中 国 气 象 局
China Meteorological Administration

国家卫星气象中心
National Satellite Meteorological Centre

Latest Update Status of FY-3 Program

Xiuqing Hu, Peng Zhang

National Satellite Meteorological Center, CMA

AOMSUC-11

FY-USERCON 2021

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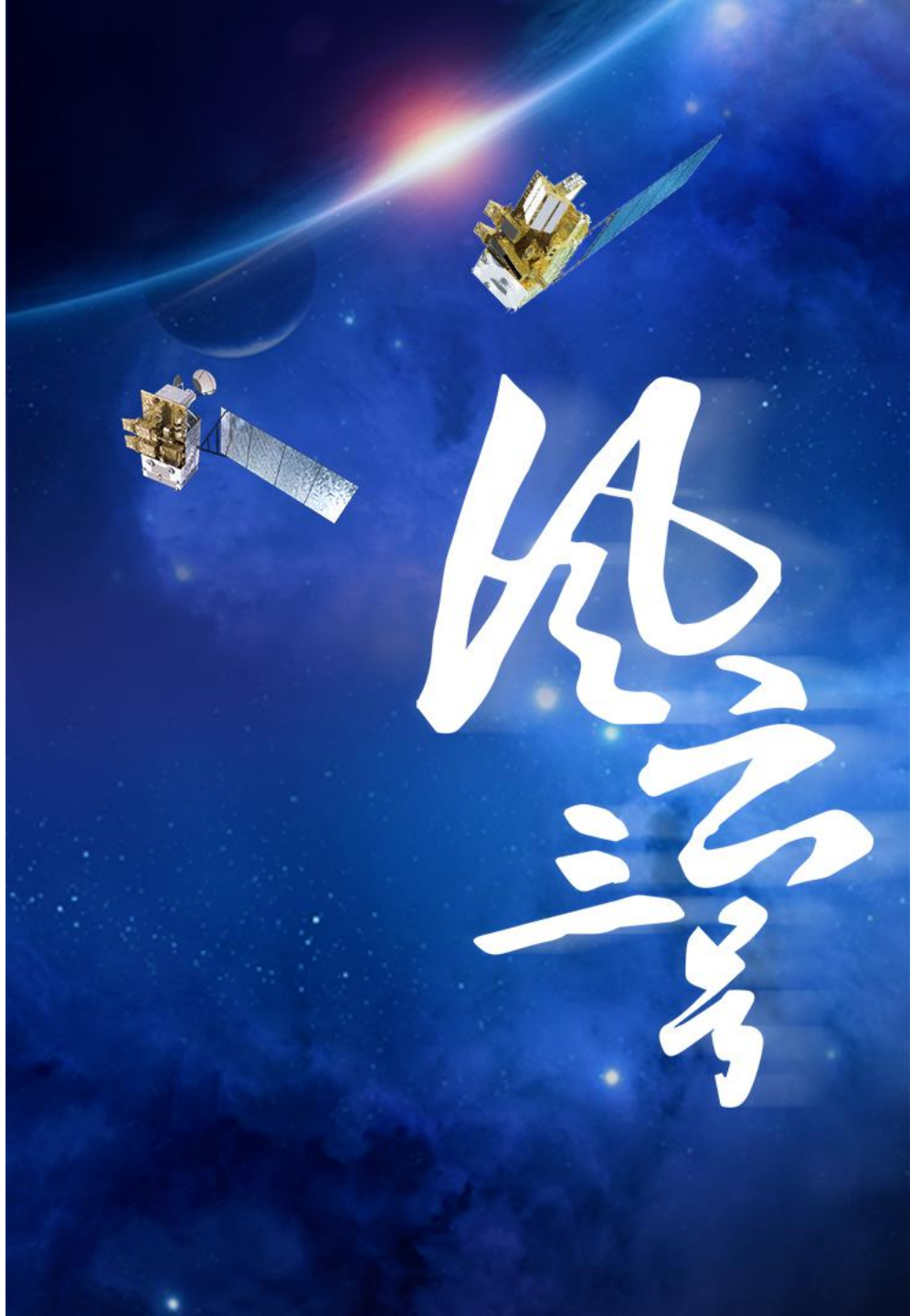
PART 01

FY-3 Satellite Program Overview



風雲 FENGYUN SATELLITE PROGRAM

FENGYUN-1

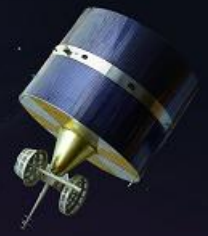
First-generation polar-orbiting meteorological satellites

FY-1A
LD:07.Sep.1988
EOL:16 Oct 1988

FY-1B
LD:03.Sep.1990
EOL:05 Aug 1991

FY-1C
LD:10.May.1999
EOL:26 Apr 2004

FY-1D
LD:15.May.2002
EOL:01 Apr 2012



FENGYUN-2

First-generation geostationary meteorological satellites

FY-2A
LD:10.Jun.1997
EOL:08 Apr 1998

FY-2B
LD:25.Jun.2000
EOL:Sep 2004

FY-2C
LD:19.Oct.2004
EOL:23 Nov 2009

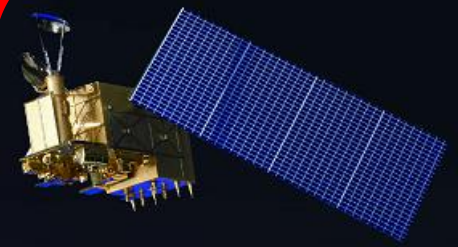
FY-2D
LD:08.Dec.2006
EOL:Jul 2015

FY-2E
LD:13.Dec.2008
EOL:31 Dec 2018

FY-2F
LD:13.Jan.2012
EOL:≥2021

FY-2G
LD:13.Dec.2014
EOL:≥2021

FY-2H
LD:05.Jun.2018
EOL:≥2022



FENGYUN-3

Second-generation polar-orbiting meteorological satellites

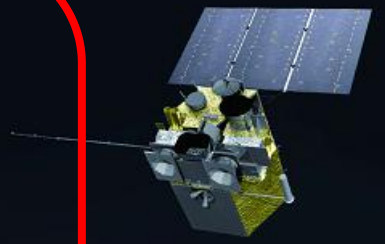
FY-3A
LD:27.May.2008
EOL:05 Jan 2015

FY-3B
LD:05.Nov.2010
EOL:≥2021

FY-3C
LD:23.Sep.2013
EOL:≥2021

FY-3D
LD:15.Nov.2017
EOL:≥2022

FY-3E
LD:05.Jul.2021
EOL:≥2026



FENGYUN-4

Second-generation geostationary meteorological satellites

FY-4A
LD:11.Dec.2016
EOL:≥2021

FY-4B
LD:03.Jun.2021
EOL:≥2028

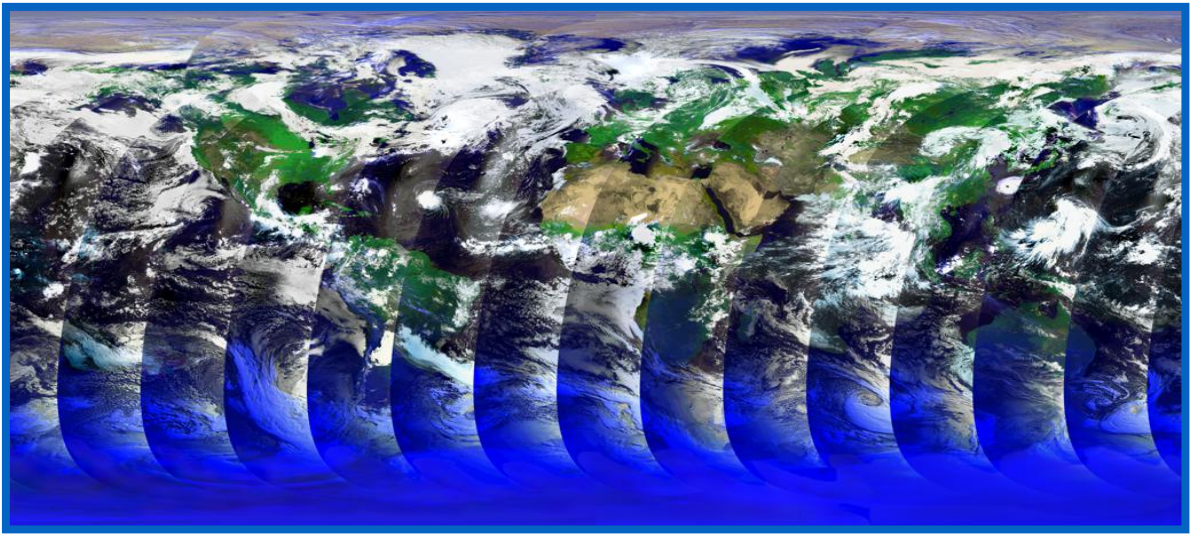
LD : Launch time
EOL : End of life

FENGYUN LEO More than 30 years:

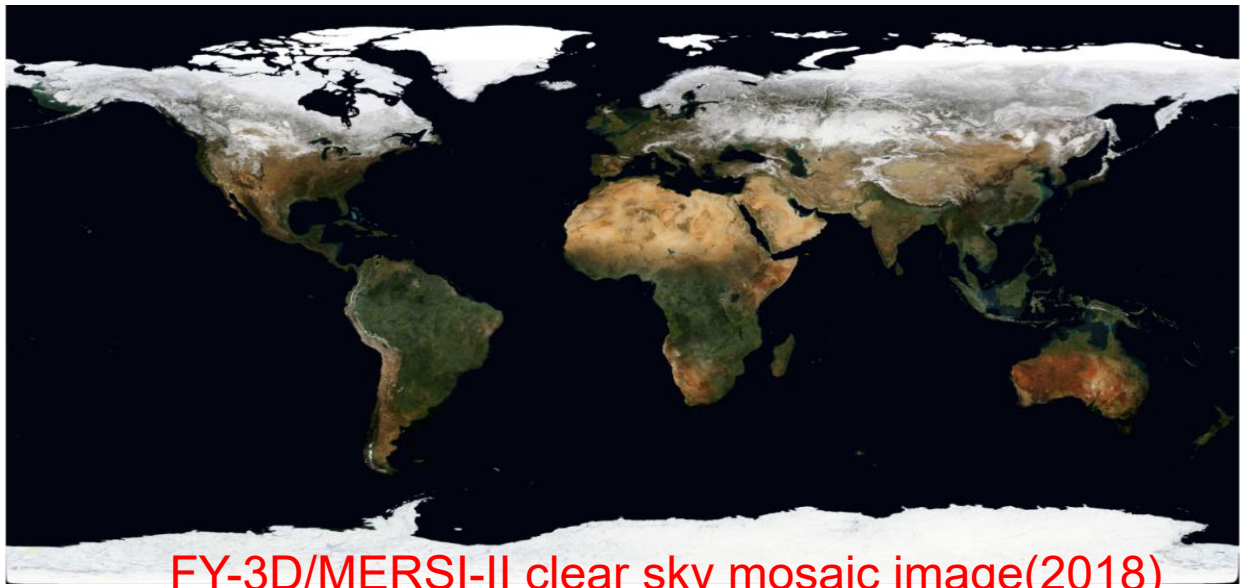
From EXPERIMENT to OPERATION

Polar-orbiting Series

1988.09.07	FY-1A	Experimental	39 Days	LEO
1990.09.03	FY-1B	Experimental	158 Days	
1999.05.10	FY-1C	Operational	6.5 Years	
2002.05.15	FY-1D	Operational	>10 Years	
2008.05.17	FY-3A	AM Orbit	7 years	
2010.11.05	FY-3B	PM Orbit	11 years	
2013.9.23	FY-3C	AM Orbit	Operational	
2017.11.15	FY-3D	PM Orbit	Operational	
2021.07.05	FY-3E	EM Orbit	Commissioning	



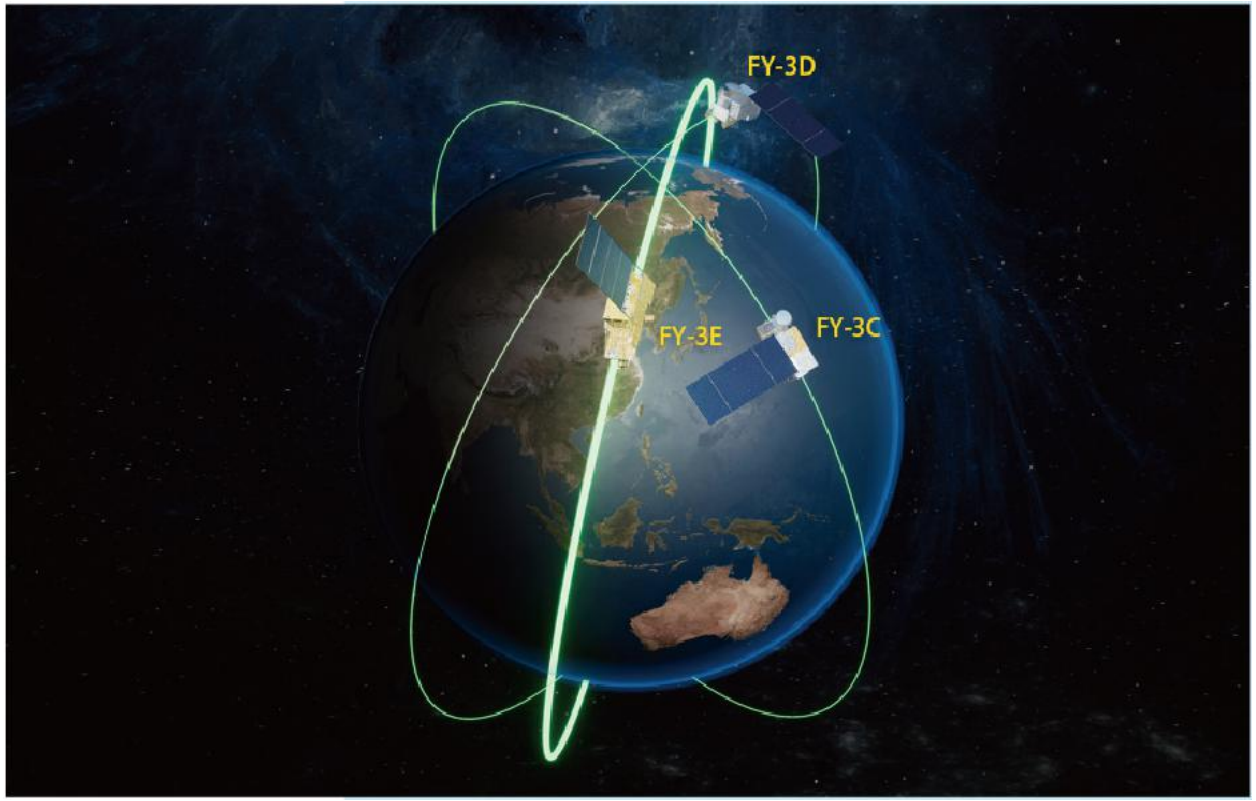
First FengYun Polar Satellites: FY-1C(1999)



FY-3D/MERSI-II clear sky mosaic image(2018)

Three Orbiting Framework of FY-3 Series was Born

FY-3 is the Chinese second generation LEO meteorological satellite. Five Satellites has already been on orbit since 2008 and three more satellites will be lunched in the next three years. The three orbiting framework of FY-3 Series with AM/PM/EM was completerly born in 2021.



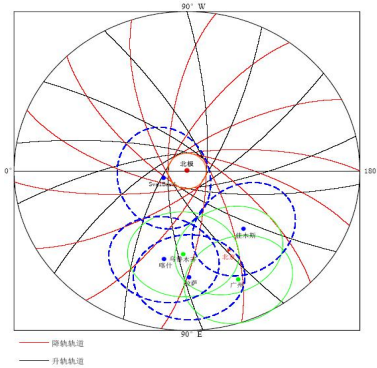
Global Data Latency within 3 hours maximum

Instruments Covering UV, VIS, IR, MW, GNSS

- ✓ Optical imaging
- ✓ Atmospheric sounding
- ✓ Microwave Imaging
- ✓ Ozone sounding
- ✓ Radiation budget from Earth/Solar

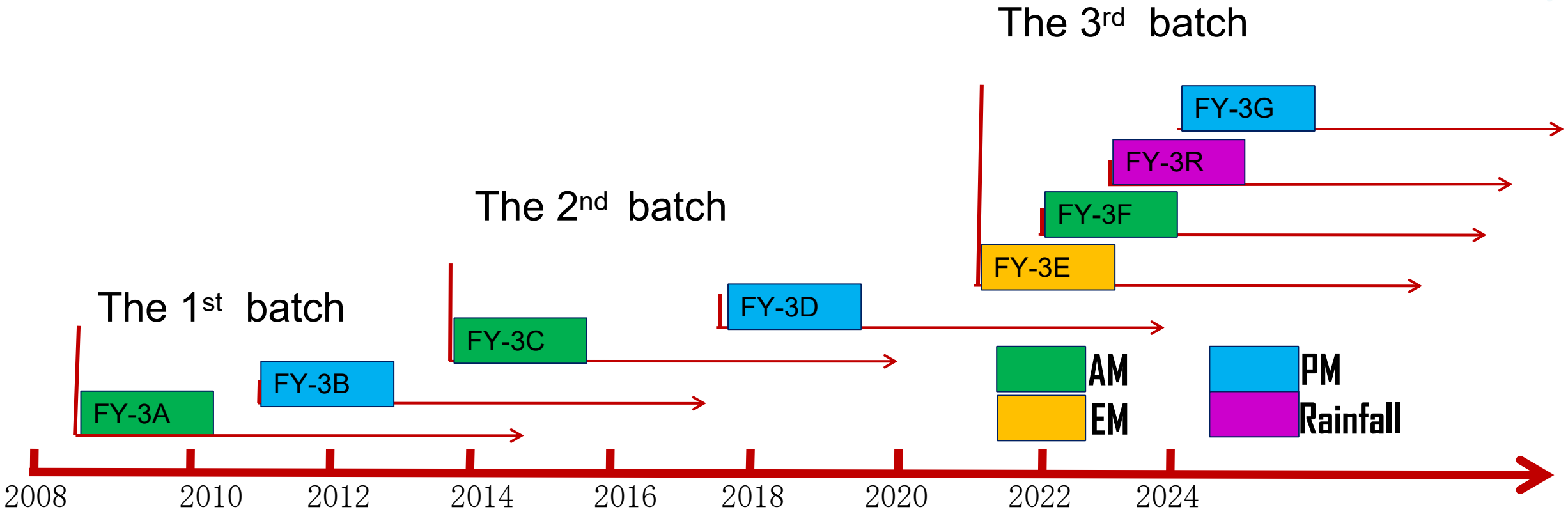
Spatial Resolution from Km to 250m

Station Name	*Longitude*	*Latitude*
Beijing Station	*116° 16′ 36″ E*	*40° 03′ 06″ N*
Guangzhou Station	*113° 20′ 20″ E*	*23° 09′ 52″ N*
Wulumuqi Station	*87° 34′ 08″ E*	*43° 52′ 17″ N*
Jiamusi Station	*130° 22′ 48″ E*	*46° 45′ 20″ N*
Kiruna Station	*21° 02′ E*	*67° 32′ N*
Antarctic station	*2.5° E*	*72S*



FY-3 Program Past and Perspective

Three batches of FY-3 series has been planned since 2008.
Specification of key instruments were Improved step by step.



Operational and future missions of FY-3 series satellites

FY-3D Instrument configuration

-- Launched on 15, Nov. 2017 and Operational Running

10 instruments on board FY-3D:

☐ 5 Successive instruments:

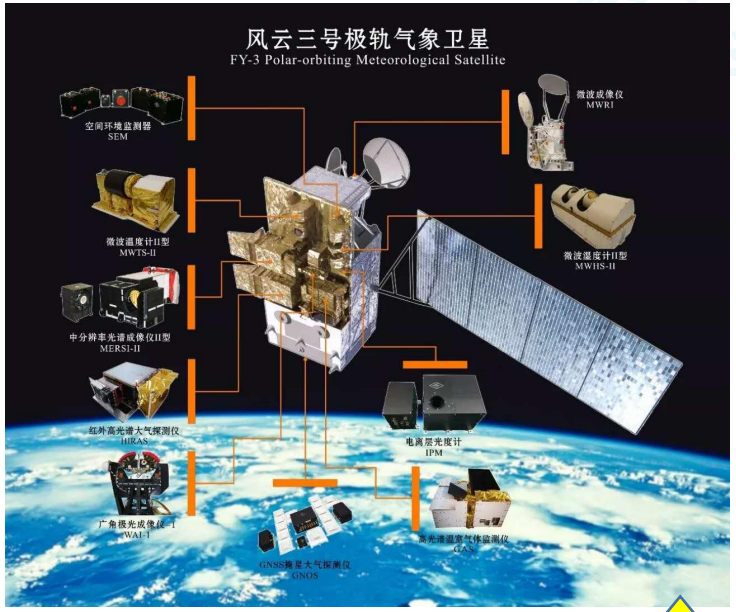
MWTS-II: Microwave Temperature sounder
MWHS-II: Microwave Humidity sounder
MWRI: Microwave Radiation Imager
GNOS: Global Navigation Occultation Sounder
SEM: Space Environment Monitor

☐ 2 Improved instruments：

MERSI-II： Improved from MERSI
HIRAS: Upgraded from filter-type sounder IRAS

☐ 3 New Instruments:

GAS: Greenhouse gases Absorption Spectrometer
WAI: Wide-angle Aurora Imager
IPM: Ionospheric Photometer

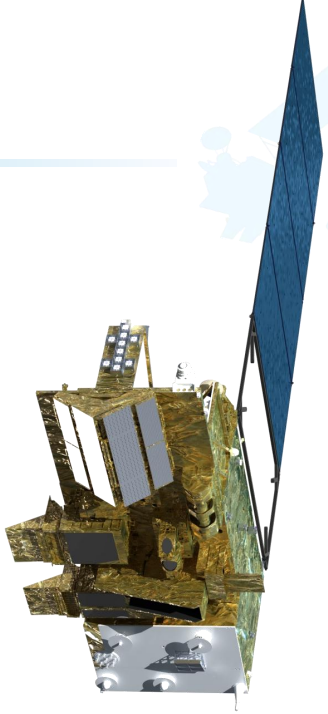


Payloads Configuration for the 3rd batch satellites

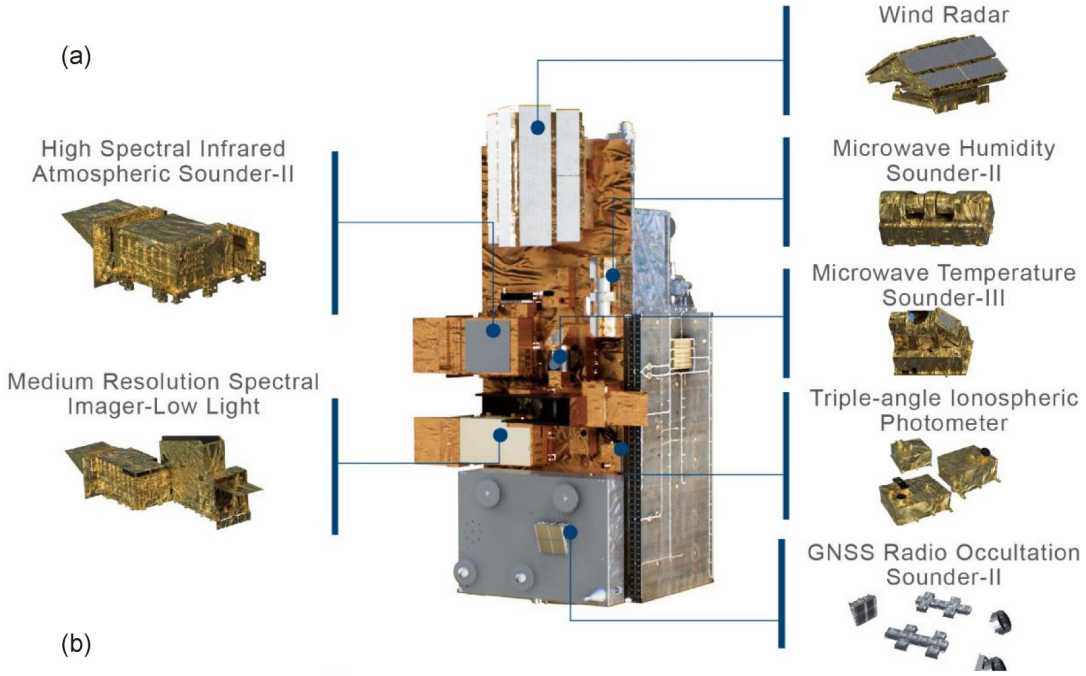
NO.	Sensor Siute	Satellite / Sensor	FY-3E （05） EM Satellite	FY-3F （06） AM Satellite	FY-3G （08） PM Satellite	FY-3R （07） Rainfall Satellite
		Scheduled Launch Date	2021	2022	2022	2023
1	Optical Imagers	MERSI	√（LL-Low Light）	√（III）	√（III）	√（-RM）
2	Passive Microwave Sensors	MWTS	III√	III√	III√	
		MWHS	√	√	√	
		MWRI		√	√	√
3	Occultation Sounder	GNOS-II	√	√	√	√
4	Active Microwave Sensors	WindRAD	√			
		Rainfall RAD				√
5	Hyperspectral Sounding Sensors	HIRAS	√	√	√	
		GAS (Greenhouse Gases Absorption Spectrometer)			√	
		OMS (Ozone Mapping Spectrometer)		√		
6	Radiance Observation Sensor Suite	ERM		√		
		SIM	√	√		
		SSIM (Solar Spectral Irradiation Monitor)	√			
7	Space Weather Sensor Suite	SEM	√			
		Wide Angle Aurora Imager			√	
		Ionosphere photometer	√(Tri-angle)		√	
		Solar X-EUV Imager	√			

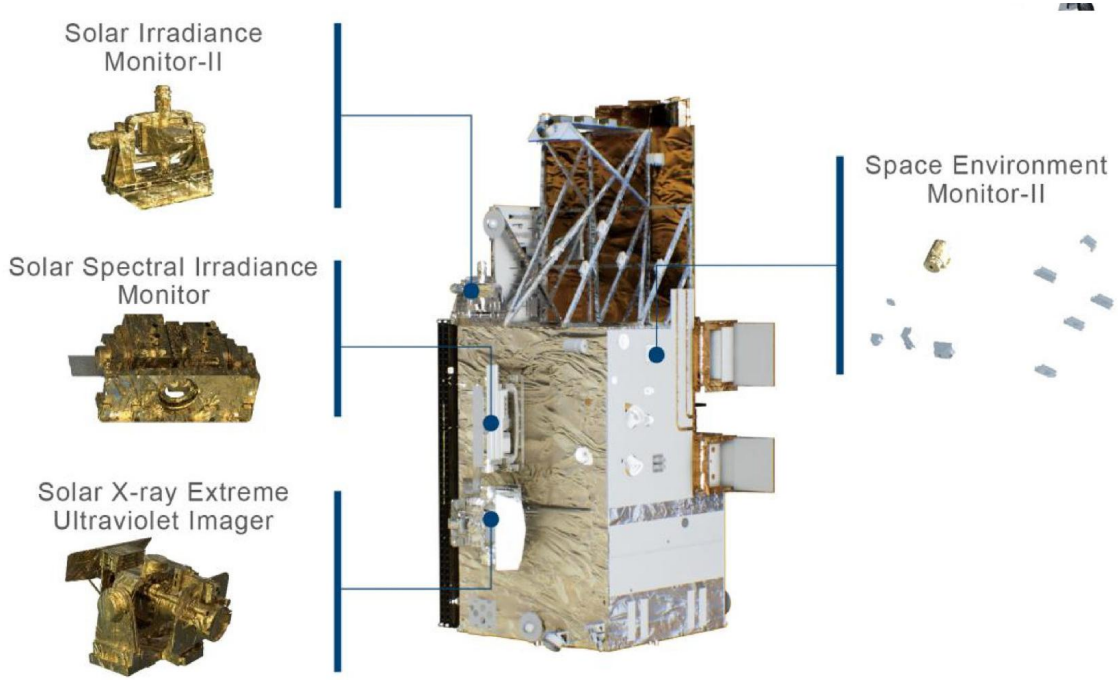
FY-3E Early Morning Satellite

launched on July 5, 2021; Located 5:30 AM



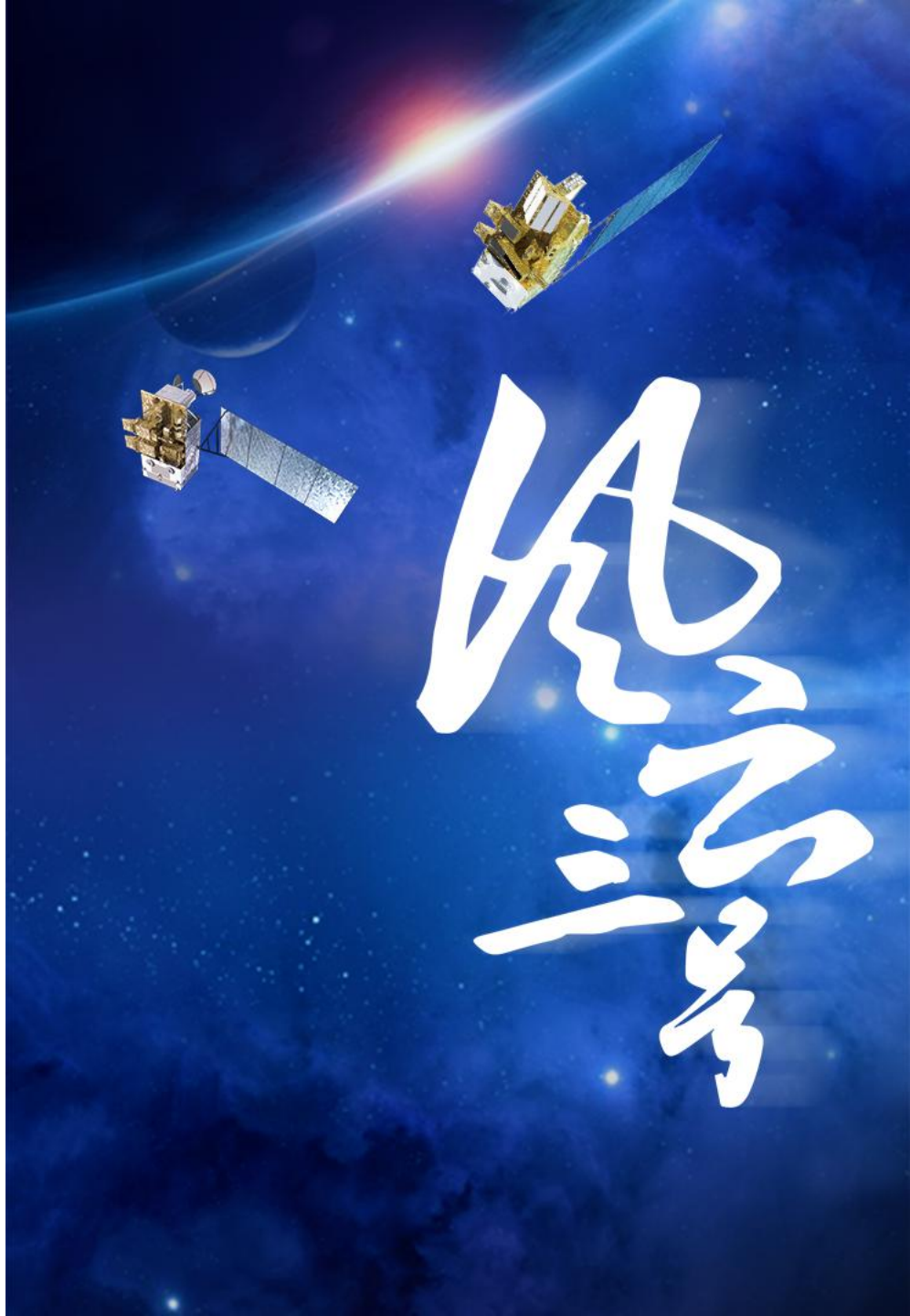
- **Three Completely New Instruments:**
  - X-EUVI, WindRAD, SSIM
- **Seven Improved Instruments**
  - MERSI-LL, MWTS-III, HIRAS-II, GNOS-II, SIM-II, Tri-IPM, SEM-II
- **One Successive Instruments**
  - MWHS-II





PART 02

Update of FY-3 Ground segment system

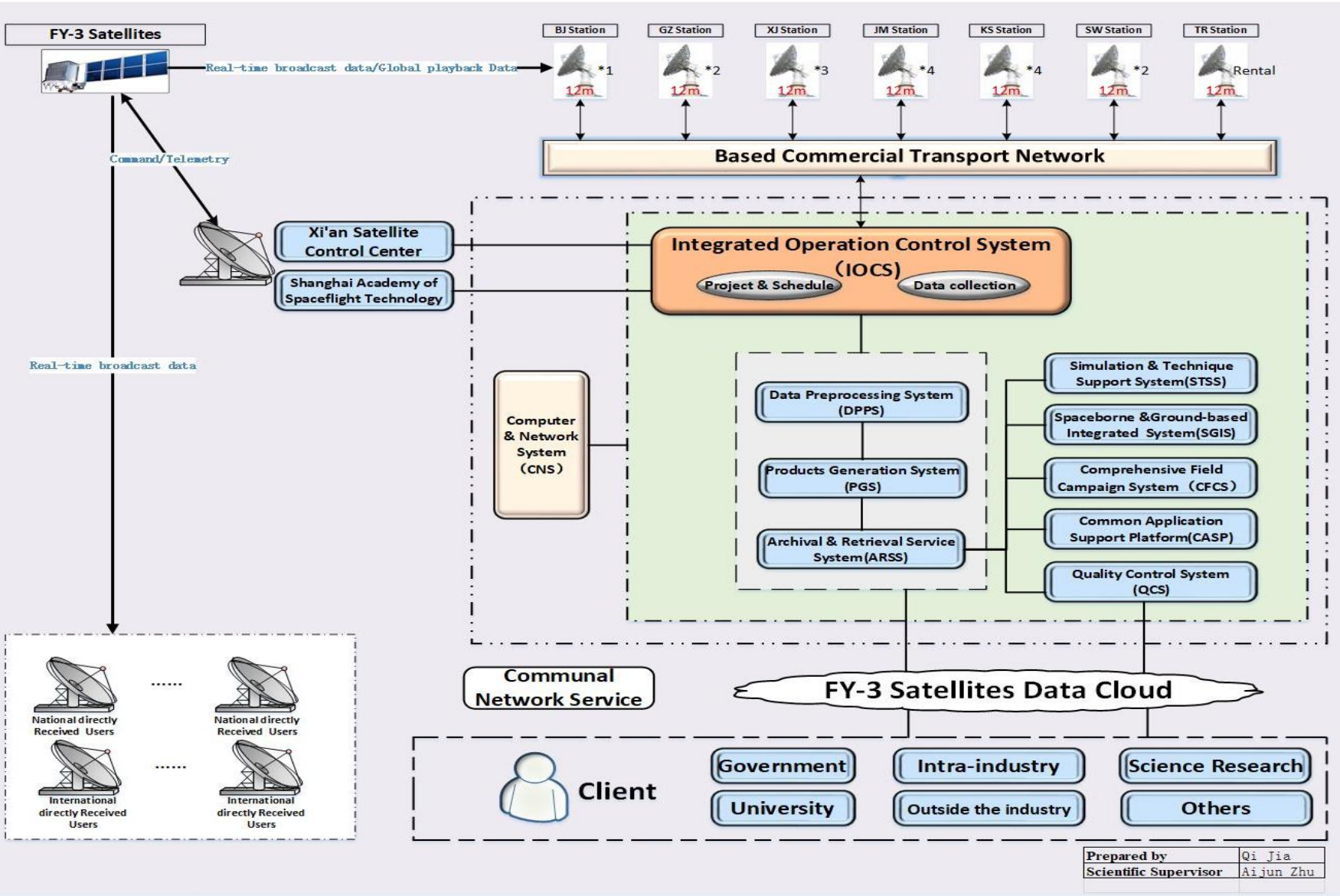


Overview of FY-3 Ground segment system

IOCS(Integrated Operation &Control System) is "Brain" :

- Operation, control and system monitoring
- Ground stations Receiving and Processing Task scheduling
- Satellites long-term health monitoring
- Data Processing Chain and IT resource scheduling

Realize Intelligent operation and maintenance without in person



Product lists of FY-3(03)

Product type	FY-3(03) Product parameters	Comparison
Cloud/Radiation	Cloud Mask, Cloud amount, Cloud type, Cloud phase, Cloud top parameters, Cloud Optical Thickness, Cloud Effective Radius, Cloud Liquid Water, Outgoing long-wave radiation, Cloud-Cleared Radiance, TOA radiation and cloud, Surface radiation budget, Total Solar irradiance, Spectral Solar Irradiance at the top of the atmosphere, Near Constant Contrast Image	FY-3(02): 11 FY-3(03): 15 New added number: 4
Atmospheric parameter	Precipitable Water Vapor, polar Atmosphere Motion Vector, Rain Detection, Rain rate, Path Integrated Attenuation, Bright Band, Rain Type, Rain Phase, Atmospheric temperature and humidity profiles, Instability index products (K index ,Lift index, Schwab index and TT index) , Lightning, Convective Initiation, Tropopause Folding	FY-3(02): 8 FY-3(03): 11 New added number: 4
Land surface	Land Surface Reflectance, Vegetation index, Land surface temperature, Soil moisture, Leaf area index, Fraction of photosynthetically active radiation, Net primary productivity, Chlorophyll Fluorescence, BRDF/Albedo, Land surface pressure, City light, Land cover	FY-3(02): 11 FY-3(03): 12 New added number: 3
Sea surface	Sea surface temperature, Water-Leaving Radiance (Ocean Color/Chlorophyll), Sea surface wind direction, sea surface wind speed	FY-3(02): 3 FY-3(03): 4 New added number: 1
Cryosphere	Snow depth, Snow water equivalent, Snow cover, Sea ice cover, Sea ice extent, Sea ice type	FY-3(02): 4 FY-3(03): 6 New added number: 2
Atmospheric composition	Aerosol over Ocean, Aerosol over Land, Dust Storm Monitoring, Total ozone, Ozone profile, Aerosol Index, Total oxygen column, X_{CO2}, X_{CH4}, Total Column SO_2, Total Column NO_2	FY-3(02): 7 FY-3(03): 11 New added number: 4
Space weather	Energetic Particle Products, Surface Potential Products, Ion/electron spectroscopy, Radiation Dose Products, Atmospheric Density profiles, Temperature, Atmospheric Refractivity profiles, Bending Angles, Pressure, Aurora egg type, Particle precipitation, the ionospheric F2 layer peak electron density, Total Electron Content, Oxygen nitrogen intensity, O and N2 Ratio, Solar X-ray Image, Solar Extreme Ultra-violet Image	FY-3(02): 12 FY-3(03): 18 New added number: 6

Product list of FY-3D/FY-3E

FY-3D: 7 categories, 56 parameters, 47 products
FY-3E: 7 categories , 34 parameters , 36 products

Instrument	Product category	Product parameter	
		FY-3D	FY-3E
FY-3D MERSI-II FY-3E MERSI-LL	Cloud	Cloud detection、cloud amount、cloud type and phase、Cloud top parameters、Cloud top height 、Cloud top pressure 、Cloud Optical Thickness、Cloud Effective Radius	Cloud detection、cloud amount、cloud type and phase、Cloud top parameters、Cloud top height 、Cloud top pressure
	radiation	Outgoing long-wave radiation	Outgoing long-wave radiation
	Atmospheric parameter	Precipitable Water Vapor, polar Atmosphere Motion Vector、fog detection	Precipitable Water Vapor, polar Atmosphere Motion Vector
	Atmospheric composition	Aerosol (land + ocean)、dust	/
	Land	Land Surface Reflectance, Vegetation index, Land surface temperature, Soil moisture, Leaf area index, Fraction of photosynthetically active radiation, Net primary productivity、fire spot detection	Land temperature
	Ocean	Ocean color、SST	SST
	cryosphere	Sea ice cover, snow cover	Snow cover
MWRI	cloud	Cloud Liquid Water	/
	Atmospheric parameter	Atmospheric precipitation at sea and surface	/
	land	Land surface temperature, Soil moisture/drought index/Flood Index	/
	ocean	Sea surface speed, sea surface temperature	/
	cryosphere	Snow depth/Snow water equivalent、sea ice concentration	/
VASS	cloud	Ice water thickness index	Ice water thickness index
	radiation	Equivalent clear sky emission radiation	Equivalent clear sky emission radiation
	Atmospheric parameter	Precipitation detection, atmospheric temperature and humidity profile, atmospheric derived instability index products (K index, uplift index, Shaq index and TT index)	Precipitation detection, atmospheric temperature and humidity profile, atmospheric ozone profile, atmospheric derived instability index products (K index, uplift index, Shaq index and TT index)
WindRAD	ocean	/	Sea surface wind speed and direction
	cryosphere	/	Sea ice edge and type
Radiation instrument package (SSIM，SIM-II)	radiation	/	Total solar irradiance, spectral solar irradiance
GNOS	Atmospheric parameter	Atmospheric profile (dry atmosphere, wet atmosphere)	Atmospheric profile (dry atmosphere, wet atmosphere)
	ocean	/	Sea surface widn speed
	Space weather	Ionospheric density	Ionospheric density
SEM	Space weather	Space environment (surface potential, radiation dose, high energy particles)	Space environment (particle products, surface potential, radiation dose, magnetic field products, ionospheric airglow and occultation ionosphere)
IPM	Space weather	Oxygen nitrogen concentration ratio	/
WAI	Space weather	Aurora image projection products	/
XEUVI	Space weather	/	Solar X-ray image, solar extreme ultraviolet image

PGS of Rainfall Satellite FY-3G

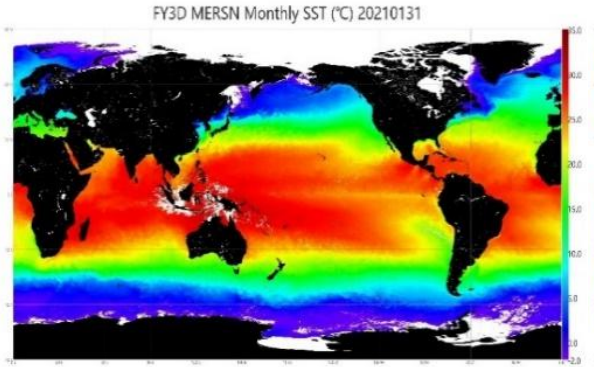
Newly Constructed Precipitation Measurement Satellite PGS

- Precipitation satellite is the first low angle orbit satellite of Fengyun series, and the main payload - precipitation radar, is also the first spaceborne active weather radar in China.
- The product system of precipitation satellite precipitation products is divided into four levels, where L2 and L3 have 7 categories of products and 55 product parameters .

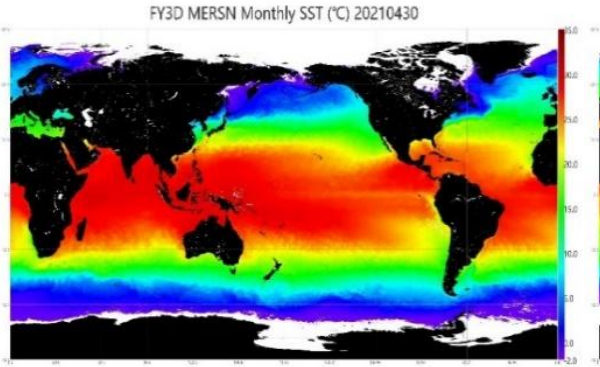
Products	Algorithm research	Prototype algorithm
Radar ground rain rate	Done	Ongoing
Three dimensional structure of precipitation	Ongoing	Not started
MWRI precipitation product	Ongoing	Not started
Hydrogel profile product	Ongoing	Not started
Atmospheric Precipitable Water	Ongoing	Ongoing
Pre precipitation cloud parameters	Ongoing	Not started
Latent heat release	Not started	Not started
Active passive joint inversion of precipitation products	Not started	Not started
Precipitation fusion products of FY-3 constellations	Not started	Not started

Product examples of FY-3D

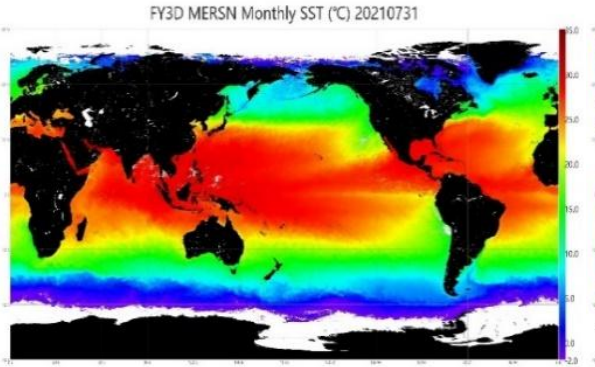
Application of FY-3D MERSI Sea surface temperature (SST) in operational monitoring



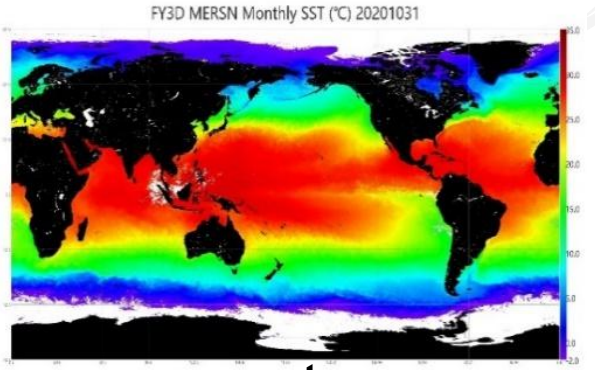
winter



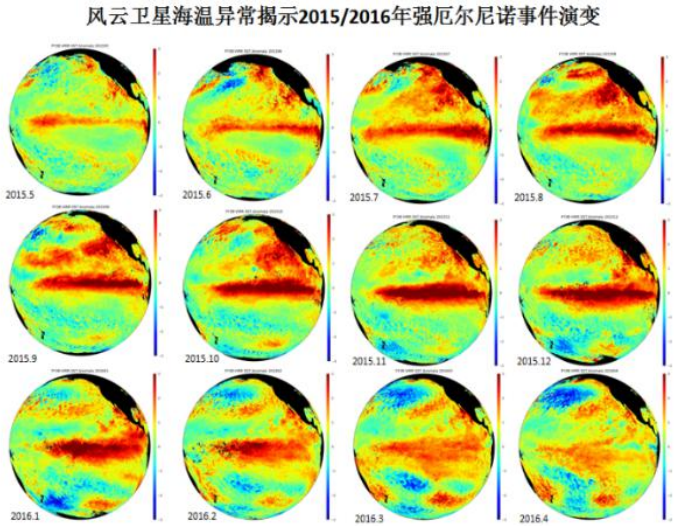
spring



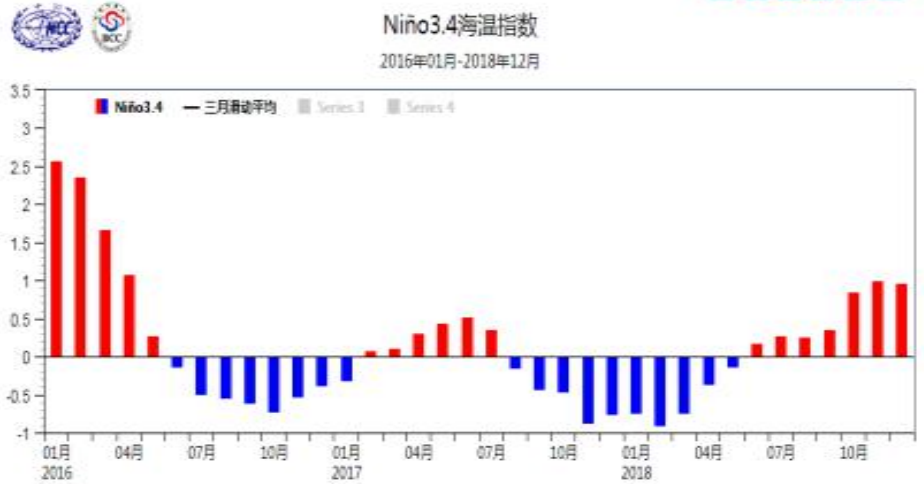
summer



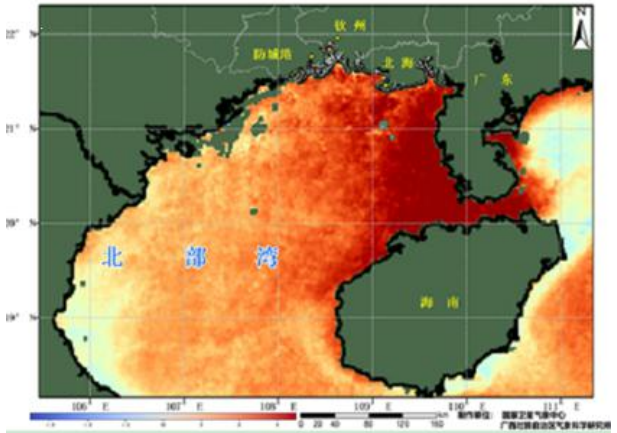
autumn



Monthly SST anomaly of FY-3B



Application of SST fusion products (FY3B+C) in ENSO Events



2020 年 7 月北部湾海温距平图（FY-3B）

（海温常年值：1982-2011 年）

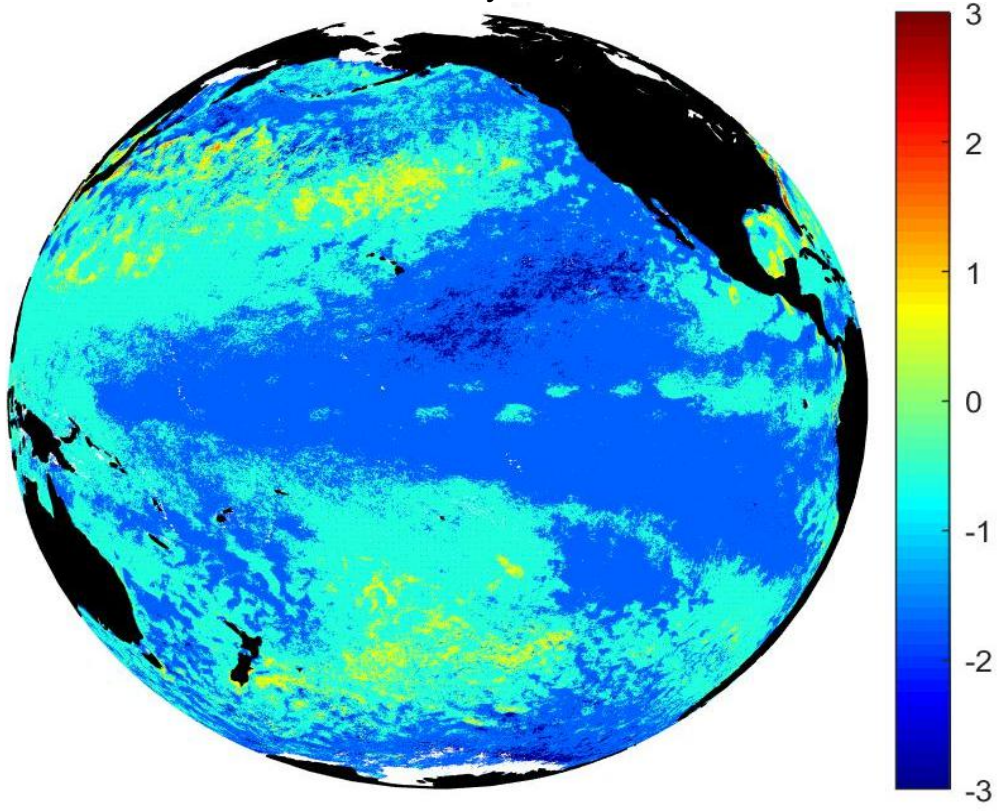
Application of FY-3B reprocessed SST in coral bleaching

Product examples of FY-3D

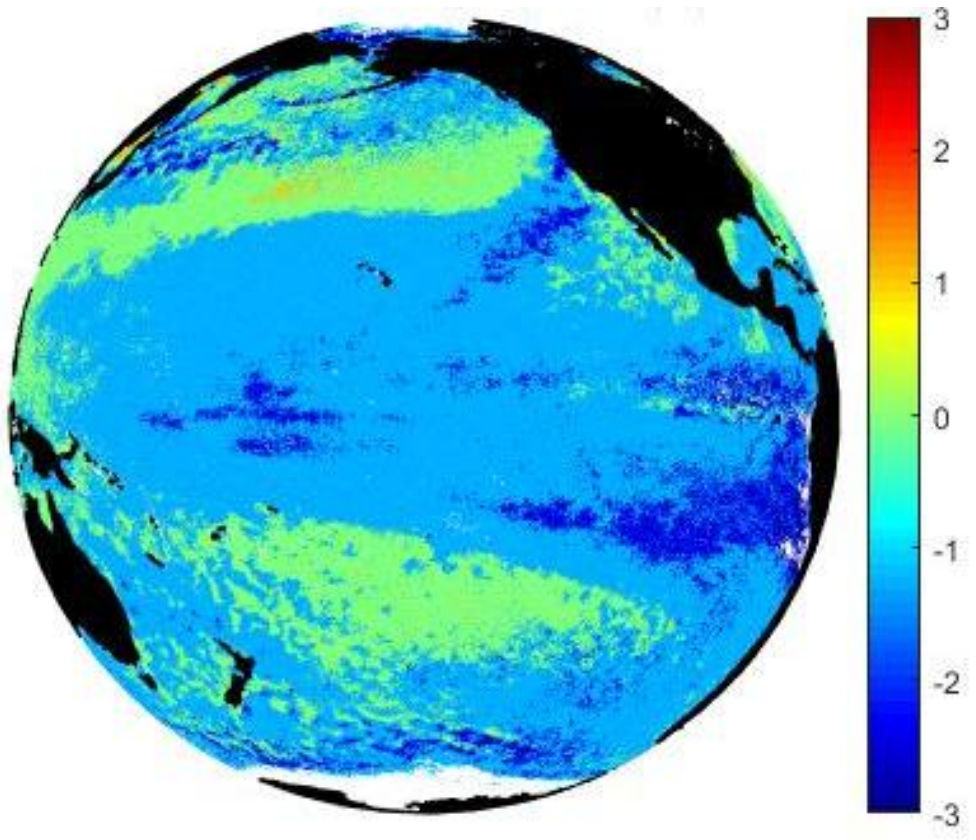
El Niño- La Niña

FY-3D SST anomalies monitor the La Niña phenomenon.
Negative SST anomalies spread from the central tropical Pacific to the eastern tropical Pacific.

FY-3D SST anomaly Mar 2021



FY-3D SST anomaly Sep 2021

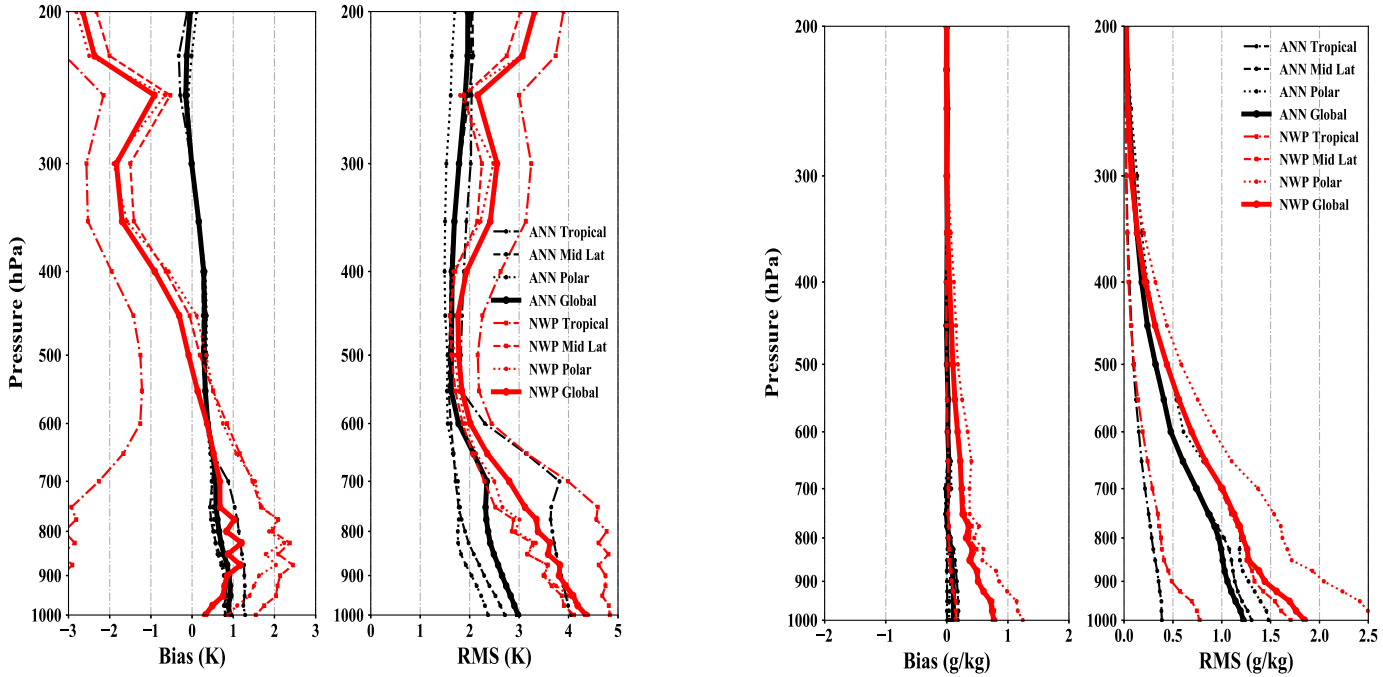


Atmospheric Tem/humidity profiles from FY-3

FY-3D feed-forward Neural networks method

- Cloud detection（MERSI）
- Precipitation detection（MWHS）
- Problem of previous EOF regression-based method
- Channels selection: (based on information entropy theory). Total selected channel number 450
- Input: compressed microwave and clear infrared radiances, along with the cosine of scan angle.
- Output: ERA5 reanalysis temperature and water vapor fields at 37 pressure levels

FY-3D NN products validation (over land)



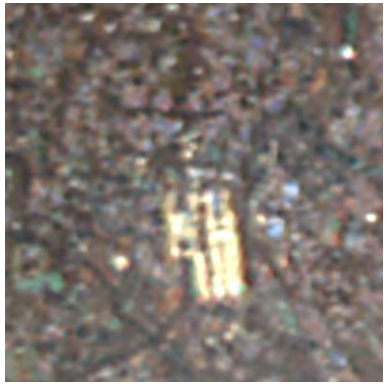
RMS and BIAS statistics for temperature (left) , water vapor (right) over land.

MERSI Imagery Super-Resolution with Deep Learning

MERSI

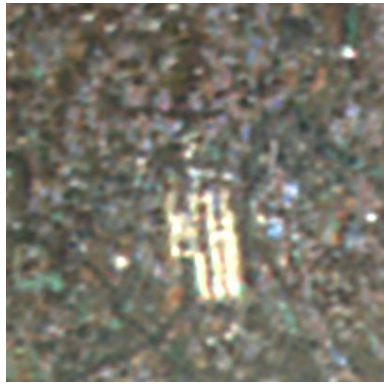
OLI

Metrics	Bicubic	SRCNN	SRGAN	DSRCNN
PSNR	32.01	33.50	27.96	**33.64**
SSIM	0.806	0.818	0.633	**0.821**
ASPSIM	0.373	0.496	0.372	**0.497**
Laplacian	40.86	131.80	**42748.64**	132.18



SRCNN

SRGAN



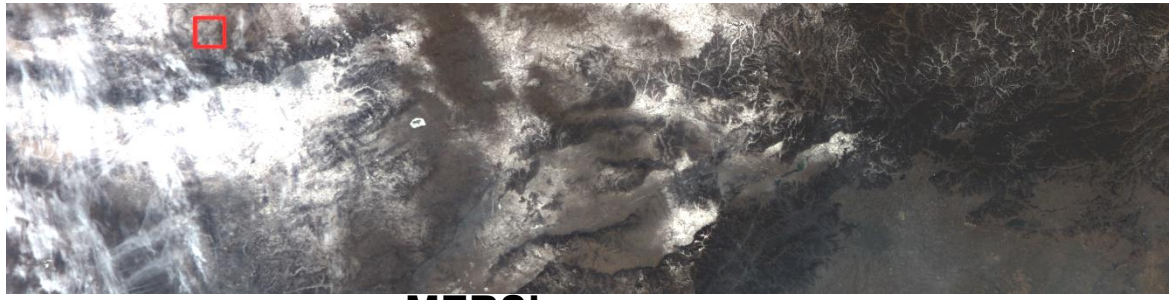
DSRCNN

- DSRCNN has a better performance on PSNR, SSIM, ASPSIM, which means making the network deeper can improve the performance.
- The mean error of the green channel between MERSI and OLI data is >4.3%, so there is a large radiation error in green channel.
- Result of SRGAN has best perceptual quality, but a low fidelity.

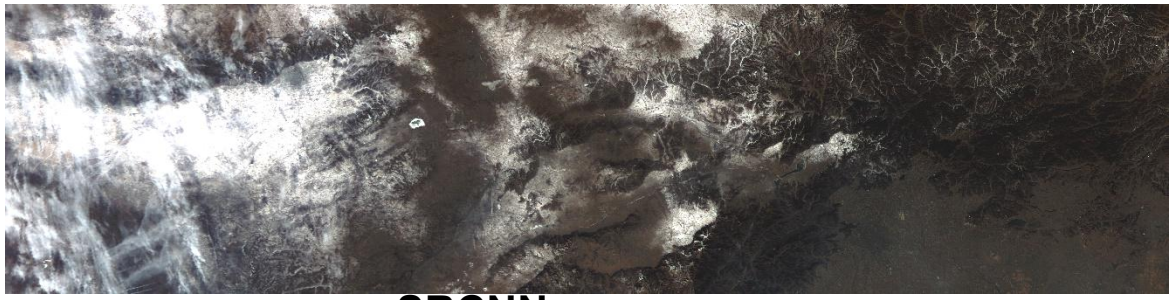
NSMC

MERSI Imagery Super-Resolution with Deep Learning

Beijing and Hebei area 2019.11.19)



MERSI

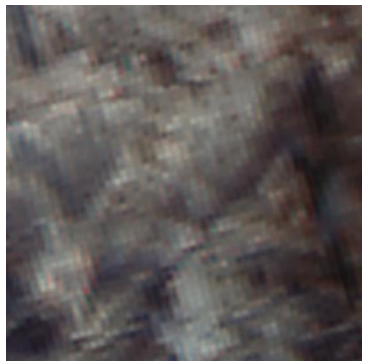


SRCNN

DSRCNN

Metrics	Bicubic	SRCNN	DSRCNN
Laplacian	18.30	55.38	**58.27**

MERSI



SRCNN

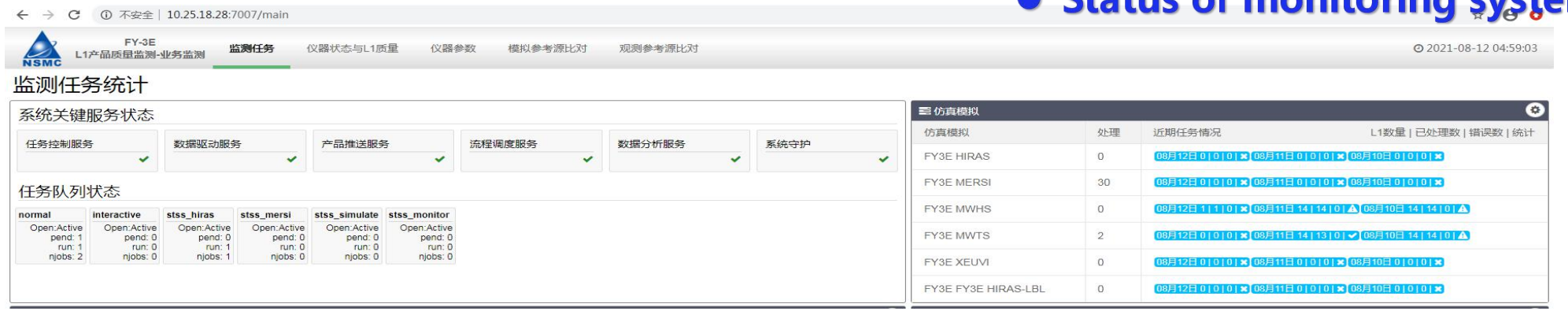
DSRCNN

Quality monitoring system for L1 data

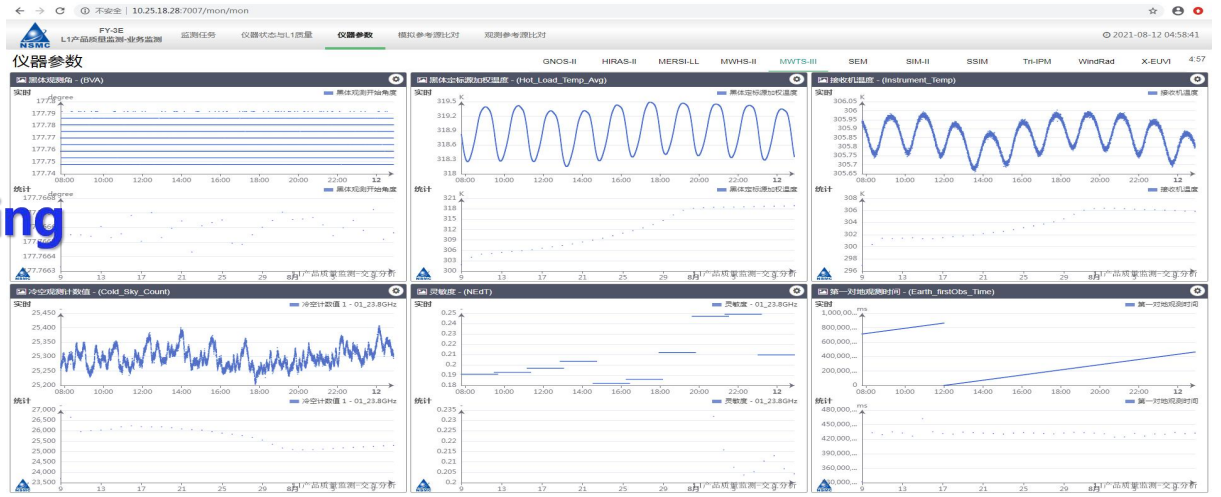
DPPS+STSS:

- satellites & instruments monitoring system
- based on both simulation and observation reference sources
- to satisfy the requirement of operational monitoring/alarming as well as scientific researches

- **Status of monitoring system**



- **Key Telemetry of instruments Monitoring**

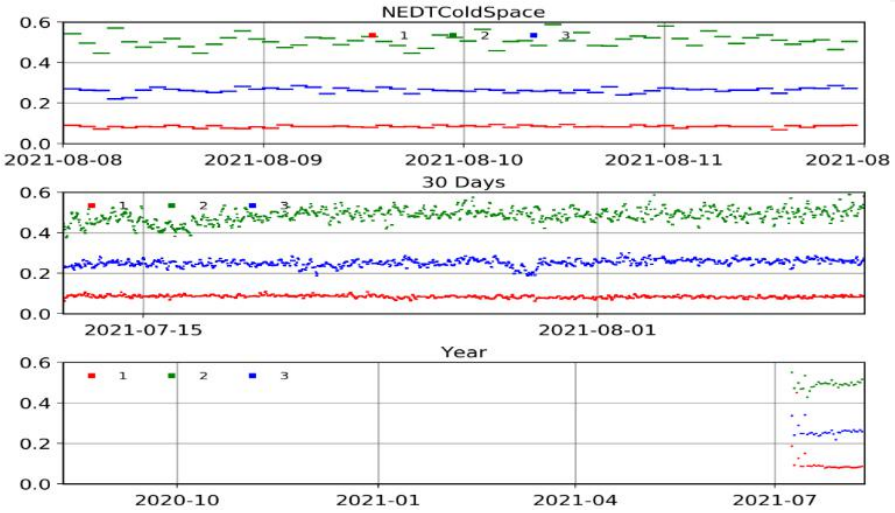


Quality monitoring system for L1 data

DPPS+STSS

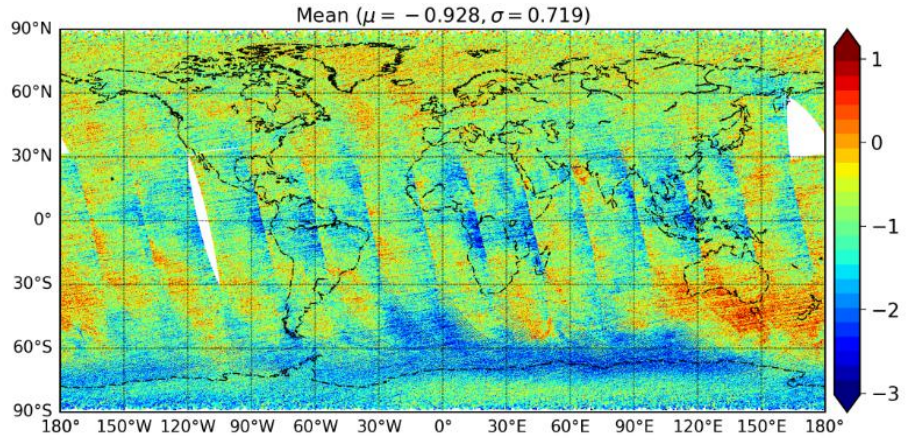
- **Platform**

- **Parameter monitoring：11 instruments**

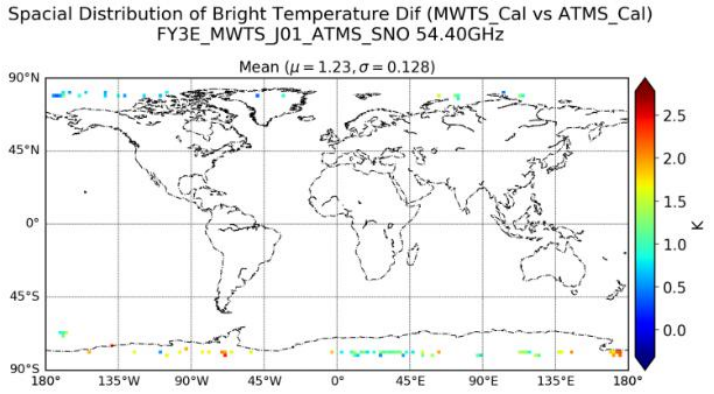


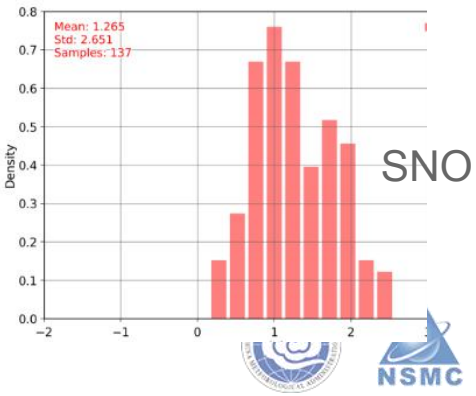
- **Simulation Radiance O-B monitoring**

OMB



- **Observation reference data monitoring**





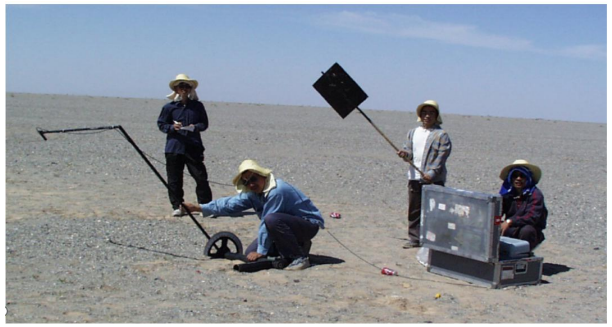
SNO

FY-3 Calibration and validation Evolution

CAL/VAL

FY-3 1st batch

- Mainly radiometric calibration, manual field campaigns
- Products validation in designing



FY-3 2 batch

- Manual field campaigns+ automated radiometric calibration + products validation

FY-3 3rd batch

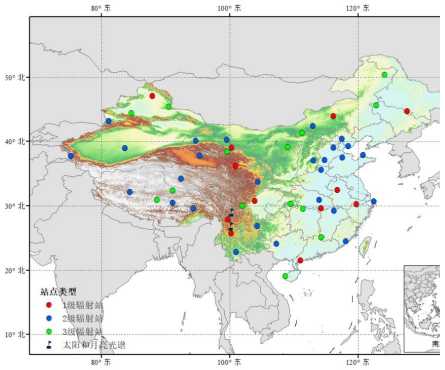
- Construction of Calibration and validation field network;
- Cross validation + in situ validation

Integrated satellite-ground observation system

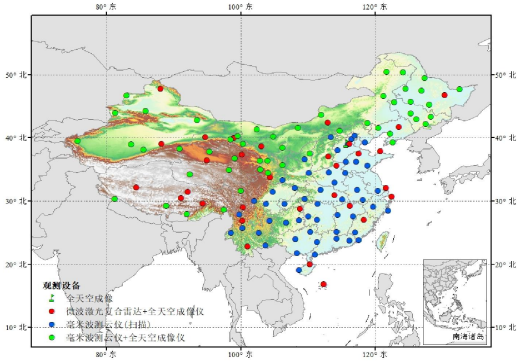
Radiometric calibration and products validation are both basic and important work for product precision and the algorithm improvement, which determine whether the product can satisfy the requirements of users。

Integrated satellite-ground products validation system

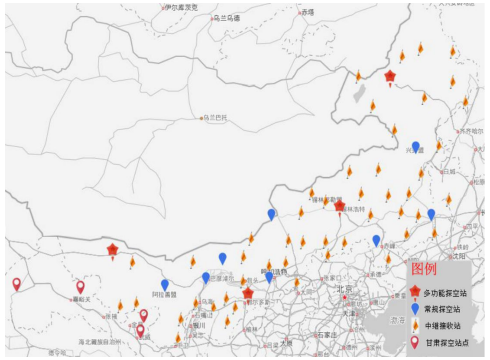
Normalized observation + special in situ observation



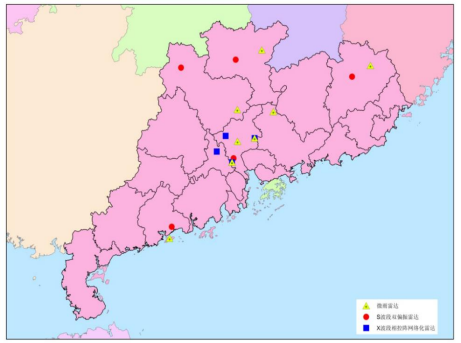
Radiation products validation stations



Cloud and aerosol products validation stations



Atmosphere products validation stations



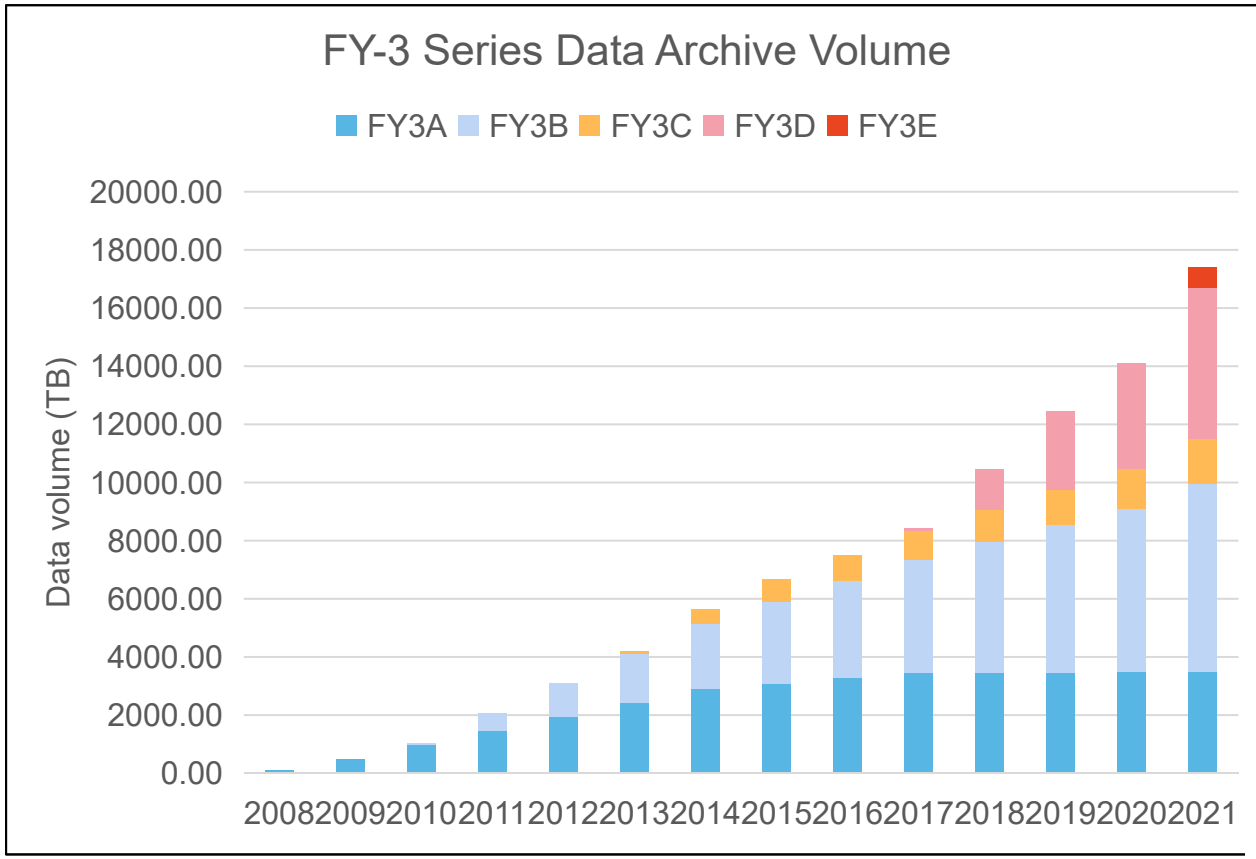
Precipitation products validation stations

Space weather products validation stations

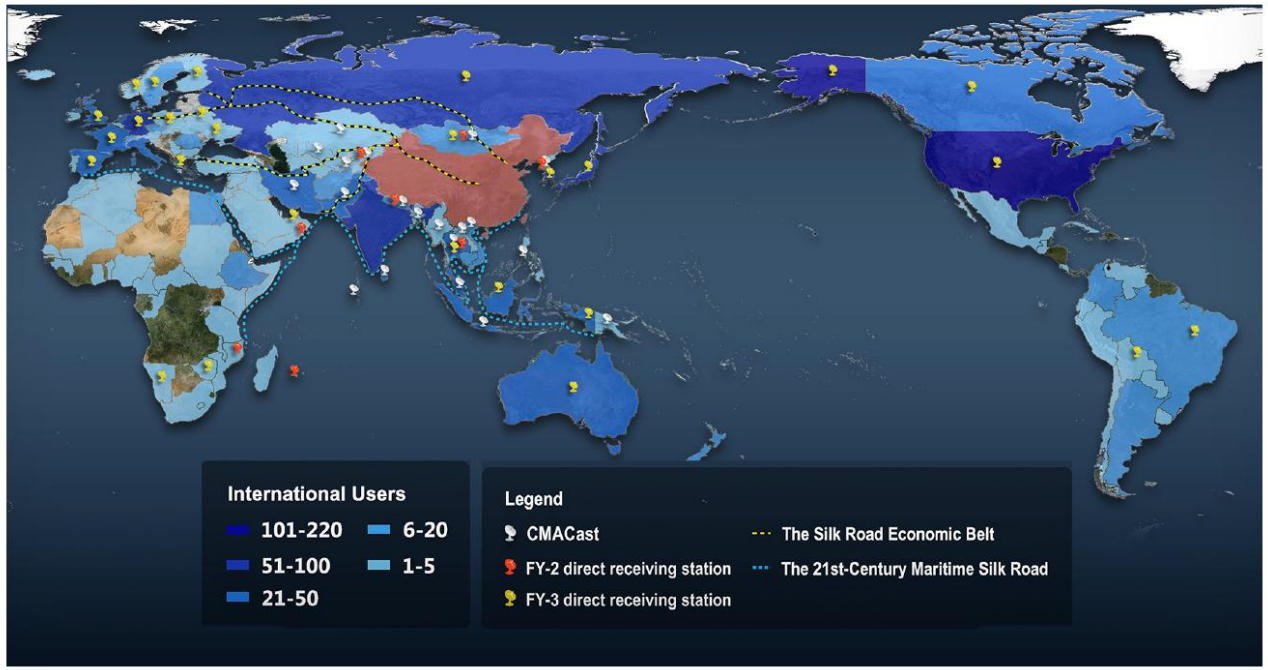
No.1	Type of products	Number of planning stations
1	cloud +aerosol	114
2	radiation	65
3	atmosphere	60
4	precipitation	15
5	space weather	5

FY-3 data and Produts service

- Data Archive of FY-3 Series Satellites
  - FY-3 Data total volume: **17 PB**
  - Accumulated Service volume: **27PB**

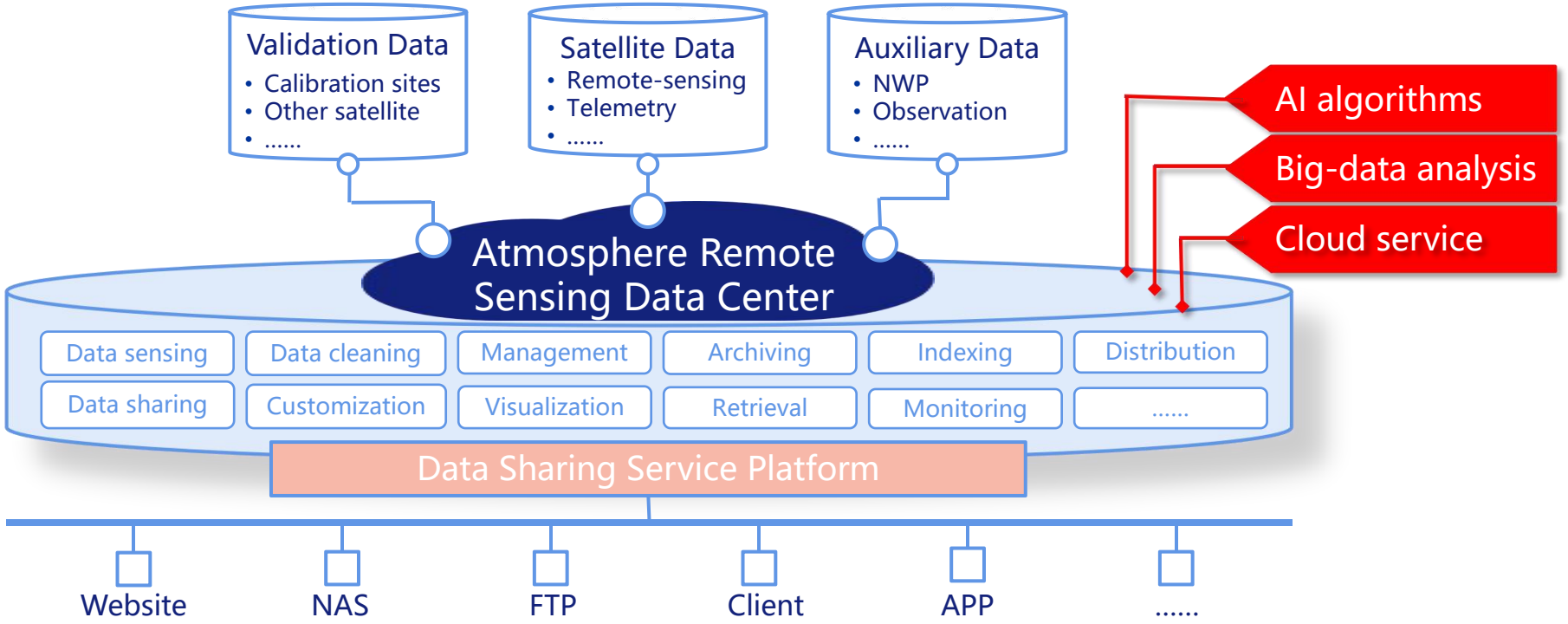


- Users of FY-3 Series Satellites
  - Domestic users: **113844** from **149** professional fields
  - Overseas users: **1603** from **121** countries



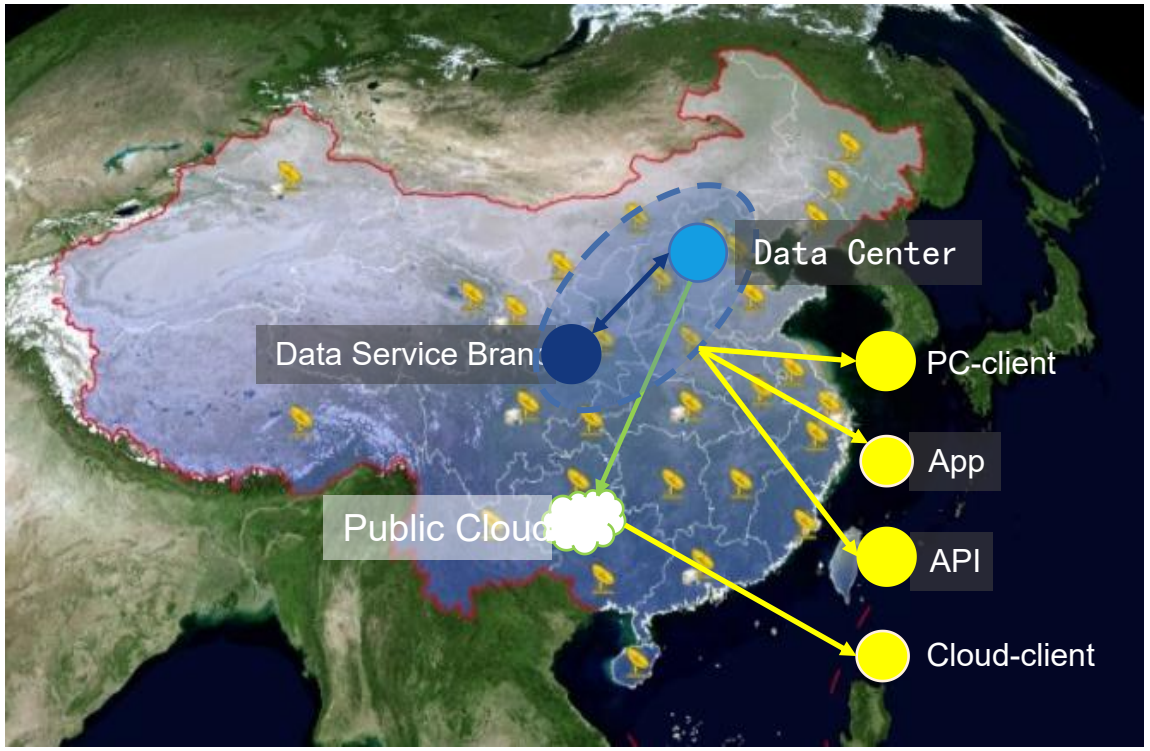
Service-Oriented FY-3 Data Service Architecture

- **A**rtificial Intelligence for multi-center cooperative service with distributed data storage
- **B**ig Data technologies-based business analysis and user experience enhancement
- **C**loud + End architecture for near real-time data sharing and on-demand downloading



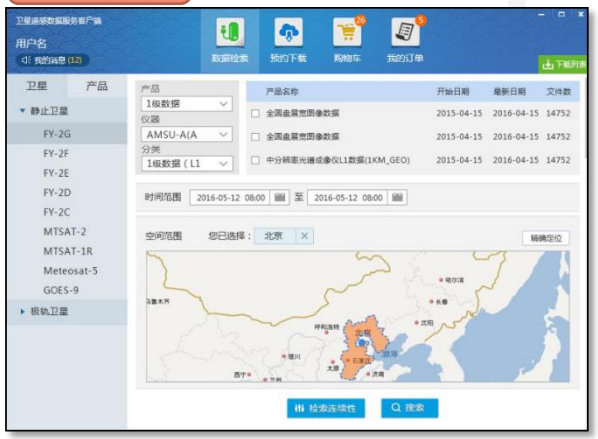
FY-3 Data and Products Service Tools

- Rich-End Service Channels of FY-3 Data and Products



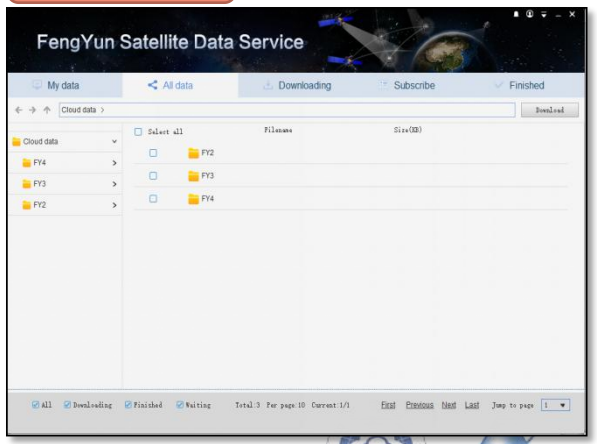
Website

PC-client



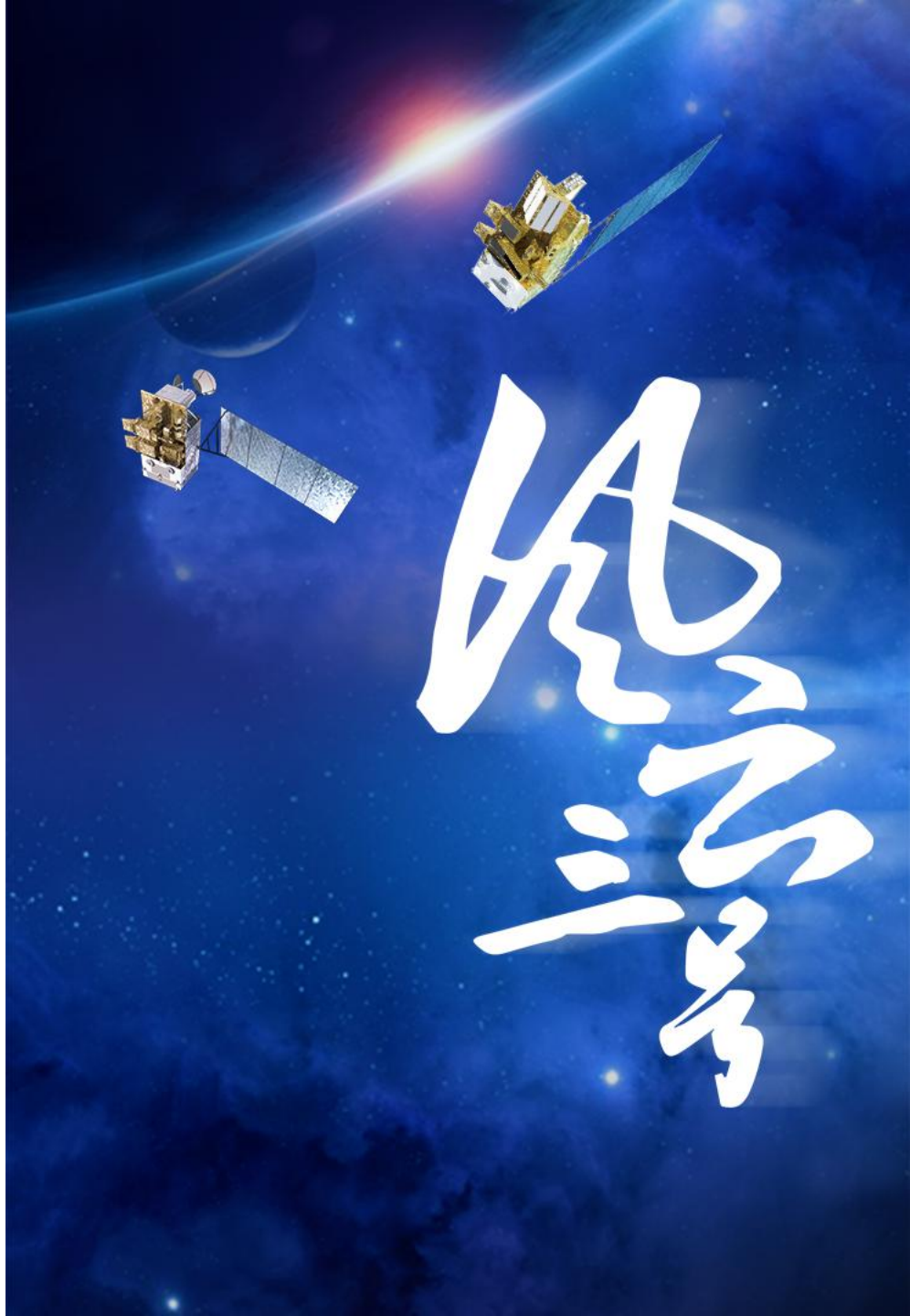
Applet in WeChat

Cloud client



PART 03

FY-3E Early Morning Satellite Latest Status



FY-3E EM Commissioning Test Phase

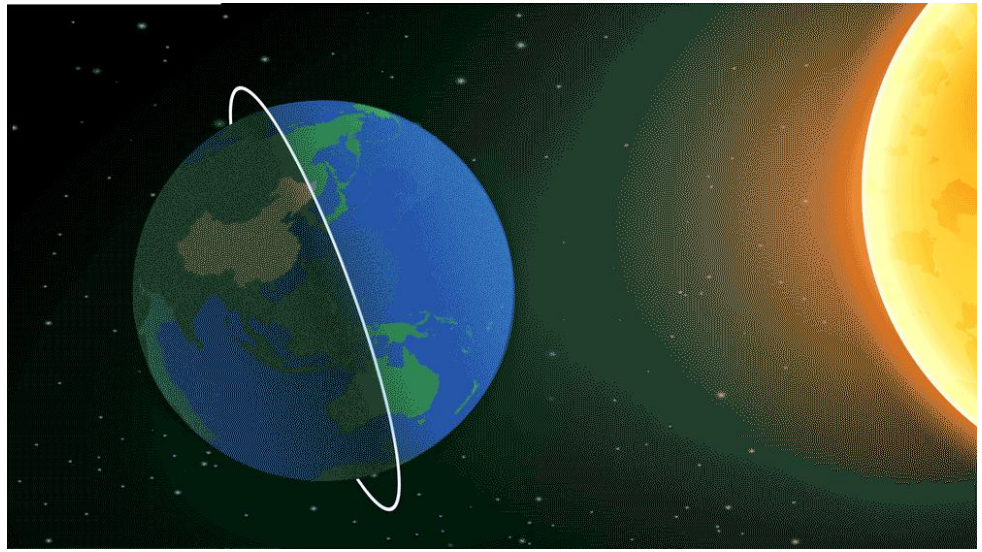
July 5, 2021 — lunched successfully

Oct. 15, 2021 — Complete Satellite Platform check out

Dec. 31 2021 — Complete Instruments Test and Satellite delivery

March 2022 — Review of L1/L2 provision for trial operation

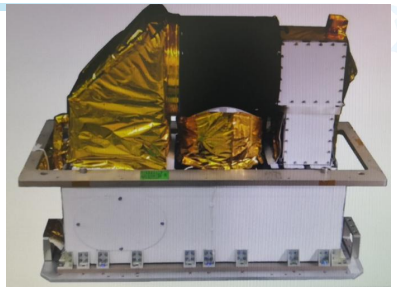
June 2022 — Turn into formal operation and data release



Atmosphere Sounding Instruments

MWTS-III

MWTS-III increase 4 frequency channels (23.8GHz, 31.4GHz, 53.246GHz ±0.08, 53.948GHz±±0.081)from 13 to 17 and better NEdT with respect to MWTS-II for atmospheric temperature profiles.

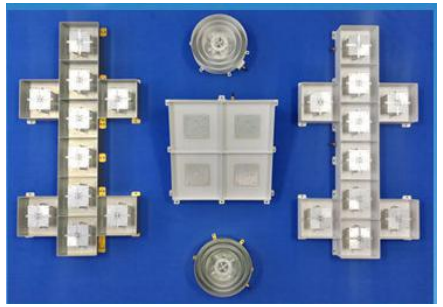


MWHS-II

Microwave humidity sounder II(MWHS-II) inherited from FY-3D with diffferent 166.0GHz channel.

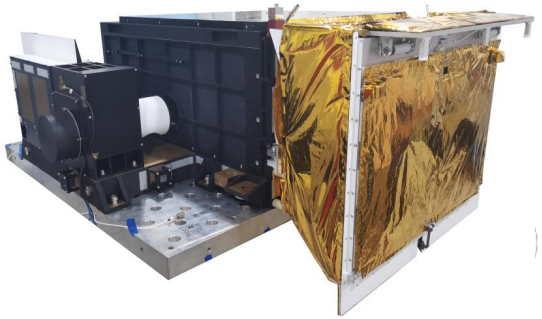
GNOS-II

GNOS-II increases the GNSS Reflectometry (GNSS-R) module for sea surface wind retrieval with combines the existing Precise Orbit Determination(POD) module and GNSS Radio Occultation (GNSS-RO) module including GPS and BeiDou system.



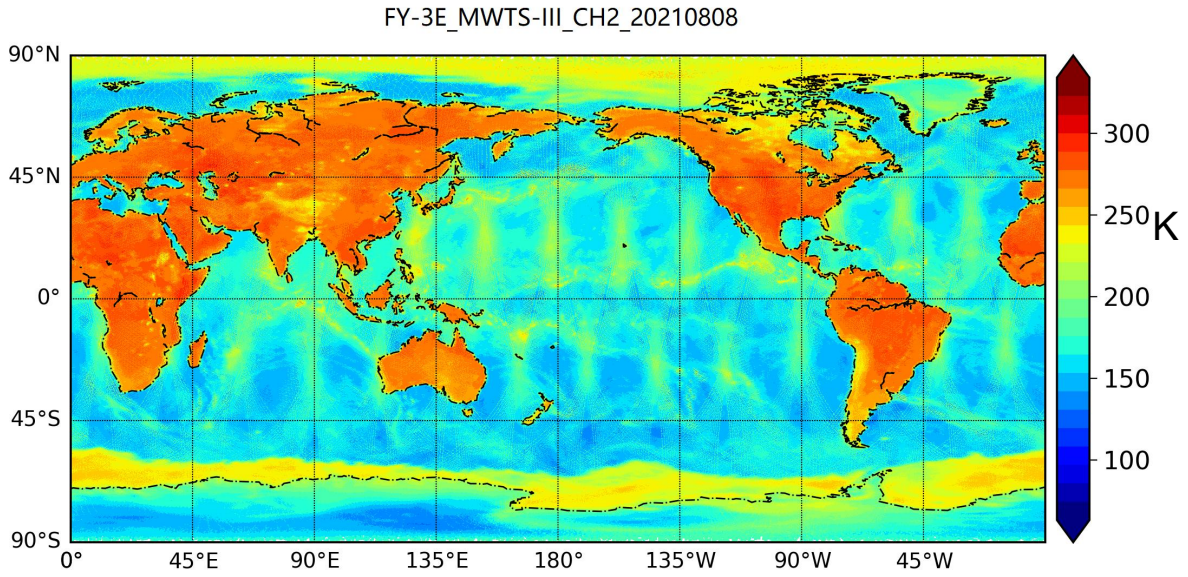
HIRAS-II

High spectral infrared atmospheric sounder (HIRAS) will be upgrade into the second generation HIRAS-II which has significant improvement including 3*3 from 2*2 FOVs within one FOR, spectral gap filling between three spectral bands and scanning cycle shortening from 10s to 8s as well as the NEDT improvement and straylight control.

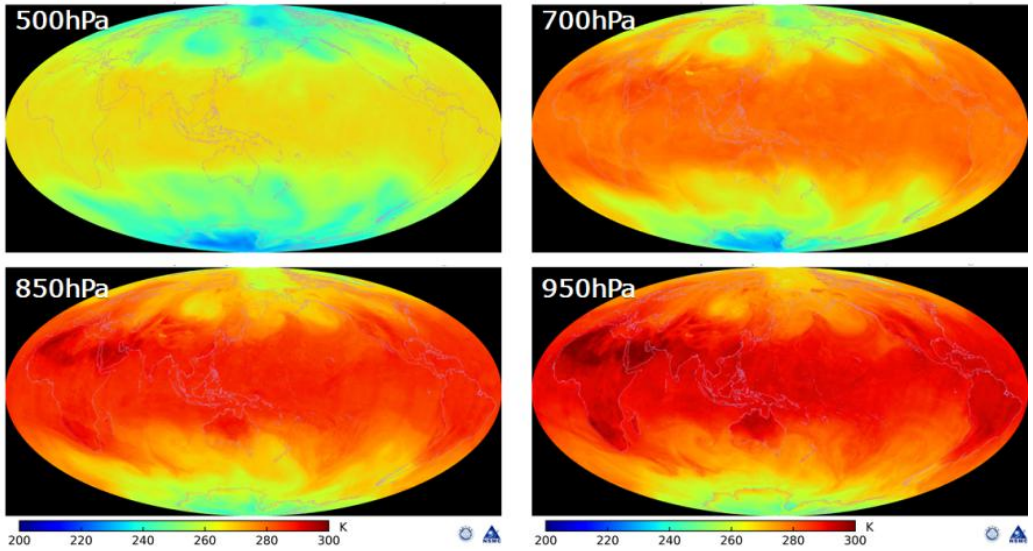


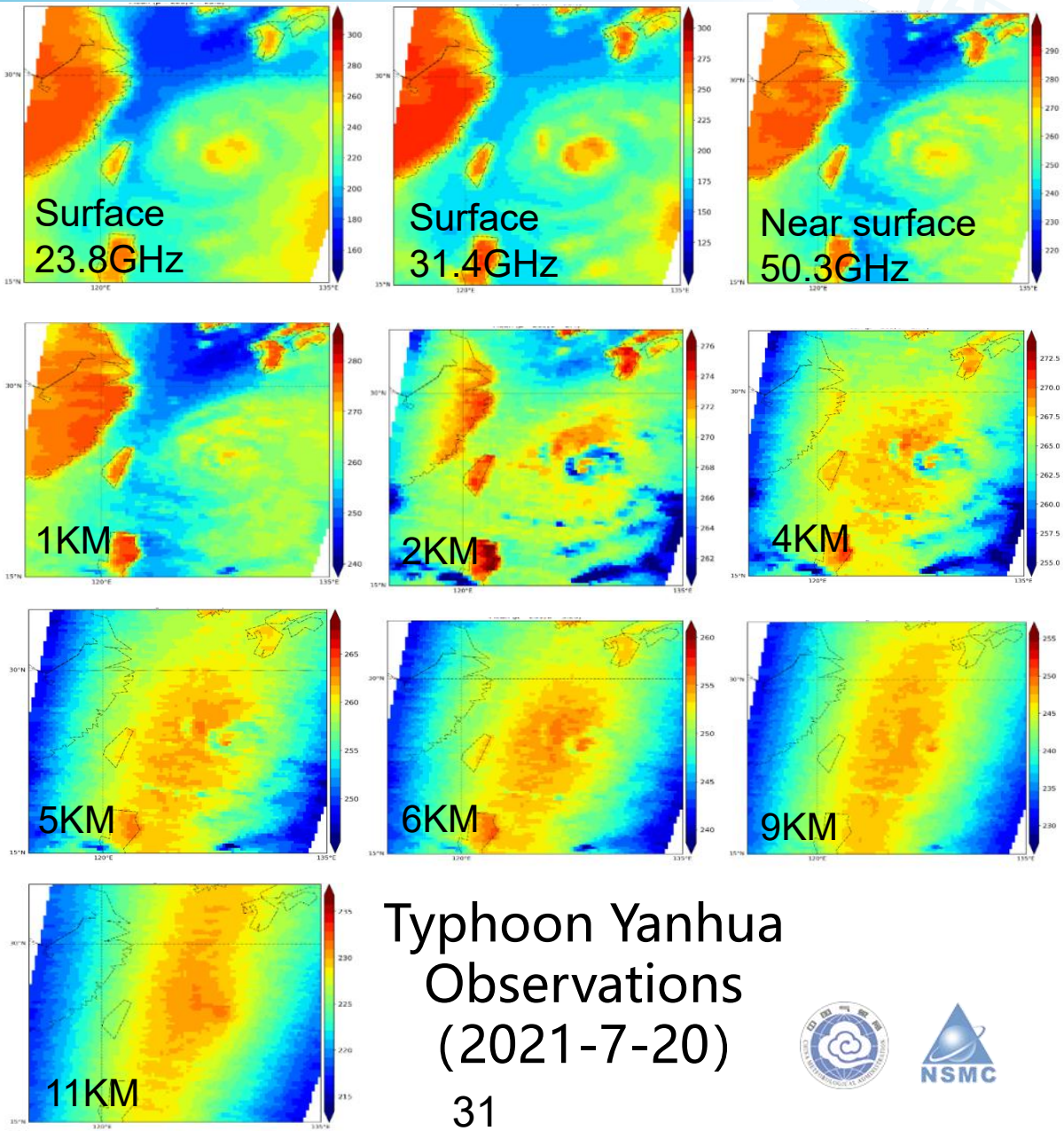
NSMC

Atmos Temperature profile from MWTS-III



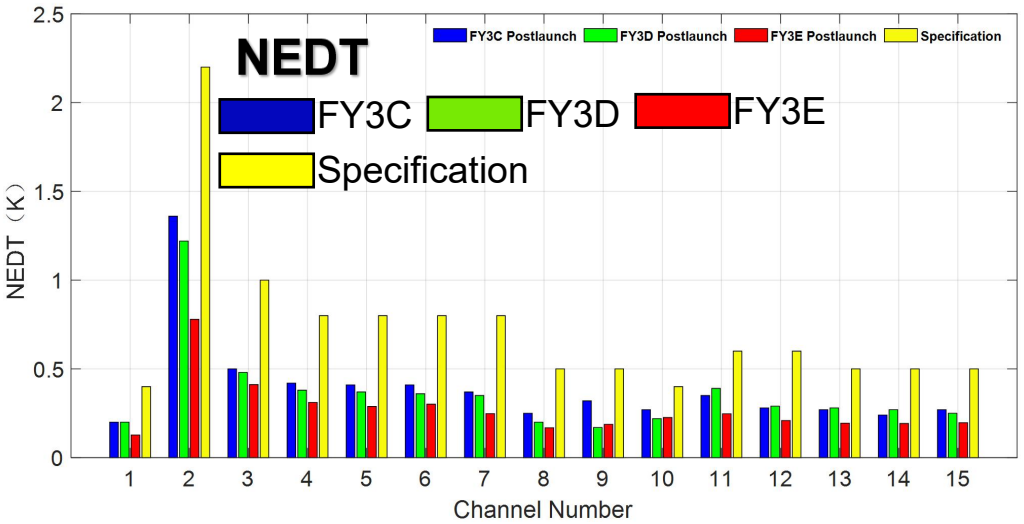
Vertical atmospheric temperature





Typhoon Yanhua Observations (2021-7-20)

Key Specification Test from MWHS-II



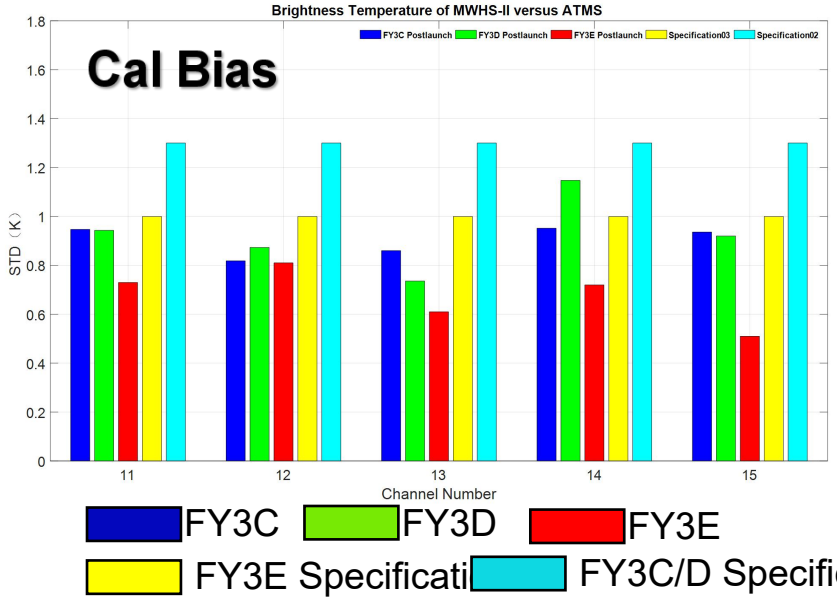
The noise equivalent delta temperature (NEDT) of MWHS-II onboard FY-3 indicates the performance of MWHS-II has been improved gradually from FY-3C to FY-3E

The standard deviations for FY-3E five humidity sounding channels are less than 1K.

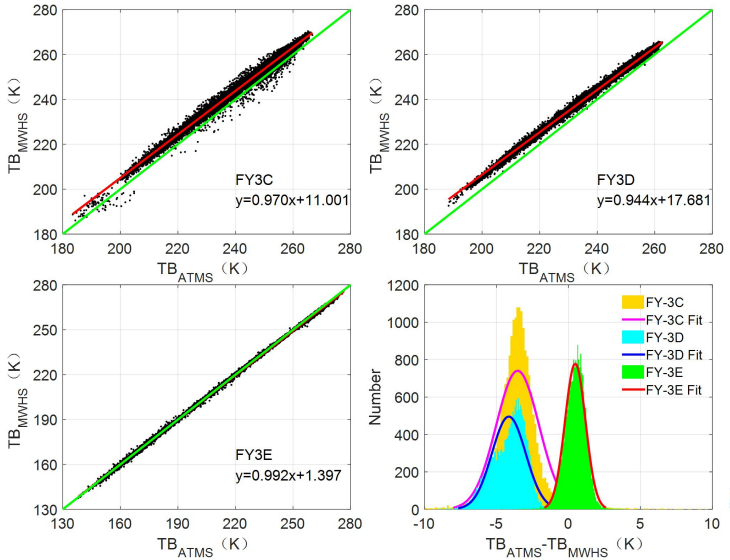
FY-3C/3D：
-3.58K/-4.13K

FY3E： 0.46K

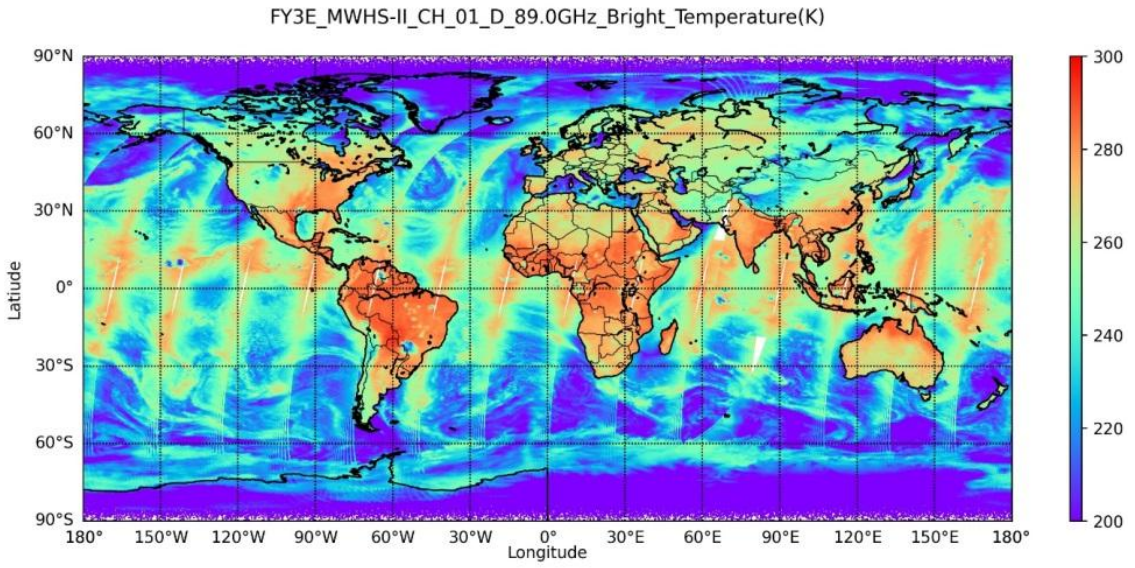
SNO results with ATMS

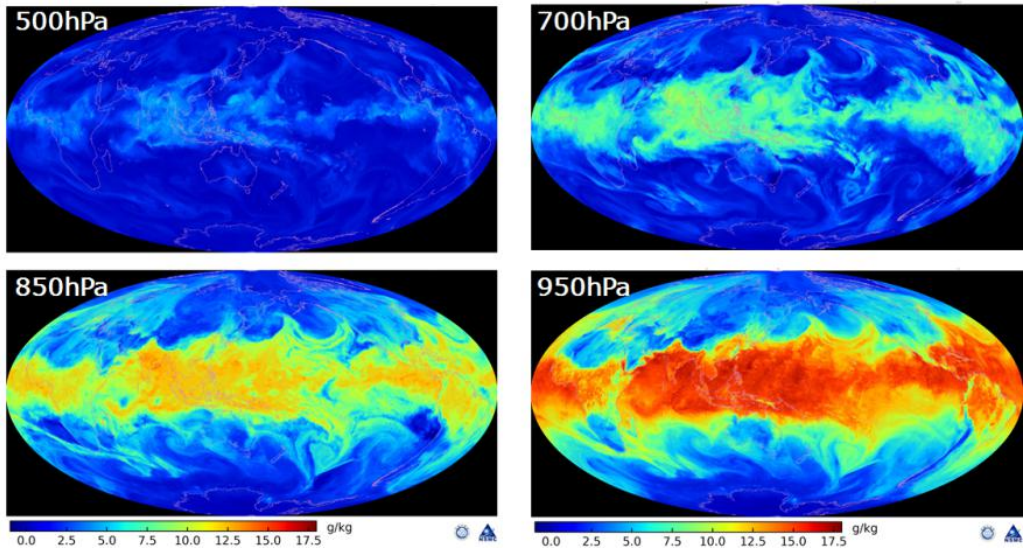


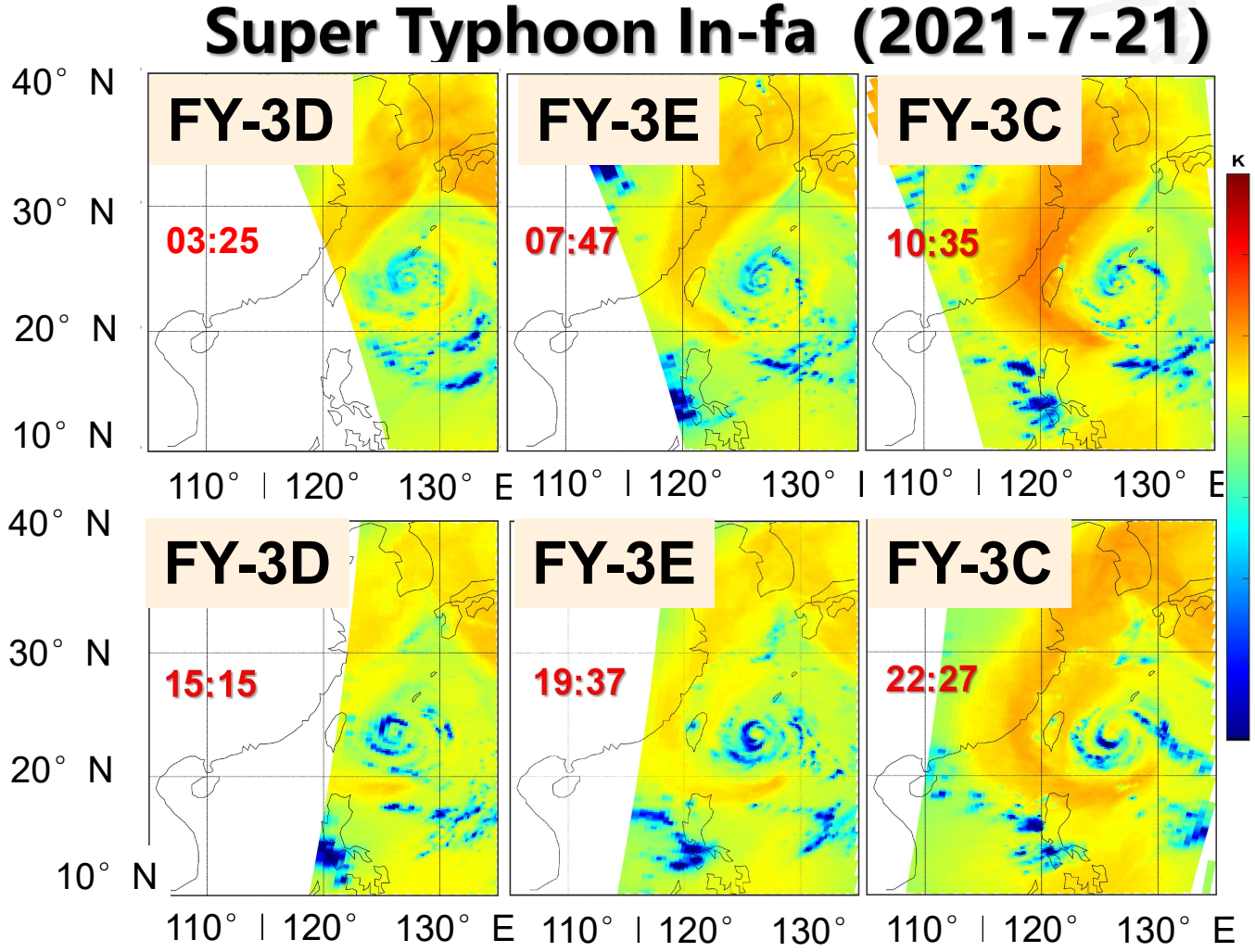
MWHS-II .VS. ATMS @ 183.31±4.5 GHz



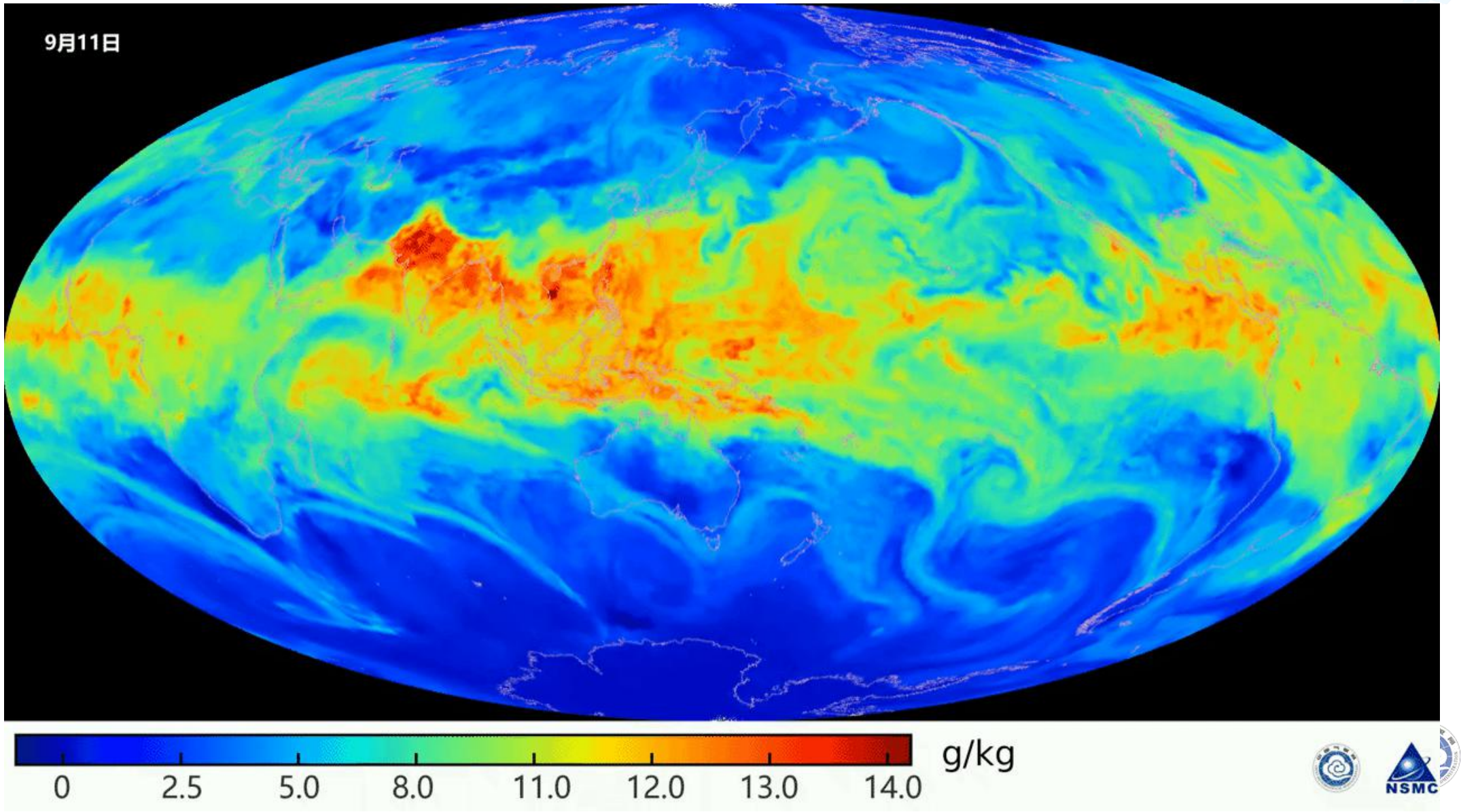
Atmos Humidity from MWHS-II





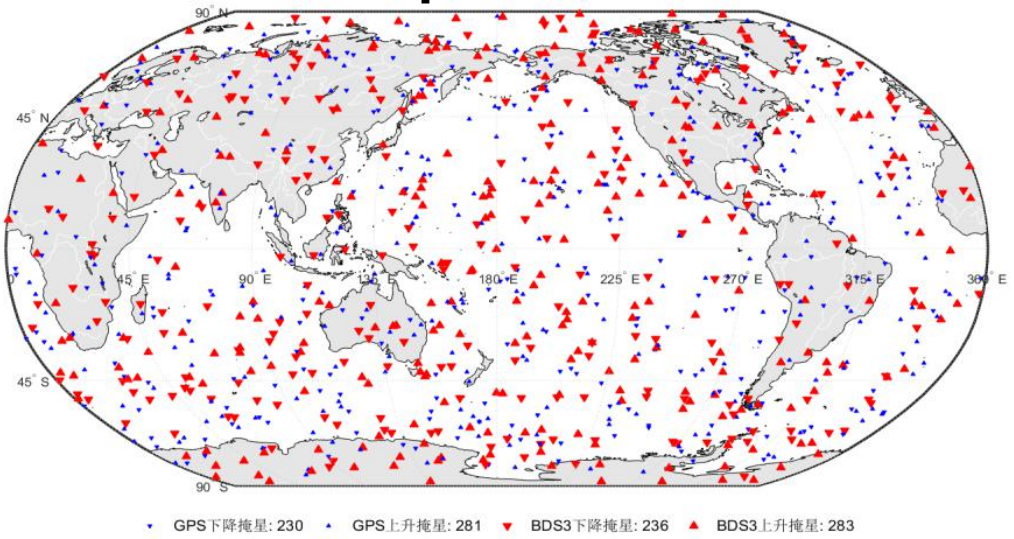


FY-3E Atmos Humidity Animation(Sep. 11-26, 2021, 850hPa)

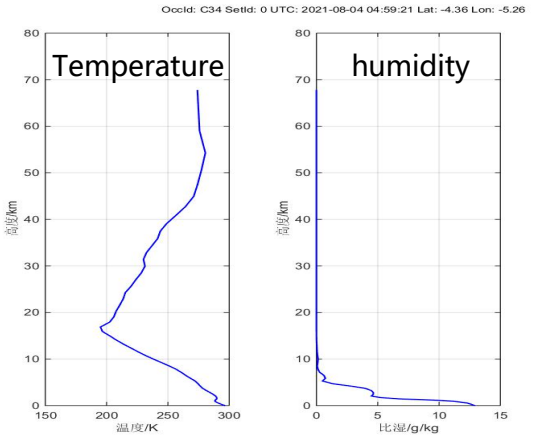


Atmos Profile and Sea Wind from GNOS-II on FY-3E

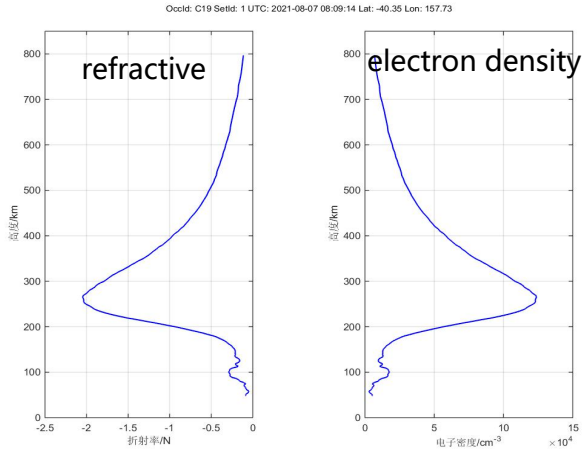
GNOS-II ionospheric RO distribution



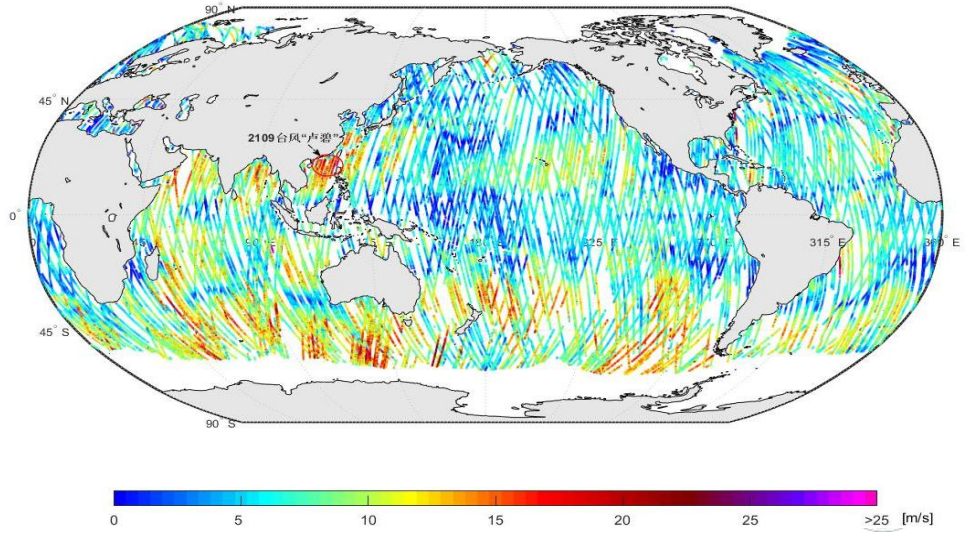
Atmospheric profile



Ionospheric profile



Sea Wind(20210802-0807)



- GNOS-II received navigation signals from Beidou 3 for the first time on the basis of GPS and Beidou 2 signals, and the total number of occultation in FY-3E was more than two times that in FY-3D.
- More than 500 GPS atmospheric occultations and more than 500 BDS atmospheric occultations can be observed every day, and about 1000 atmospheric profiles can be provided for numerical weather prediction operation and more than 1000 ionospheric profiles for space weather operation every day.

NSMC

WindRAD ON FY-3E

Four antennae (two polarization of each frequency) of WindRAD rotate slowly around the vertical axis of spin platform, and each pixel within the swath will be illuminated from more azimuth directions than current scatterometers due to the low rotation rate. It is the first dual frequency and dual polarization radar.

- Better spatial resolution than other scatterometers;
- High wind retrieval capability ;
- Nearly all-weather capability .

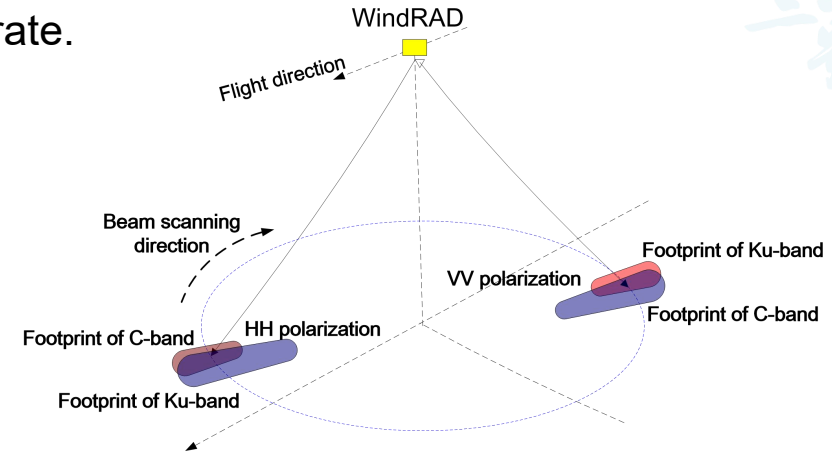


Table WindRAD required Specification

Parameter	Metric	
Frequency	5.4 GHz (C band)	13.256 GHz (Ku band)
Polarization	VV、HH	VV、HH
Spatial resolution (azimuth×range)	25 ×0.5km	10 ×0.5km
Swath	> 1200km	
Scanning mode	360° conical scanning	
Minimum detectable wind speed	3 m/s(-26.2dB)	3 m/s(-30.8dB)
Radiometric resolution	0.5dB (wind speed≥5 m/s) 1.0dB (wind speed = 3 m/s)	
Radiometric accuracy	≤ 0.6dB	

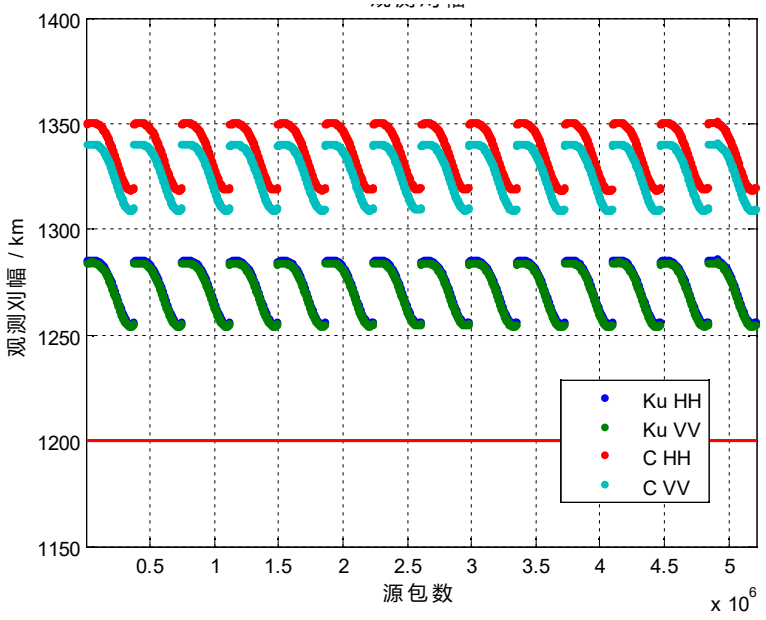
Table WindRAD Specification compared with others

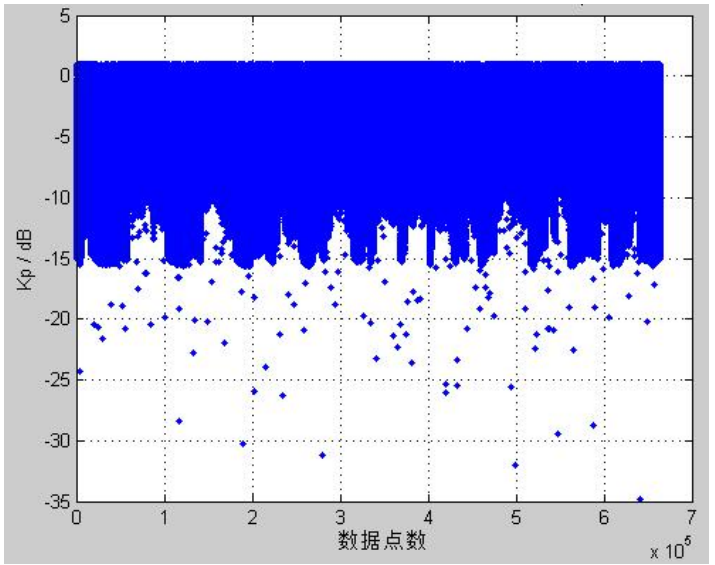
Payloads	Operator	band	polorization	Scanning System	Swath	Spatial Resolution
QuikSCAT SeaWinds	NASA/JPL	Ku	VV/HH	Pen beam conical scanning	1600km	25km
ASCAT	ESA	C	VV	Fixed fan beam	550km×2	Standard Quality:25km
WindRAD	**NSMC,CMA**	**Ku/C**	**VV/HH**	**Cone beam scanning**	**1200km**	**C-band:25km Ku-band:10km**

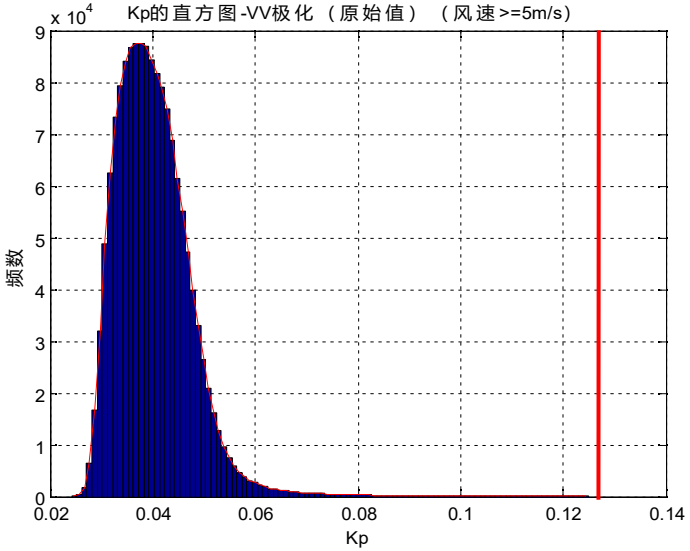
WindRAD in-orbit test

Important metrics test results

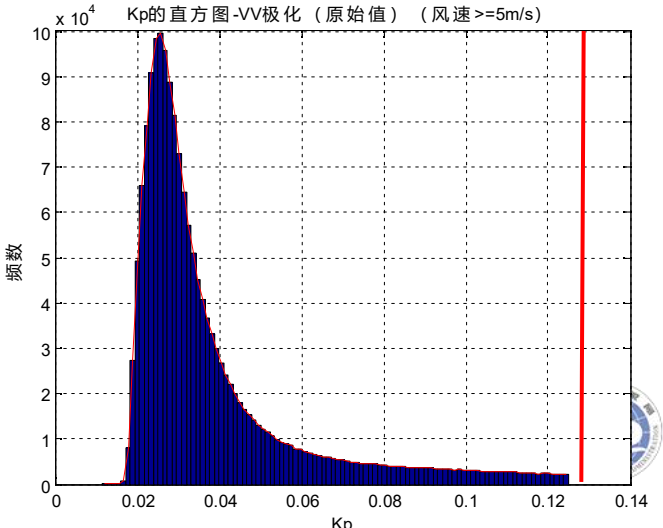
Swath | Minimum detectable wind speed | Radiation resolution







←C



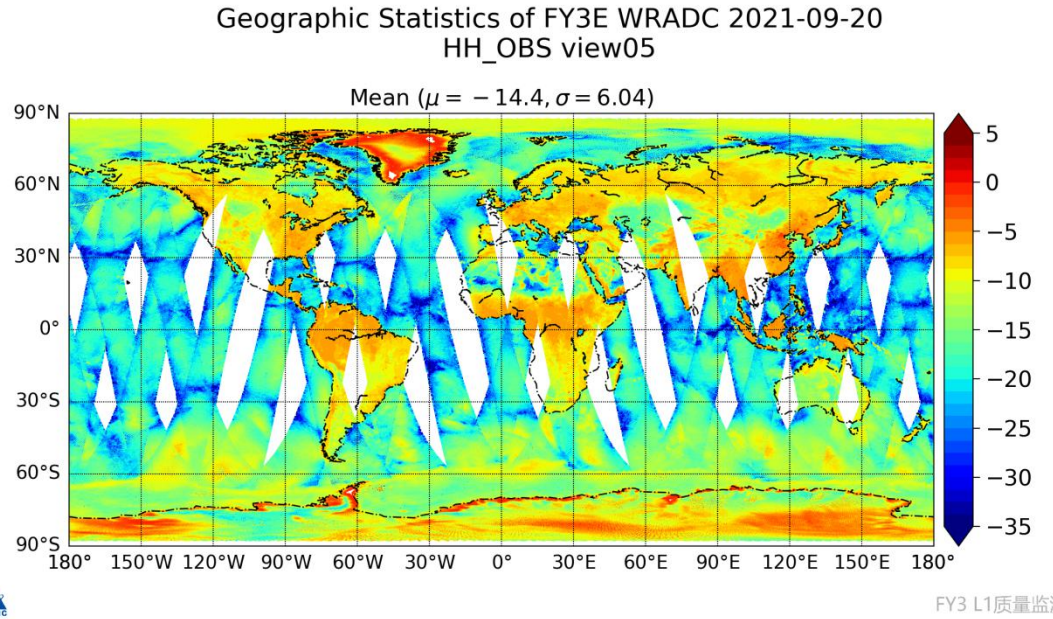
←Ku

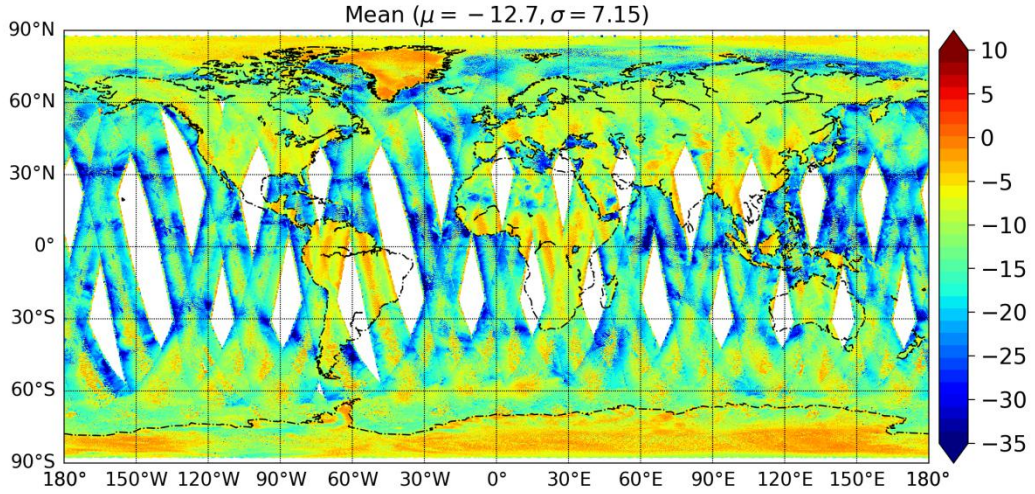
Item	Swath
C-band	HH：1337km VV：1327km
Ku-band	HH：1273km VV：1272km

Frequency	Proportion of data better than 3 m/s	
C 20km grid	HH	72.35%
	VV	70.46%
Ku 20km grid	HH	87.07%
	VV	89.59%

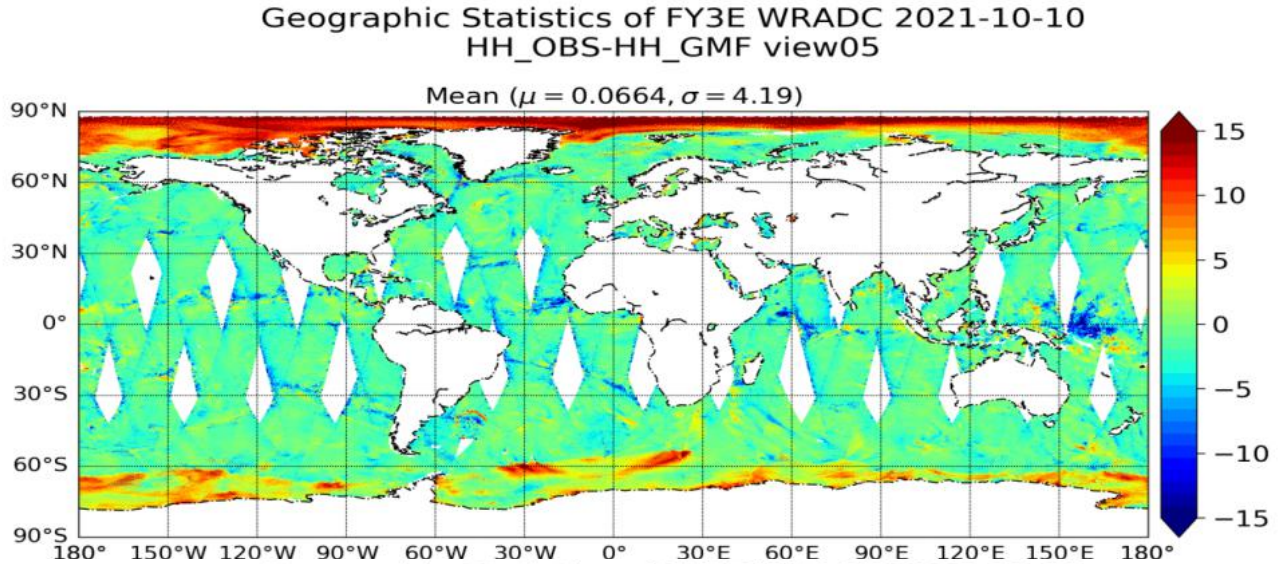
WindRAD in-orbit test

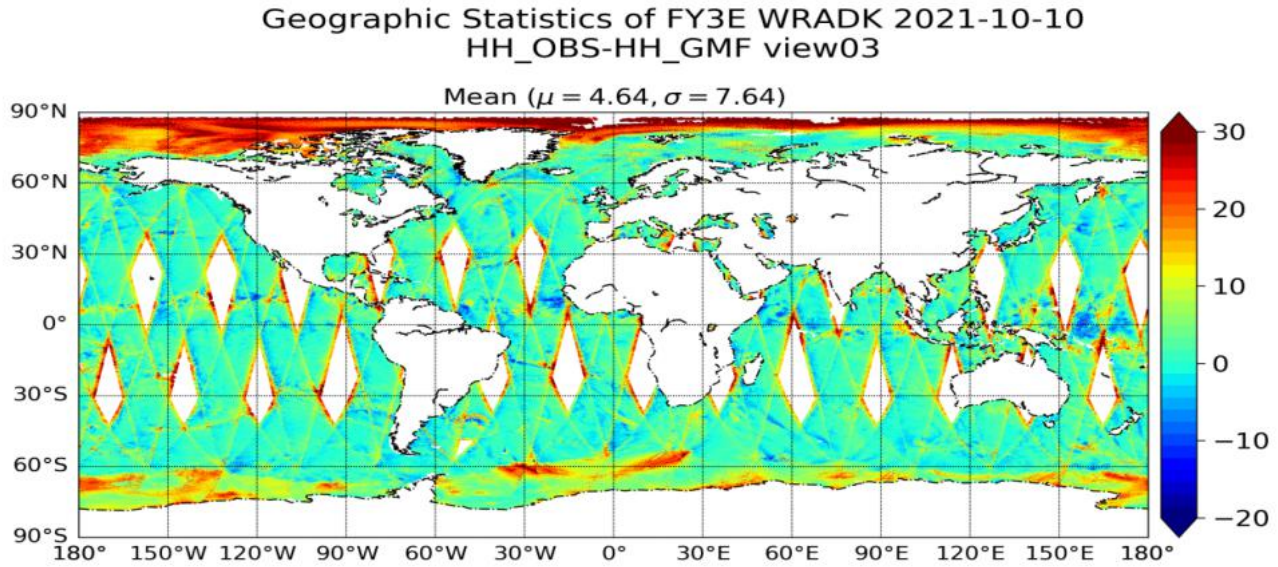
L1 product – backscattering coefficient



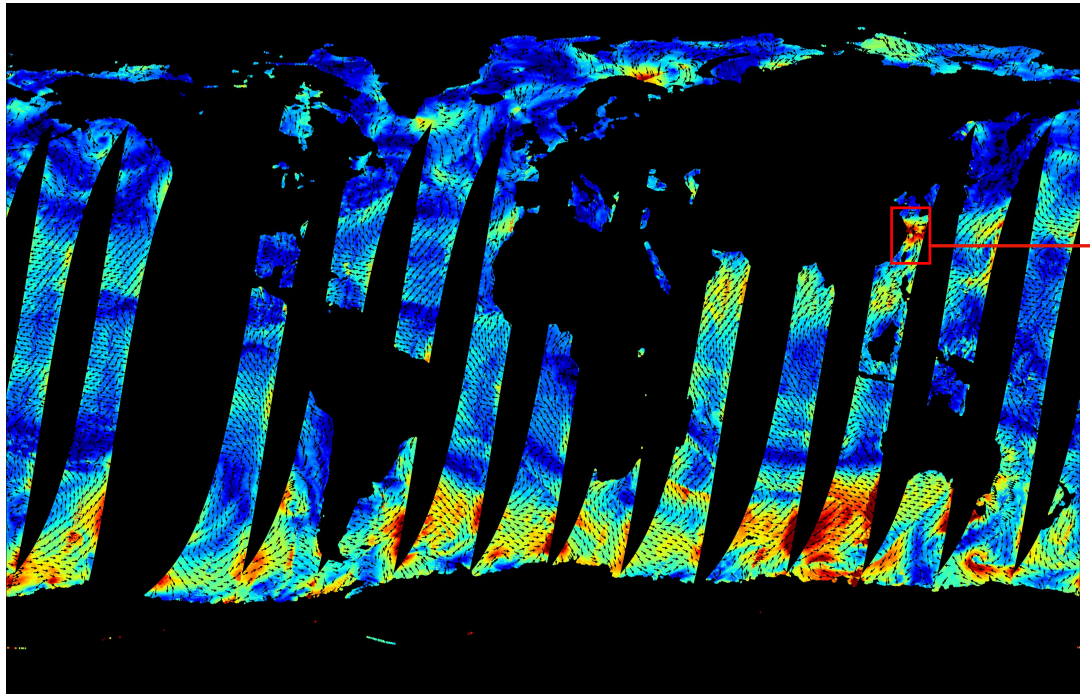


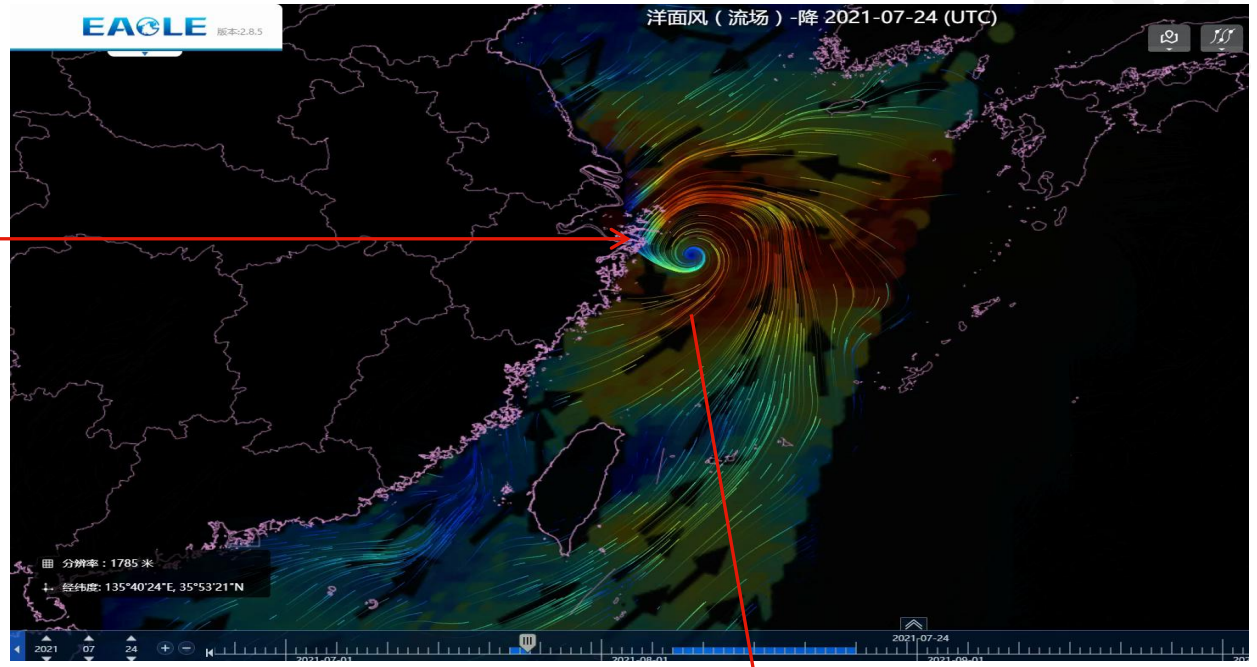
O-B result

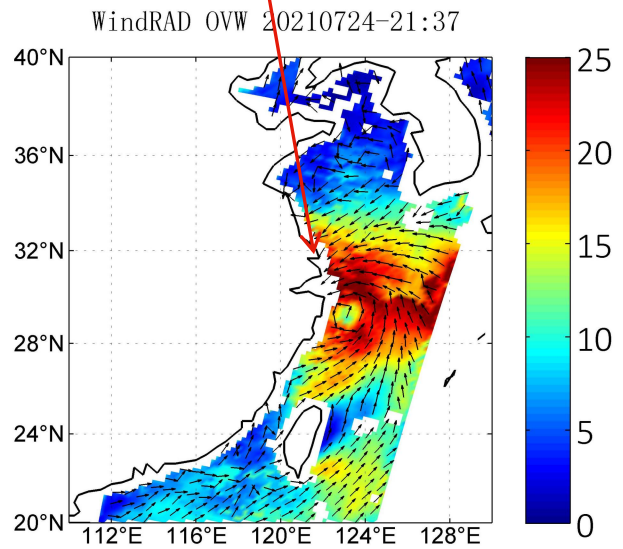




WindRAD sea surface wind product



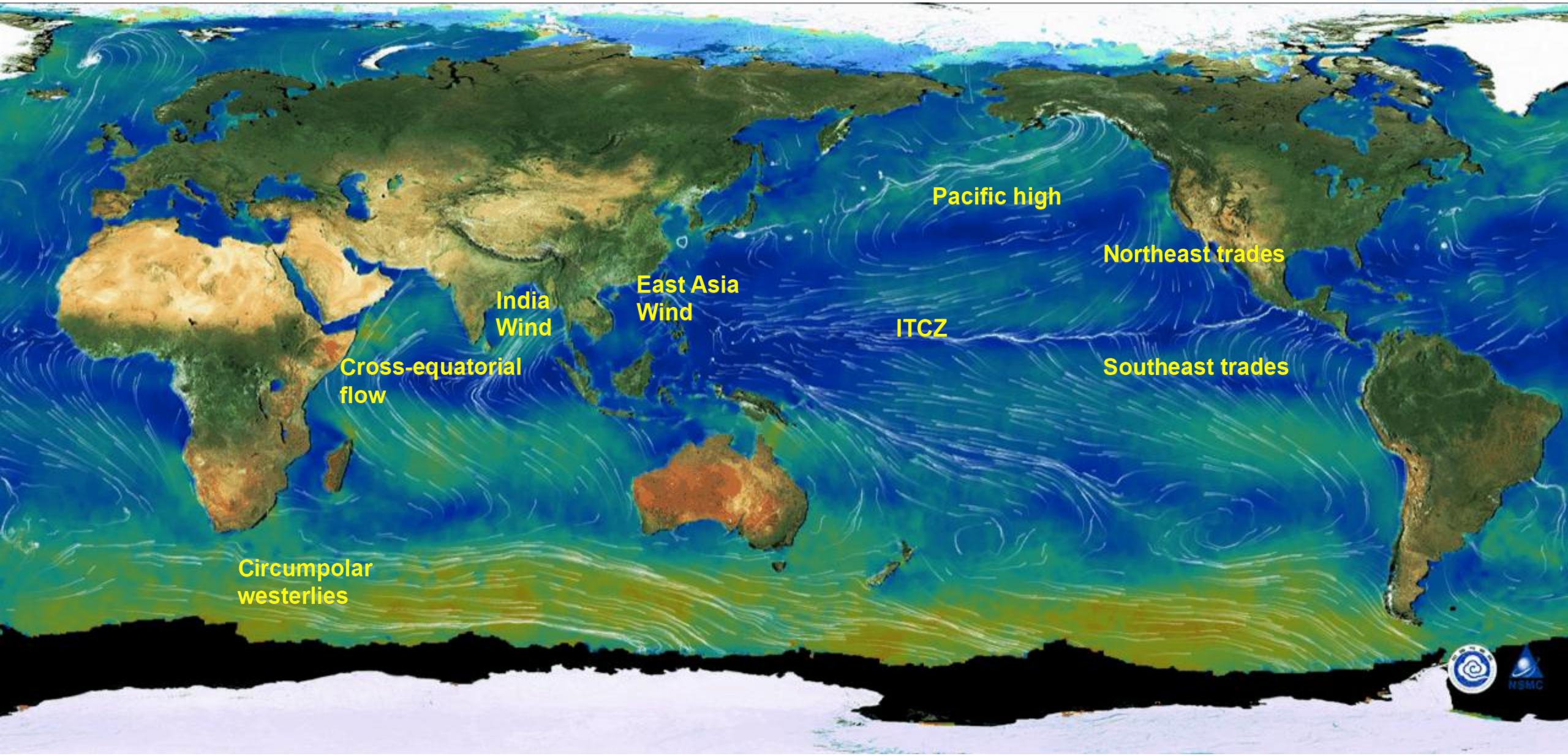




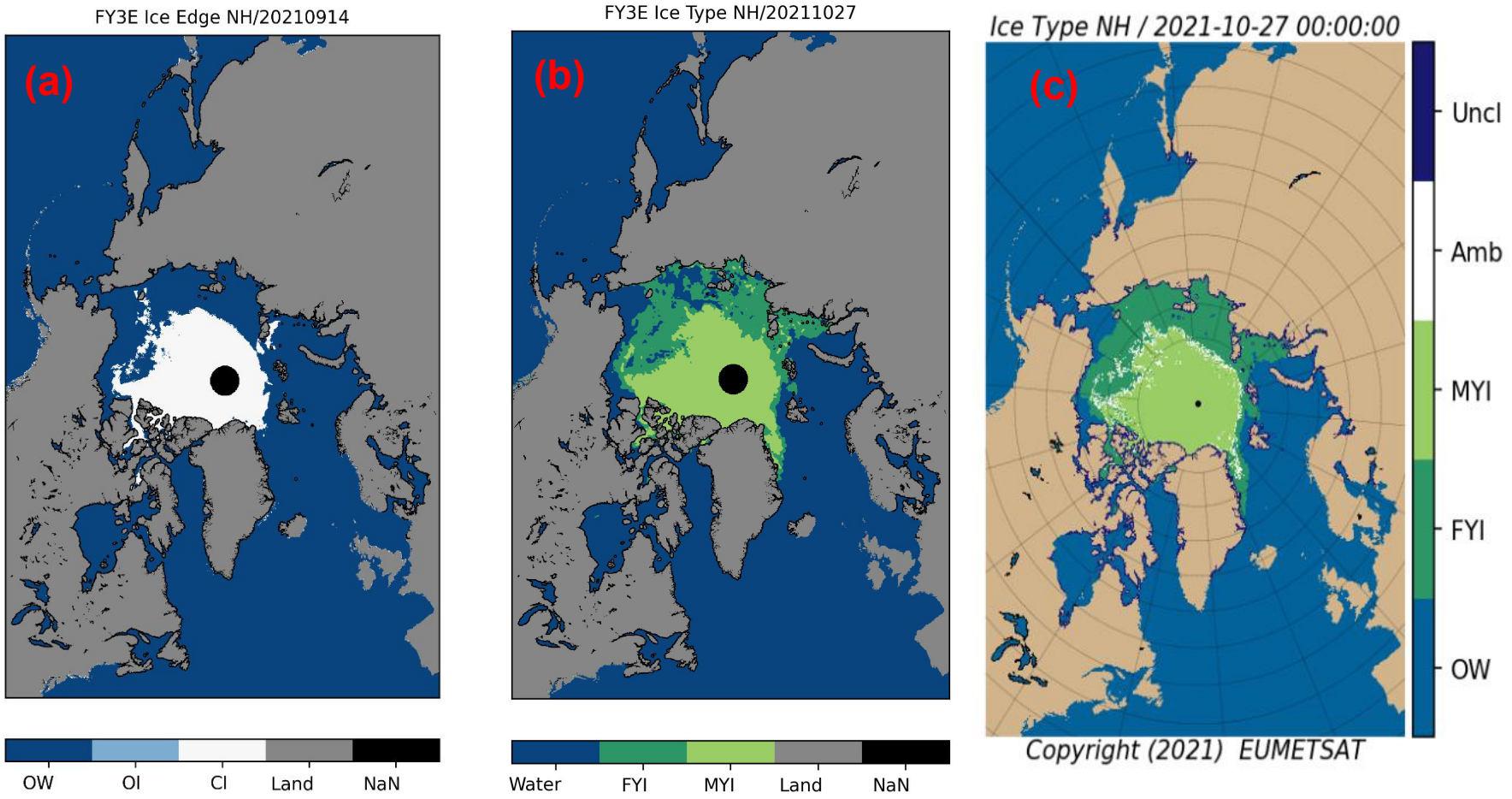
The global distribution of sea surface wind derived from WindRAD can clearly identify:

- the peripheral gale area of tropical storm "Lupi" in the west of Taiwan Island;
- tropical storm "Yinhe" in the east of Taiwan Island;
- the overall circulation structure of tropical storm "Nida" in the east of Japan island,
- the vortices converging in the Bering Sea of the North Pacific and the North Atlantic,
- polar cyclone systems in the South Atlantic and South Pacific

FY-3E sea surface wind Monthly （September, 2021）



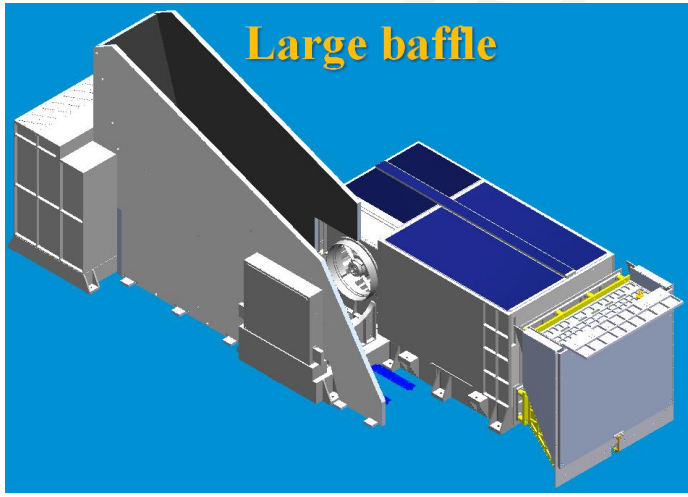
FY-3E WindRAD Arctic sea ice edge and type



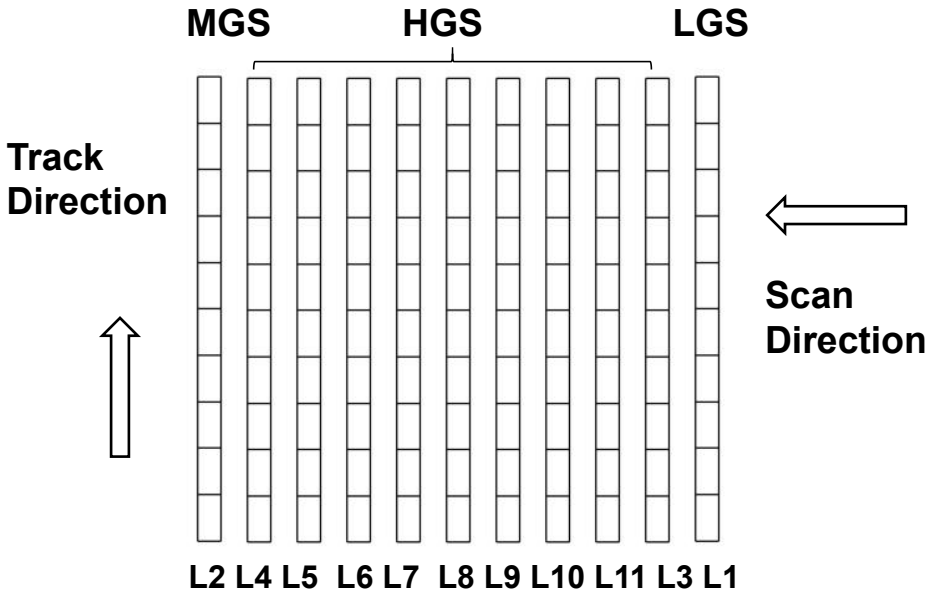
- **Figure (a)**: the 2021 Arcitc **minimum sea ice area** retrieved from WindRAD was likely reached on **Sept. 14.**
- **Figure (b) and (c):** the distribution example of **Arctic sea ice type** (first-year ice and multi-year ice) on **Oct. 27** shows good consistency with OSI SAF sea ice type product.

MERSI-LL, EM Low light Imager With IR bands

- **Predecessor Instruments**: FY-3D/MERSI-II, Inherit all IR bands of MERSI-II.
- **Bands**: six infrared bands following FY-3D, one panchromatic low-light channel with a spectral range of 500-900 nm and one shortwave infrared band(1.24μm).
- **Stray light restriction** is key design for Low light imager on EM orbit.



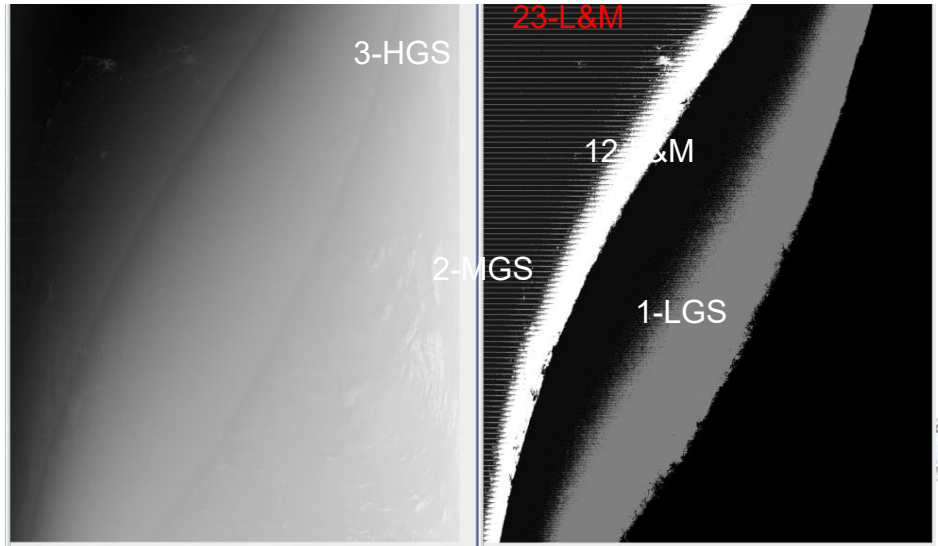
Low-Light band (LLB) Detectors:
Array: 1 line for LGS and MGS, 9 lines HGS



Status

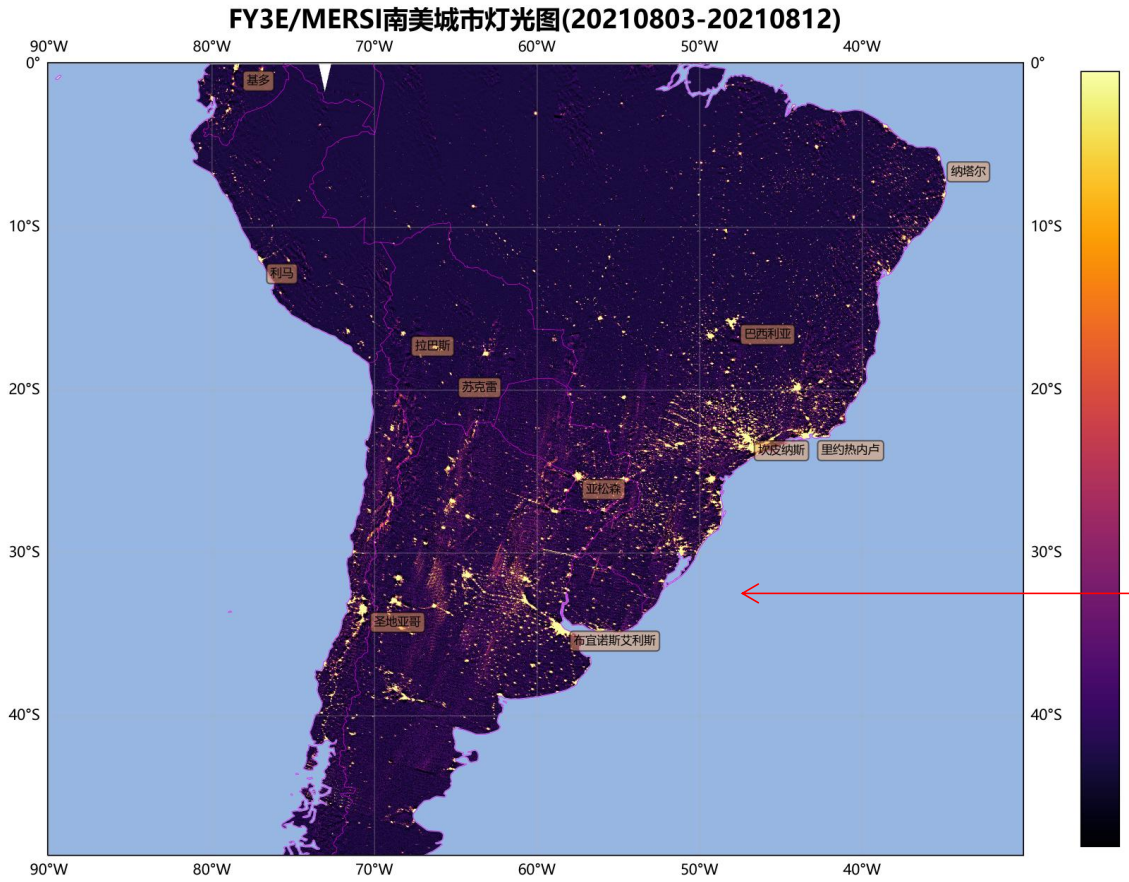
- **Launch**: July 5, 2021
- **RBS actativity**： July 9, 2021
- **IR actativity**： September 7, 2021

Image Normalization using gain transtion region



FY-3E MERSI LLB and IR Images at EM

City Light NTL Product Experiment
Aug. 03--12, 2021



Still stray light remaining....

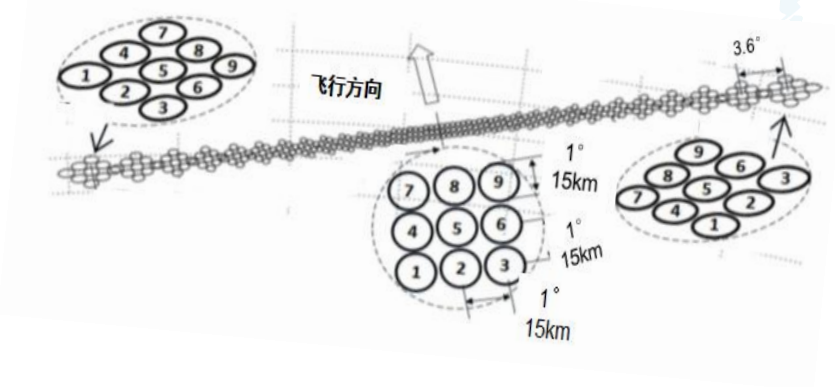
LLB Image August 2, 2021

All IR images are very nice without stray light contamination

HIRAS-II Upgrade from FY-3D HIRAS

- **FY-3E HIRAS-II will have a number of upgrades with respect to HIRAS, including the number of detectors from 4 to 9 per band and a full coverage of the spectral range from 650 to 2550 cm-1 without spectral gaps.**
  - FOVs number: from 2*2 to 3*3
  - FOV size: from 16km to 15km at nadir
  - Space gap between Scans: 10km to ~0km at nadir
  - Detector response uniformity: more uniform
  - Scan duration: from 10s to 8s
  - Sweeps Number: from 33 to 32 Scenes on each scan.
  - Filling Spectral gap：three bands are overlapped with no gap
  - NEDT：Increased markedly, especially for MW/SW bands
  - Absorbing gel gas issue was fixed and avoid response degradation
  - Blackbody accuracy: increase phase cell temperature traceability

■ **FOVs number: 2*2 --> 3*3**



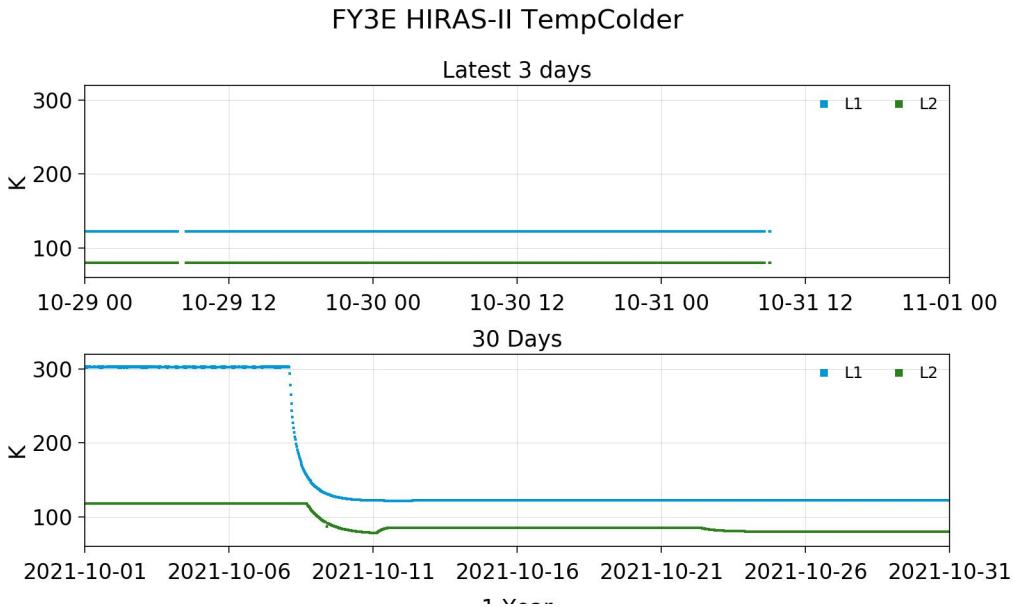
Band	Spectral range (cm-1)	Spectral resolution (cm-1)	NEΔT@280K		Radiometric accuracy min /Expect (K)		Spectral accuracy min/Expect (ppm)	
			FY-3E	FY-3D	FY-3E	FY-3D	FY-3E	FY-3D
LW	650 ~ 1135 (15.38μm ~ 8.8 μm)	0.625	0.2-0.4K	0.4K	0.5K	1K/0.7K	7 ppm/ 5 ppm	10 ppm
MW	1210 ~ 1750 (8.26μm ~ 5.71 μm)	0.625	0.3K	0.7K	0.5K			
SW	2155 ~ 2550 (4.64μm ~ 3.92 μm)	0.625	0.3-0.5K	1.2K	0.5K			

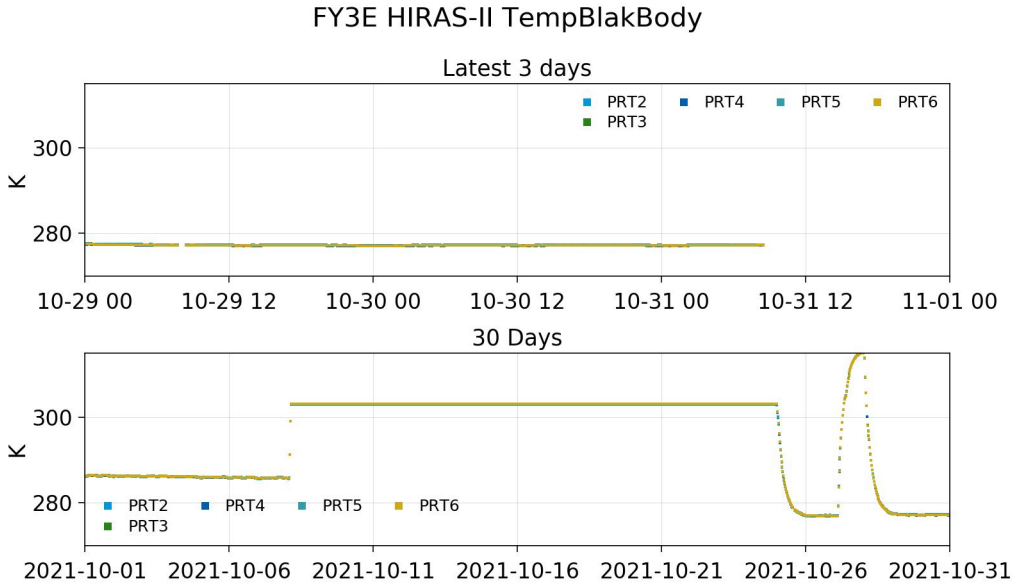
Instrument Specification

Parameters	HIRAS-II	HIRAS(FY-3D)
Scan angle	50.4 Deg	50.4 Deg
Pixels per scan line	28*9	29*4
View angle	1 Deg	1.1 Deg
Nadir spatial resolution	14 Km	16 Km
Scan period	8 s	10 s
Detectors	3 × 3	2 × 2
Pointing precision	0.06 Deg	0.1 Deg
Pointing stability	0.45 Mrad	/

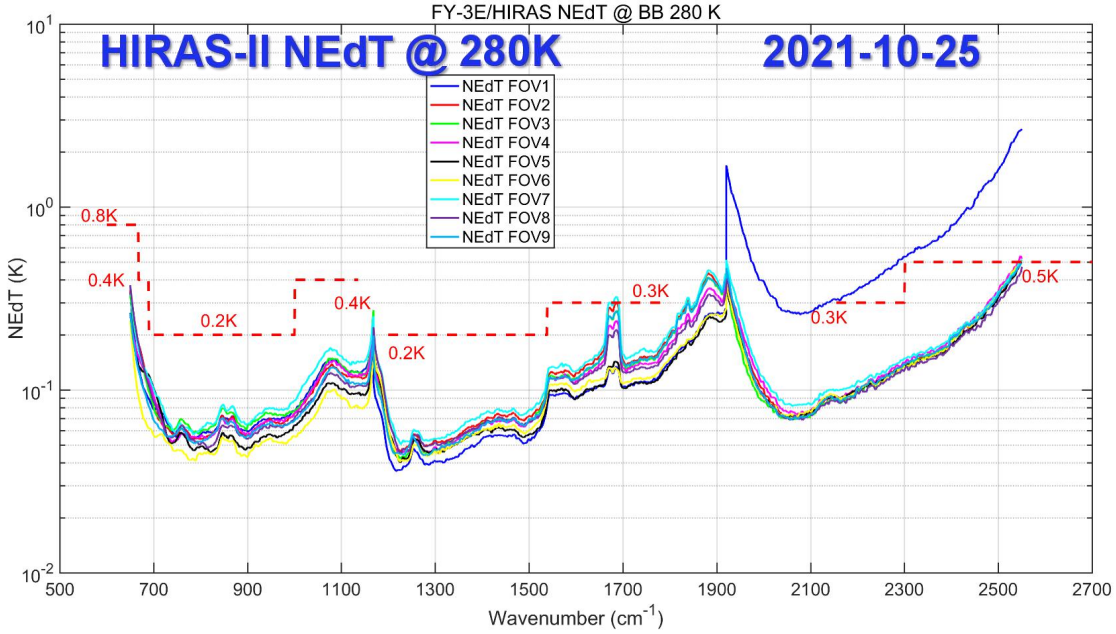
HIRAS-II Instrument Action & Data Processing

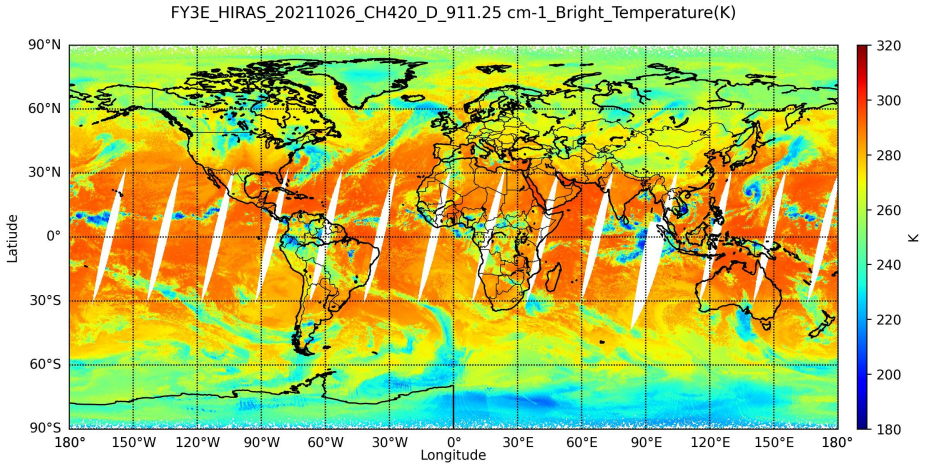
- ✓ July 5 ~ Oct 7,
  - Instrument heating and decontamination
- ✓ Oct. 8 ~ 12,
  - Instrument heating off,
  - ICT temperature control, instrument temperature set at 10
  - Radometric cooler temperature control activated.
- ✓ Oct. 13 ~ 21,
  - HIRAS infrared detectors and Interfermeter powered on
  - Telemetry parameters check, IGM check
  - Interferometer fixed-mirror alignment, ZPD position tuning
  - Ground processing system began running.
- ✓ Oct. 22~ 28,
  - 2nd radometric cooler temperature control off
  - ICT temperature control off, temperature cooled down
  - ICT built-in Gallium Cell phase change fixed point Test
- ✓ Nov. 1~ Dec 31,
  - SDR Processing Parameter modification
  - Characterization Full On-orbit test
  - L1 data provisional





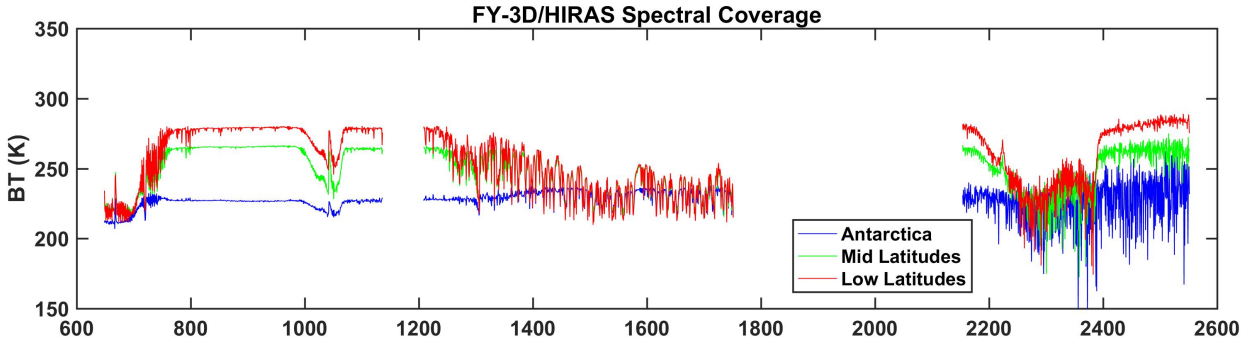
Day-1 Spectrum and NEdT

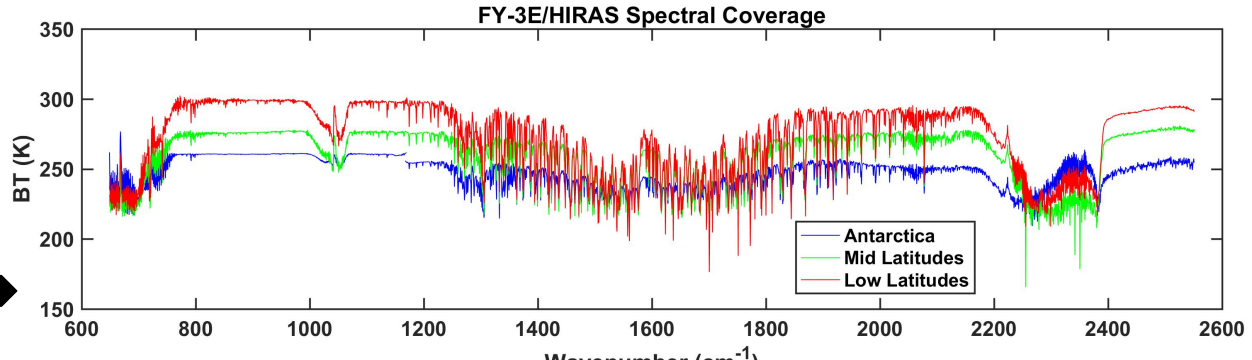




FY-3E/HIRAS Global BT and Typeical Spectrums➔

- HIRAS-II NEdT is well improved than that of FY-3D/HIRAS.
- HIRAS-II noise levels were comparable to CrIS and IASI in LWIR band, while in MWIR and SWIR bands are still higher.
- NEdTs meet requirements in all three spectral bands, except abnornal FOV1 of SW band .
- NEdT in 1700 cm^{-1} nearby channels are slightly higher than others, which may be caused by the electronic crosstalks, still in investigating.

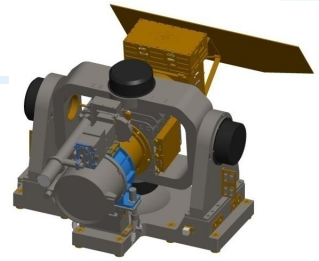




Solar and Space Weather Instruments

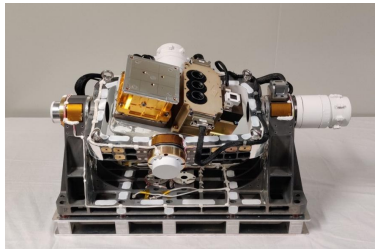
Solar X-EUV Imagers (X-EUVI)

The effective combination of the EUV imaging and X-ray imaging is beneficial to better understand the solar eruption process, so as to provide more accurate references to space weather forecast. FY-3E/X-EUVI is a 6-channels radiometer, five in X-ray and one in EUV at 19.5 nm (Fe-XII) .



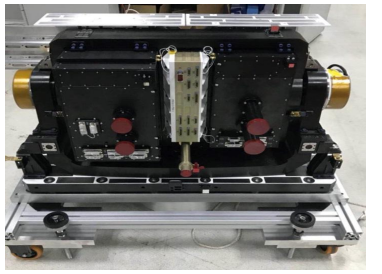
Solar Irradiance Monitor-II (SIM-II)

Solar Irradiance Monitor-II (SIM-II) is designed to measure the total solar irradiance (TSI) with solar irradiance absolute radiometer (SIAR) detector and international DARA payload from PMOD at the same satellite



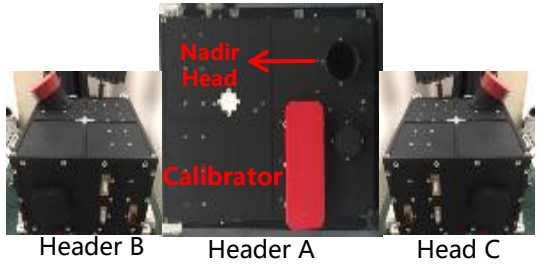
Solar Spectral Irradiance Monitor (SSIM)

Solar Spectral Irradiance Monitor (SSIM) is a new developed spectrometer measuring the solar spectral irradiance from 165nm to 1650nm for recording spectral character of solar energy change and providing high accuracy continuous data for solar, atmospheric and climate research.



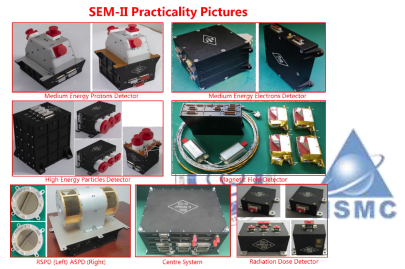
Triple Ionospheric Photometer (Tri-IPM)

Triple Ionospheric Photometer is used to remote sensing the ionospheric environment and neutral atmospheric composition with the triple angles (nightside-nadir-daytime side) which make it more unique observation with respect to the FY-3D/IPM. Observations from IPM can also be used to correct the inversion errors of radio occultation. In the polar region, IPM can be used to determine the boundaries of auroral oval.



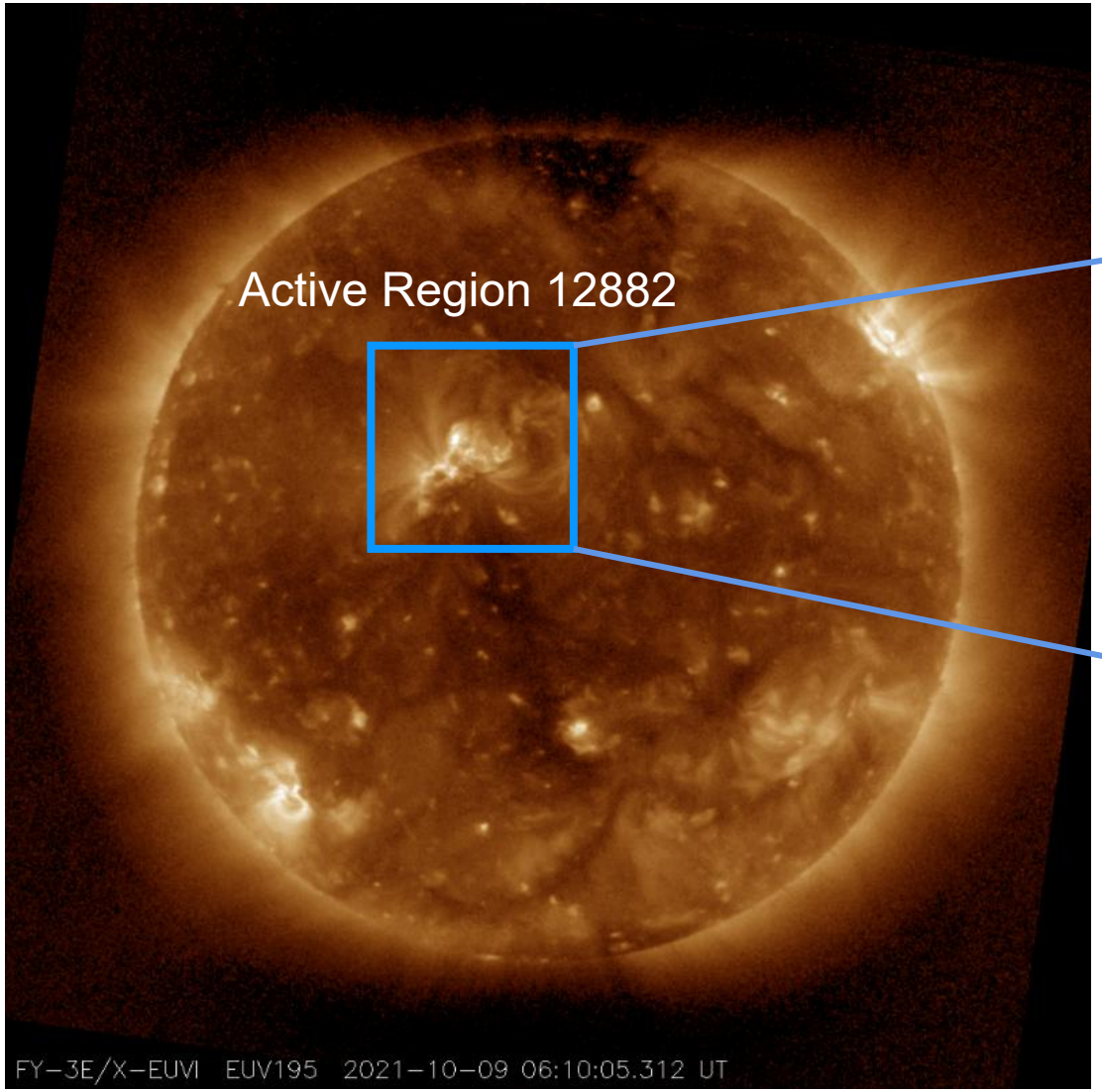
Space Environment Monitor II (SEM-II)

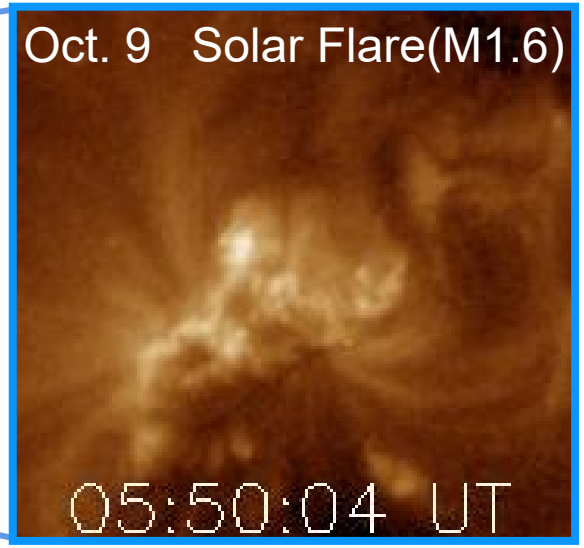
FY-3E SEM package contains Energetic Particle Detector (EPD), Radiation Dose Detector(RDD), Surface Potential Detector (SPD) and Magnetic Field Detector (MFD). The MFD is a new instrument for the FengYun-3 series satellites.



X-EUVI Applications: Solar Flares & Active Regions

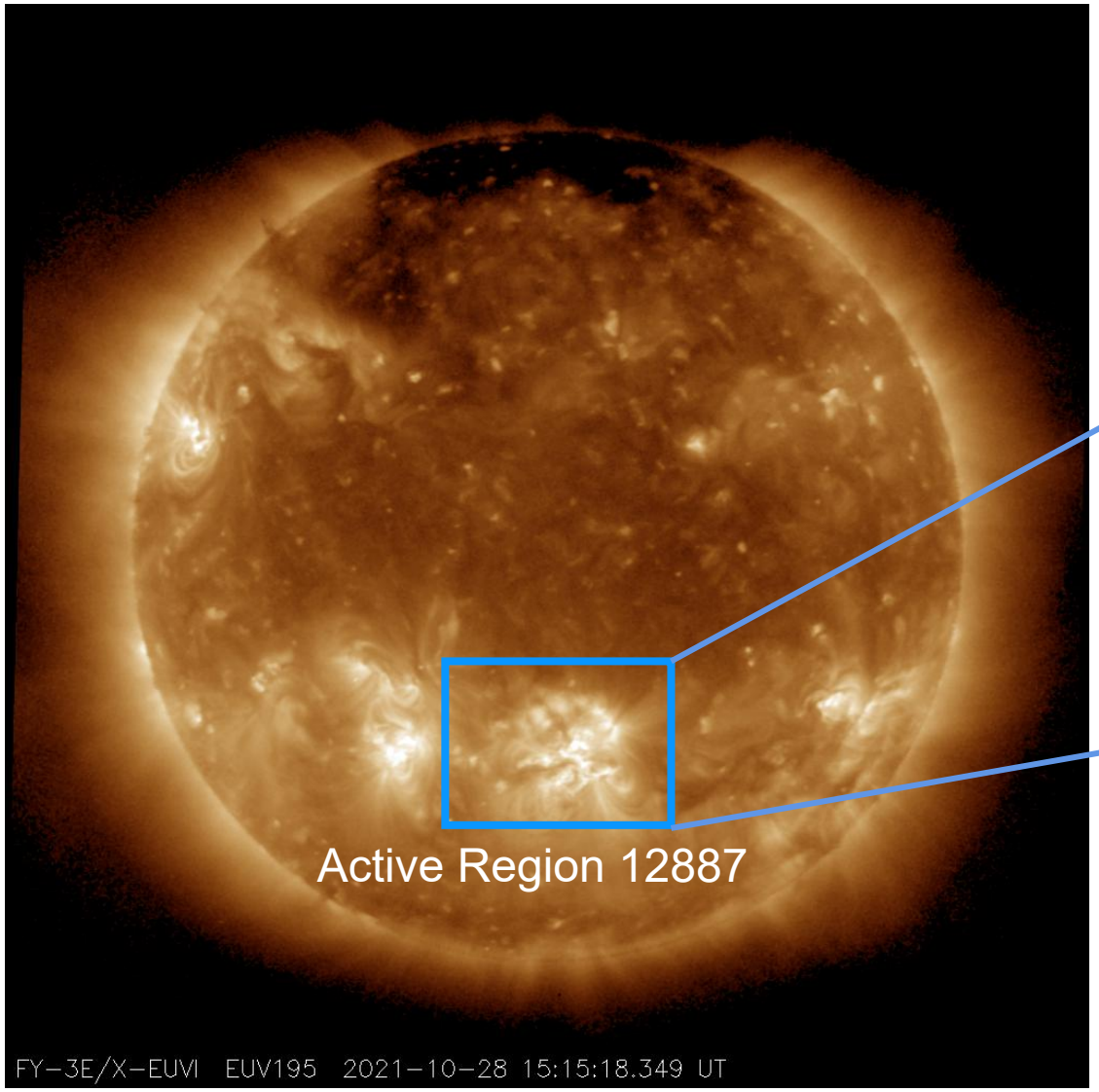
Monitoring our star: the sun is the main source of space weather



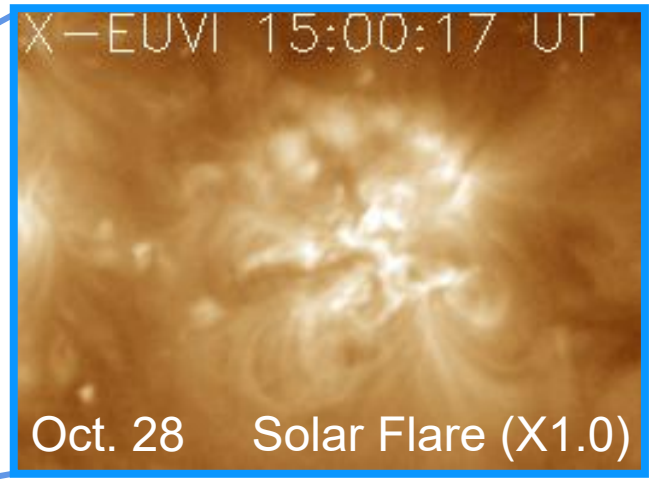


HF Radio,
Navigation …

X-EUVI Applications: Solar Flares & Active Regions



Monitoring our star: the sun is the main source of space weather



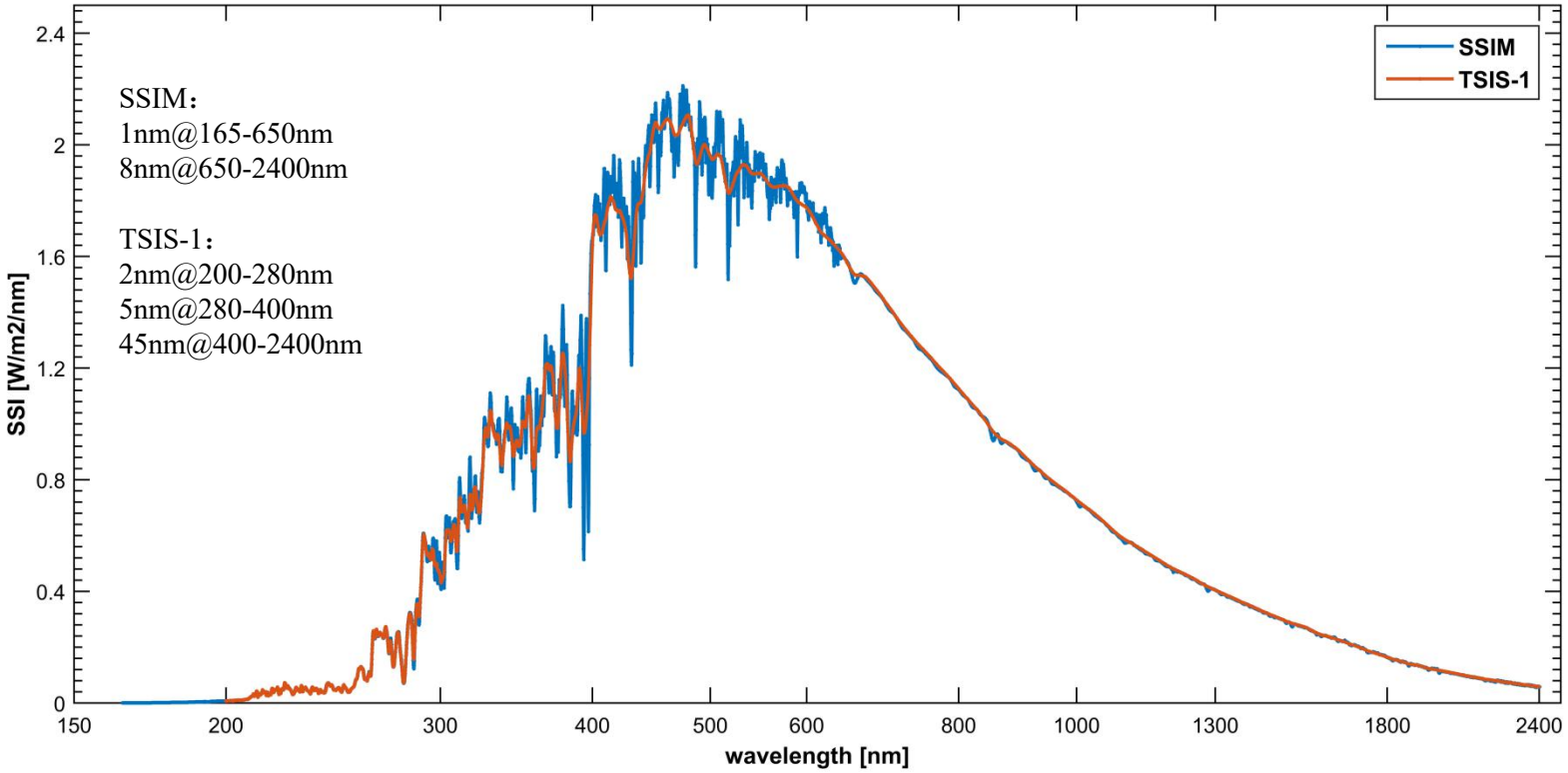
HF Radio, Navigation…

Solar Spectral Irradiance Sample From SSIM

Solar Spectral Irradiance Monitor (SSIM)

Solar Spectral Irradiance Monitor (SSIM) is a new developed spectrometer measuring the solar spectral irradiance from 165nm to 1650nm for recording spectral character of solar energy change and providing high accuracy continuous data for solar, atmospheric and climate research.

Solar Spectral Irradiance observation from SSIM and TSIS-1, 28/9/2021



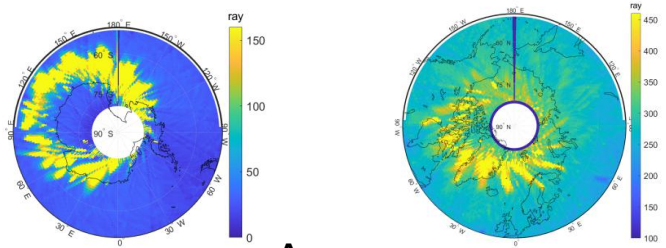
Tri-Ionospheric PhotoMeter(Tri-IPM)

- Topside airglow sounder with three direction (detect day-twilight-night glow simultaneously) with High sensitivity
- Tri-IPM measures OI 135.6 nm and N2 LBH airglow emission and aurora features

Parameters	Function Requirement
Direction	0°,+30°,-30°
FOV	~3.5°(X direction)×1.6°(Y direction)
Wavelength	Oxygen Airglow： 135.6 nm
	Nitrogen Lyman - Birge - Hopfield (N2 LBH) bands：150-170nm
Dynamic Range	0.1R-10000R
Sensitivity	Daytime/twilight airglow：≥1 counts/s/Rayleigh
	Nighttime airglow：≥150 counts/s/Rayleigh（@135.6nm）
Spatial Resolution	~30 km(@300km)

North Pole

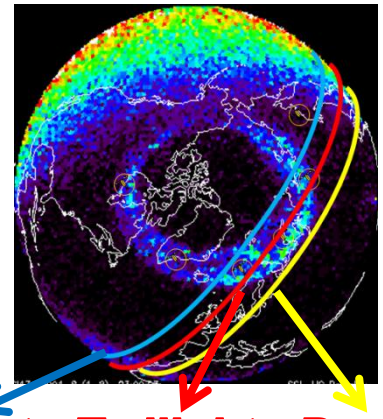
South Pole



Aurora

➢How are Tri-IPM measurements used?

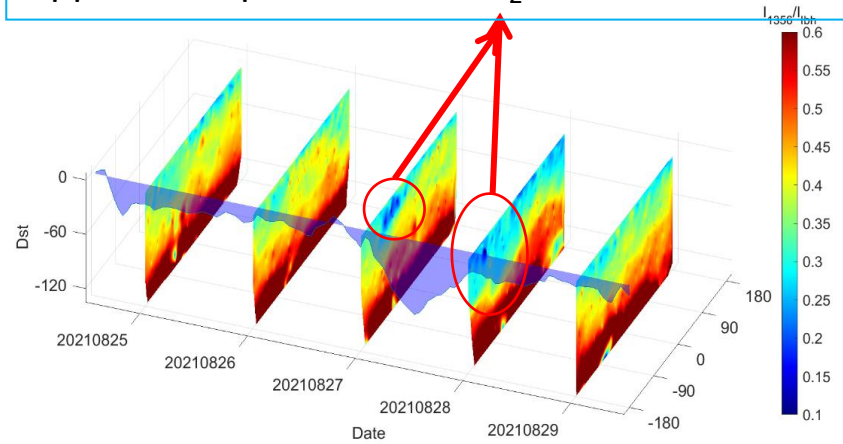
- Ionosphere/Thermosphere morphology
- thermospheric composition O/N2 estimates
- Ionospheric gradients
- TEC/NmF2 estimates
- GNSS-TriIPM joint retrievals

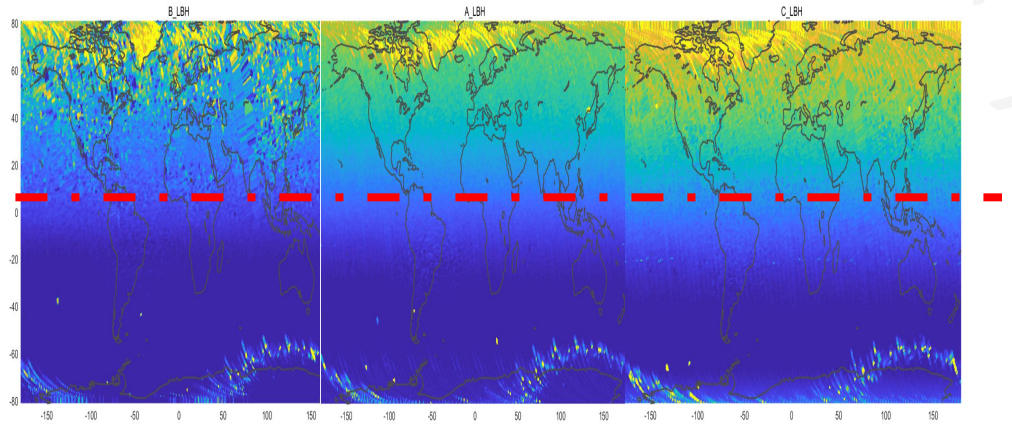


Night- Twilight- Day Headers

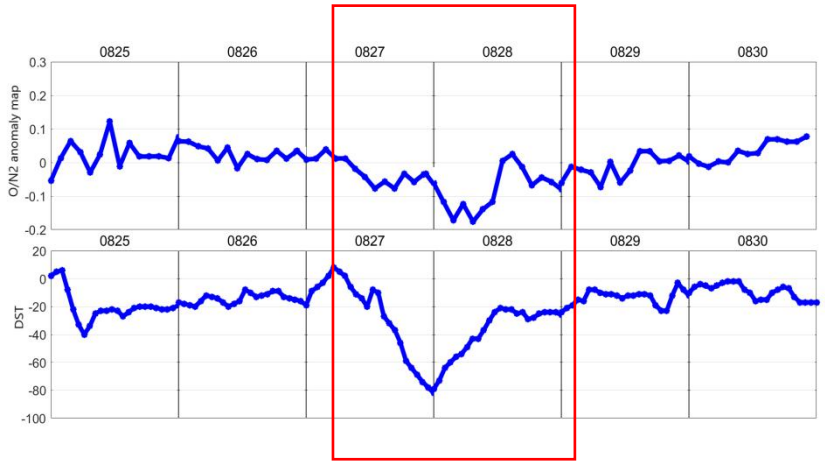
Tri-Ionospheric PhotoMeter(Tri-IPM)

Apparent depletion of O/N_2 with Dst down to -82

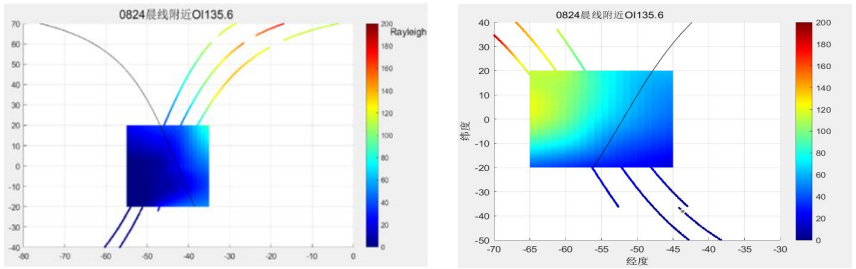




Airglow map with different sensor
(Tri-IPM has three sensors with different local time 17:25, 17:40 and 17:55)



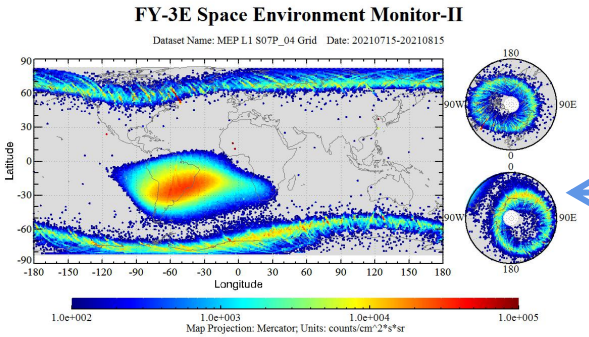
Responses of O/N_2 to geomagnetic storms
(Dst deplet)



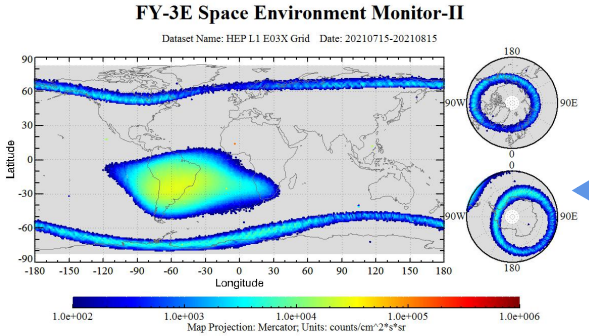
Dayg -Twilight-Nightglow
(Observed at the same time)

FY-3E SEM-II: Typical Products

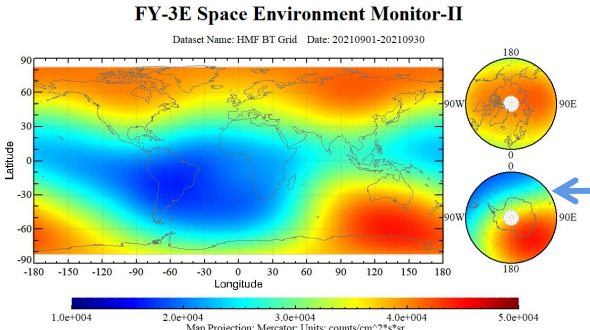
SEM-II can measure the space factors (particles, radiation dose, surface potential, magnetic field vectors, etc.) in situ surrounding FY-3E. The space environment information derived from SEM can be utilized for satellite security designs, scientific studies, development of radiation belt models, and space weather monitoring and disaster warning.



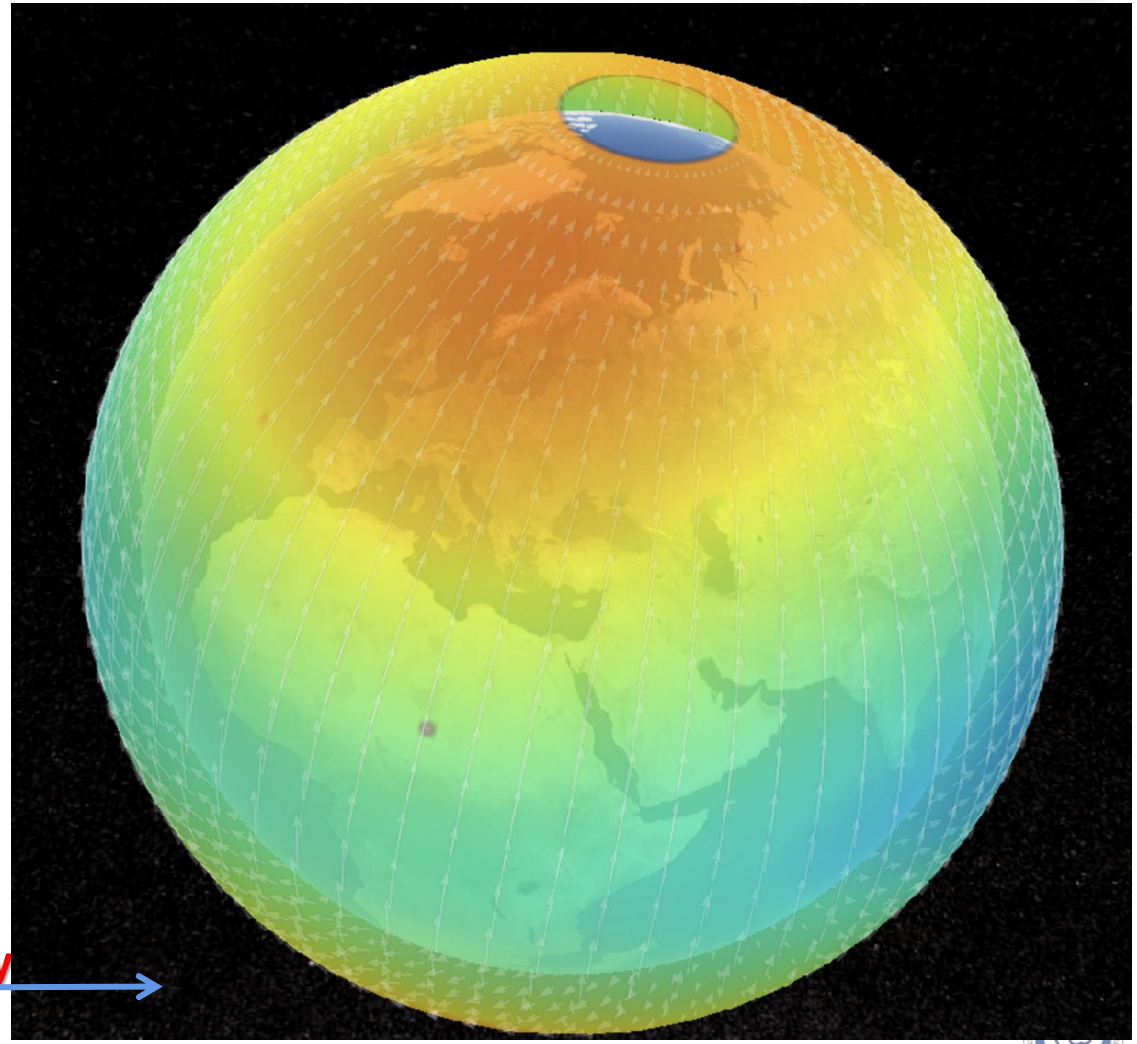
Medium Energy Proton



High Energy Electron



Geomagnetic Field Intensity



Latest Status of Products Generation System (PGS)

- FY-3E PGS has completed the system interface transformation, process test, and preliminary product processing timeliness test of all products related to the instruments that have started observation.
- Some Typical products such as low-light NCC image, temperature and humidity profile, ocean surface wind vector, sea ice type and classification, electron density profile, solar image, and space environment have automatic processing capabilities.
- Other 11 typical products in 5 categories involving images, atmospheric parameters, sea and land surfaces, cryosphere, and space weather have completed demonstration. system testing of cloud, radiation and land surface products, and the quality assessment of automatic-running products are being carried out.
- More than 20 EDR products will be produced operationally.

Key Geophysical Parameters (KGP) of FY-3E

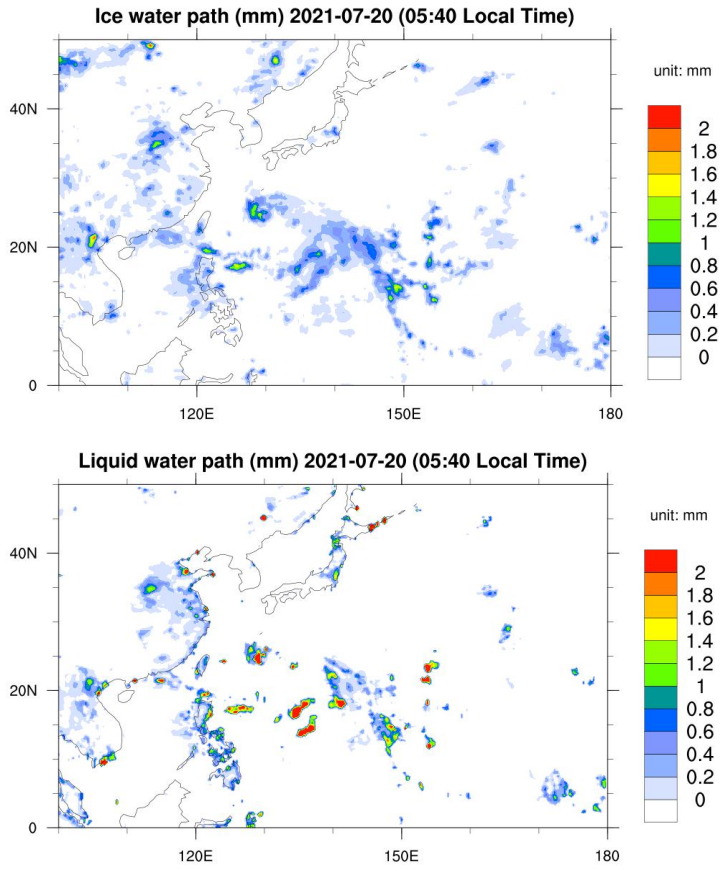
Instruments	L2 Products
MWTS/MWHS/HIRAS	Vertical Atmospheric Temperature/ Humidity Sounding Suits（VASS）
MERSI-LL	Cloud Mask
	NCC Imagery
	City Lights
	Polar wind motion
HIRAS	Efficient Cloud fraction
	OLR
	Temperature/Humidity Profile
	Ozone profile
Solar Irradiance Monitor(SIM/SSIM)	Total solar irradiance
	solar spectral irradiance
WindRAD	ocean surface wind
	Ocean ice
GNOS-II	GNSS-RO(GPS and BDS) GNSS-R ocean surface wind
IPM-II	Triple-angle IPM observation Oxygen/Nitrogen RatioAirglow intensity
XEUVI	Solar X-ray image
	Solar EUV image
SEM	Geomagnetic field
Multi-sensorl Fusion Products	OLR\SST\LST Ice\Snow

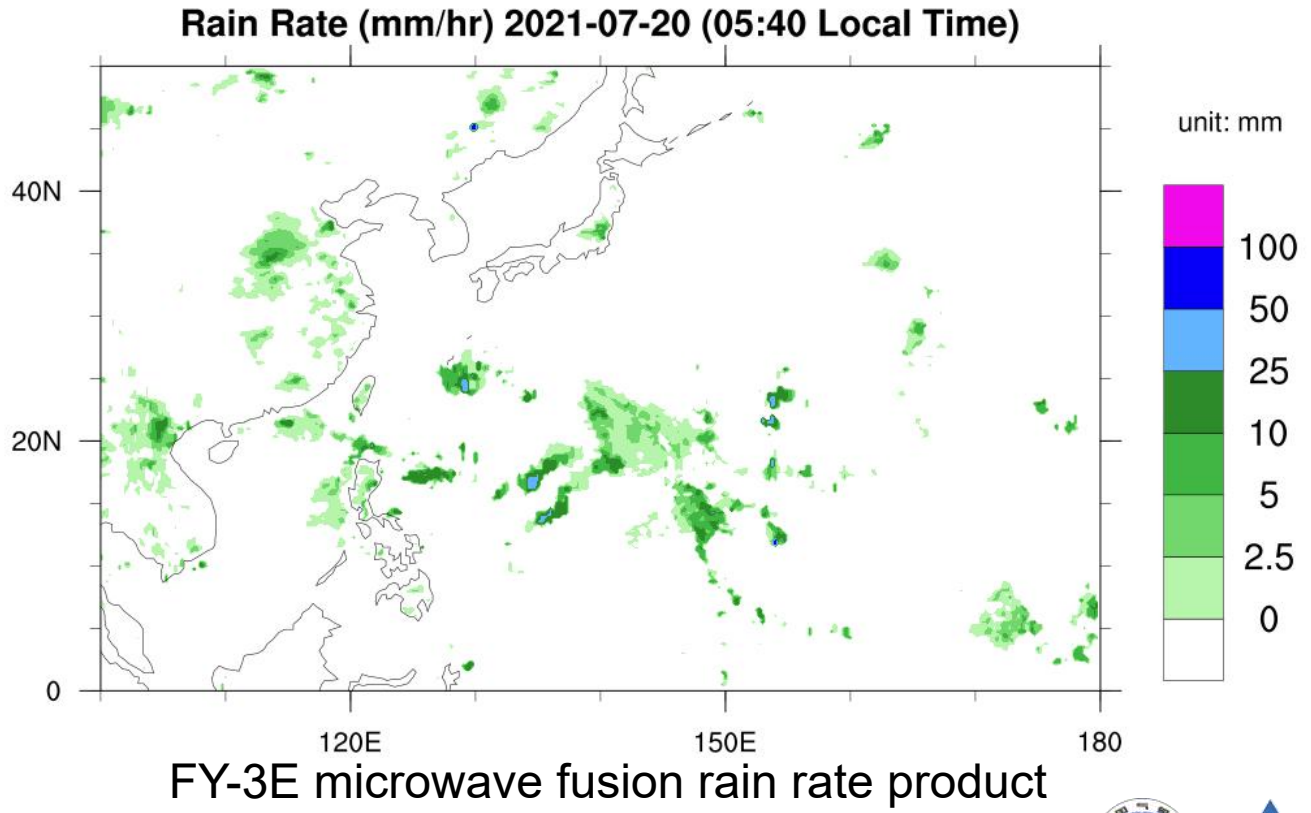
Field Campaigns for FY3E Cal/Val in 2021

No.	Location/Sites	Task	Purpose
1	Delingha	LLB vicarious calibration	Radiometric calibration/validation
2	Qinghai Lake	Thermal infrared Vicarious calibration	
3	Dunhuang	Optical instrument calibration and BRDF observation with UAV	
4	Simao	Passive microwave instrument Vicarious calibration	
5	Xilinhaote	WindRAD ARC calibration	
6	Xilinhaote	Land surface and atmospheric Products Validation	Products validation
7	Tibet plateau	Temperature and Moisture Validation and Observations in multi-scales	
8	Northeast	Snow products validation	
9		Construction observation network of four component radiation sensors	
10		Space weather in situ observation	
11		Soil moisture measurement in the source region of the Huanghe River	cooperationobservations
12	Qilian Mountain area	Ecological meteorology measurement Validation	
13	others		

Microwave fusion rain rate product of FY-3E:

The vertical distribution of solid water (such as ice) and liquid water (such as rain) in the cloud is monitored by FY-3E, the whole column of solid aquatic products and liquid aquatic products are obtained, then the rain rate on the sea and land are estimated, finally, FY-3E microwave fusion rain rate product is generated.



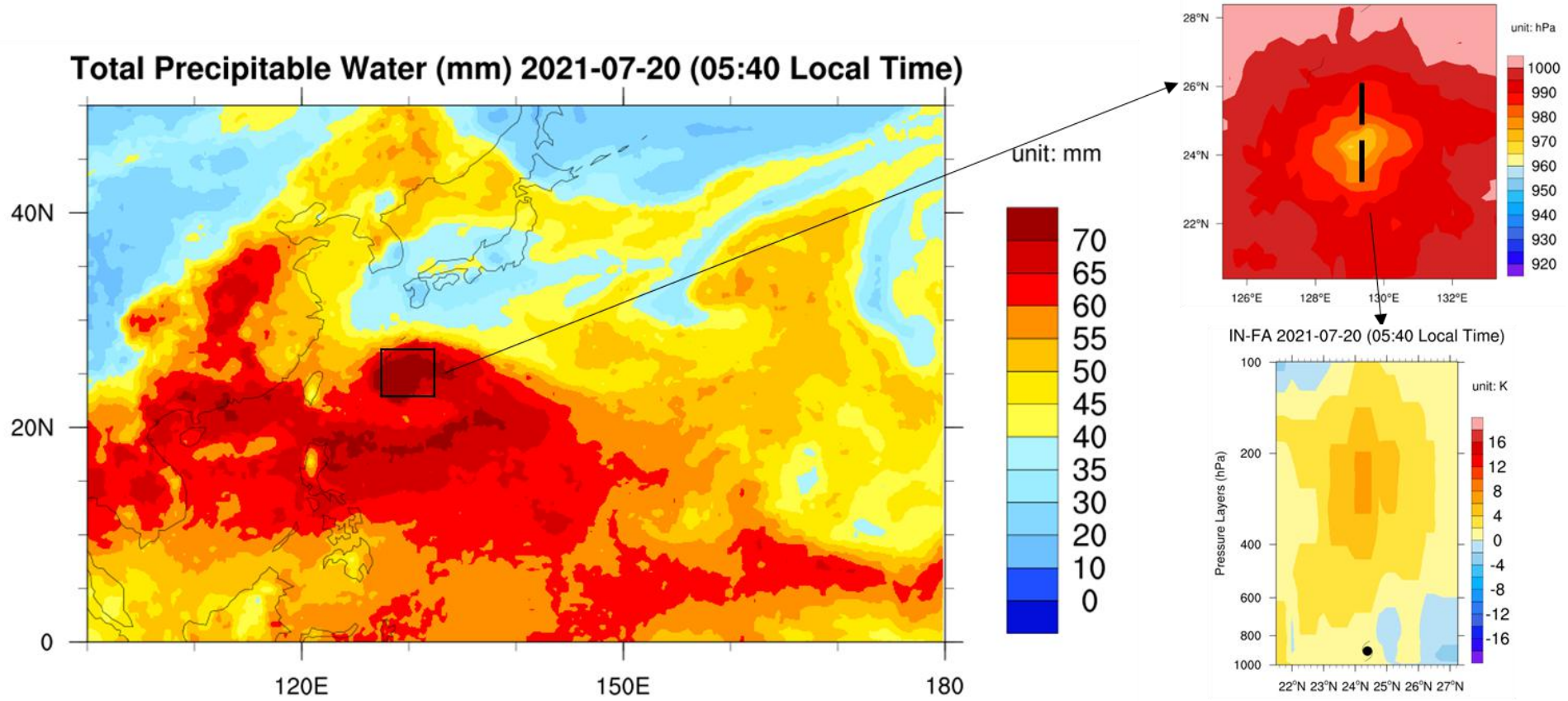


FY-3E microwave fusion rain rate product

（From Fuzhong Weng）

Typhoon monitoring of FY-3E data:

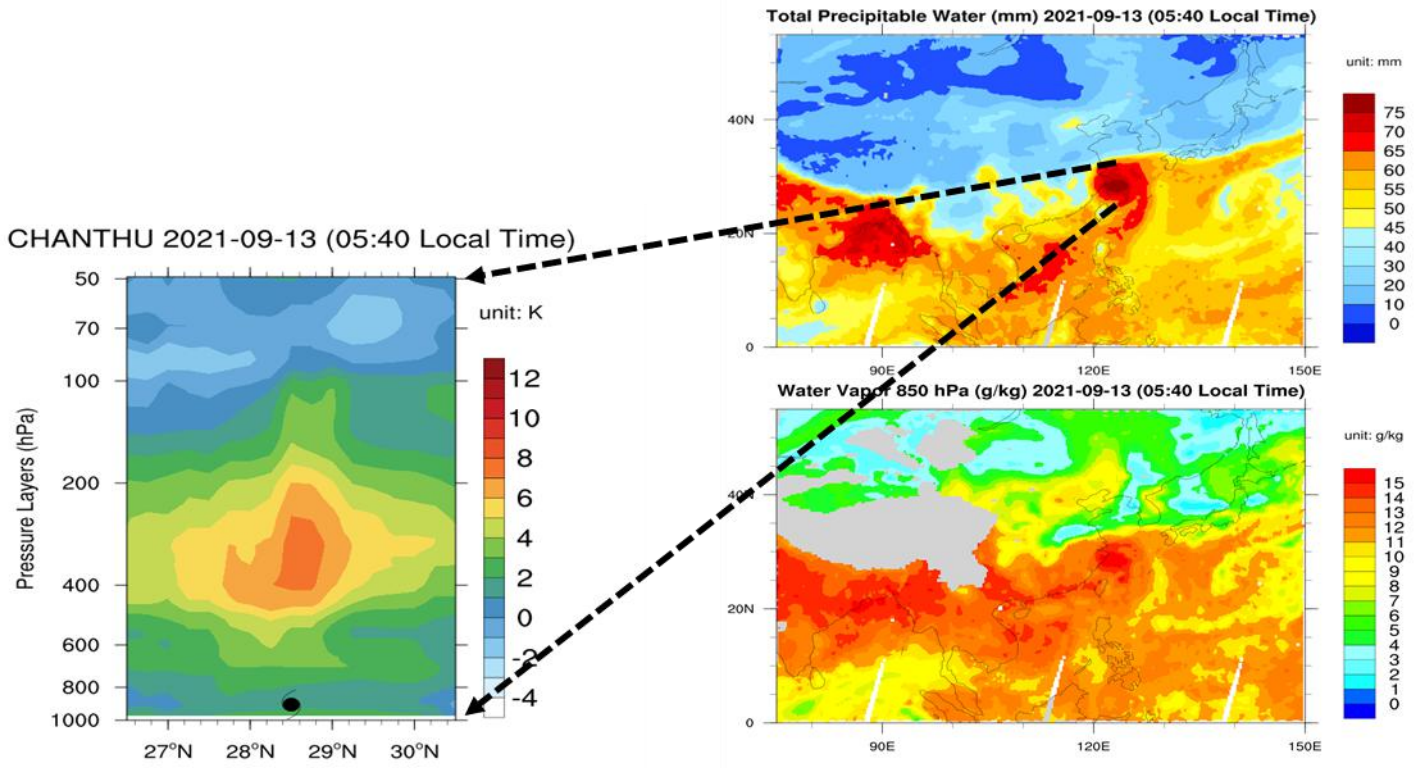
FY-3E microwave fusion Total Precipitable Water (TPW) are used to monitor the distribution of water vapor content in the whole atmosphere, microwave fusion sea level pressure products are used to monitor the scale, position and intensity of typhoon, and microwave fusion typhoon warm core products are used to monitor the structure and intensity of typhoon. These products play an important role in predicting the future development of typhoon "In-fa".



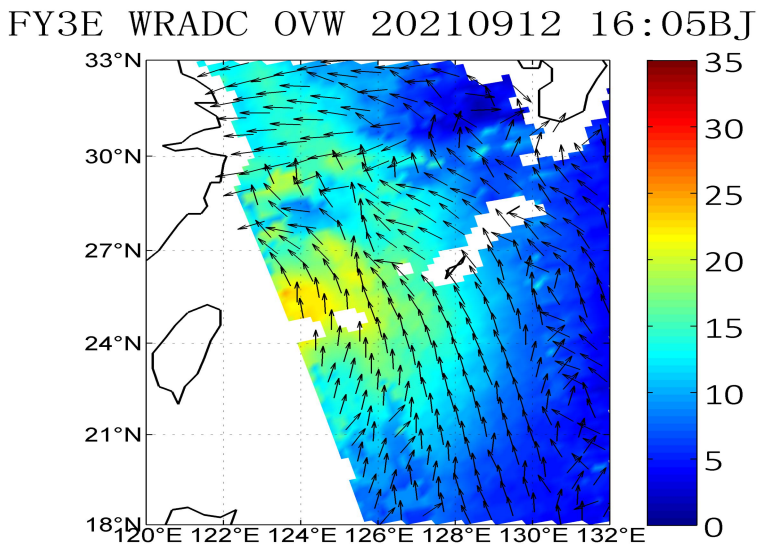
（From Fuzhong Weng）

Typhoon monitoring of FY-3E data:

The Total Precipitable Water, the warm core structure and peripheral wind field in the core area of the typhoon product are provided by FY-3E microwave sundering, these products play an important role in predicting the future development of the typhoon “CHANTHU”.



FY-3E Total Precipitable Water product

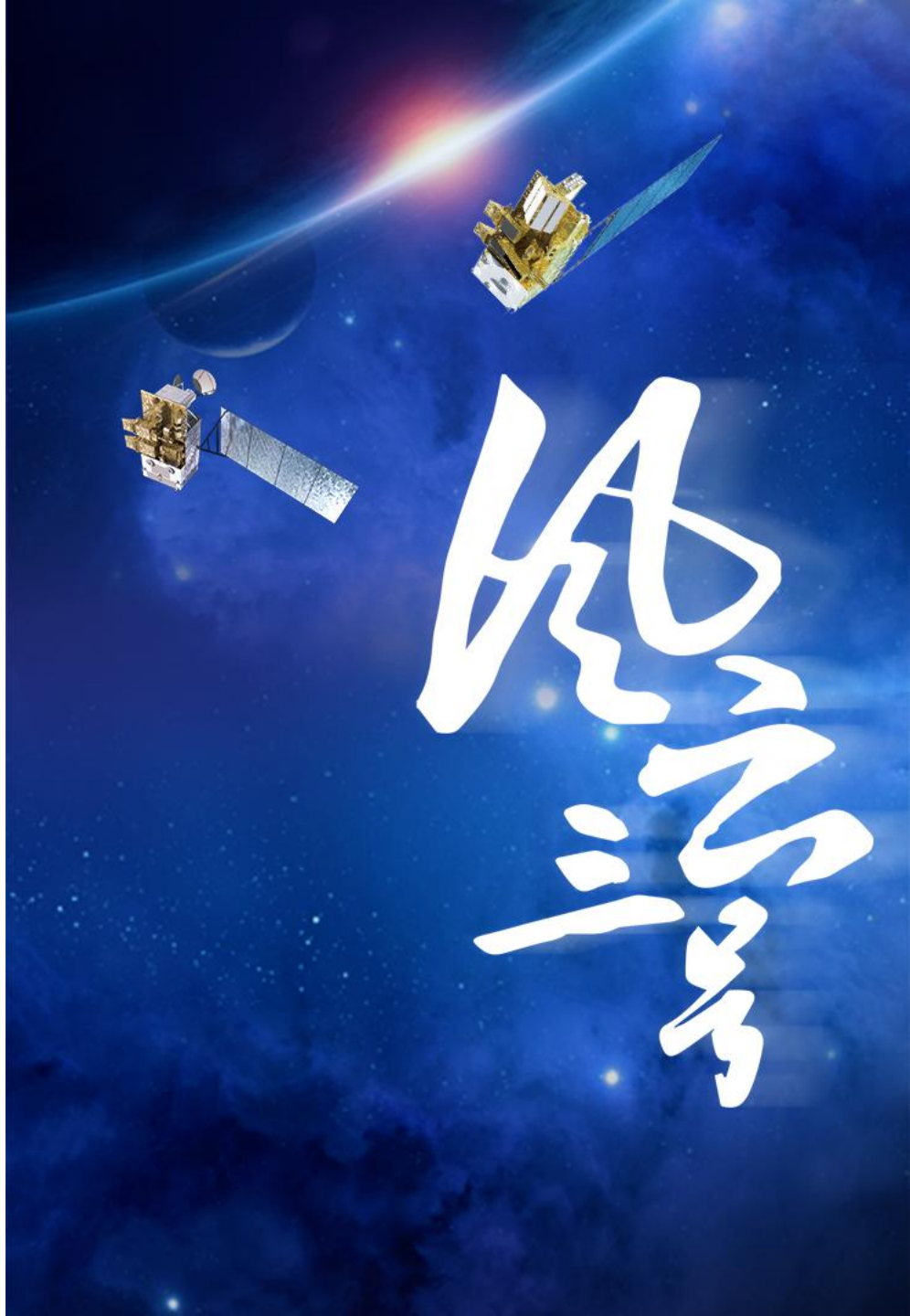


FY-3E wind speed and wind vector

（From Fuzhong Weng）

PART 04

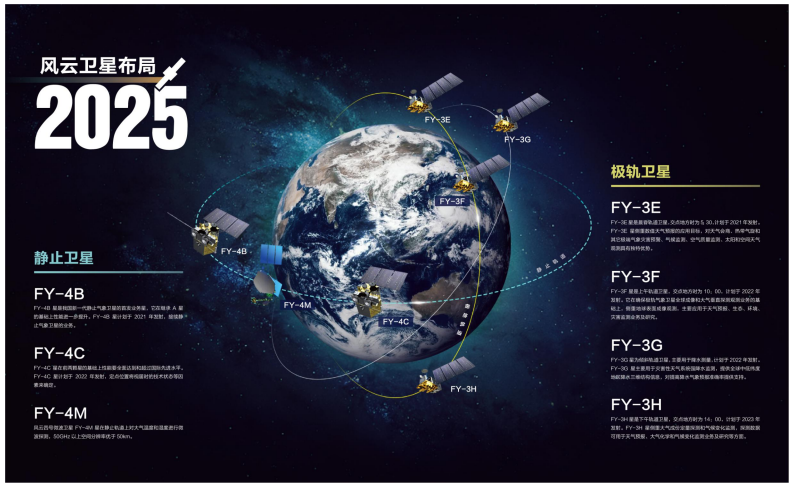
Forward Way

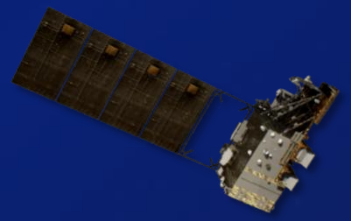


Comming Launch Plan of FY-3 Series

Busy Time continue for FY-3 team...

- FY-3F AM satellite and Rainfall Satellite FY-3G will be launched in the second half of 2021
- FY-3H PM Satellite will be launched in late 2023or earlier 2024
- Added two satellites of FY-3 series are planning with one more EM and rainfall satellites for filling gap of FY-5 first launch. They will be launched in 2026 and 2027.
- Third generation FY-5 detailed Design are doing...





Thanks

Xiuqing Hu Email: huxq@cma.gov.cn