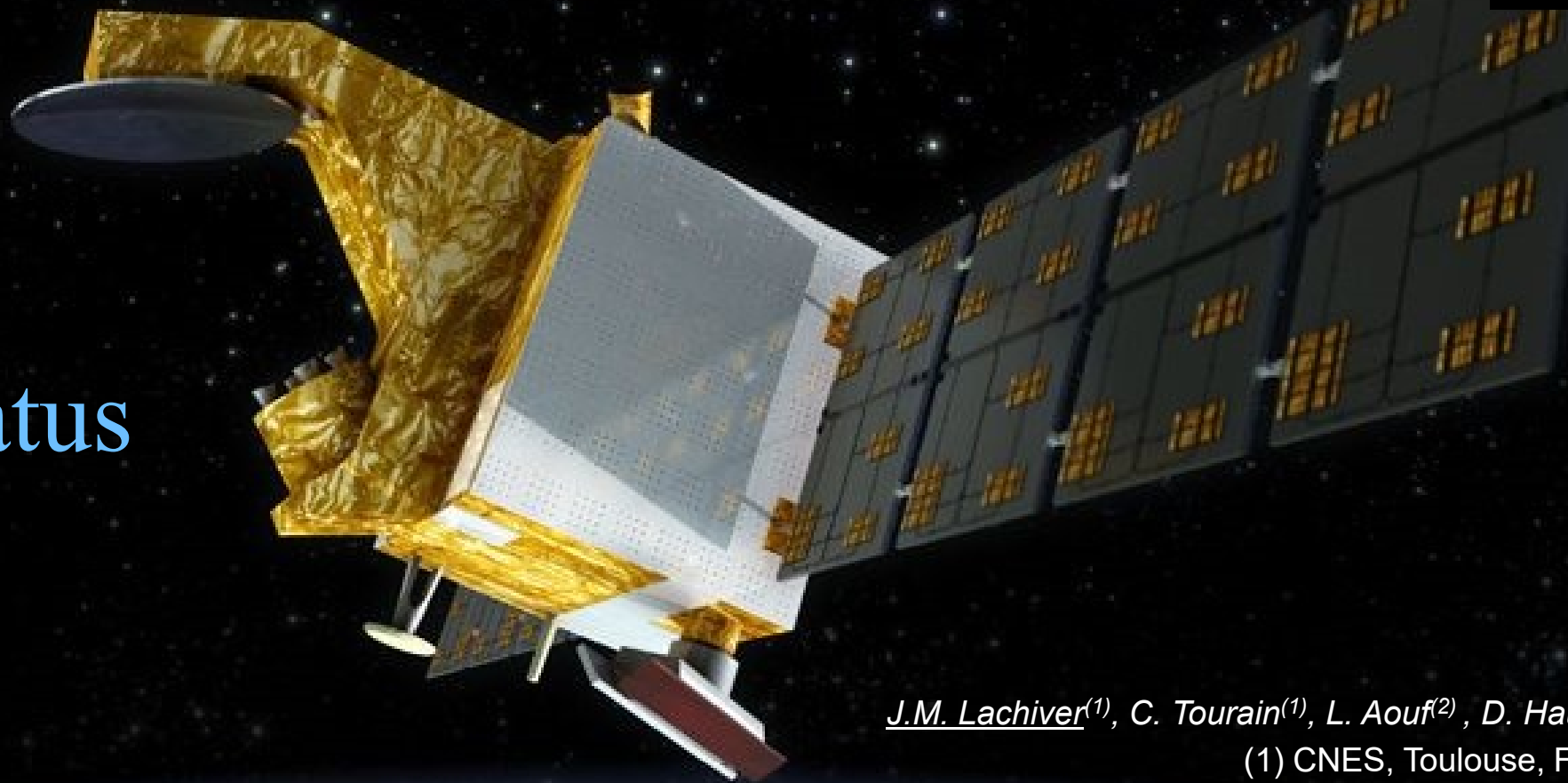




# CFOSAT: China-France Oceanography SATellite



## Mission Status

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*(2) Météo-France, Toulouse, France*

*(3) LATMOS, CNRS, UVSQ, UPMC, Guyancourt, France*



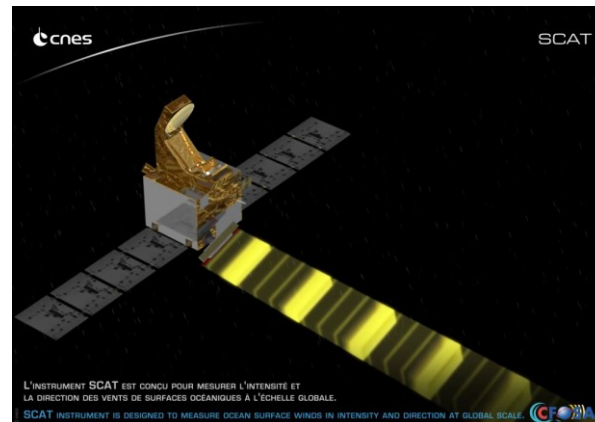
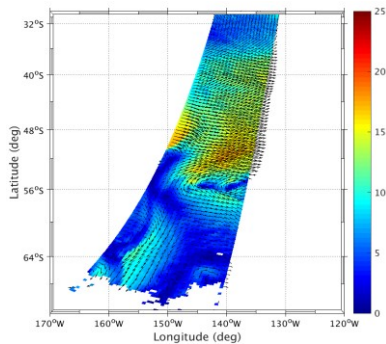
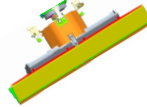
# Main Objective: Measure at the global scale ocean surface wind and waves spectral properties



## SCAT

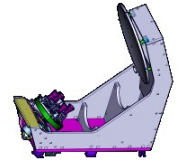
### Wind scatterometer

- ❖ Fan beam concept
  - Large swath
  - Rotating antenna: 3 rpm
- ❖ Incidences between 26° and ~50°
- ❖ Provides
  - $\sigma_0$
  - Ocean wind vector

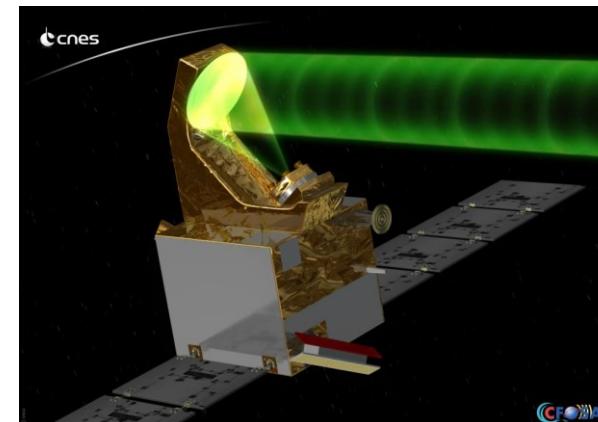
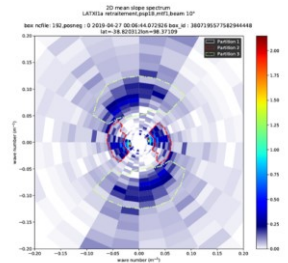


## SWIM

### Wave scatterometer



- ❖ Ku band real aperture radar,
- ❖ Sequential illumination with 6 incidences: 0°, 2°, 4°, 6°, 8°, 10°
- ❖ Rotating antenna (all azimuth direction acquisition): 5,6 rpm
- ❖ Provides:
  - Directional wave spectra
  - Significant wave height and wind speed
  - $\sigma_0$  mean profiles, 0° to 10°





## Main events



**2018/10/29: Successful launch**

**Sept. 2019: 1<sup>st</sup> International Science Team in Nanjing (China)**

**Feb. 2020: Data release to users**

- ❖ Aviso+
- ❖ NSOAS/OSDDS

**June 2020: SWIM-NRT for operational applications**

**March 2021: 2<sup>nd</sup> International Science Team, e-meeting**

**Sept. 2022: 3<sup>rd</sup> International Science Team in Saint-Malo (France)**

...

**Four years in orbit**



**One year beyond the nominal period**

## Platform

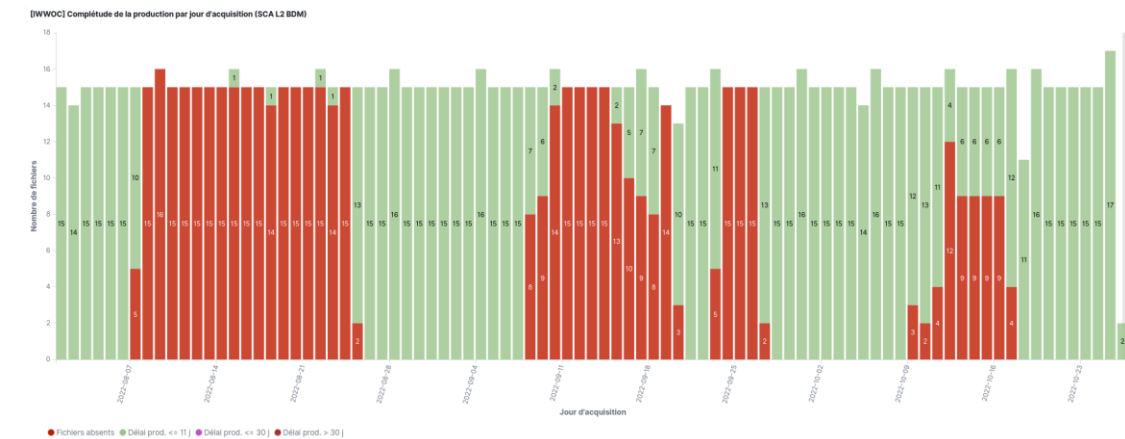
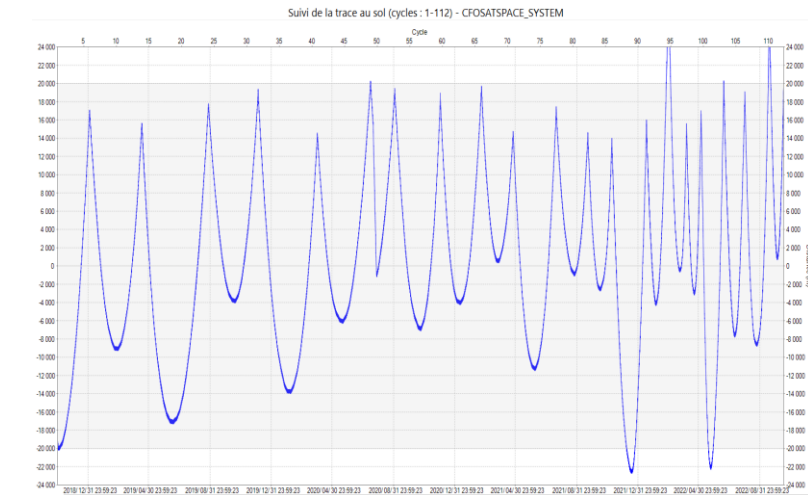
- ❖ CFOSAT bus: **Ok**
- ❖ More frequent station keeping manoeuvre during the last year due to solar activity

## SCAT

- ❖ SCAT has been facing antenna stuck problem that has prevented from a nominal rotation since August, the 8<sup>th</sup>
- ❖ 3 periods during which data are unavailable (totally or partially)
- ❖ Several tries made by NSOAS to fix the problem and resume rotation (including reverse rotation)
- ❖ SCAT has nominally worked since October, 17<sup>th</sup>
- ❖ Under monitoring...

## SWIM

- ❖ SWIM instrument is: **Ok**



# CalVal instruments performances status

Requirement	Value	Compliance
SCAT Sigma0	± 1.0 dB for Wind Speed [4-6 m/s] ± 0.5 dB for Wind Speed [6-24 m/s]	✓
SCAT Ocean Wind Vector	Wind speed: 2 m/s or 10% (the largest) for Wind speed [4-24 m/s] Wind direction: ± 20°	✓ Consistent with models and buoys
SWIM Nadir	SWH: error < 10% of SWH or 50 cm max Wind Speed: error < 2 m/s	✓
SWIM Sigma0 profiles	Sigma0: restitution better than 1 dB inter-beams bias: error < 0.2 dB	✓
SWIM Wavelength	Wavelength identification range: 70- 500 m Wavelength restitution error: 10%	✓ (50 – 500) ✓ Consistent with models and buoys
SWIM Direction	Restitution error < 15°	Globally compliant with outliers to be analyzed
SWIM Spectral Peak Power	error < 15% (for SWH > 2 m)	✓

## Information about CalVal status available on Aviso+ website (cyclic validation reports)

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



## Earth Terminals

- ❖ Chinese S-Band and X-band stations: **Ok**
- ❖ French X-Band (Kiruna, Inuvik): **Ok**

## Control Center

- ❖ Chinese CLTC: **Ok**

## Mission and processing Centers

- ❖ NSOAS CFMC (Beijing): **Ok**
- ❖ CNES CWWIC NRT processing (Toulouse): **Ok**
- ❖ Ifremer IWWOC DT processing (Brest): **In operation since beginning of 2021**



## CFOSAT Data availability

- ❖ Requirement:
  - The availability of the Satellite for generating Observation data (Measurement and Calibration) shall be greater than 95 %
  
- ❖ From the beginning of life (2018/10/29) till now (2022/10/29): 1460 days
  - House Keeping manoeuvres (including collision avoidance): 7 days
  - On-board X-band interruption: 5 days
  - SWIM anomaly (2021/01/06): 5 days
  - SCAT switch to redundant (end of December 2019) + switch off: 11 days
  - SCAT antenna stop rotating (2022/08/07): 30 days

## Global CFOSAT Products availability performance:

**SCAT: 96.3%**

**SWIM: 98.8%**

## CFOSAT Near Real Time production and distribution

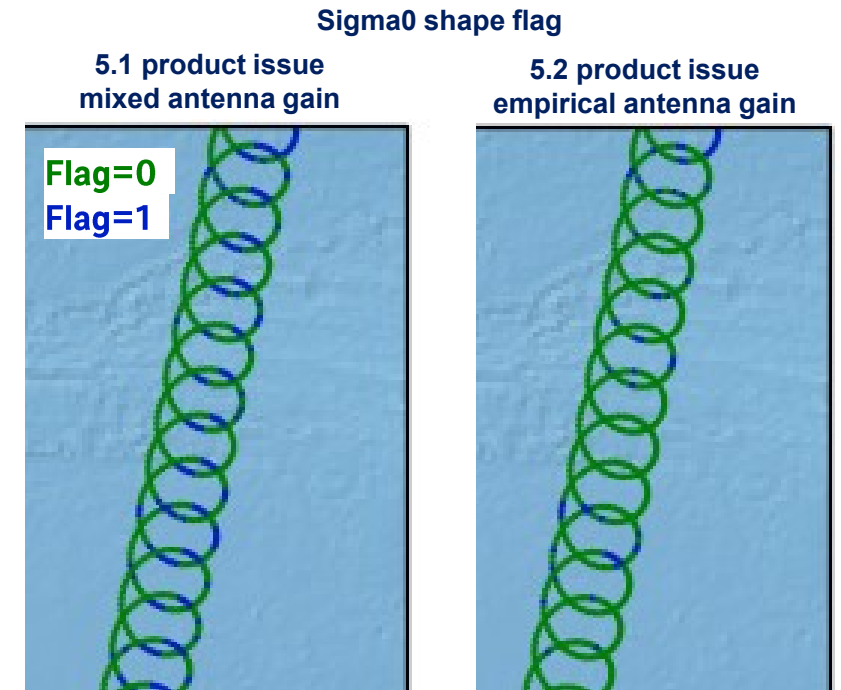
- ❖ Requirement:
  - NRT data shall be made available at meteorological or oceanographic operational centers within 3 hours from acquisition time, with an availability of 75 %
- ❖ From the beginning of life (2018/10/29) till now (2022/10/29): 1460 days
- ❖ SWIM
  - 93.2 % of SWIM NRT products under 3 hours
- ❖ SCAT
  - 96,7 % of SCAT NRT products under 3 hours



## Main evolutions in the latest product issues

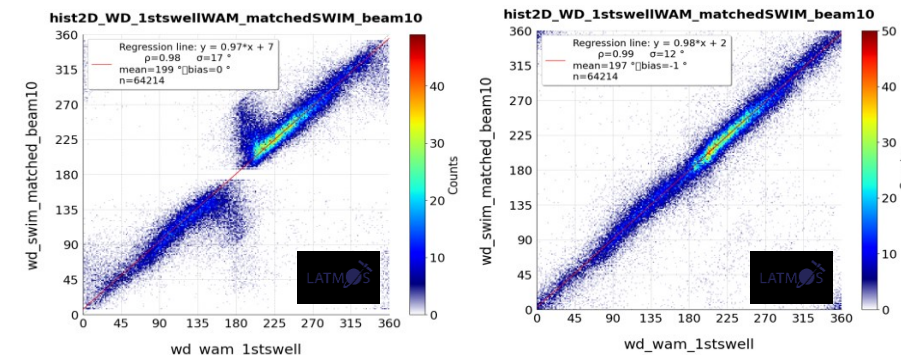
- ❖ 5.2 (2021/07/27)
  - New Antenna gain diagram
    - Empirical gain diagram, obtained by specific ground processing
    - Largely corrects azimuthal asymmetry in sigma0 profiles
  - Direction restitution anomaly corrected
    - Wrong direction values for waves around 0/180 observed in previous issue
    - Direction more consistent with model
- ❖ 6.0 (2022/06/27)
  - Microcuts detection algorithm improvement
  - Signal variability parameter propagation
  - Sigma0 profiles filtering improvement
- ❖ Product evolutions history given on Aviso+ website:
  - <https://www.aviso.altimetry.fr/en/missions/current-missions/cfosat/product-evolutions.html>
- ❖ 2<sup>nd</sup> full reprocessing campaign starts today (OP06 version)...

Work on-going for carrying-on improving products...



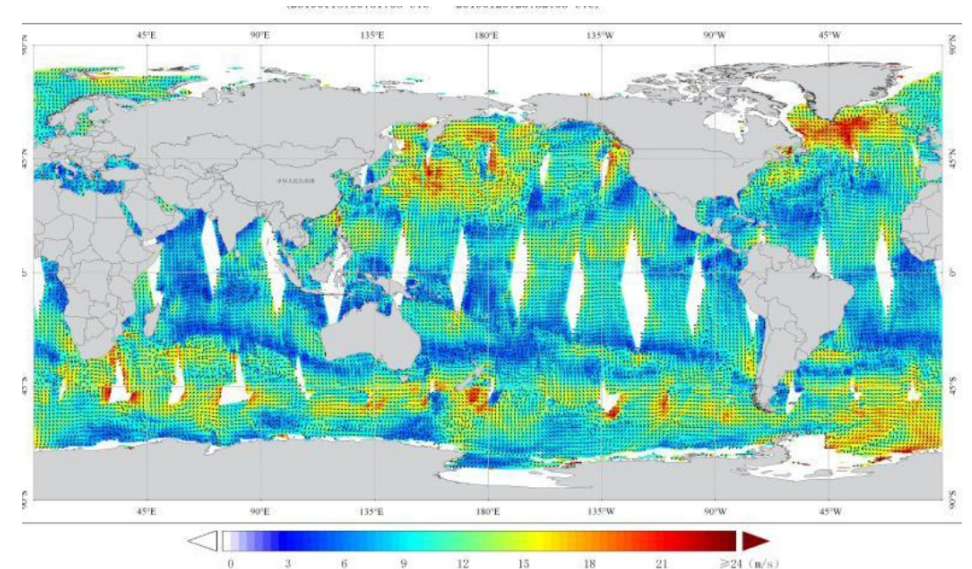
Wave direction from SWIM wave spectra vs WAM model, beam 10°

5.1 product issue      5.2 product issue



## Main evolutions in the latest product issues

- ❖ 3.2 (March 2021) and 3.3 (December 2021)
  - Level 1B
    - The change of satellite orbit influence SCAT temperatures and causes the fluctuation of signals
    - Noise calibration adaptive algorithm updated in 3.3
  - Level 2
    - Update the LUTs of MLE normalization, QC threshold and VV /HH calibration coefficients
- ❖ Full reprocessing campaign to come...

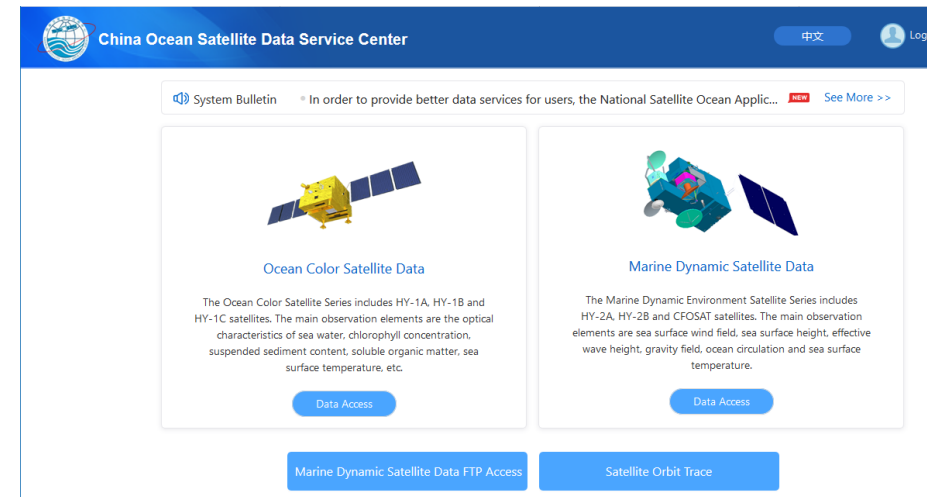


## System products from Mission Centers

- ❖ SWIM and SCAT level 1 and level 2 products
- ❖ On Aviso+ Website: <https://www.aviso.altimetry.fr/>
- ❖ On NSOAS Website: <https://osdds.nsoas.org.cn/#/>

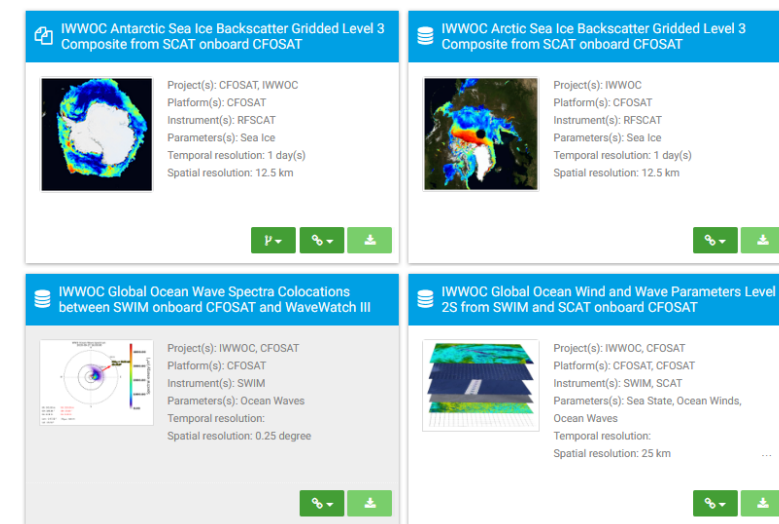
## Value-added products from CNES Mission Center (CWWIC)

- ❖ NRT products
  - SWIM-L2P-SWH-Nadir-1Hz
  - SWIM-L2P-OFF-NADIR
  - For Copernicus Marine Service operational usage
- ❖ NTC products
  - SWIM-L2P-SWH-Nadir-1Hz and 5Hz
  - Reprocessed series for climate studies
- ❖ Available on Aviso+ Website: <https://www.aviso.altimetry.fr/>



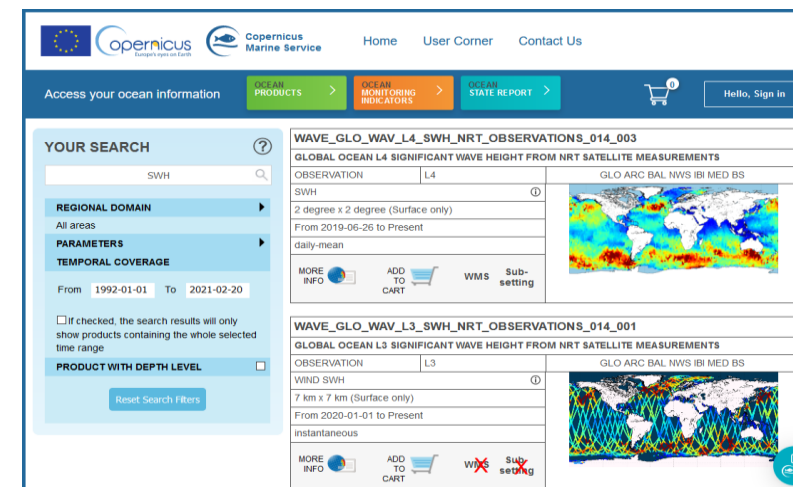
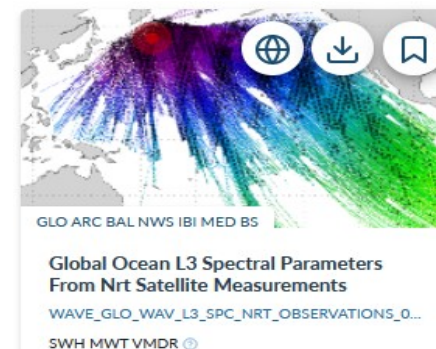
## Value-added products from Ifremer Processing Center (IWWOC)

- ❖ Higher level products : L2S to L3/L4 (global fields of wind and wave parameters)
- ❖ Synergy between SWIM and SCAT, alternative processing method and testing
- ❖ Cross-overs with altimeters/scatterometers/SAR and models (WW3)
- ❖ Match-ups with in situ data
- ❖ On ODATIS Website : <https://www.odatis-ocean.fr/>
  - Some products available since beginning 2022: SWIM-L2S, SCAT-L3-ICE, Colocations SWIM-WW3
  - Others products to come soon...



## Products from Copernicus Marine Service

- ❖ Global L3 and L4 SWH NRT products
- ❖ L3 Spectral NRT products
  - CMEMS website: <https://resources.marine.copernicus.eu/>

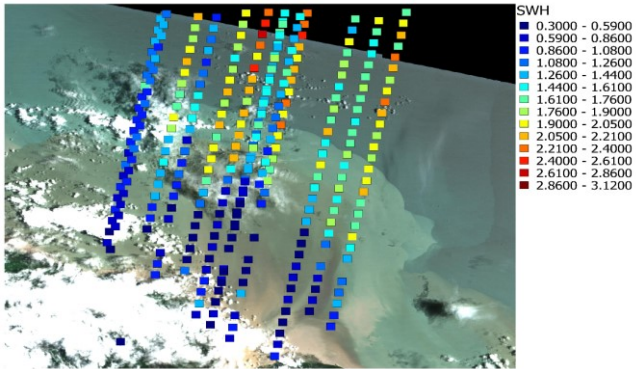




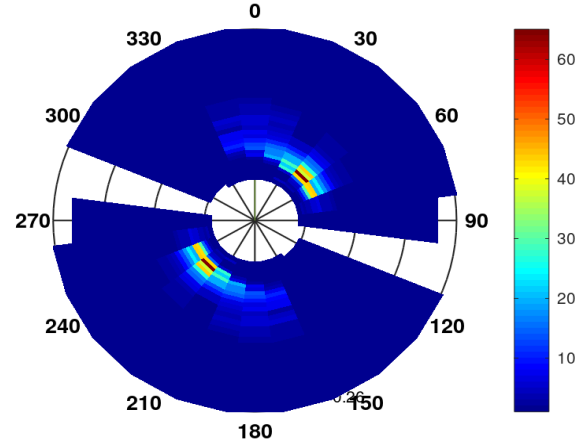
# Science: uniqueness of CFOSAT

- ❖ Transition from short wind-waves to long wave (growth, extreme,...)
- ❖ Wind variability in critical seas
- ❖ Better sampling of SWH
- ❖ Wide swath SWH
- ❖ Sea ice...and further more

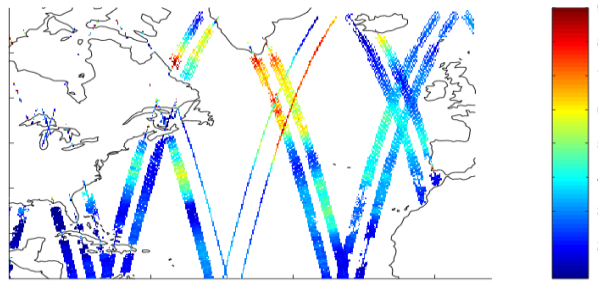
SWH nadir 5Hz



SWIM spectrum

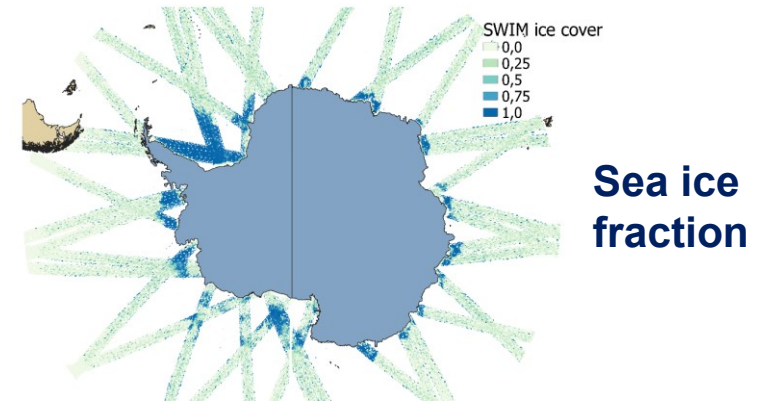
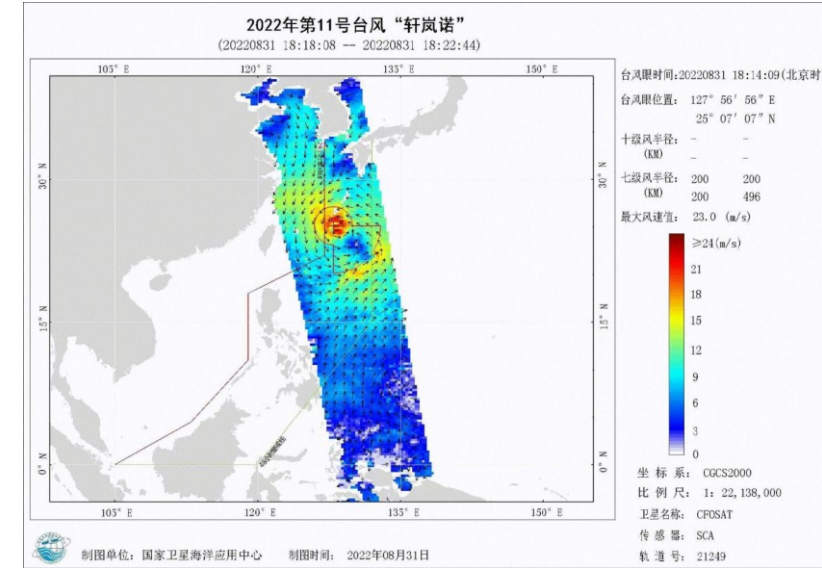


Ocean surface as never  
observed before



SWH nadir and swath

SCAT wind field

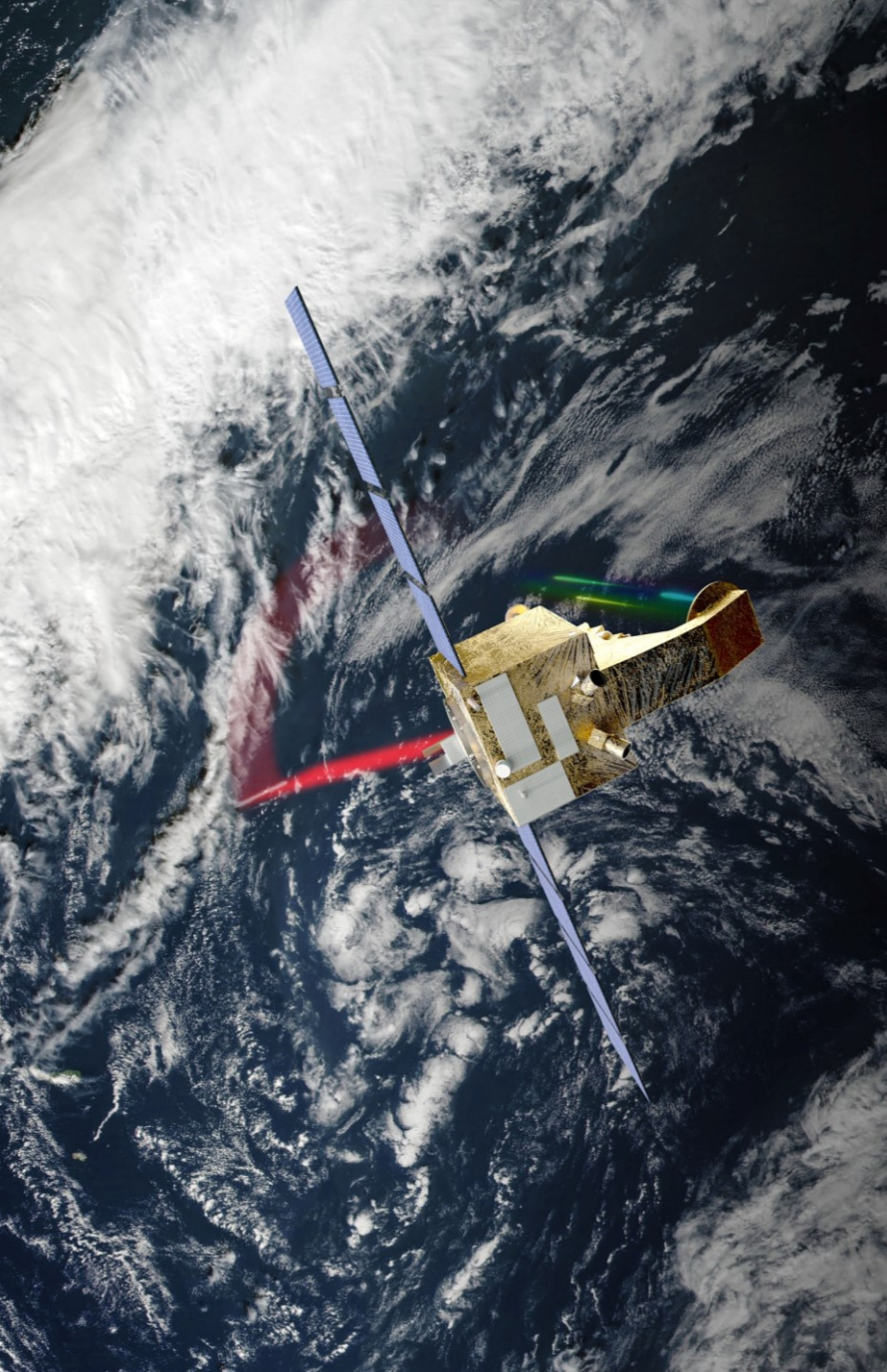


## Several achievements related to mission exploitation and outcomes from the Science Team

- ❖ Validation and improvements of processing and products (SWIM & SCAT)
- ❖ Geophysical analysis: global wave field properties, specific cases analysis - tropical cyclones, wave-current interactions, coastal, ocean/atmosphere interactions, indicators for extreme waves
- ❖ Operational use of CFOSAT directional wave observations in wave forecast (CMEMS, MF,...) and preparing a better coupled models (ocean/waves)
- ❖ Implementation and retrieval of new products from CFOSAT: Stokes drift (oil spills and drifting bodies), sea ice fraction and classification, orbital velocity, estimate of Mean Square Slope,...
- ❖ Complementary use with other missions: better capturing of small scale of waves than Sentinel-1

Learn more at CFOSAT Splinter, on Thursday at 9:00 am





## Conclusions

**CFOSAT Mission continues to perform well after  
four years in orbit**

**It's already a great success**

**To be continued...**

### **To come:**

- ❖ SWIM 2<sup>nd</sup> full reprocessing by the end of the year
- ❖ SCAT 1<sup>st</sup> full reprocessing in the same schedule



谢谢！Thank you！Merci！