Systematic Calval SWIM - CFOSAT

CNES, CASYS

Synthesis report on parameters quality: cycle 129 (2023-05-23 - 2023-06-05)

Contents

Main Part I

Introduction

Part 1

Context

Document overview This document reports the major features that characterize the quality of SWIM/CFOSAT data. It is released on a cyclic basis.

The main goals of the document are:
- to report any changes in software and data processing;
- to present the main instrumental parameters;
- to provide insights on data quality and coverage.

Software version This cycle was produced with:
- product version: 6.1.0;
- CDB version: 23_32;
- CASYS version: 2.7.

Specific events Data partially missing from June 1st, 2023, at 06:51 to 07:04.

Long term monitoring Statistics are provided on a long-term prospect, starting from April 19th, 2019 (cycle 14).

Table 1.1: Dates of AWWAIS' versions

AWWAIS version	Date
AWWAIS 4.0.2	06/11/2018 00:00:00
AWWAIS 4.1.1	18/12/2018 11:00:00
AWWAIS 4.2.1	12/03/2019 14:00:00
AWWAIS 4.2.2	23/04/2019 16:00:00
AWWAIS 4.3.1	16/07/2019 05:33:00
AWWAIS 5.0.1	24/06/2020 11:57:26
AWWAIS 5.1.1	12/10/2020 13:30:00
AWWAIS 5.1.2	16/11/2020 14:00:00
AWWAIS 5.2.0	27/07/2021 06:53:21
AWWAIS 6.1	27/06/2022 10:36:06

Part 2

Glossary

Track, Pass refers to a half-orbit of CFOSAT.

Cycle refers to the 13-day period that takes CFOSAT to come back to the same position.

AWWAIS SWIM processing chain in the French ground segment associated with a version number.

Main Part II

Instrumental

Part 3

Review

The following table summarizes the performance of the SWIM instrument during the current cycle and gives notice of possible incidents.

	Parameter	Comments
1	Operating modes	The operating mode is OK (normal tracking sequences and calibration modes) Data missing 01/06/2023 06:51 - 07:04 (passes 269 - 270)
2	Macrocycle configuration	0°, 2°, 4°, 6°, 8°, 10°
3	Antenna Rotation	rotated
4	Speckle Mode	False
5	Temperatures and EDAC errors	The temperature profiles are nominal
6	Calibration 1	All the PTR calibration sequences are OK
7	Specific investigations	
8	Status	The SWIM altimeter performed well during this cycle

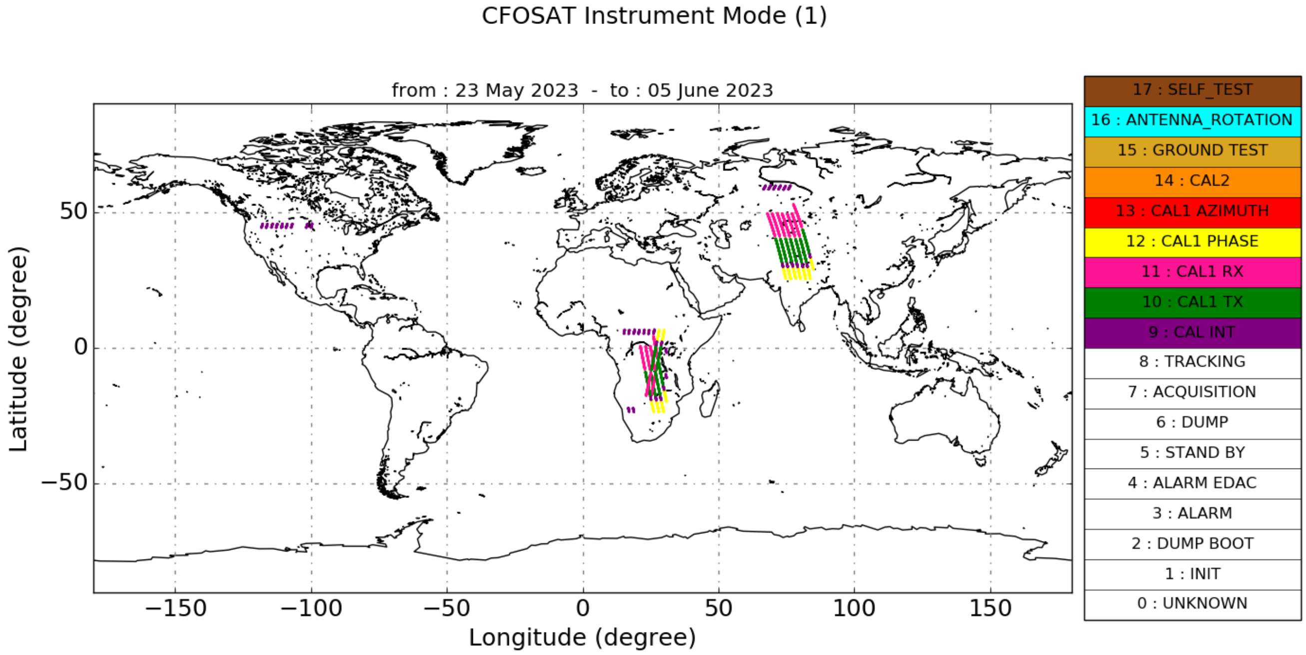
Color legend:

	OK
	Warning
	NOK

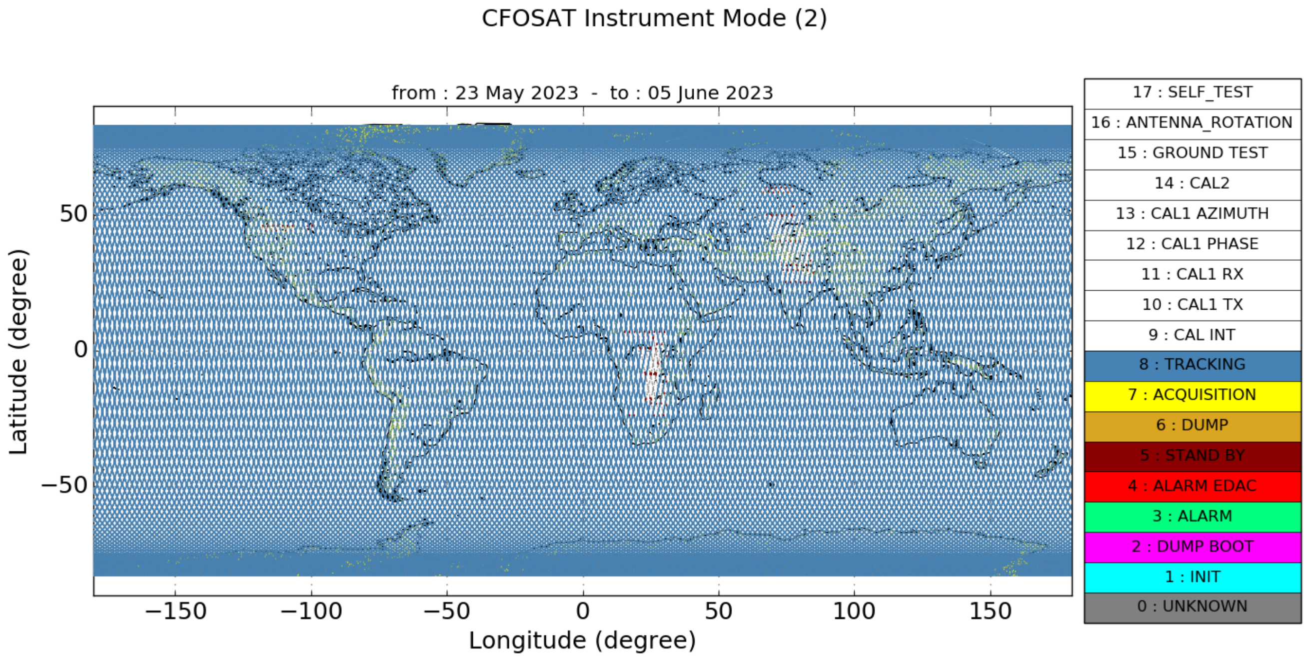
Part 4

Instrument mode and House Keeping

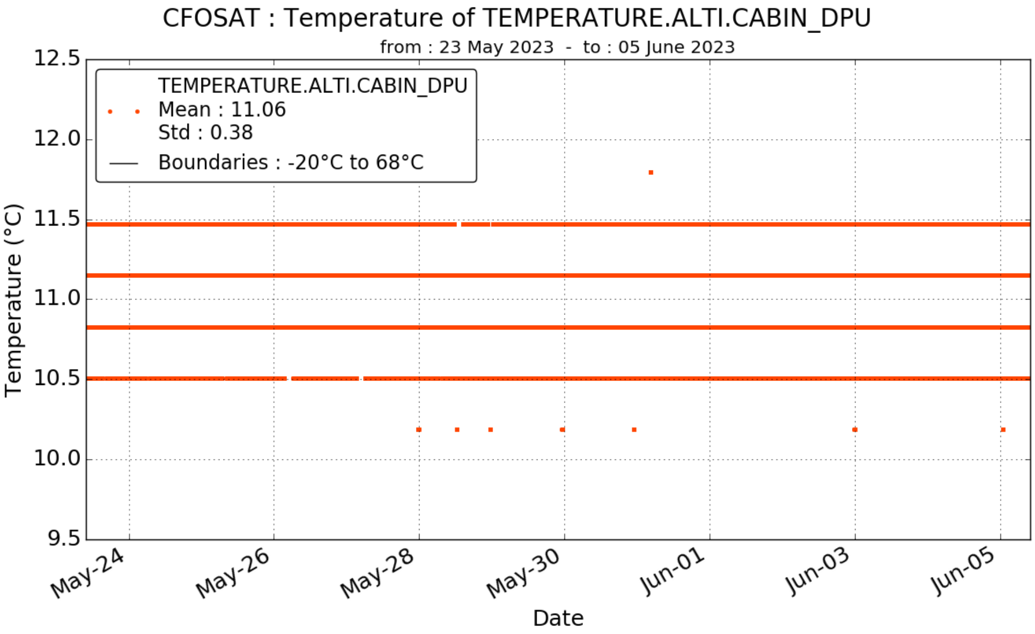
This part presents the instrument modes and the DPU cabin temperature for the current cycle (taken from the House Keeping telemetry data).



1

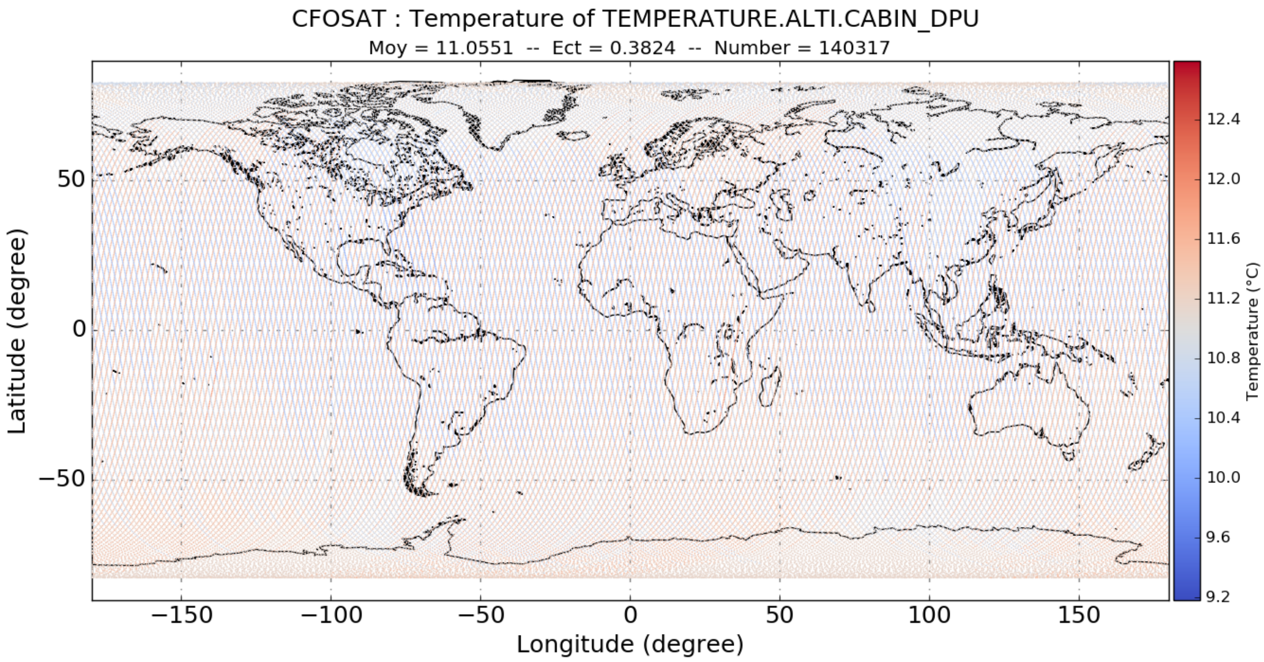


2



CFOSAT : Temperature of TEMPERATURE.ALTI.CABIN_DPU
from : 23 May 2023 - to : 05 June 2023
TEMPERATURE.ALTI.CABIN_DPU
Mean : 11.06
Std : 0.38
Boundaries : -20°C to 68°C
Temperature (°C)
Date

3



CFOSAT : Temperature of TEMPERATURE.ALTI.CABIN_DPU
Moy = 11.0551 -- Ect = 0.3824 -- Number = 140317
Latitude (degree)
Longitude (degree)
Temperature (°C)

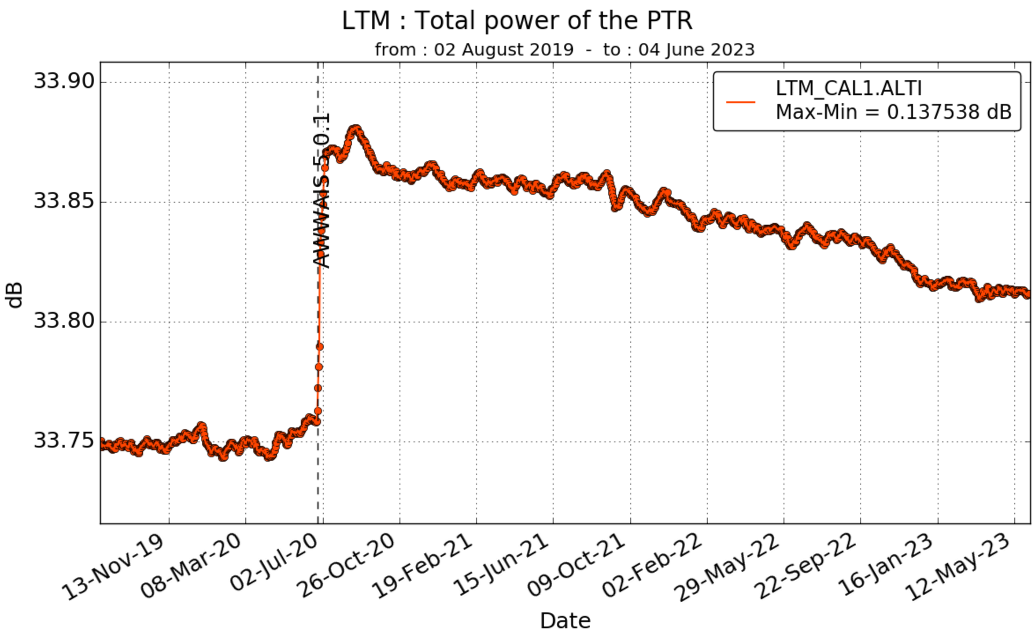
4

Part 5

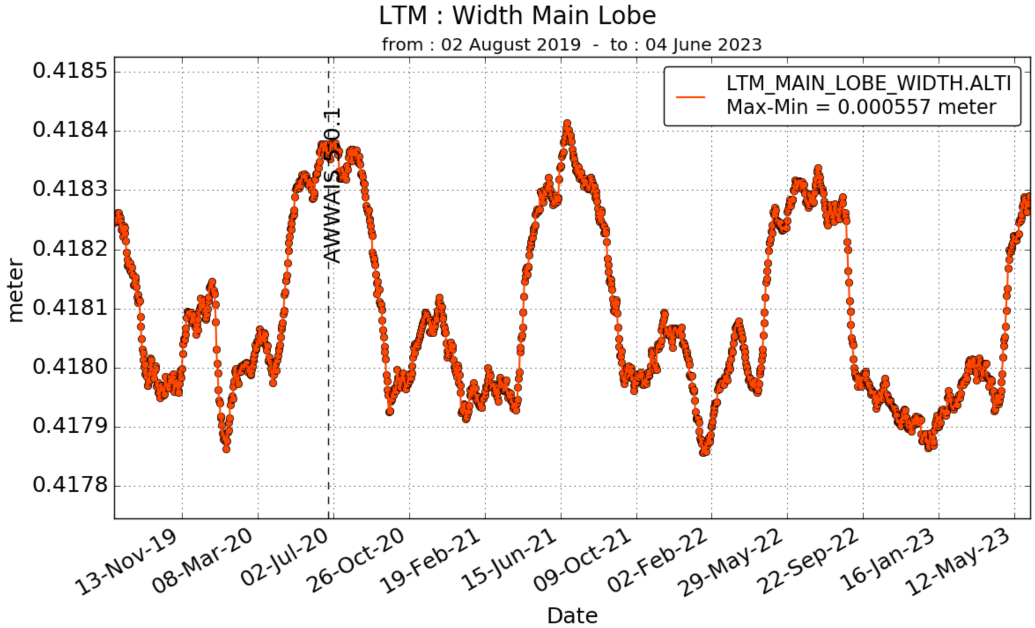
CAL1 internal sequence

This part presents the major characteristics - total power, width, and position of the peak - of the main lobe of the Point Target Response (PTR), since cycle 22 (averaged within a 13-day sliding window).

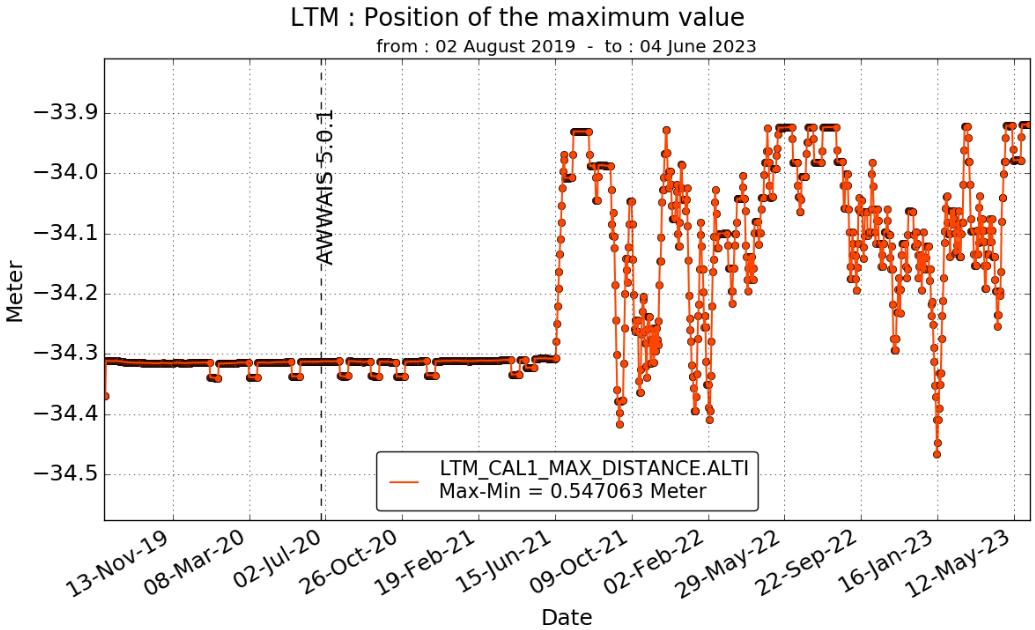
The increase in the PTR total power on June 24 2020 is due to an update of the gain calibration table, made upon the change of AWWAIS version (4.3.2 to 5.0.1). Occasional PTR shifts are the cause of the troughs seen in the figure position of the maximum value. The origin of the shifts is still under investigation, though these do not affect the data.



5


LTM : Width Main Lobe
from : 02 August 2019 - to : 04 June 2023
LTM_MAIN_LOBE_WIDTH.ALTI
Max-Min = 0.000557 meter
AWWAIS 5.0.1
meter
0.4185
0.4184
0.4183
0.4182
0.4181
0.4180
0.4179
0.4178
13-Nov-19
08-Mar-20
02-Jul-20
26-Oct-20
19-Feb-21
15-Jun-21
09-Oct-21
02-Feb-22
29-May-22
22-Sep-22
16-Jan-23
12-May-23
Date

6

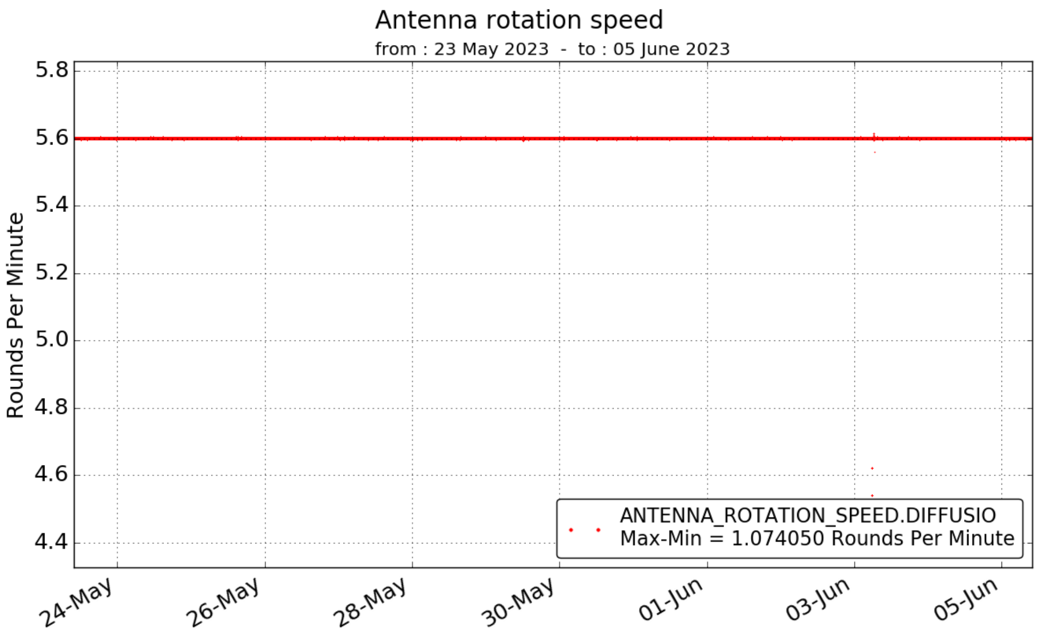

LTM : Position of the maximum value
from : 02 August 2019 - to : 04 June 2023
AWWAIS 5.0.1
LTM_CAL1_MAX_DISTANCE.ALTI
Max-Min = 0.547063 Meter
Meter
−33.9
−34.0
−34.1
−34.2
−34.3
−34.4
−34.5
13-Nov-19
08-Mar-20
02-Jul-20
26-Oct-20
19-Feb-21
15-Jun-21
09-Oct-21
02-Feb-22
29-May-22
22-Sep-22
16-Jan-23
12-May-23
Date

7

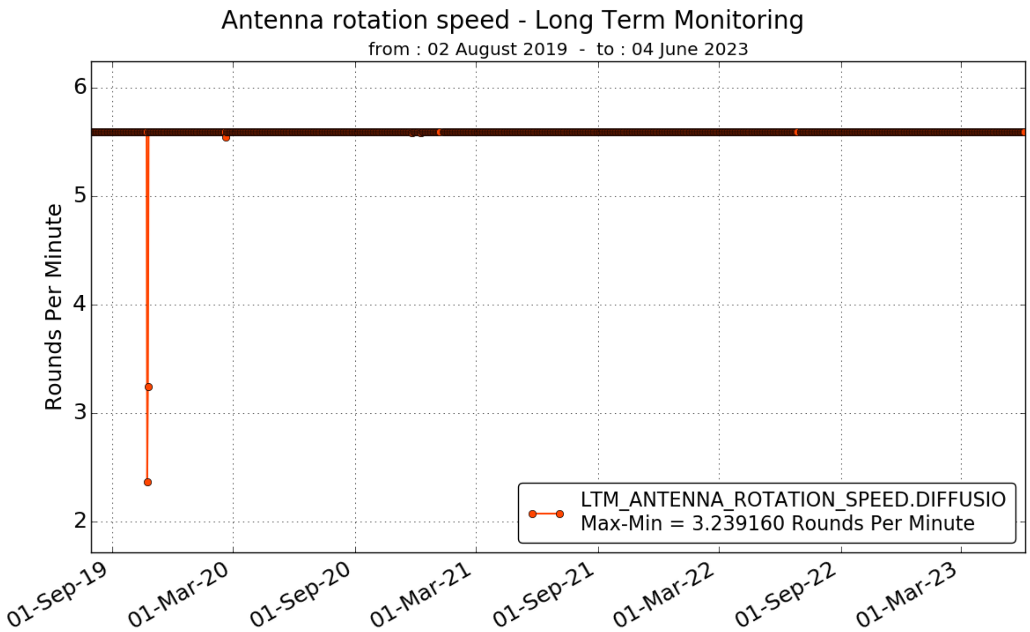
Part 6

Antenna rotation speed

The following plots show the antenna rotation speed for the current cycle and since cycle 22 (averaged within a day). The antenna was stopped on October 24/25 2019 (cycle 28) during 24h for hardware behavior analysis, leading to the couple of points at low rotation speed seen in the bottom plot.



8



9

Main Part III

Coverage

Part 7

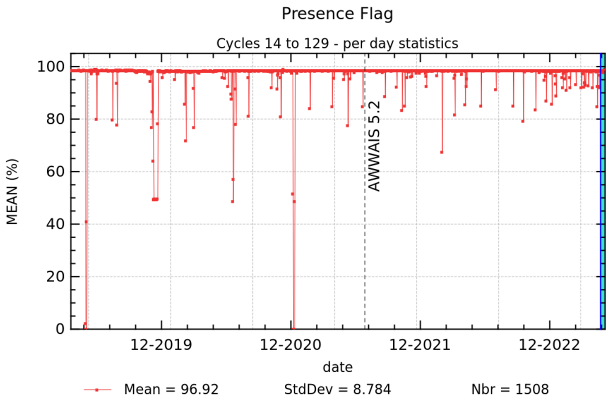
Coverage nadir 5Hz

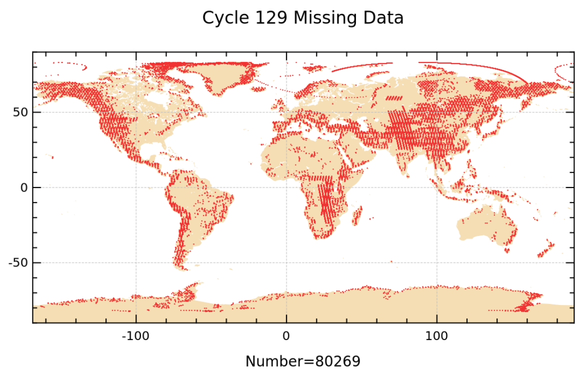
Coverage is monitored by the presence flag, which gives the percentage of nadir points available in CFOSAT Level-2 products regardless of surface type. This information is obtained by comparing the 5Hz resolution time with the theoretical ground track.

Missing data cycle 129 Data partially missing from June 1st, 2023, at 06:51 to 07:04.

Table 7.1: SWIM nadir 5Hz coverage

Percentage on current cycle	Cycle 129
Percentage of available measurements over ocean	99.89 %
Percentage of missing measurements over ocean	0.11 %





Part 8

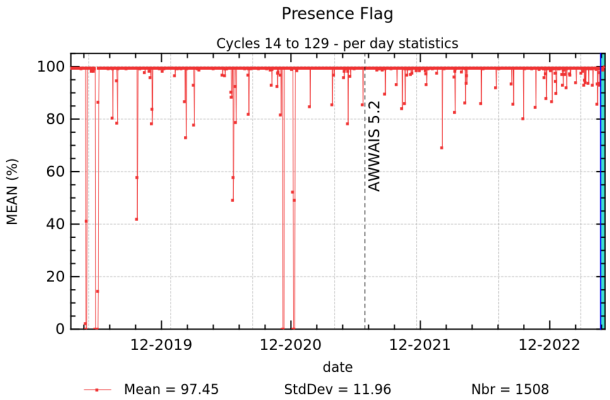
Coverage off-nadir

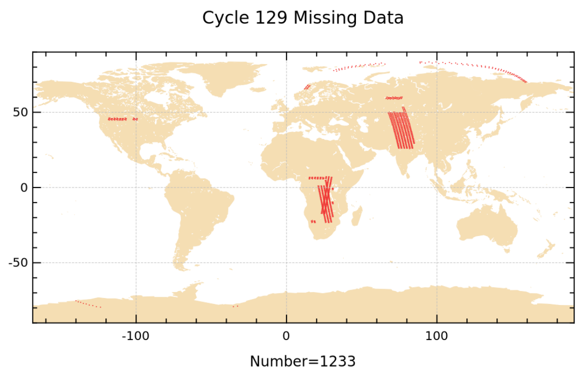
Coverage is monitored by the presence flag, which gives the percentage of points available in CFOSAT Level-2 products regardless of surface type. This information is obtained by comparing the Box Left/Right time with the theoretical ground track.

Missing data cycle 129 Data partially missing from June 1st, 2023, at 06:51 to 07:04.

Table 8.1: SWIM Box Left/Right coverage

Percentage on current cycle	Cycle 129
Percentage of available measurements over ocean	99.94 %
Percentage of missing measurements over ocean	0.06 %





Main Part IV

Editing

Part 9

Nadir 5Hz Nsec

The data are edited based on two types of criteria: quality (flag) and thresholds, both defined in the table below. The quality criterium is applied first. It is based on the SWH flag that is included in the Level-2 products and illustrated by the "Edited data by quality control" figure below. This flag takes into account surface (land) and sea-ice coverage at a threshold defined in the product attributes. As for the second criterium, thresholds on several variables are applied. Values outside minimal and maximal limits are rejected and are not taken into account in the statistical analyses.

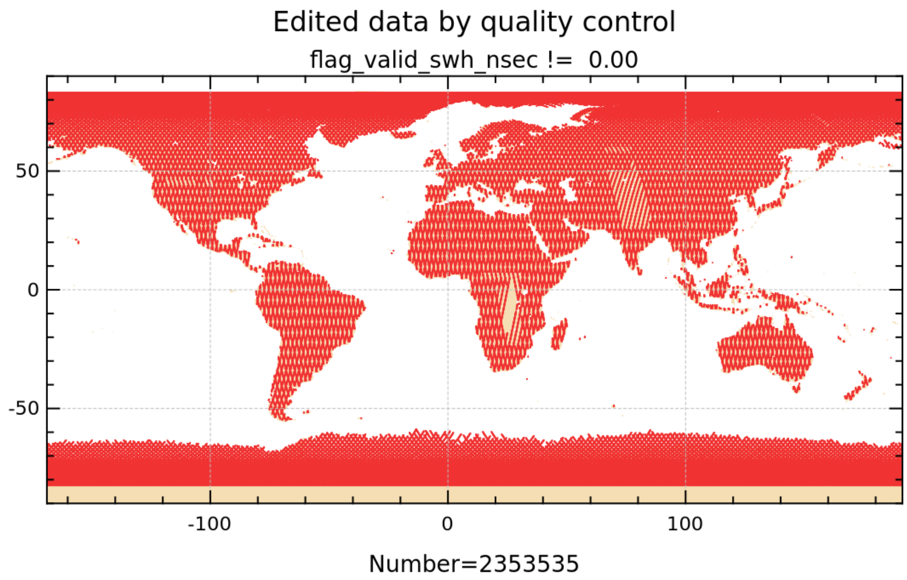
Maps in this part represent data on land and ocean for the current cycle, whereas temporal monitorings are given on ocean only.

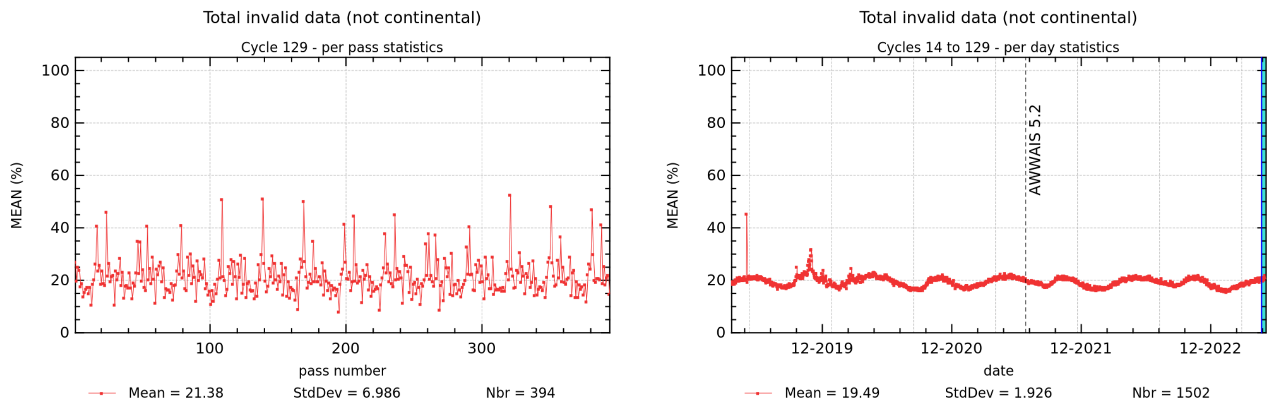
Table 9.1: Thresholds for data editing

Variables 5Hz	Min value	Max value
nadir_swh_native	0	20
nadir_swh_nsec_used	10	20
nadir_swh_nsec_std	0	0.4+SWH.ALTI*0.028
wind_speed	0	30
nadir_sigma0_nsec	5	25
nadir_sigma0_nsec_std	0	3.0
nadir_sigma0_nsec_used	10	20
flag_swh	0	0
ice_flag	0	0

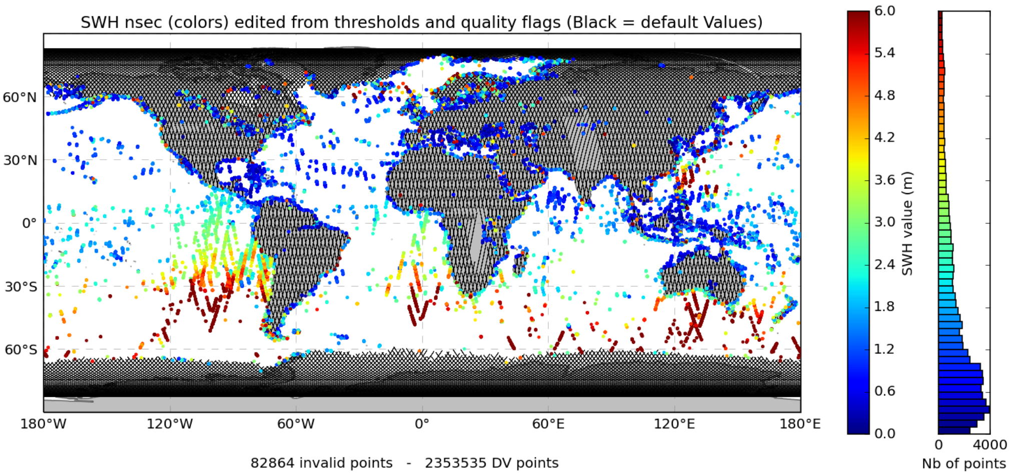
Table 9.2: SWIM nadir 5Hz coverage

Percentage on current cycle	Cycle 129
Percentage of rejected points due to quality flag swh including product ice flag over ocean	18.82 %
Additionnal percentage of threshold rejection	1.88 %
Total percentage of rejected measurements over ocean	20.70 %





The figure on the left represents rejected values based on the editing criteria listed in Table 9.1. The map shows the SWH values of rejected points in colour. When this representation is not possible (masked points, non-computed values) points are represented in black.



Part 10

Off-nadir

Editing is based on sea-ice and land coverage, as well as on thresholds on SWH, as described in the table below. It is applied to all Box Left/Right data. This editing will be improved over time.

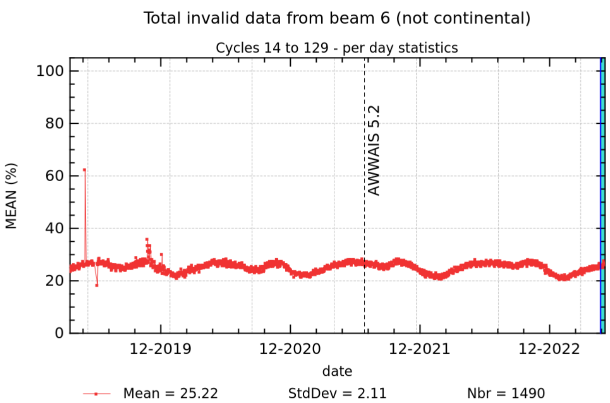
Table 10.1: Thresholds for data editing

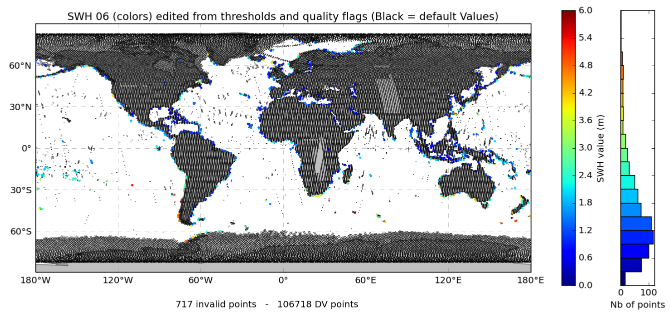
Variables Box LeftRight	Min value	Max value
swh masked per beam	non-default	non-default
sea-ice coverage per beam	0.0	0.0
land coverage per beam	0.0	0.0
swh per beam threshold	0.0	20.0

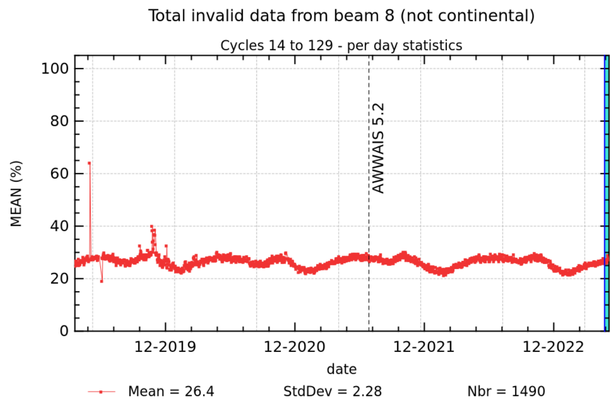
Table 10.2: Percentage of edited data

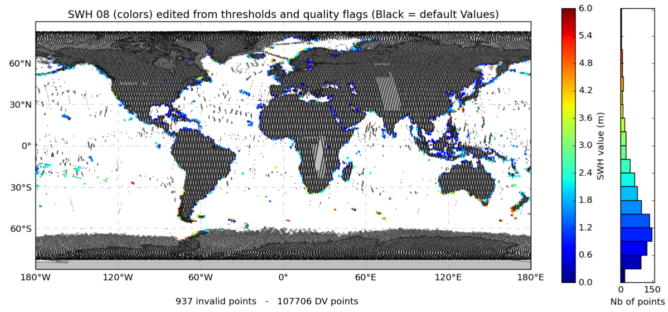
Variables	Beam 6	Beam 8	Beam 10	Combined
Total percentage of default value in the product over ocean	25.55 %	26.31 %	27.65 %	2.25 %
Additionnal ice rejection over all available measurements	0.00 %	0.00 %	0.01 %	12.87 %
Additionnal land rejection over all available measurements	0.51 %	0.67 %	0.74 %	11.11 %
Additional threshold rejection over ocean	0.00 %	0.00 %	0.00 %	0.00 %
Total percentage of rejected measurements over ocean	26.06 %	26.98 %	28.39 %	26.24 %

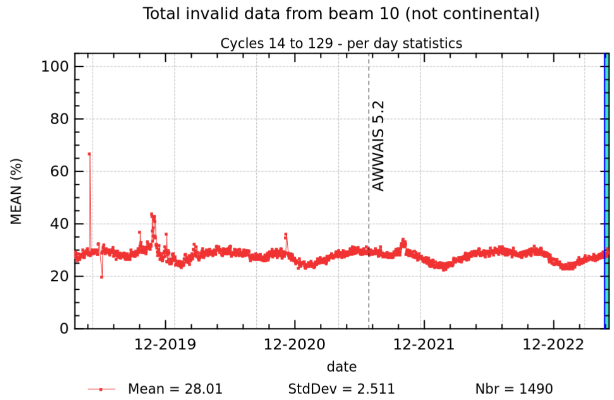
The following figures on the left show the percentage of rejected SWH points for beams 6°, 8°and 10° based on the editing criteria defined in Tables 10.1 and 10.2. The following maps on the right show, for beams 6°, 8°and 10°, the values of SWH (colors) that have been rejected. When this representation is not possible (masked points, non-computed values), the points are marked as black dots.

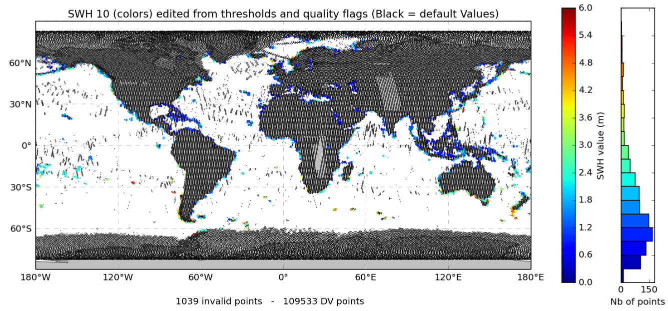





Total invalid data from beam 8 (not continental)
Cycles 14 to 129 - per day statistics
MEAN (%)
AWWAIS 5.2
12-2019
12-2020
12-2021
12-2022
date
Mean = 26.4
StdDev = 2.28
Nbr = 1490


SWH 08 (colors) edited from thresholds and quality flags (Black = default Values)
937 invalid points - 107706 DV points
SWH value (m)
Nb of points


Total invalid data from beam 10 (not continental)
Cycles 14 to 129 - per day statistics
MEAN (%)
AWWAIS 5.2
12-2019
12-2020
12-2021
12-2022
date
Mean = 28.01
StdDev = 2.511
Nbr = 1490


SWH 10 (colors) edited from thresholds and quality flags (Black = default Values)
1039 invalid points - 109533 DV points
SWH value (m)
Nb of points

Main Part V

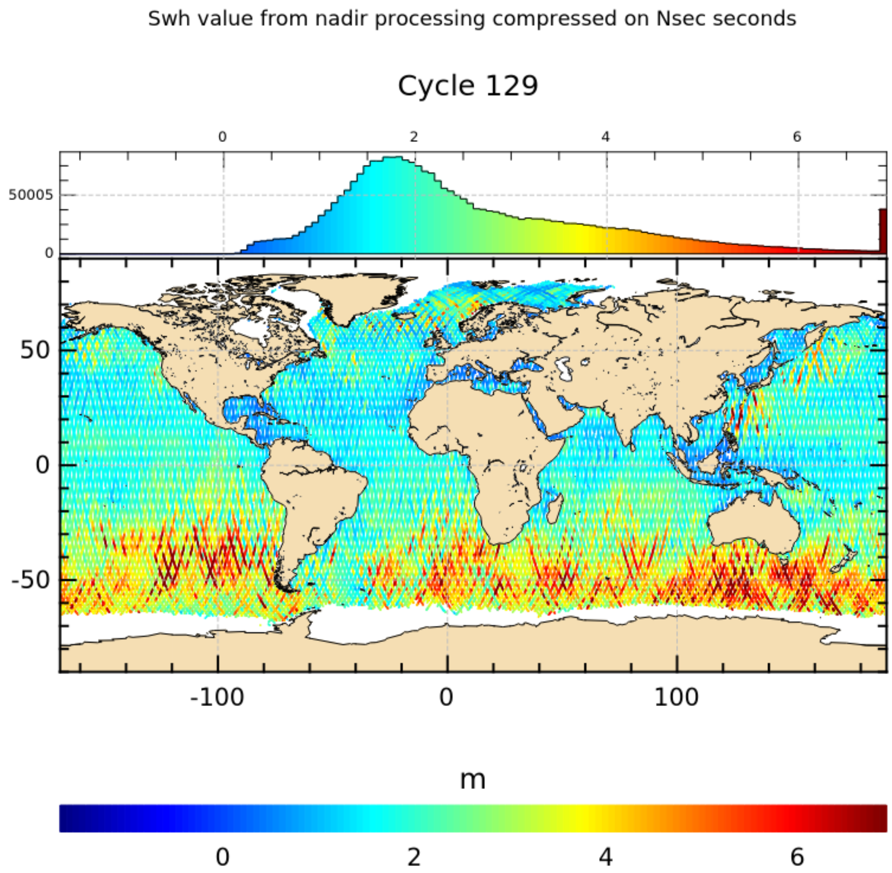
SWIM nadir monitoring

Part 11

Current cycle maps of valid SWH and wind speed

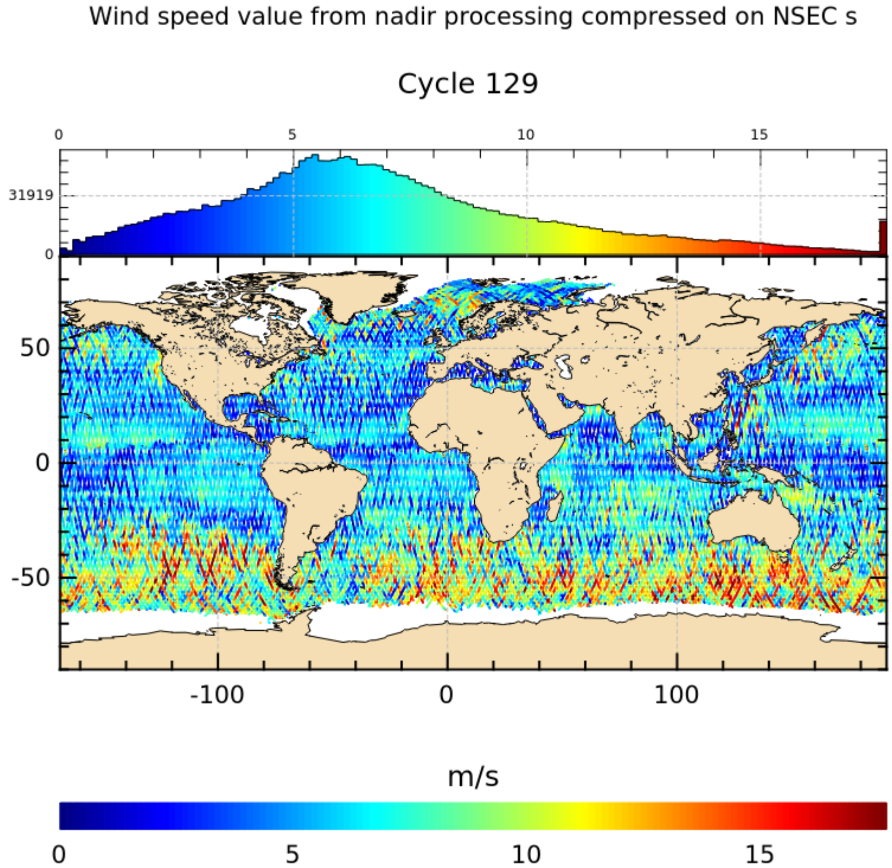
11.1 Current cycle map of valid SWH

Two types of nadir waves are monitored: native SWH and Nsec SWH. The native SWH is the output of the adaptive retracking at 5Hz resolution. The Nsec SWH is the native SWH compressed with a sliding window of N seconds; here Nsec has a 5Hz resolution. In this part, only valid data are assessed, i.e. all values rejected based on the editing described previously are not taken into account.



Nbr :	2731552	Std Dev :	1.437978	Min :	0.073
Mean :	2.6054786	Median :	2.202	Max :	14.363

11.2 Current cycle map of wind speed



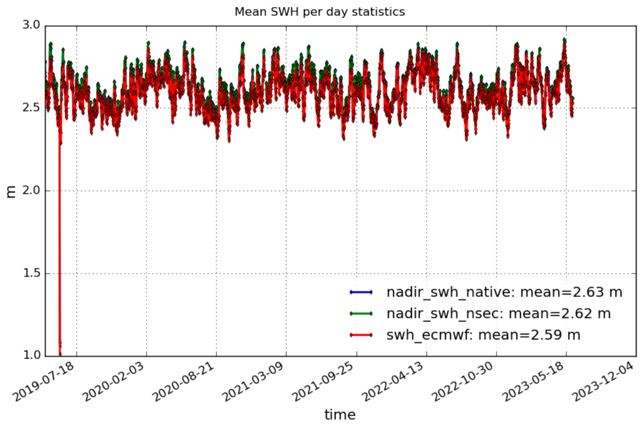
Nbr :	*2731552*	*Std Dev :*	*3.5774302*	*Min :*	*0*
Mean :	*6.9664345*	*Median :*	*6.457*	*Max :*	*24.146*

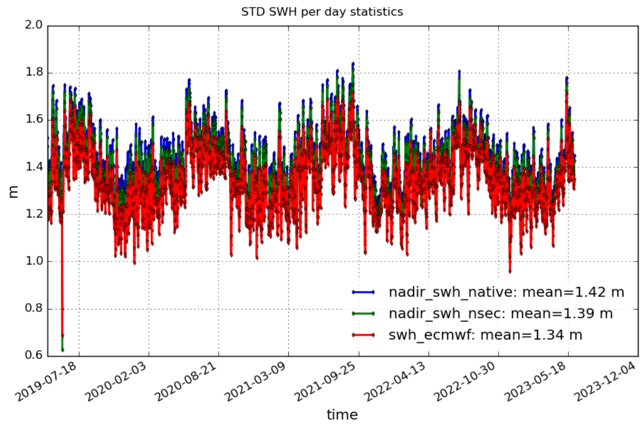
Part 12

SWIM nadir versus ECMWF model

The following figures compare SWH from SWIM nadir to that of the ECWMF model. The editing criteria applied to SWIM data are equally applied to ECMWF in order to perfom a direct comparison.

12.1 Long term monitoring along track for SWH

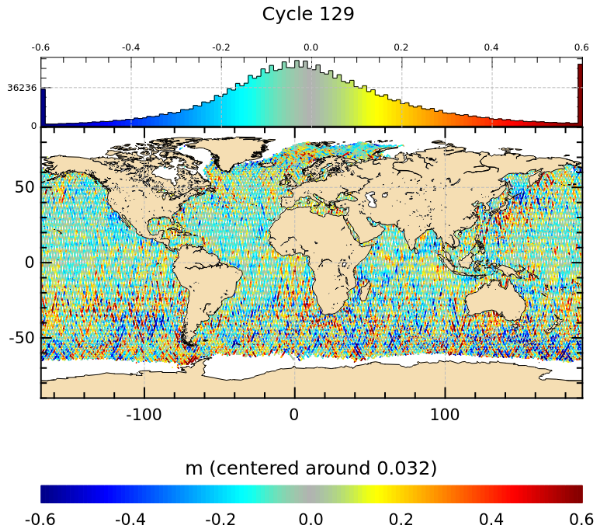




12.2 Current cycle map of SWH difference with ECMWF model

This maps represent the difference SWIM nadir - ECMWF for the current cycle.

Significant wave height Nsec vs ECMWF differences



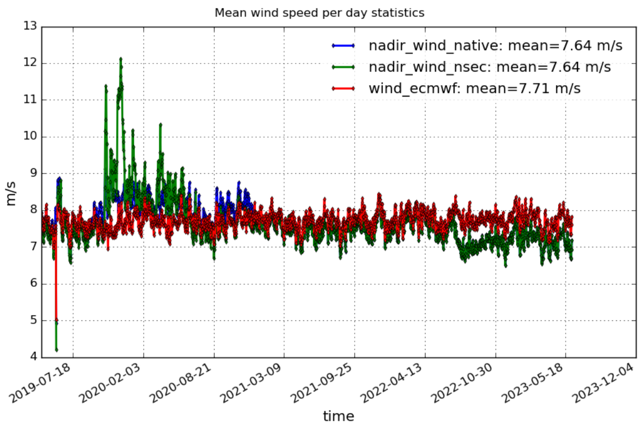
Nbr :	*2723645*	*Std Dev :*	*0.25126594*	*Min :*	*-2.586446*
Mean :	*-2.3527771e-16*	*Median :*	*-0.016445963*	*Max :*	*4.537554*

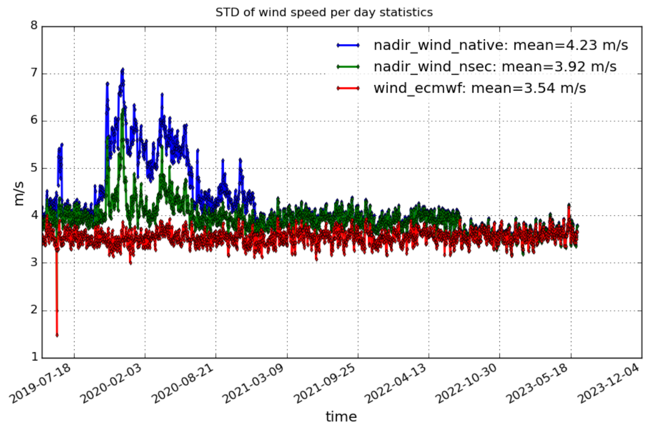
Part 13

Wind speed versus ECMWF model

The following figures compare the wind speed from SWIM nadir to that of the ECWMF model.

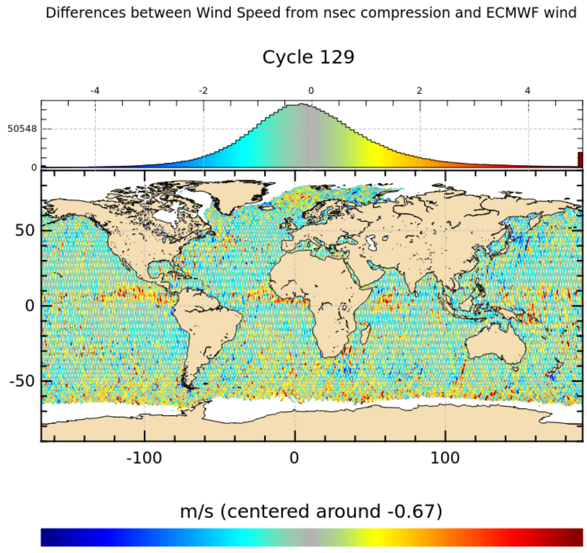
13.1 Long term monitoring along track for wind speed





13.2 Current cycle map of Wind speed difference with ECMWF model

This maps represent the difference Wind Nadir (Nsec) - ECMWF for the current cycle.

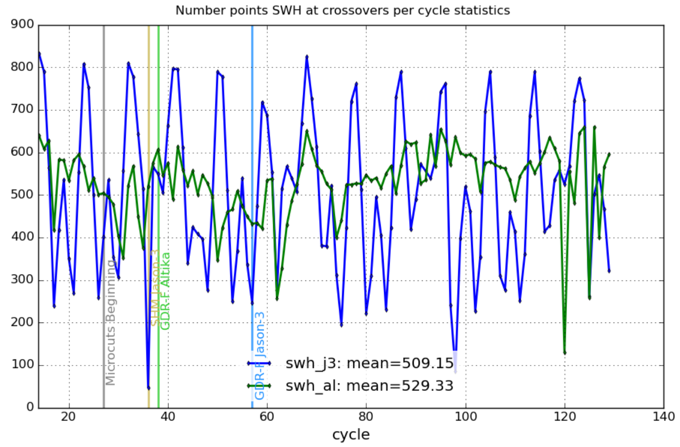


Nbr :	2731552	Std Dev :	1.383212	Min :	-30.13281
Mean :	3.0175457e-14	Median :	-0.11339828	Max :	14.966461

Part 14

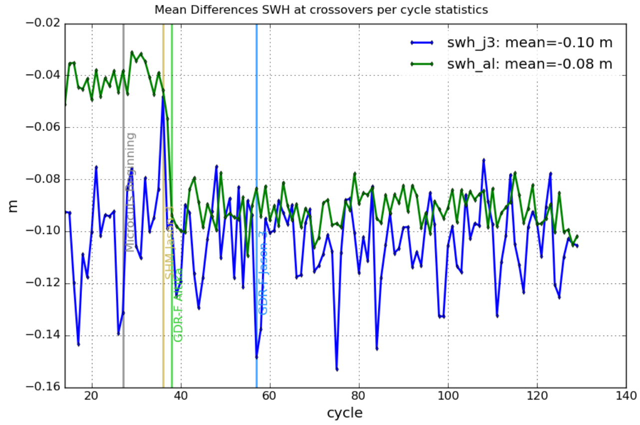
CFOSAT/SWIM nadir versus AL and J3 at crossovers (3h)

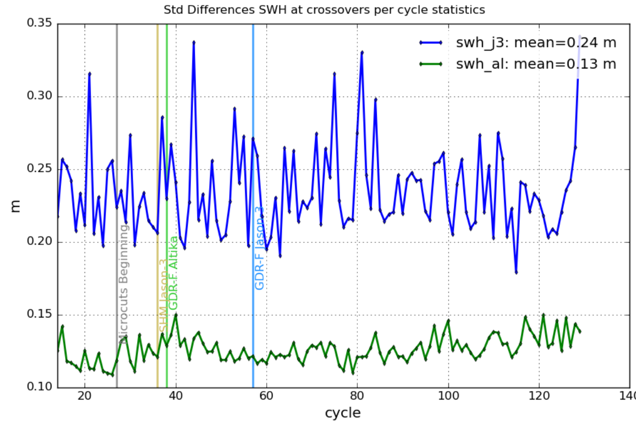
Crossovers are computed between CFOSAT nadir/Altika and CFOSAT nadir/Jason-3, using a maximum time lag of 3 hours. The parameters SWH, sigma0, and wind are compared at the crossing points, and the corresponding differences are computed between two satellites (CFOSAT minus crossing satellite). The SWH validity flag is applied to Altika and Jason-3, and the editing described in Part 9 is applied to CFOSAT (cf. Table 9.1). The number of crossover points between Altika and CFOSAT is stable, whereas that between CFOSAT and Jason-3 varies due to Jason-3's orbit geometry, creating a subcycle of 120 days as seen in the figure below.



14.1 Long term monitoring along track SWH (CFO/AL/J3)

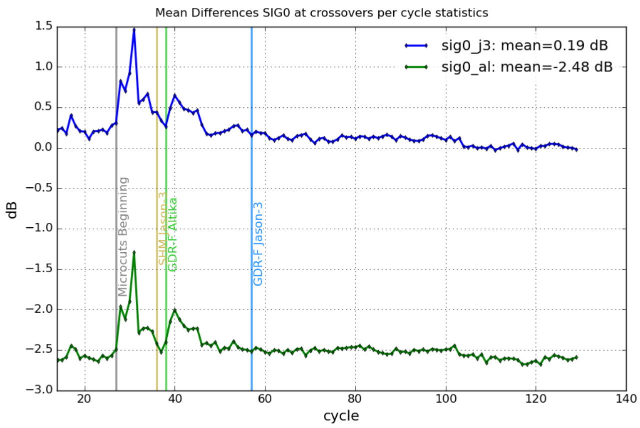
A change in Altika's mission ground segment, to standard-F, occured during SWIM's cycle 38. This lead to a variation in the SWH mean difference between the two satellites, from 4 to 10 cm, while the standard deviation remained stable. The change of Jason-3 to standard-F occured during SWIM's cycle 57.

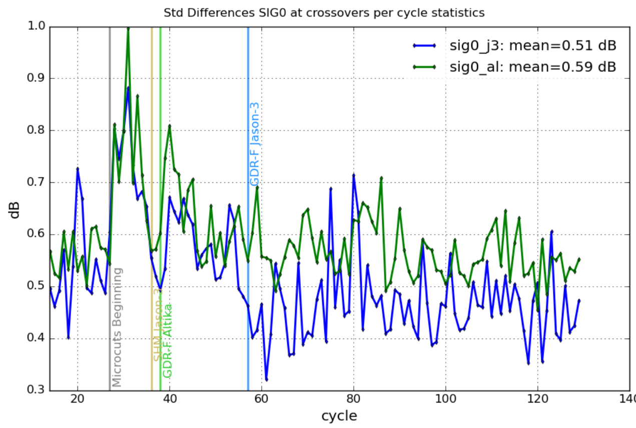




14.2 Long term monitoring along track sigma0 (CFO/AL/J3)

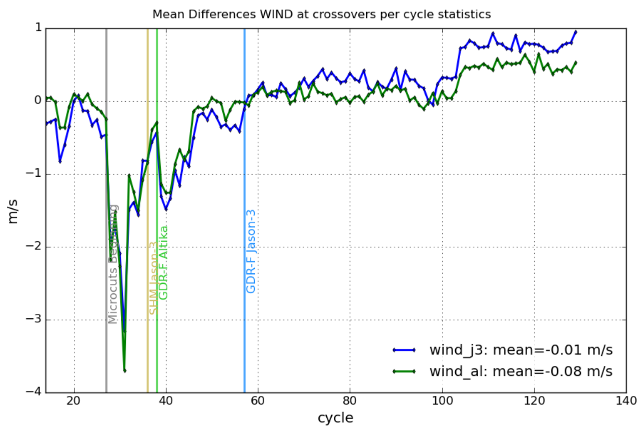
Since mid October 2019, SWIM has been affected by microcuts that occasionally and randomly lower the level of the radar echoes inside a macrocycle. This problem introduces a decrease in SWIM's sigma0, therefore an increase in the differences between satellites, seen in both the mean and standard deviation figures below (after the vertical line "Microcuts beginning"). Starting from cycle 47 (end of June 2020), a new variable that flags affected data is computed and included in the products.
Both CFOSAT and Jason-3 operate at Ku-band, whereas Altika operates at Ka-band, which explains the offset in the mean sigma0 differences between CFOSAT and Altika.

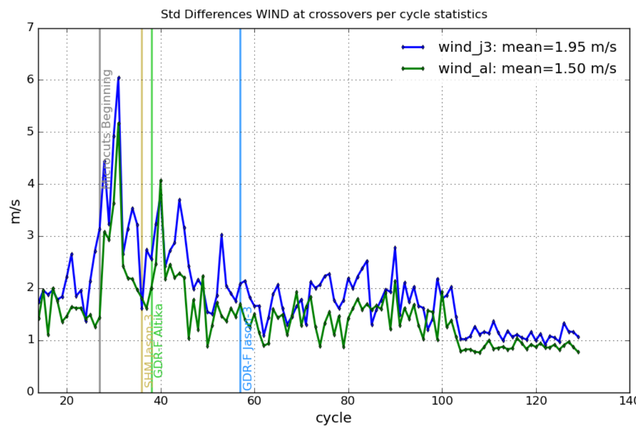




14.3 Long term monitoring along track wind (CFO/AL/J3)

Following SWIM's sigma0 variations due to the microcuts, the differences in wind between CFOSAT and Altika/Jason-3 also increased between cycles 27 and 45. These have nevertheless decreased since June 2020, when the change in SWIM's ground segment occured (represented by the vertical line "AWWAIS 5.0.1" in the figures).





Main Part VI

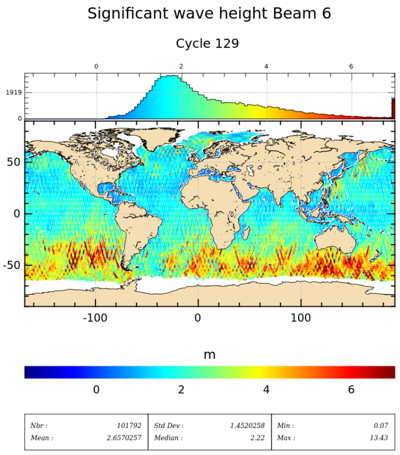
SWIM off-nadir monitoring

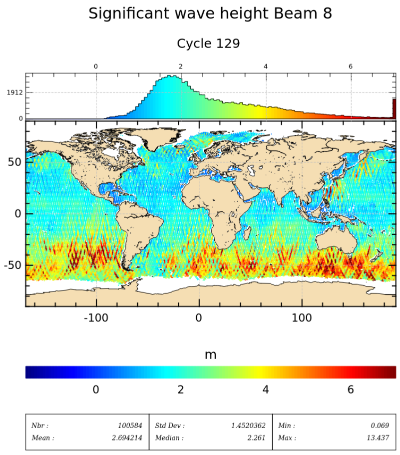
Part 15

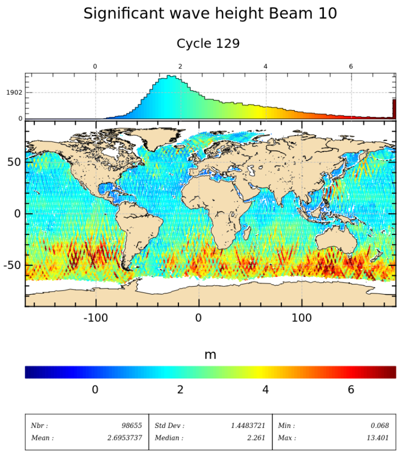
SWIM off-nadir current cycle maps per beam

15.1 SWH

SWH is retrieved from the spectra of beams 6°, 8° and 10°. This wave parameter is monitored in the following maps for the current cycle.

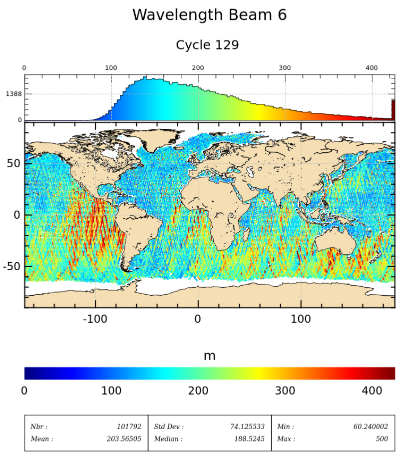


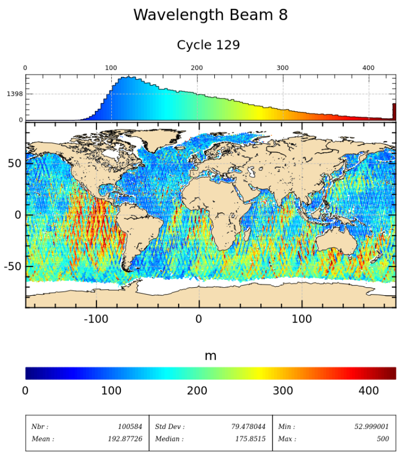


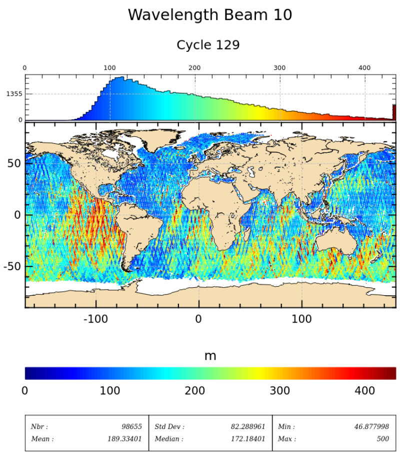


15.2 Wavelength

Peak wavelength is retrieved from the spectra of beams 6°, 8° and 10°. This wave parameter is monitored in the following maps for the current cycle.

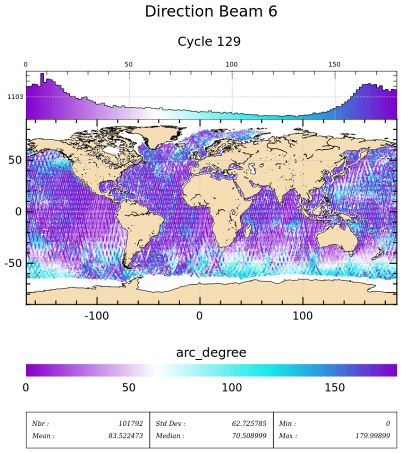


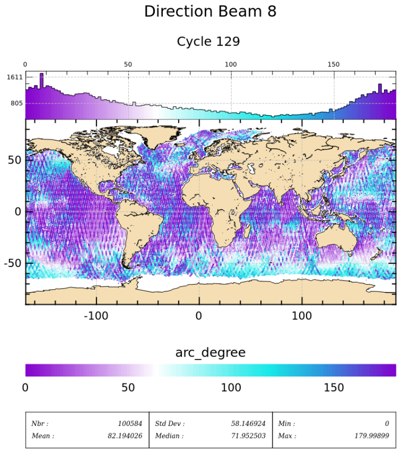


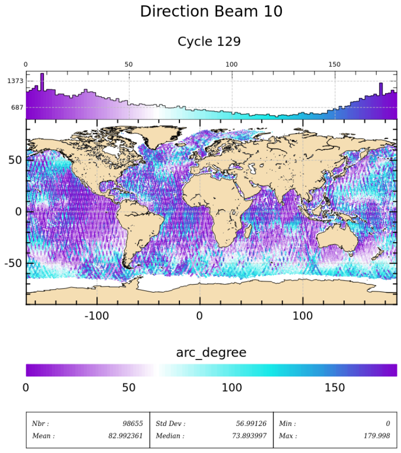


15.3 Direction

Peak direction is retrieved from the spectra of beams 6°, 8° and 10°. This wave parameter is monitored in the following maps for the current cycle.







Part 16

SWIM off-nadir versus models

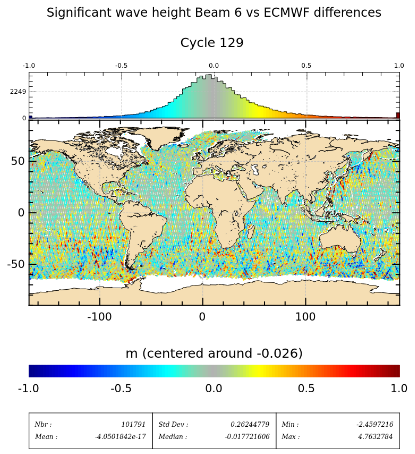
Two main events affect the time series shown below:
- at the beginning of the period concerned by the microcuts, the attenutation suffered by sigma0 affected the spectral distribution and thus the resulting estimated parameters;
- the introduction of the microcuts flagging and the evolution of the ground segment (e.g. MTF and speckle managing) upon the AWWAIS upgrade in June 2020.

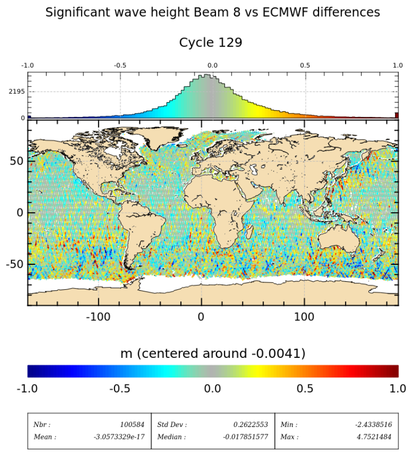
The figures of difference represent Model values subtracked from SWIM.

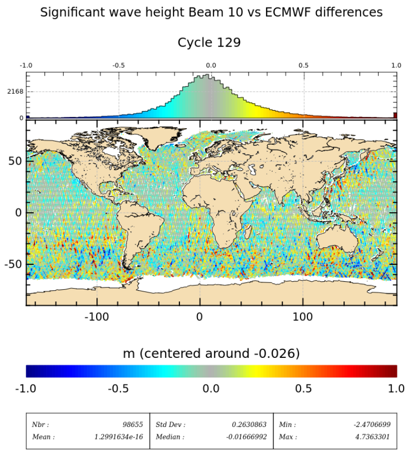
16.1 SWIM SWH versus ECMWF SWH

SWIM's SWH from beams 6°, 8° and 10° are compared to those from the ECMWF model, at the colocated points given in the Level-2 products.

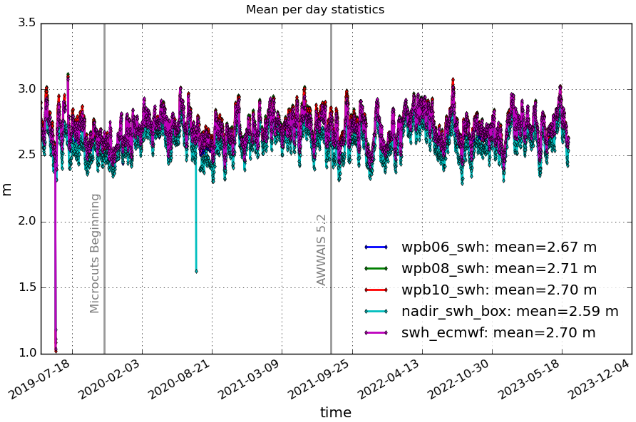
16.1.1 Current cycle maps of differences with ECMWF model

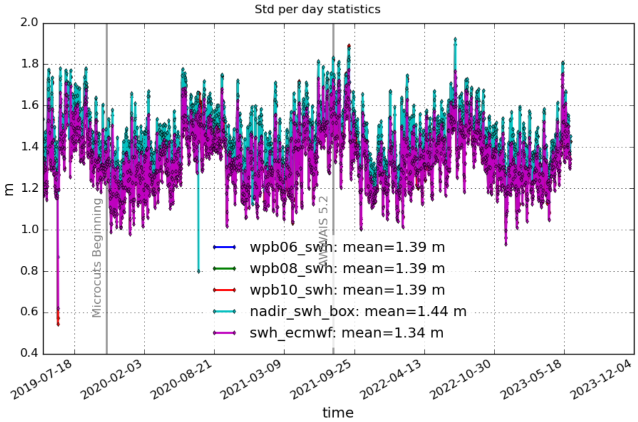






16.1.2 Long term monitoring along track

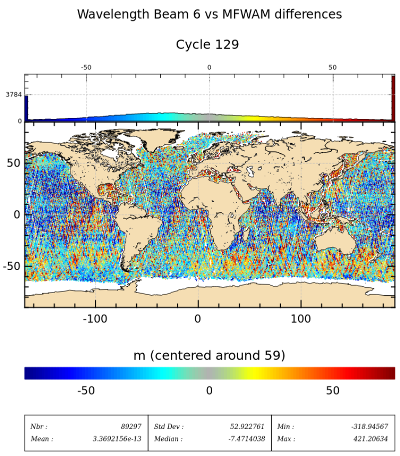


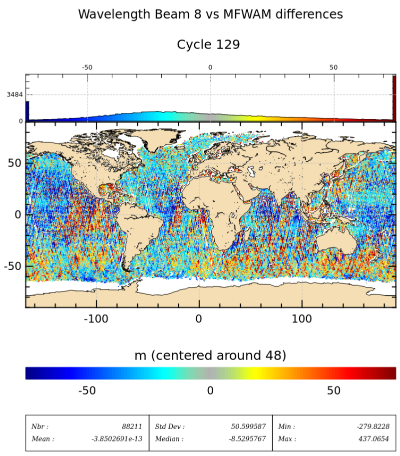


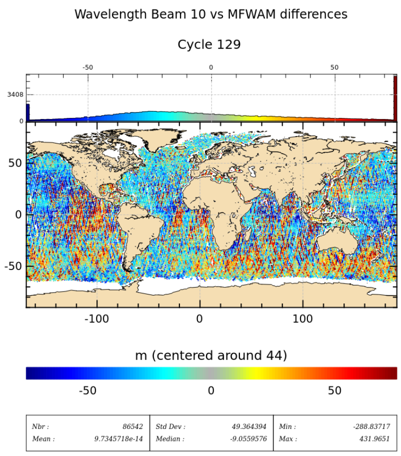
16.2 SWIM wavelength versus MFWAM wavelength

SWIM's wavelengths from beams 6°, 8° and 10° are compared to those from the MFWAM model, at colocated points.

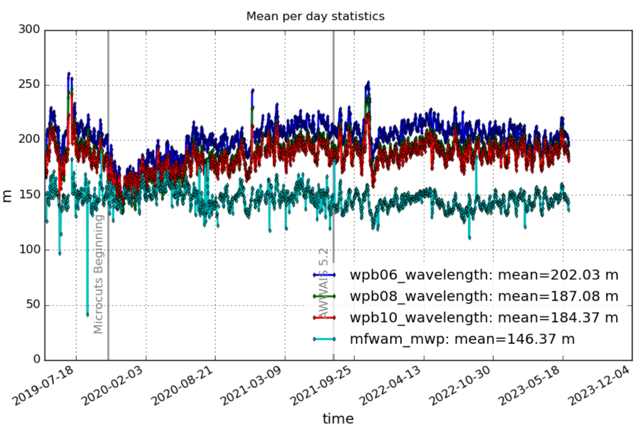
16.2.1 Current cycle maps of differences with MFWAM

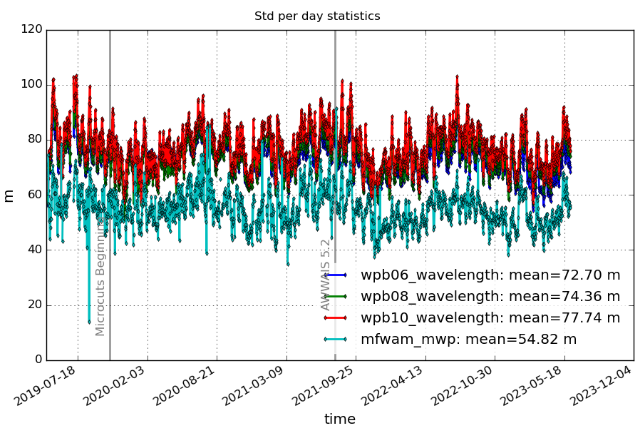






16.2.2 Long term monitoring along track

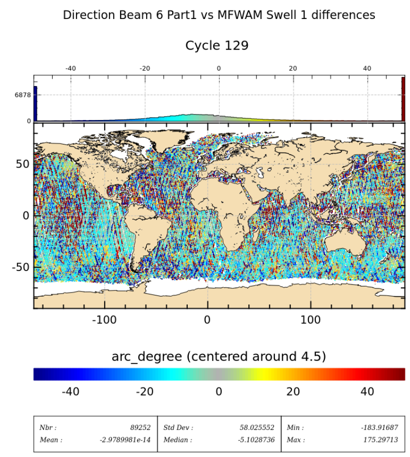


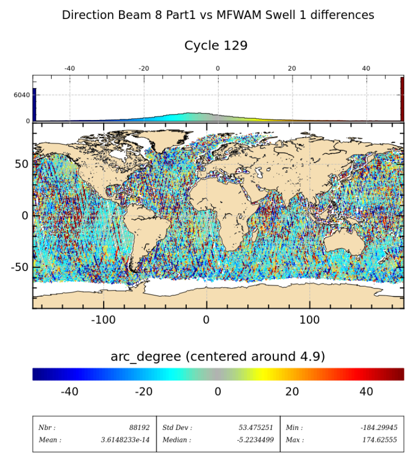


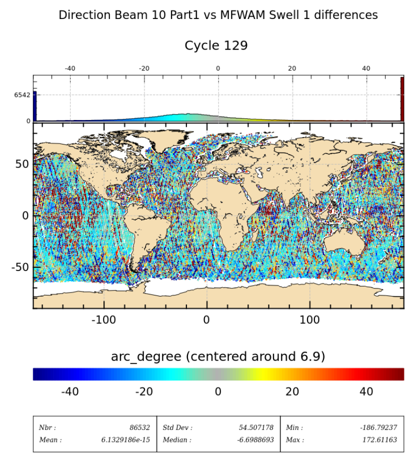
16.3 SWIM direction versus MFWAM direction

SWIM's peak directions of partition 1 from beams 6°, 8° and 10° are compared to those from the MFWAM model, at colocated points. MFWAM's peak direction is calculated from the mean direction of swell 1. To be comparable, MFWAM's peak values have been transformed from direction (0 - 360) to orientation (0 - 180).

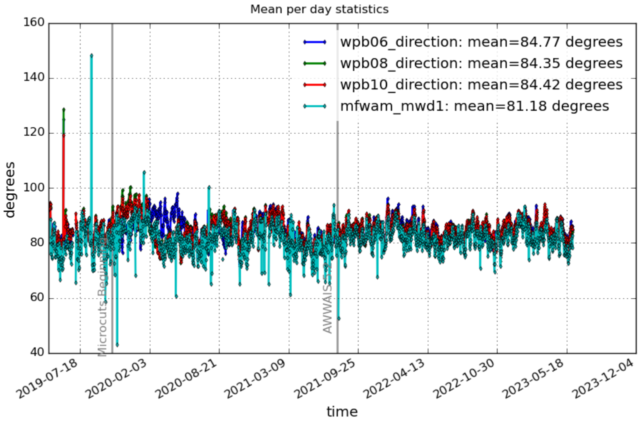
16.3.1 Current cycle maps of differences with MFWAM

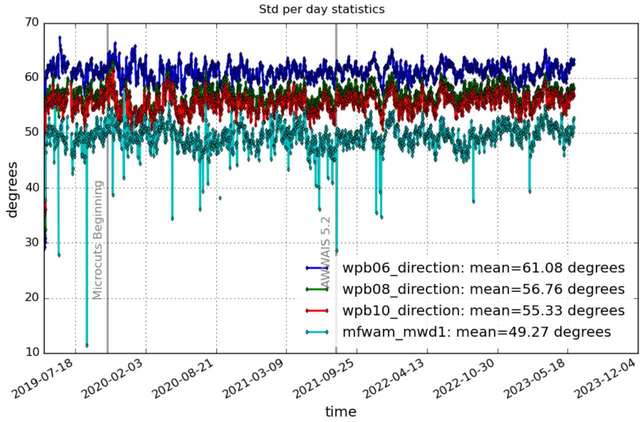






16.3.2 Long term monitoring along track





Part 17

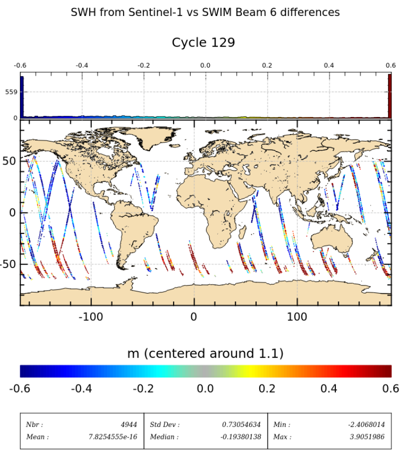
SWIM off-nadir versus Sentinel-1

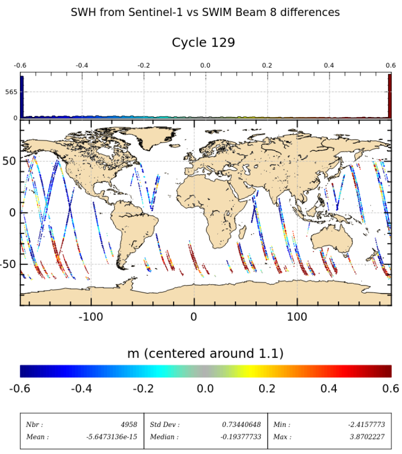
Crossovers are computed between Sentinel-1 and CFOSAT SWIM off-nadir data. Crossover points are selected if:
- the distance between Sentinel-1 and CFOSAT spectra is less than 100 km;
- the time difference is less than 1 hour.

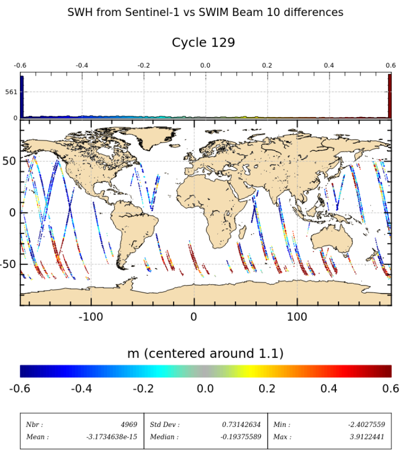
This leads to a specific pattern: Sentinel-1 and CFOSAT crossovers happen only in ascending CFOSAT passes.
The maps below show the along track differences between Sentinel-1 (most significant partition) and CFOSAT/SWIM per beam, for this cycle. The figures of difference represent Sentinel-1 values subtracked from SWIM.

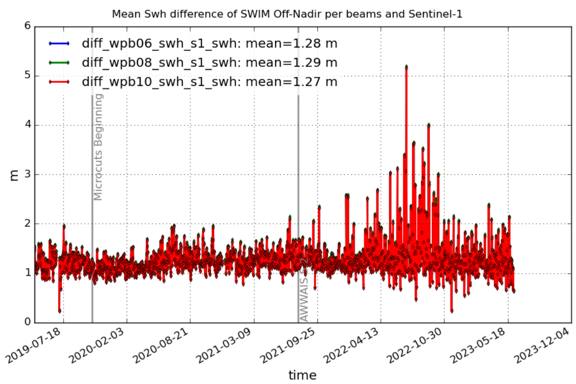
17.1 SWH

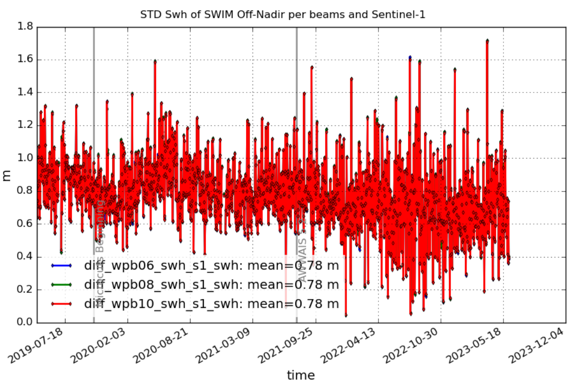
The following figures show the SWH comparison between SWIM and Sentinel-1.











17.2 Wavelength

The following figures show the wavelength comparison between SWIM and Sentinel-1. Here, the largest differences are possibly due to instrinsic discrepancies in behaviour between the two instruments; this subject is under investigation.