Envisat GDR
Quality Assessment Report

Cycle 017

02-06-2003 07-07-2003

Prepared by :	Y. Faugere, CLS	
	F. Mertz, CLS	
	J. Dorandeu, CLS	
Accepted by :	J. Dorandeu, CLS	
Approved by :	N. Picot, CNES	

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

    Cross Calibration with ERS-2

2 Cycle overview

2.1 Data and software version

This cycle has been produced with the IPF processing chain V4.54 and the CMA Reference Software V6.1_01.

The following algorithms have been implemented in this version:
- Neural MWR algorithm
- CLS01.1 Mean Sea Surface
- GOT2000 and FES2002 tide models
- Non parametric Sea State Bias
- DORIS ionospheric correction

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

As mentionned by J. Benveniste (internet communication, 9 nov 2002) an anomaly occasionally occurs on the S-Band. Consequently the Dual Frequency ionosphere correction is not available during these periods. 14 passes are impacted by the S-Band anomaly (see **section 3.2**).

2.4 Platform and instrument events

Orbit Maintenance Maneuver (from 2003/06/07 01:08:16 to 2003/06/07 03:08:23 TAI).

2.5 Cycle quality and performances

Good general results are obtained for this cycle of data.
The crossover standard deviation is 7.55 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 10.4 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.

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.
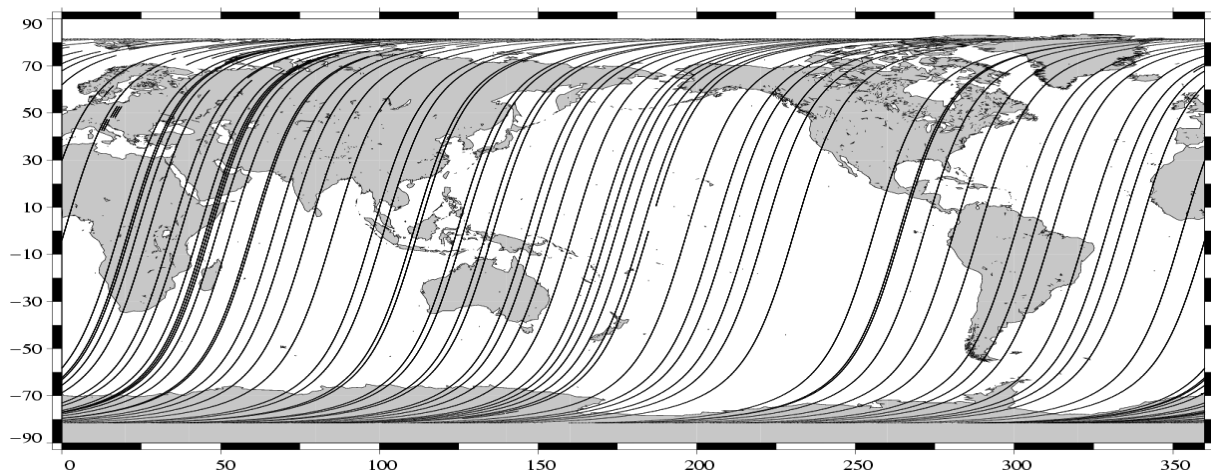
3.1 Missing measurements

2388235 are present, and 326615 (12.0%) 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 017 (02/06/2003 / 07/07/2003)
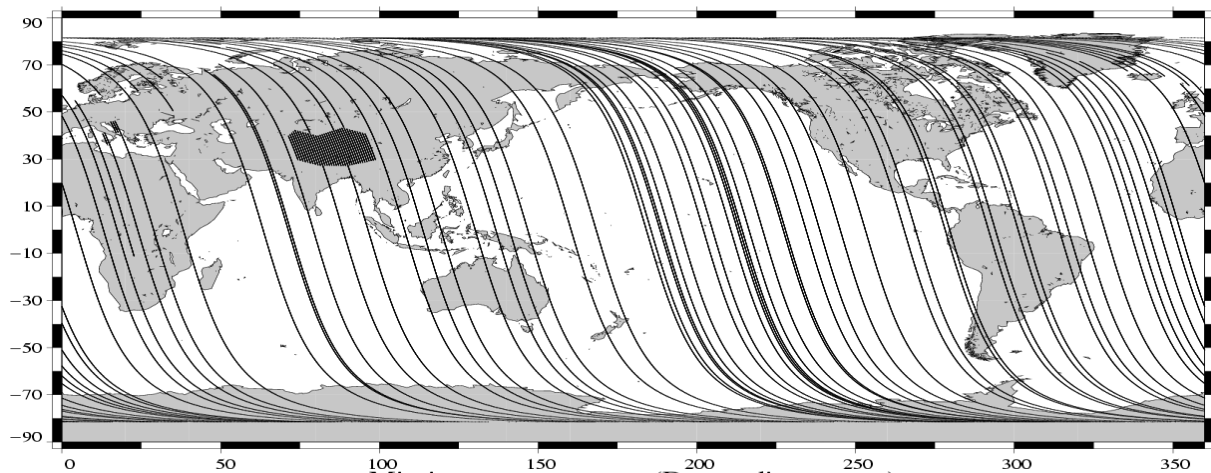
Missing measurements (Descending passes)
Envisat Cycle 017 (02/06/2003 / 07/07/2003)

79 passes are missing all due to level1 B data unavailability.

3.2 Edited measurements

3.2.1 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	1048984	49.74
Ice flag	692700	32.85
S-Band anomaly flag	389628	18.48

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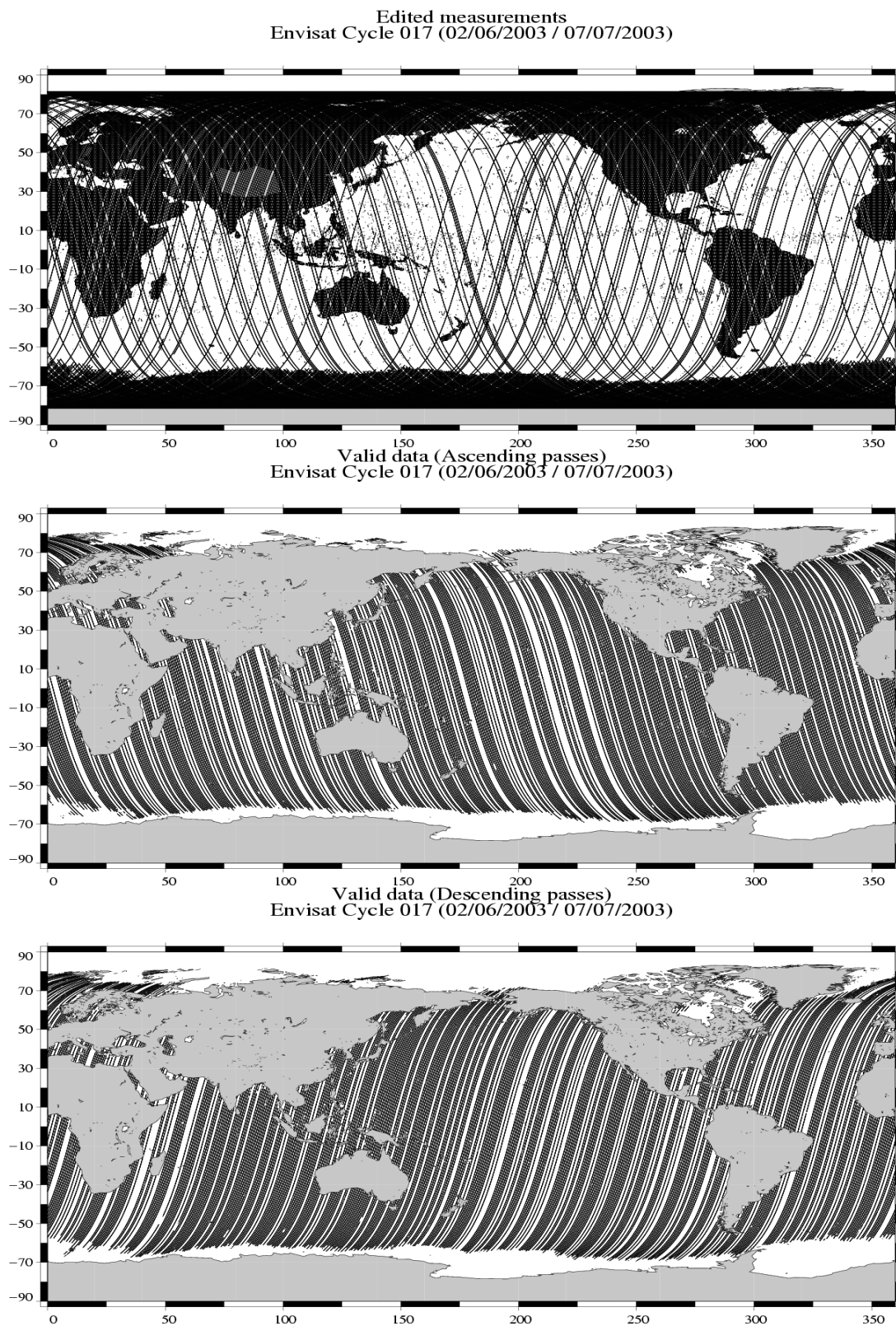
The next table gives for each tested parameter, minimum and maximum thresholds, the number and the percentage of points removed.

Parameters	Min Thres.	Max Thres.	Nb rejected	% rejected
Sea surface height (m)	-130.000	100.000	747	0.07
Variability relative to MSS (m)	-2.000	2.000	3589	0.34
Number of 18Hz valid points	10.000	-	89	0.01
Std. deviation of 18Hz range (m)	0.000	0.250	11927	1.14
Off nadir angle from waveform (deg2)	-0.200	0.160	8083	0.78
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	1208	0.12
Dual Ionospheric correction (m)	-0.400	0.040	1338	0.13
Significant wave height (m)	0.000	11.000	707	0.07
Sea state Bias (m)	-0.500	0.000	1937	0.19
Backscatter coefficient (dB)	7.000	30.000	1197	0.11
GOT00 ocean tide height (m)	-5.000	5.000	964	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 394 (0.04 %) measurements.

3.2.2 Figures

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

Edited measurements
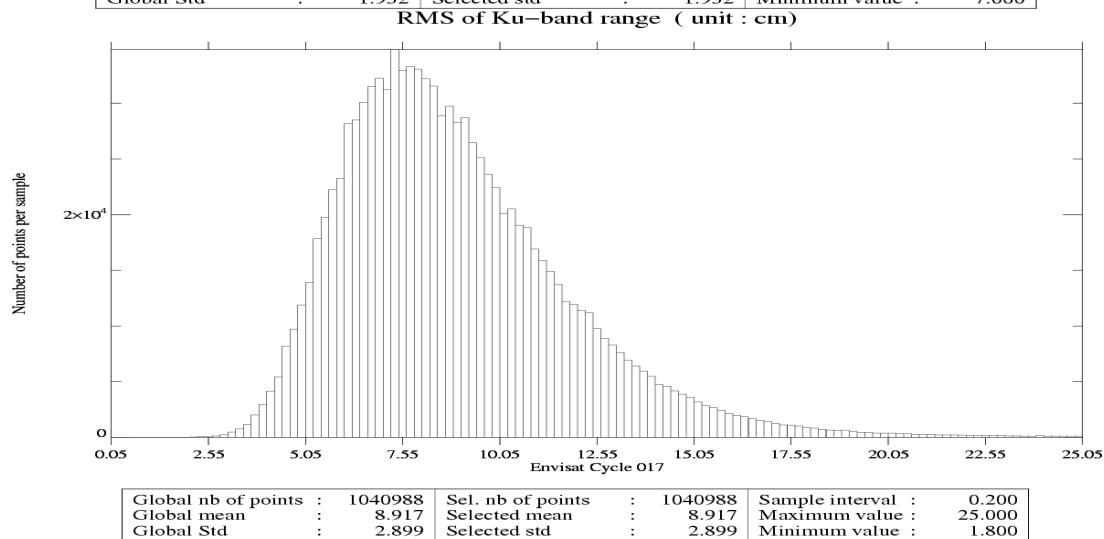Envisat Cycle 017 (02/06/2003 / 07/07/2003)

Valid data (Ascending passes)
Envisat Cycle 017 (02/06/2003 / 07/07/2003)

Valid data (Descending passes)
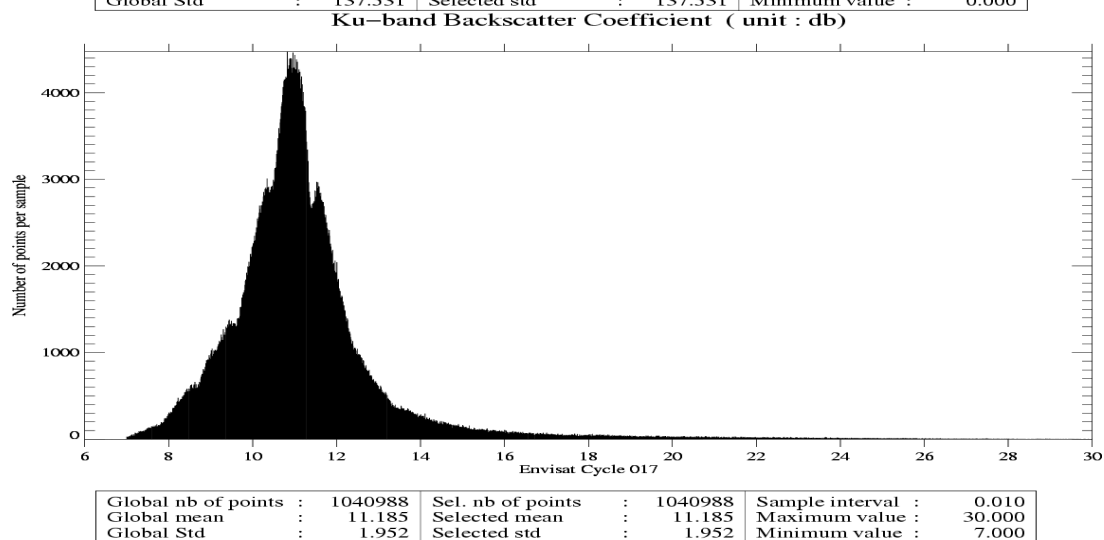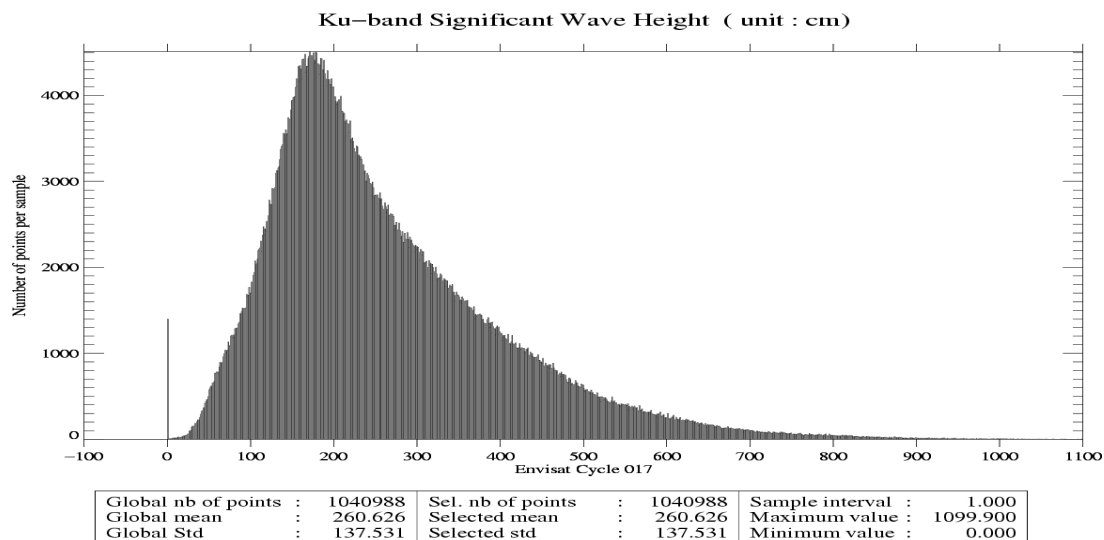Envisat Cycle 017 (02/06/2003 / 07/07/2003)

3.2.3 Comments

923 passes have been delivered. Among these passes:
- 128 passes are entirely edited on the radiometer land flag (no MWR correction)
- 14 passes (273 to 279, 422 to 424, 864 to 867) 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 altimetre (T/P, Jason) mainly due to rain comtamination.

3.3 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.

Ku-band Significant Wave Height (unit : cm)

Envisat Cycle 017

Global nb of points	:	1040988	Sel. nb of points	:	1040988	Sample interval	:	1.000
Global mean	:	260.626	Selected mean	:	260.626	Maximum value	:	1099.900
Global Std	:	137.531	Selected std	:	137.531	Minimum value	:	0.000

Ku-band Backscatter Coefficient (unit : db)

Envisat Cycle 017

Global nb of points	:	1040988	Sel. nb of points	:	1040988	Sample interval	:	0.010
Global mean	:	11.185	Selected mean	:	11.185	Maximum value	:	30.000
Global Std	:	1.952	Selected std	:	1.952	Minimum value	:	7.000

RMS of Ku-band range (unit : cm)

Envisat Cycle 017

Global nb of points	:	1040988	Sel. nb of points	:	1040988	Sample interval	:	0.200
Global mean	:	8.917	Selected mean	:	8.917	Maximum value	:	25.000
Global Std	:	2.899	Selected std	:	2.899	Minimum value	:	1.800

3.4 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.
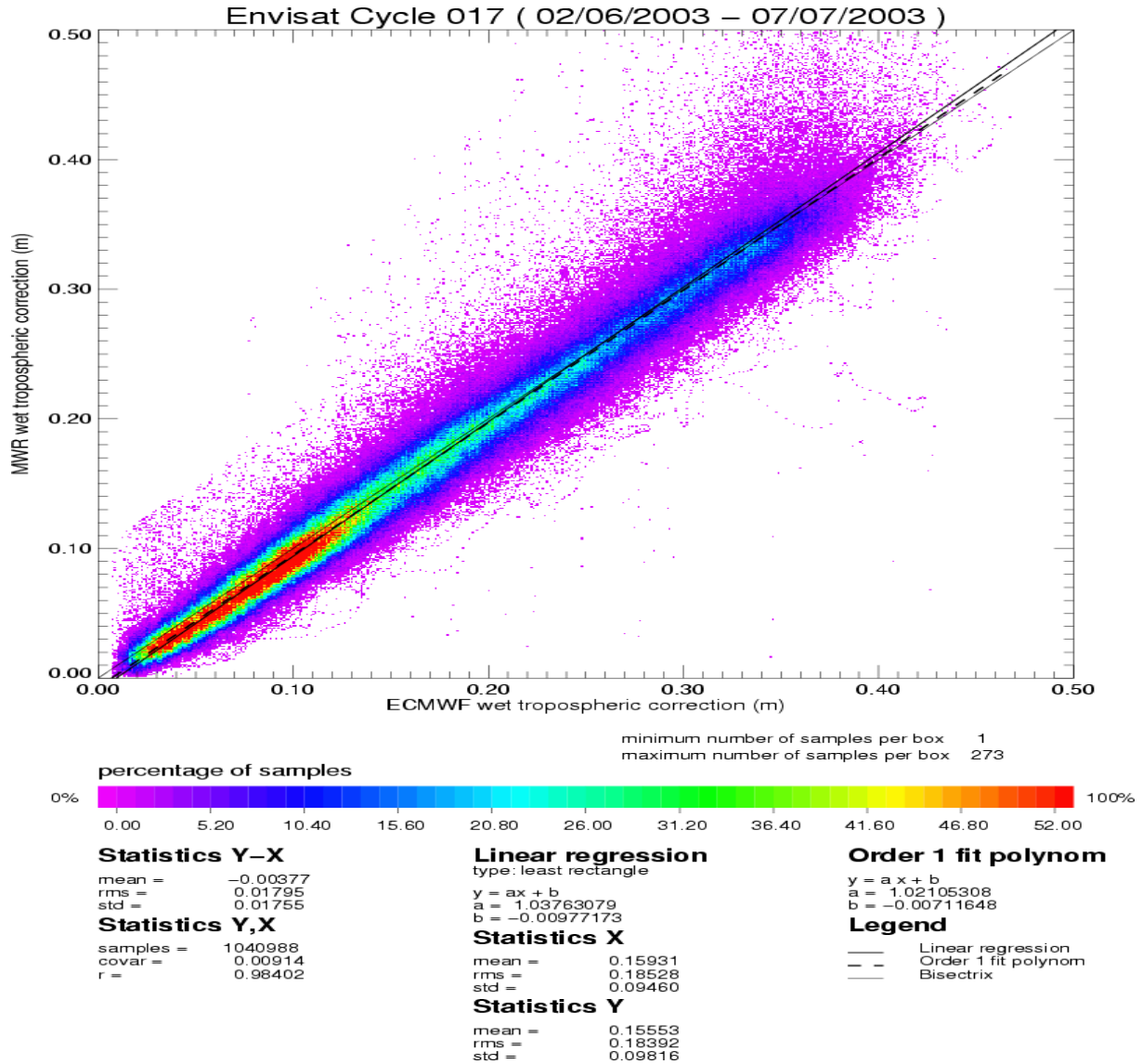

The radiometer-model mean difference is 0.4 cm. A drift on the Envisat 23.8GHz brightness temperature has been detected and has to be monitored on the long term. Note that the neural algorithm is now implemented on Envisat.
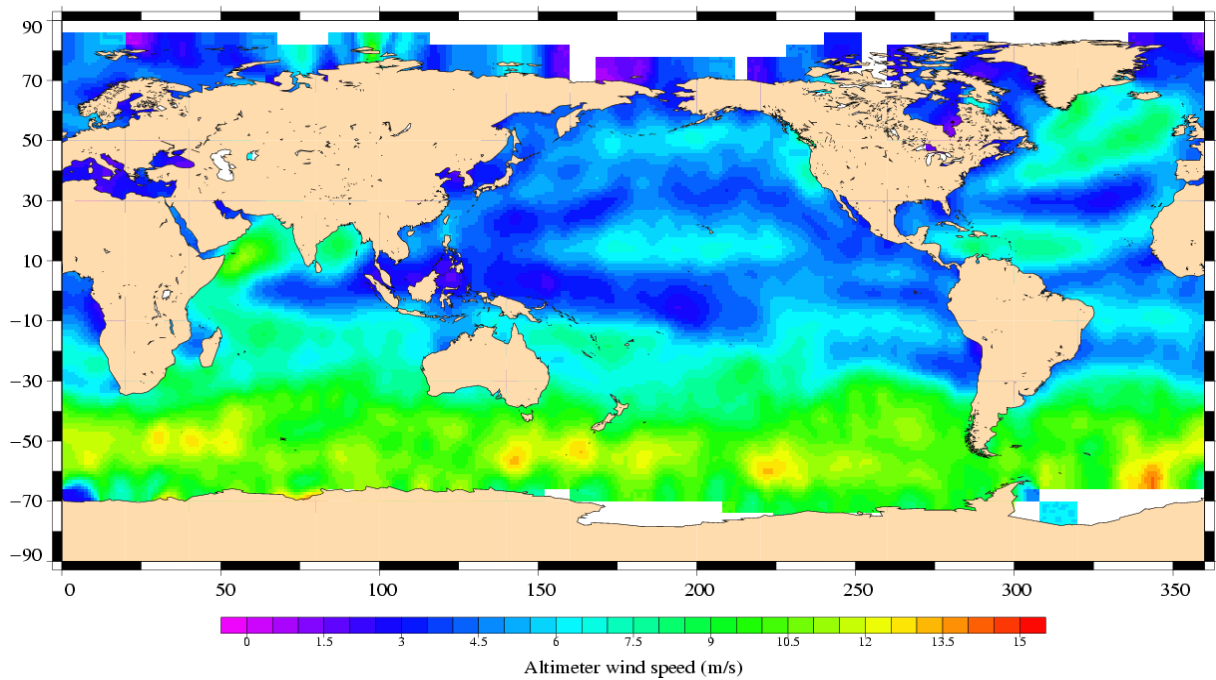
3.5   Wind and wave maps

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

Envisat Cycle 017
02/06/2003 − 07/07/2003
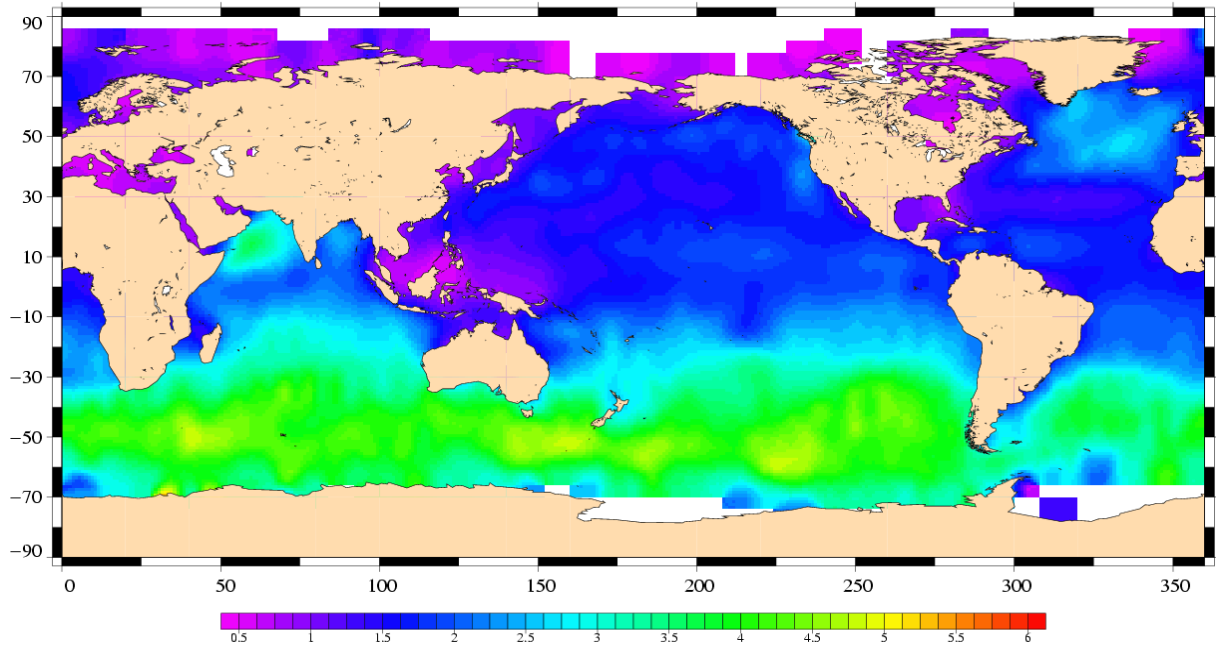
Significant Wave Height (m)

Envisat Cycle 017
02/06/2003 − 07/07/2003

Altimeter wind speed (m/s)

3.6 Crossover statistics

3.6.1 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 8.80 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 7.55 cm rms. This statistic is a stable estimation of the system performance as it is not influenced by sea ice coverage.

3.6.2 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: an orbit error and a model ionospheric correction. The orbit error 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
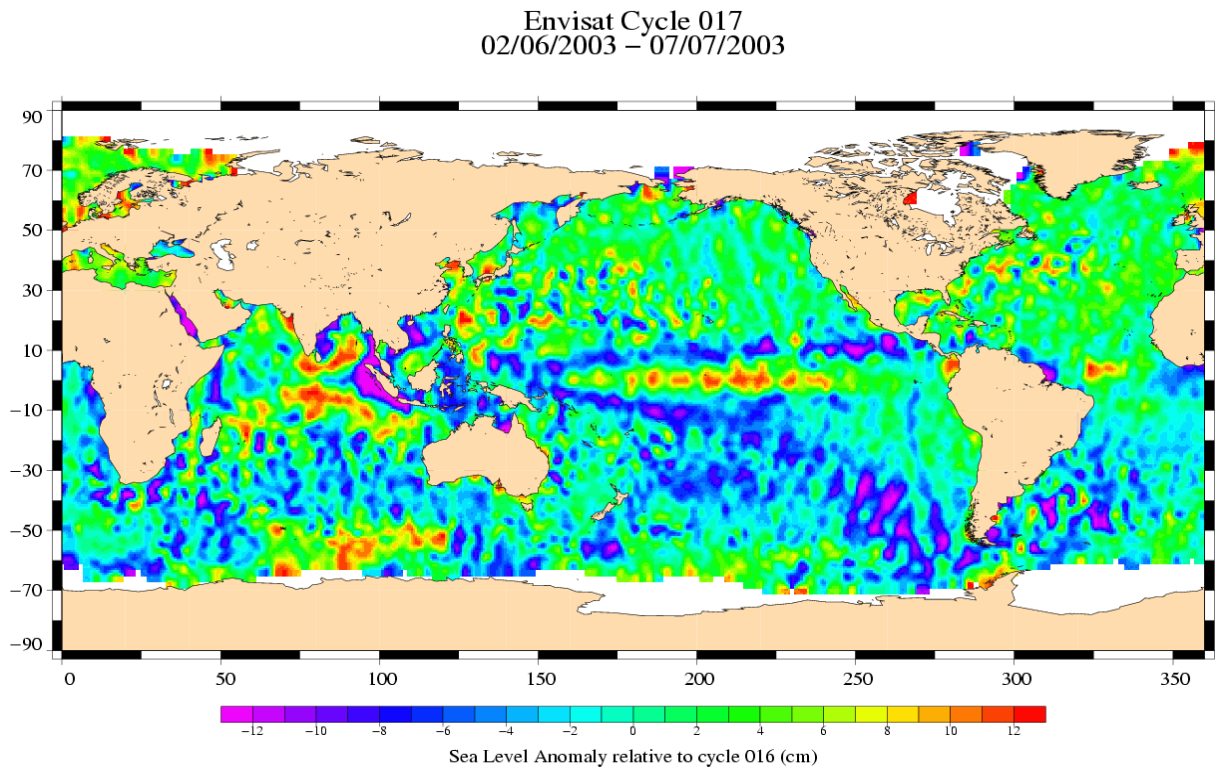## Impact of geophysical corrections

	H1	H2	H3	H4	H5	H6
mean	0.91	0.03	1.15	0.64	0.90	0.72
std	8.80	7.97	8.84	8.92	8.79	8.91

Type of analysis

differences threshold

std

mean

H1 = SSH

H2 = SSH with orbit error (computed)

H3 = SSH with GIM ionospheric correction (computed)
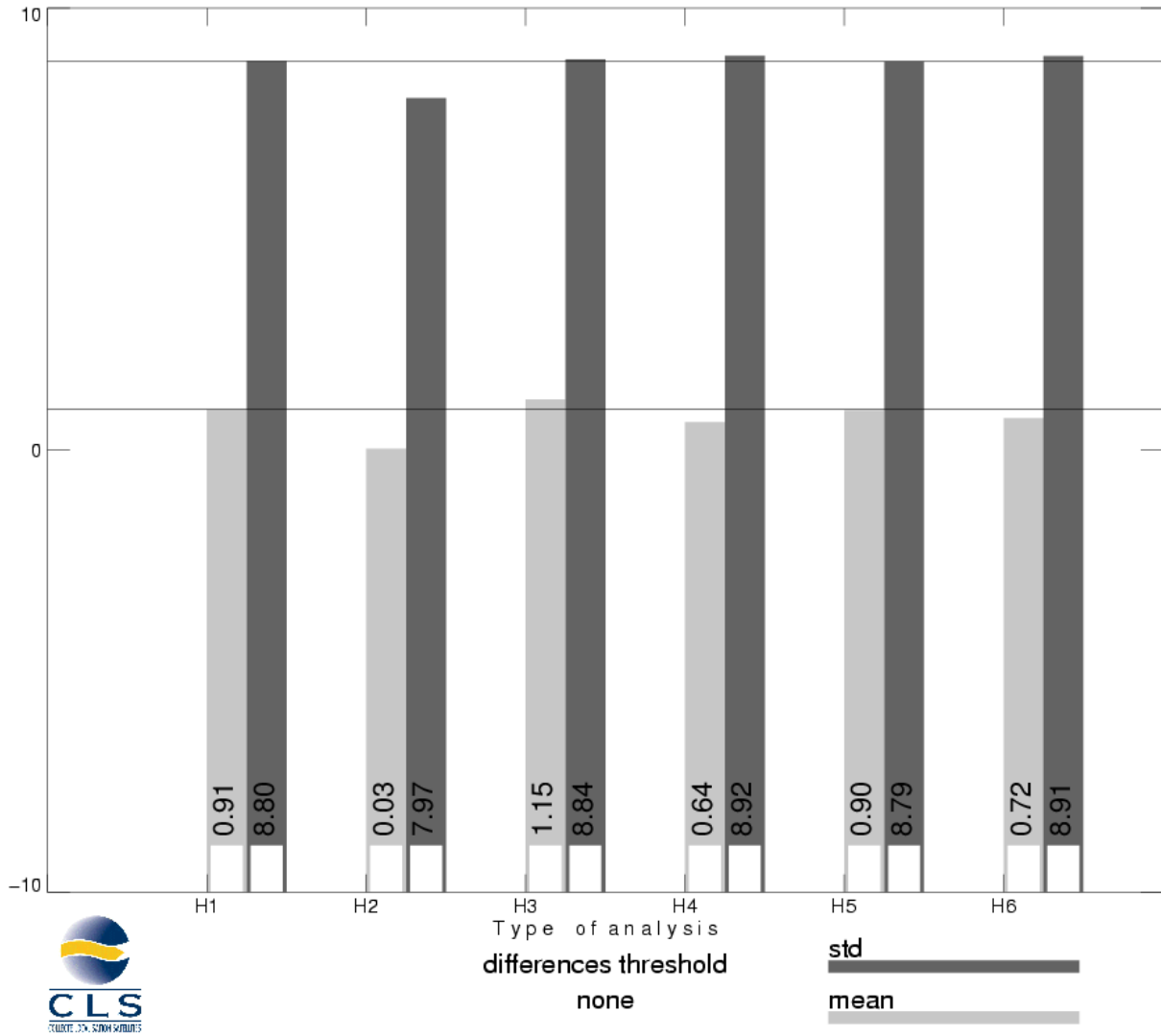
H4 = SSH with DORIS ionospheric correction (in product)

H5 = SSH with FES02 tide model (in product)

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

3.7 SSH variability

3.7.1 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 017
02/06/2003 − 07/07/2003

Sea Level Anomaly relative to cycle 016 (cm)

Envisat Cycle 017
02/06/2003 − 07/07/2003

Sea Level Anomaly relative to a 7 year mean (cm)
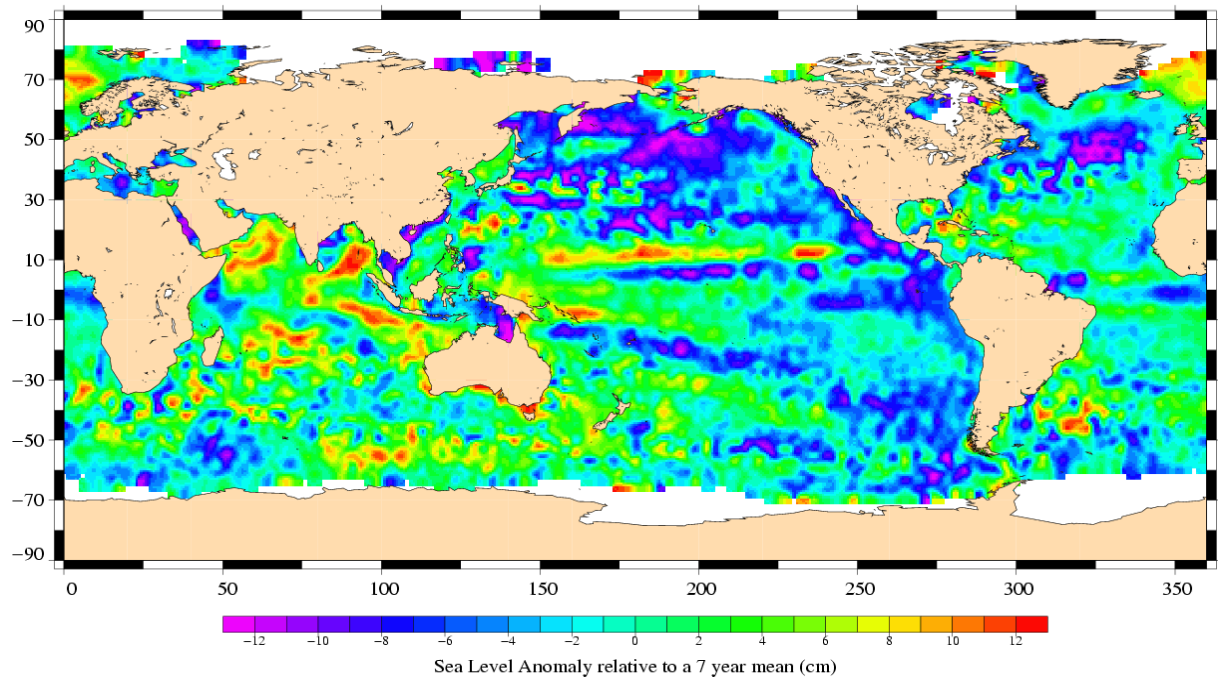
3.7.2 Comparison to a precise Mean Sea Surface

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.
1163346	43.57	10.44

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.
730134	43.68	9.19

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 017
02/06/2003 − 07/07/2003

Variability relative to MSS (cm)
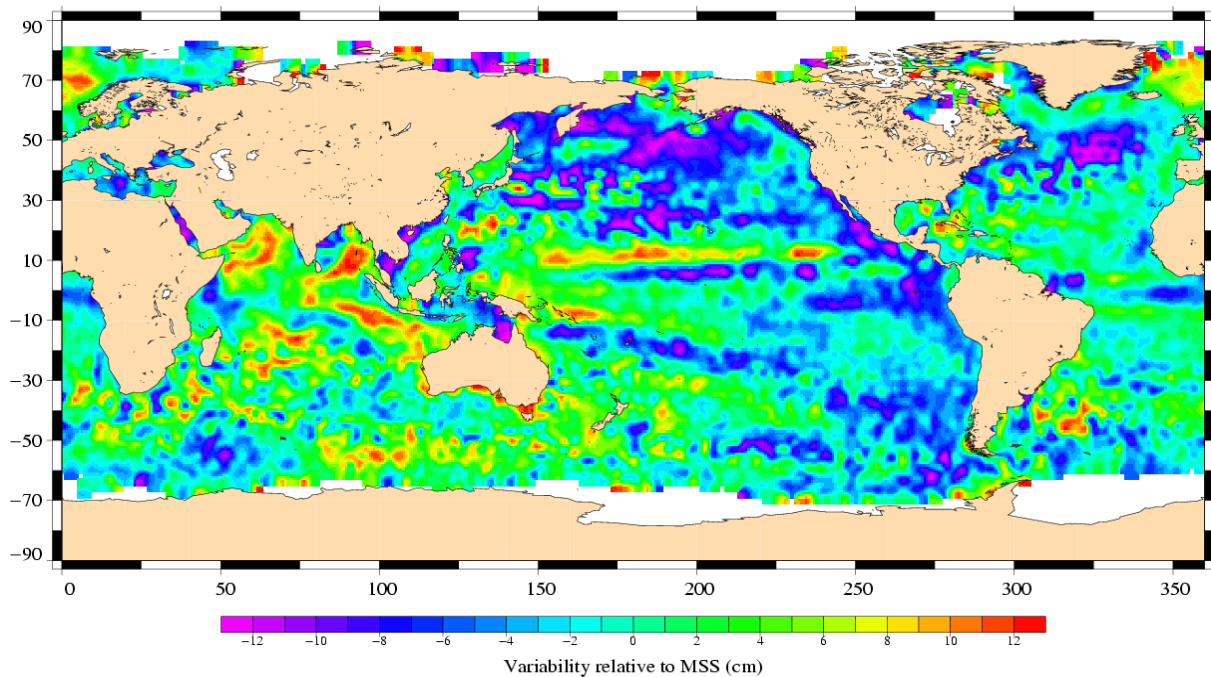
(SSH − MSS) centered, differences greater than 30 cm
Envisat / Cycle 017
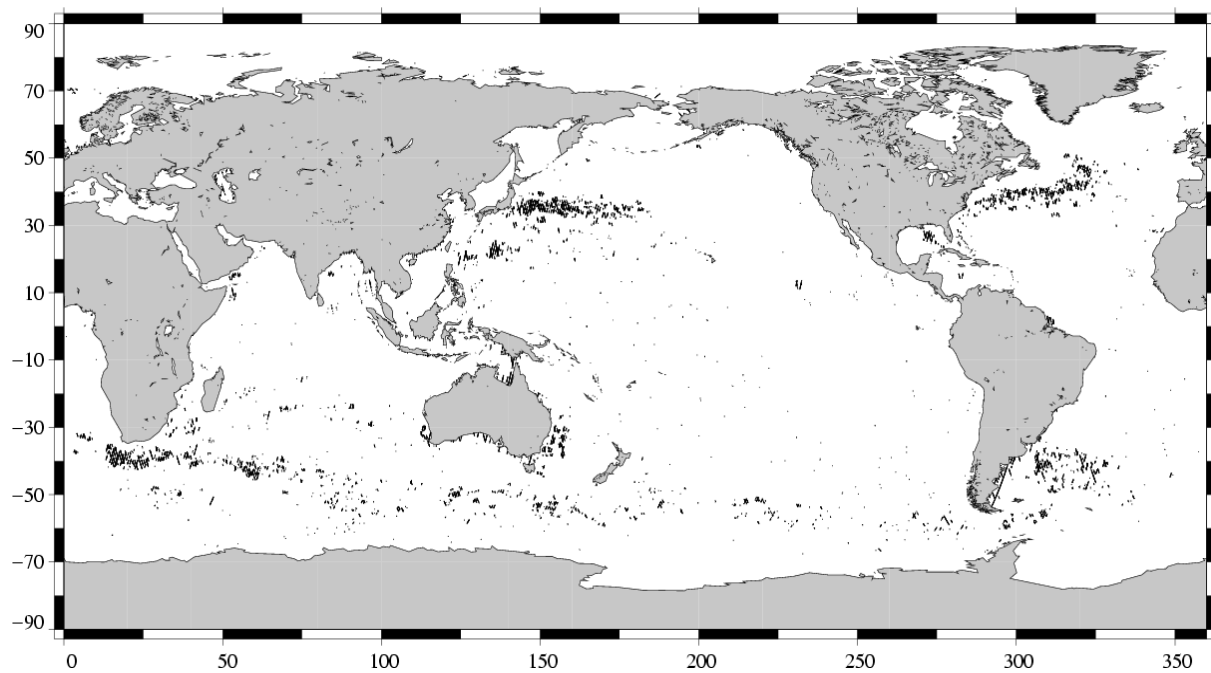
4 Cross Calibration with ERS-2

Envisat flies on the same ground track as ERS-2, 30 minutes ahead. This section presents results that illustrate the difference with ERS-2.
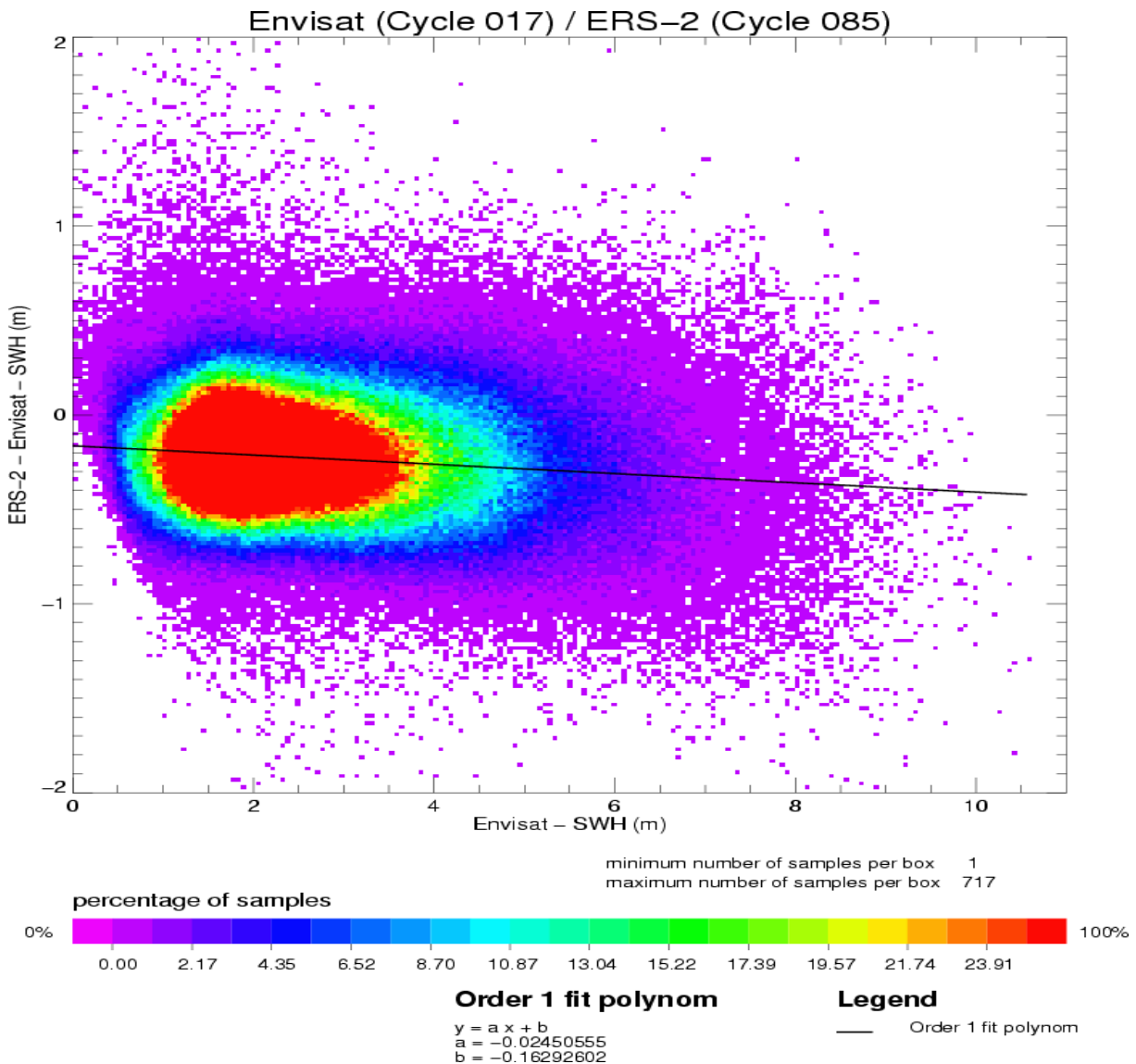
Envisat cycle 017 data are collocated to data from ERS-2 GDR cycle 080 in order to compare the main parameters from repeat-track analysis.
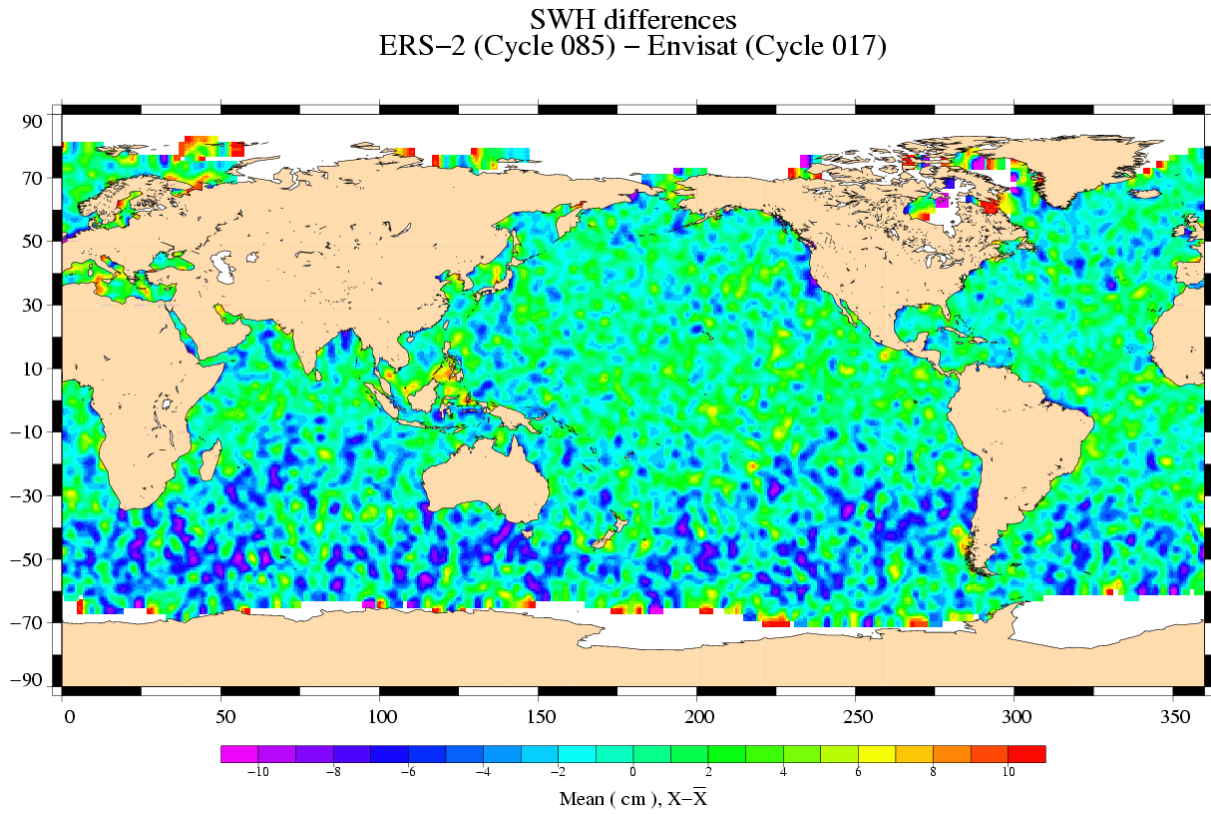
4.1 [ERS-2 - Envisat] Ku SWH differences

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

Number	Mean	Std. dev.
743908	-21.85	27.37

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

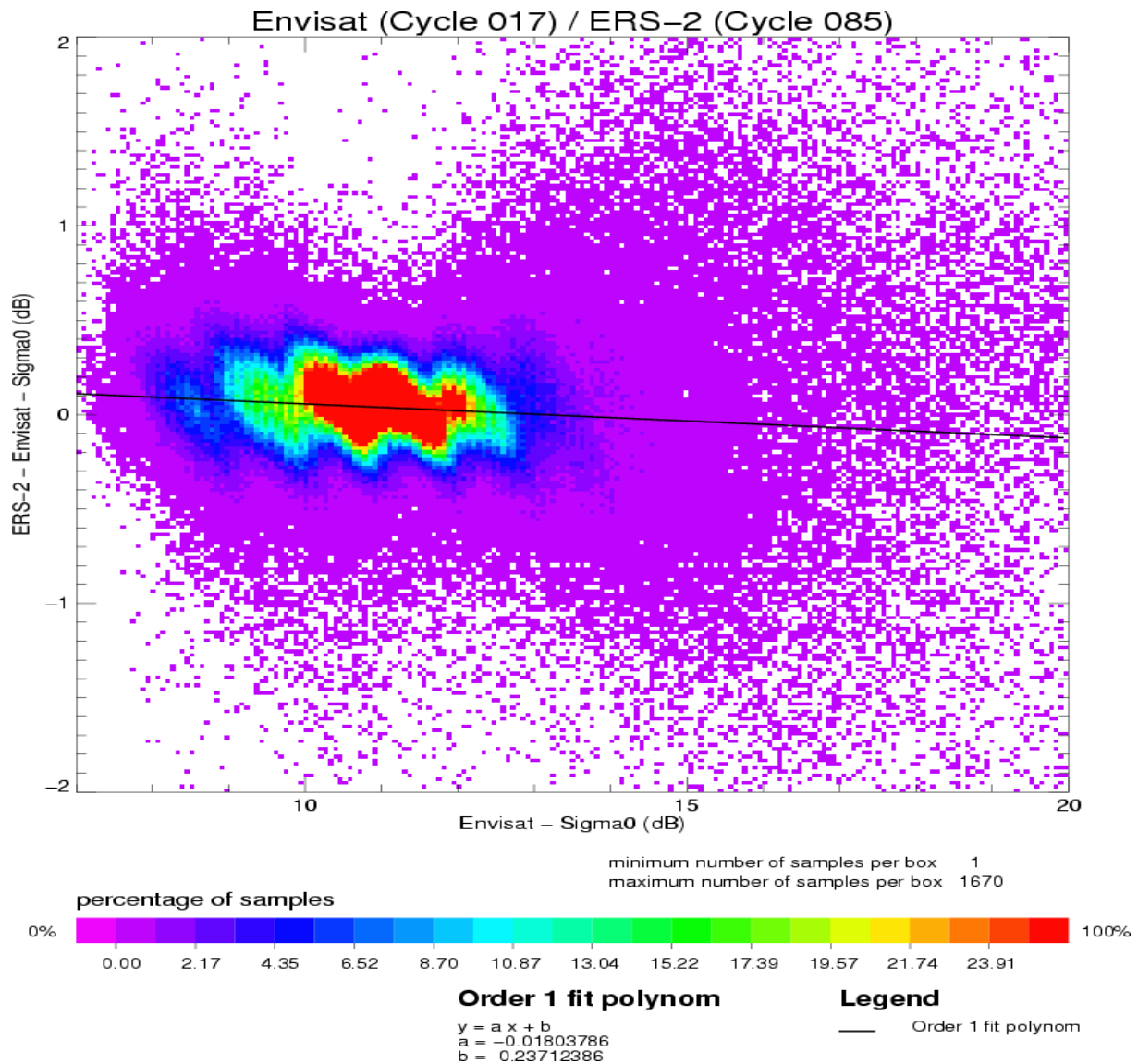These differences are plotted on the following figure (data are centered about the mean value).

SWH differences
ERS−2 (Cycle 085) − Envisat (Cycle 017)

High SWH areas appear due to greater differences for high SWH values.

4.2   [ERS-2 - Envisat] Ku Sigma0 differences

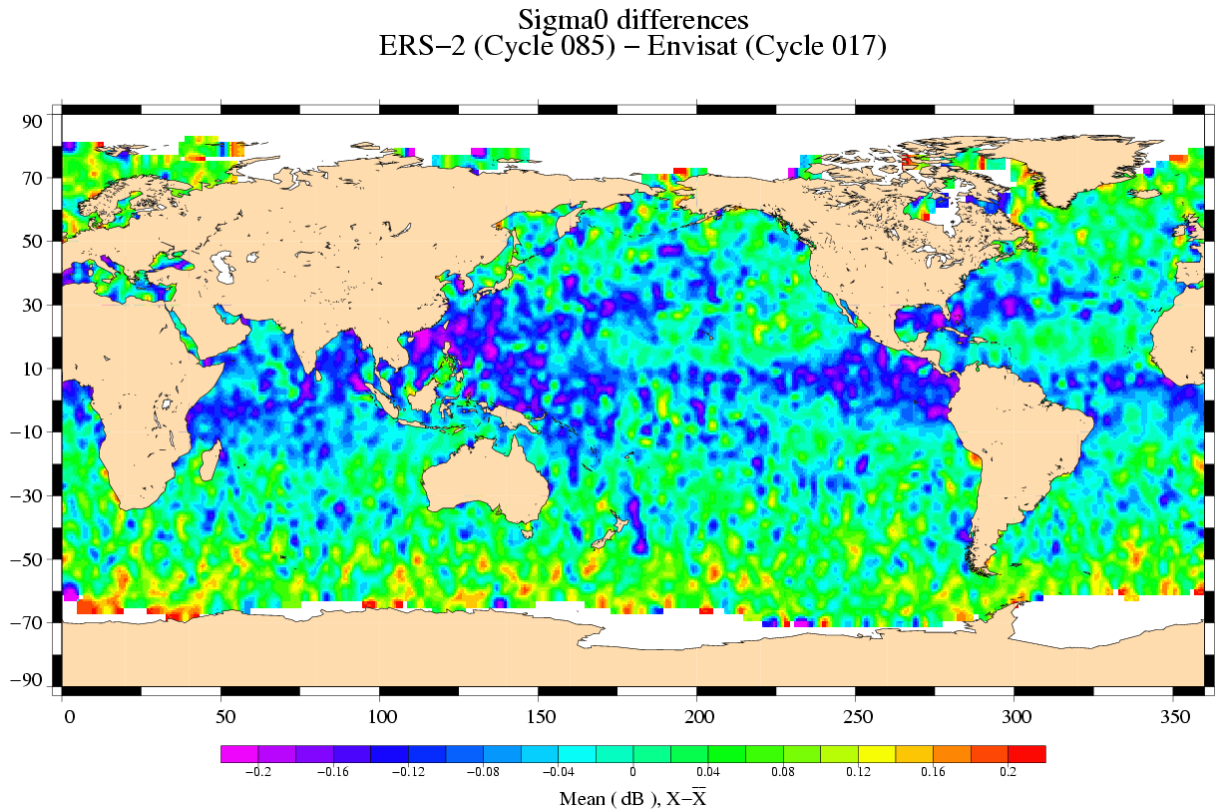Global statistics of [ERS-2 - Envisat] Ku Sigma0 differences are (dB):

Number	Mean	Std. dev.
743908	0.04	0.28

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 085) − Envisat (Cycle 017)

Wet areas appear because the ERS-2 atmospheric attenuation on Sigma0 is uncomplete (it only contains cloud liquid water path attenuation), contrary to Envisat one.

4.3 [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 (cm):

Number	Mean	Std. dev.
743908	0.01	0.88

The scatter plot between Envisat and ERS-2 radiometer wet troposphere corrections is given on the following figure:
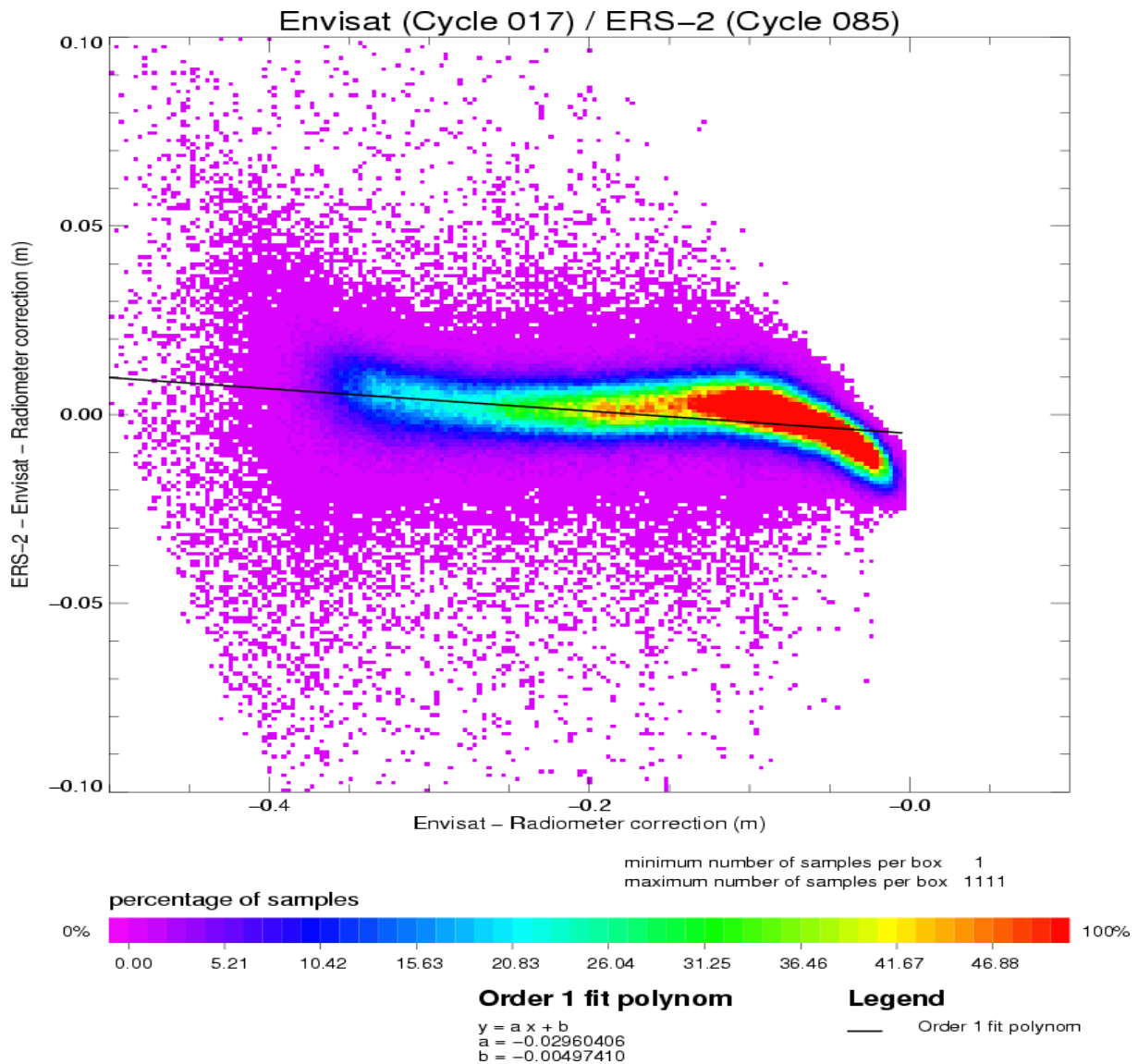
The differences between Envisat and ERS-2 radiometer corrections are plotted on the following figure (data are centered about the mean value).

Radiometer correction differences
ERS–2 (Cycle 085) – Envisat (Cycle 017)
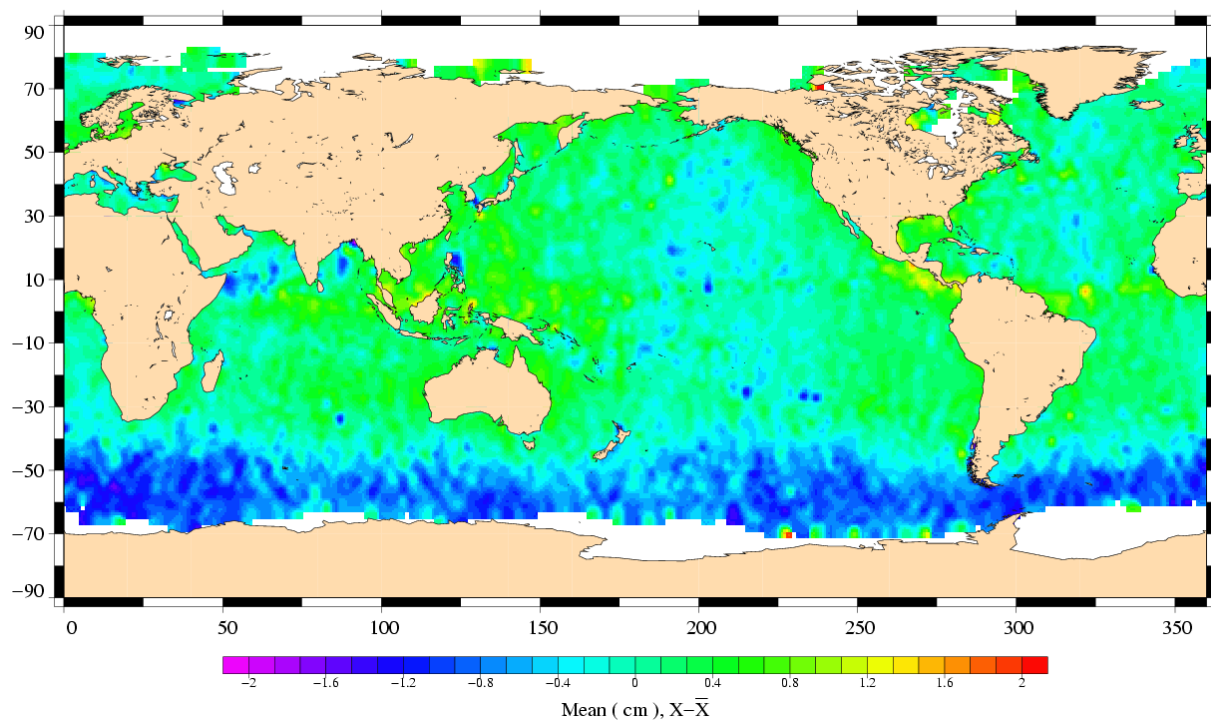
The two MWR corrections are consistent except in dry areas where ERS-2 under-estimates this correction.

4.4   [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
- DGME04 orbit
- ECMWF wet tropospheric correction (rectangular grids)
- 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

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 (rectangular grids)
Note that, in order to be consistent with ERS-2, the ECMWF model derived wet tropospheric correction using rectangular grid has been computed on Envisat.

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

Number	Mean	Std. dev.
743251	-34.65	5.34

These SSH differences are plotted on the following figure.

Corrected SLA (model configration)
ERS−2 (Cycle 085) − Envisat (Cycle 017)

Cycle   17 (cm), X−X̄
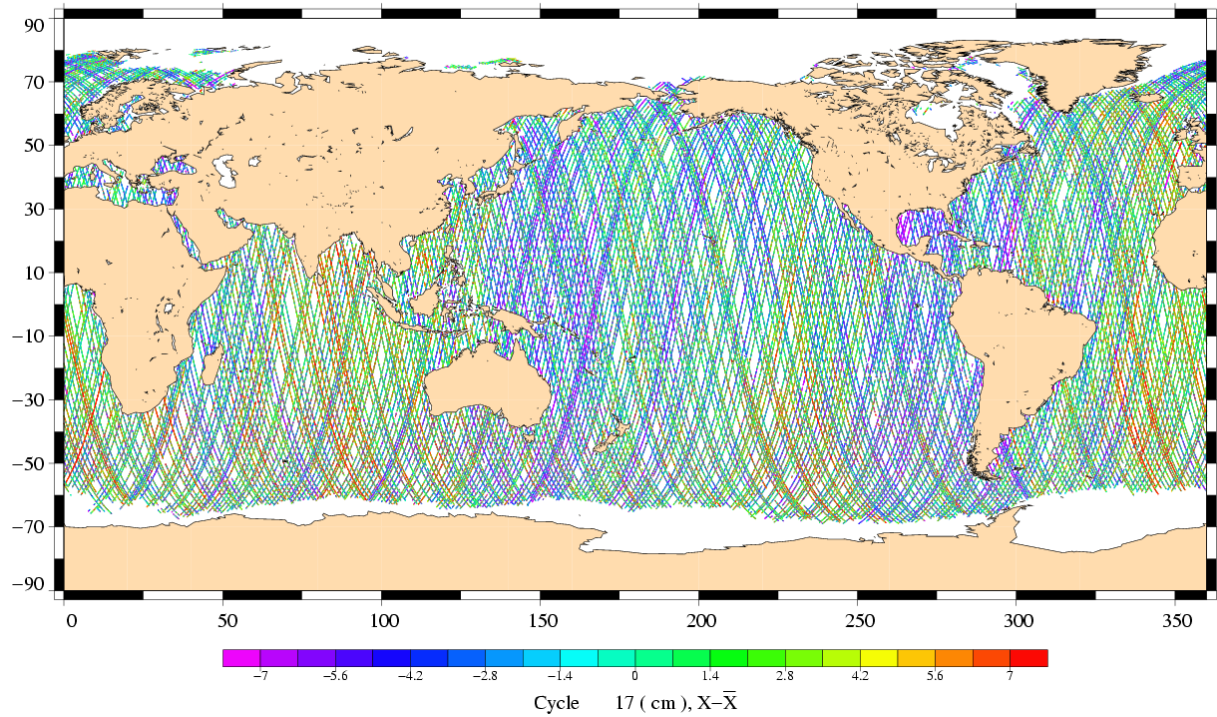
The main source of differences is the ERS-2 orbit errors.