Envisat GDR
Quality Assessment Report

Cycle 026

12-04-2004 17-05-2004

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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
Particular investigations
Cross Calibration with ERS-2

2 Cycle overview

2.1 Data and software version

This cycle has been produced with the IPF processing chain V4.56
and the CMA Reference Software V6.3_01 and V6.3_02.

The IPF V4.56 upgrades convcerning GDRs are:
- Correction of the AGC evaluation for Ku and S-band. - New IF mask Auxiliary Data File (RA2_IFF_AX)

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

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

High SSH-MSS are found on passes 30-45 (see **section 3.2**).

13 passes have no radiometer correction (see **section 3.3**).

22 passes are impacted by the S-Band anomaly (see **section 3.3**).

A portion of pass 790 have high SSH-MSS values (see **section 4**).

2.4 Platform and instrument events

RA-2 in STANDBY/REF DUE TO MCMD H202 FAILURE (2004-22-04 15:15:36 2004-22-04 17:07:05)

RA-2 Switch down to RESET/WAIT due to too many SEU's reported. (2004-05-10 02:06:31 2004-05-10 11:27:30)

Orbit Inclination Maneuver (2004/04/14 04:43:02 2004/04/14 06:55:00)

Orbit Maintenance Maneuver (2004/05/07 01:08:56 2004/05/07 03:09:04)

2.5 Cycle quality and performances

The quality of this cycle is impacted by the 14-April maneuver. After editing of degraded passes, the performances are still slightly lower than usual.

The crossover standard deviation is 8.31 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 9.8.

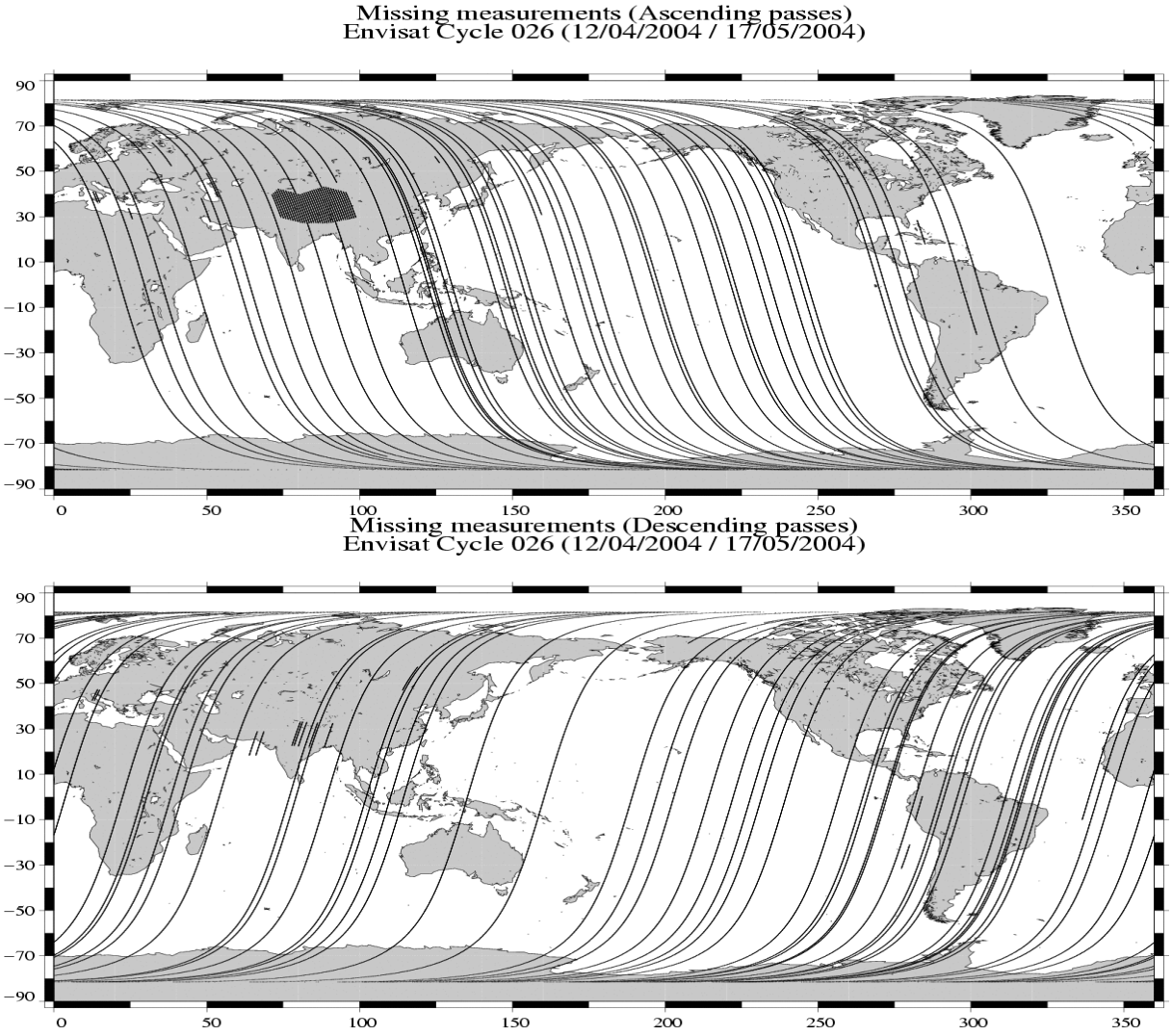
Detailed CALVAL results are presented in **section 3**.

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

2467046 are present, and 247876 (9.1%) are missing. The maps below illustrate missing 1Hz measurements in the GDRs, with respect to a 1 Hz sampling of a nominal repeat track.



1 pass (280) is missing due to "RA2 in STANDBY/REF DUE TO MCMD H202 FAILURE"
10 passes (780-789)are missing due to "RA2 instrument was Switch down to RESET/WAIT due to too many SEU's reported"
72 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 14-April-2004 a single burn out-of-plane orbit inclination maintenance manoeuvre was executed as planned.
On the 07-May-2004, a 1-burn in-plane orbit maintenance manoeuvre was executed as planned.

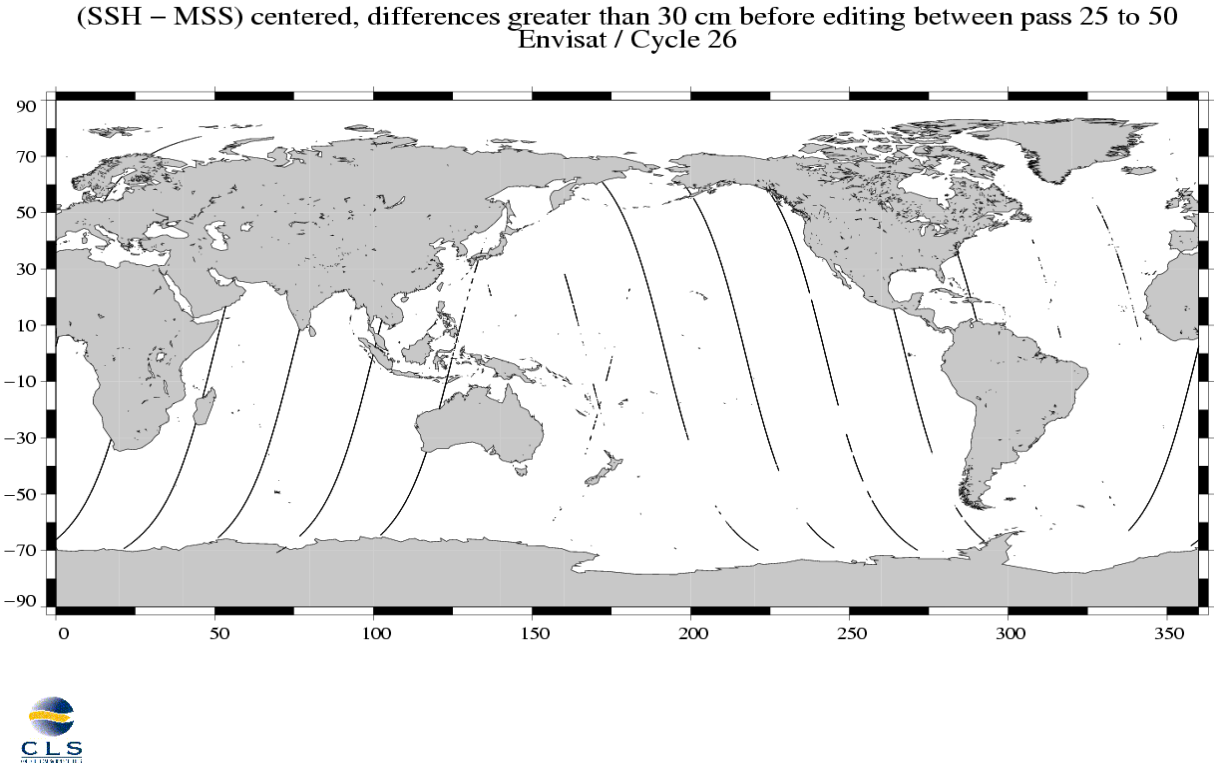
3.2.2 Doris and Laser performances

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)
12/04/2004 to 19/04/2004	35859	656	3.42980
19/04/2004 to 26/04/2004	37870	1113	1.76420
26/04/2004 to 03/05/2004	36723	1496	1.79070
03/05/2004 to 10/05/2004	36496	805	1.61490
10/05/2004 to 17/05/2004	36193	1122	1.89710

3.2.3 Impact on SLA

The SLA is impacted by the 14-April maneuver. High SSH-MSS values are found on passes 30-45. The following figure shows the edited passes .



Users are advised to remove passes 30-45 from their data set. After editing of degraded passes, the performances at crossover are still lower than usual.

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	863472	40.12
Ice flag	704051	32.71
S-Band anomaly flag	388372	18.04

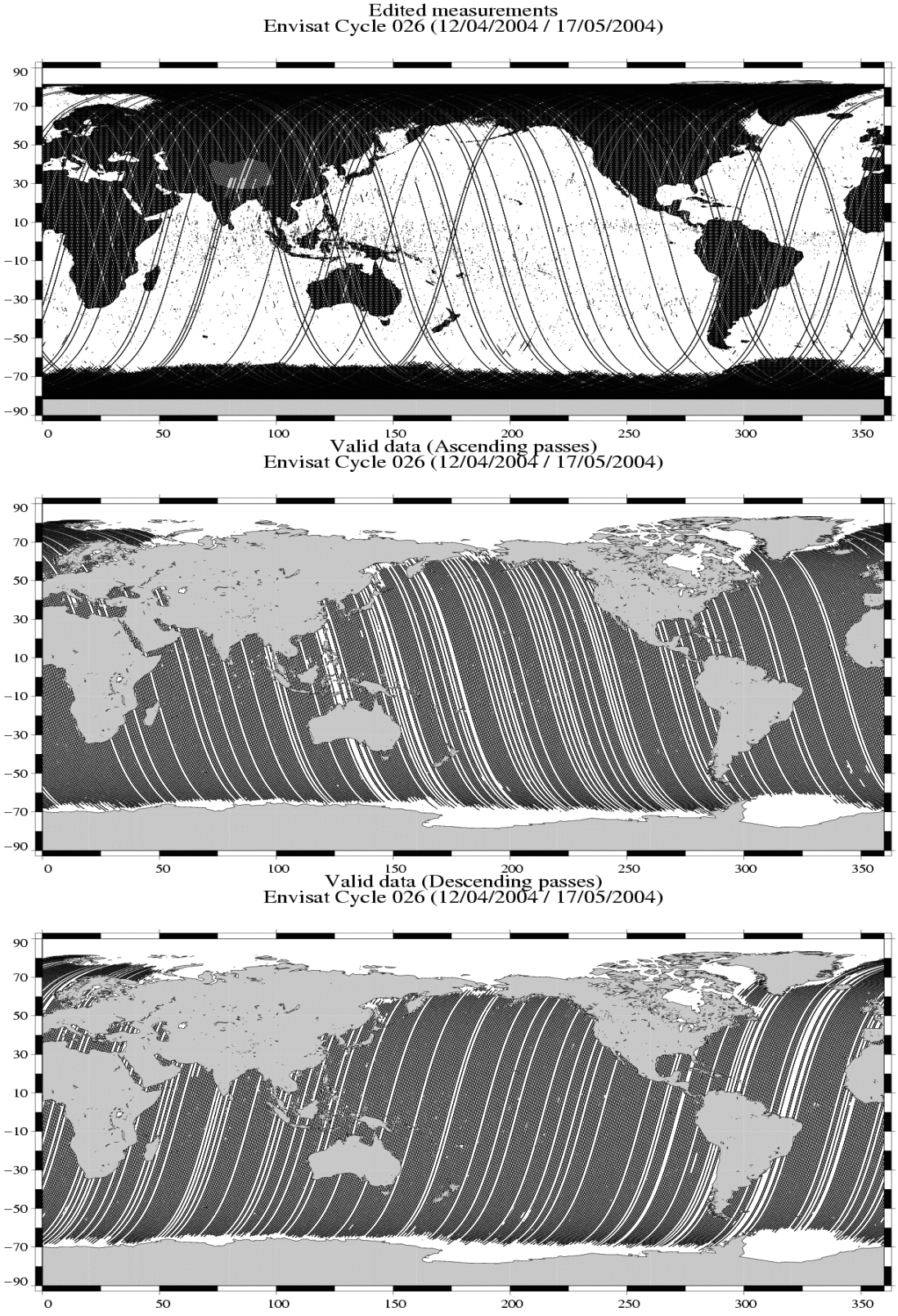
Then, measurements are edited using thresholds on several parameters. These thresholds are expected to remain constant throughout the Envisat mission, so that monitoring the number of edited measurements allows a survey of data quality.
The next table gives for each tested parameter, minimum and maximum 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	791	0.06
Variability relative to MSS (m)	-2.000	2.000	6246	0.49
Number of 18Hz valid points	10.000	-	85	0.01
Std. deviation of 18Hz range (m)	0.000	0.250	13055	1.03
Off nadir angle from waveform (deg2)	-0.200	0.160	9166	0.72
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	1603	0.13
Dual Ionospheric correction (m)	-0.400	0.040	2822	0.22
Significant wave height (m)	0.000	11.000	1217	0.10
Sea state Bias (m)	-0.500	0.000	1936	0.15
Backscatter coefficient (dB)	7.000	30.000	2045	0.16
GOT00 ocean tide height (m)	-5.000	5.000	966	0.08
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 430 (0.03 %) measurements.

3.3.2 Figures

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



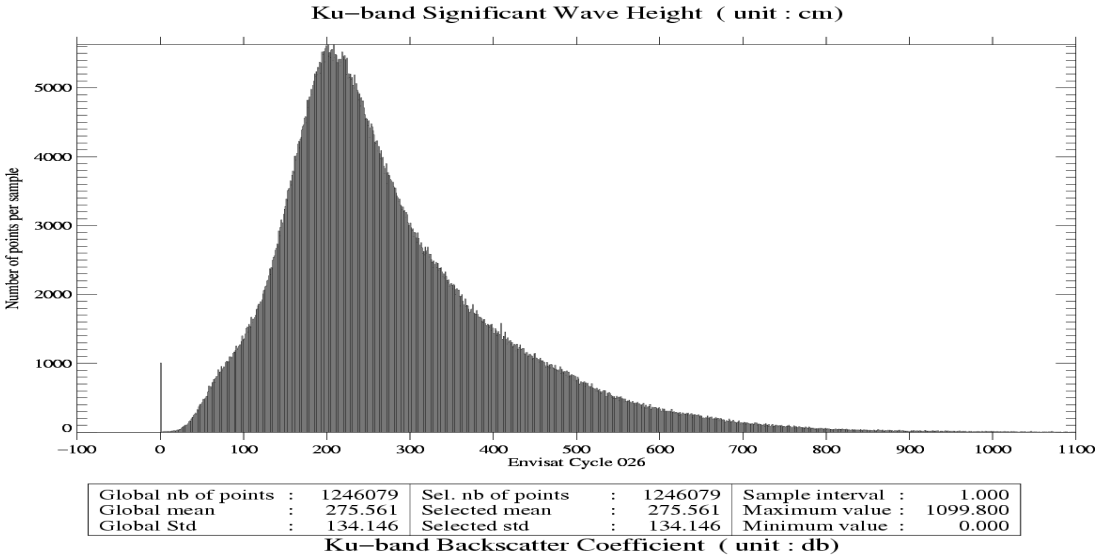
3.3.3 Comments

919 passes have been delivered. Among these passes:
- 13 passe are entirely edited on the radiometer land flag (no MWR correction)
- 22 passes (412-416, 526-537, 902-909) 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.

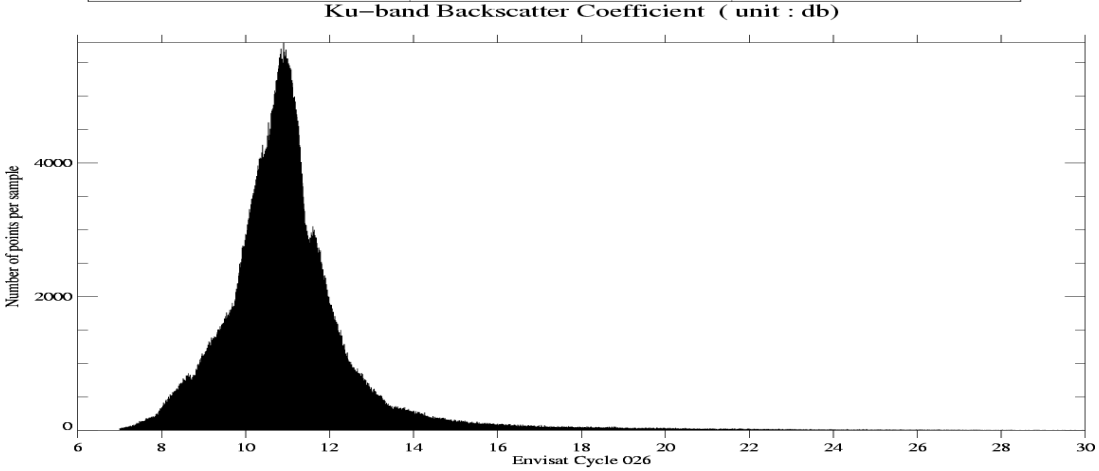
Wet areas appear in the plot of removed data. Similar features are observed with other altimeters (T/P, Jason) mainly due to rain comtamination.

3.4 Altimeter parameters

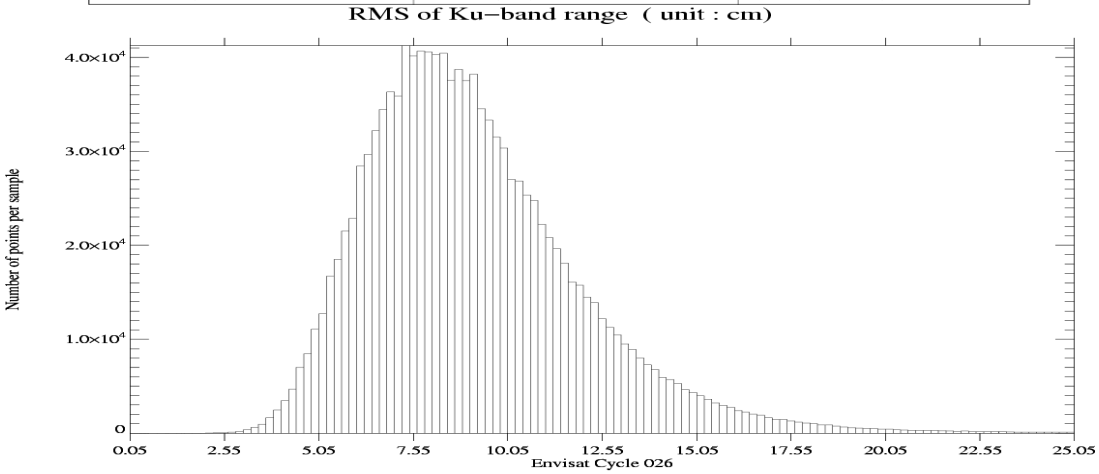
In order to assess and to monitor altimeter parameter measurements, histograms of Envisat Ku-band Significant Wave Height (SWH), Backscatter coefficient (Sigma0) and RMS of altimeter range are computed.



Global nb of points	:	1246079	Sel. nb of points	:	1246079	Sample interval	: 1.000
Global mean	:	275.561	Selected mean	:	275.561	Maximum value	: 1099.800
Global Std	:	134.146	Selected std	:	134.146	Minimum value	: 0.000



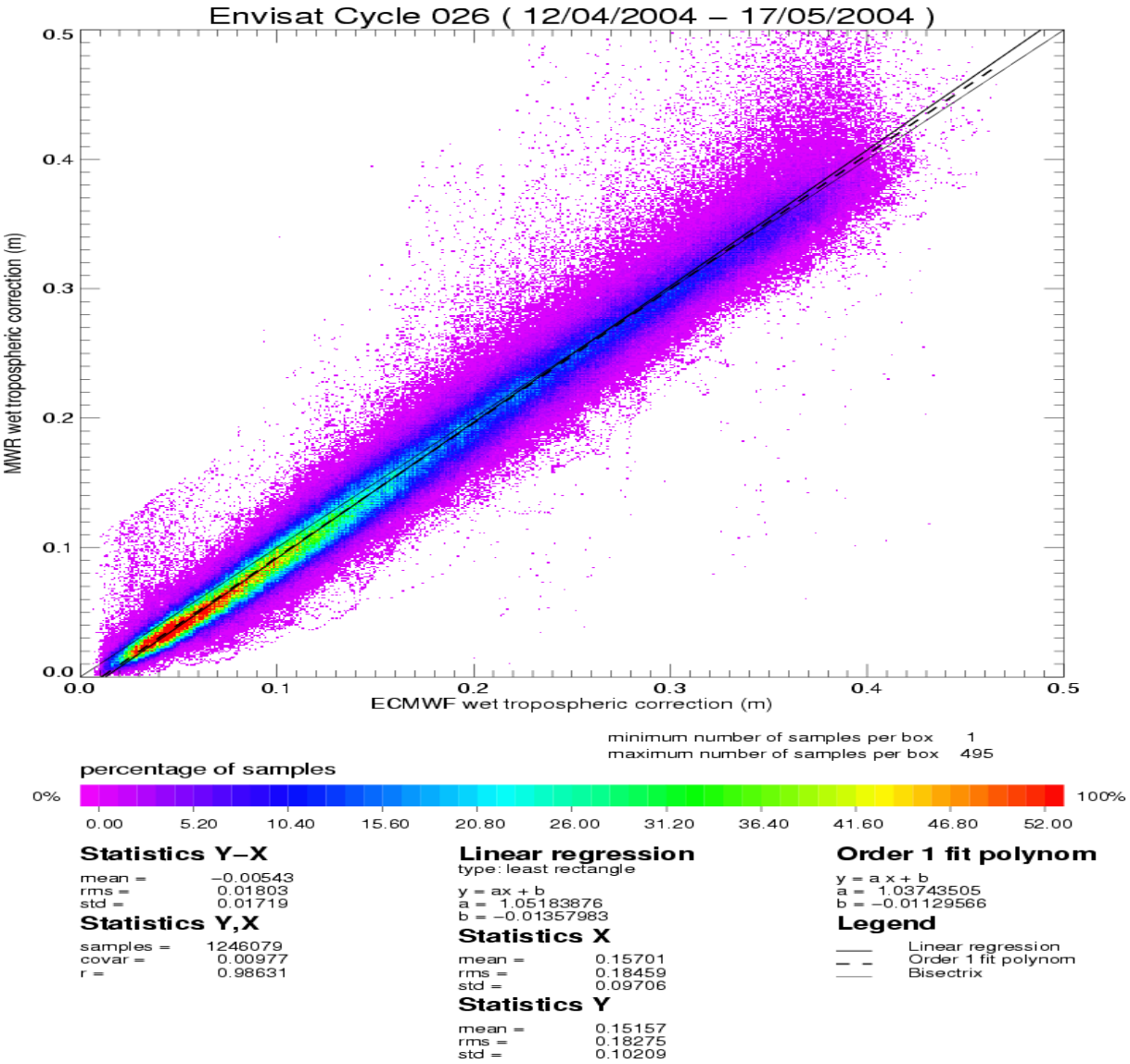
Global nb of points	:	1246079	Sel. nb of points	:	1246079	Sample interval	: 0.010
Global mean	:	11.043	Selected mean	:	11.043	Maximum value	: 29.980
Global Std	:	1.773	Selected std	:	1.773	Minimum value	: 7.000



Global nb of points	:	1246079	Sel. nb of points	:	1246079	Sample interval	: 0.200
Global mean	:	9.136	Selected mean	:	9.136	Maximum value	: 25.000
Global Std	:	2.828	Selected std	:	2.828	Minimum value	: 1.600

3.5 Radiometer

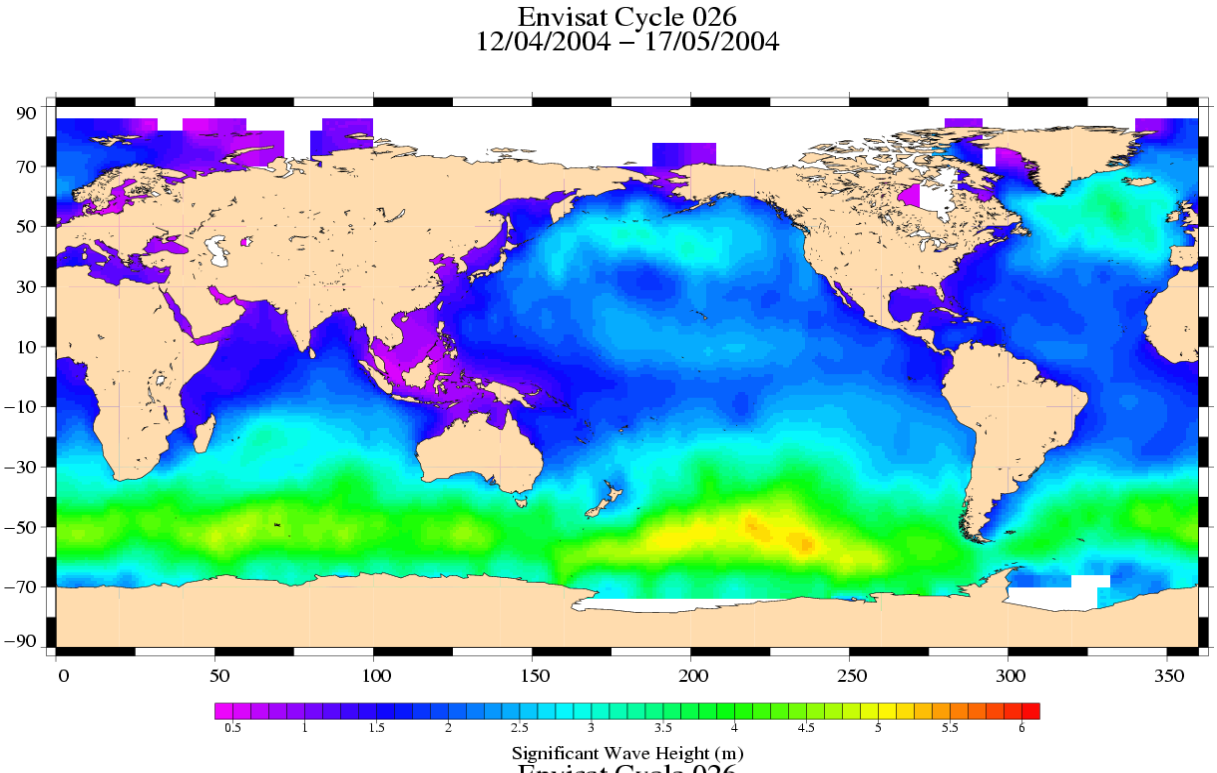
In order to assess and to monitor radiometer measurements, a scatter plot between the radiometer wet troposphere correction and the ECMWF model is computed for the valid data set previously defined.

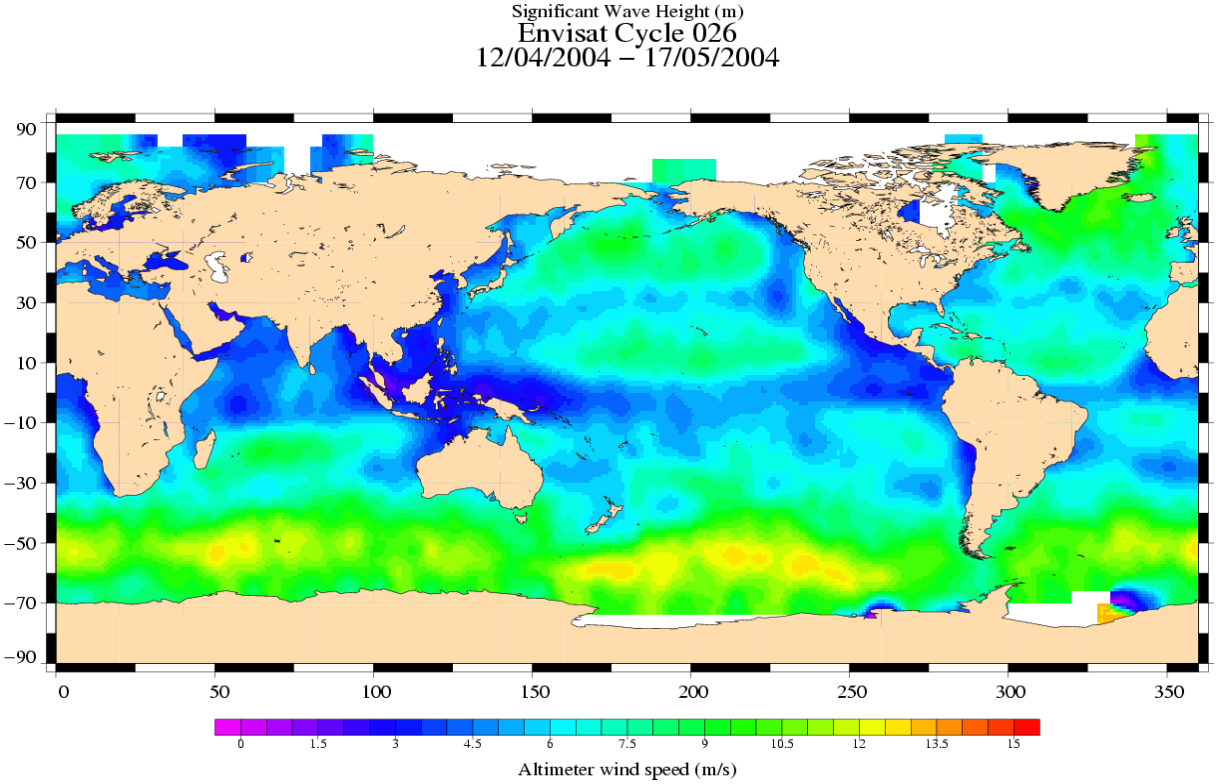


The radiometer-model mean difference is 0.5 cm. A drift on the Envisat 23.8GHz brightness temperature has been detected and has to be monitored on the long term. Note that the neural algorithm is now implemented on Envisat.

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

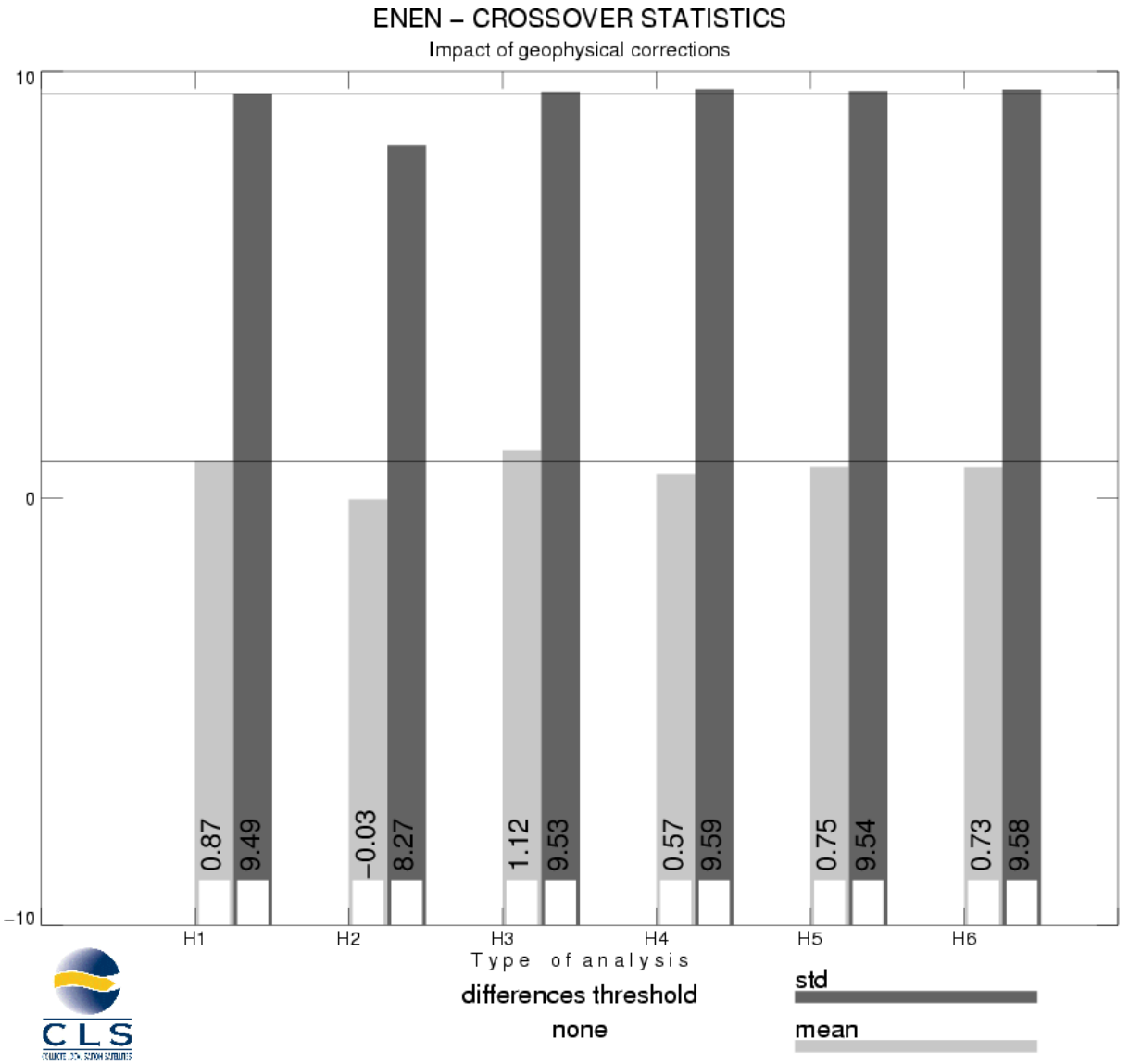
3.7.1 General comment

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 9.49 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 8.31 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).



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)

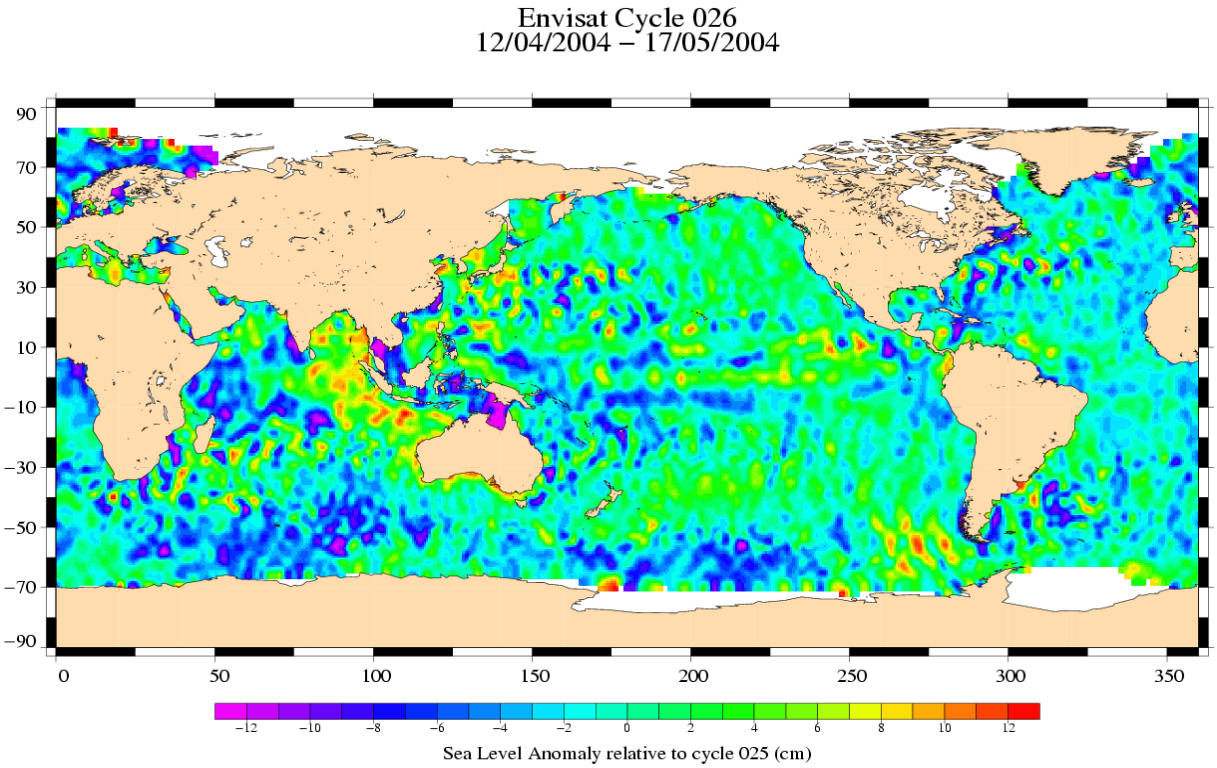
H5 = SSH with FES02 tide model (in product)

H6 = SSH with ECMWF wet tropospheric correction (in product)

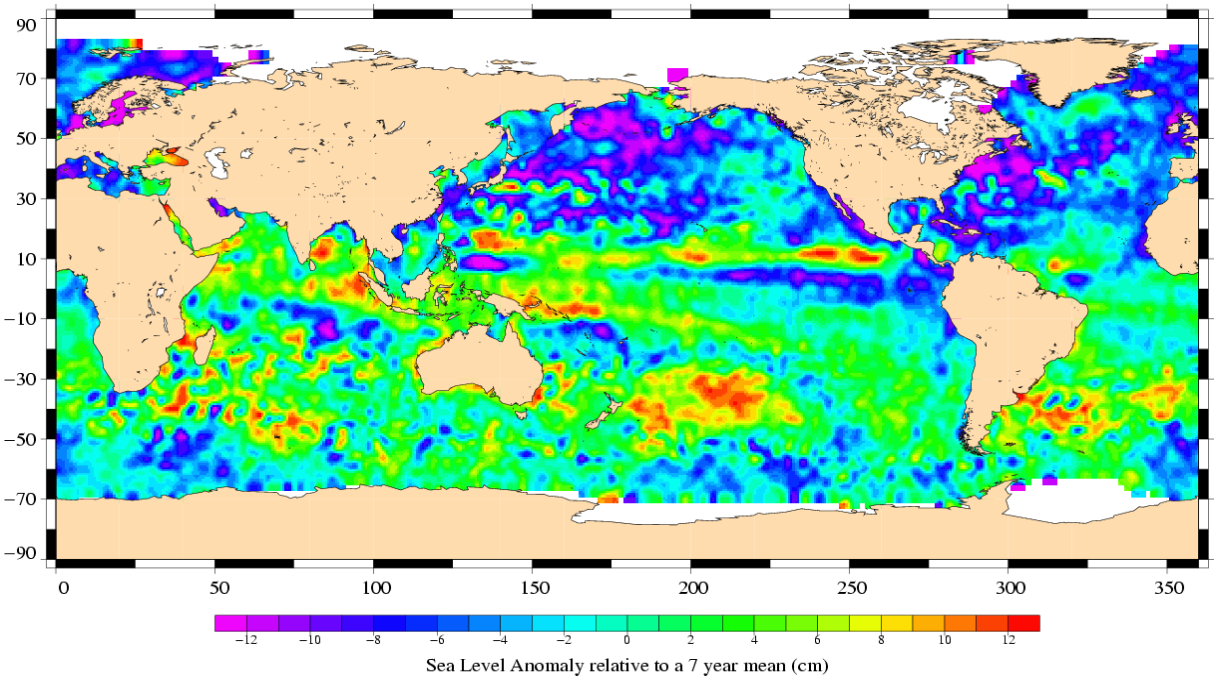
3.8 SSH variability

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.



Envisat Cycle 026
12/04/2004 – 17/05/2004



3.8.2 Comparison to a precise Mean Sea Surface

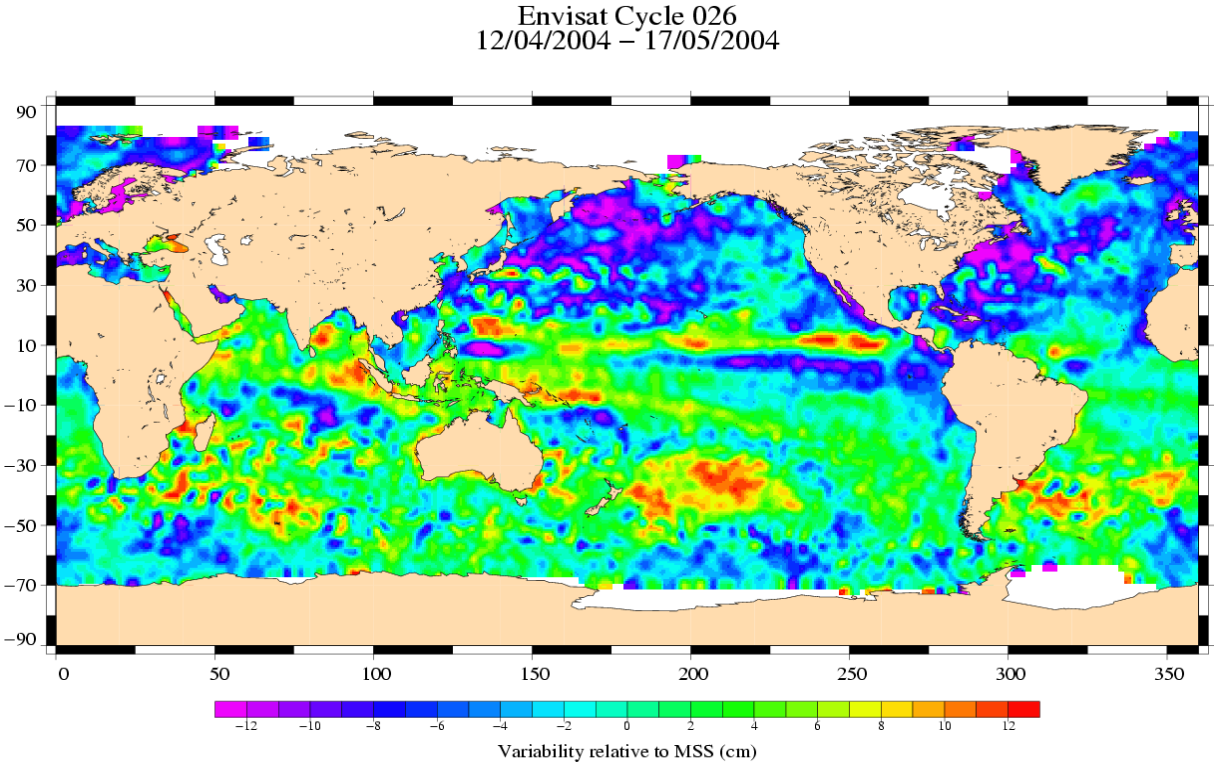
The MSS from the product is used as a reference to compute SLA. Global statistics of Envisat SSH-MSS are (cm):

Number	Mean	Std. dev.
1397370	43.24	10.74

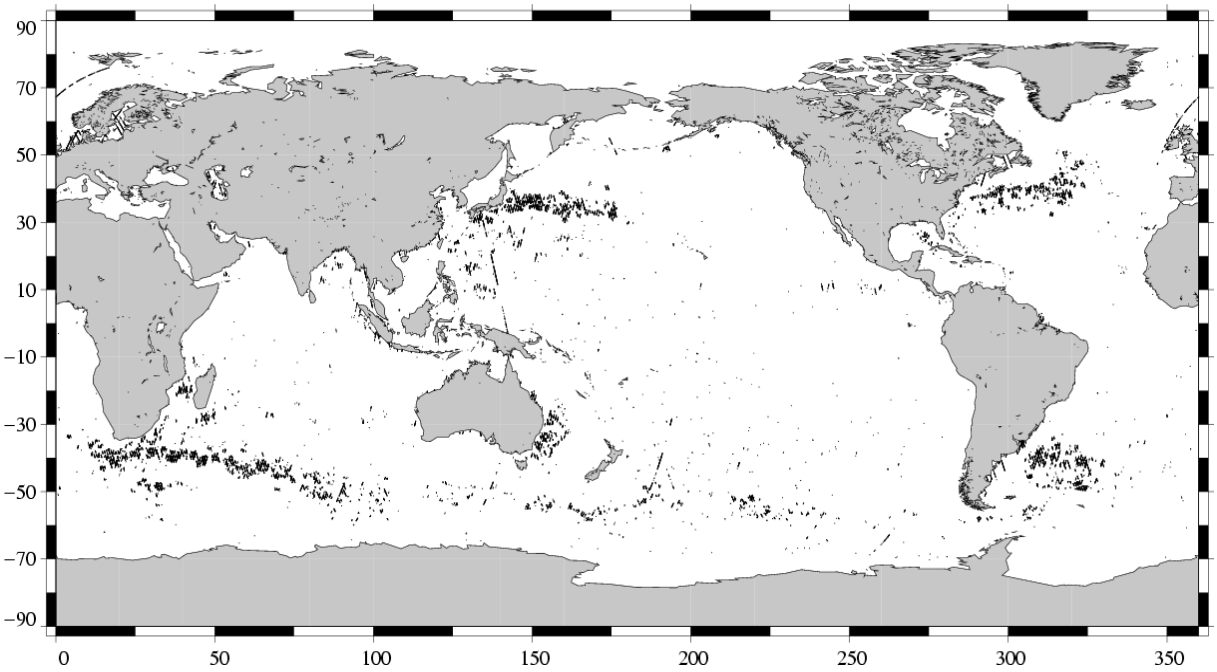
When using a selection to remove shallow waters (1000 m), areas of high ocean variability and high latitudes ($> |50|$ deg) statistics are:

Number	Mean	Std. dev.
852287	43.92	9.76

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.



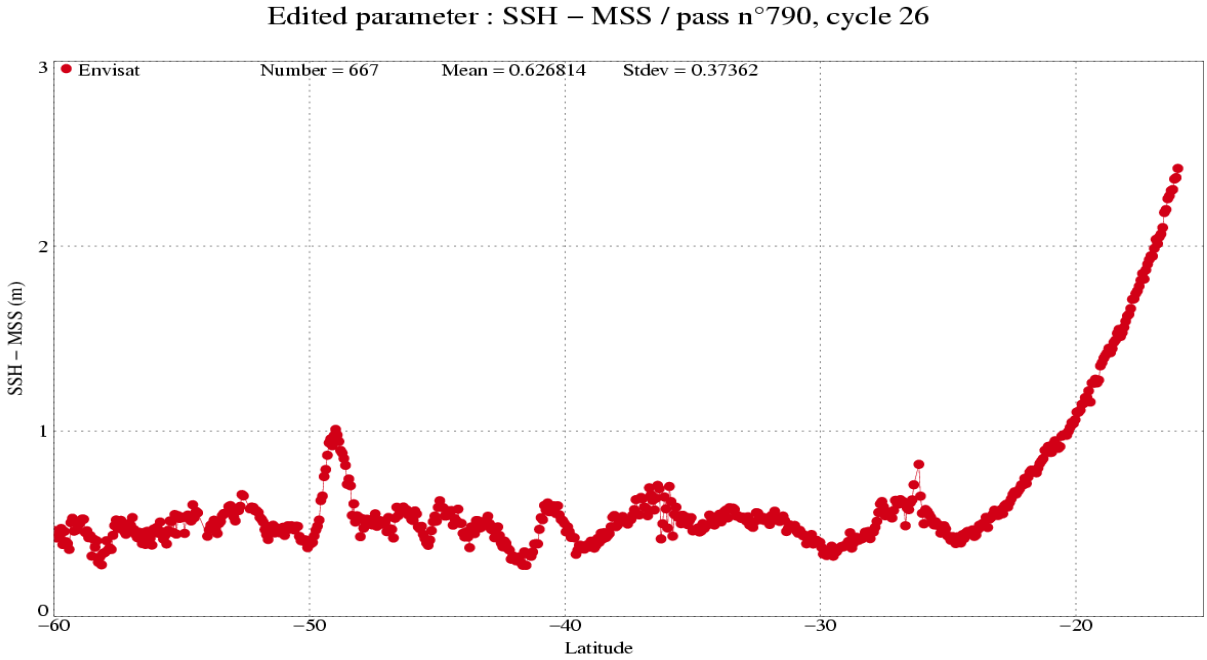
(SSH − MSS) centered, differences greater than 30 cm
Envisat / Cycle 026



4 Particular investigations

4.1 High SSH-MSS on pass 790

High SSH-MSS values are found on pass 790 between 30S and 10S. The following figure shows SSH-MSS on this pass.



Note that the anomalous measurements occur just after an RA-2 unavailability. The stability of the USO clock after anomaly is suspected. Users are advised to use these data with care.

5 Cross Calibration with ERS-2

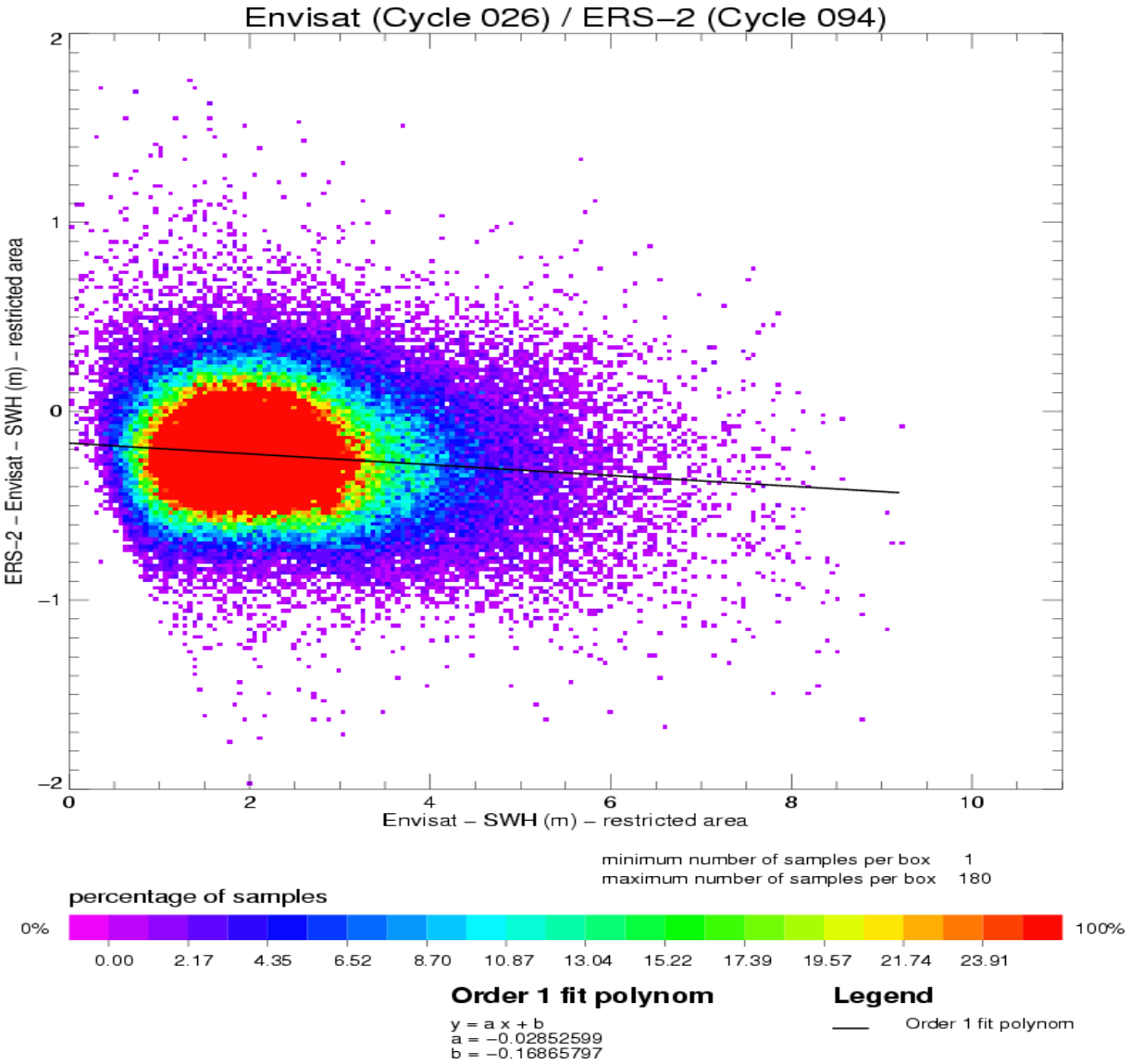
Envisat flies on the same ground track as ERS-2, 30 minutes ahead. This section presents results that illustrate the difference with ERS-2.
A failure of the ERS-2 tape recorder occured on 22 June 2003. The ERS-2 Low Rate mission continues within the visibility of ESA ground stations over Europe: North Atlantic, Arctic and western North America. Nevertheless, cross calibration with ERS-2 can be performed on this zone. Envisat cycle 026 data are collocated to data from ERS-2 GDR cycle 093 in order to compare the main parameters from repeat-track analysis.

5.1 [ERS-2 - Envisat] Ku SWH differences

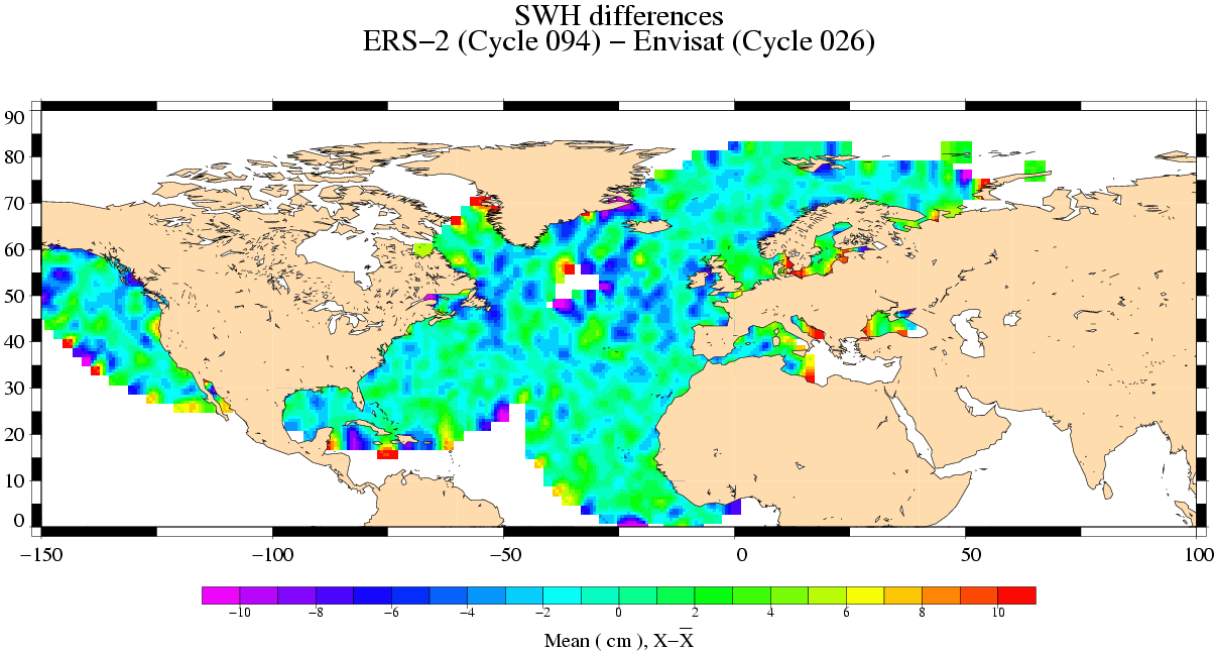
Global statistics of [ERS-2 - Envisat] Ku SWH differences are (cm):

Number	Mean	Std. dev.
161218	-22.32	24.95

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


Envisat (Cycle 026) / ERS–2 (Cycle 094)
ERS–2 – Envisat – SWH (m) – restricted area
Envisat – SWH (m) – restricted area
minimum number of samples per box 1
maximum number of samples per box 180
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 = –0.02852599
b = –0.16865797
Legend
Order 1 fit polynom

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

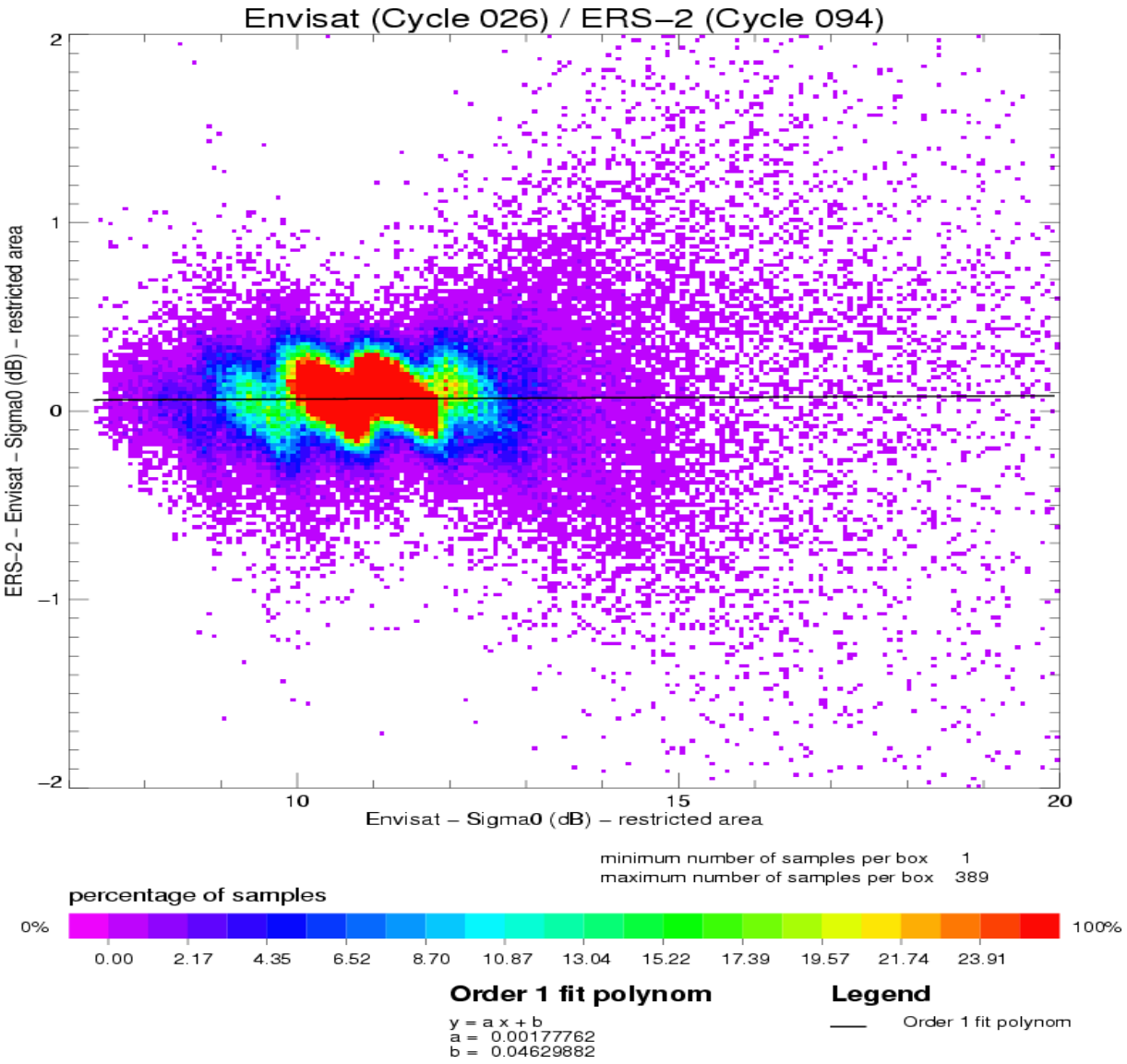


5.2 [ERS-2 - Envisat] Ku Sigma0 differences

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

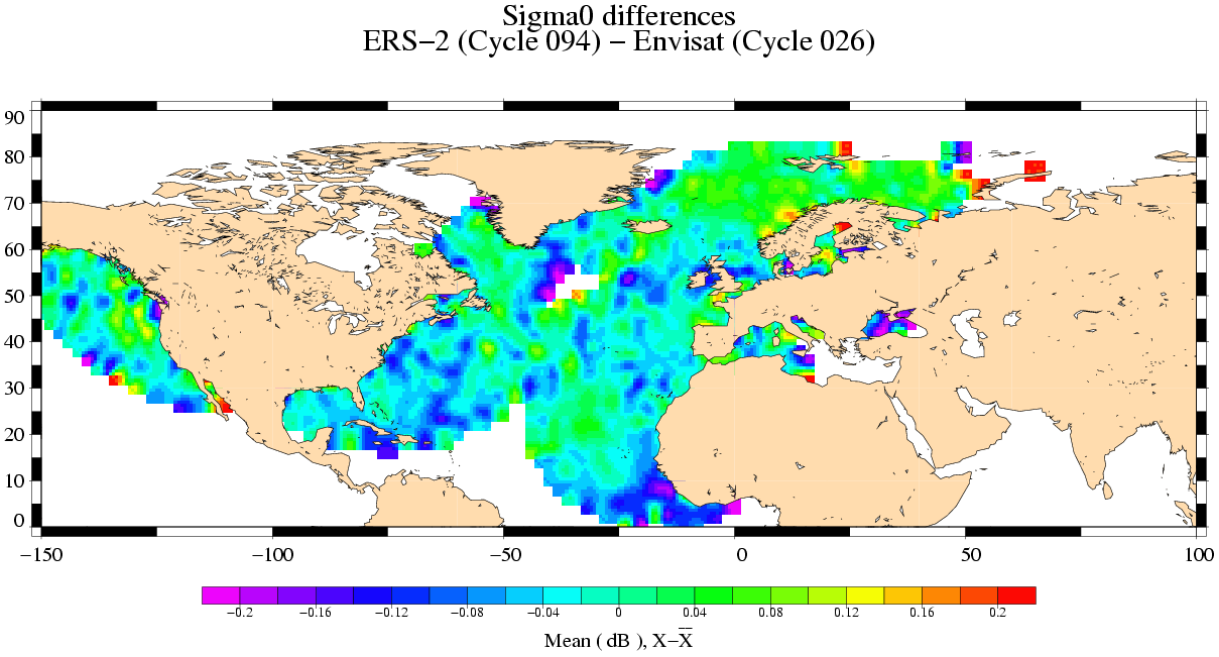
Number	Mean	Std. dev.
161218	0.07	0.26

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).

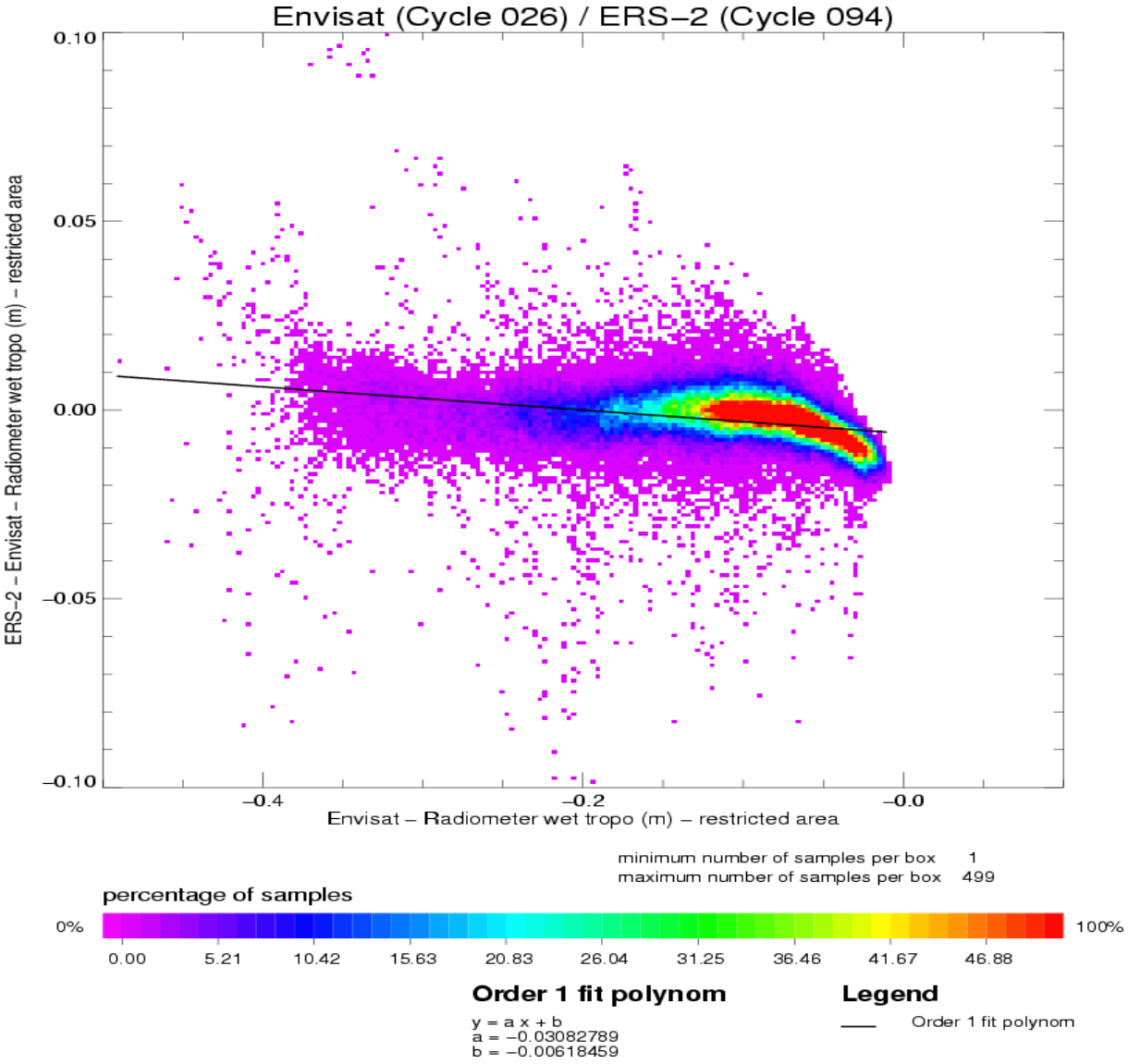


5.3 [ERS-2 - Envisat] radiometer wet troposphere correction differences

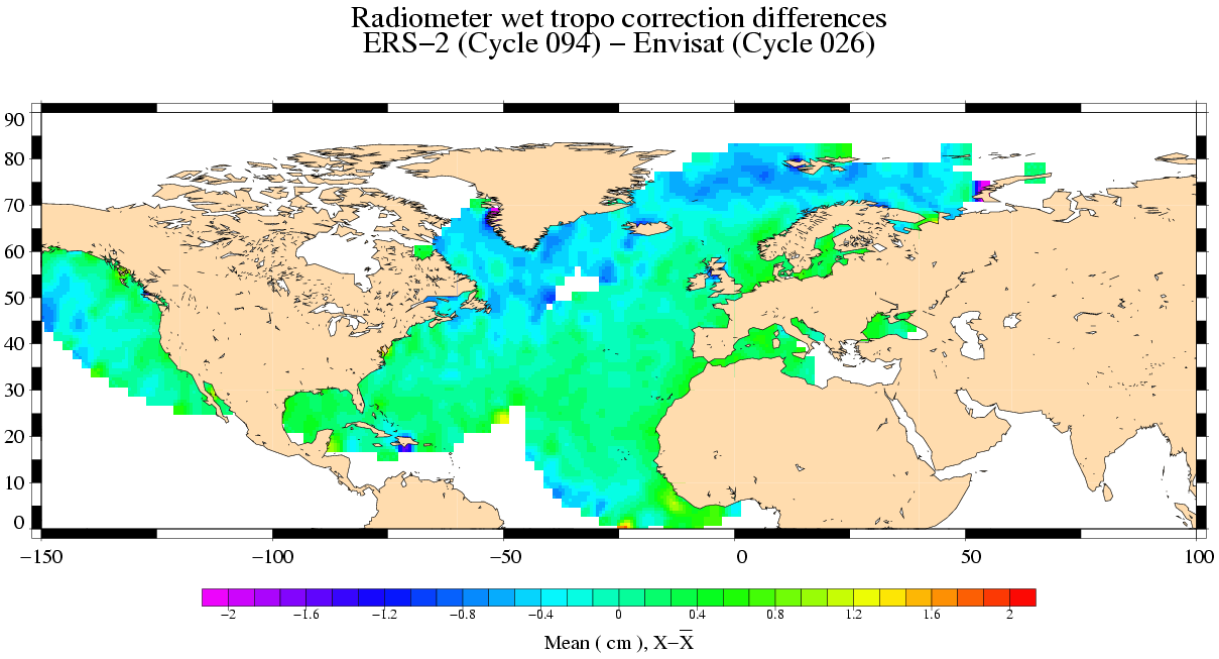
The ERS-2 radiometer correction is recomputed to correct the gain drop and the drift of the 24 GHz brightness temperature (Obligis et al., 2003).
Global statistics of [ERS-2 - Envisat] radiometer wet troposphere correction differences are (cm):

Number	Mean	Std. dev.
161218	-0.23	0.65

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

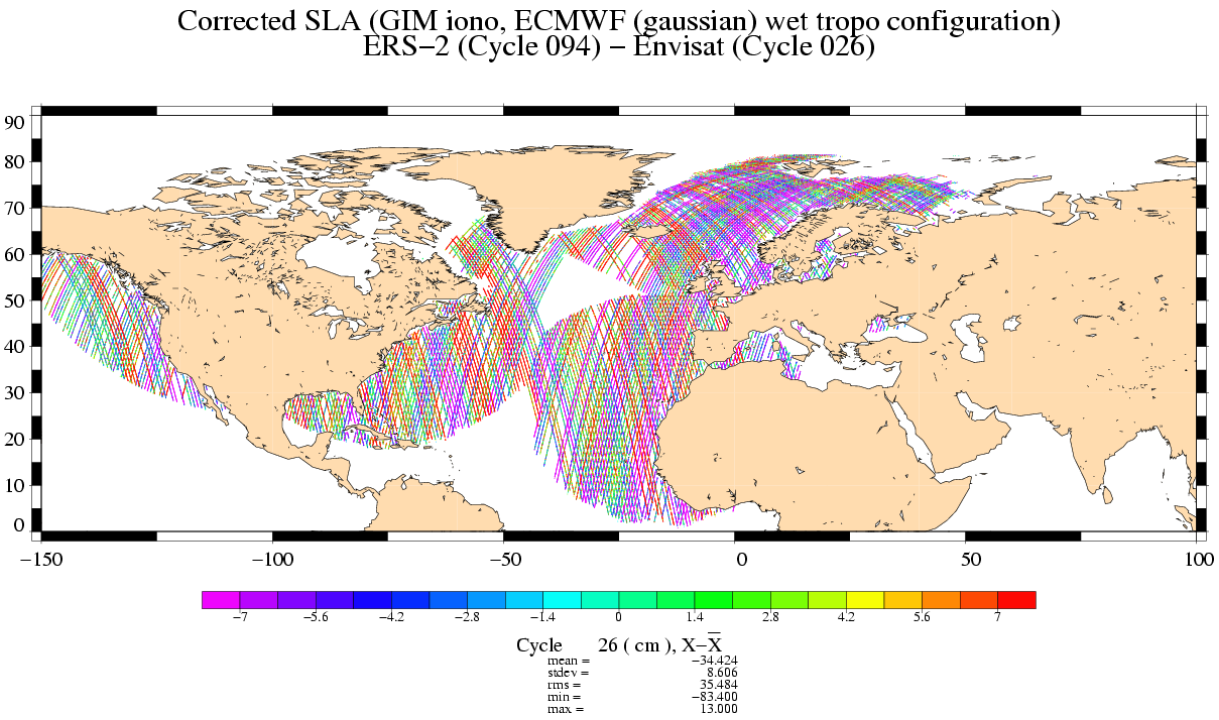
In order to compare the ERS-2 SSH with the Envisat SSH, ERS-2 GDRs have been updated with algorithms and corrections similar to Envisat:
- Range corrected from SPTR, USO, time tag bias
- ECMWF wet tropospheric correction
- Model dry tropospheric correction
- 3-parameters sea state bias
- Inverted barometer 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 093, 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.
161218	-34.42	8.60

These SSH differences are plotted on the following figure.



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