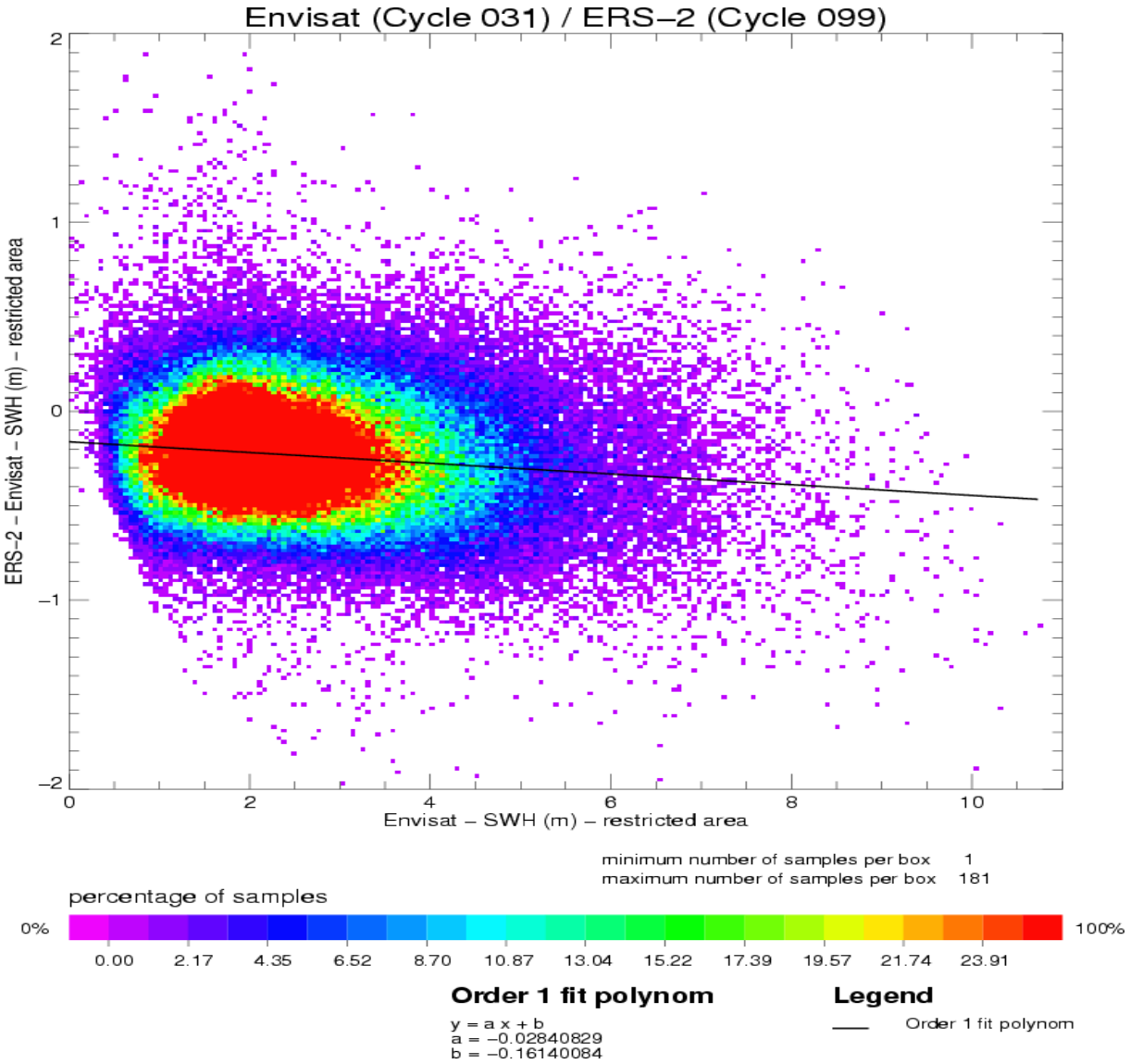
Envisat flies on the same ground track as ERS-2, 30 minutes ahead. This section presents results that illustrate the difference with ERS-2.
A failure of the ERS-2 tape recorder occured on 22 June 2003. The ERS-2 Low Rate mission continues within the visibility of ESA ground stations over Europe: North Atlantic, Arctic and western North America. Nevertheless, cross calibration with ERS-2 can be performed on this zone. Envisat cycle 031 data are collocated to data from ERS-2 GDR cycle 098 in order to compare the main parameters from repeat-track analysis.

5.1 [ERS-2 - Envisat] Ku SWH differences

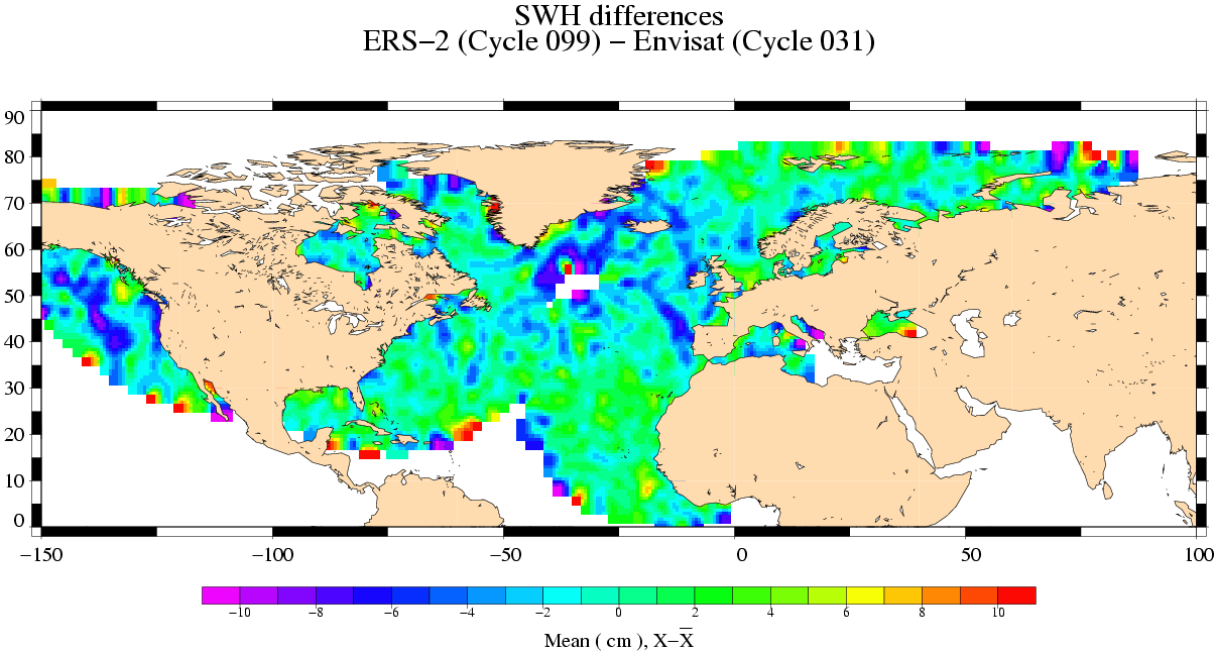
Global statistics of [ERS-2 - Envisat] Ku SWH differences are (cm):

Number	Mean	Std. dev.
183487	-22.39	27.18

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


Envisat (Cycle 031) / ERS–2 (Cycle 099)
ERS–2 – Envisat – SWH (m) – restricted area
Envisat – SWH (m) – restricted area
2
1
0
–1
–2
0
2
4
6
8
10
minimum number of samples per box 1
maximum number of samples per box 181
percentage of samples
0%
100%
0.00
2.17
4.35
6.52
8.70
10.87
13.04
15.22
17.39
19.57
21.74
23.91
Order 1 fit polynom
y = a x + b
a = –0.02840829
b = –0.16140084
Legend
Order 1 fit polynom

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

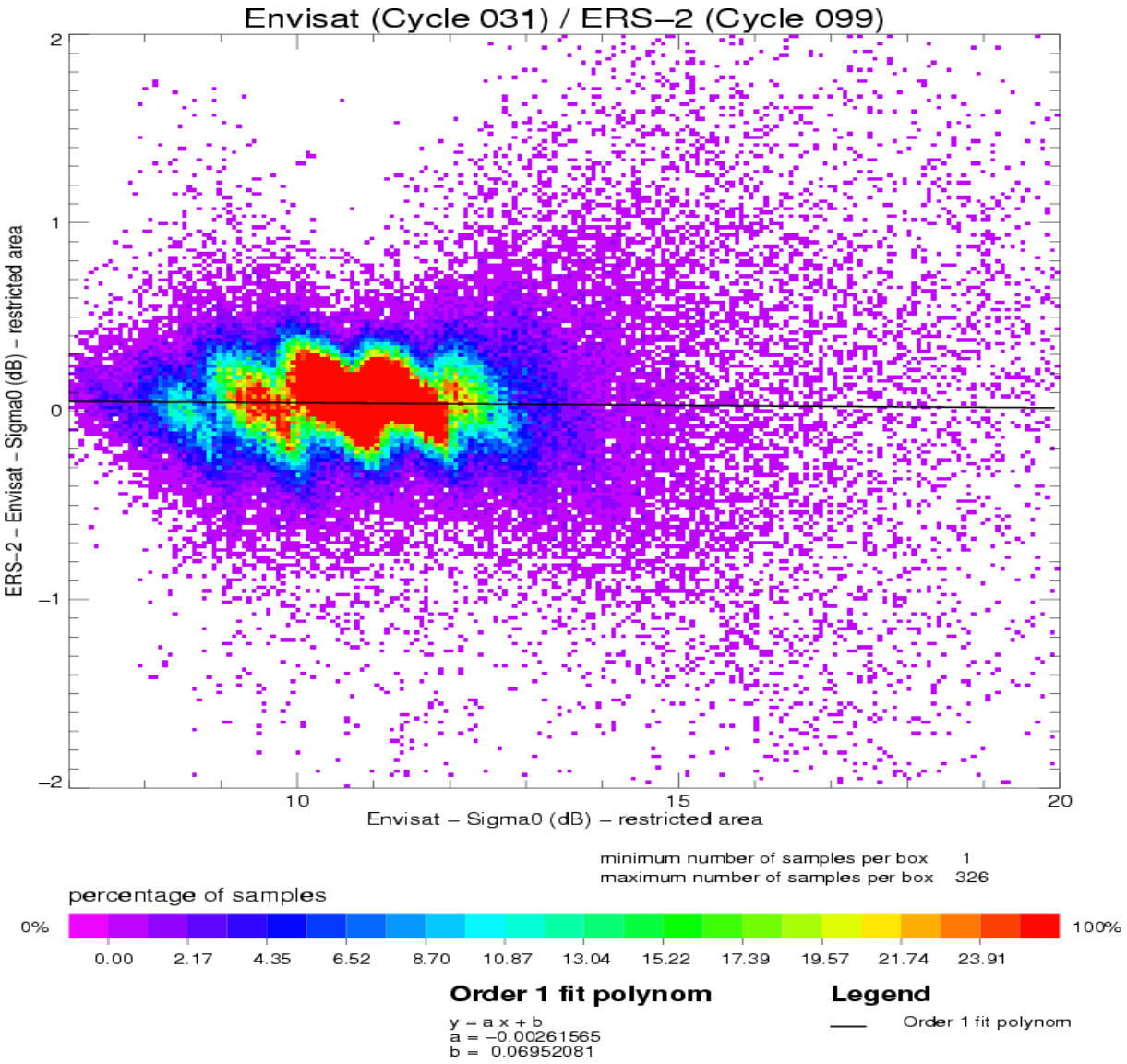


5.2 [ERS-2 - Envisat] Ku Sigma0 differences

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

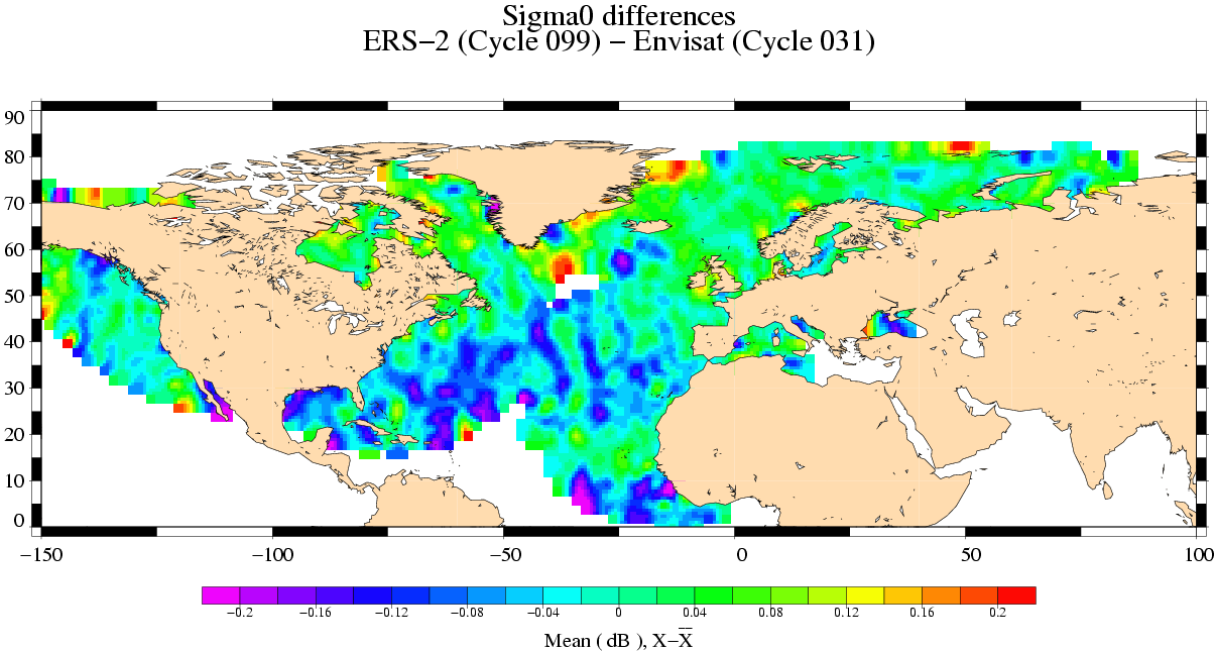
Number	Mean	Std. dev.
183487	0.04	0.30

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).

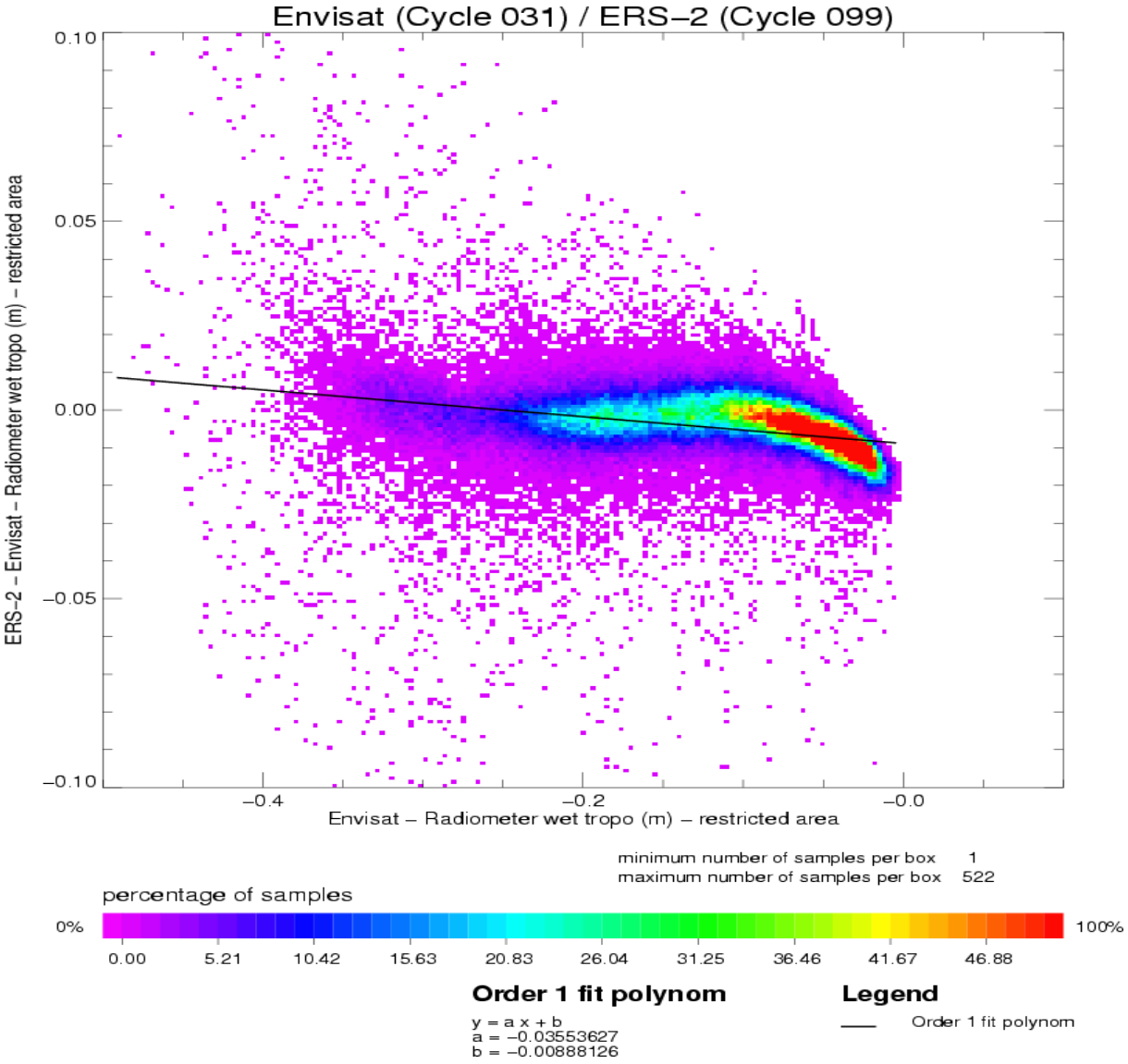


5.3 [ERS-2 - Envisat] radiometer wet troposphere correction differences

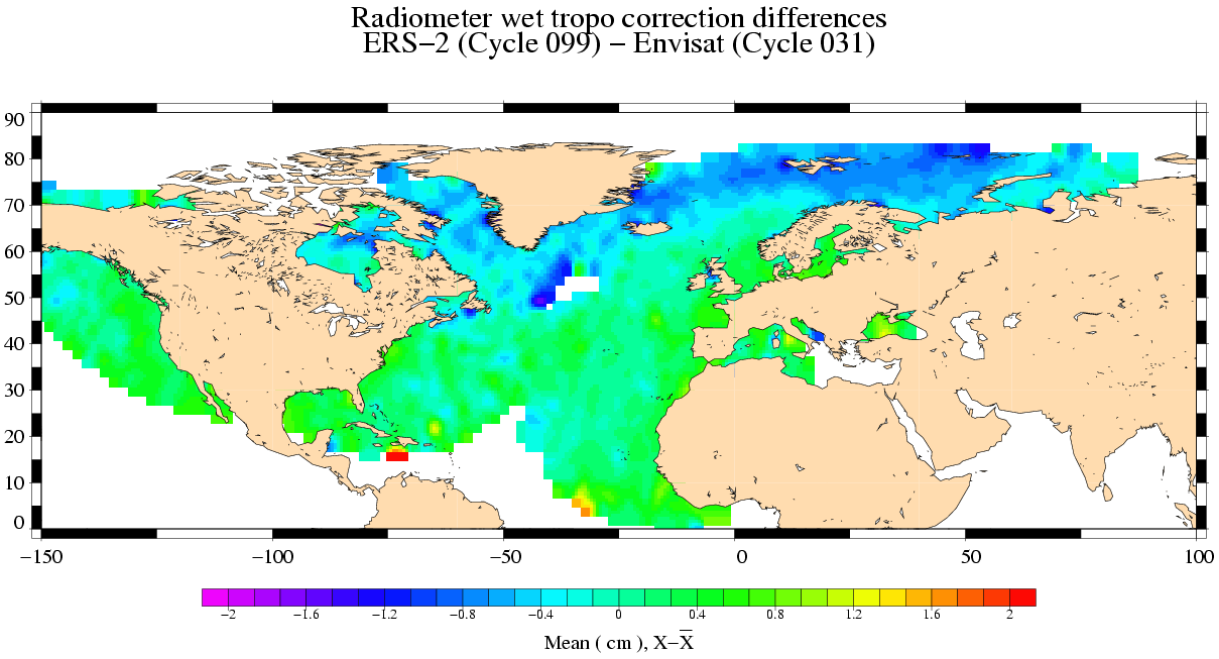
The ERS-2 radiometer correction is recomputed to correct the gain drop and the drift of the 24 GHz brightness temperature (Obligis et al., 2003).
Global statistics of [ERS-2 - Envisat] radiometer wet troposphere correction differences are (cm):

Number	Mean	Std. dev.
183487	-0.42	0.91

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).



5.4 [ERS-2 - Envisat] SSH differences

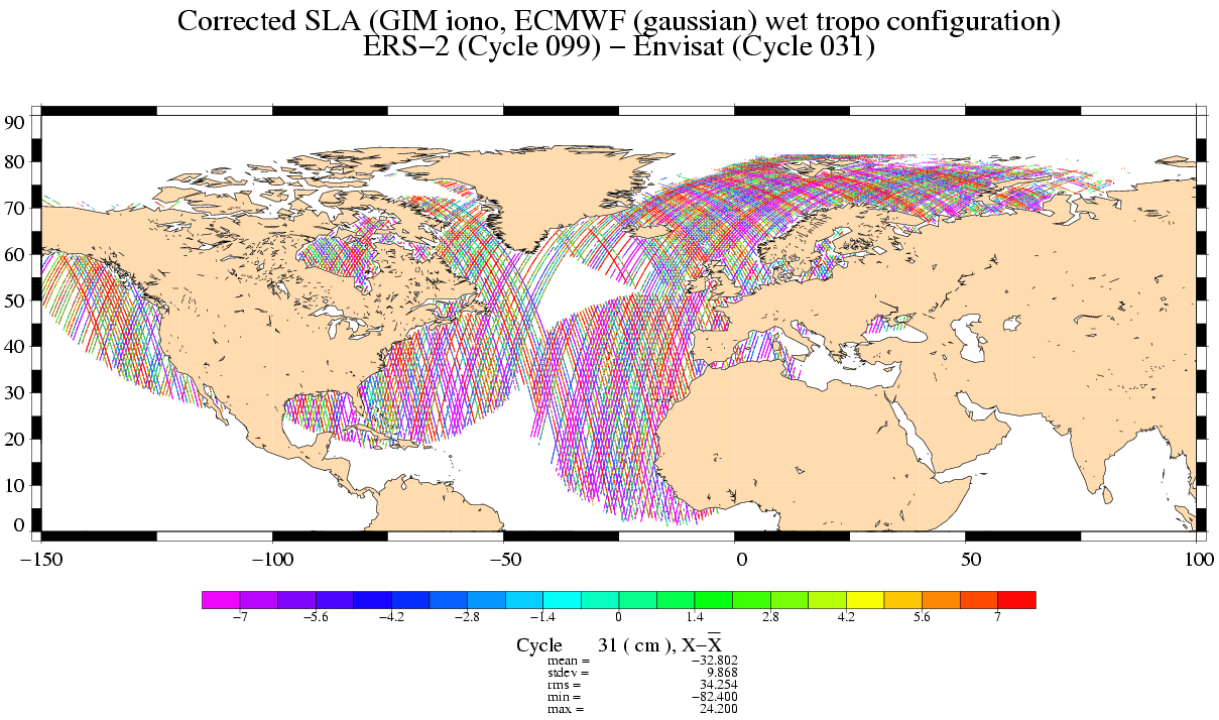
In order to compare the ERS-2 SSH with the Envisat SSH, ERS-2 GDRs have been updated with algorithms and corrections similar to Envisat:
- Range corrected from SPTR, USO, time tag bias
- ECMWF wet tropospheric correction
- Model dry tropospheric correction
- 3-parameters sea state bias
- Inverted barometer 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 098, 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.
183487	-32.80	9.86

These SSH differences are plotted on the following figure.



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

6 Particular investigations