SCAT INSTRUMENT STATUS AND PERFORMANCE
CHOGS (CHINESE GROUND SEGMENT) STATUS

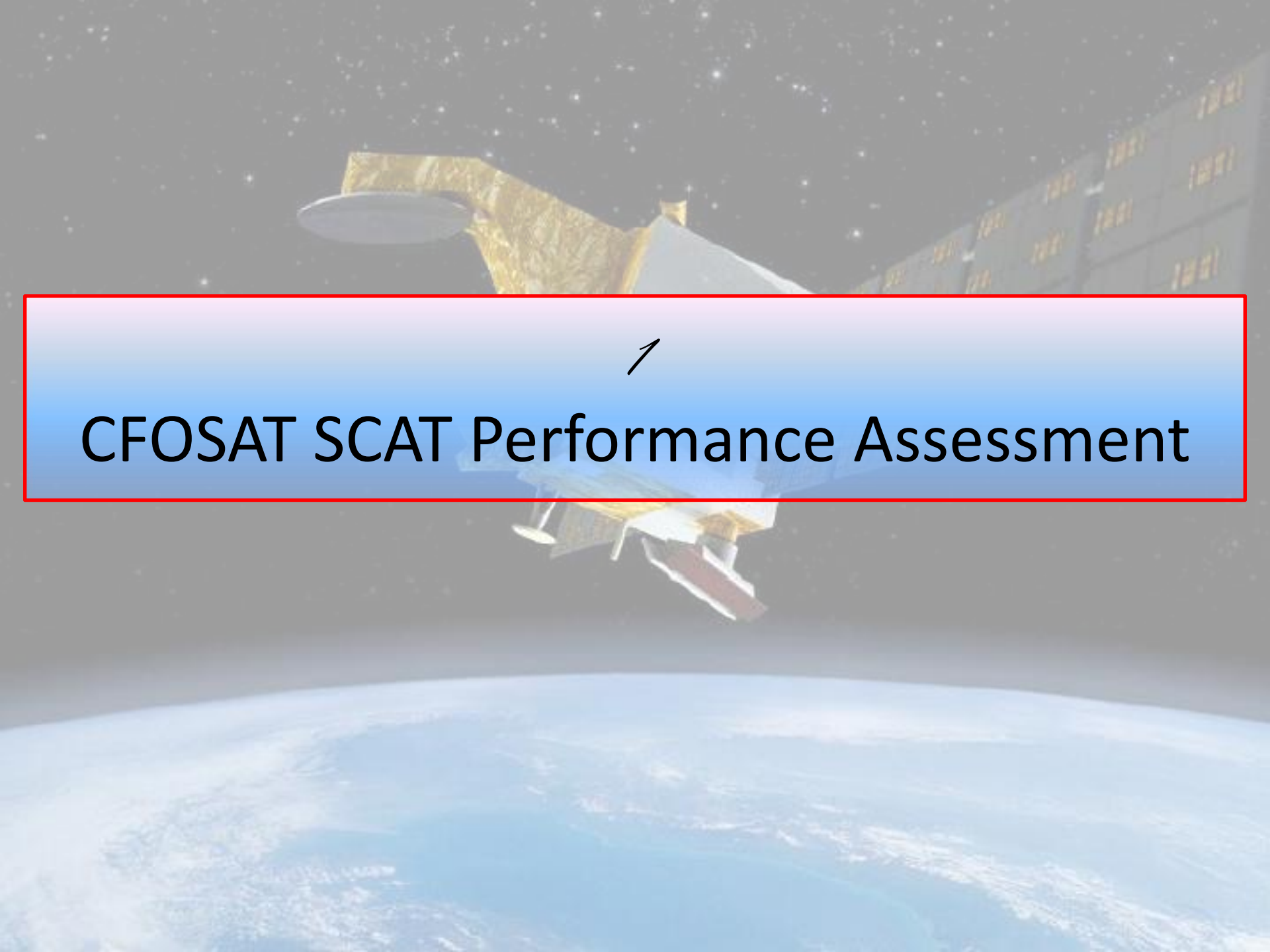
National Space Science Center, CAS

National Satellite Ocean Application Service,NSOAS

March, 2021

Outline

- CFOSAT SCAT Performance Assessment
- CFOSAT SCAT Product Quality Control
- CFOSAT SCAT Products CAL/VAL status
- Conclusions



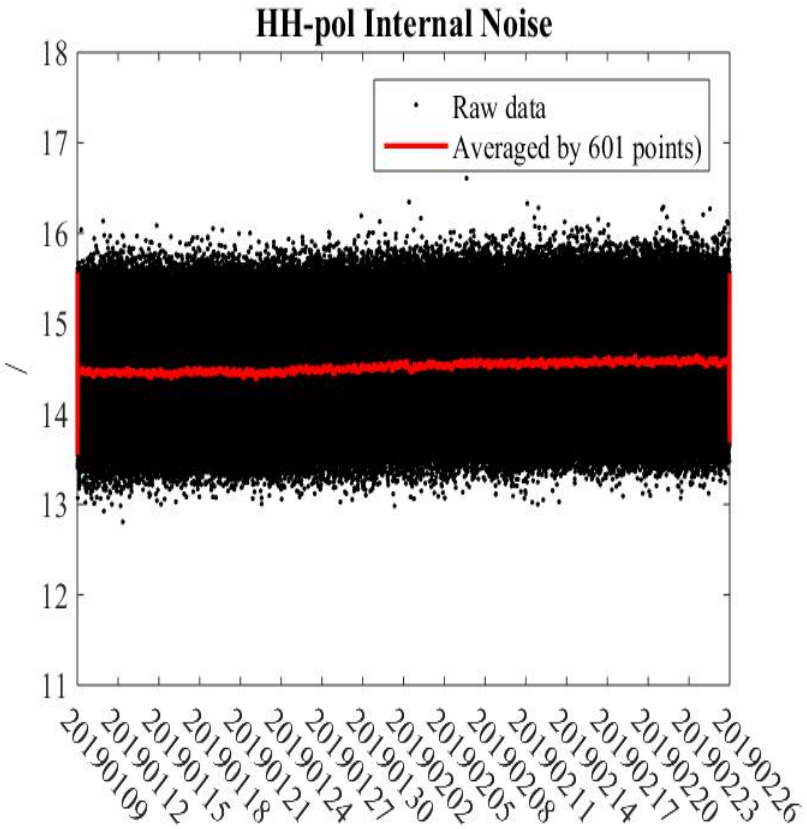
CFOSAT SCAT Performance Assessment

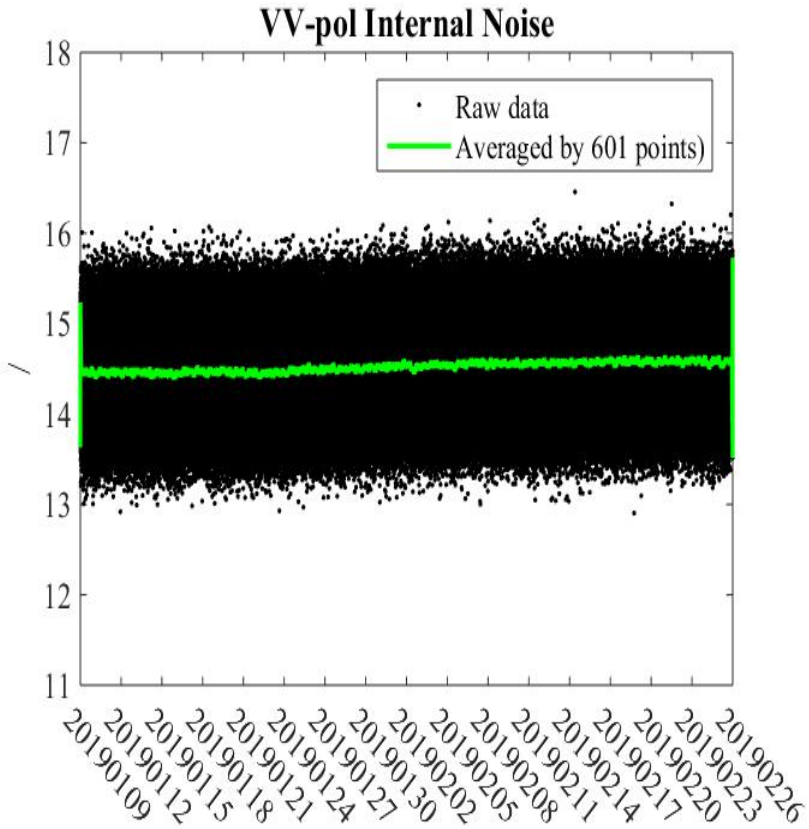
Important Events of SCAT

#	Time	Content	Comments
1	Oct. 29, 2018	CFOSAT successfully launched	UTC:20181029T0043
2	Nov. 01, 2018	SCAT starts up The first revolution scientific data is obtained.	
3	Nov. 04, 2018	SCAT obtains wind vector for the first time.	
4	Dec. 10, 2018	Transport SCAT L1 IPFs (version 1.0) to CNES	
6	Dec. 18, 2018	Upload the on-board slice division LUT	Data before December 18, after special processing can also be used
7	Apr. 17, 2019	Discuss data and software issues with French team in France	
8	May.20, 2019	Update SCAT L1 IPFs (version 2.0)	
9	Jun.1~Jun.5,2019	Abnormal shutdown of DTS TWTA	Normal after DTS TWTA reset
10	Jul.14~Jul.17,2019	L0 data frame dislocation	Normal after reset; Data can be used after frame relocation processing
11	Dec.19~Dec.30, 2019	TWTA abnormal	Unable to recover
12	Dec.30, 2019	Switch to backup TWTA Upload the on-board slice division LUT	
13	Mar.30, 2020	Update SCAT L1 IPFs (version 3.0)	
14	Sep.08, 2020	AGC values abnormal	Normal after reset/SEU
15	Dec.28~Dec.29, 2020	AGC values abnormal	Normal after reset/SEU
16	Jan.25, 2021	AGC values abnormal, Noise/Cal. value abnormal	Normal after reset/SEU

CFOSAT SCAT Received Signal Stability

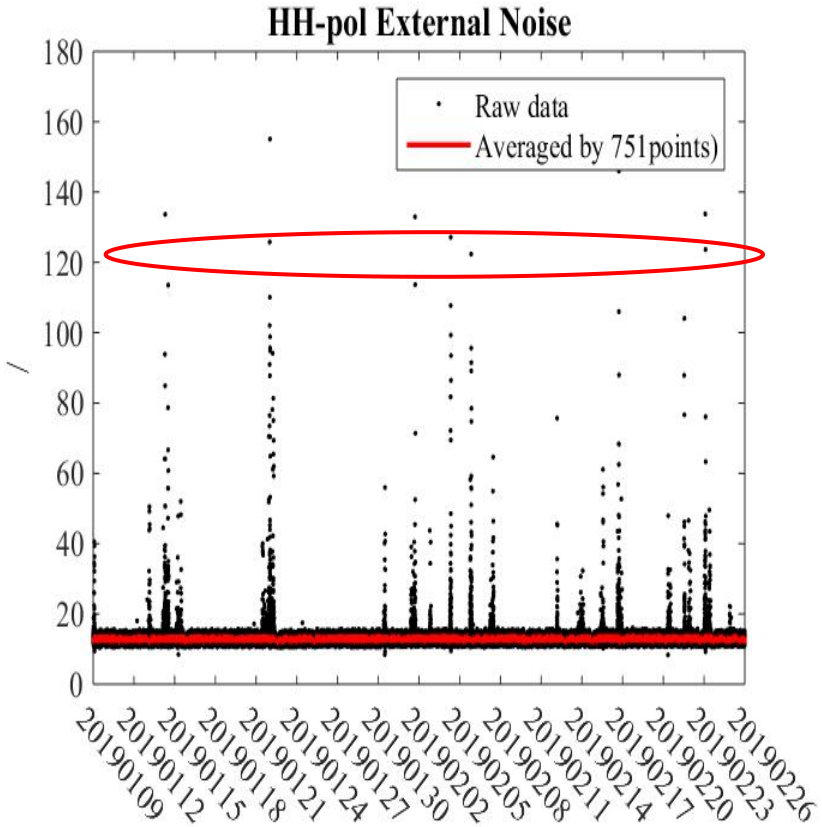
- SCAT Primary Received Signal(Nov. 1,2018~Dec. 30, 2019)

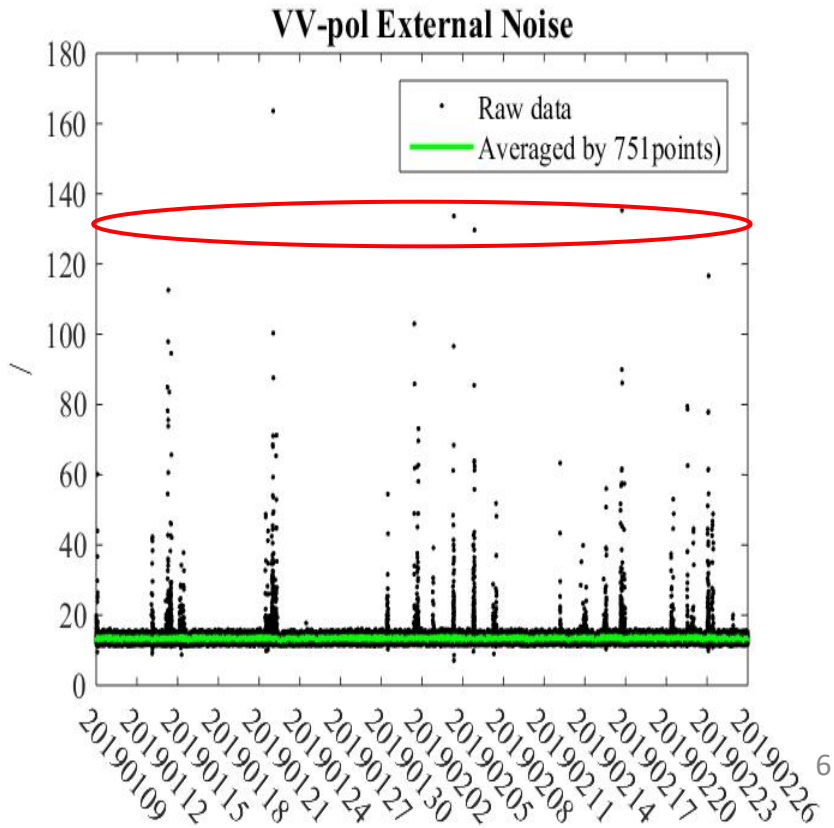




CFOSAT SCAT Received Signal Stability

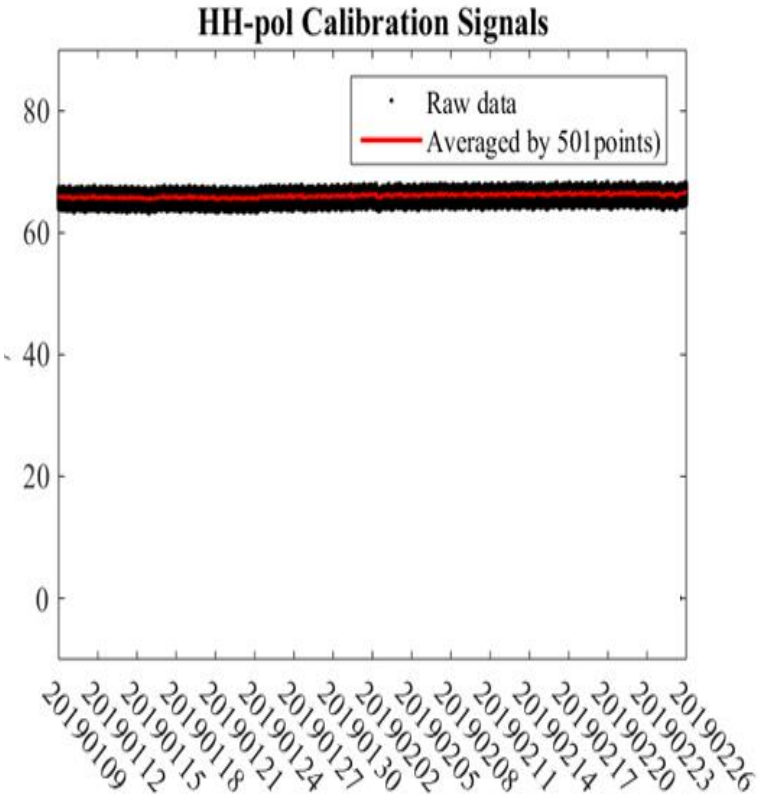
- SCAT Primary Received Signal(Nov. 1,2018~Dec. 30, 2019)
  - External Noise Signal

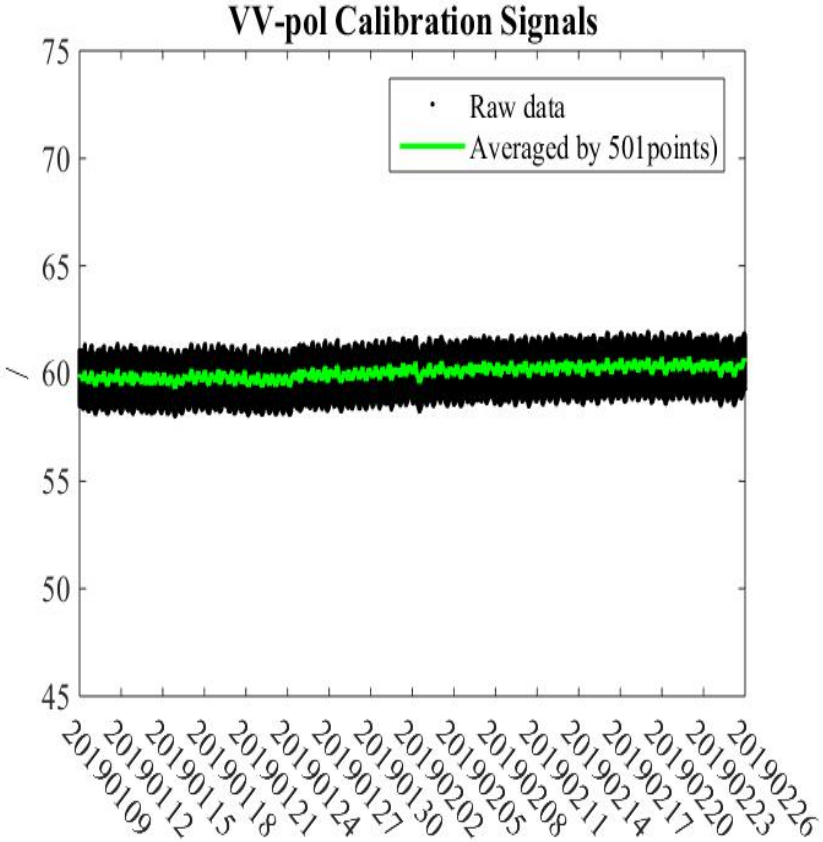




CFOSAT SCAT Received Signal Stability

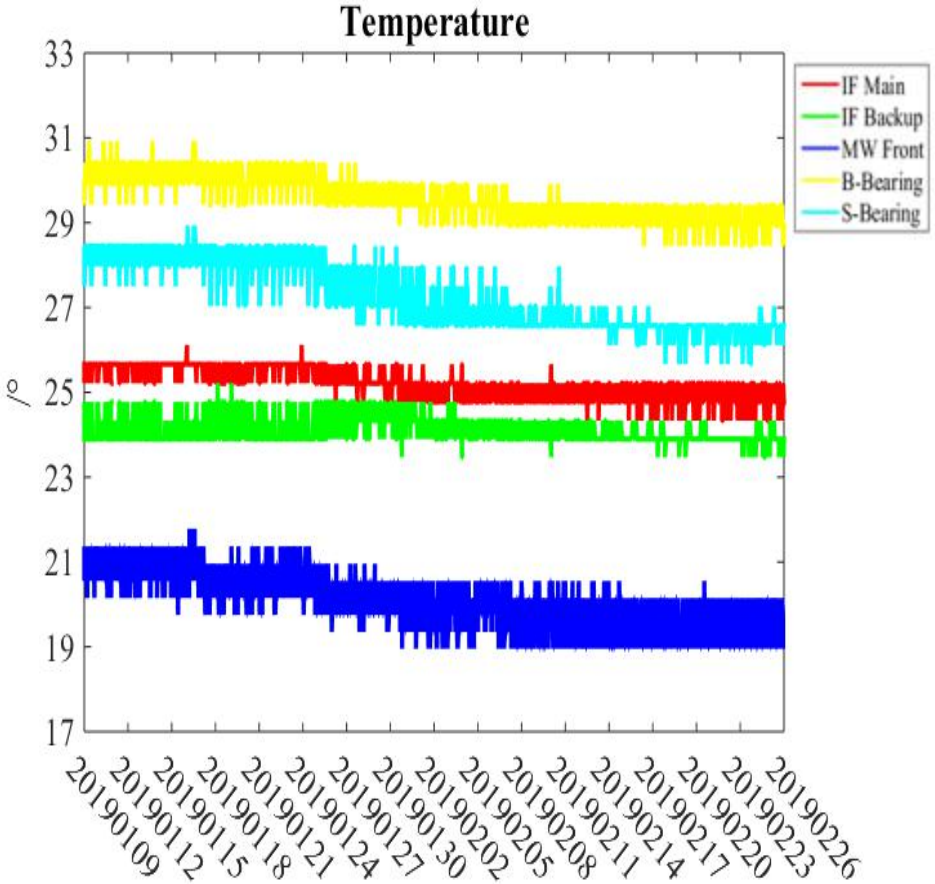
- SCAT Primary Received Signal(Nov. 1,2018~Dec. 30, 2019)
  - Internal Calibration Signal





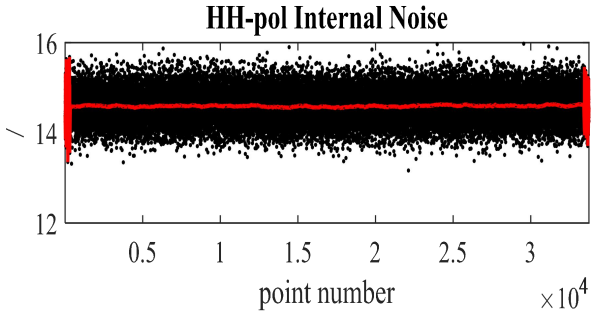
CFOSAT SCAT Received Signal Stability

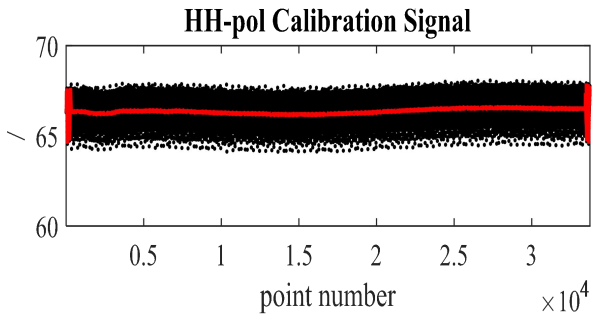
- SCAT Primary Received Signal(Nov. 1,2018~Dec. 30, 2019)
  - Temperature

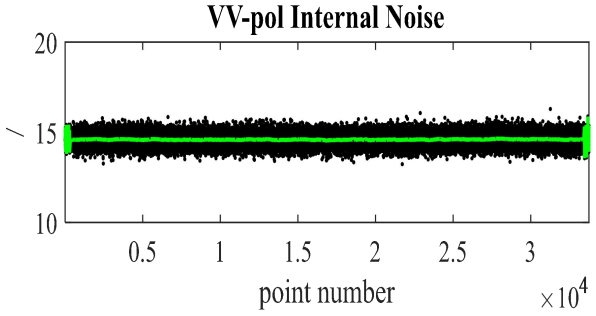


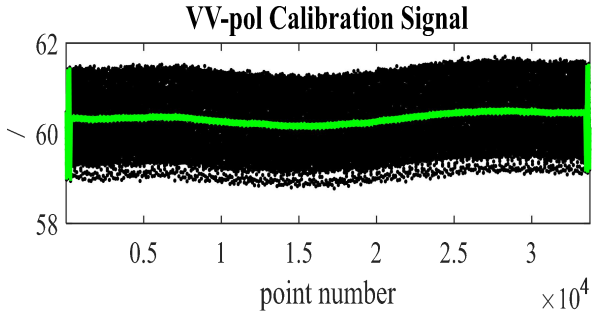
CFOSAT SCAT Received Signal Stability

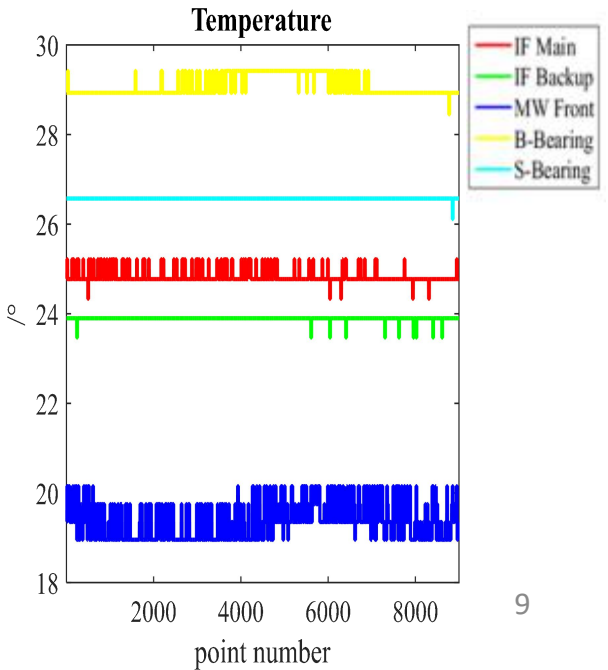
- SCAT Primary Received Signal(Nov. 1,2018~Dec. 30, 2019)
  - Single revolution
    - CFO_OPER_SCA_L1A_OR_C_20190316T182655_20190316T200555_02100_01.nc





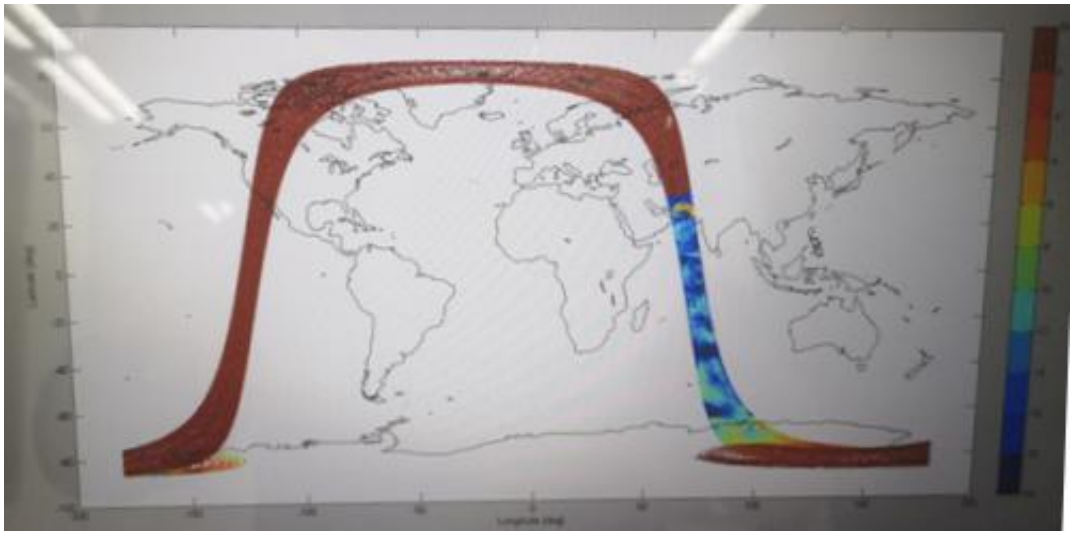




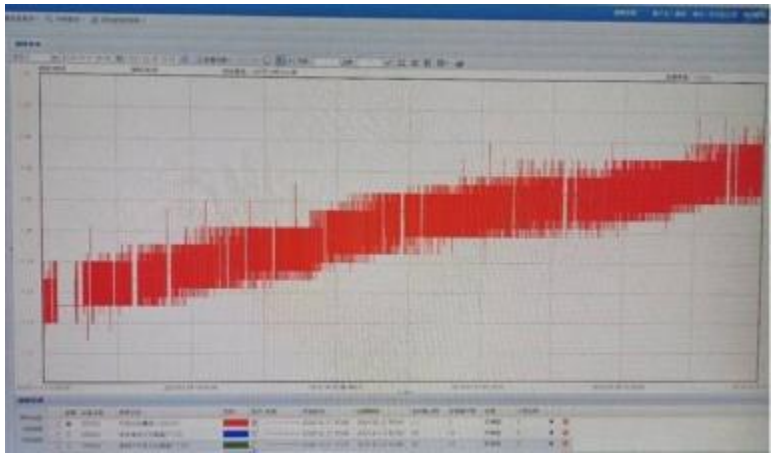


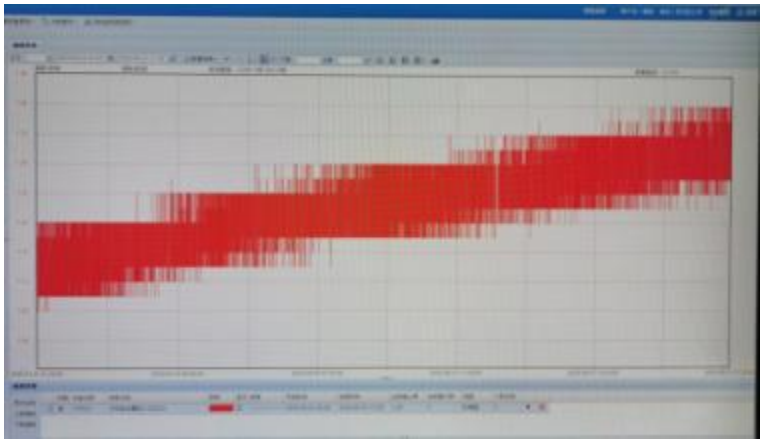
SCAT TWTA Auto Switch off

- 2019.12.19, 14:40 UTC, CFOSAT SCAT Primary TWTA automatically switched off
- 2019.12.20, 11:15 UTC, during TT&C visibility, we decided to switch off part of SCAT equipment, including transceiver and DPU of SCAT, only leave PDU on and antenna rotating.
- 2019.12.29， SCAT Switched to backup.



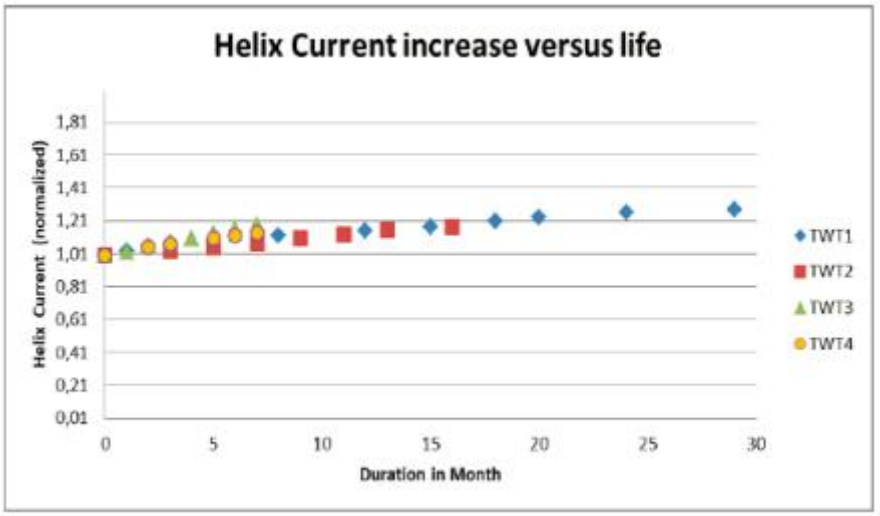
SCAT TWTA Helix Current in one year





Left：TWTA Primary　　Right：TWTA Backup

- Confirm with Thales that the increase of Helix Current is normal.



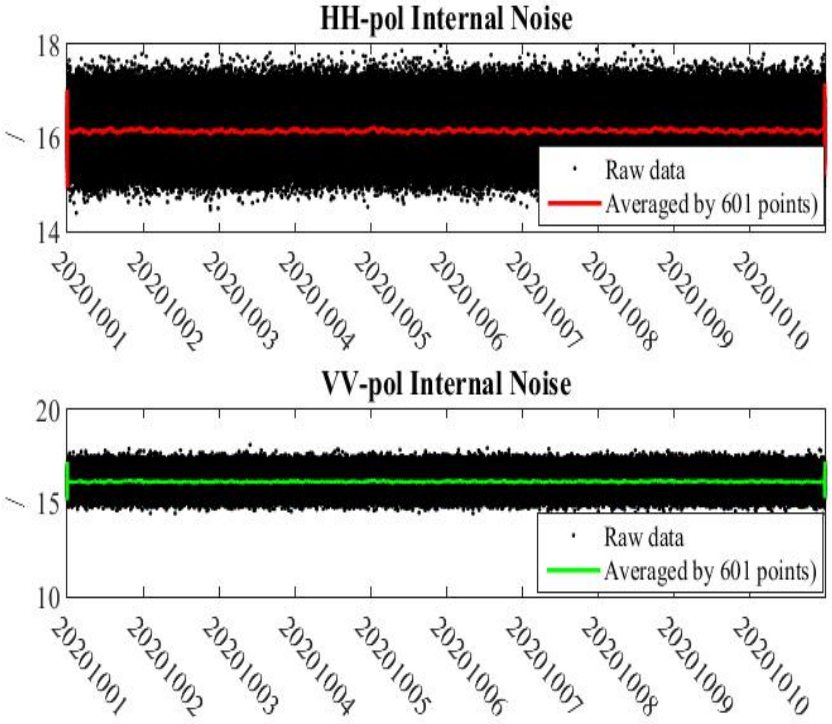
Comparison of Helix increase of different TWTs

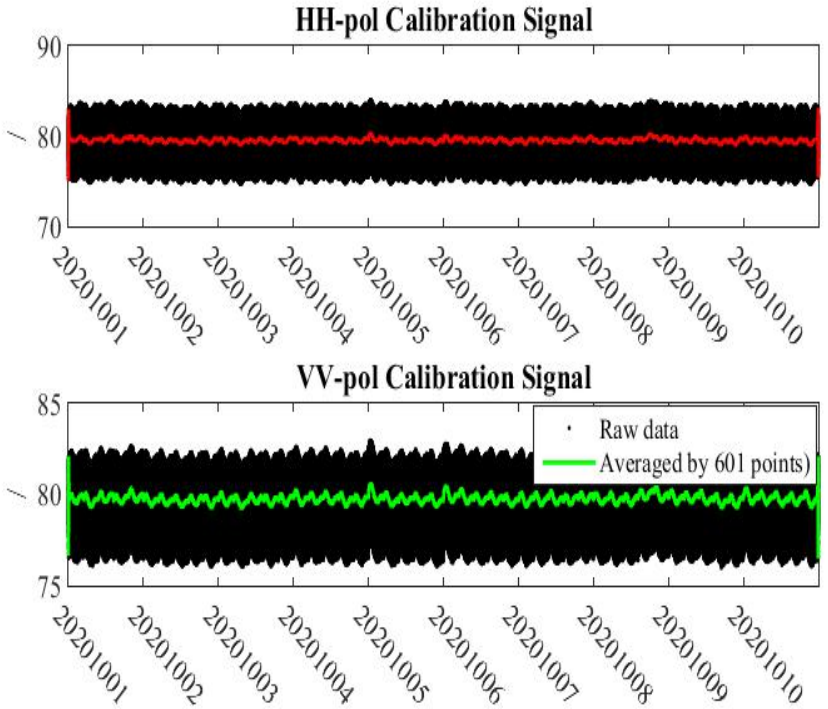
CFOSAT SCAT Received Signal Stability

- Summary of SCAT Primary Received Signal
  - In general, the stability of CFOSAT SCAT received signal is excellent; the received signal is nearly not changed with temperature
  - The external noise anomaly mainly comes from RFI. In practice, the outliers can be removed by setting reasonable thresholds, which usually does not affect the quality of data products

CFOSAT SCAT Received Signal Stability

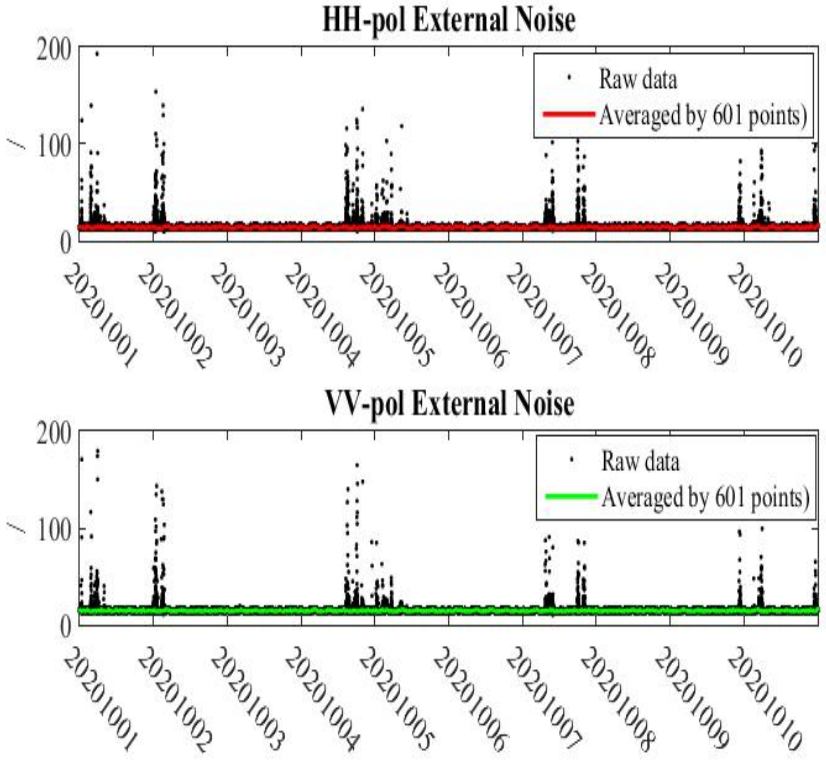
- SCAT Backup Received Signal(Dec. 31,2019~)
  - Internal Noise & Internal calibration signal

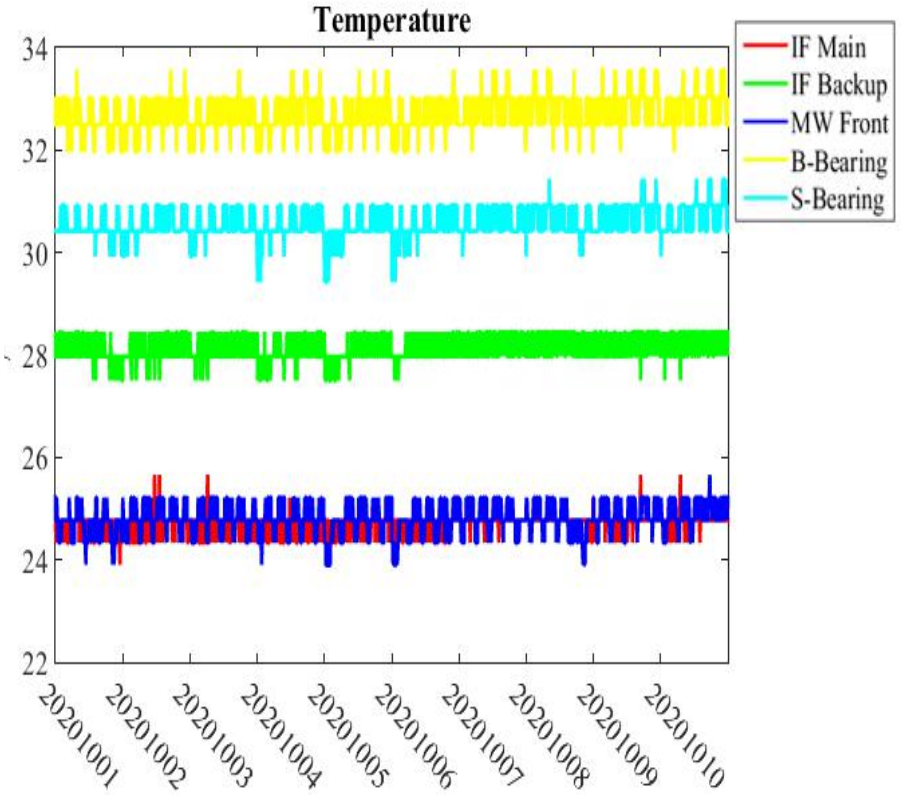




CFOSAT SCAT Received Signal Stability

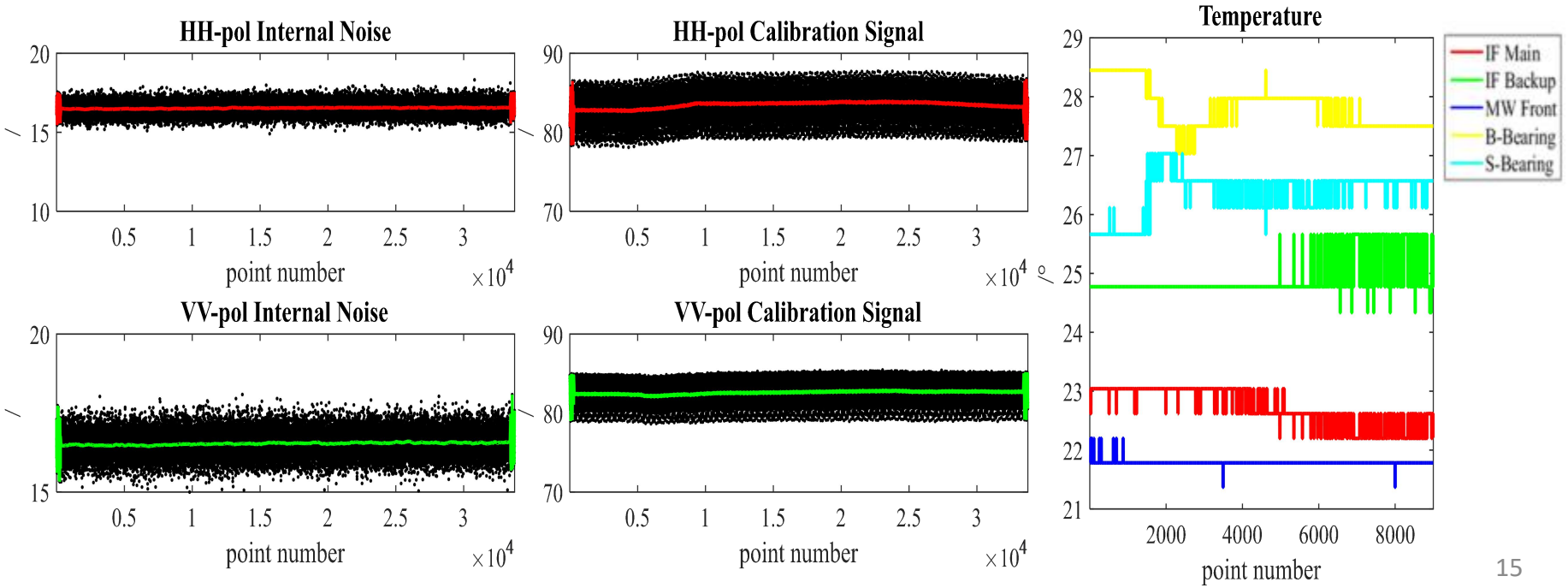
- SCAT Backup Received Signal(Dec. 31,2019~)
  - External Noise signal & Temperature





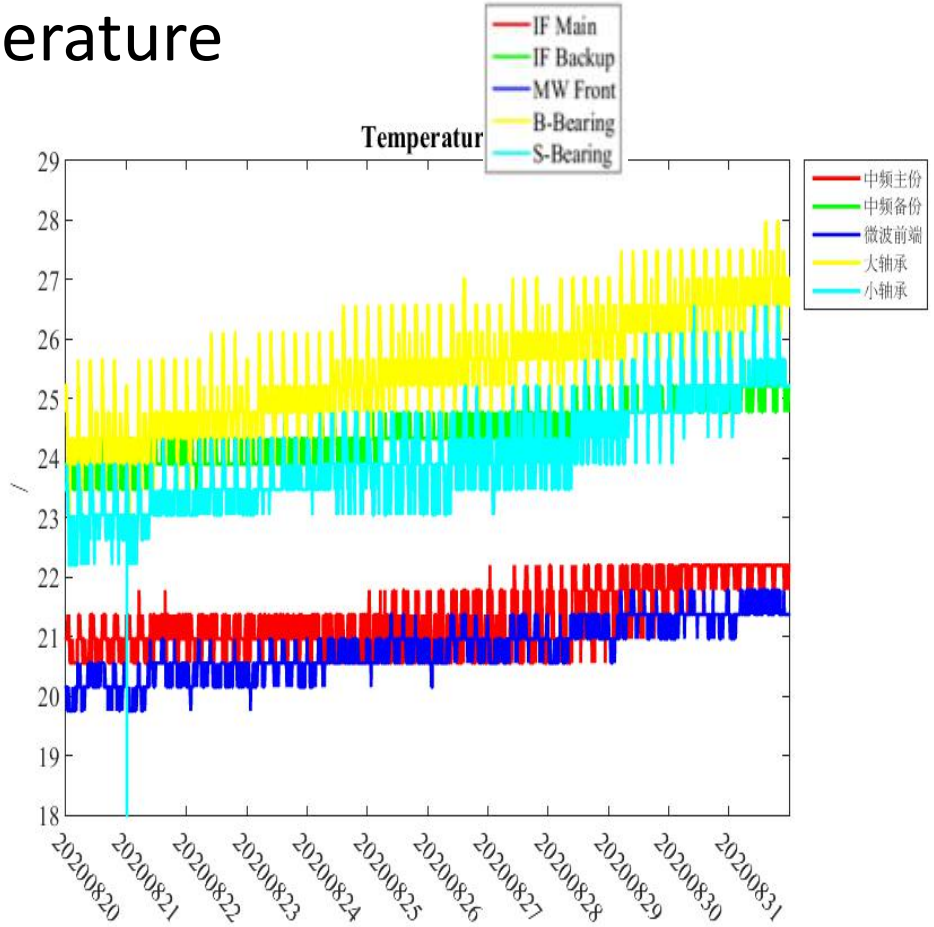
CFOSAT SCAT Received Signal Stability

- SCAT Backup Received Signal(Dec. 31,2019~)
  - Single revolution
  - CFO_OPER_SCA_L1A_OR_C_20200410T040147_20200410T054048_08016_01.nc



CFOSAT SCAT Received Signal Stability

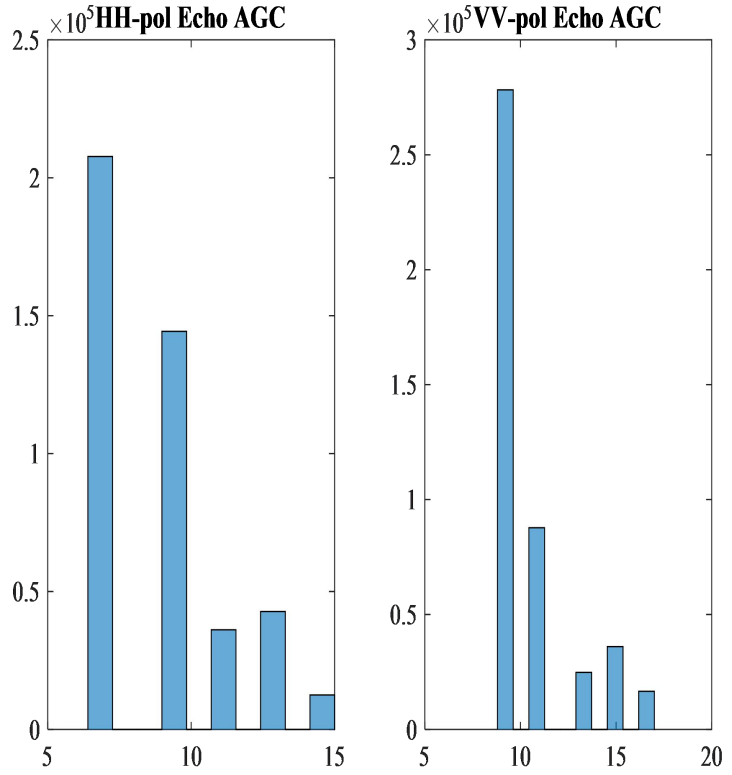
- SCAT Backup Received Signal(Dec. 31,2019~)
  - Temperature



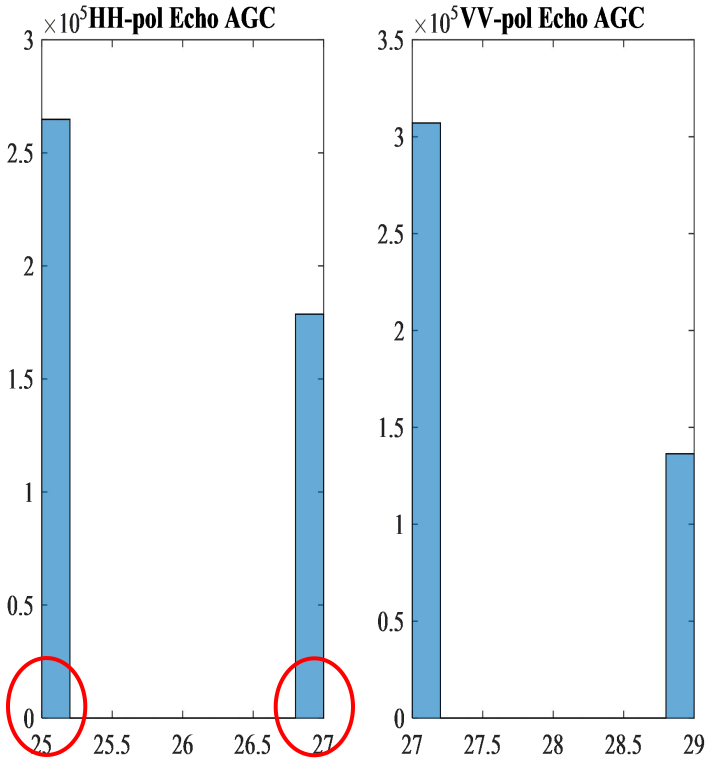
CFOSAT SCAT Received Signal Stability

- AGC abnormal

Normal



Abnormal



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CFO_OPER_SCA_L1A_OR_C_20210125T202836_20210125T220738_12421_03.nc

CFOSAT SCAT Received Signal Stability

- Summary of SCAT Backup Received Signal
  - In general, comparing with SCAT primary, SCAT backup is sensitive to temperature change. Especially in some time period, the signal fluctuates in 1 revolution
  - Like the SCAT primary received signal, the external noise anomaly and the internal calibration signal anomaly of HH-pol still exist, which actually does not significant affect the quality of data products
  - AGC anomaly occurs occasionally, which may be due to SEU

CFOSAT SCAT Performance assessment

- In general, the CFOSAT SCAT works normally, the received data is stable and the telemetry data is correct.
- SEU(Single Event Upset) sometimes cause the data abnormal

2

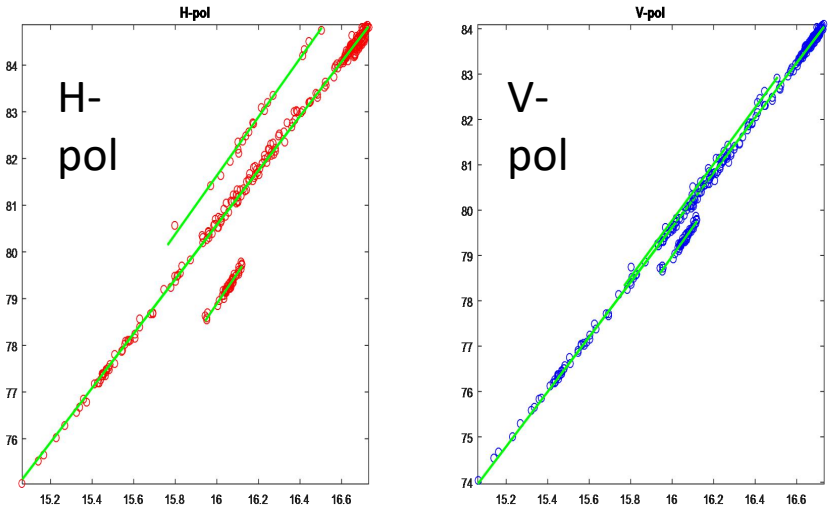
CFOSAT SCAT Product Quality Control

CFOSAT SCAT Product Quality Control

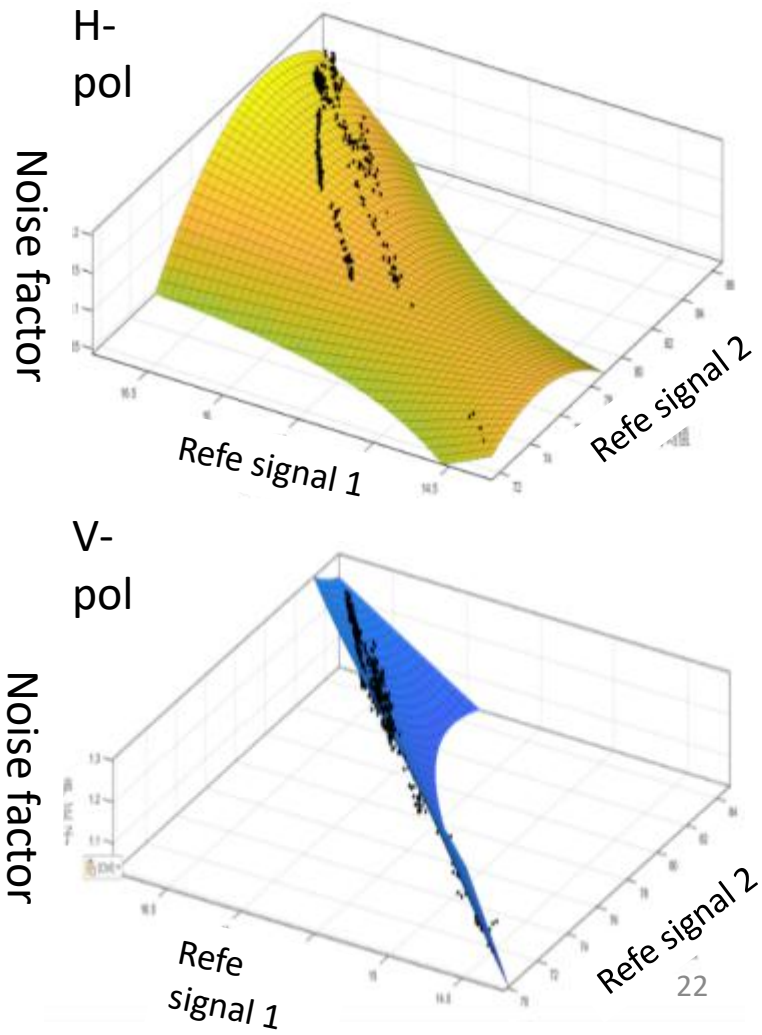
- Possible causes of data quality fluctuation
  - Low SNR echoes from the edge of the swath
  - Inaccurate estimation of noise energy
  - Backscattering coefficient calibration coefficient drift
  - Wind field inversion processing(eg. Abnormal data elimination criterion)

CFOSAT SCAT Product Quality Control

- Adaptive estimation algorithm of SCAT slice noise energy is used



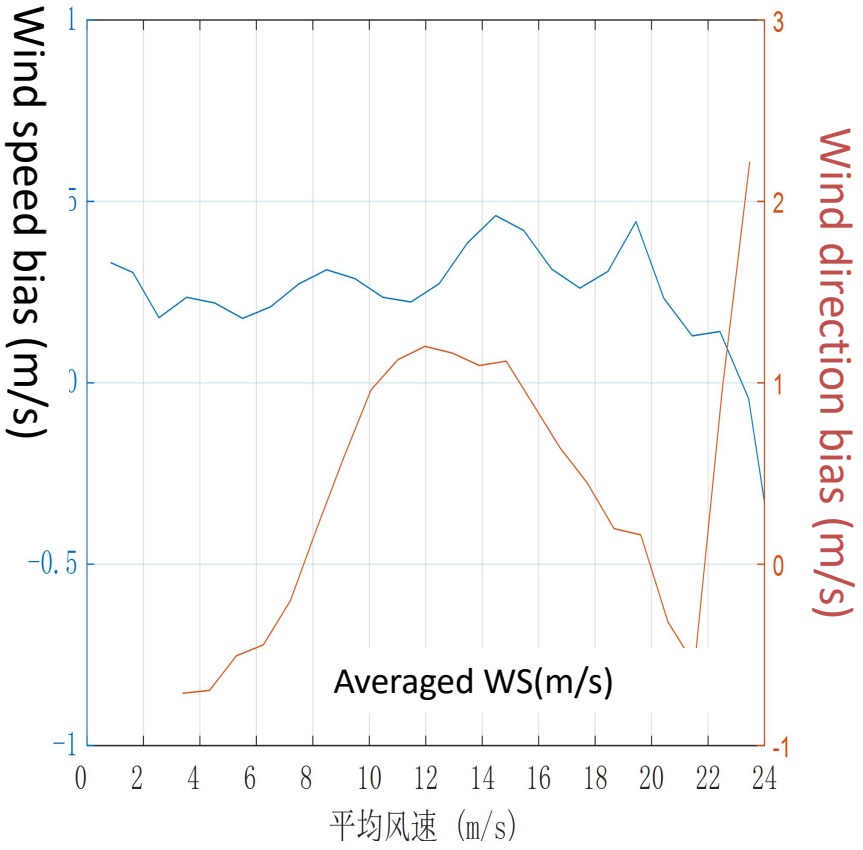
- The noise energy estimation is related to the stability of the received signal
- A noise energy estimation adaptive algorithm based on Bivariate polynomial fitting is used for improving the noise estimation



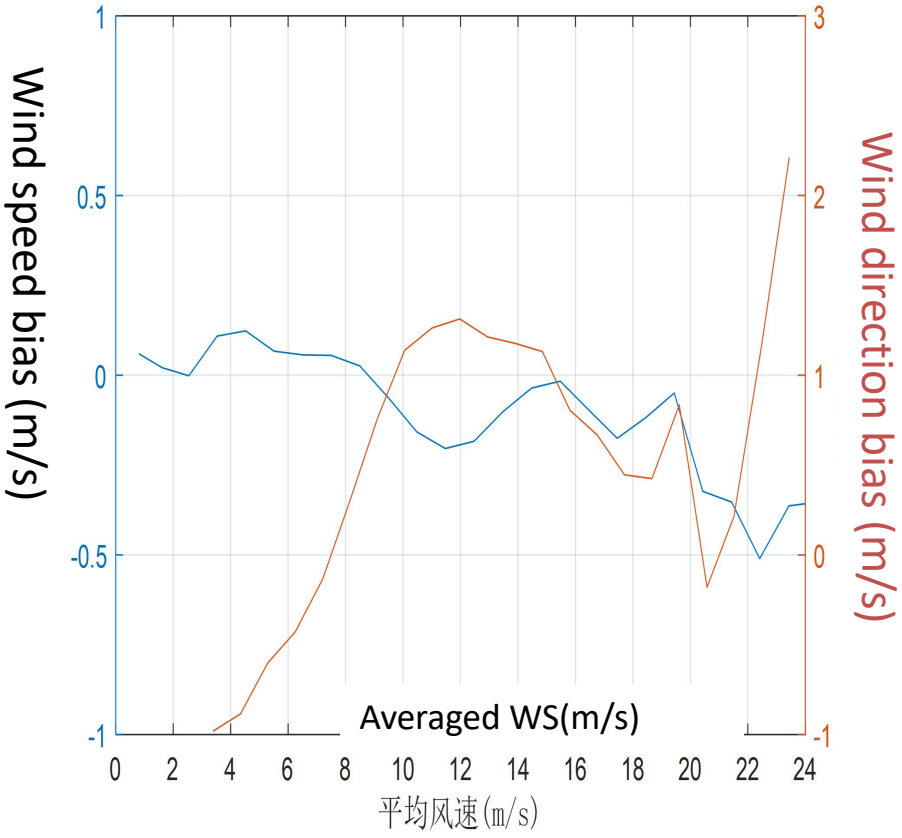
CFOSAT SCAT Product Quality Control

Aug, 2020(221 revolutions)

Before Noise Adaptive Processing



After Noise Adaptive Processing

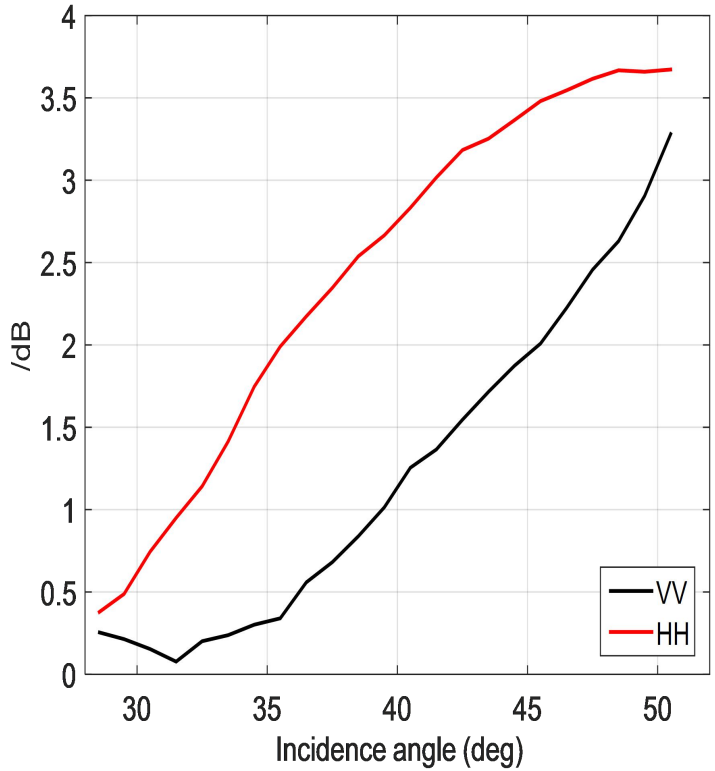


3

CFOSAT SCAT Products CAL/VAL Status

CFOSAT SCAT Products CAL/VAL Status

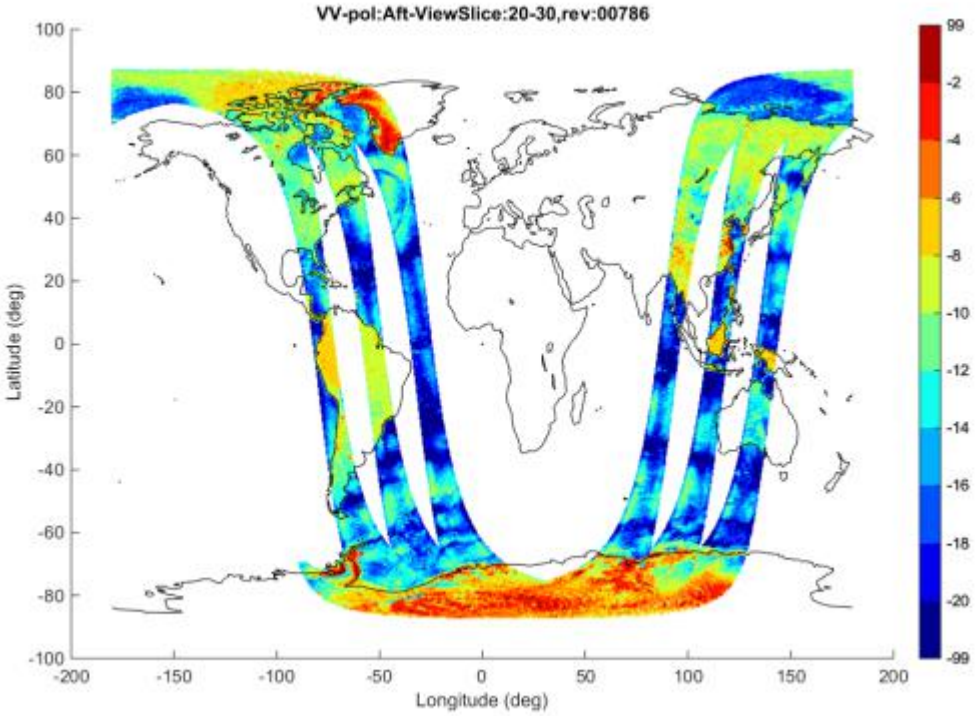
- The NOC backscattering coefficient calibration method is used on SCAT Level 2A product



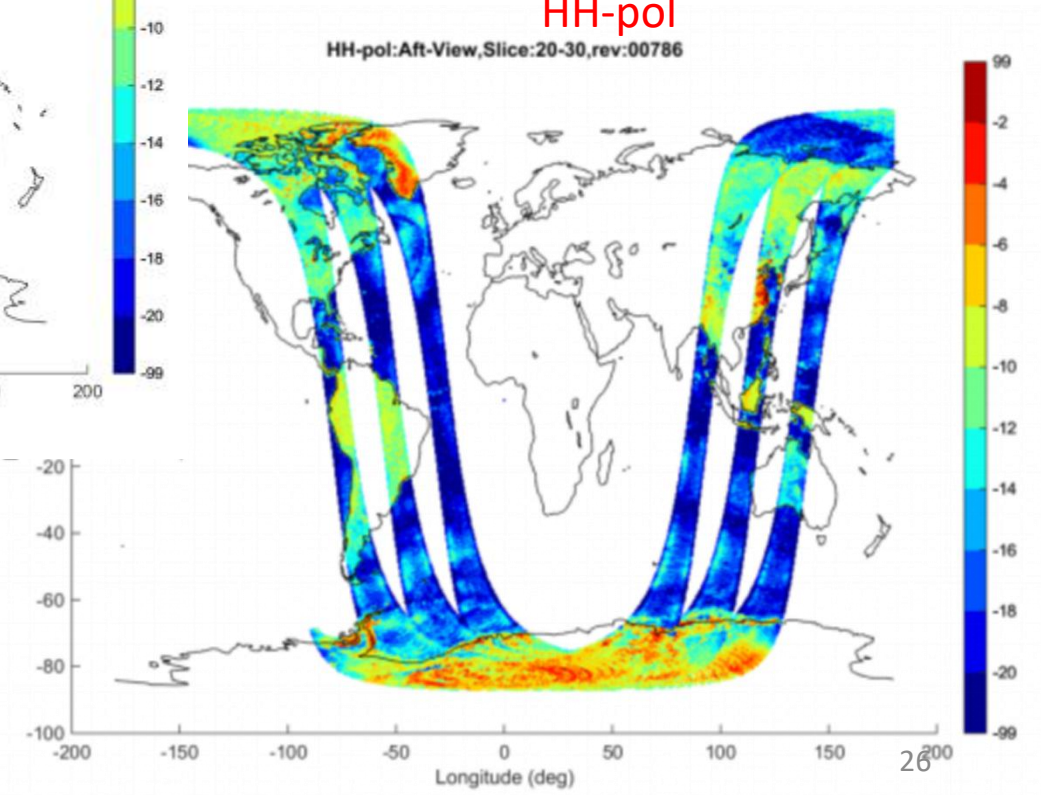
(NOC coefficients of Processor Version 3.0)

CFOSAT SCAT Sigma0

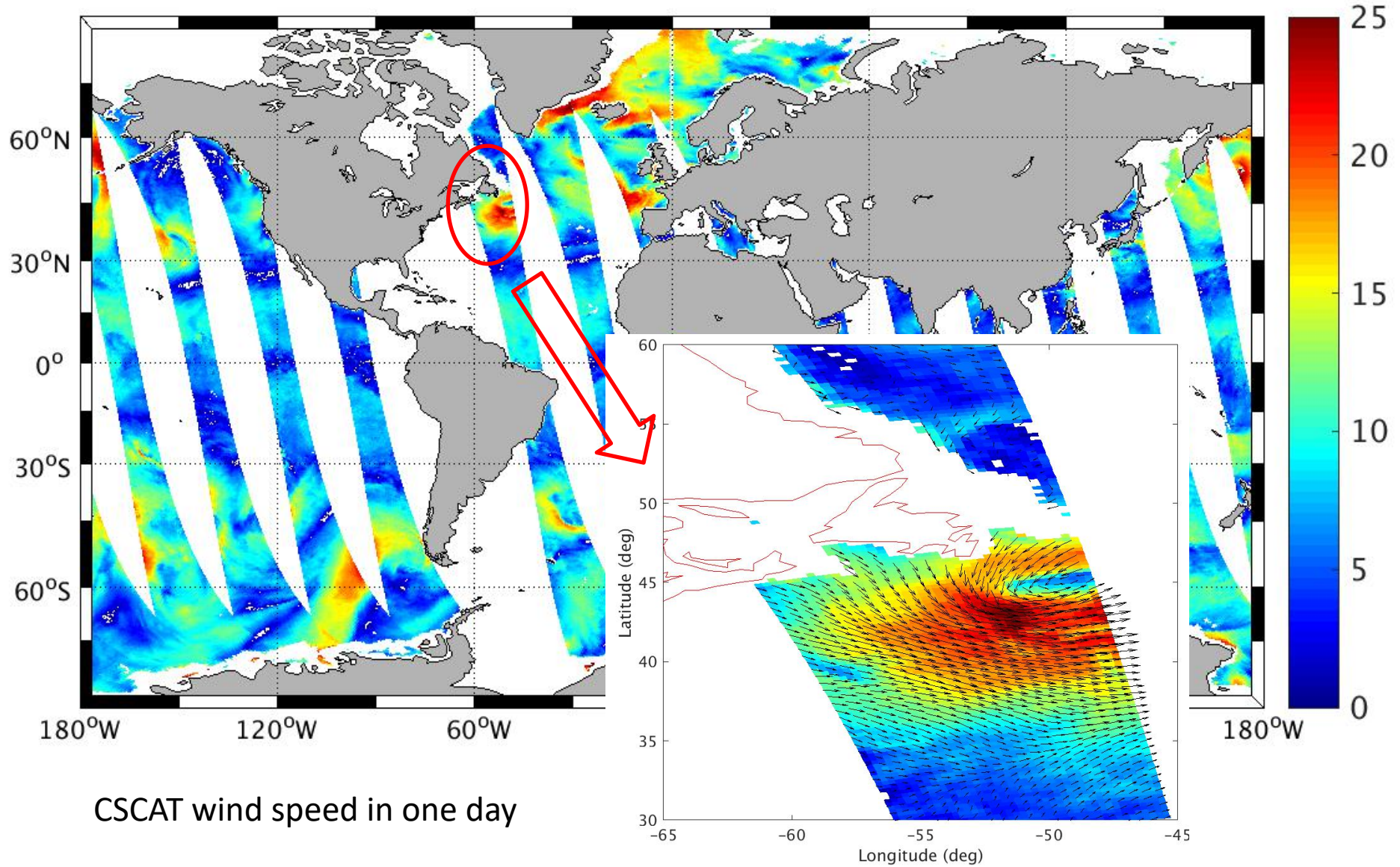
VV-pol



HH-pol



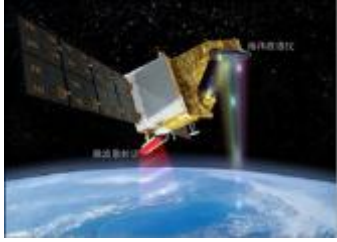
CFOSAT SCAT Wind Products



CSCAT wind speed in one day

Conclusions

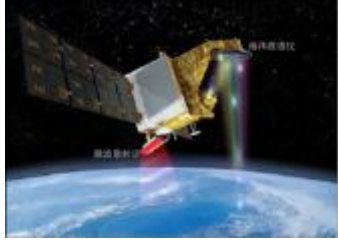
- In general, the CFOSAT SCAT works normally, the received data is stable and the telemetry data is correct
- The data abnormal monitoring is strengthened, and noise energy adaptive estimation algorithm is used to improve the occasional data quality fluctuation
- The NOC calibration method is used is used routinely, the calibration coefficients is basically stable
- It is expected the CFOSAT SCAT can work stably for a long time, and consistently obtain stable and accurate wind products



CHOGS (CHinese Ground Segment) Status

Outline

- CFMC operation overall
- Ground station status
- SCAT production status (software,sigma0 analysis, wind-field evolution)
- Validation activity
- SWIM production status at CFMC
- System requirement complaint table
- Distribution Status at CFMC
- Some SCAT and SWIM application



CFOSAT

China France Oceanography SATellite

SWIM

SCAT

DTS

CAST 2000 Platform

S-Band link, telecommand and telemetry

X-Band link, telemetry, science payload data (4 orbits)

X-Band science payload data + HKTM (14 orbits)

CLTC

China Launch & Tracking Control Center

TT&C (China)

Chinese Tracking Telemetry Command Stations

XSCC (Xi'an)

Chinese Control Center

CHOGS

CHinese Oceanographic Ground Segment

COSGS (NSOAS)

Chinese X-Band Stations

MDJ

BJ

SY

CFMC (Beijing)

Chinese Mission Center

DCN - Chinese Com. Network

FROGS - FRench Oceanographic Ground Segment

DCN - French Com. Network

GSXB - French NRT X-Band Stations (CNES)

KRX Kiruna

IVK Inuvik

CWWIC

CNES Waves & Wind Instrument Center

CNES - Toulouse

SWEC

SWIM Experts

CaSyS

SWIM Cal/Val

IWWOC

IFREMER Waves & Wind Operational Center

IFREMER - Brest

WWEC METEO F

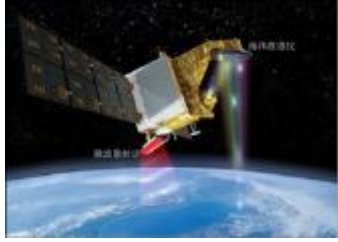
WWEC LATMOS

WWEC IFREMER

Scientific Experts

CalVal & Expertise

CFOSAT end users

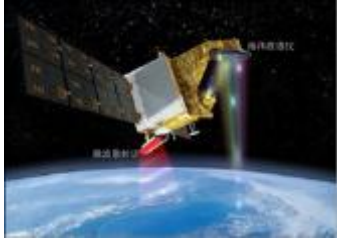


SCAT operation 7 times
SWIM operation 4 times
Platform manoeuvre 10 times
Avoid collision one time.

CFMC operation
Satellite platform monitor

Launch
Oct.29th
Nov.22nd
Operation after launch
Jan.3rd
Manoeuvre
2018
2019
SWIM exception
Apr.3rd
Parameter
modification
Apr.25th
Parameter
modification
Apr.17th
Jun.1st
EPC
Jul.14th
SCA
Aug.16th
EPC
Aug.28th
Abnormity
Dec.5th
Dec.19 & 20th
SCA
EPC
Mar.7th
EPC
Mar.10th
Abnormity
Avoid collision
Jul.21st
Recover
Jul.28th
Manoeuvre
SCA
Dec.28th
DPU handling
Jan.7th & 8th
SWIM exception
2020
2021
Manoeuvre
Apr.1st
Jul.16th
Sep.3rd
Dec.3rd
Feb.23th
Today

From **2020-04-16**, upload SCAT EPC ON TC and execute each cycle to avoid abnormal EPC OFF.

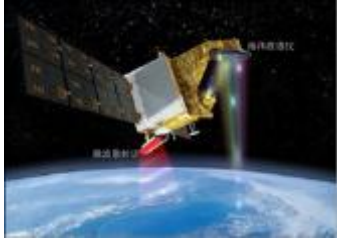


CFMC operation overall

- From satellite launch to end of 2020(2020-12-31): NSOAS upload 239 times TC, including downlink plan(15843 orbit number), platform and payload operation.
- 783 times TM parameters transferred to CNES12 times demand from CNES and 43GB data transferred to CNES

	Downlink (number)	Downlink/day (number)	Downlink (minutes)	Downlink/day (minutes)
NSOAS	3289	4	35445	45
CNES	12554	15	25108	31

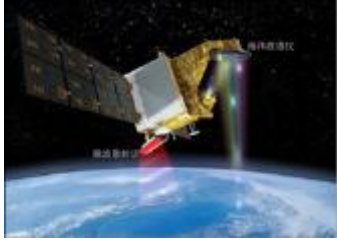
Data type	Number of file	volume in GB(compressed)
SCAT L0B	65	8.2
SWIM L0B	67	35.1
total	132	43.3



Chinese Ground station status

•from launch to end of 2020
•Chinese ground station(Beijing, Sanya and Mudanjiang) ingest 3289 orbits and 22.2TB org data.

Year	Number of ingesting orbit	volume
2018	377	1.2TB
2019	1437	8.4TB
2020	1475	12.6TB
total	3289	22.2TB



CFMC Operation
SCAT data levels at CHOGS

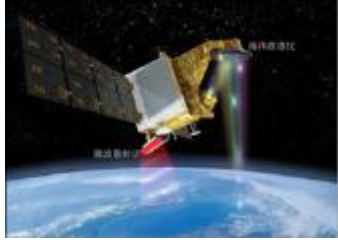
File Name	File Type	File Description
SWI_L1A___	L1a product	Contains : ECHO_x°_L1a
SWI_L1ALG_	L1a product in speckle mode	Contains : ECHO_LG_x°_L1a
SWI_L1B___	L1b product	Contains : DELTA_SIGR_x°_L1b, DELTA_SIGX_x°_L1b, PDSIG_x°_L1b, PM_x°_L1b, PSP_x°_L1b, PIR_x°_L1b, CROSS_x°_L1b
SWI_L2____	L2 product	Contains : MTF_x°, SIGMA0_PROFILE, SIGMA0_NAD, SWH, SWH_2D, WS, F_2D_x°, F_2D, PARTITIONS
SWI_NRT___	NRT product delivered to meteorological agencies	Contains : PM_x°_L1b, SIGMA0, SIGMA0_NADIR, SWH, WS, F_2D_x°, F_2D, PARTITIONS

File Name	File Type	File Description
SCA_L1B___	L1b product	Contains : Cell_lat_L1b, Cell_lon_L1b,Cell_azimuth_L1b, Cell_incidence_L1b, Cell_sigma0_L1b, Cell_snr_L1b, Cell_kpc_a_L1b, Sigma0_qual_flag_L1b, Sigma0_mode_flag_L1bm
SCA_L2A___	L2a product	Contains : WVC_row_time, Row_number, Num_sigma0, Cell_index, Num_sigma0_per_cell, Sigma0, Sigma0_qual_flag, Sigma0_mode_flag ,Kp_alpha ,Kp_beta ,Kp_gamma,Surface_flag,Sigma0_attn_rm
SCA_L2B___	L2b product	Contains : WVC_row_time, WVC_row, WVC_index, WVC_lat, WVC_lon, WVC_quality_flag, Num_ambigs, WVC_selection, Wind_speed_selection,Wind_dir_selection,Nof_rain_index, Model_speed,Model_dir,Wind_speed,Wind_dir, Wind_speed_err,Wind_dir_err,Max_likelihood_est
SCA_L3___	L3 product	Daily, wind speed and directions in 0.25°×0.25° global grid.
SCA_L4___	L4 product	Separating the ascending and descending passes.

SCAT: SCA_L0B，SCA_L1A，SCA_L1B_OR，SCA_L2A_OR，SCA_L2B_OR，SCA_C_L2A，SCA_C_L2B

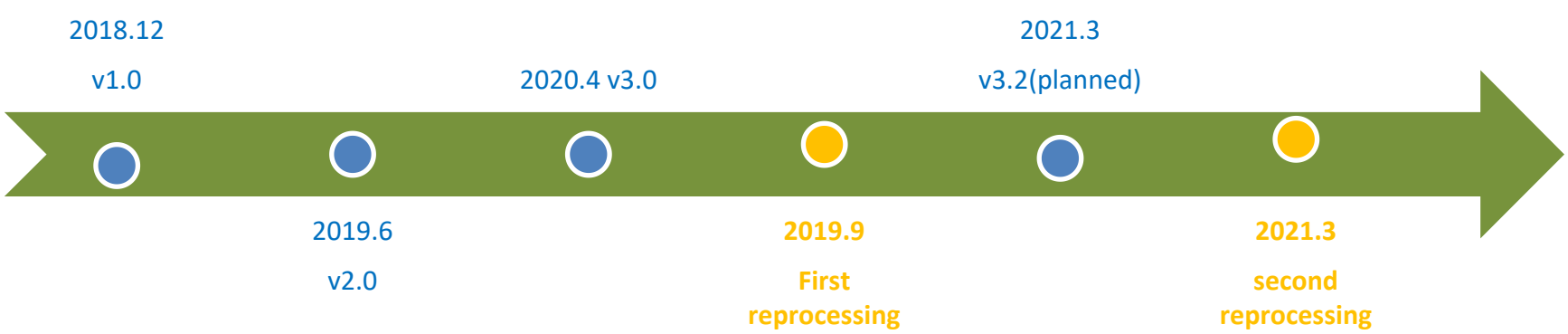
SWIM:SWI_L0B，SWI_L1A，SWI_L1B，SWI_L2ABOX，SWI_L2ANAD，SWI_L2ASIG，SWI_L2SPEC和SWI_L2

15 standard products and sea-ice, wind-wave joint products, etc



SCAT Production Status
data processing

4 times SCAT processing Kit Version release

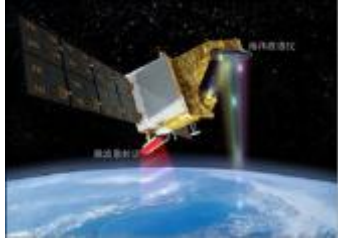


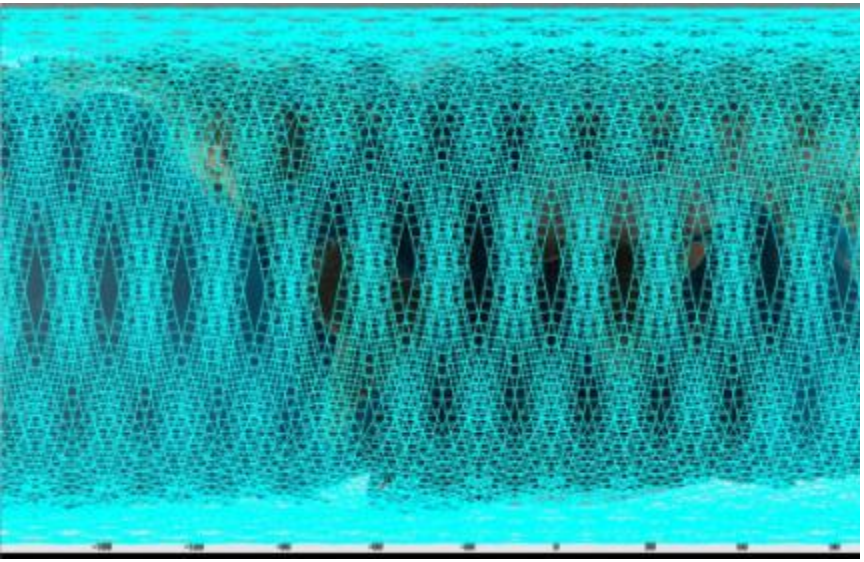
Product level	File number	volume
L1B	10283	8.4TB
L2B	10154	34.7GB

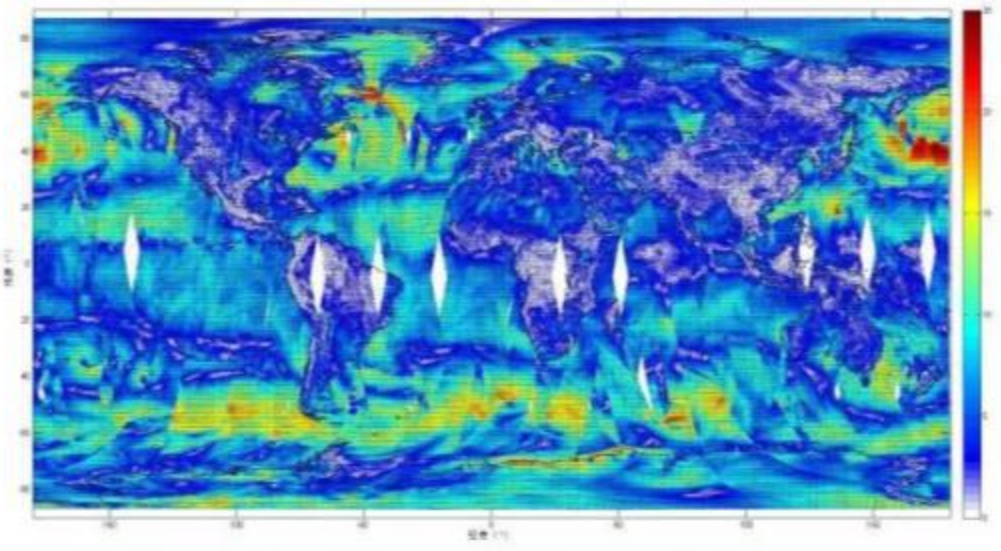
- CFO_EXPR_SCA_C_L2B_OR_YYYYMMDDTHHMMSS_xxxxx_250_VV_owv (on going)
- CFO_OPER_SCA_F_L2B_OR_YYYYMMDDTHHMMSS_250_VV_owv (on going)
  same version
- CFO_EXPR_SCA_C_L2B_OR_YYYYMMDDTHHMMSS_xxxxx_coa_VV_owv (to be released)

SCAT Production Status

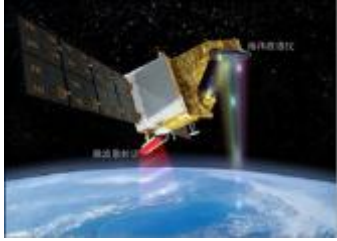
coverage



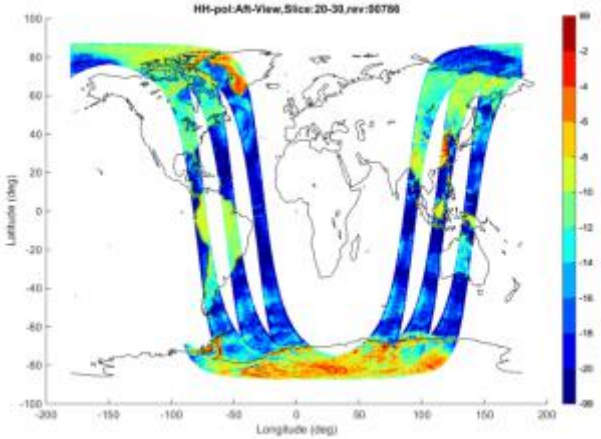


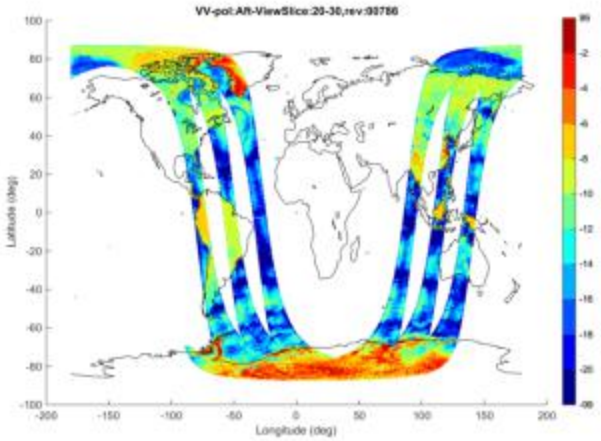


- 1 day, 80.06%, 3days 95.15%

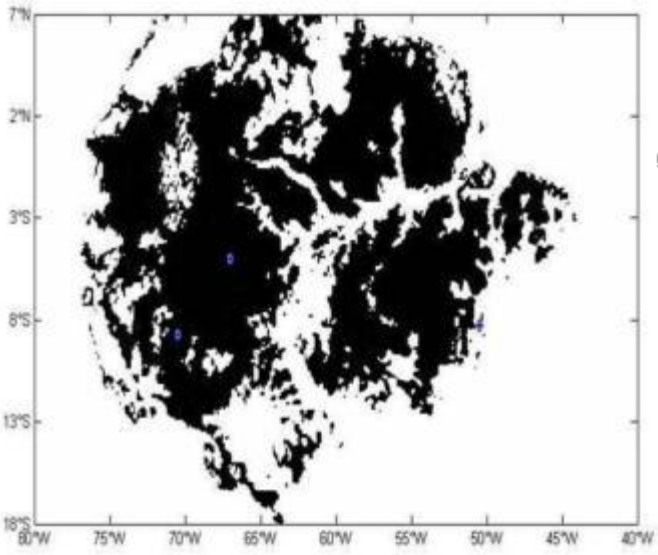


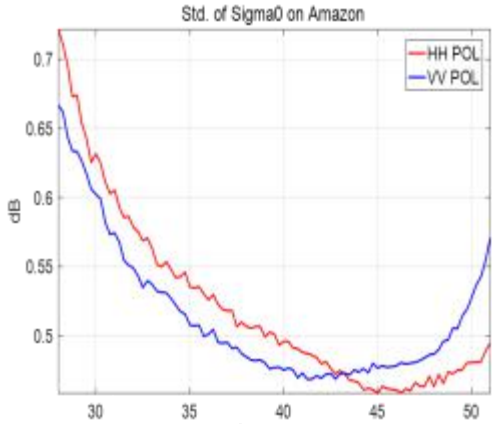
SCAT Production Status
sigma0 Analysis





- Along track sigma0





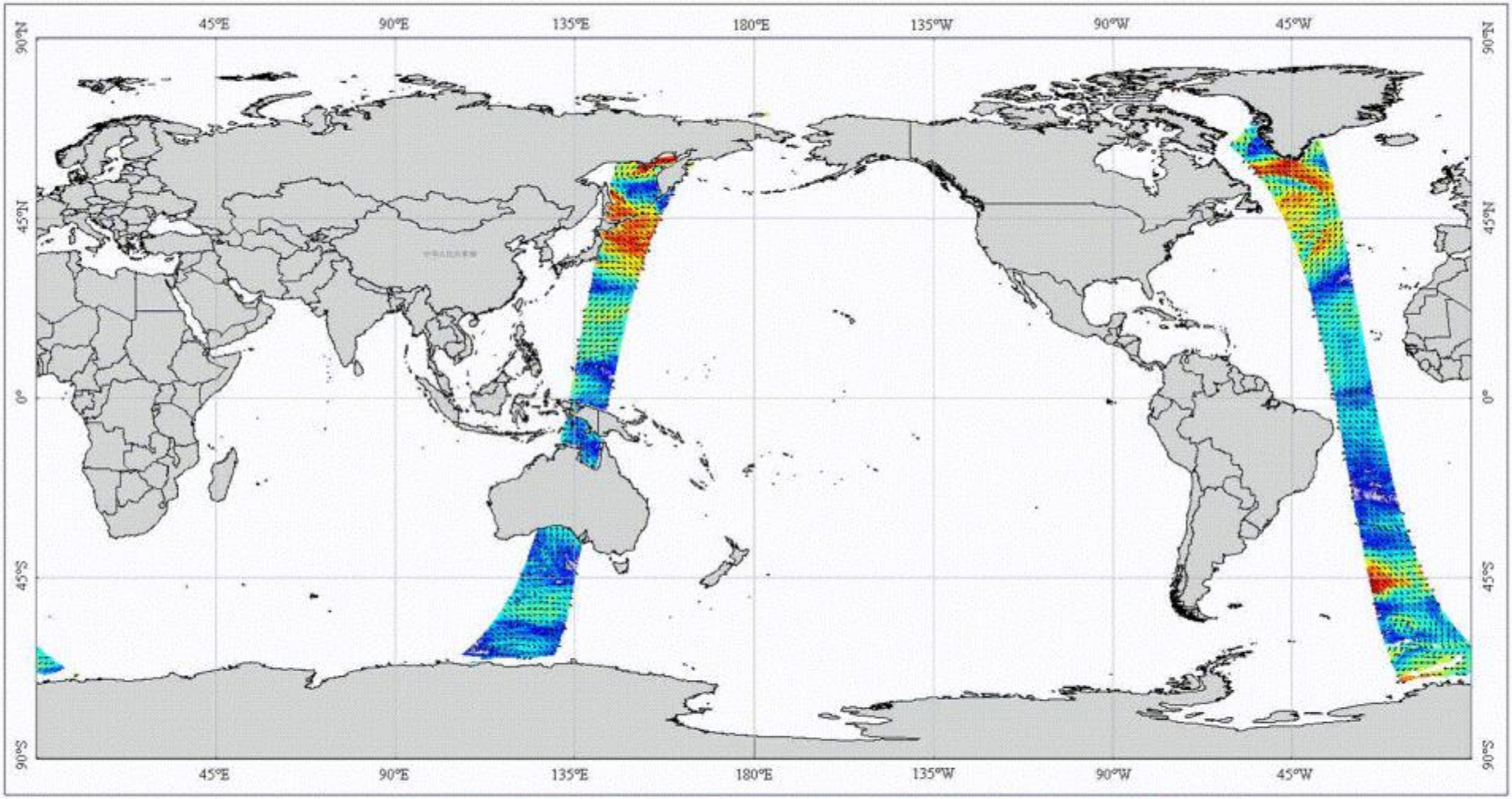
- Amazon rainforest area data is used for sigma0 analysis
- Apr. 2019
- L1B data 25 km*25 km grid sigma0 standard

- For HH-pol and VV-pol SCAT sigma0, the nadir STD is less than 0.5dB
- Far nadir STD is less than 0.75dB
- Update with SCAT processing Kit version

全球海面风场专题图

(20181219T20:41:49 UTC -- 20181219T22:14:48 UTC)

单轨产品时间序列



制图单位：国家卫星海洋应用中心

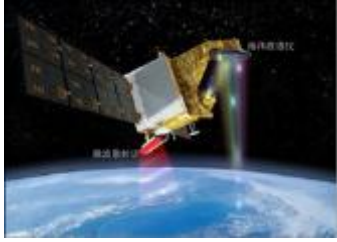
制图时间：2019年09月05日

坐标系：CGCS2000

比例尺：1:100,000,000

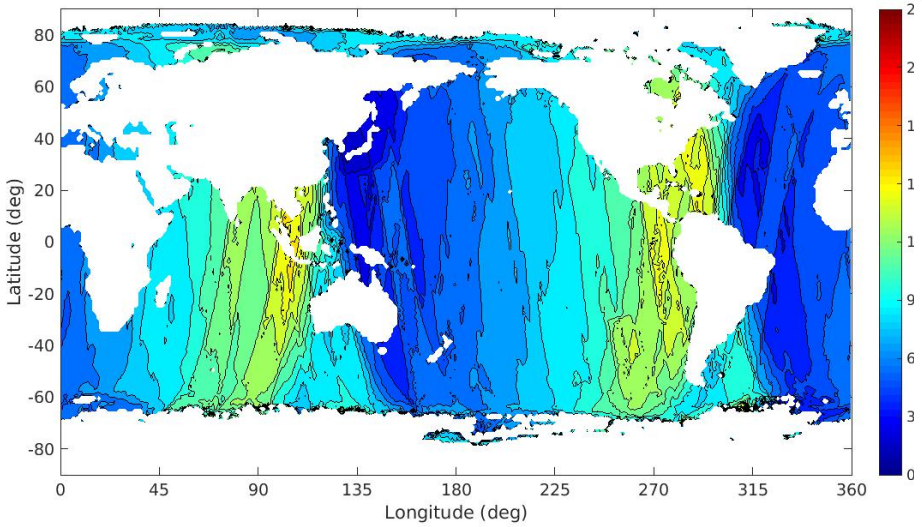
卫星名称：CFOSAT

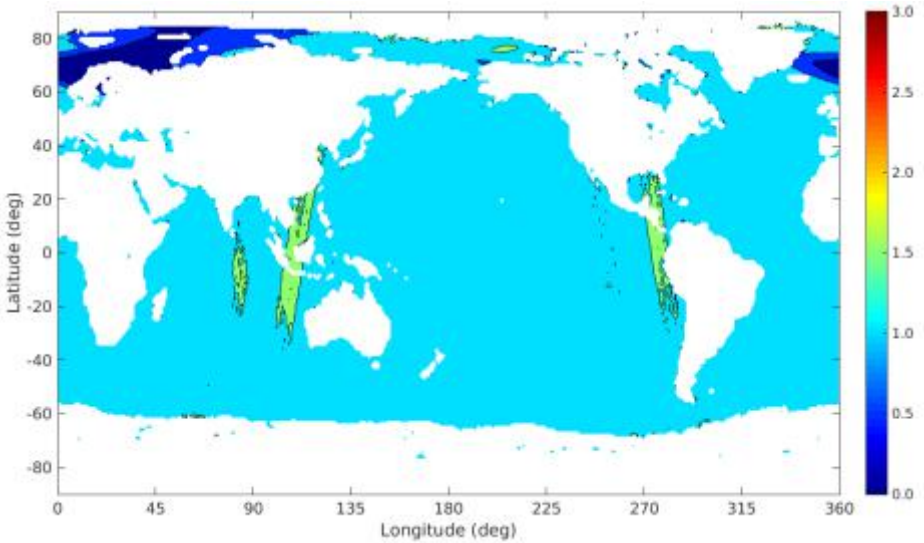
传 感 器：微波散射计



SCAT Product Status

Latency [T_{output} - T_{obs}]



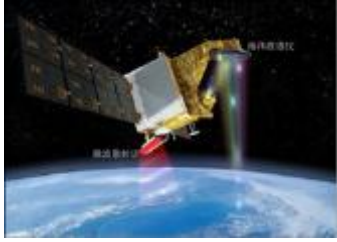


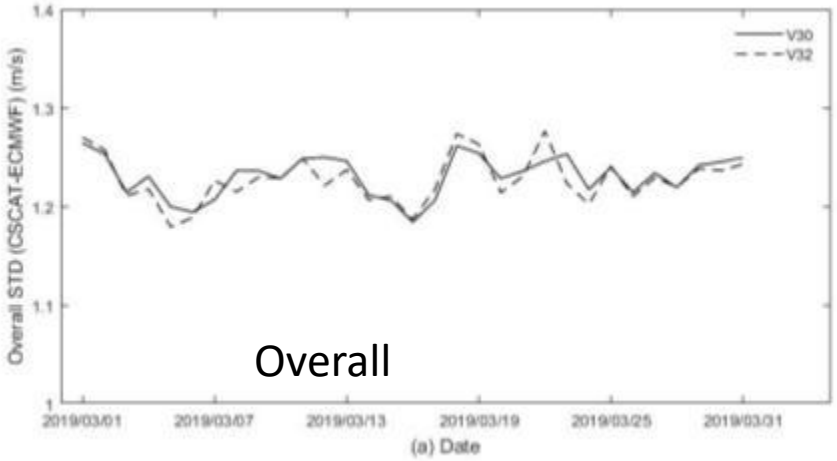
Geographic distribution of the L2B latency

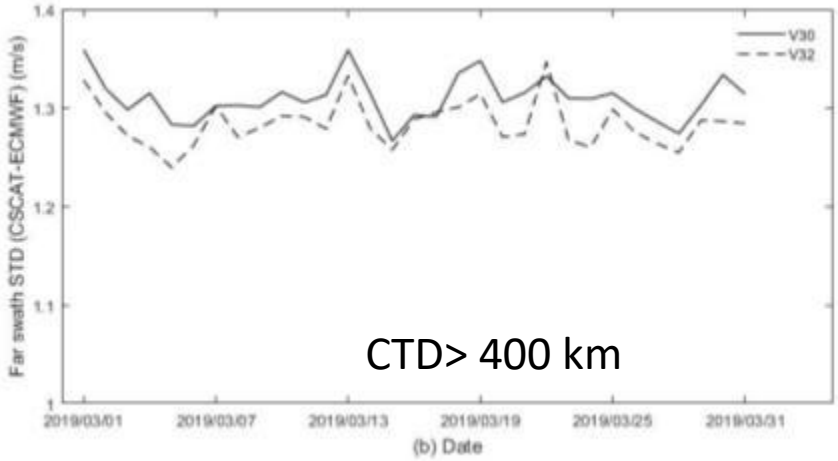
NRT product is planned to be distributed at CHOGS.

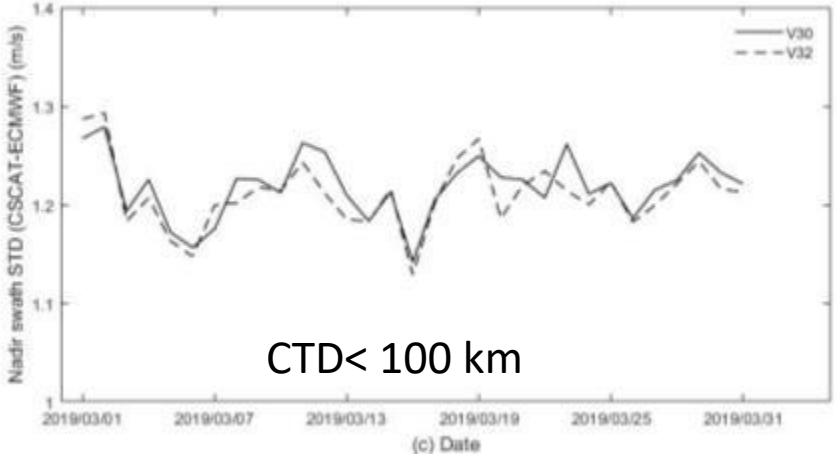
SCAT Production Status

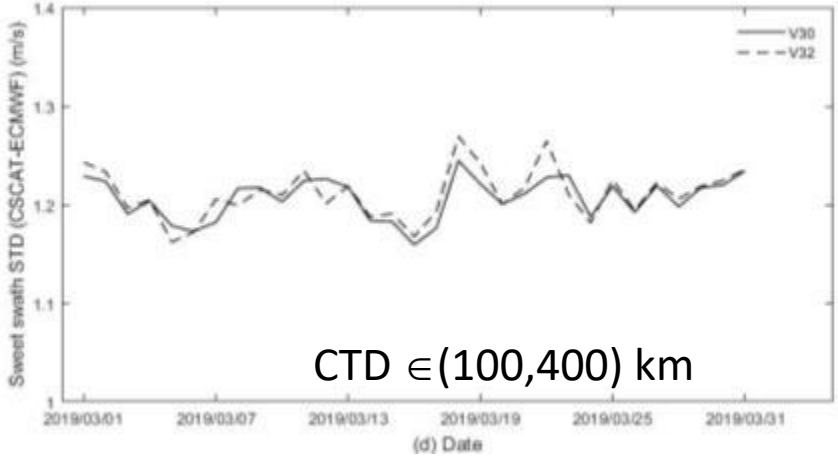
Evolution







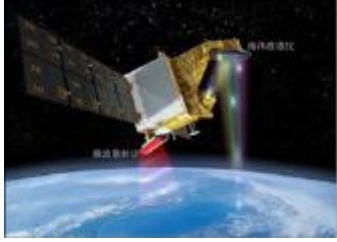


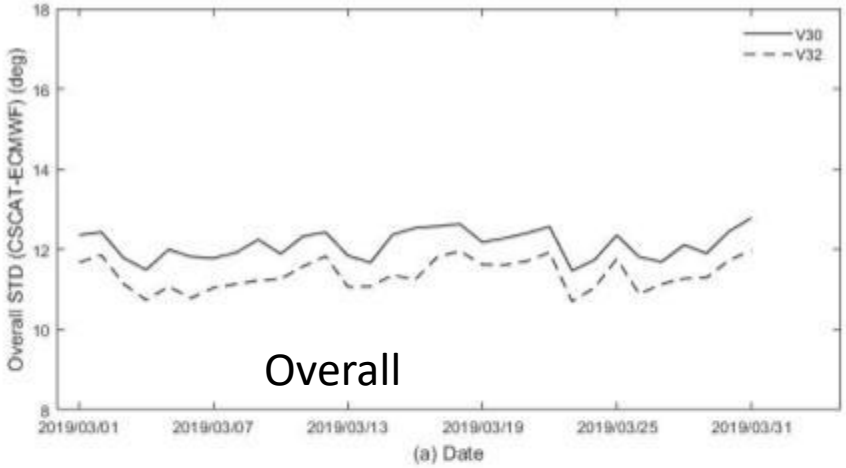


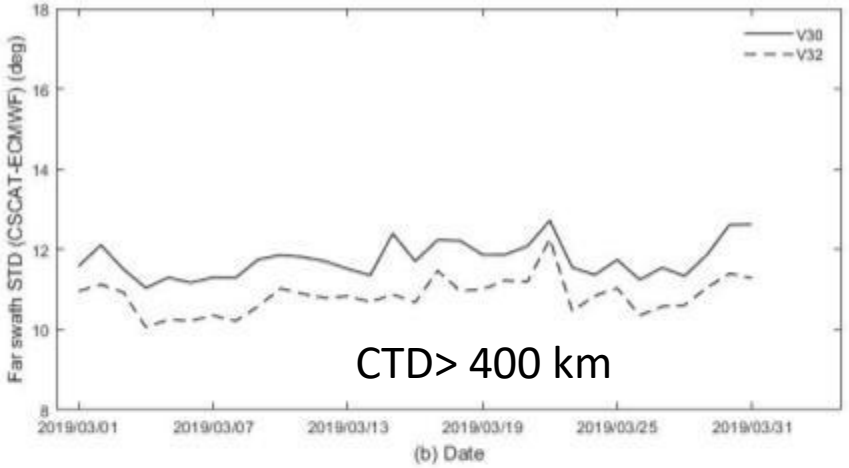
STD Temporal series of SCAT wind speed w.r.t. ECMWF SSW 1.26 – 1.48 m/s

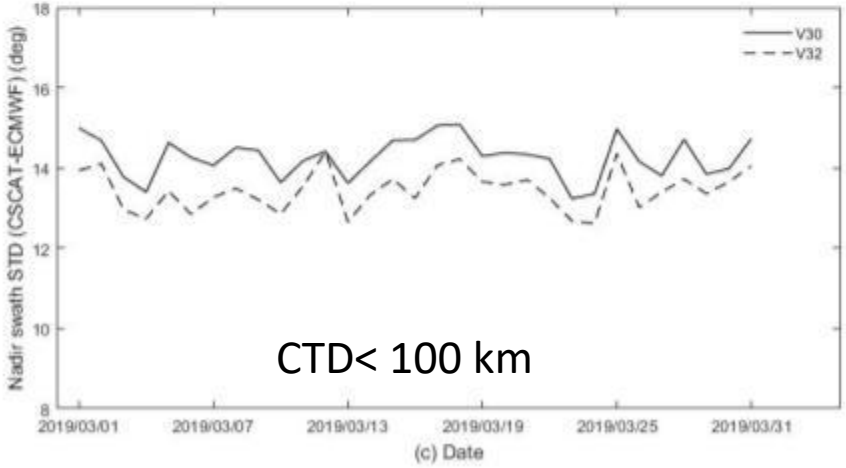
SCAT Production Status

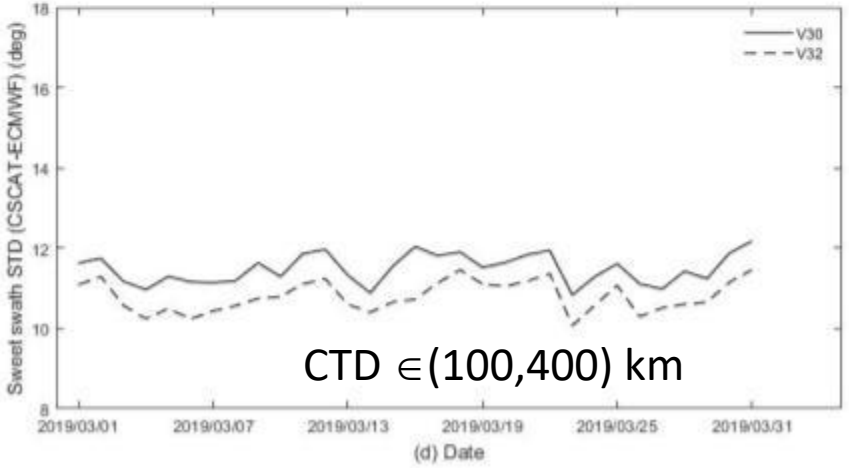
Evolution





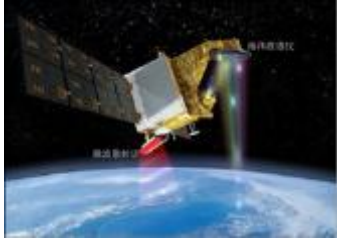






STD Temporal series of SCAT wind direction w.r.t. ECMWF SWD 11.0-14.37°

CAL/VAL activity
Validation by ECMWF data



NSOAS team recent work:
Version 3.2 SCAT processing kit have been implemented and plan to release.

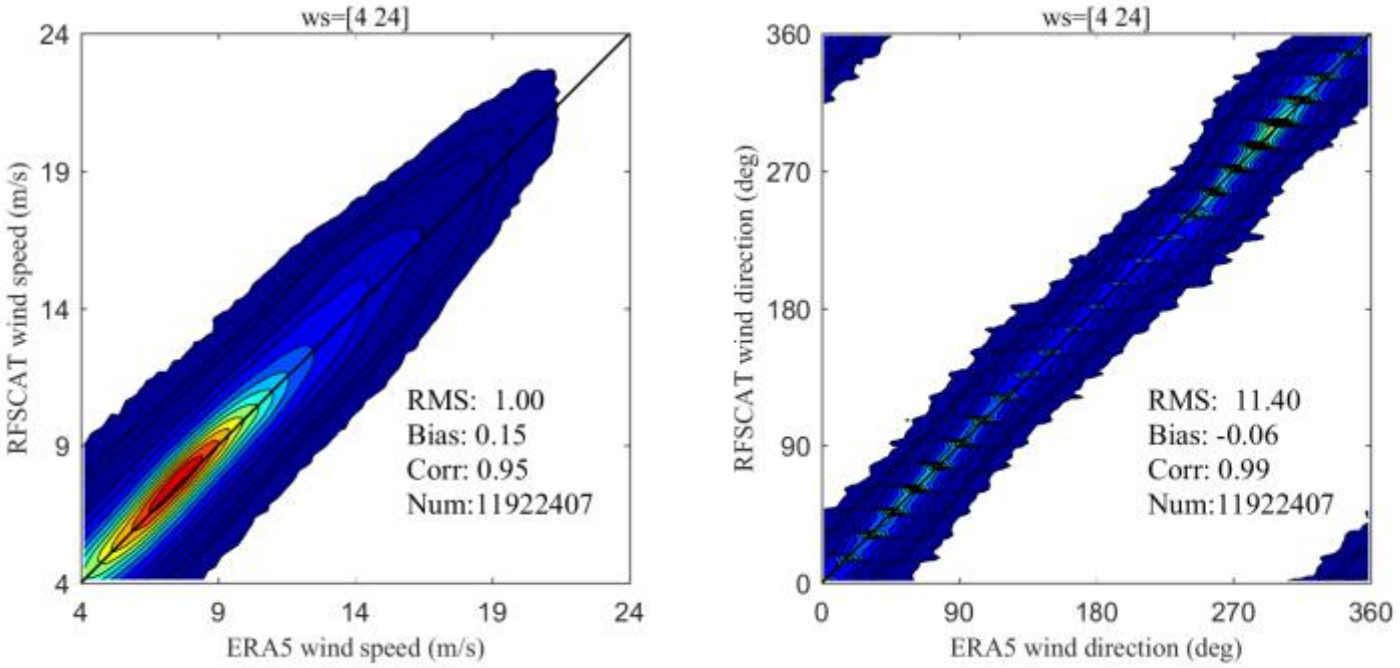
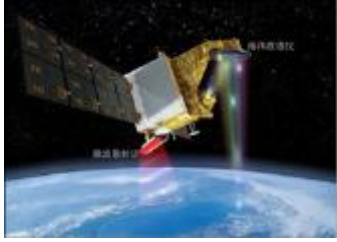
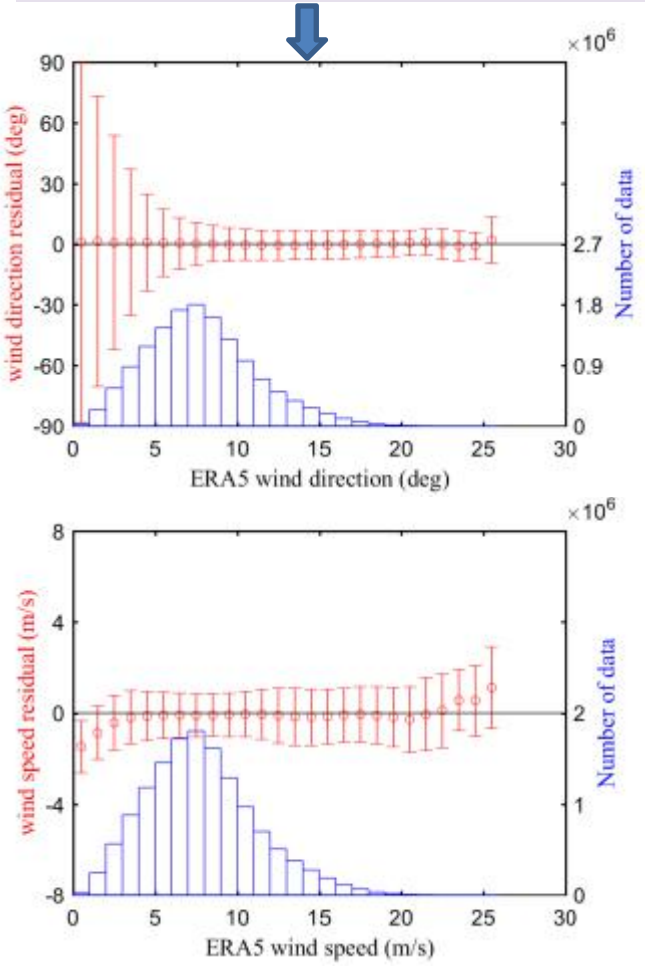


Figure : the validation results of L2B wind products measured in August 2020 using ECMWF data

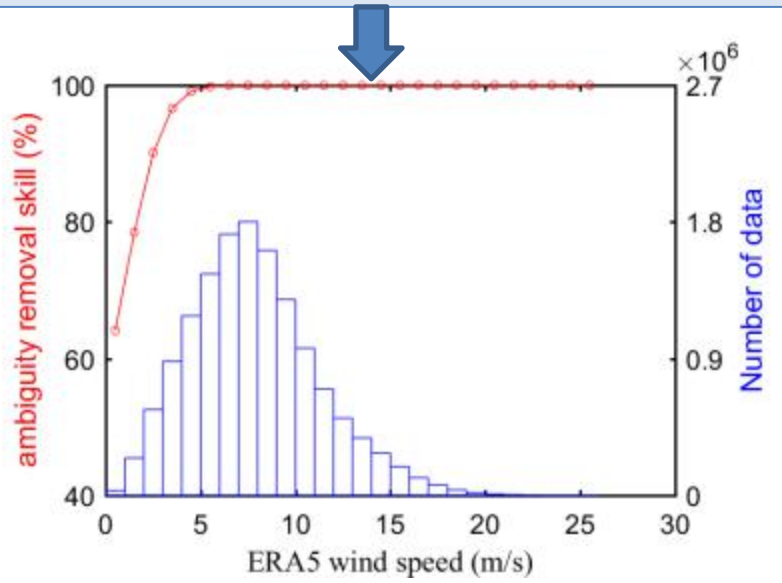
CAL/VAL activity
Validation by ecwmf data



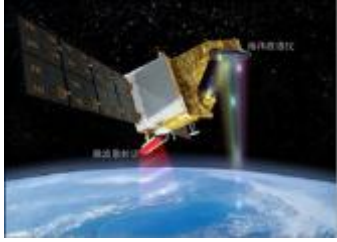
The two figures show the residual differences under different wind speed conditions. For wind direction, the lower the wind speed, the greater the residual difference. For wind speed, the biases is relatively small within valid measurement range ([4m/s, 24 m/s]).



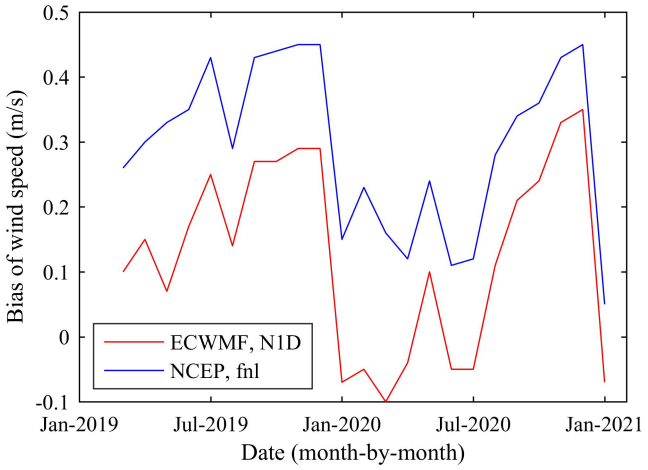
The figure shows the ambiguity removal performance. The performance is worse in low wind speed and good in moderate and high wind speed. This is similar with launched scatterometers.



LONG-TERM VALIDATION RESULT



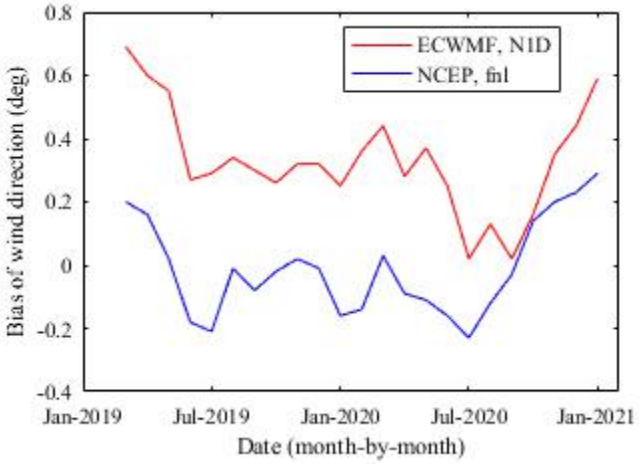
The long-term validation results each month , from Mar-2019 to Jan-2021.
The quality of wind-field product is stable.



波散射计的海面风速（SSW）和海面风向（

匹配数量	平均偏差	标准差
1056194	0.22	0.86
232100	-0.26	0.80
2595986	0.10	1.11
2		

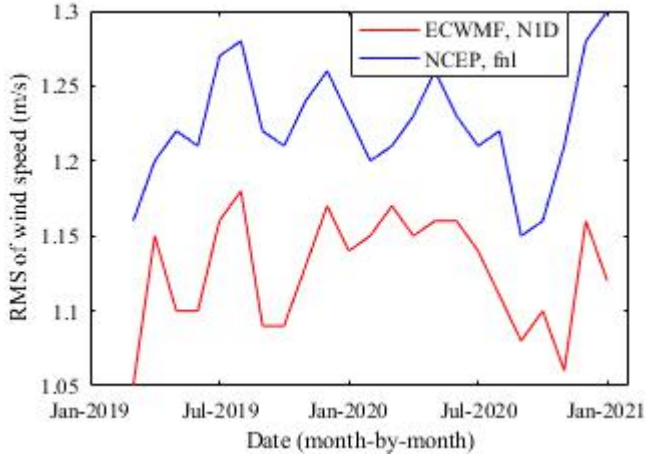
wind speed RMS<2m/s
wind direction RMS <20°

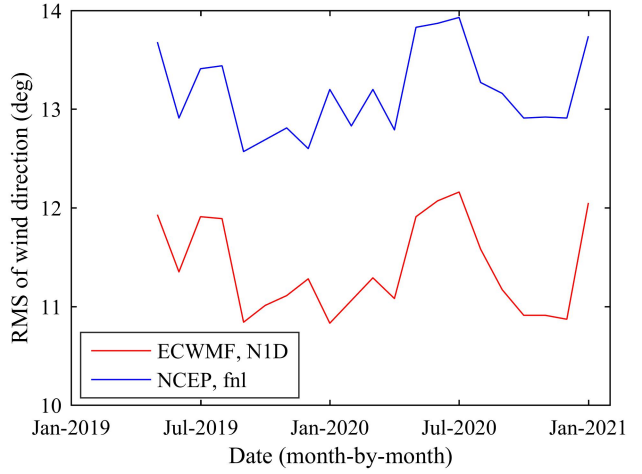


HY-2B 卫星
微波散射计

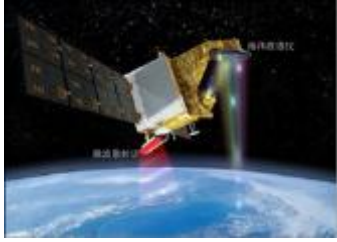
232100	-0.45	13.33
2595986	0.78	12.31
2836925	0.44	14.25

13.50 0.99



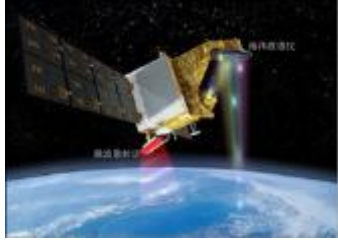


System requirement complaint(SCAT)



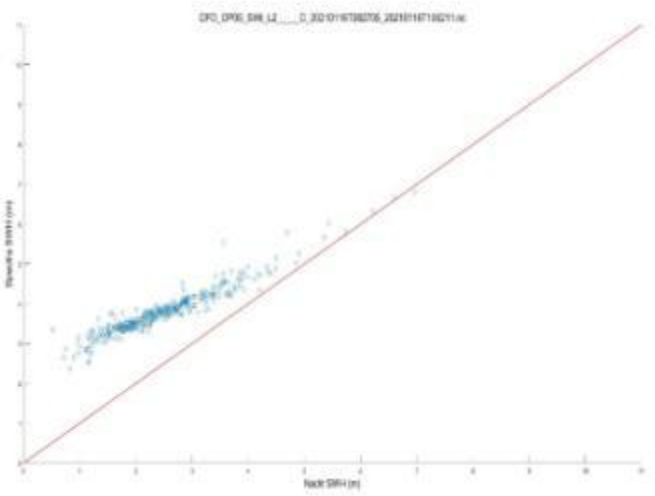
Requirement	Value	Compliance
CF-SY-RD-04700: SCAT Data Localisation	10 km	8km
CF-SY-RD-02500: SCAT Product Resolution	50 km² (25 km² as a goal)	25 km² /12.5 km²
SCAT Sigma0	± 1.0 dB for Wind Speed [4-6 m/s] ± 0.5 dB for Wind Speed [6-24 m/s]	0.5dB nadir/0.75dB far
CF-SY-RD-02800: SCAT Ocean Wind Vector	Wind speed: 2 m/s or 10% (the largest) for Wind speed [4-24 m/s] Wind direction: ± 20°	1.5 m/s [4-24 m/s] ± 15° (w.r.t.ECMWF) ± 20° (w.r.t.BUOY)
Swath	>1000km	1050 km
3days coverage	95%	95.23%

- Localisation: transponder GPS, land-sea edge

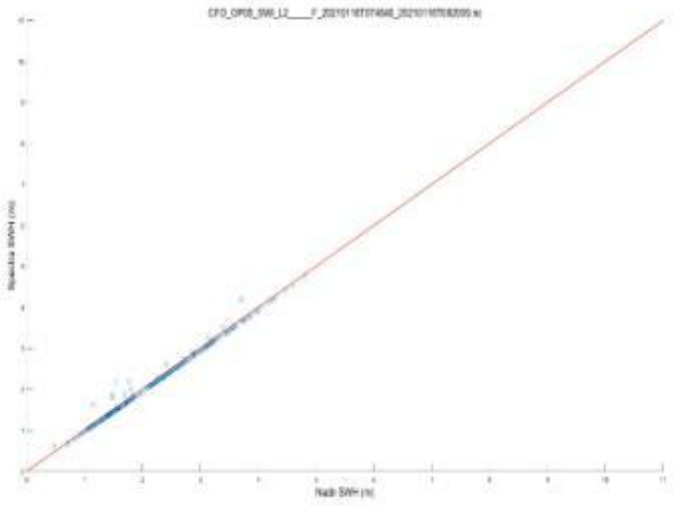


SWIM product status at CFMC

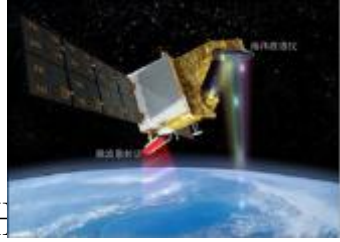
- CNES has provided NSOAS with 3 versions of SWIM IPFs(4.3, 5.0, 5.1).
- These versions have been successfully integrated in the CHOGS.
- At present, the spectrum SWHs are different between SWIM IPFs in FROGS and CHOGS, the new IPFs is in test.



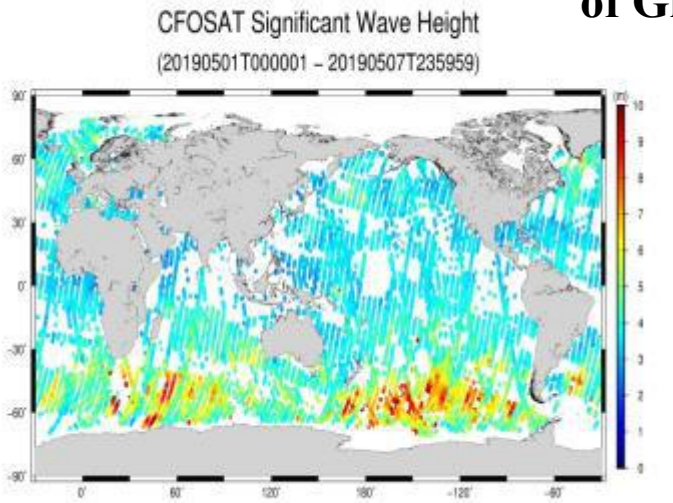
CHOGS spectrum SWHs



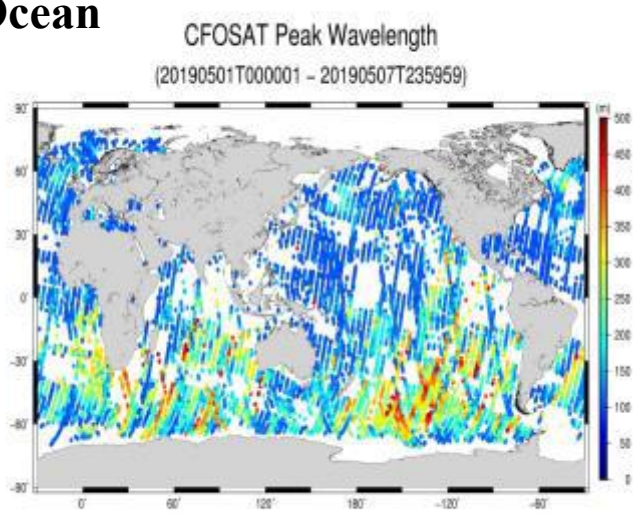
FROGS spectrum SWHs



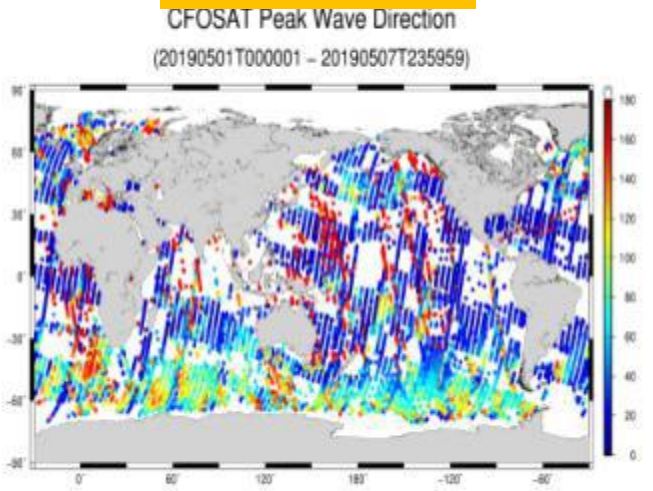
SWH, Peak Wavelength, Peak Wave Direction and Merged SWH of Global Ocean



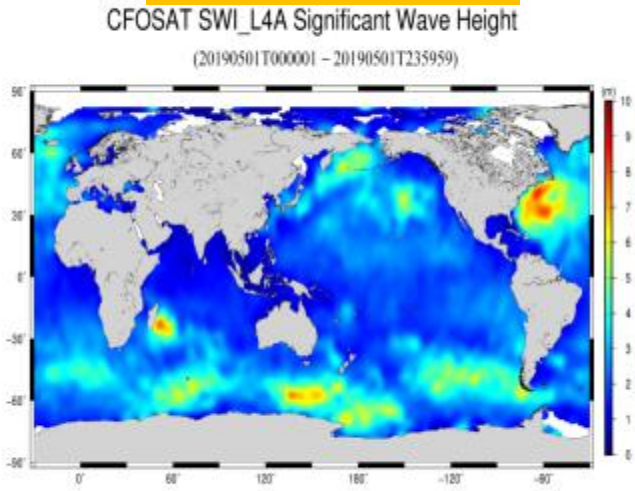
Weekly SWH-Along track



Weekly Wavelength-Along track

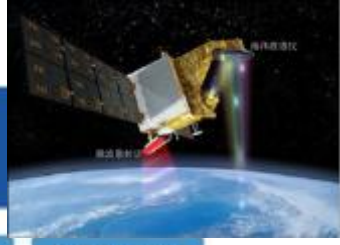


Weekly Wave Direction-Along track



Daily SWH-Merged

Distribution Status
Web site and users



Ocean Satellite Data Service Center

中文

Marine Dynamic Satellite Data Obtain

Map Query | Shop Car

HY-2B | CFOSAT | FUSION

Basic Parameters

* Sensor : SCA SWI

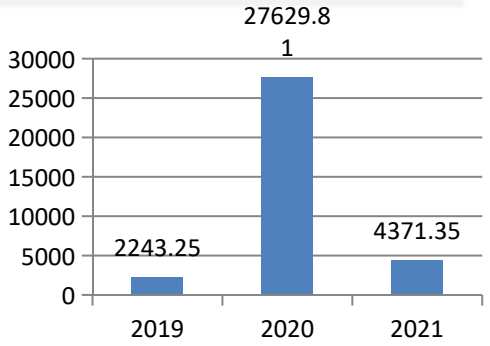
* Level :

Acquisition time: 2020-12-02 11:01:59 ~ 2021-03-02 11:01:59

Format : Please select the prod...

- 2021： 143 users
- 9.4TB

https://osdds.nsoas.org.cn



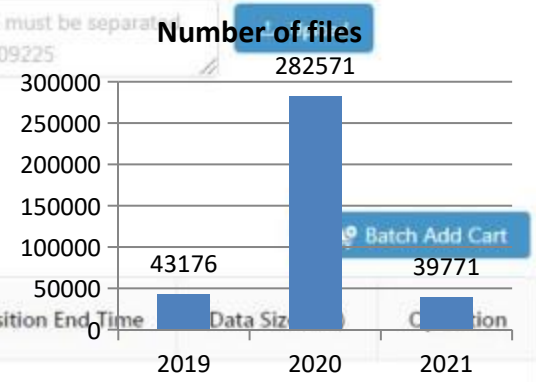
Advanced Parameters

Orbit : The track number can be uploaded or entered, please upload a file in .txt format, please enter the following types such

Upload

Name : The product name can be uploaded or entered. Please upload a file in .txt format. Each product name must be separated by a comma, such as H2A_SM1B20180122_09223, H2A_SM1B20180122_09224, H2A_SM1B20180122_09225

Query | Reset

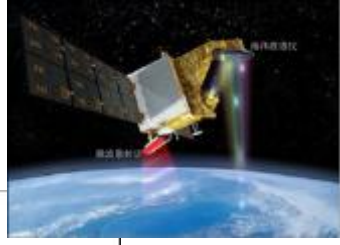


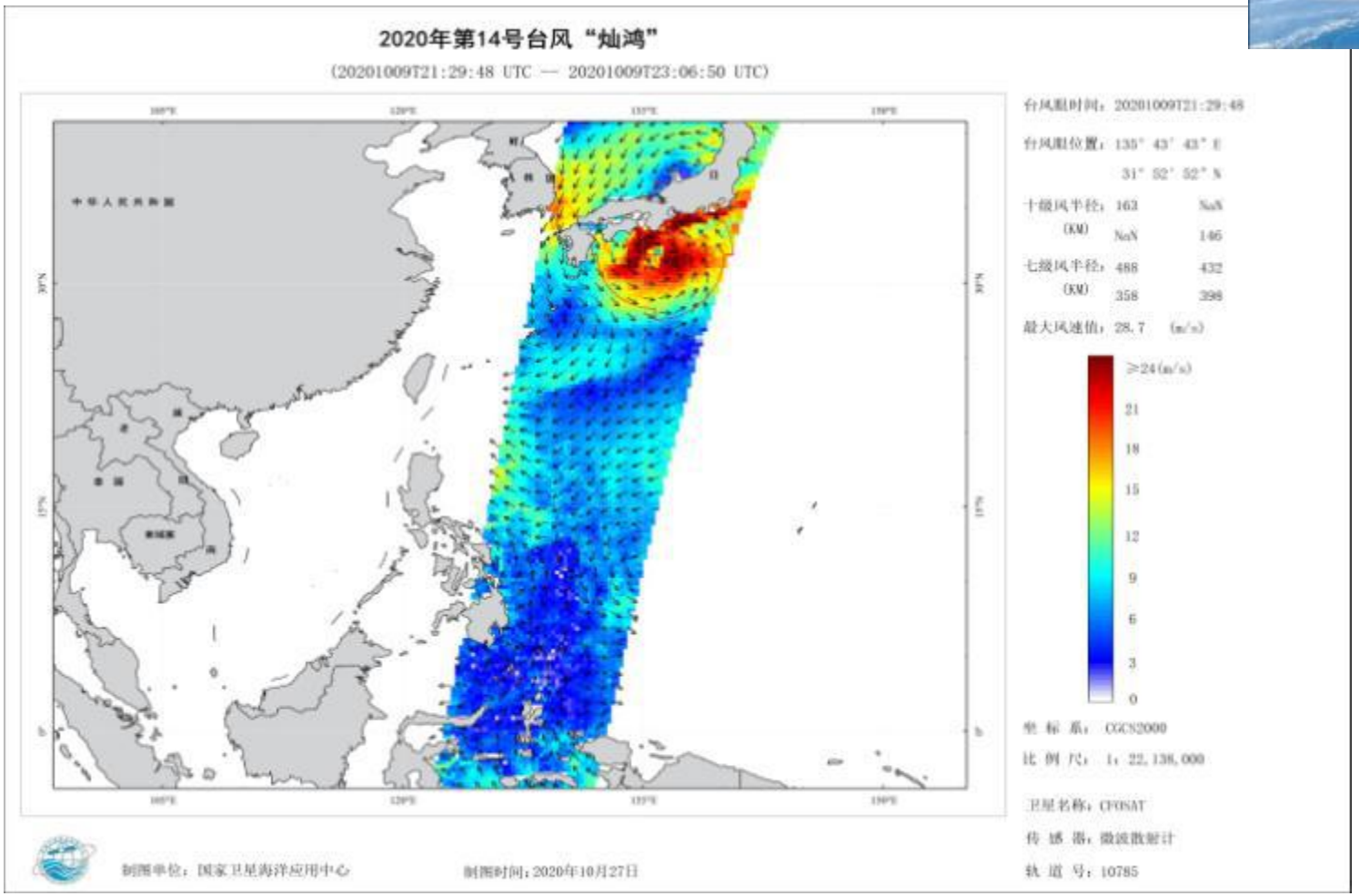
Date Acquisition Query Results Numbers : 0 Strip

Batch Add Cart

Product Name	Satellite	Sensor	Product Level	Format	Acquisition start time	Acquisition End Time	Data Size	Operation

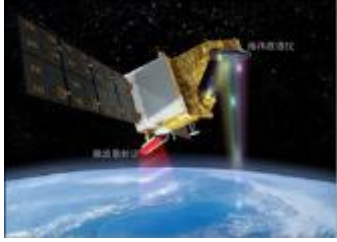
SCAT Applications: Typhoon

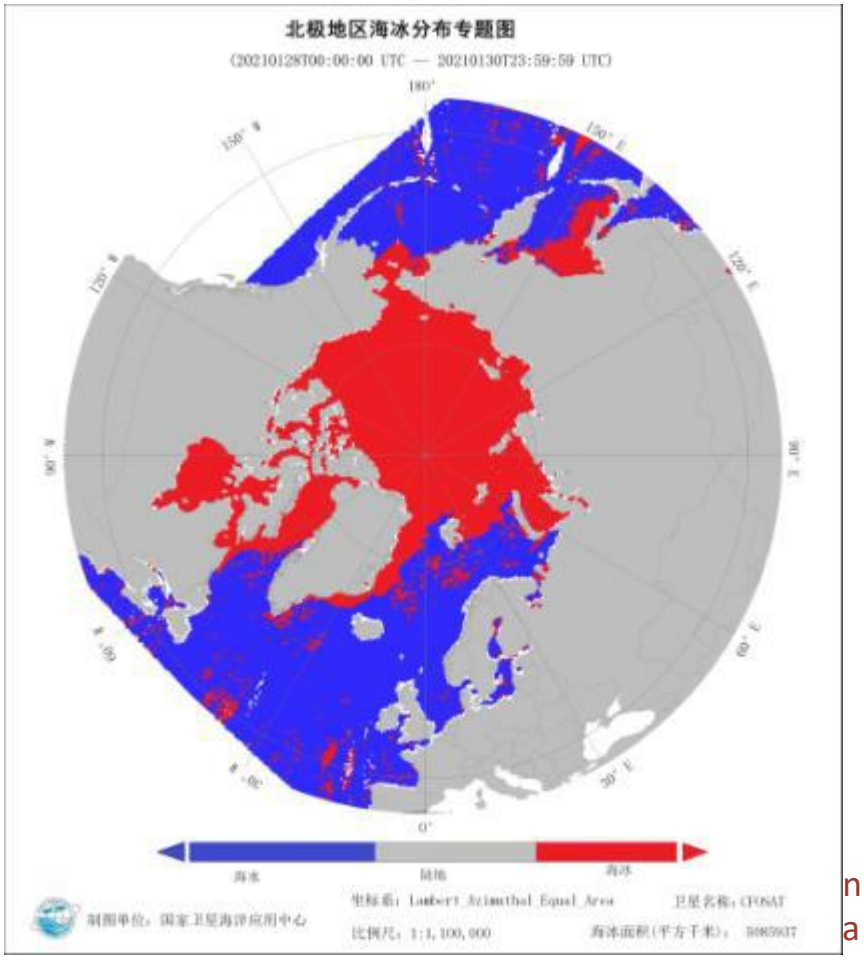


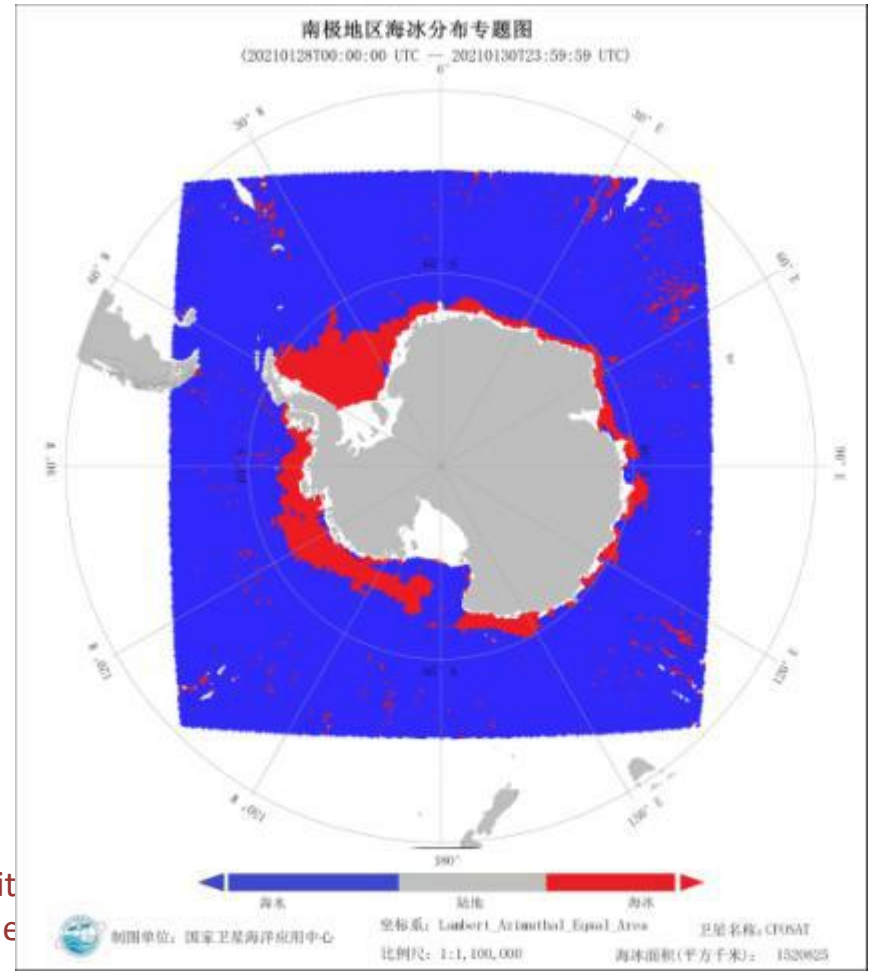


Typhoon thematic map would be released as quickly as possible.

SCAT Applications: Polar Sea Ice

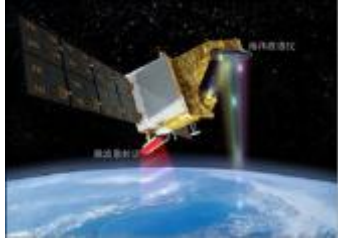


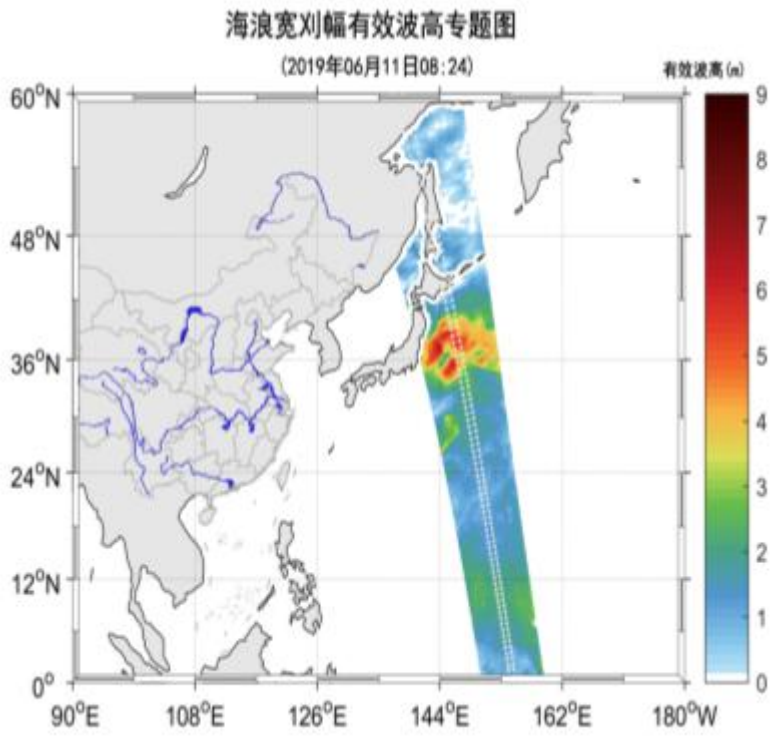




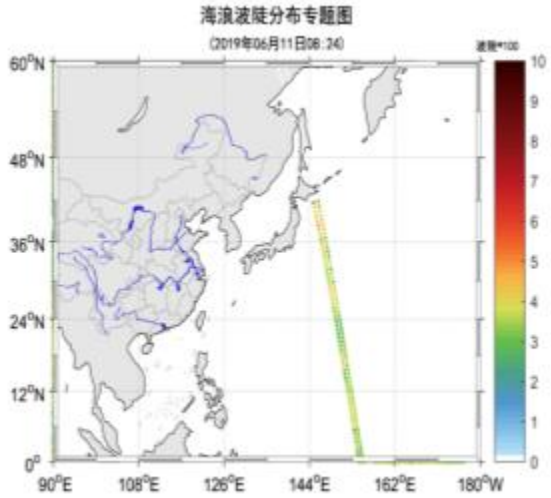
High level SWIM products

Wide Swath SWH, Wave Steepness,Dangerous Sea State (Along track)

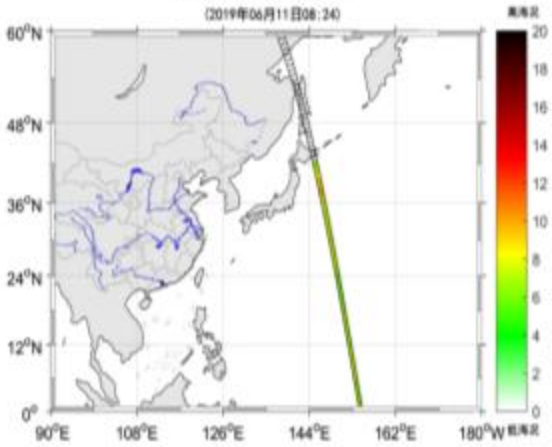




Wide Swath SWH - Along track



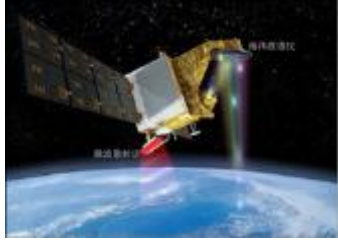
Wave Steepness - Along track

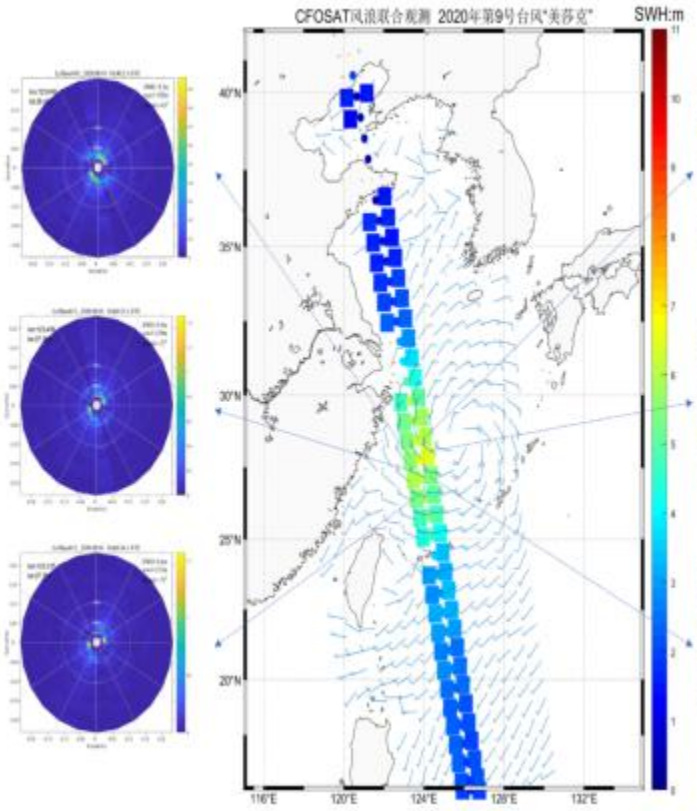


Dangerous Sea State - Along track

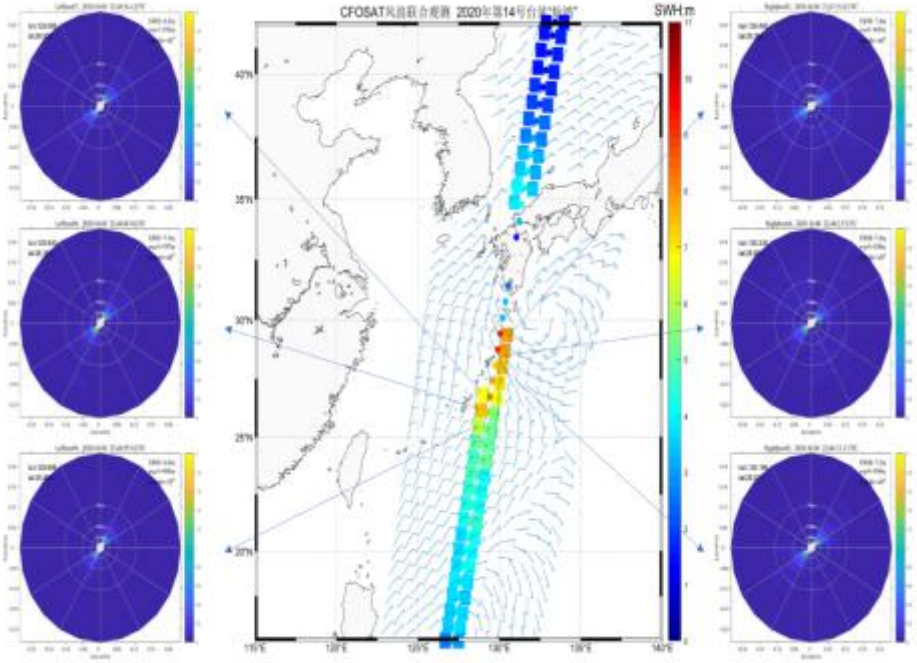
SWIM Application

Wave and Wind Observation of Tropical Cyclone





Typhoon 'Maysak' in 2020



Typhoon 'Chan-hom' in 2020


CFOSAT
Thank you for your attention