



## Systematic Calval SWIM - CFOSAT

CNES, CASYS

Synthesis report on parameters quality: cycle 27 (2019-10-05 - 2019-10-18)



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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: 6.0.3;
- CDB version: 23\_32;
- CASYS version: 6.0.2.

**Specific events** Nothing to report.

**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 |

## 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 altimeter during the current cycle and gives notice of possible incidents.

|   | Parameter                    | Comments  |
|---|------------------------------|---|
| 1 | Operating modes              | The operating mode is OK<br>(normal tracking sequences and calibration modes) |
| 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                           |

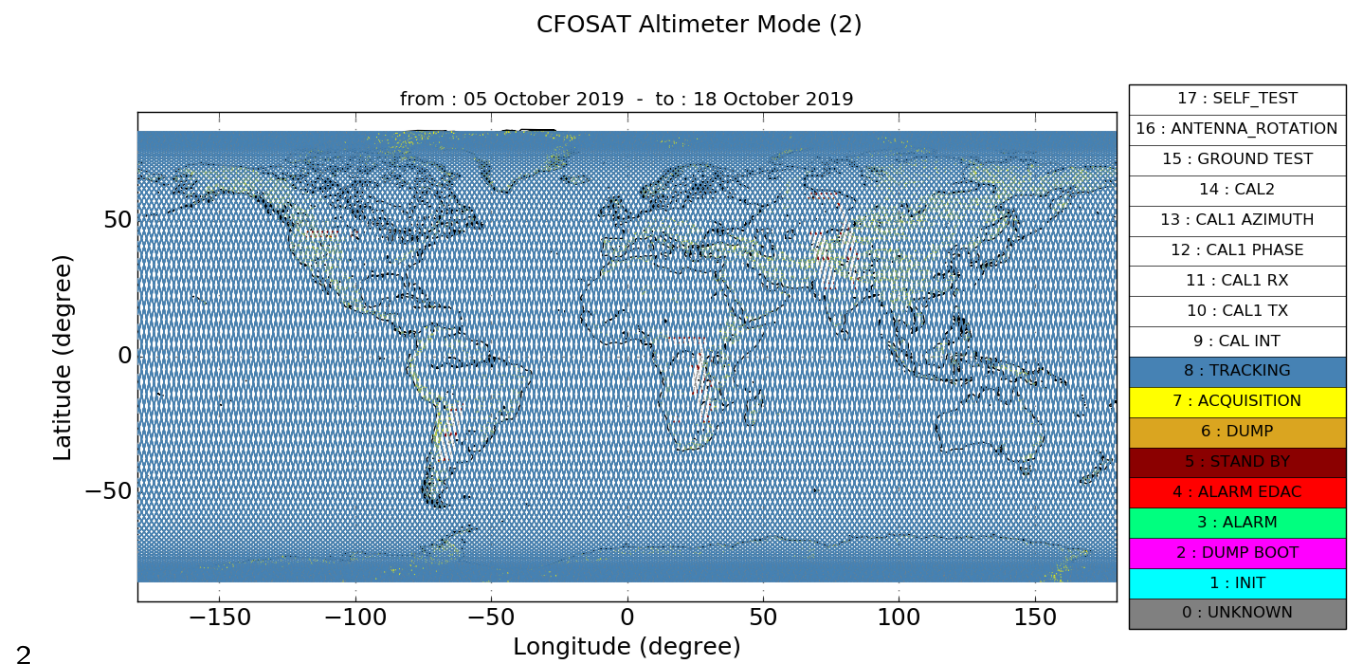
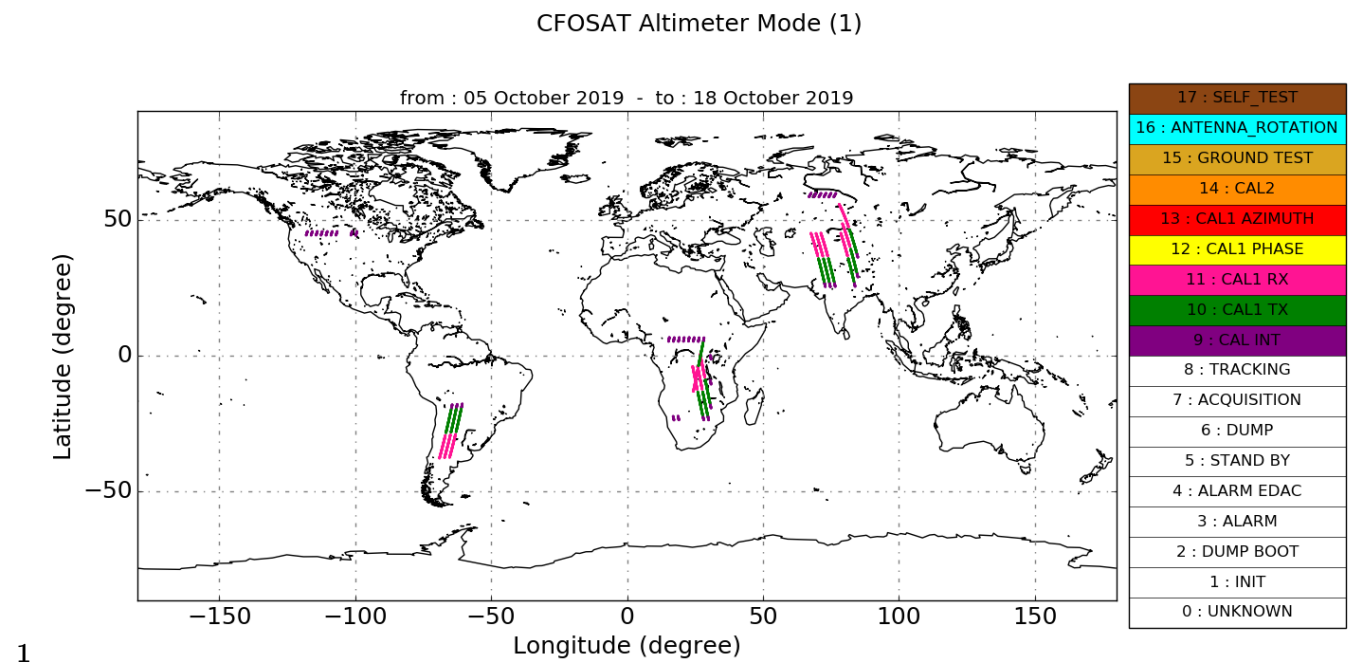
Color legend:

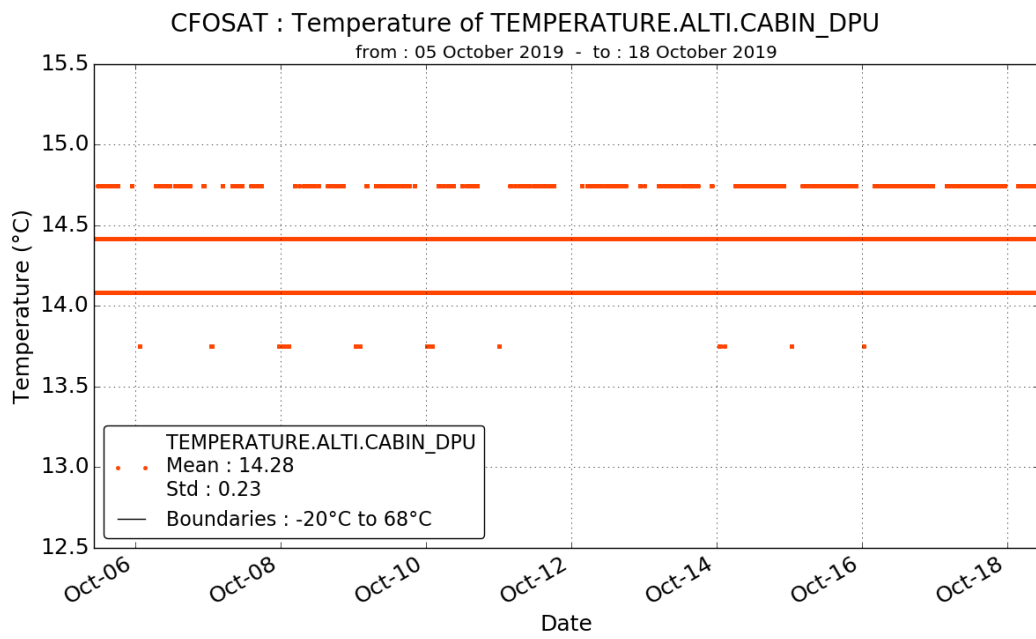
|  |         |
|--|---------|
|  | OK      |
|  | Warning |
|  | NOK     |

Part 4

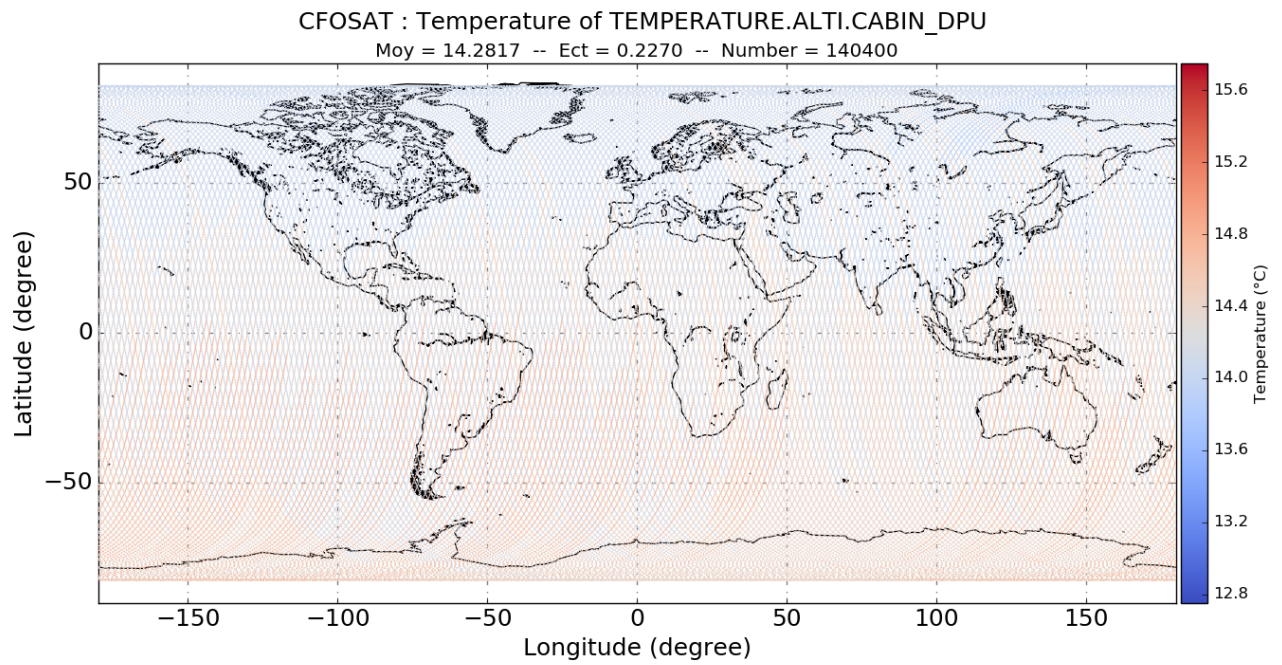
Altimeter Mode and House Keeping

This part presents the altimeter modes and the DPU cabin temperature (taken from the House Keeping telemetry data).





3

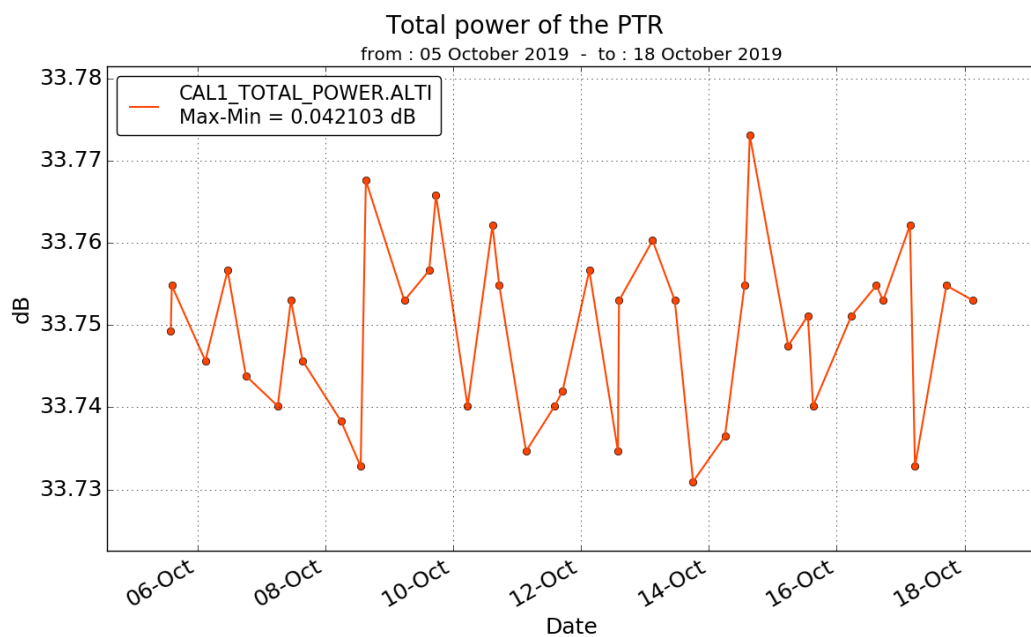


4

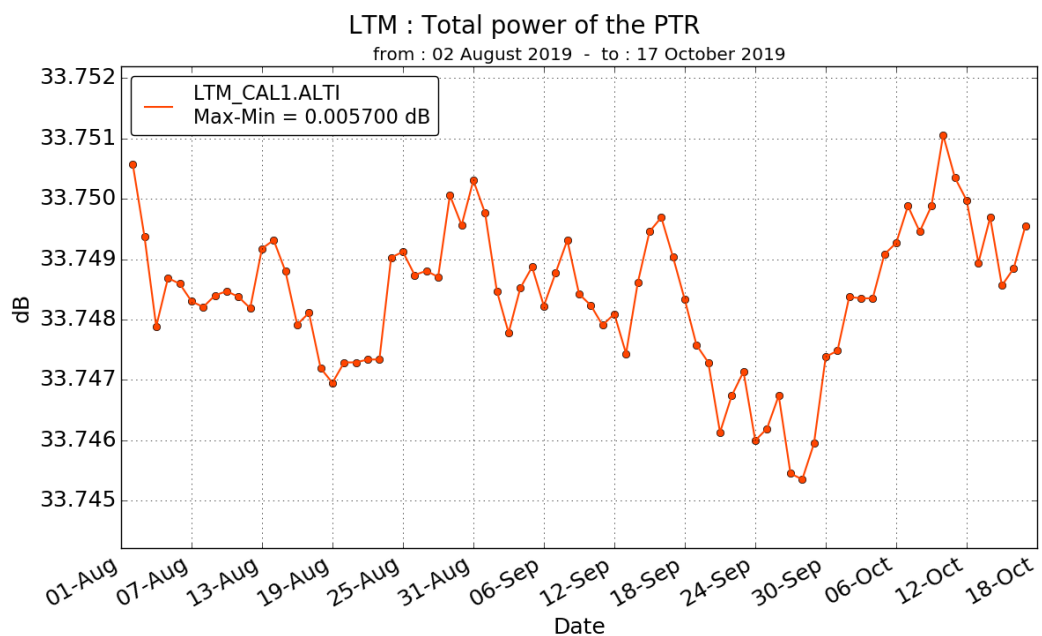
## Part 5

# CAL1 Internal Sequence

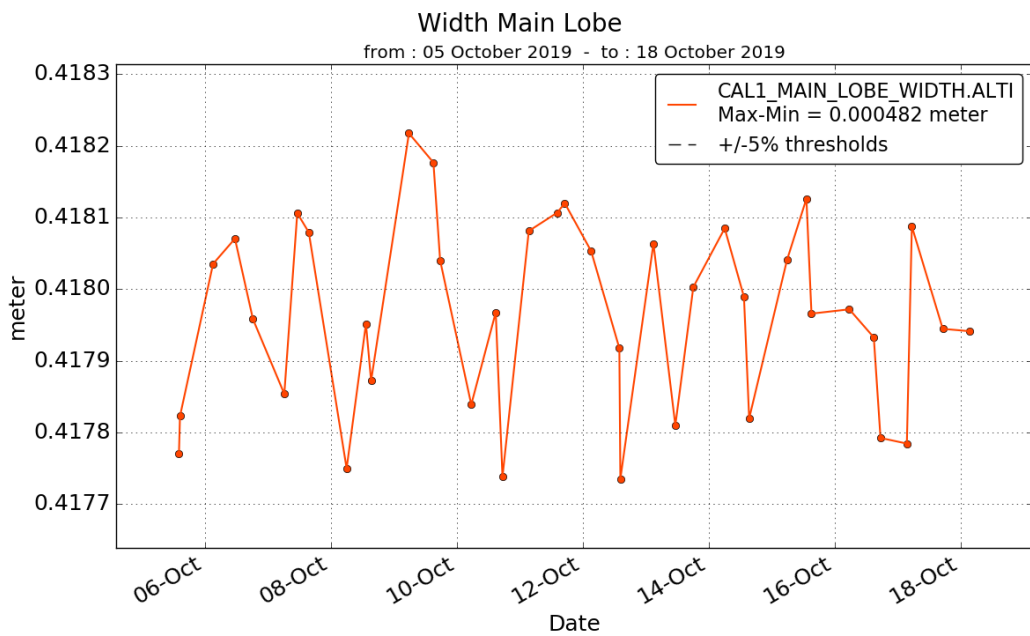
This part presents the major characteristics - total power, width, and position of the peak - of the main lobe of the Point Target Response (PTR). These are presented for the current cycle and since cycle 22 (averaged within a 13-day sliding window).



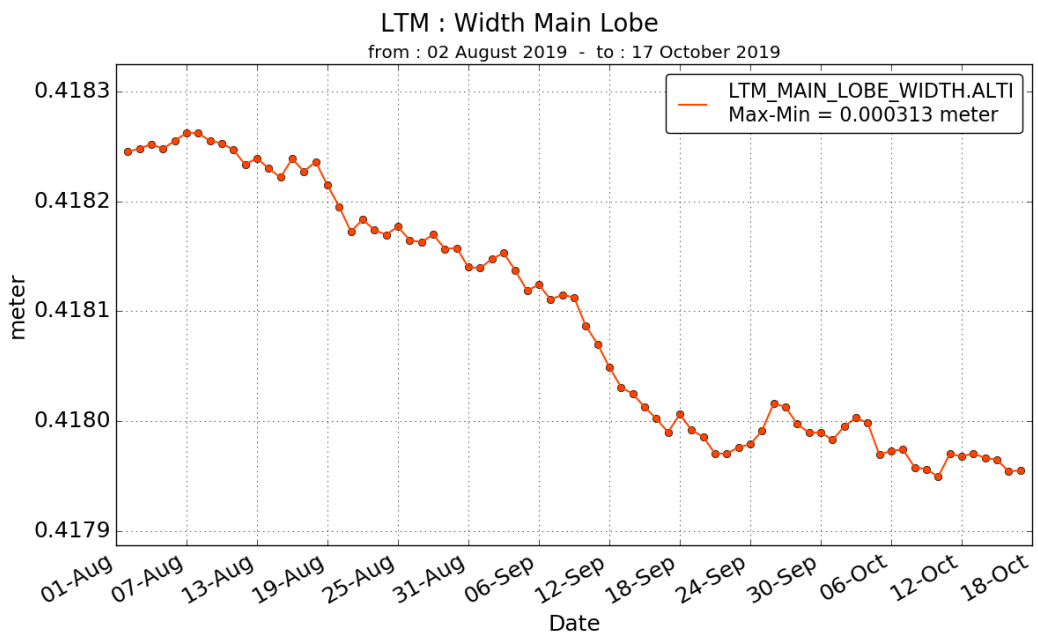
5



6



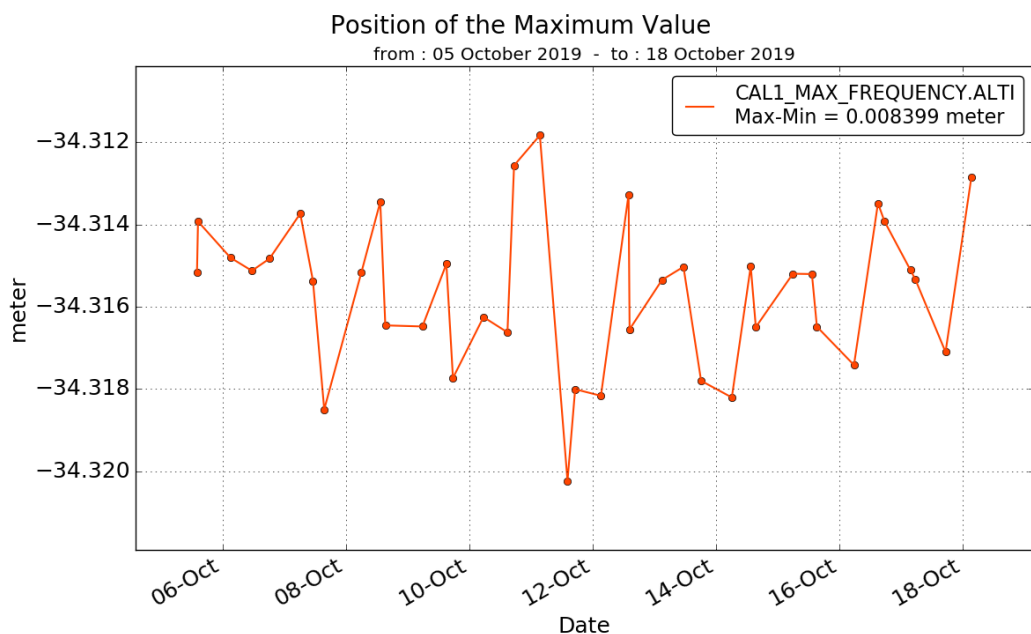
7



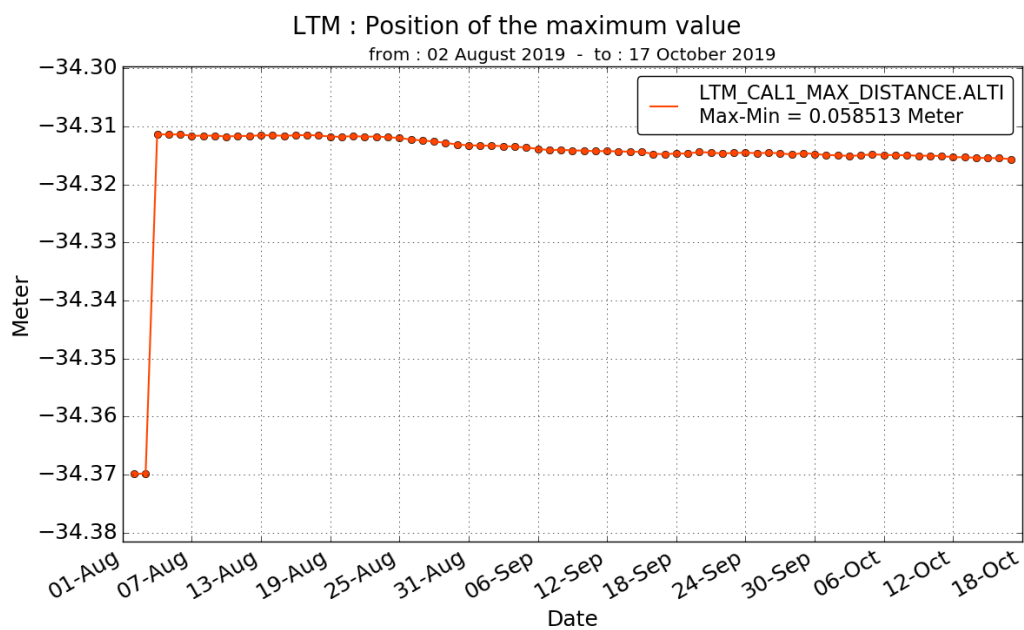
8



9



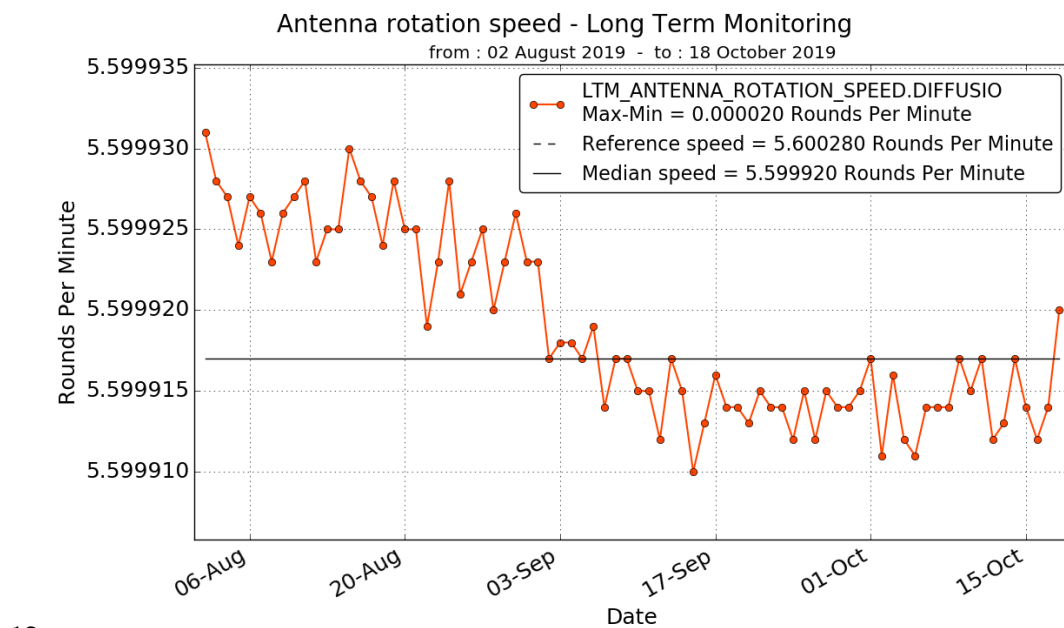
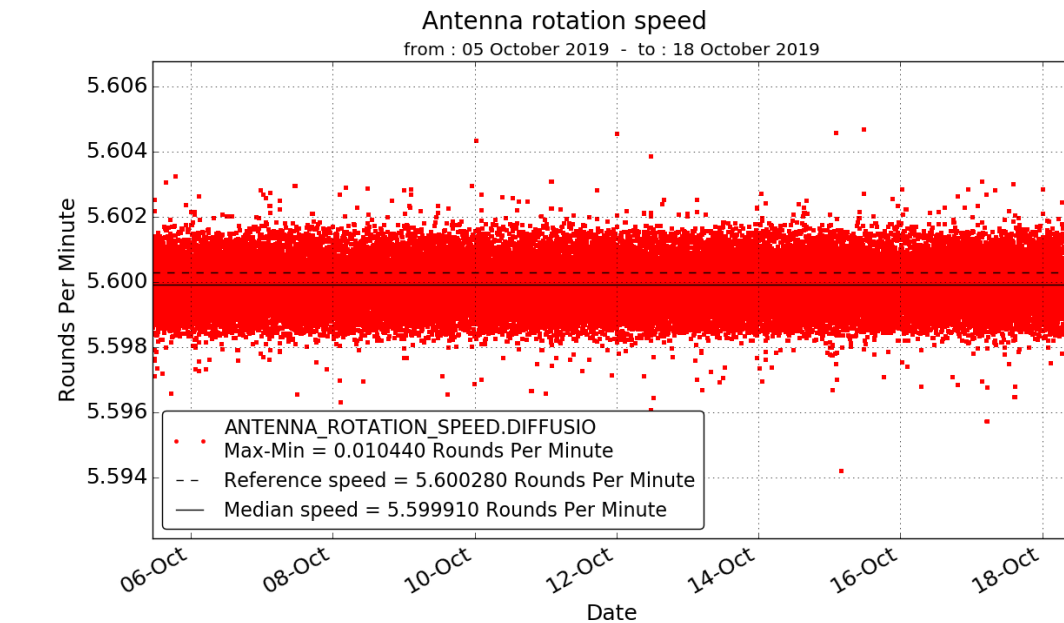
10



## Part 6

# Antenna Rotation Speed

The following plots shows the antenna rotation speed for the current cycle and since cycle 22. For more information on possible data gaps in the top plot please refer to Parts 1 and 2.



# Main Part III

## Coverage

## Part 7

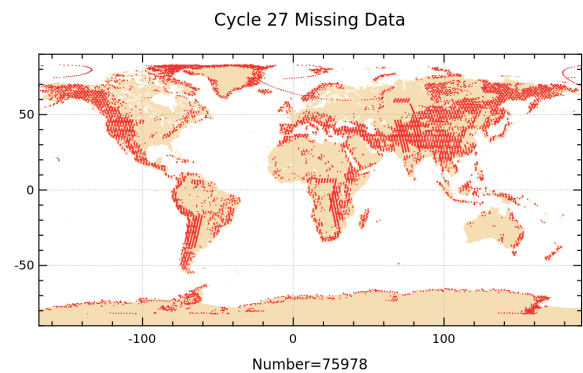
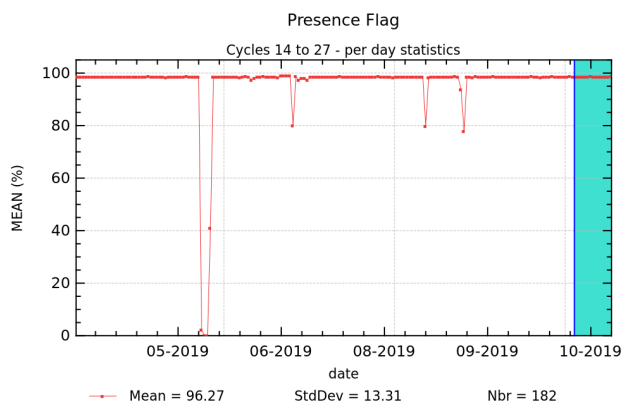
# Coverage nadir 5Hz

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 027** No missing data.

Table 7.1: SWIM nadir 5Hz coverage

| Percentage on current cycle                     | Cycle 27 |
|---|----------|
| Percentage of available measurements over ocean | 99.95 %  |
| Percentage of missing measurements over ocean   | 0.05 %   |



## Part 8

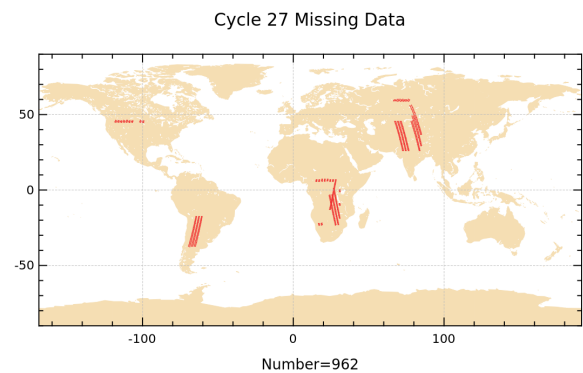
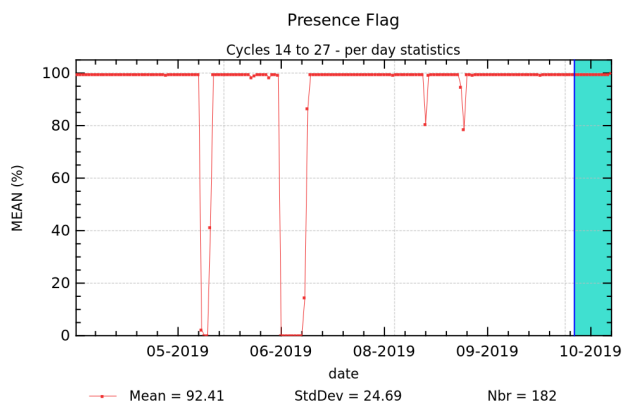
# Coverage off-nadir

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 027** No missing data.

Table 8.1: SWIM Box Left/Right coverage

| Percentage on current cycle                     | Cycle 27 |
|---|----------|
| Percentage of available measurements over ocean | 100.00 % |
| Percentage of missing measurements over ocean   | 0.00 %   |



# 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.

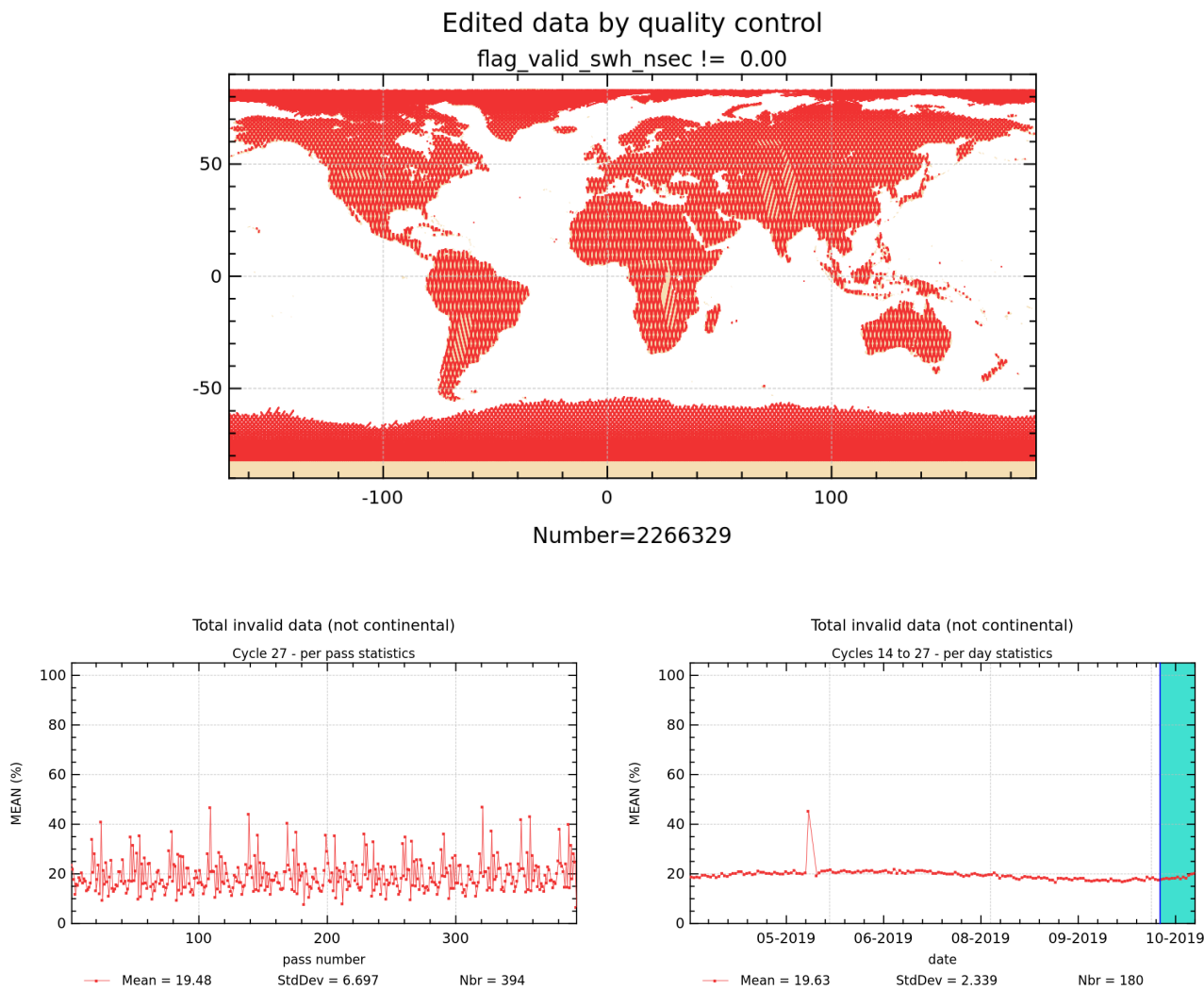
Maps in this part represent data on land and ocean for the current cycle, whereas temporal monitorings are given on ocean only.

Table 9.1: Thresholds for data editing

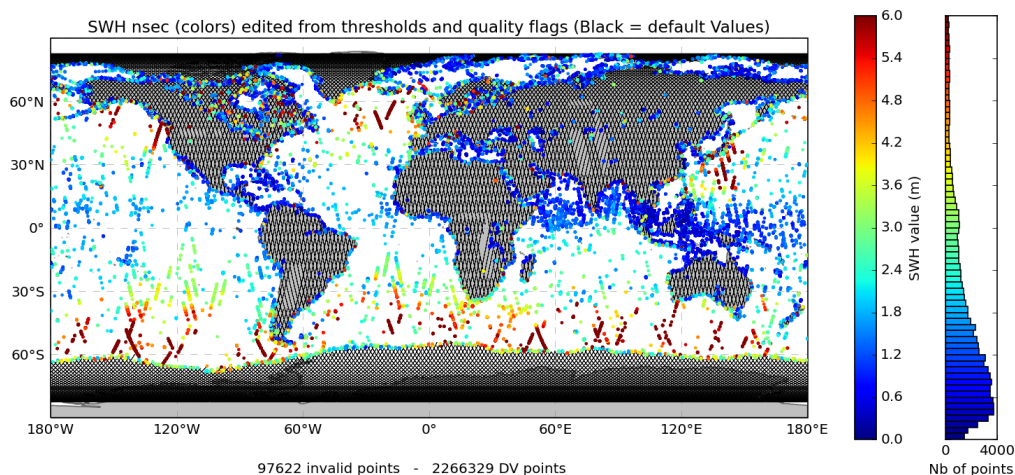
| Variables 5Hz          | Min value | Max value                       |
|------------------------|-----------|---------------------------------|
| nadir_swh_native       | 0         | 20                              |
| nadir_swh_nsec_used    | 10        | 20                              |
| nadir_swh_nsec_std     | 0         | $0.4 + \text{SWH.ALTI} * 0.028$ |
| 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 27 |
|---|----------|
| Percentage of rejected points due to quality flag swh including product ice flag over ocean | 16.40 %  |
| Additionnal percentage of threshold rejection   | 2.18 %   |
| Total percentage of rejected measurements over ocean  | 18.58 %  |



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.

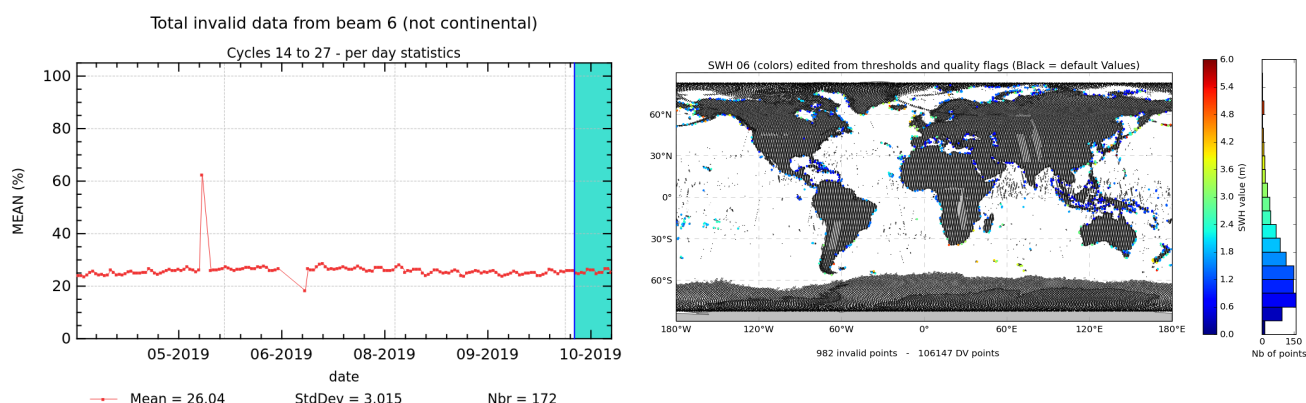
Table 10.1: Thresholds for data editing

| 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        |

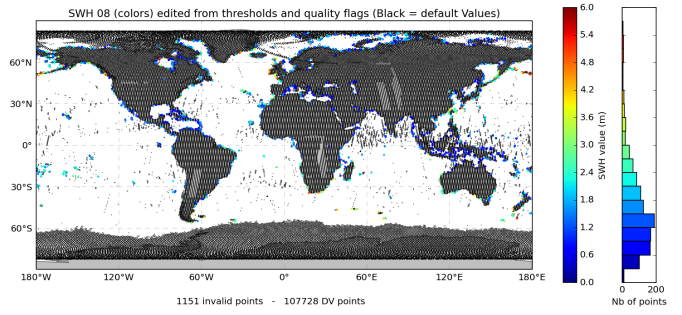
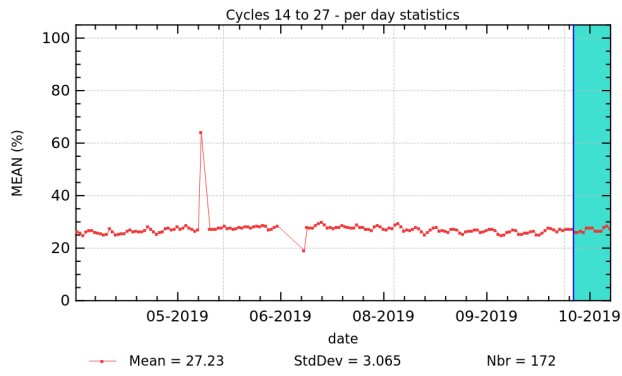
Table 10.2: Percentage of edited data

| Variables   | Beam 6  | Beam 8  | Beam 10 | Combined |
|---|---------|---------|---------|----------|
| Total percentage of default value in the product over ocean | 25.08 % | 26.26 % | 28.00 % | 1.99 %   |
| Additional ice rejection over all available measurements    | 0.00 %  | 0.00 %  | 0.01 %  | 12.72 %  |
| Additional land rejection over all available measurements   | 0.70 %  | 0.82 %  | 0.93 %  | 11.31 %  |
| Additional threshold rejection over ocean                   | 0.00 %  | 0.00 %  | 0.00 %  | 0.00 %   |
| Total percentage of rejected measurements over ocean        | 25.78 % | 27.09 % | 28.94 % | 26.03 %  |

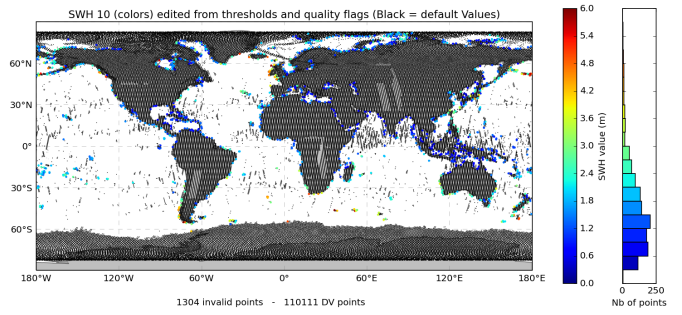
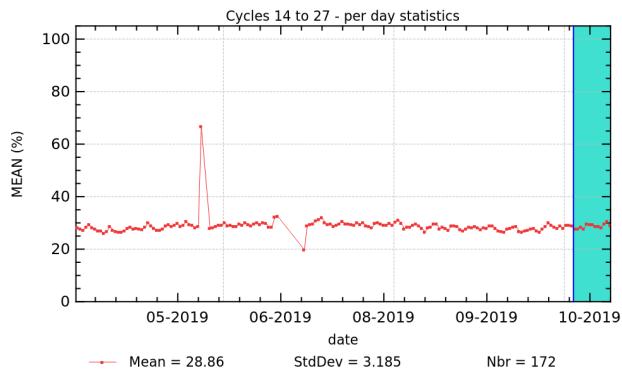
The following figures on the left show the percentage of rejected SWH points for beams 6°, 8° and 10° based on the editing criteria defined in Tables 10.1 and 10.2. The following maps on the right show, for beams 6°, 8° and 10°, the values of SWH (colors) that have been rejected. When this representation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



Total invalid data from beam 8 (not continental)



Total invalid data from beam 10 (not continental)



Main Part V

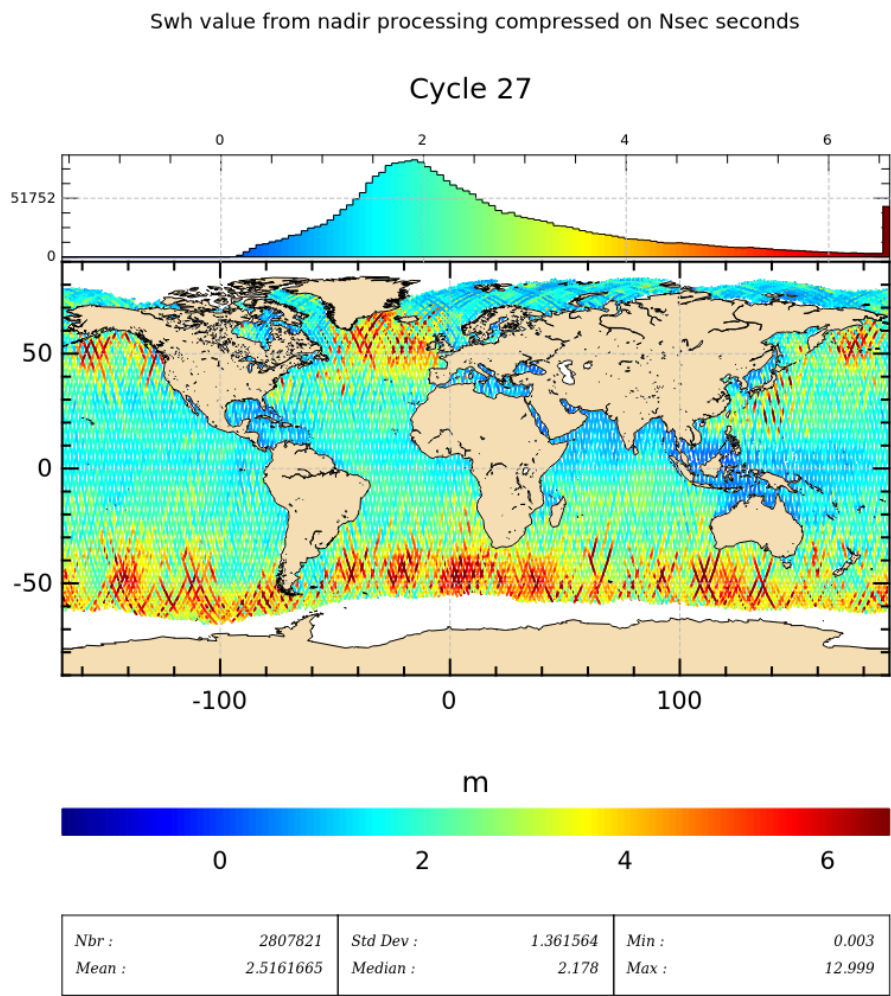
SWIM nadir monitoring

# Part 11

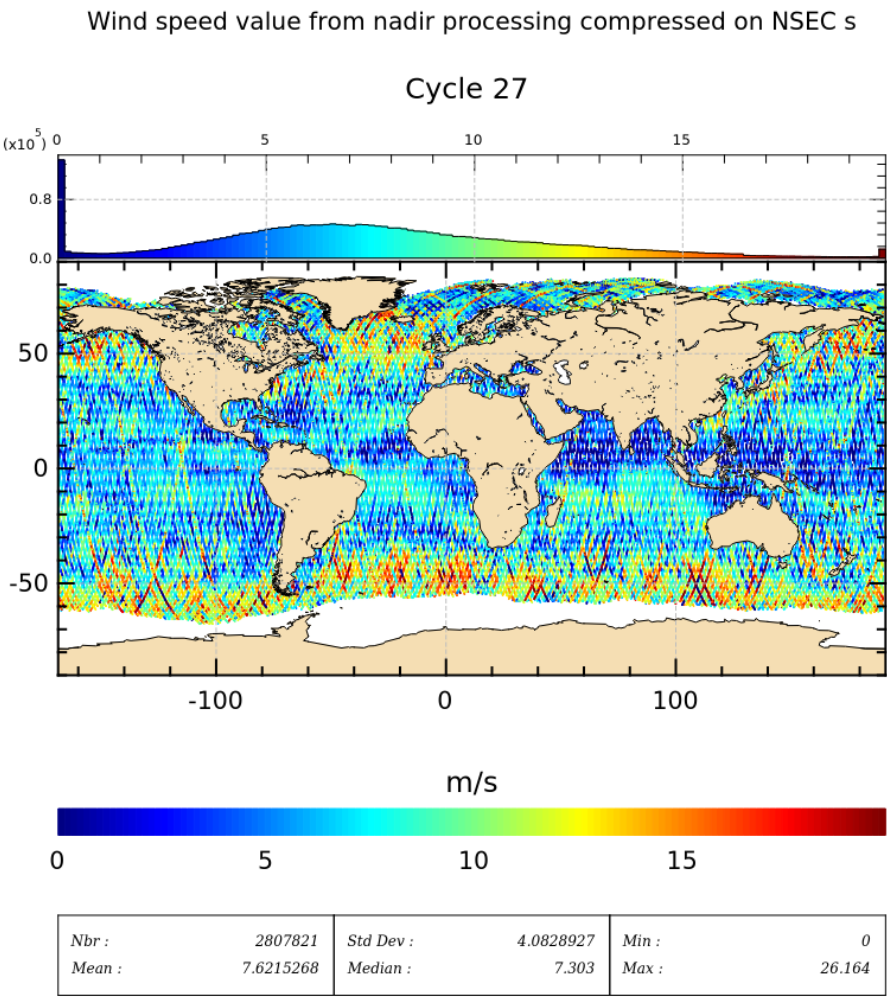
## Current cycle maps of valid SWH and wind speed

### 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.



11.2 Current cycle map of wind speed

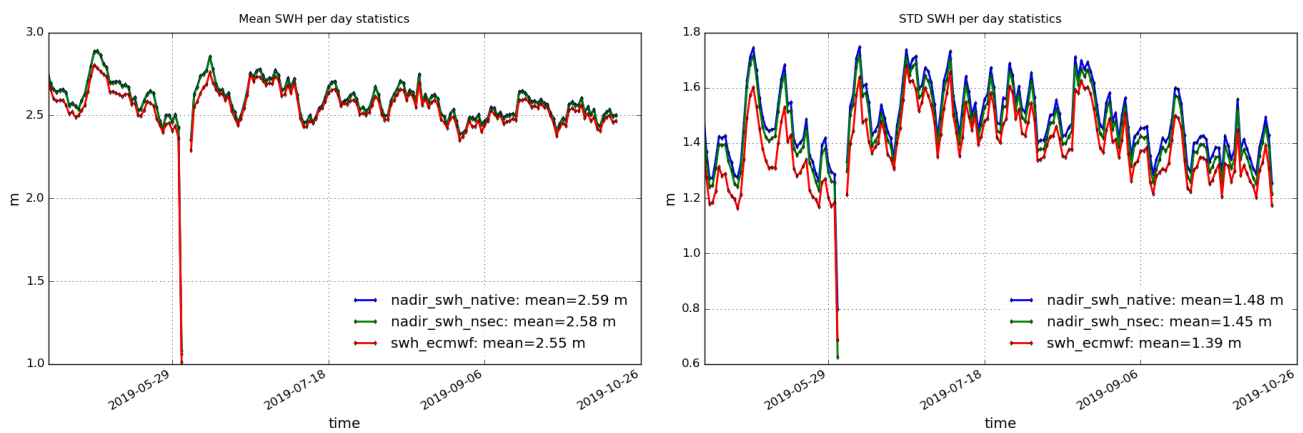


## Part 12

# SWIM nadir versus ECMWF model

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

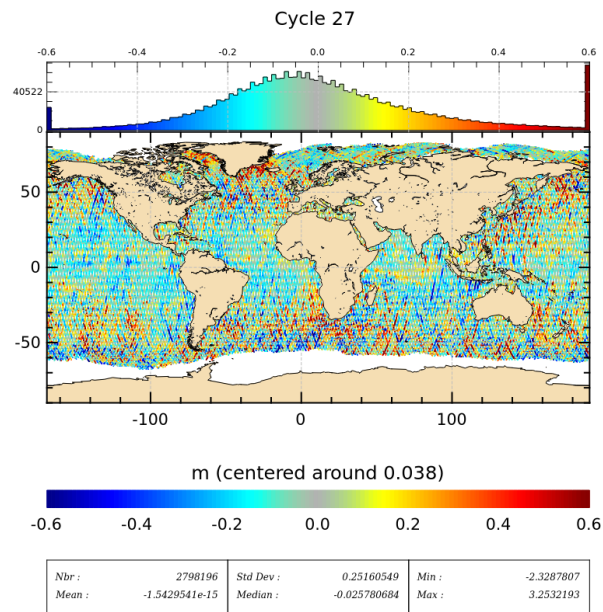
### 12.1 Long term monitoring along track for SWH



### 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

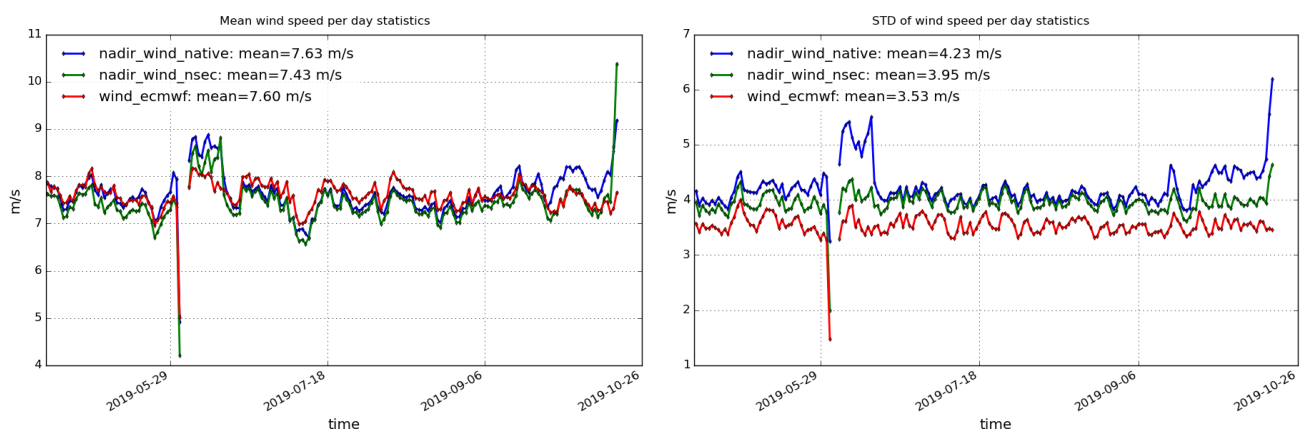


## Part 13

# Wind speed versus ECMWF model

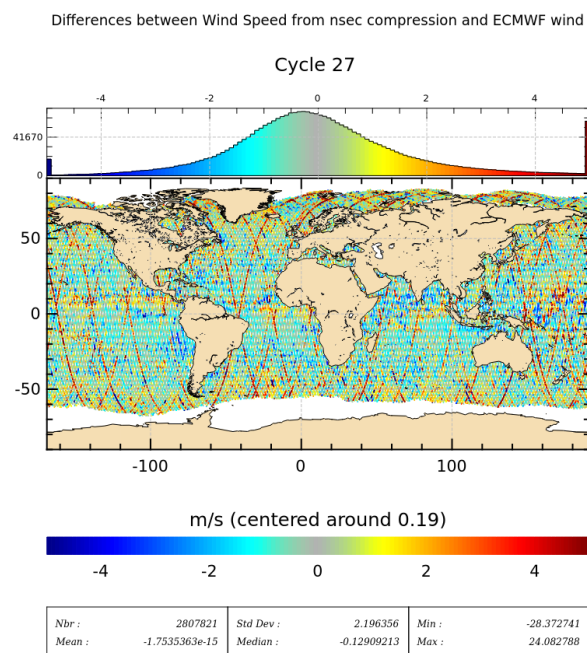
The following figures compare the wind speed from SWIM nadir to that of the ECMWF model.

### 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.

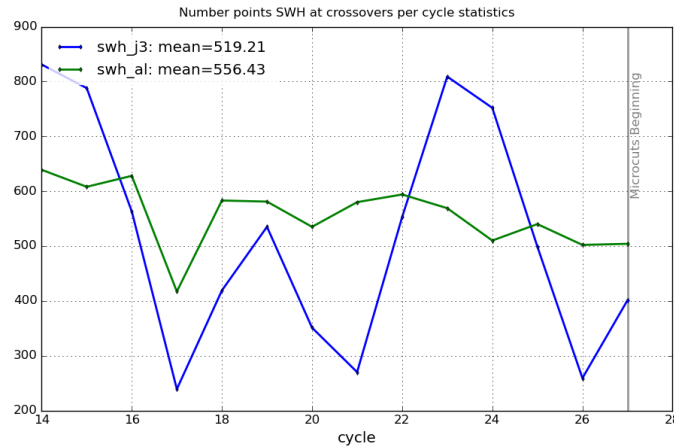




## Part 14

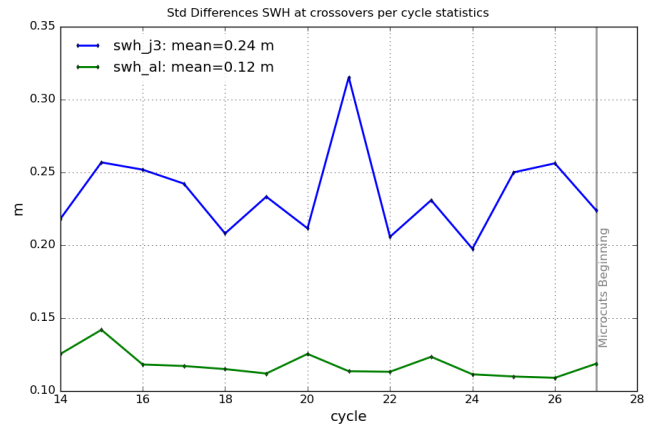
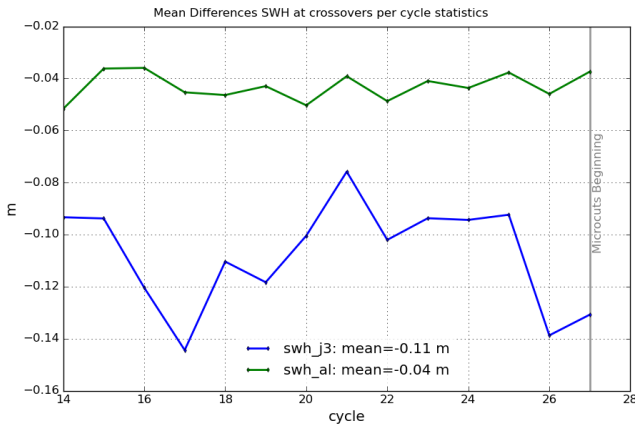
# CFOSAT/SWIM nadir versus AL and J3 at crossovers (3h)

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)

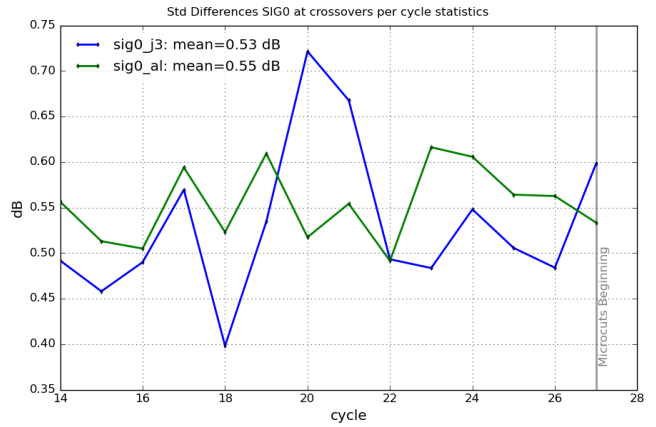
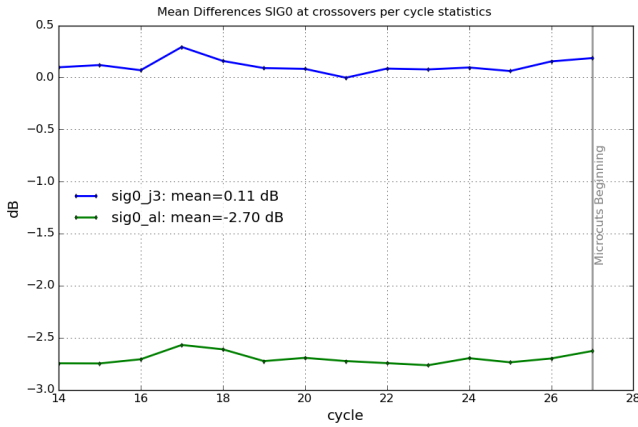
A change in Altika's mission ground segment, to standard-F, occurred during SWIM's cycle 38. This led to a variation in the SWH mean difference between the two satellites, from 4 to 10 cm, while the standard deviation remained stable. The change of Jason-3 to standard-F occurred during SWIM's cycle 57.



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

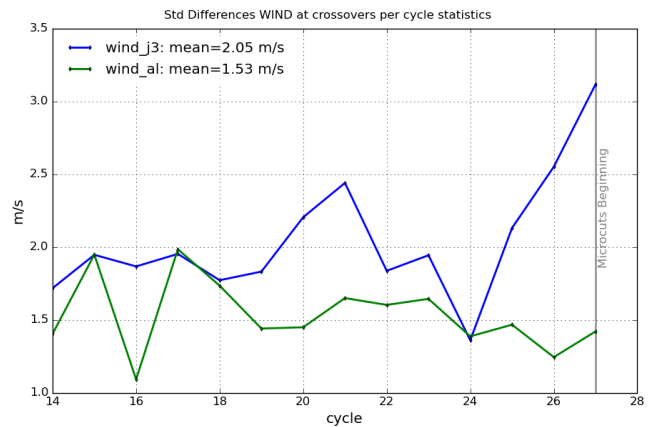
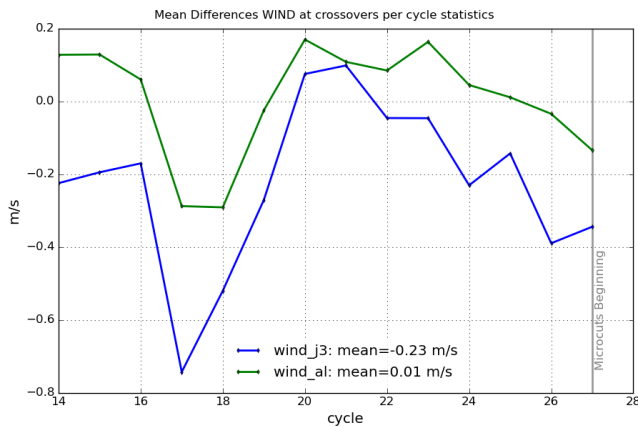
Since mid October 2019, SWIM has been affected by microcuts that occasionally and randomly lower the level of the radar echoes inside a macrocycle. This problem introduces a decrease in SWIM's sigma0, therefore an increase in the differences between satellites, seen in both the mean and standard deviation 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 occurred (represented by the vertical line "AWWAIS 5.0.1" in the figures).



## Main Part VI

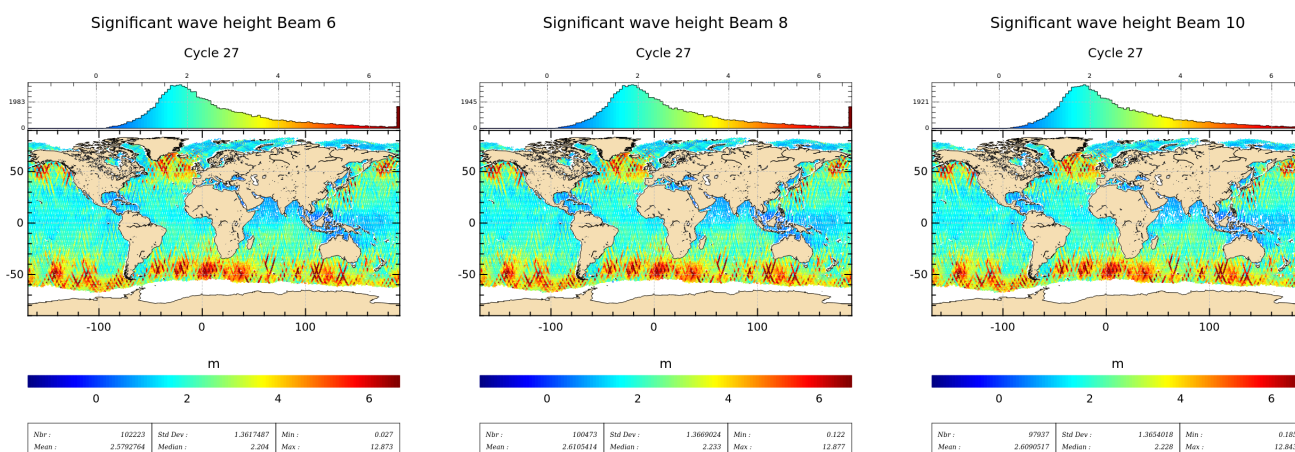
# SWIM off-nadir monitoring

## Part 15

# SWIM off-nadir current cycle maps per beam

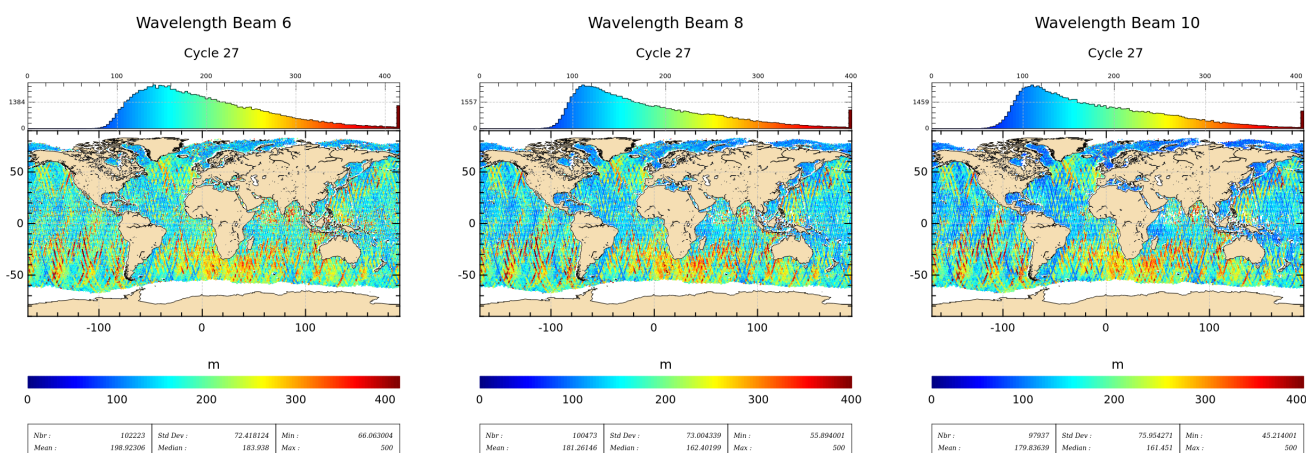
## 15.1 SWH

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.



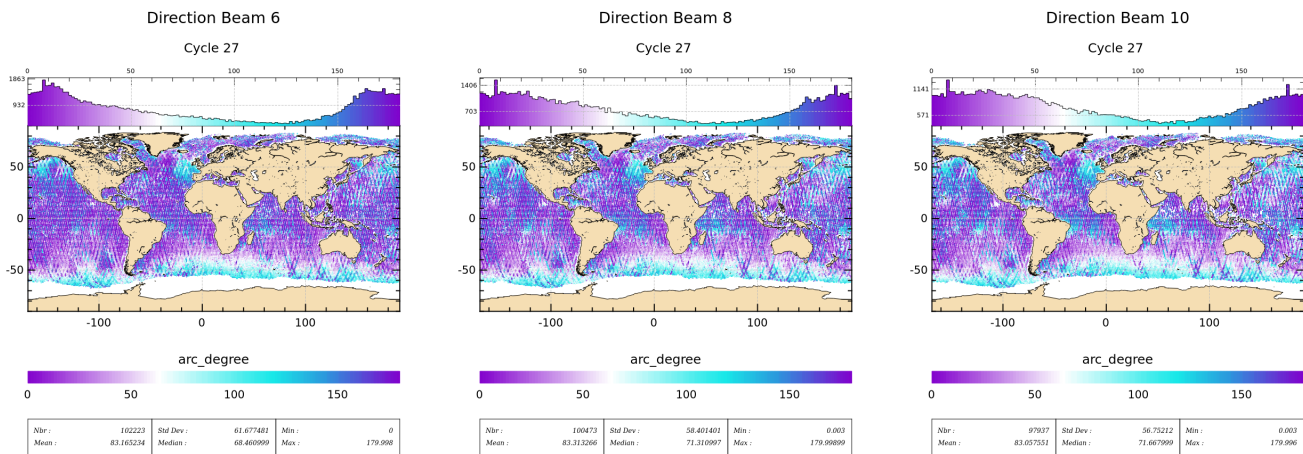
## 15.2 Wavelength

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:

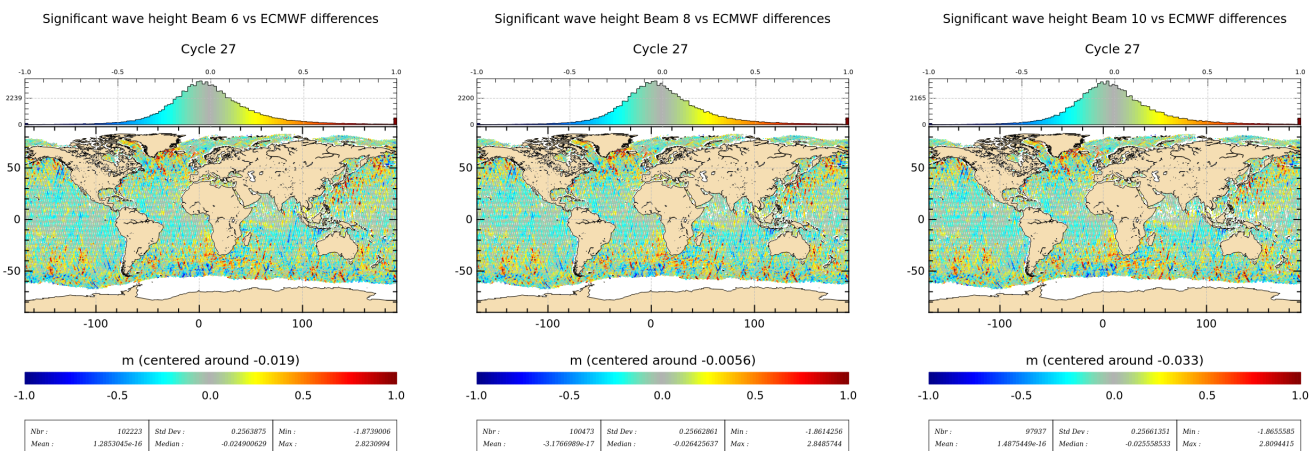
- at the beginning of the period concerned by the microcuts, the attenuation suffered by sigma0 affected the spectral distribution and thus the resulting estimated parameters;
- the introduction of the microcuts flagging and the evolution of the ground segment (e.g. MTF and speckle managing) upon the AWWAIS upgrade in June 2020.

The figures of difference represent Model values subtracked from SWIM.

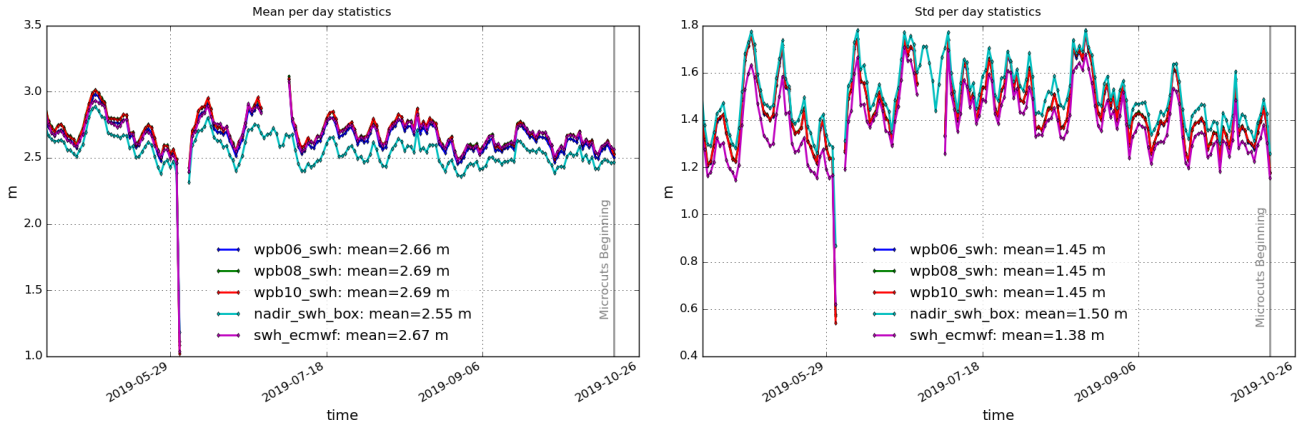
### 16.1 SWIM SWH versus ECMWF SWH

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



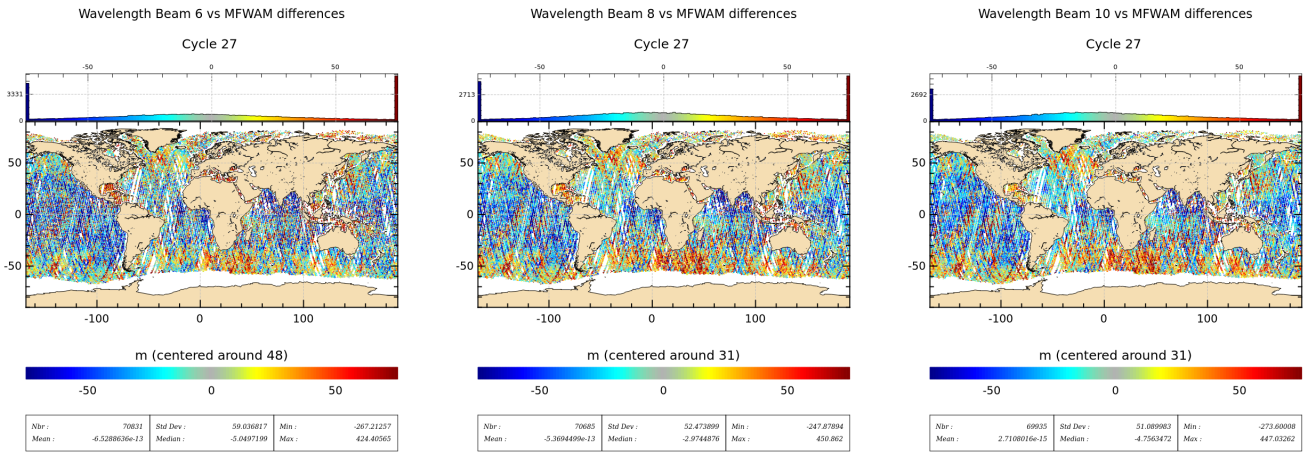
## 16.1.2 Long term monitoring along track



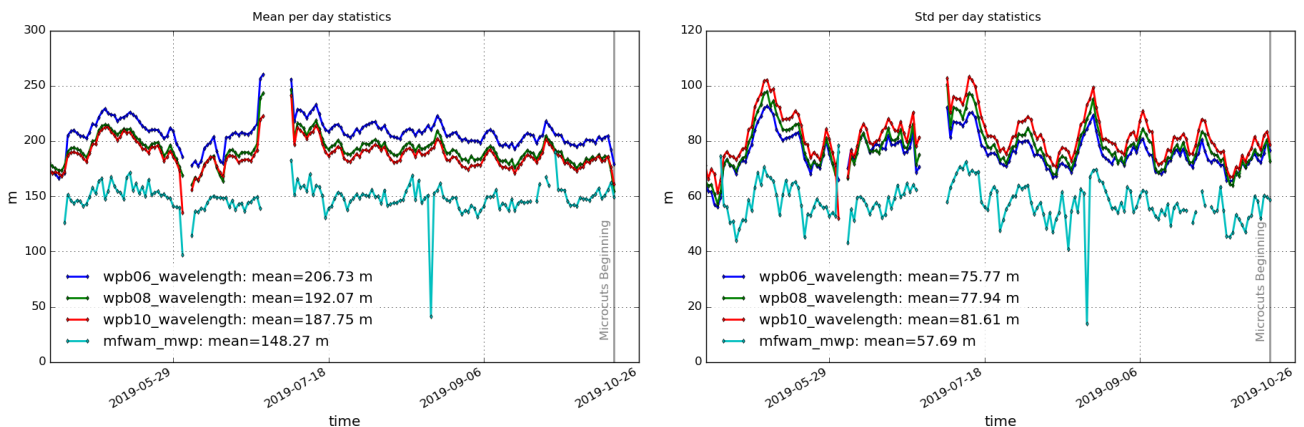
## 16.2 SWIM wavelength versus MFWAM wavelength

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

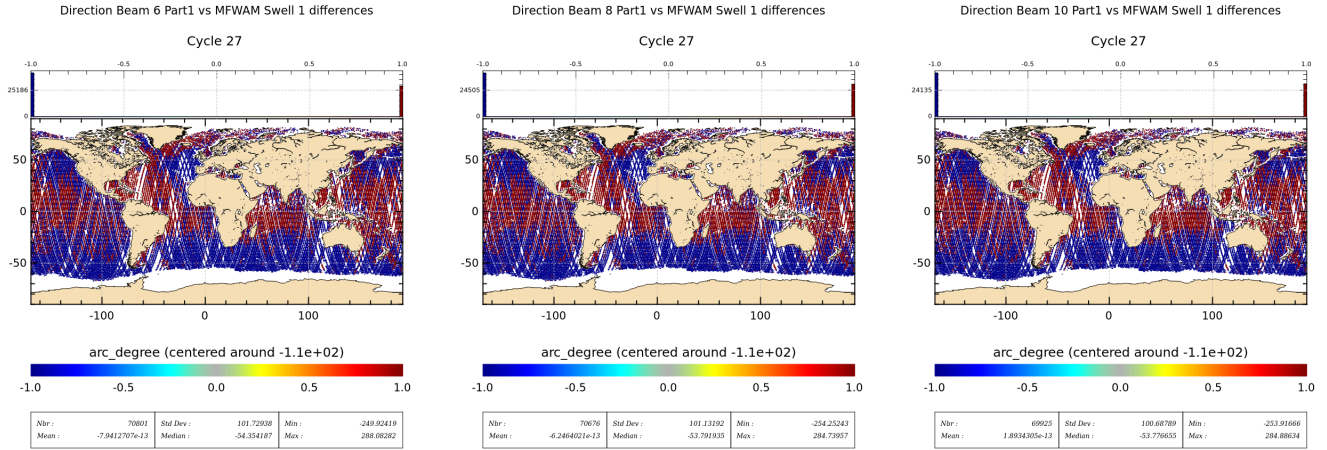




## 16.3 SWIM direction versus MFWAM direction

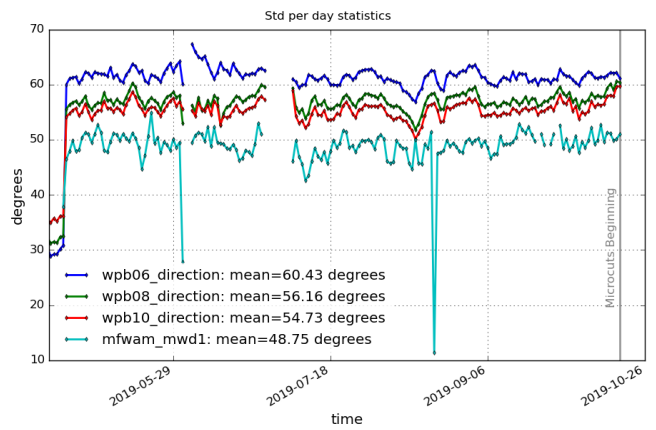
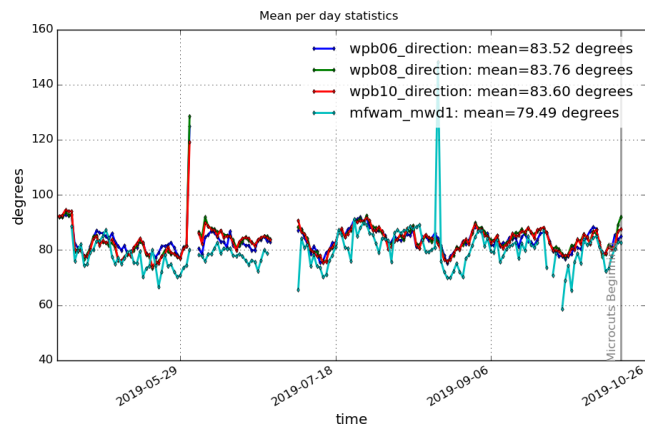
SWIM's peak directions of partition 1 from beams 6°, 8° and 10° are compared to those from the MFWAM model, at colocated points. MFWAM's peak direction is calculated from the mean direction of swell 1. To be comparable, MFWAM's peak values have been transformed from direction (0 - 360) to orientation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

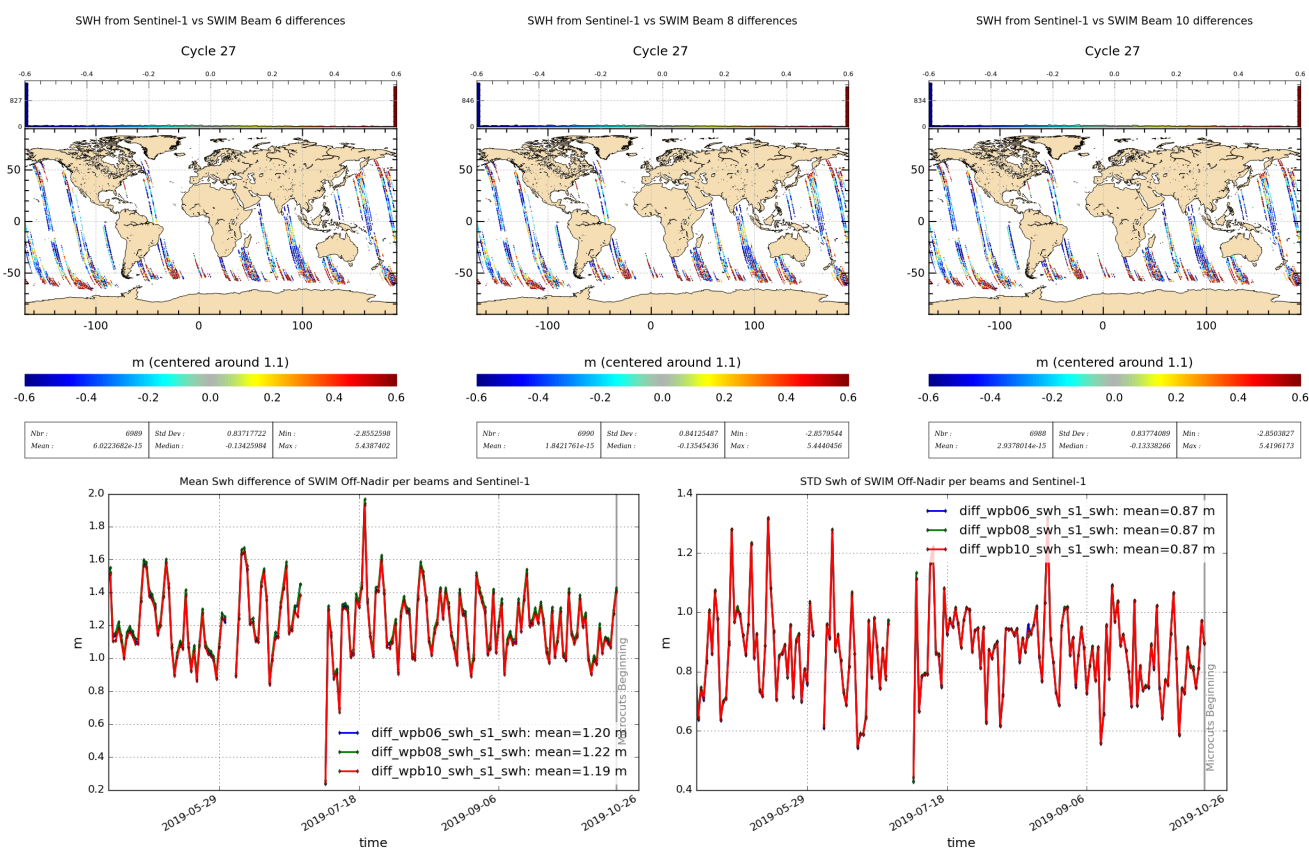
- the distance between Sentinel-1 and CFOSAT spectra is less than 100 km;
- the time difference is less than 1 hour.

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 intrinsic discrepancies in behaviour between the two instruments; this subject is under investigation.

