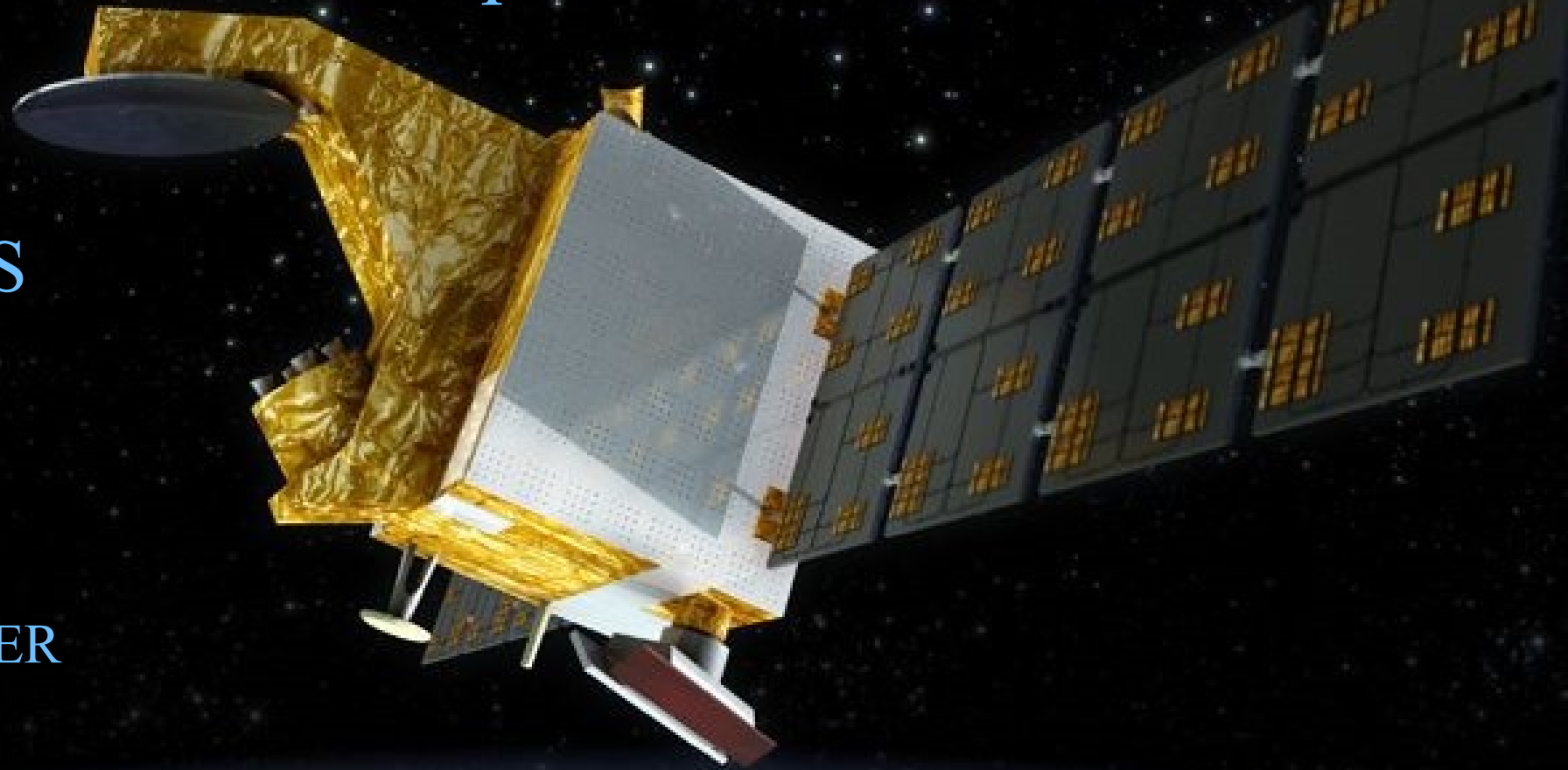


# CFOSAT: 3<sup>rd</sup> international Science Team Meeting 12-14 September 2022

## SWIM & FROGS Status

Cédric TOURAIN  
Jean-Michel LACHIVER  
CNES - France





## Agenda

### ❖ SWIM

- Instrument status
- CAL/VAL status

### ❖ FROGS Status

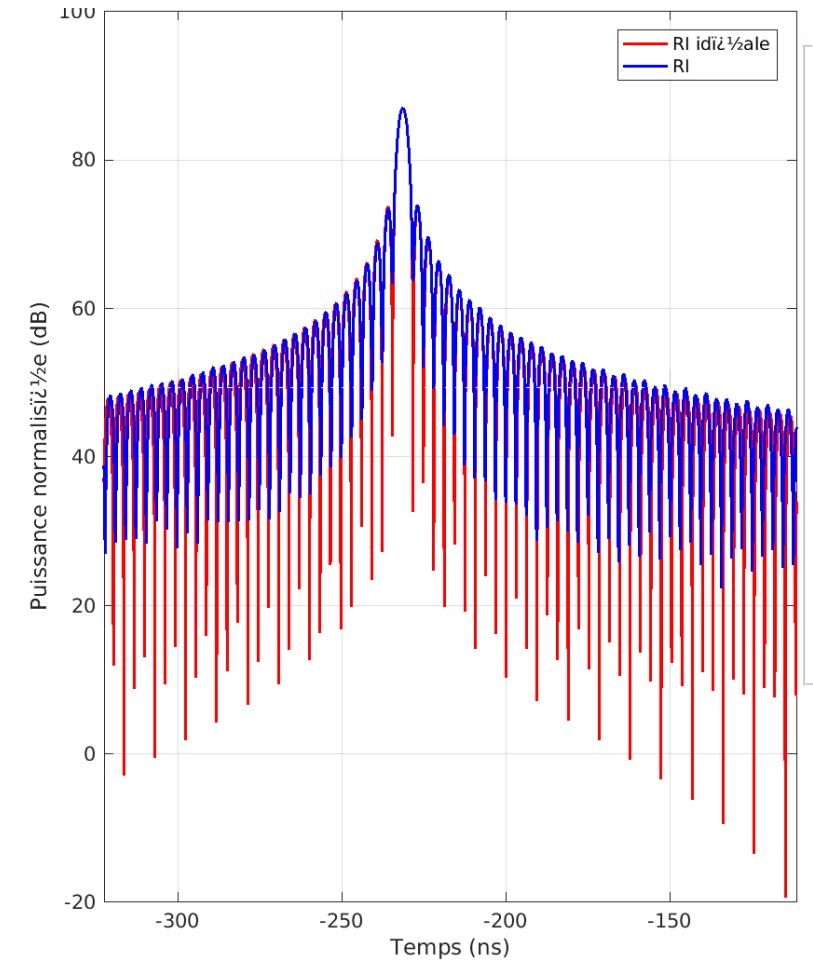
- Processing chains status
- System availability performances
- Production performances
- SWIM reprocessing
- Products access & distribution
- IWWOC

1

# SWIM INSTRUMENT STATUS

## SWIM Functional and Performances validation

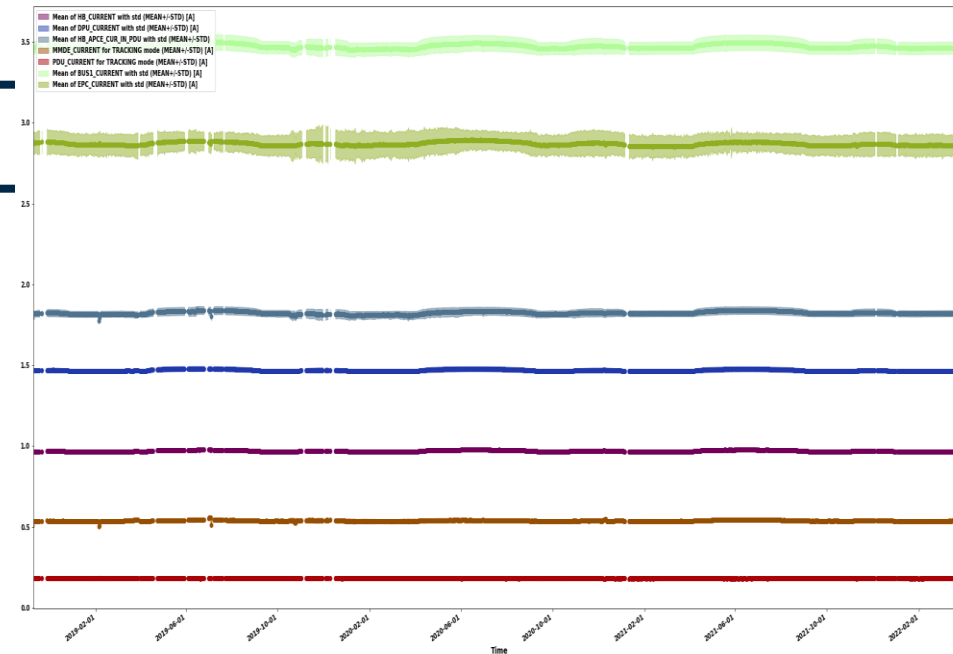
SWIM FONCTIONNAL VALIDATION	WITHIN REQUIREMENTS?	STABLE IN TIME?
Impulse response	✓	✓
Power/current consumption	✓	✓
Temperature	✓	✓
Coverage in tracking mode	✓	✓
Antenna rotation speed	✓	✓



## SWIM Functional and Performances validation

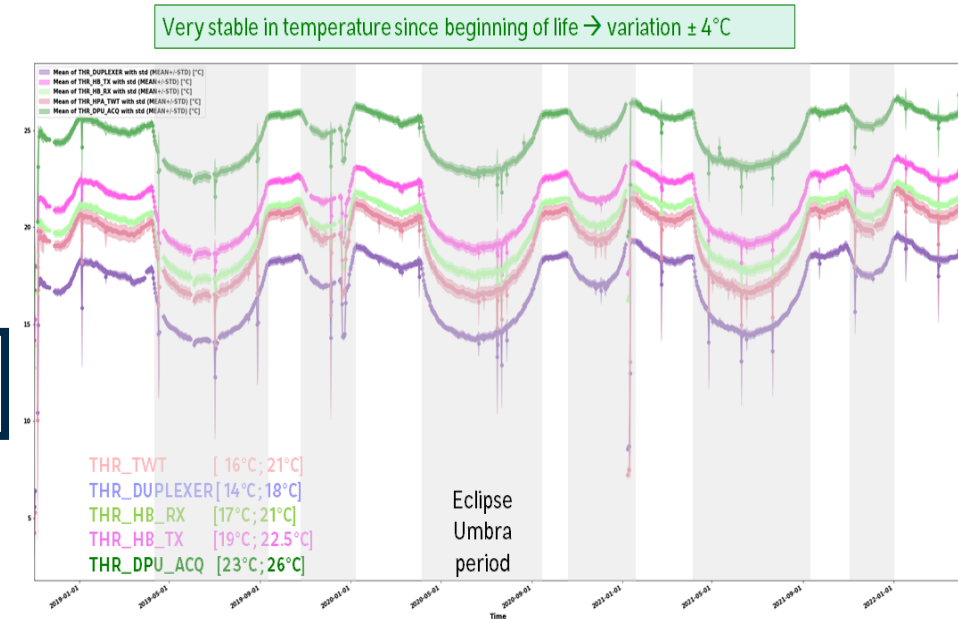
SWIM FONCTIONNAL VALIDATION	WITHIN REQUIREMENTS?	STABLE IN TIME?
Impulse response	✓	✓
<b>Power/current consumption</b>	✓	✓
Temperature	✓	✓
Coverage in tracking mode	✓	✓
Antenna rotation speed	✓	✓

Very stable in current consumption since beginning of life



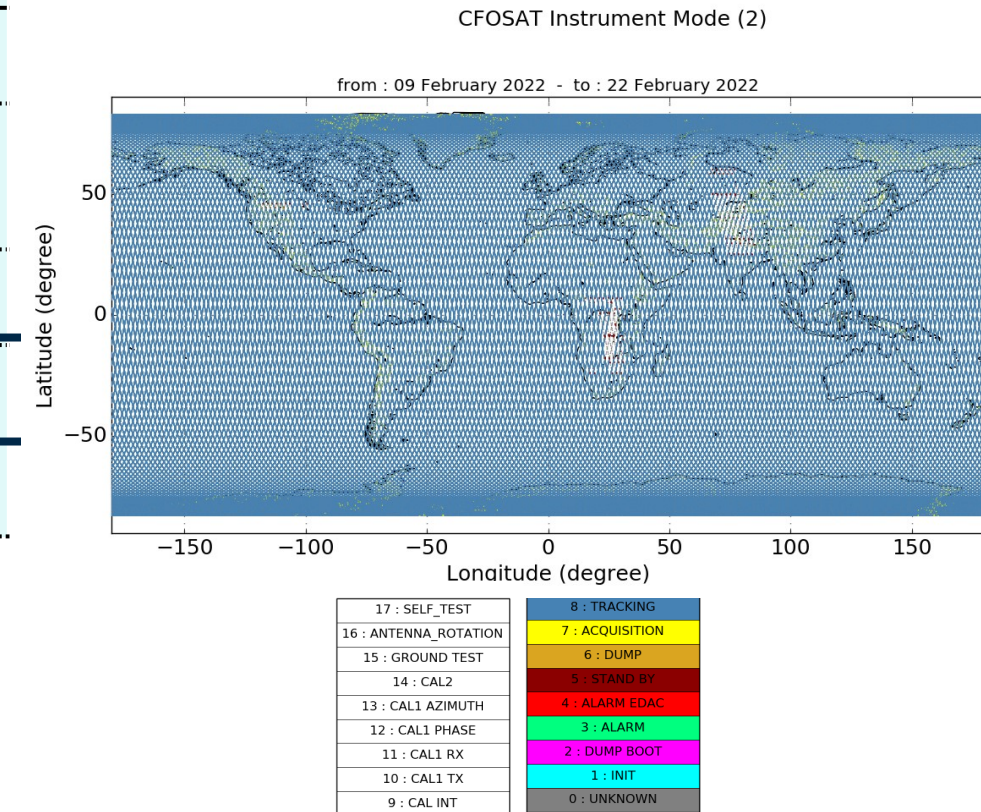
## SWIM Functional and Performances validation

SWIM FONCTIONNAL VALIDATION	WITHIN REQUIREMENTS?	STABLE IN TIME?
Impulse response	✓	✓
Power/current consumption	✓	✓
<b>Temperature</b>	✓	✓
Coverage in tracking mode	✓	✓
Antenna rotation speed	✓	✓



## SWIM Functional and Performances validation

SWIM FONCTIONNAL VALIDATION	WITHIN REQUIREMENTS?	STABLE IN TIME?
Impulse response	✓	✓
Power/current consumption	✓	✓
Temperature	✓	✓
Coverage in tracking mode	✓	✓
Antenna rotation speed	✓	✓

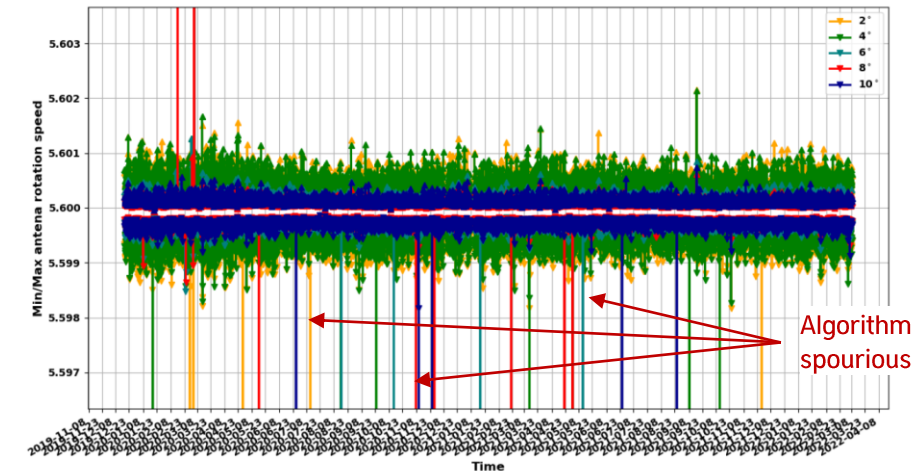




## SWIM Functional and Performances validation

SWIM FONCTIONNAL VALIDATION	WITHIN REQUIREMENTS?	STABLE IN TIME?
Impulse response	✓	✓
Power/current consumption	✓	✓
Temperature	✓	✓
Coverage in tracking mode	✓	✓
<b>Antenna rotation speed</b>	✓	✓

Minimum and maximum of antenna rotation speed by beam from 2019/10/01



✓ Compliant with requirements :  $5.600280 \pm 9.15e-14$

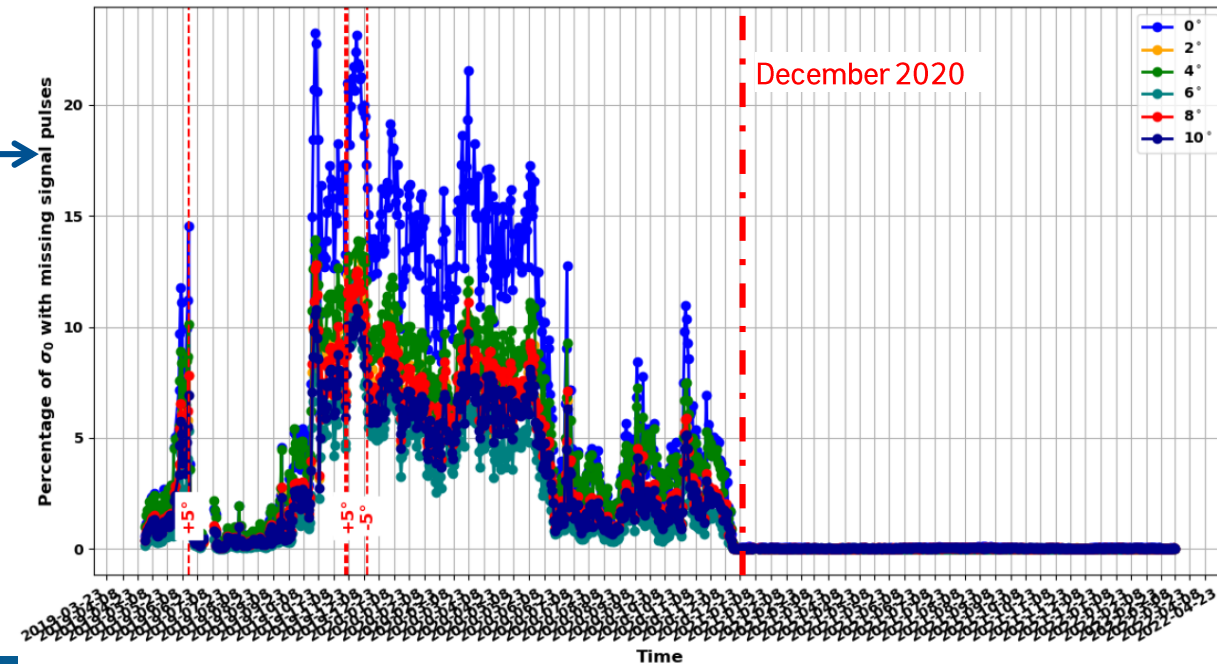


## Main Events

Events	WITHIN REQUIREMENTS?	STABLE IN TIME?
Signal transmission behavior Anomaly	monitored	monitored

Rate of micro-cuts impact on sigma0 profiles during tracking mode from 01/05/2019 to 09/03/2022

- ⇒ Cause: pollution or outgazing suspected
- ⇒ Phenomenon monitored daily
- ⇒ Phenomenon disappeared since December 2020
- ⇒ No major impact on SWIM products
- ⇒ Dedicated flag (L1a) implemented in products



2

CALVAL STATUS

## ➤ Main evolutions in the latest product issues

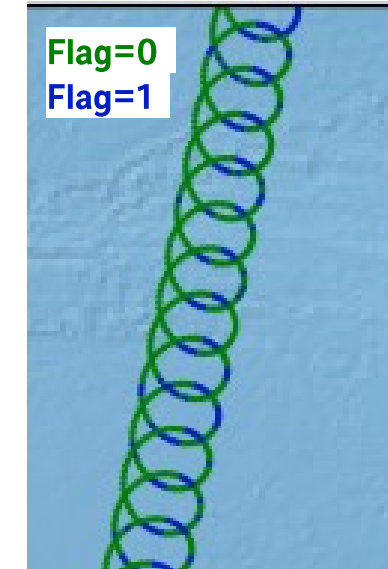
- 5.2 (2021/07/27)
- ❖ New Antenna gain diagram
  - Empirical gain diagram, obtained by specific ground processing
  - Largely corrects azimuthal asymmetry in sigma0 profiles
- ❖ Direction restitution anomaly corrected:
  - Wrong direction values for waves around 0/180 observed in previous issue
  - Anomaly corrected
  - Direction more consistent with model
- 6.0 (2022/06/27)
- ❖ Microcuts detection algorithm improvement
- ❖ Signal variability parameter propagation
- ❖ Sigma0 profiles filtering improvement

Product evolution history given on AVISO website :

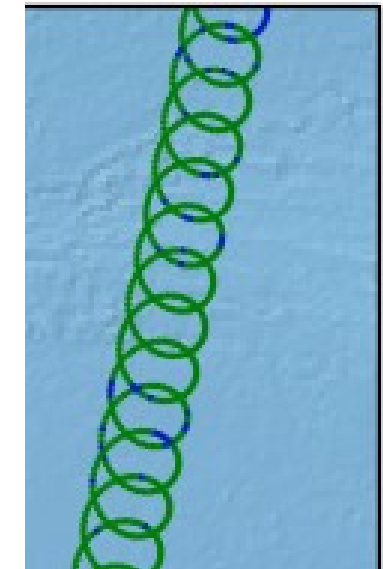
- <https://www.aviso.altimetry.fr/en/missions/current-missions/cfosat/product-evolutions.html>

Sigma0 shape flag

5.1 product issue  
mixed antenna gain

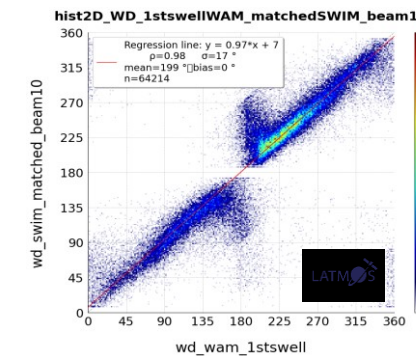


5.2 product issue  
empirical antenna gain

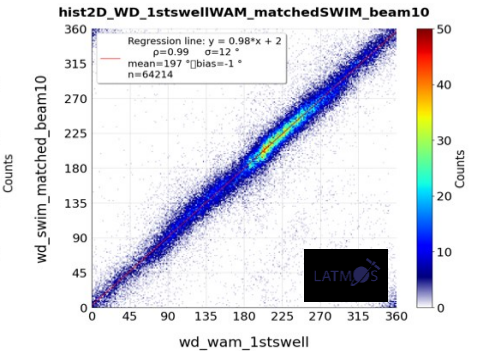


Wave direction from SWIM wave spectra vs WAM model, beam 10°

5.1 product issue



5.2 product issue

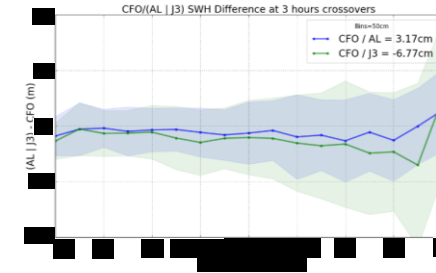
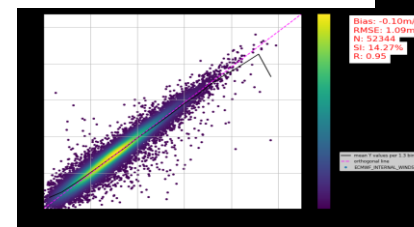


## ➤ Current CFOSAT SWIM products quality

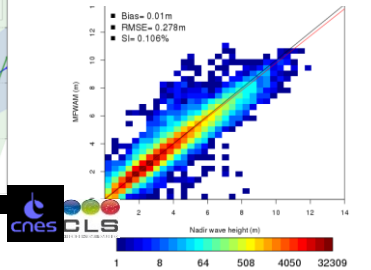
### ❖ Nadir data

- SWH: **Compliant with specification: error < 10% of SWH or 50 cm max**
  - Compared to model: around 30 cm
  - Same performance as altimetry missions (Jason-3, AltiKa, HY-2X...)
- Wind speed: **compliant with specification: error < 2m/s**
  - Compared to model: around 1m/s

Wind speed from SWIM nadir data vs ECMWF (15 days of data)



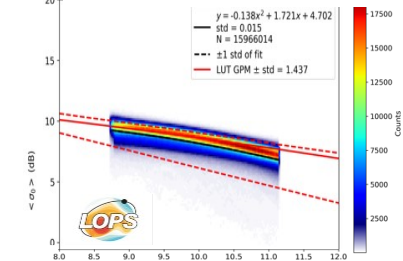
SWH from SWIM nadir data vs MFWAM (3 months of data)



### ❖ Sigma0 profiles

- Ocean surface
  - Trends consistent with TRMM/GPM: Consistency better than 1dB => **compliant with requirement**
- Sea ice and land surface
  - good sensitivity and consistent with literature

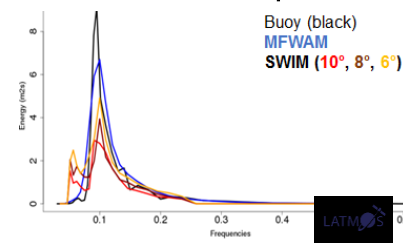
Incidence dependency (all SWH at Wind speed)



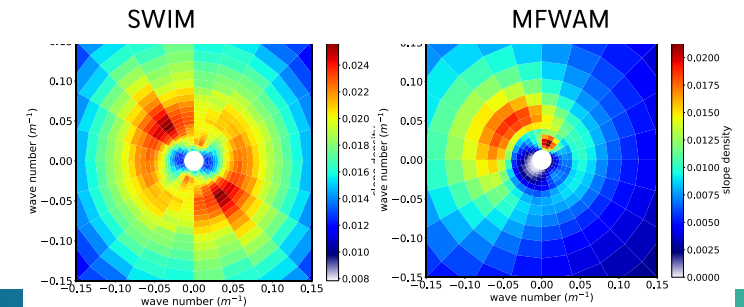
### ❖ 1D Wave spectra

- Shape consistent with model and buoy data
- Good wavelength estimation
- Some parasite peaks still to be filtered out

Omni directional spectra



Mean 2D wave spectra, over 12days, for SWH <2m, beam 10°



### ❖ 2D wave spectra

- Good shape of the spectra
  - Compared to model or other instrument (Sentinel1)

## ➤ Current CFOSAT SWIM products quality

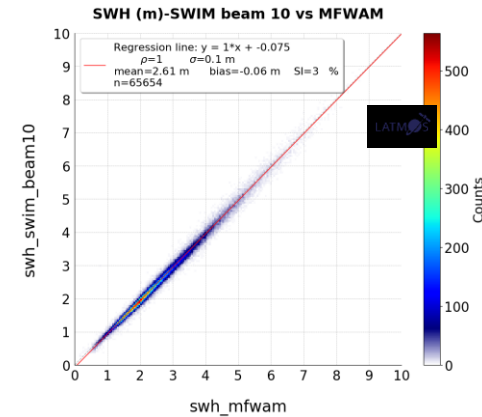
### ❖ Wave parameters SWH, wavelength and direction

➤ Waves identified between 50 and 500 m => **compliant with specification (70-500 m)**

➤ Consistent with model and buoys data

- Strong consistency for SWH, equivalent to nadir SWH: **compliant with specification: error < 10% of SWH or 50 cm max**
- Good consistency for wavelength: **compliant with specification**, better consistency with WAM than S1
- Global good consistency for direction: **some specific zones with differences to analyze**
- **See A. Olivier presentation (Tuesday, 8:30) for detailed analysis**

SWH



## ➤ Foreseen activities

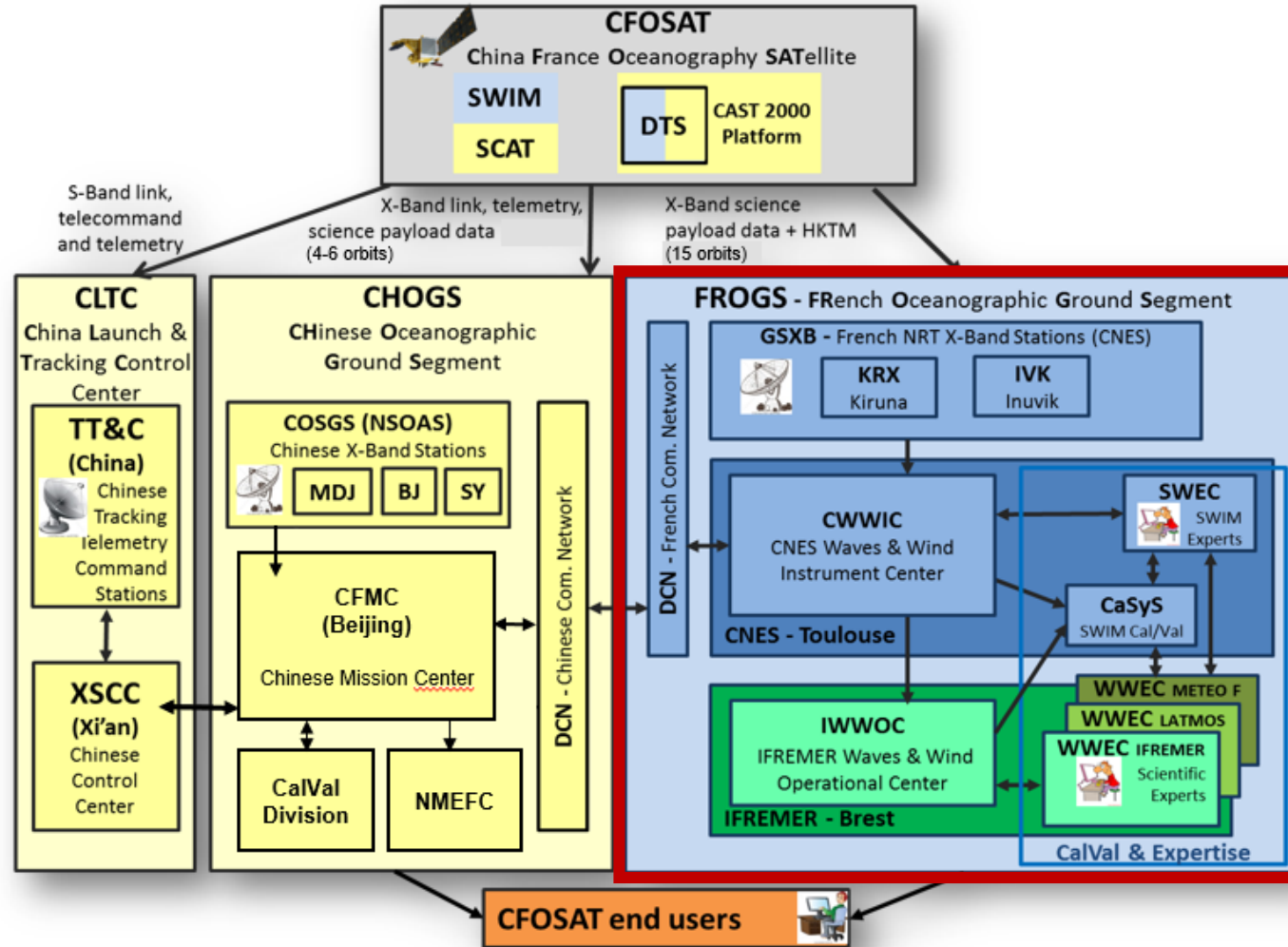
- ❖ Mitigation of parasite peaks in 1D spectra
  - Filtering method under analysis: new approaches currently evaluated
- ❖ Speckle noise correction
  - Continuous work to continue improving this correction
- ❖ Alternative MTF algorithm
  - Continuous work to get algorithm closer to the geophysical phenomena
- ❖ In-situ and airborne campaign data exploitation
  - **Cf. D. Hauser presentation today at 10:50**

3

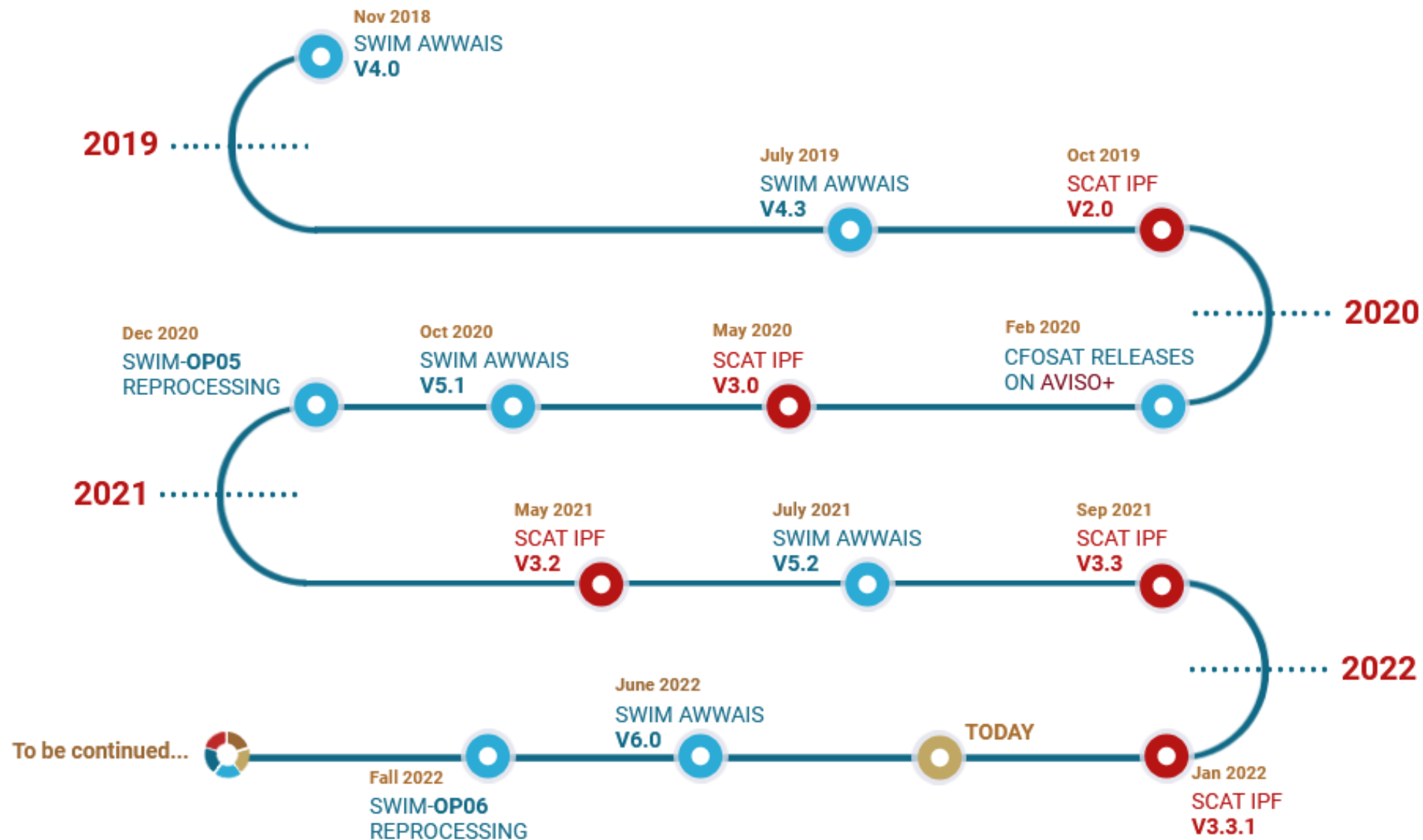
FROGS STATUS



# The FROGS in the System



## SCAT-IPF & SWIM-AWWAIS Timeline



## Requirement:

- ❖ The availability of the Satellite for generating Observation data (Measurement and Calibration) shall be greater than 95 %

## From the beginning of life (2019/11/05) till now (2022/09/01): 48 months/1450 days

- ❖ Station Keeping manoeuvres (including 1 collision avoidance): 7 days
- ❖ On-board X-band interruption (EPC OFF anomaly): 5 days
- ❖ SWIM anomaly (2021/01/06): 5 days
- ❖ SCAT switch to redundant (end of December 2019) + switches off: 11 days
- ❖ SCAT antenna stop rotating (August 2022): 17 days



## Global CFOSAT availability performance:

**SWIM: 98.8%**

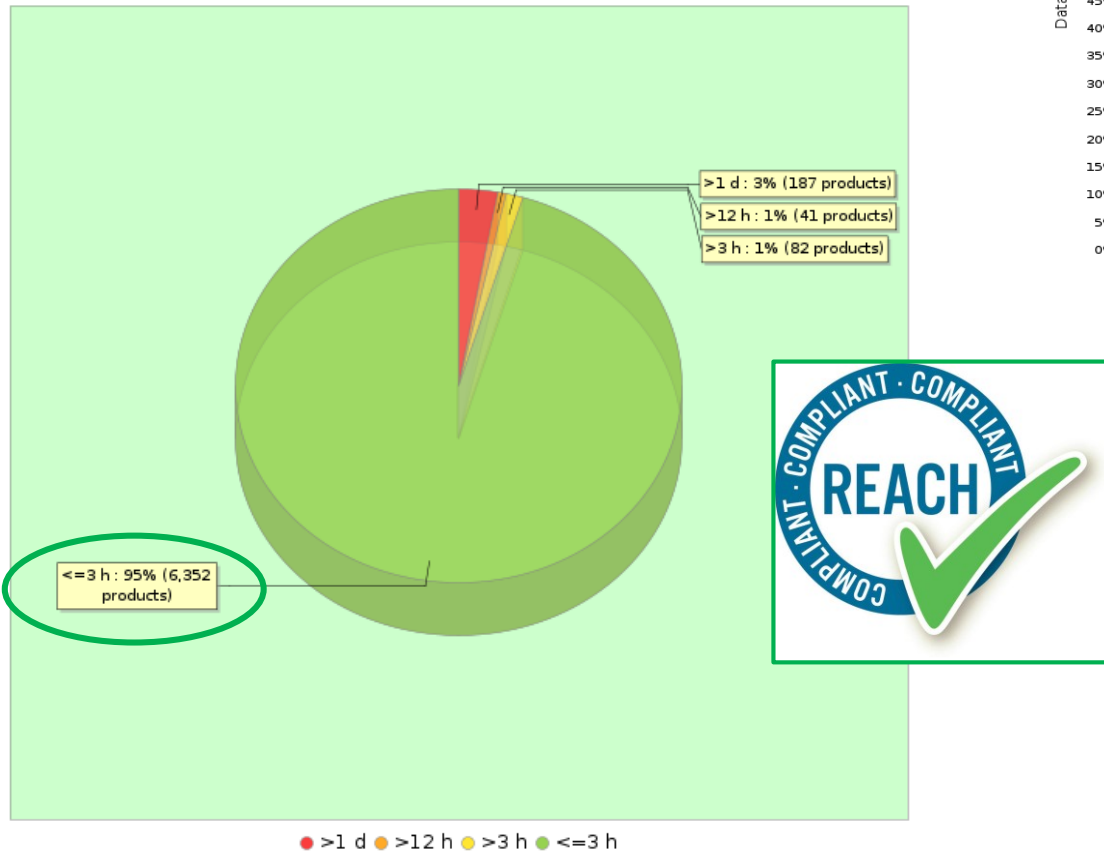
**SCAT: 97.2%**

**Thanks again to good coordination between both operational teams**

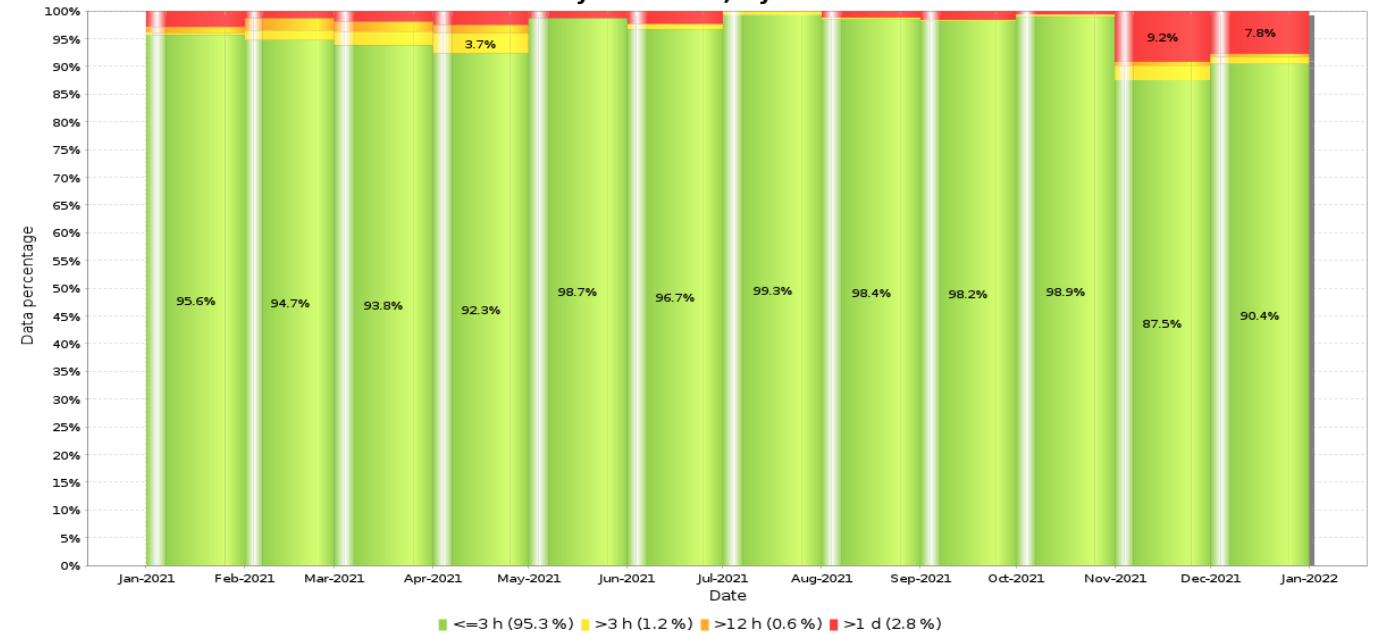
## SWIM-NRT Production delay < 3 hours

- ❖ 2021/01/01 – 2021/12/31
- ❖ Requirement: better than 75%

SWIM-NRT Statistics production delay



Delay statistics, by month



### Main events

- ❖ Dump lost or unscheduled: 3 days
- ❖ IT Facilities unavailability (incident/maintenance): 3/5 days
- ❖ SWIM processing: 2 days

Very good performances of the programming loop, the reception function (GSXB) and the IT facilities (HPC)

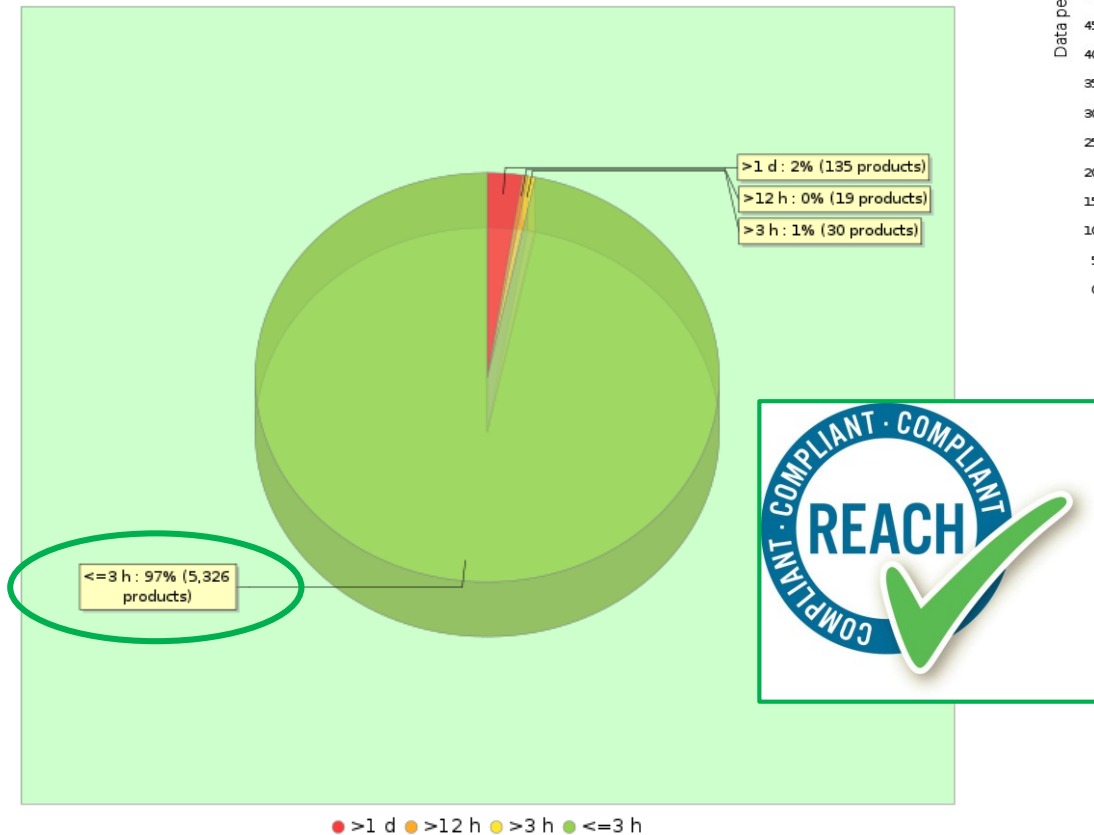
Very good robustness of SWIM-AWWAIS



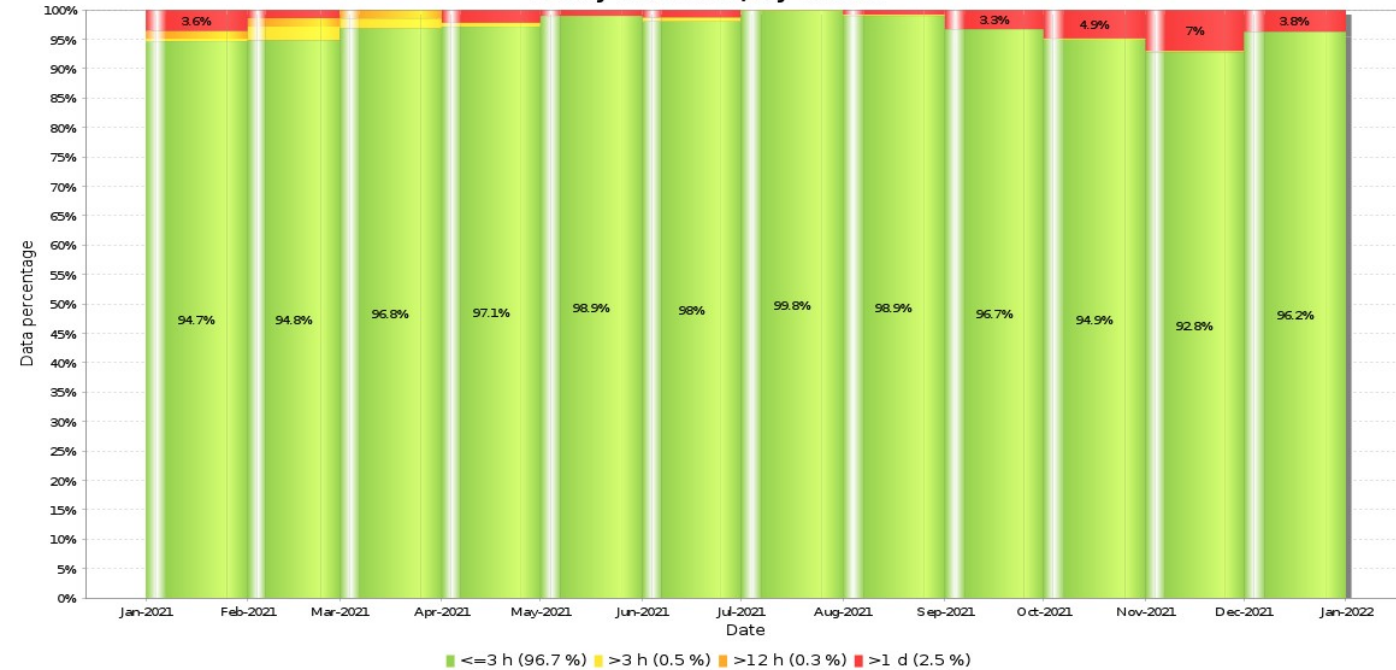
## SCAT-NRT Production delay < 3 hours

- ❖ 2021/01/01 – 2021/12/31
- ❖ Requirement: better than 75%

SCAT-NRT Statistics production delay



Delay statistics, by month



### • Main events

- ❖ Dump lost or unscheduled: 3 days
- ❖ CWWIC Data server (SdS) unavailability: 1,5 days

Very good performances of the programming loop and the reception function (GSXB)  
 Very good robustness of SCAT-IPF

## Availability of the SWIM-AWWAIS 6.0. release since the 27<sup>th</sup> of June 2022

### Comparing with the 5.1. release (2020/11/16)

- ❖ Microcuts detection algorithm improvement
- ❖ Signal variability parameter propagation
- ❖ Sigma0 profiles filtering improvement

### Very good level of product quality: nadir and off nadir measurements

- ❖ Ready for a full reprocessing of SWIM products from beginning of life to provide users with the longest time series
  - From 2019/04/25 to 2022/07/06 for users

### Reprocessing

- ❖ Reprocessing and verification will start at the beginning of next month (October)
- ❖ Reprocessed products will be available by the beginning of next year (code OP06 in the product name)
- ❖ Reprocessing chain ready to be used after each major SWIM-AWWAIS release. Next planned for 2024 (TBC)

## CFOSAT products are available

### ❖ For CWWIC products

#### ➤ On Aviso+ Website:

<https://www.aviso.altimetry.fr/>

- For SWIM-L2, SWIM-L1B on line on a FTP server:

- <ftp://ftp-access.aviso.altimetry.fr/cfosat>

- For all the products (including SCAT), on the long term archive:

- <https://aviso-data-center.cnes.fr/>

### ❖ For IWWOC products

#### ➤ On ODATIS website:

<https://www.odatis-ocean.fr/en/>



The screenshot shows the Aviso+ website interface. At the top, there is a header with the 'cnes' logo and the 'AVISO+' logo with the tagline 'Satellite Altimetry Data'. A 'Mobile version' button is visible in the top right. Below the header is a navigation menu with options: MY AVISO+, DATA, USER CORNER, APPLICATIONS, MISSIONS (highlighted), TECHNIQUES, NEWS, and MULTIMEDIA. A breadcrumb trail below the menu reads: AVISO+ > MISSIONS > CURRENT MISSIONS > CFOSAT. The main content area is titled 'CFOSAT' and features an image of the satellite in orbit. To the right of the image is a text block: 'The Chinese (CNSA) and French (Cnes) Space Agencies jointly plan a satellite mission devoted to the monitoring of the ocean surface wind and wave, and related ocean and atmospheric science and applications: CFOSAT project (Chinese-French Oceanic SATellite). The CFOSAT embark two main instruments: the french radar SWIM (Surface Wave Investigation and Monitoring) to determine the direction, amplitude and wavelength of surface waves and the chinese scatterometer SCAT to measure wind speed. The ground segment is shared between chinese (Mission and Control centers) and french centers (Instrument mission center and waves and wind mission center).' Below the image is a table of satellite specifications:

Satellite	CFOSAT
Launch on	29/10/2018
End Date	
Altitude	~500
Inclination	90°
Repetitivity	
Agency	Cnes-CNSA
Goals	Measure sea state (wind/wave)
Link	



# Products dissemination



## CFOSAT products are distributed

- ❖ To NSOAS
  - SWIM-NRT & SCAT-NRT
- ❖ To KNMI/EUMETSAT
  - SWIM-NRT
  - SCAT-L1B for SCAT-L2-NRT processing
- ❖ By EUMETSAT via EUMETCast:
  - To EUMETSAT Member States & ECMWF
  - Only for SWIM-NRT at the time being
  - **Status to be made for SCAT-NRT**
- ❖ To CMEMS Waves-TAC:
  - SWIM-L2P-SWH-Nadir-1Hz products & SWIM-L2P-OFF-NADIR (also available on Aviso+ website)
- ❖ By CMEMS:
  - Global L3 and L4 SWH NRT products
  - L3 Spectral NRT products
    - CMEMS website: <https://resources.marine.copernicus.eu/>

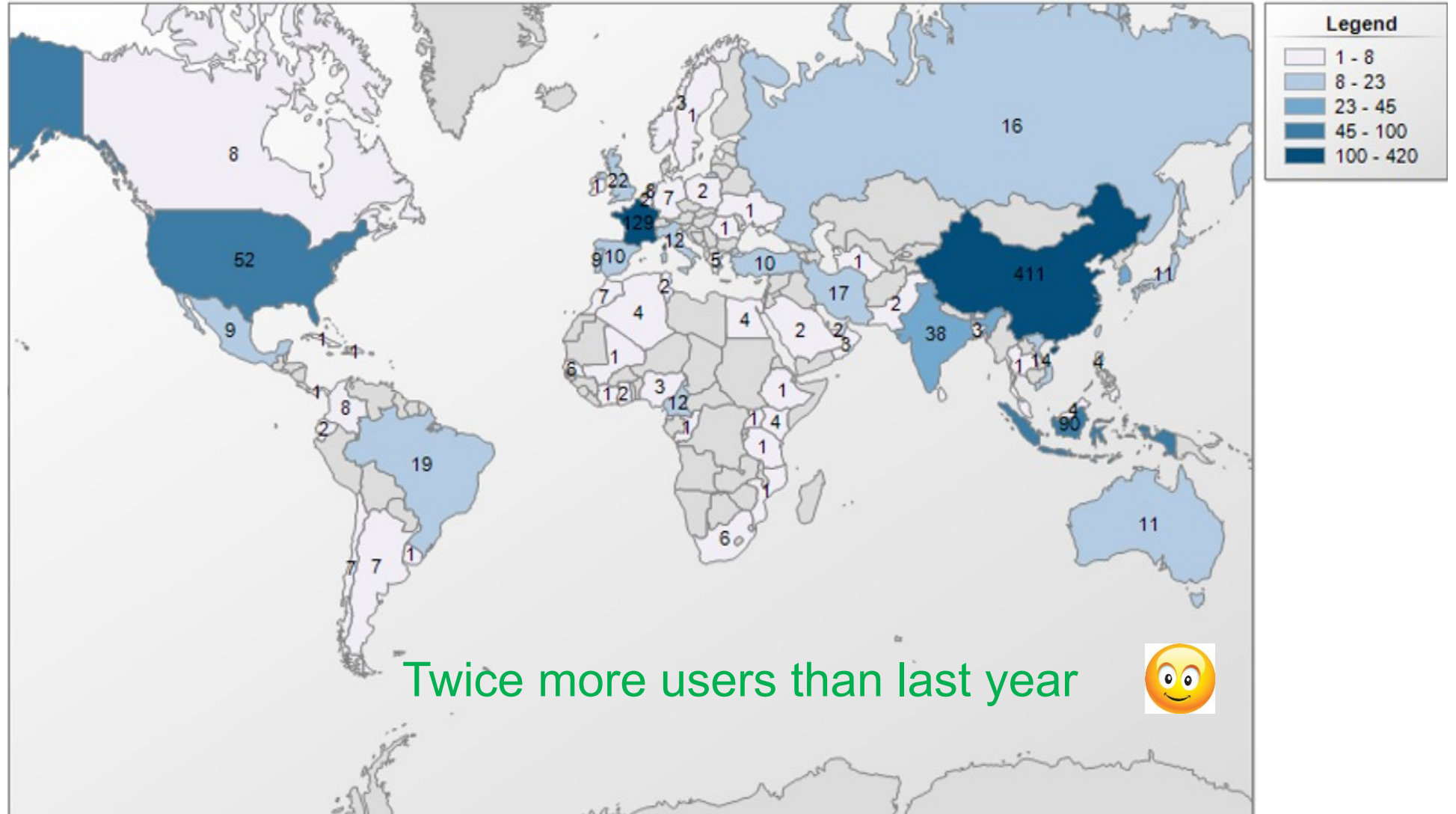
The screenshot shows the Copernicus Marine Service website interface. At the top, there are logos for the European Union, Copernicus, and Copernicus Marine Service, along with navigation links for Home, User Corner, and Contact Us. Below the navigation bar, there are three main menu items: OCEAN PRODUCTS, OCEAN MONITORING INDICATORS, and OCEAN STATE REPORT. A search bar is present with the text 'SWH' and a magnifying glass icon. To the right of the search bar, there are buttons for 'OCEAN PRODUCTS', 'OCEAN MONITORING INDICATORS', and 'OCEAN STATE REPORT'. Below the search bar, there are several filter sections: 'REGIONAL DOMAIN' (All areas), 'PARAMETERS' (TEMPORAL COVERAGE), and 'PRODUCT WITH DEPTH LEVEL'. The 'TEMPORAL COVERAGE' section shows a date range from 1992-01-01 to 2021-02-20. Below the filters, there is a 'Reset Search Filters' button. To the right of the filters, there are two product cards. The first card is titled 'WAVE\_GLO\_WAV\_L4\_SWH\_NRT\_OBSERVATIONS\_014\_003' and describes 'GLOBAL OCEAN L4 SIGNIFICANT WAVE HEIGHT FROM NRT SATELLITE MEASUREMENTS'. It includes details about the observation (L4), parameters (2 degree x 2 degree (Surface only), From 2019-06-26 to Present, daily-mean), and a world map showing wave height data. The second card is titled 'WAVE\_GLO\_WAV\_L3\_SWH\_NRT\_OBSERVATIONS\_014\_001' and describes 'GLOBAL OCEAN L3 SIGNIFICANT WAVE HEIGHT FROM NRT SATELLITE MEASUREMENTS'. It includes details about the observation (L3), parameters (7 km x 7 km (Surface only), From 2020-01-01 to Present, instantaneous), and a world map showing wave height data. Below the product cards, there is a third card showing a detailed view of a wave height map with a 'Global Ocean L3 Spectral Parameters From Nrt Satellite Measurements' title and a 'WAVE\_GLO\_WAV\_L3\_SPC\_NRT\_OBSERVATIONS\_0...' title. The card also includes a 'SWH MWT VMDR' label and a globe icon.

## CFOSAT

❖ After two years

1099 users

75 countries



Twice more users than last year



The **Ifremer Wind and Wave Operation Center** (IWWOC) is the downstream French CFOSAT processing centre, operated by CERSAT (Ifremer Satellite Data Processing and Dissemination Centre) and supported by experts from the Laboratory of Space and Physical Oceanography (LOPS)

IWWOC is co-developed with experts from two associated companies: OceanDataLab (for SWIM products) and eOdyn (for SCAT products)

IWWOC focus is on advanced research product:

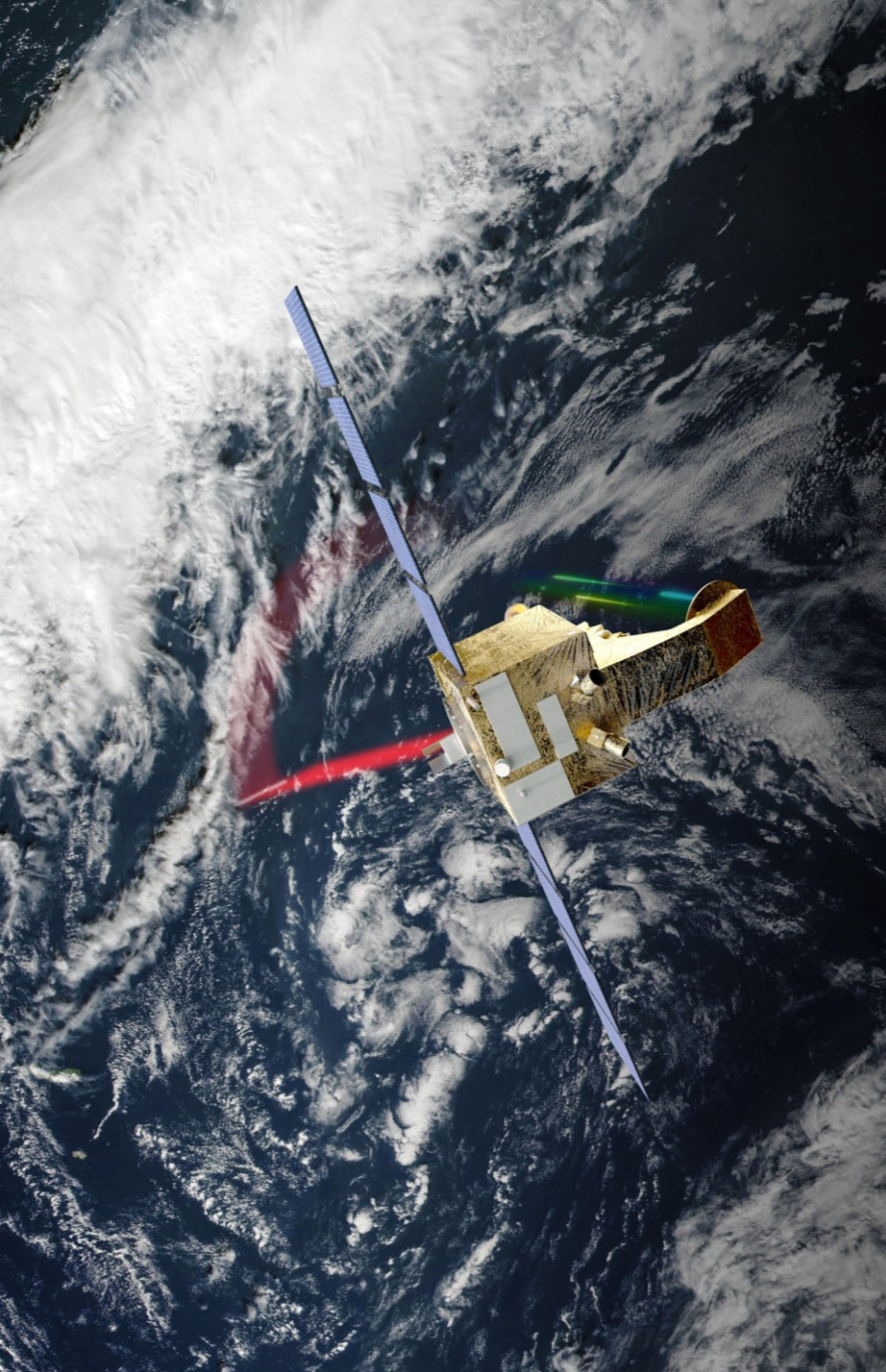
- ❖ Delayed mode, long and consistent time series to complete climate data series from other missions
- ❖ Higher level products : L2S to L3/L4 (global fields of wind and wave parameters)
- ❖ Synergy between SWIM and SCAT, alternative processing method and testing
- ❖ Ultimately combination with other missions such as Sentinel-1
- ❖ Resources for CalVal and algorithm development: cross-overs with altimeters/scatterometers/SAR, match-ups with in situ data, dedicated wave hindcast over SCAT & SWIM measurement locations (WW3)

The first products distribution have started for 6 months (SWIM-L2S, SCAT-ICE)

The products are distributed through **ODATIS** portal, the French federated access to national Ocean data







**A FROGS fully operational (for the greater part) since the launch**

**An excellent operational coordination with China**

**Very good performances in products generation**

- ❖ Routine
- ❖ Reprocessing

**Numerous users registered and interested in CFOSAT**



谢谢！ Thank you ! Merci !

# BACKUP