Overview of Fengyun Program and DB Service Preparation of FY-3E

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National Satellite Meteorological Center

Outline

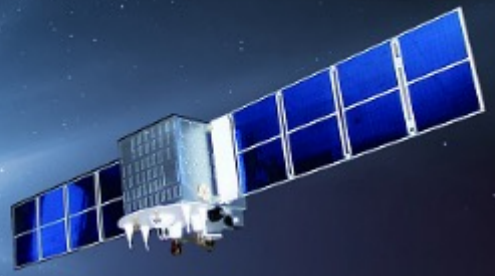
1. Fengyun Program Overview
2. Current Missions and Data Services
3. Latest Launch
4. Future Program
5. DB Service of FY-3E
6. Summarization

Retrospect

- 1957, first man-made satellite Sputnik by former Soviet Union
- 1960, first meteorological satellite TIROS-1 by US
- 1988, first FY meteorological satellite in China

AMS100: meteorological satellites have changed the way scientists understand the Earth

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

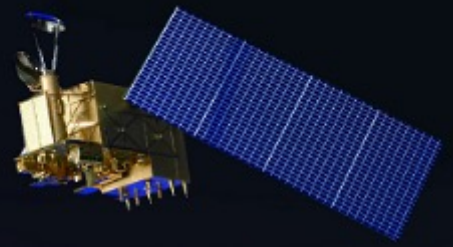
FY-2D
LD:08.Dec.2006
EOL:Jul 2015

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

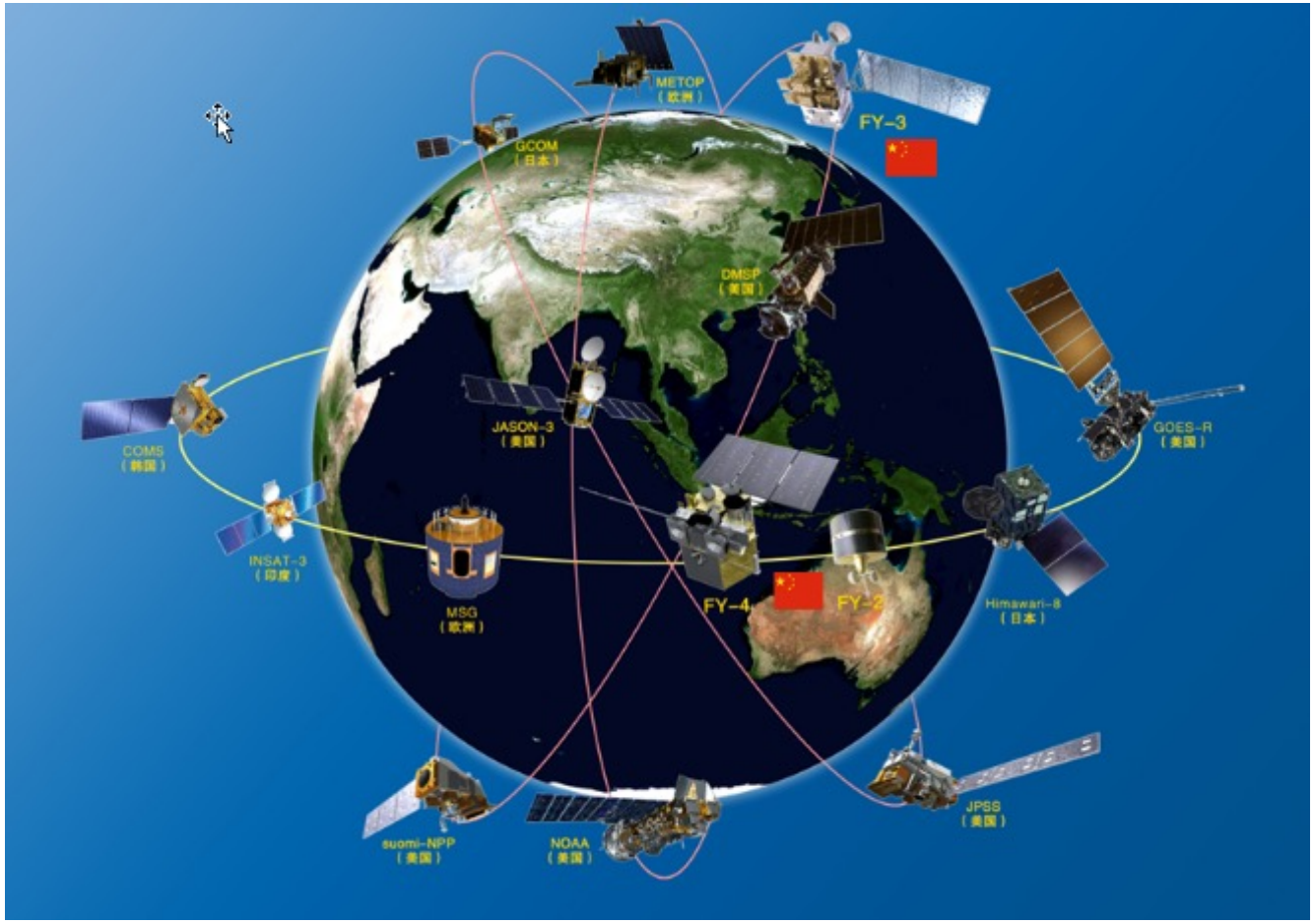
Second-generation geostationary meteorological satellites

FY-4A
LD:11.Dec.2016
EOL:≥2021

FY-4B
LD:03.Jun.2021
EOL:≥2028

LD : Launch time
EOL : End of life

Important Component of WMO Space Program

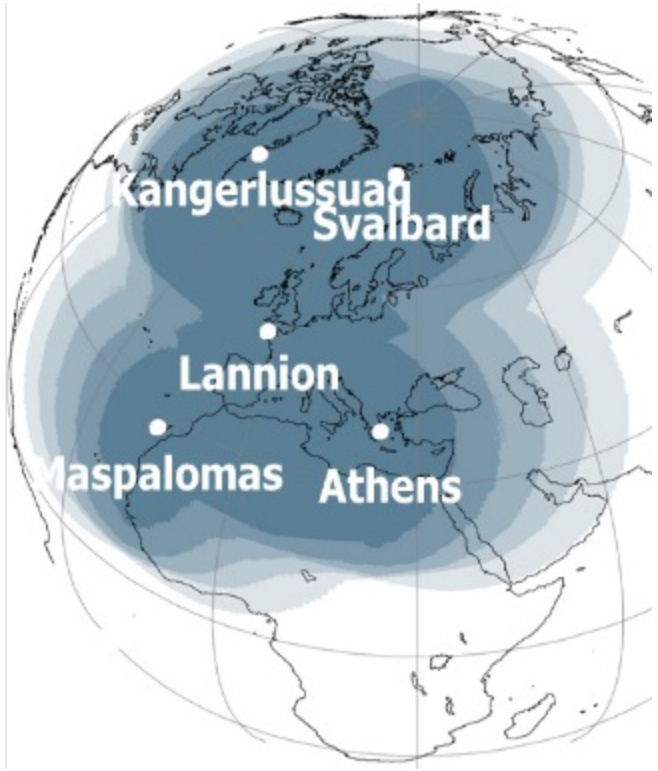


- ☐ reliable and sustained observation in operation
- ☐ open data policy to free access
- ☐ supporting DB users

Zhang, P., and Coauthors, 2019: Latest progress of the Chinese meteorological satellite program and core data processing technologies. *Adv. Atmos. Sci.*, **36**(9), 1027--1045, https://doi.org/10.1007/s00376-019-8215-x

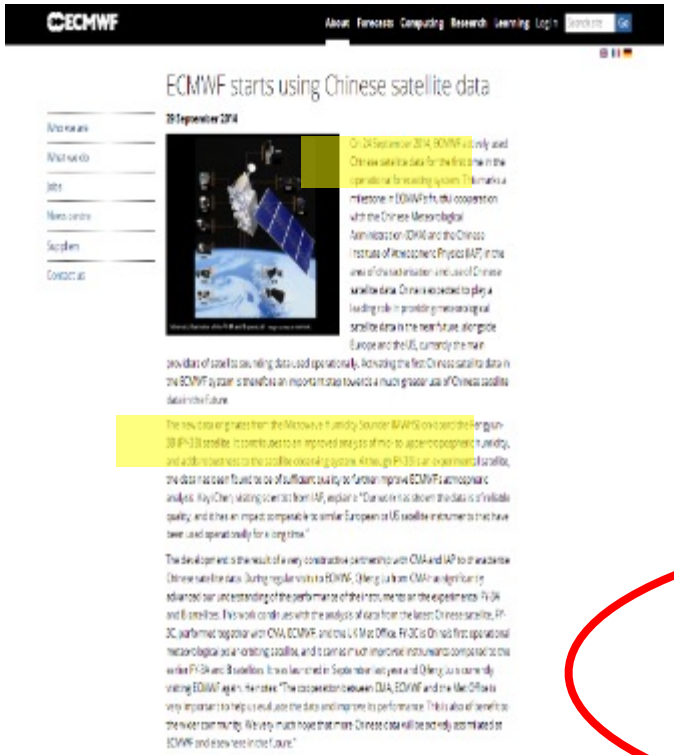
International Users and Feedback

Regional Data



EUMETSAT Advanced Retransmission Service

Global Data



FY-3 sounding data have been assimilated into CMA GRAPES, ECMWF, UK NWP model operationally.

The data quality is now comparable to that from equivalent US and European meteorological satellites

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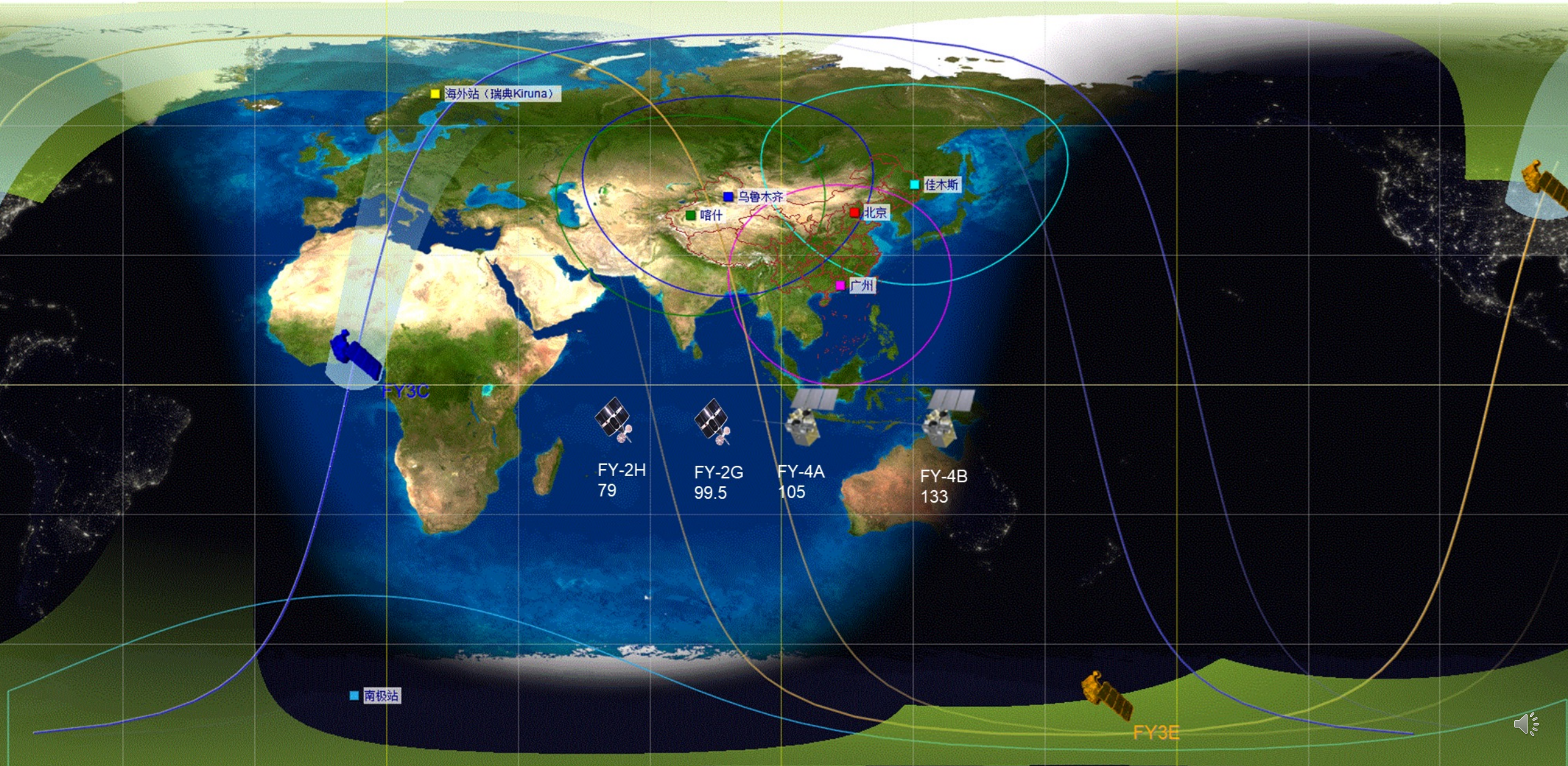
On-Orbit in Operation (7 satellites)

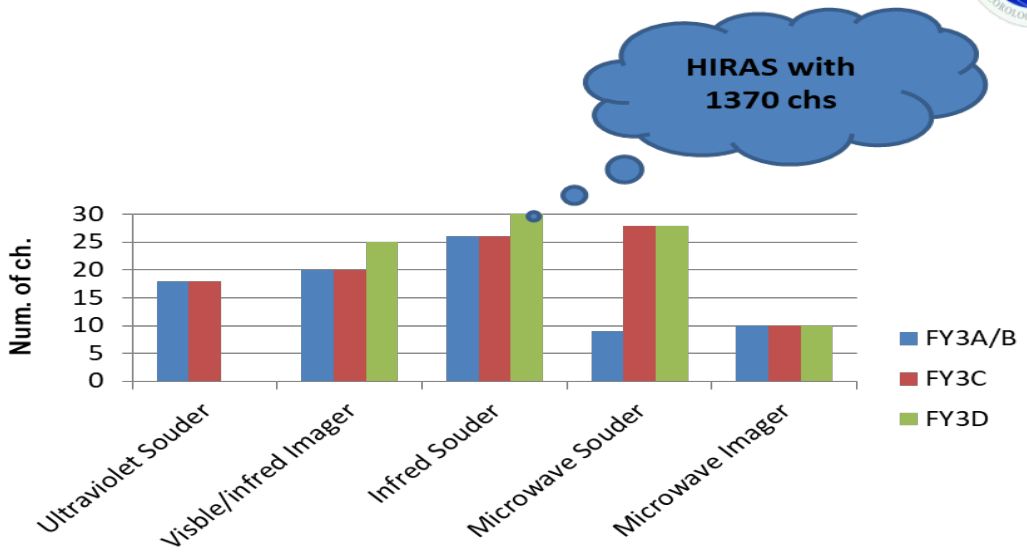
LEO : 3 orbits (EM, AM, PM)

GEO: 4 positions (79°E to 133°E)



Current Instruments for EO

Satellite		No. of Instruments	Name in Abbrev.
FY-1	FY-1 A/B	2	5-channel VIRR
	FY-1 C/D	2	10-channel VIRR
FY-2	FY-2 A/B	1	3-channel VISSR
	FY-2 C/D/E	1	5-channel VISSR
FY-3	FY-3 A/B	10	10-channel VIRR
			MERSI
			IRAS
			MWTS
			MWHS
			MWRI
			SBUS
			TOU
			ERM
			SIM
	FY-3C	11	GNOSS
	FY-3D	10	HIRAS
			GAS
	FY-3E	11	SSIM
			XEUVI
			WindRAD
FY-4	FY-4A	3	AGRI
			GIIRS
			LMI
	FY-4B	4	GHI
			SEP



Optical Imager

Atmospheric Sounder

Microwave Imager

Atmospheric Composition Detector

Radiation Budget Monitor

Space Environment Package

Active Radar

Status of On-orbit Instruments in Operation

Current Fengyun GEO Satellites as of June 1, 2022

Satellite (status)		Location	Launch Data	EO Instruments			
FY-2G	Op	99.5 E	2014-12-31	VISSR	SEM		
FY-2H	Op	79 E	2018-06-05	VISSR	SEM		
FY-4A	Op	105 E	2016-12-11	AGRI	GIIRS	LMI	SEP
FY-4B	Op	133 E	2021-06-03	AGRI	GIIRS	GHI	SEP

Operational(or capable of)
Operational with limitations(or Standby)
Operational with Degraded Performance
Not Operational
Functional, Turned Off

Op = Operational
P = Pre-operational
B = Back-up, secondary
L = Limited availability

Current Fengyun LEO Satellites as of June 1, 2022

Satellite (status)		Orbit	Launch Data	EO Instruments			
FY-3C	L	Morning	2013-09-23	MERSI-I	VIRR	MWTS-II	MWHS-II
				MWRI-I	IRAS	TOU	SBUS
				SIM-I	ERM-I	GNOS-I	SEM
FY-3D	Op	Afternoon	2017-11-15	MERSI-II	HIRAS-I	MWTS-II	MWHS-II
				MWRI-I	GAS	WAI	IPM
				GNOS-I	SEM		
FY-3E	Op	Early Morning	2021-07-05	MERSI-LL	HIRAS-II	MWTS-III	MWHS-II
				GNOS-II	WindRAD	SSIM	SIM-II
				X-EUVI	Tri-IPM	SEM	

FengYun Products

D. Xian, P. Zhang, et al., 2021, Adv. Atmos. Sci

Atmosphere（33）

- Aerosol
- *Aerosol optical thickness*
- Aerosol over Land Surface
- Total Precipitable Water
- Precipitation
- Rain Type
- Rain Phase
- Radar Rain Rate
- Atmospheric bending angle
- Atmospheric refractive index
- *Atmospheric density*
- Electron density profile
- ***total sulfur dioxide column***
- ***Total Nitrogen Dioxide column***
- Atmospheric humidity profile (GNOS)
- Atmospheric temperature profile(III、MWRI、GNOS)
- Atmospheric temperature and humid Profile(MWHS-II)
- Atmospheric temperature and humidity Profile(HIRAS/MWHS-II/MWTS-III)
- Atmospheric temperature and humidity Profile(MWHS-III/HIRAS)
- Atmospheric temperature and humidity Profile(MWTS-III/HIRAS)
- Atmospheric temperature and humidity Profile(MWHS-II/MWTS-III/MWRI)
- ***Total oxygen column***
- ***Carbon dioxide mixing ratio***
- ***Methane mixing ratio***
- total ozone column
- ***Nadir Ozone vertical profile***
- ***Limb Ozone vertical profile***

Cloud & Radiation（17）

- Equivalent emission radiation for clear sky
- *OLR of HIRAS*
- *Cloud Top Parameters*
- Top-up Radiation and Clouds
- Surface radiation budget
- ***Total solar irradiance downward from the atmospheric top***
- ***solar band irradiance at the top of the atmosphere***
- Cloud Mask
- Cloud Amount
- CLoud Classification
- *Cloud Top Temperature/Cloud Top Pressure*
- *Cloud Optical Depth*
- *the Effective Radius of Cloud*
- Outgoing Longwave Radiation
- ***Polar Winds***
- ***Water leaving Reflectance***
- ***Cloud Liquid Water Content***

Space Weather（13）

- ***zeta potential***
- ***Radiation dose***
- ***Magnetic field***
- ***particle(Medium and high energy proton、Electronic three-directional flow、Particle throw angle）***
- ***scan imaging***
- ***Push-broom scan imaging***
- ***Aurora egg morphology***
- ***Particle sedimentation***
- ***IPM night product***
- ***IPM daytime product***
- ***IPM multi-angle product***
- ***Solar extreme ultraviolet imager***
- ***solar x ray imager***

Ocean（7）

- Aerosol over Ocean
- Total ***Precipitable Water over Ocean***
- MERSI Sea Surface Temperature
- ***MWRI Sea Surface Temperature***
- ***MWRI Sea surface wind direction***
- GNOS Sea surface wind Speed
- PR Sea surface wind Speed
- PR Sea surface wind direction

Ice&Snow（4）

- Sea ice
- Snow Cover
- Snow Depth
- SWE
- Polar Sea Ice Cover

Biology（4）

- ***Leaf area index***
- Fraction of Photosynthetically Active Radiation
- Net Primary Production
- ***Chlorophyll fluorescence***
- Vegetation Index

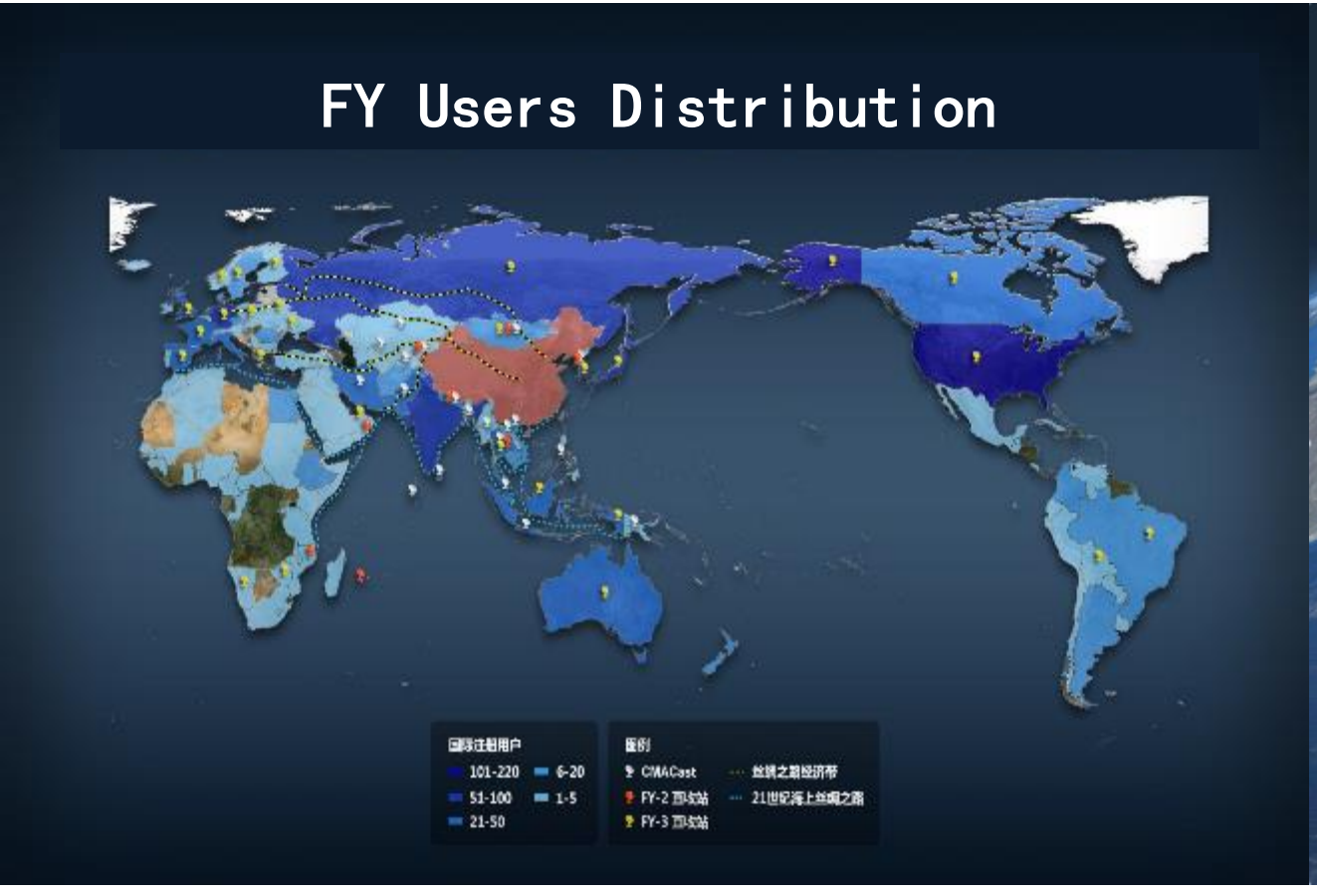
Land（12）

- Land Reflectance Factor
- Land Surface Temperature
- *Land Surface Bidirectional Reflection/ Albedo*
- *Land Cover*
- Dust Product
- *Near-Constant Contrast Image*
- ***City Light/Urban low-light background mosaic***
- *Land Surface Temperature*
- *Soil moisture content*
- Surface pressure
- surface reflectance

• **Operational Product** • ***Research product***

Integrated Space and Ground Based Data Service System

- At present, the archive data for various satellites in NSMC have reached **22PB**
- the **daily archived data volume is 21TB**
- In 2021, the total amount of data services has **exceeded 10PB**
- Real time : Direct Broadcast , CMACast
- Non-Real Time: Website, Cloud Service, FTP Service, Manual Service



Ground Segment – Receiving Stations

- Established a global satellite data receiving station network 1+5+2
- **5 domestic** ground receiving stations
- **2 overseas** data receiving stations: Kiruna (2008) and Troll (2016)
- 15 global data receiving antennas
- Satellite-to-ground transmission rate 480M bps

Timeliness of global data acquisition : 2 hours


Beijing


Guangzhou


Urumchi


Data Processing Center


Kiruna

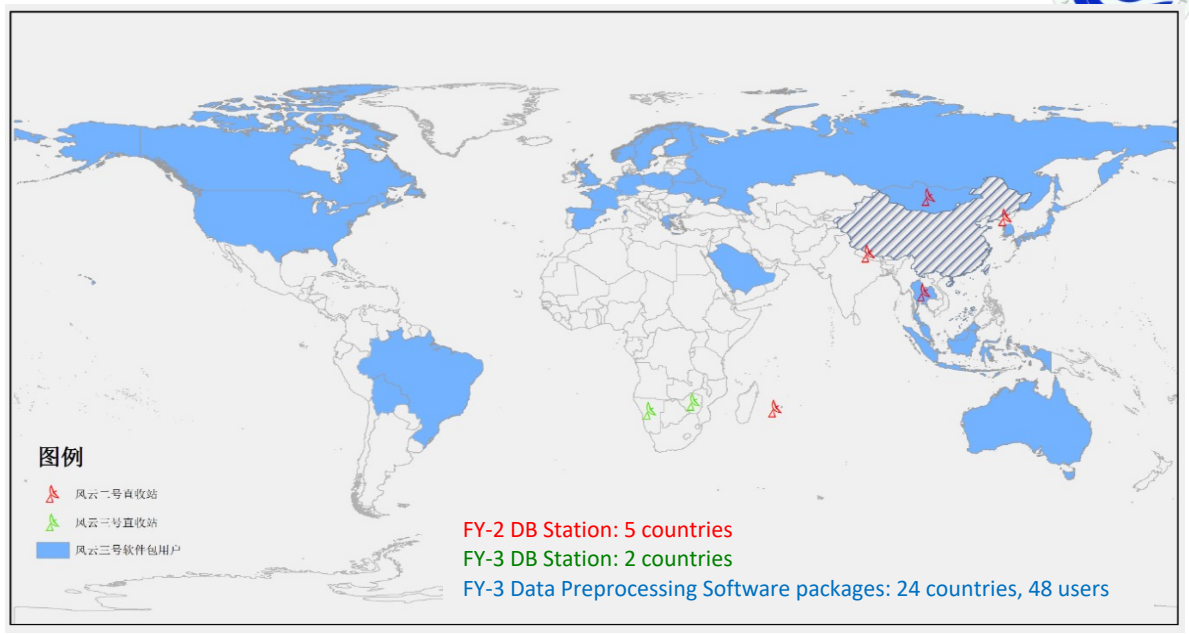

Kashgar


Kiamusze


Troll

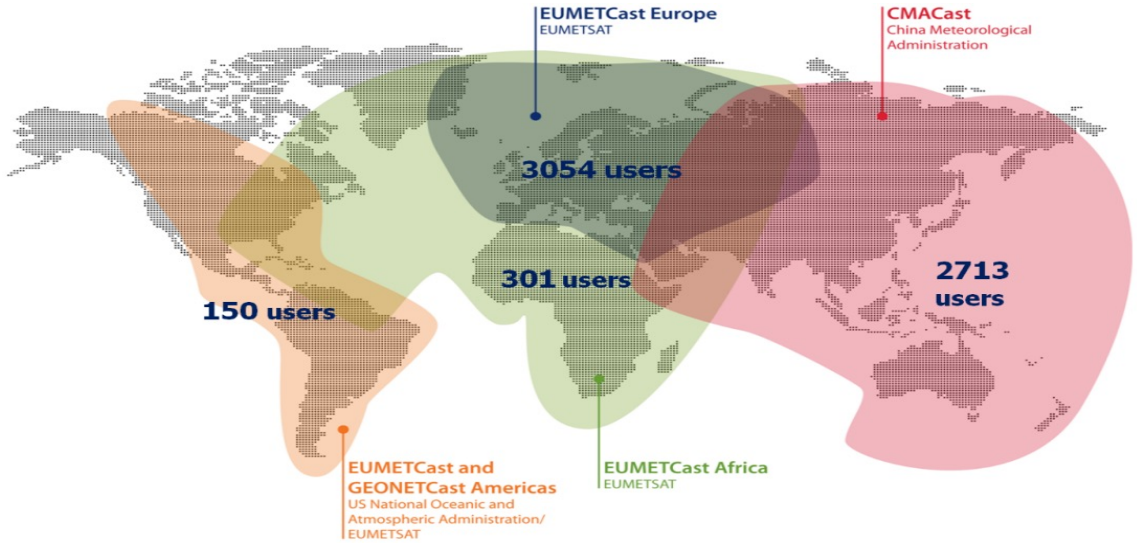
Space-based Services

FENGYUN satellite Direct Broadcasting System (FY-DBS)



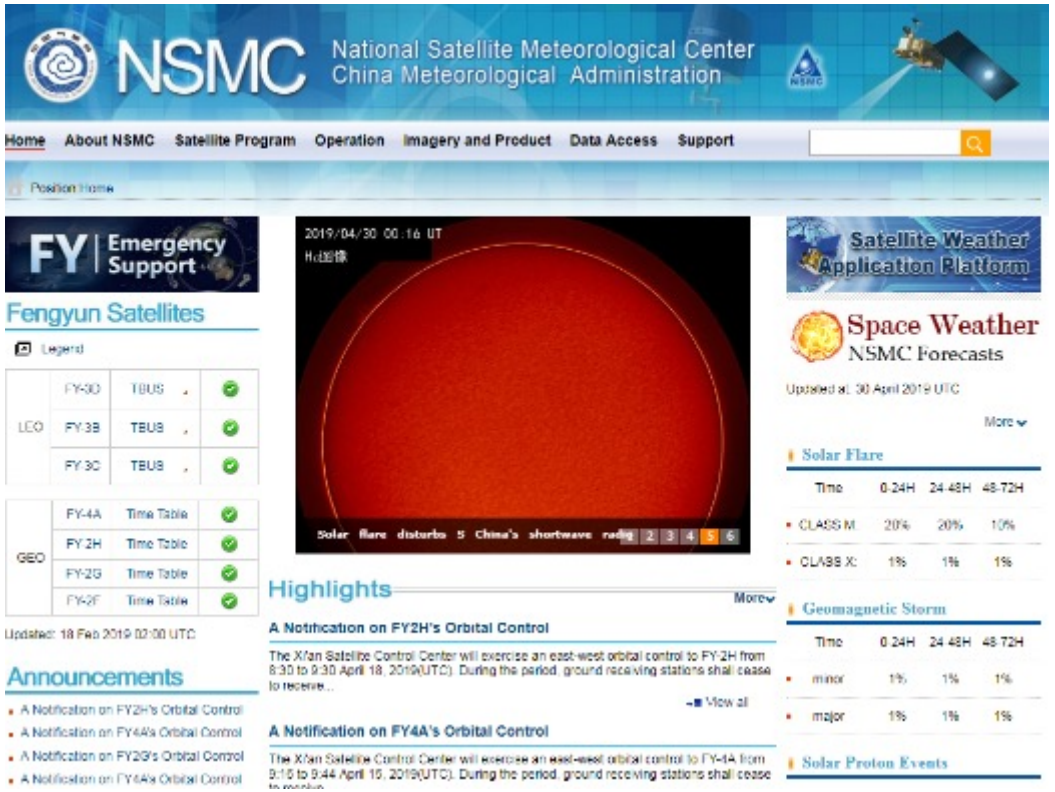
- Over 2600 DVB-S users
- Over 500 Utilization Stations of Geostationary Meteorological Satellite
- Over 3000 Data User Terminals
- Over billions people viewing Satellite Cloud Images through TV and Internet
- Nearly 100 countries and regions

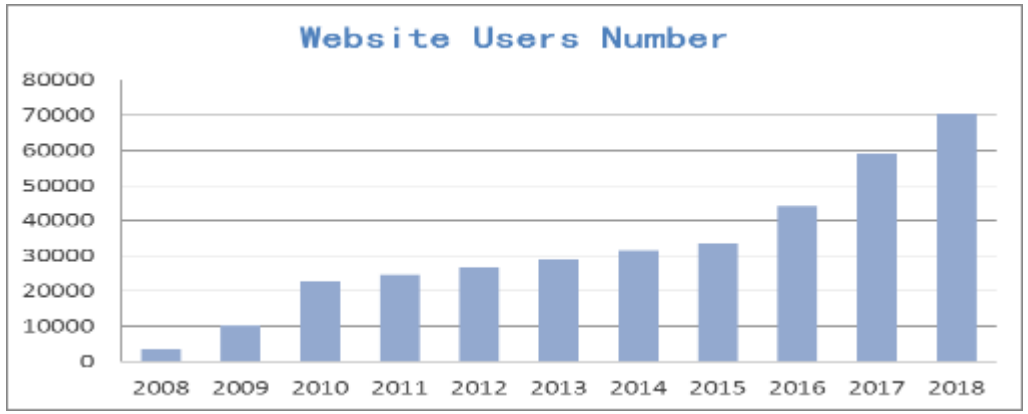
CMA satellite data broadcasting system (CMACast)



CMACast has been deployed in 19 countries

Web Portal Service http://www.nsmc.org.cn





International Users

Data Sharing

120 countries
2865 online data services sheet, data volume12.5TB
29 FY_ESM users
29 countries updated FY-3 software package
39 countries has green channel
3 countries with FY-2 DB station

Products Services

60+countries using SWAP (web)
24 BRI Remote sensing services reports
8 countries received remote support SWAP
14 Emergency support （6 for FY_ESM）
3 countries received customized service
1 high resolution image
4 virtual meetings

International Training

1000+trainee，90+countries
2 V-lab training
3 on-line international training
1 user manual

（by 2020）

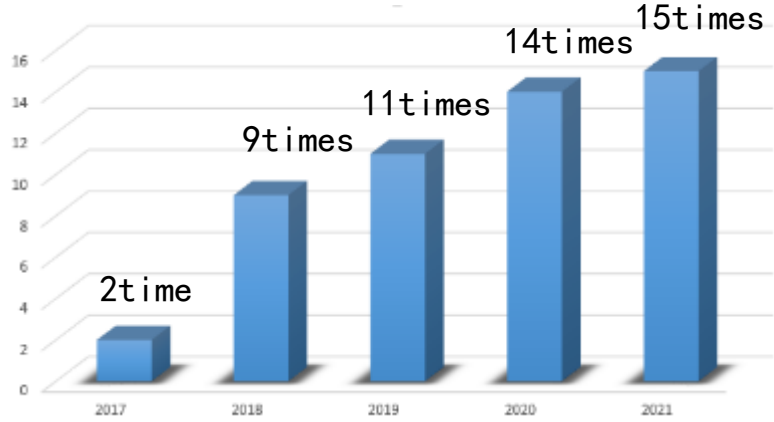
Customer satisfaction with our service runs at more than 80%

FY-ESM and FY Satellite User Conference

Emergency Support Mechanism for International Users of **FengYun** Meteorological Satellites in Disaster Prevention and Mitigation

Emergency support in 2021

	Date	Country	Event
1	2021.01.28	Swaziland	Tropical cyclone &Flood
2	2021.02.08	India	Flood
3	2021.02.23	Philippines	Tropical cyclone &Flood
4	2021.02.24	Philippines	Tropical cyclone &Flood
5	2021.04.07	Indonesia	Heavy rainfall &Flood
6	2021.04.08	Timor-Leste	Tropical cyclone
7	2021.04.13	St.Vincent	Volcanic eruption
8	2021.05.24	Congo	Volcanic eruption
9	2021.06.07	Sri Lanka	Oil spilling
10	2021.06.07	Sri Lanka	Flood
11	2021.06.08	Sri Lanka	Oil spilling
12	2021.06.09	Sri Lanka	Flood
13	2021.07.09	Tunisia	Forest fire
14	2021.07.22	Russia	Forest fire
15	2021.08.09	Russia	Flood



FY-ESM Requests increased year -on-year

Capacity Building

Promote capacity building for disaster prevention and mitigation

- FY-3 satellite direct data reception station: 2 countries
- FY-2 satellite direct data reception station: 8 countries
- CMACast : 20 countries

Delivery ceremony

CMA experts and trainees of INAM

FY-2 satellite data receiving system installed in Mozambique on 2nd January 2020

Web Consultation Meeting

- A multi-center joint international meteorological consultation mechanism has been initially established
- On May, 2021, a virtual seminar on fire monitoring between EUMETSAT and CMA has been organized

Letter from SMA


e below some points raised by the CEO during the meeting on Friday

I. If it's possible to establish an "active line of communication" where both CMA and SMA can contact each other and receive fa
sponse. For example for SMA to be able to contact and get weather advice from CMA when a bad weather event is expected to
ect Seychelles. The active line of communication can be in the form of "a phone line, WhatsApp, Wechat or Cisco Webex.
. We have noticed from the presentations that you can determine the amount of rain per hour from a convective system throug
erpretation of satellite images, is this correct? If yes, do you think with training SMA can also be able to forecast amount of rain
m convective clouds using satellite pictures?
. This question is a follow-up to question 2 above; At the SMA we have always believe that in order to determine water content
convective system we need a weather radar, is this true? How a weather radar and satellite complement each other?
4. Can CMA and SMA sign a memorandum of understanding (MOU) to strengthen cooperation particularly in research and capa
velopment, work attachment, visits to CMA and SMA...and so on.

Letter from EUMETSAT

EUMETSAT-CMA Wild fir... (25 MB)

Dear colleagues,

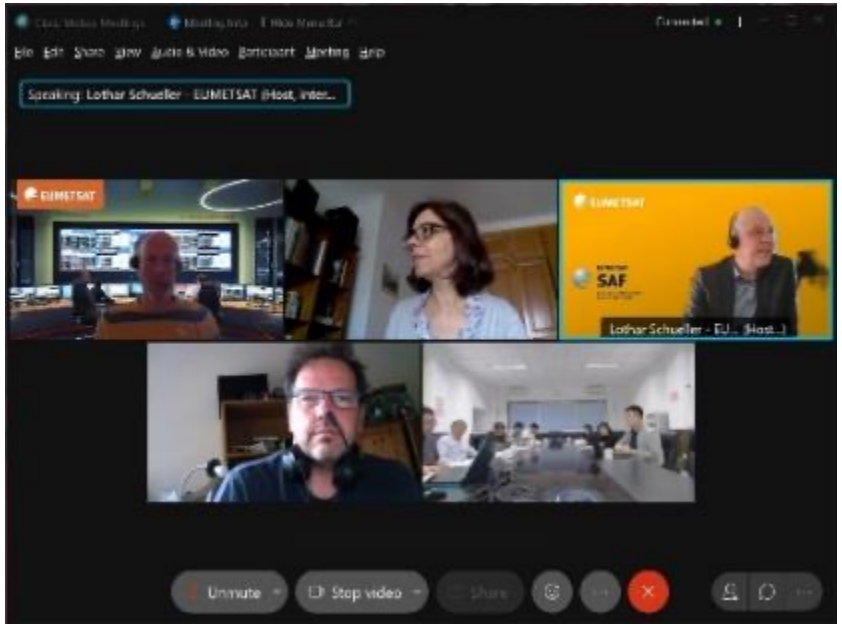
Thanks for your input to the meeting summary and your slides. Please find attached the finalised documents with al
he presentation slides in annex.

Thanks again for the fruitful meeting. I look forward to further interaction in this group.

Best regards from Darmstadt,

Lothar

EUMETSAT-CMA Seminar on Fire



Sri Lanka and CMA online meeting

SMA, NSMC,WMC-BJ held an online meeting

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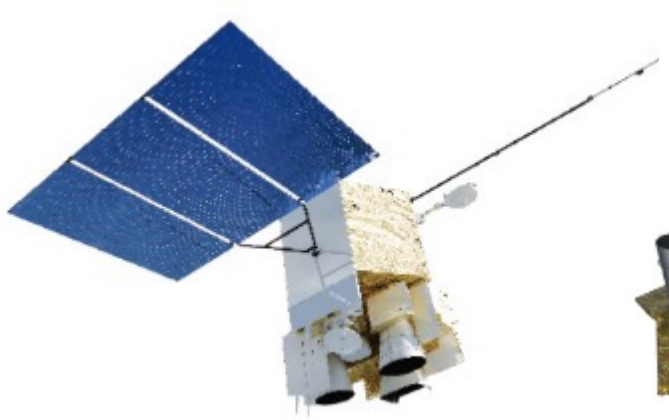
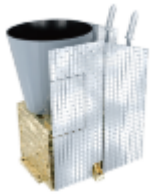
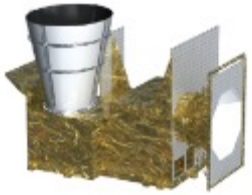
FY-4B

- FY-4B, the second satellite of FY-4 series, was designed to be **the first operational satellite** of FY-4 series and launched on June 3, 2021

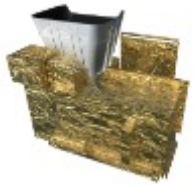




Geostationary High-speed Imager (GHI)



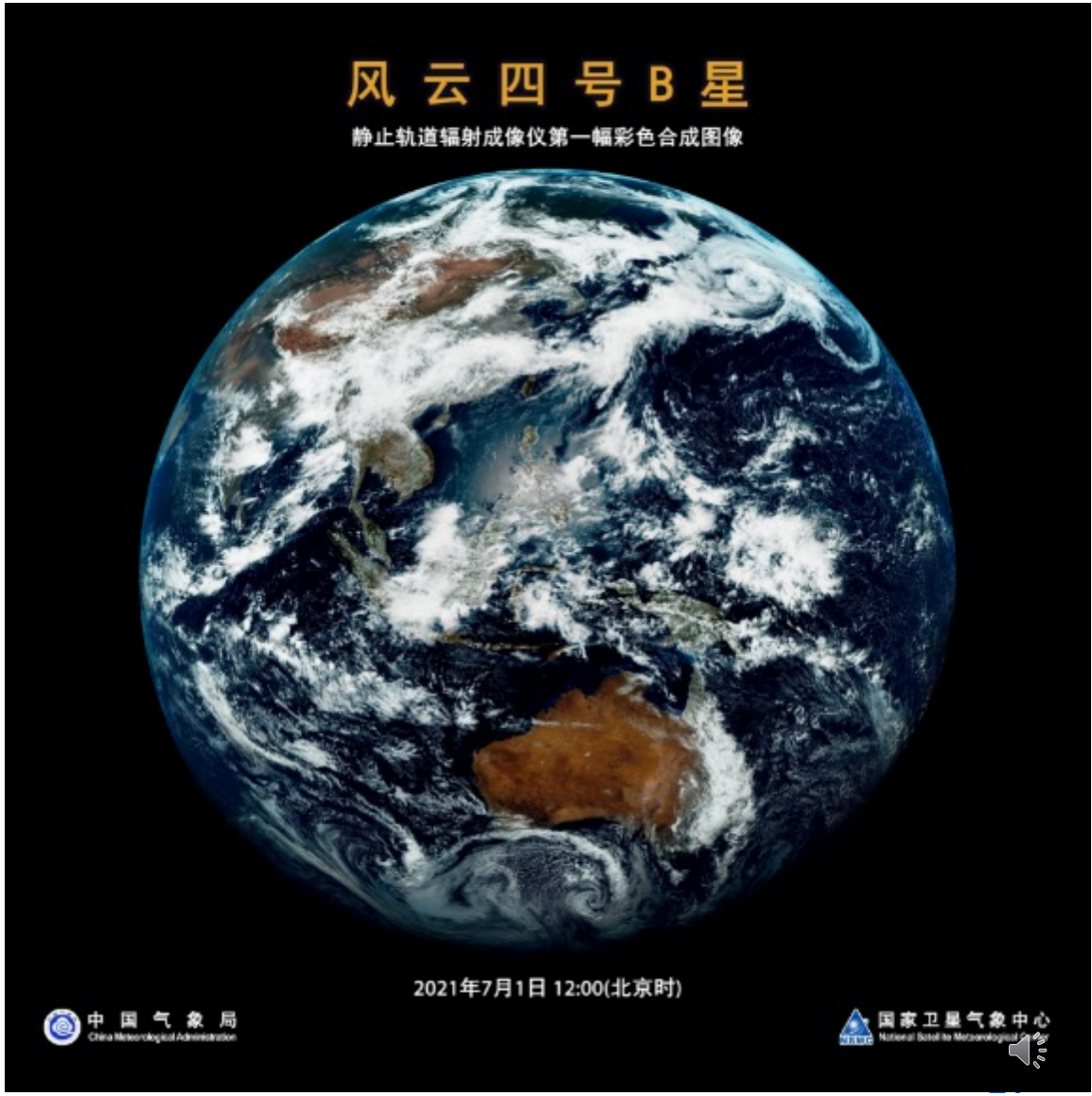
Geostationary Interferometric Infrared Sounder (GIIRS)



Advanced Geostationary Radiation Imager (AGRI)

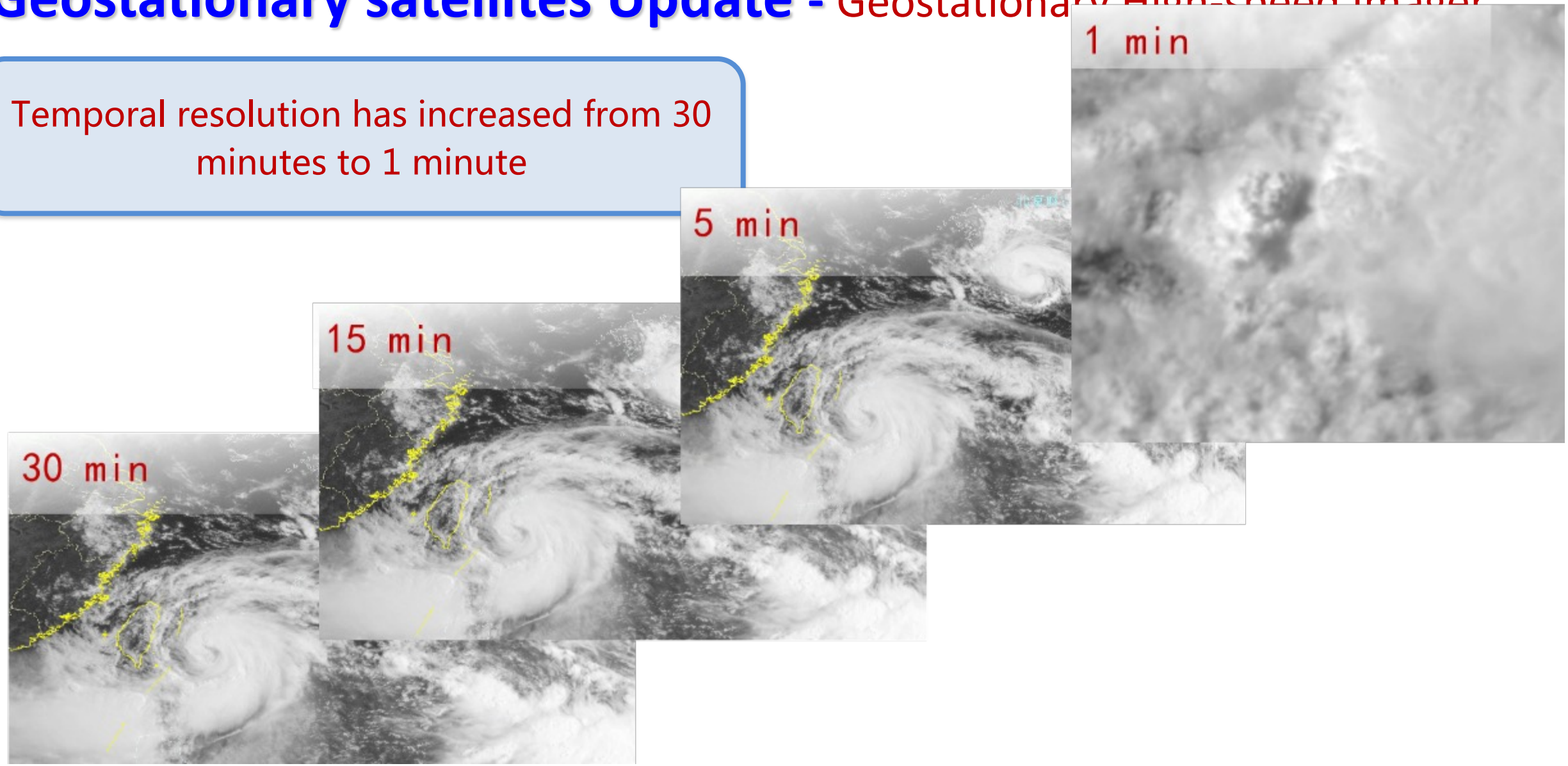
Space Environment Monitoring Instrument Package (SEP)

http://fy4.nsmc.org.cn/nsmc/en/theme/FY4B.html



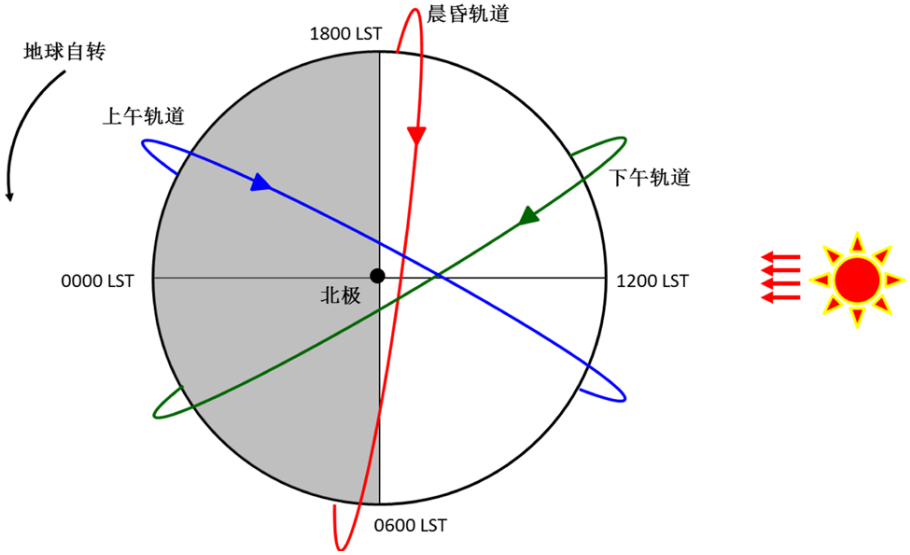
Geostationary satellites Update - Geostationary High-speed Imager

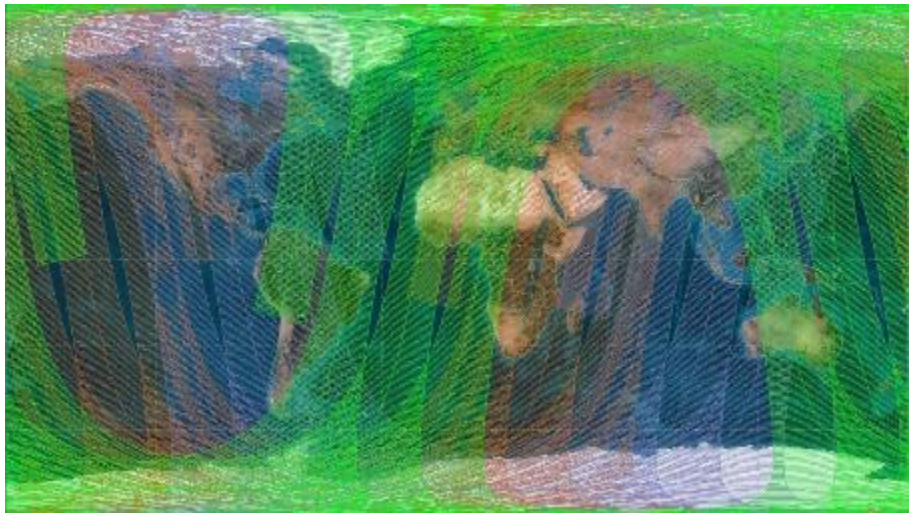
Temporal resolution has increased from 30 minutes to 1 minute



FY-3E

- FY-3E is the world 's **first** meteorological satellite **in early morning orbit for civil service,** filling in the observing gap in early morning.





Metop-A 9:30 AM

NPP 13:30 PM

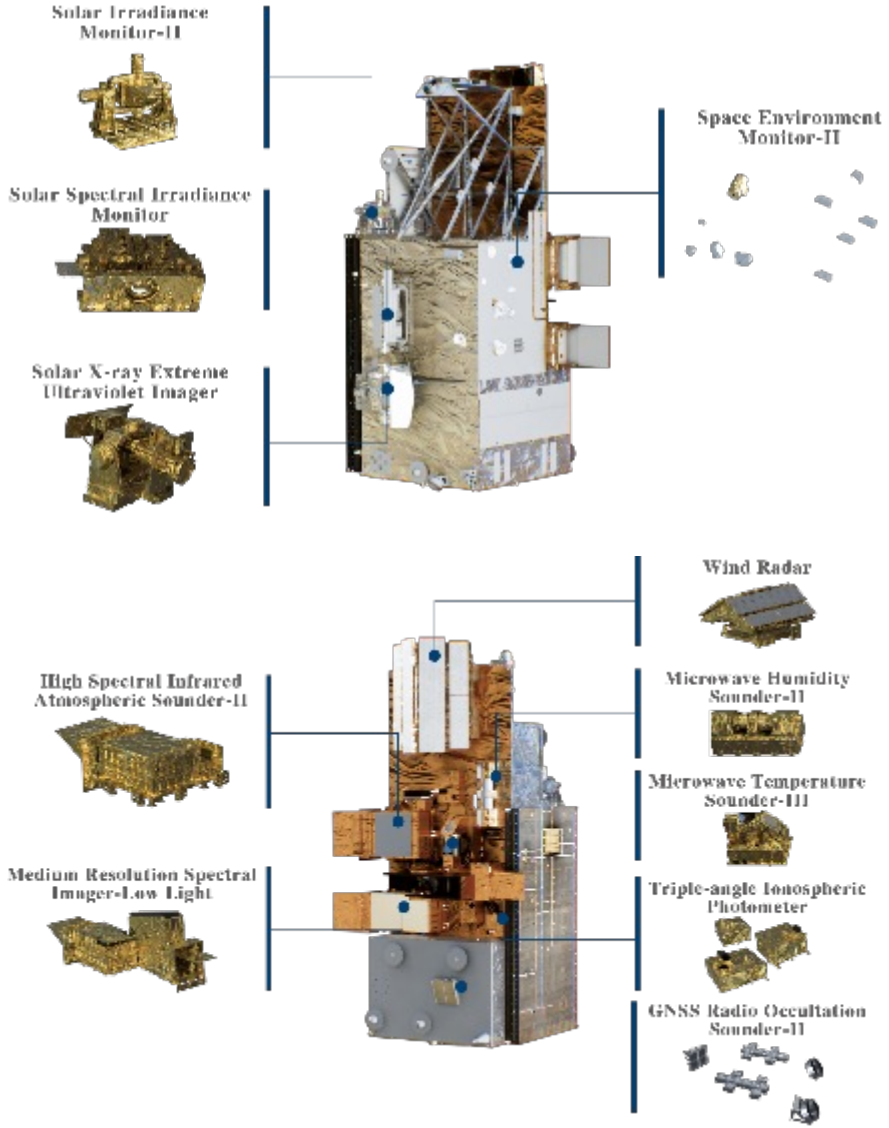
FY-3 Early Morning 6:00 AM

4 capabilities in category of FY-3E:

- **High-precision IR + microwave combined** atmospheric temperature and humidity vertical distribution detection;
- **Active C + Ku Radar** for wind field accurate detection;
- Global optical observation with **low-light imaging** in 250-meter resolution;
- Comprehensive detection of the **sun and space environment**.

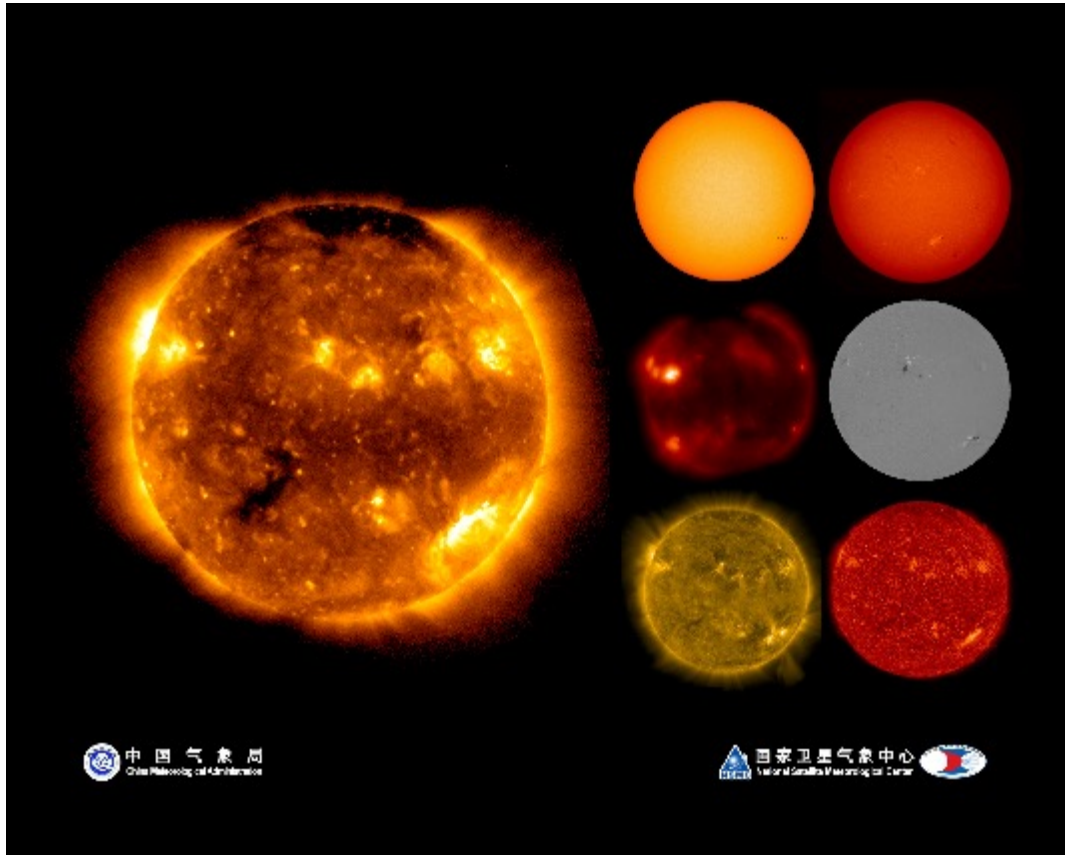
Zhang, P., et al., 2021: FY-3E: The first operational meteorological satellite mission in an early morning orbit. Adv. Atmos. Sci., https://doi.org/10.1007/s00376-0211304-7.

There are 11 instruments on FY-3E, 3 instruments are newly developed, 7 instruments are upgraded, 1 inherited instrument.

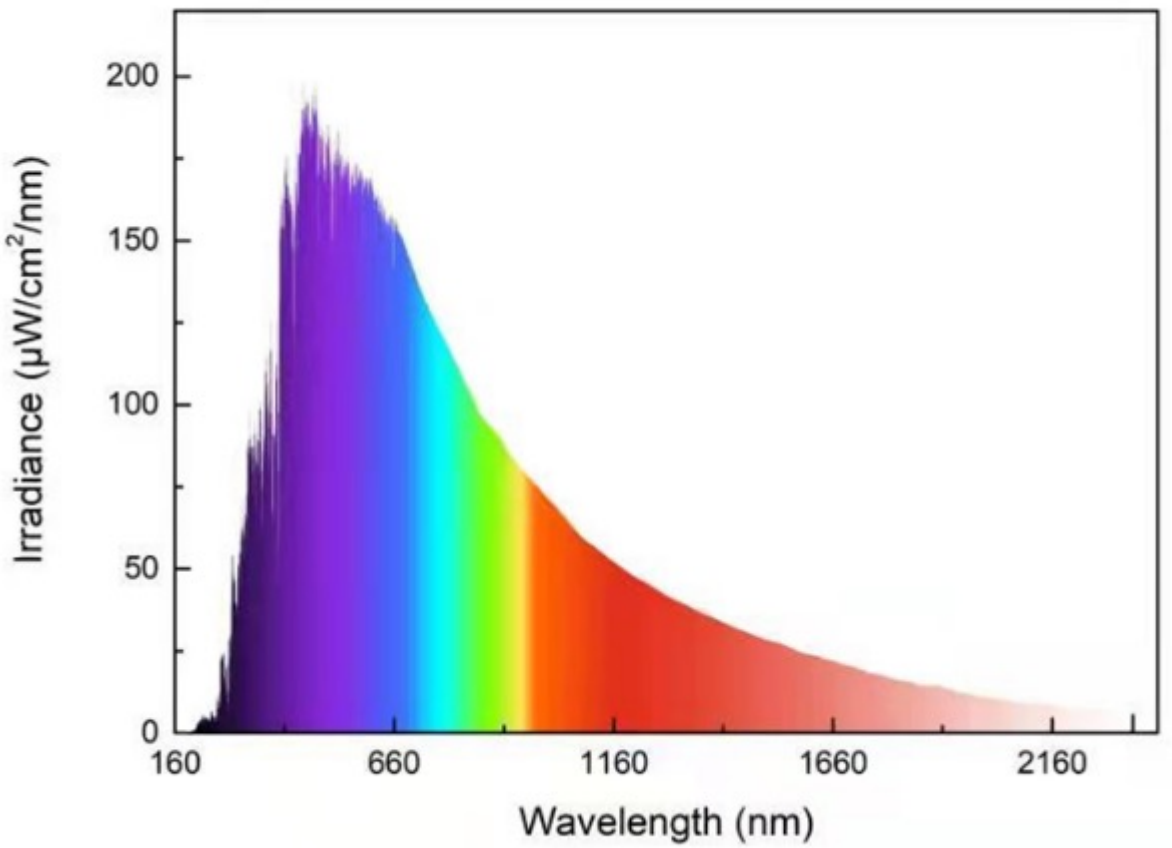


No.	Instruments	Statues
1	Dual- frequency wind radar (WindRAD)	**new**
2	Solar spectral irradiance monitor (SSIM)	
3	Solar X-EUV Imagers (XEUVI)	
4	MERSI-LL	**improved**
5	MWTS-III	
6	HIRAS-II	
7	GNOS-II	
8	SIM-II	
9	SEM	
10	Tri-IPM	
11	MWHS-II	**inherited**

The first set of images captured by FY-3E satellite

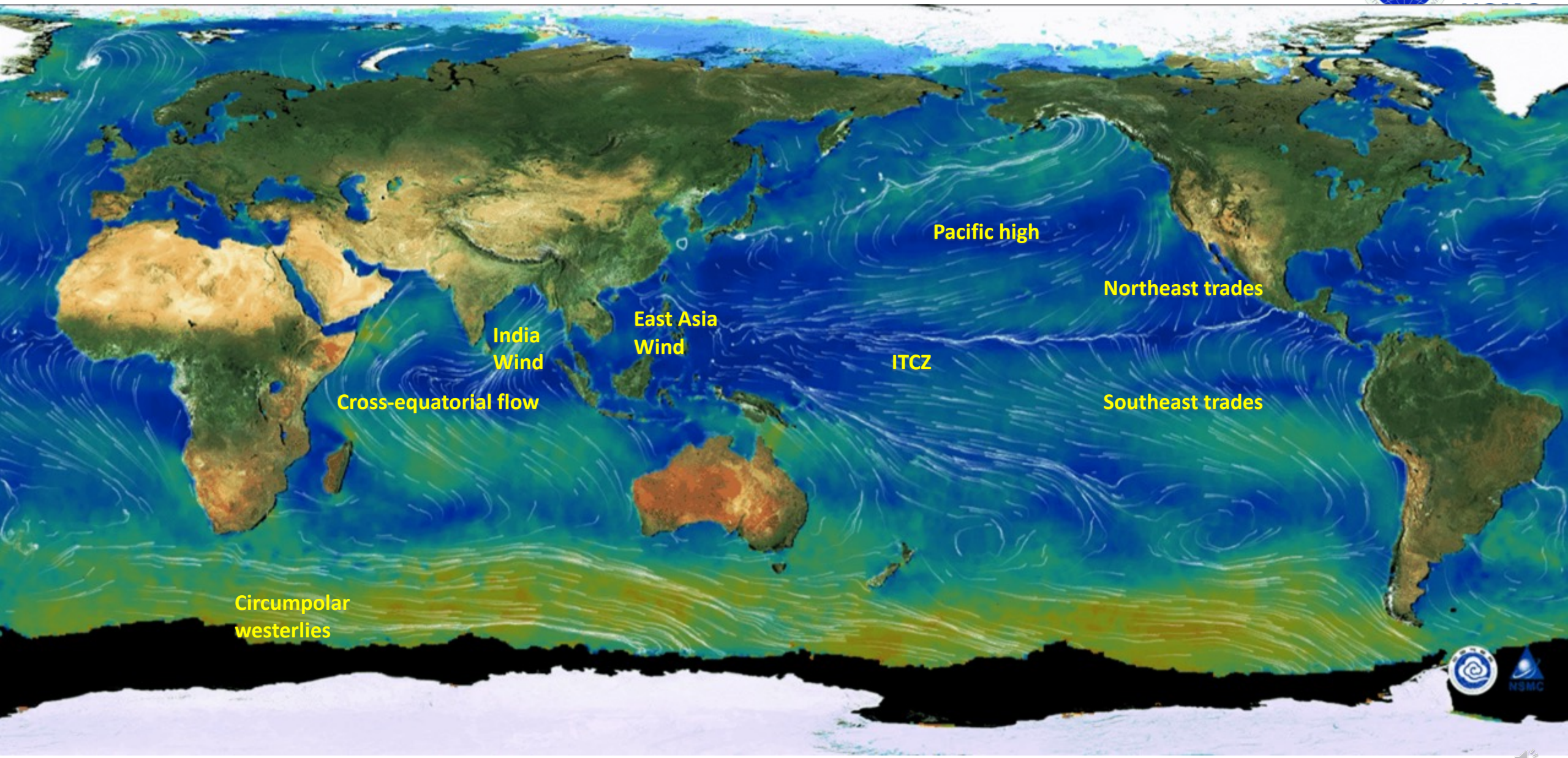


EUV animation of the sun captured by FY-3E satellite

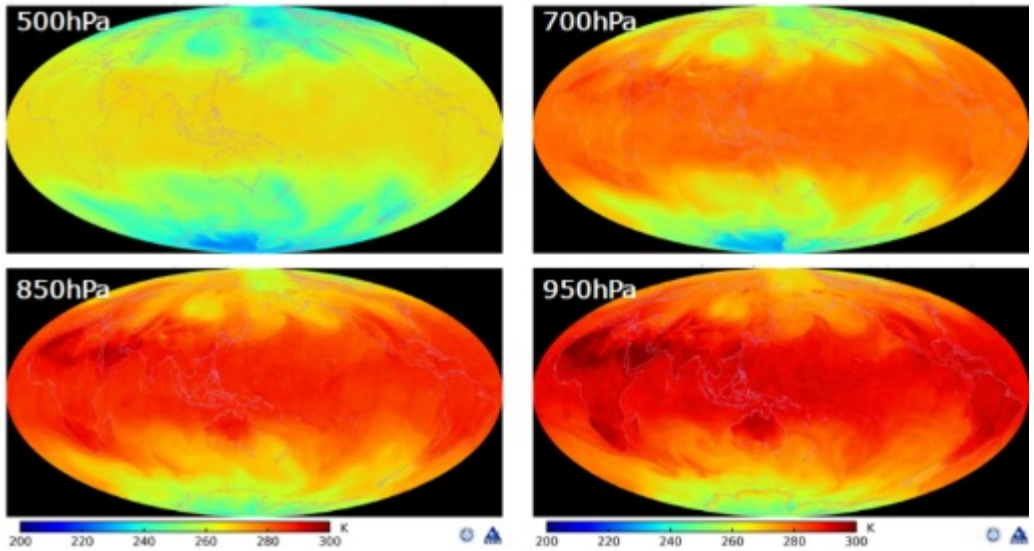


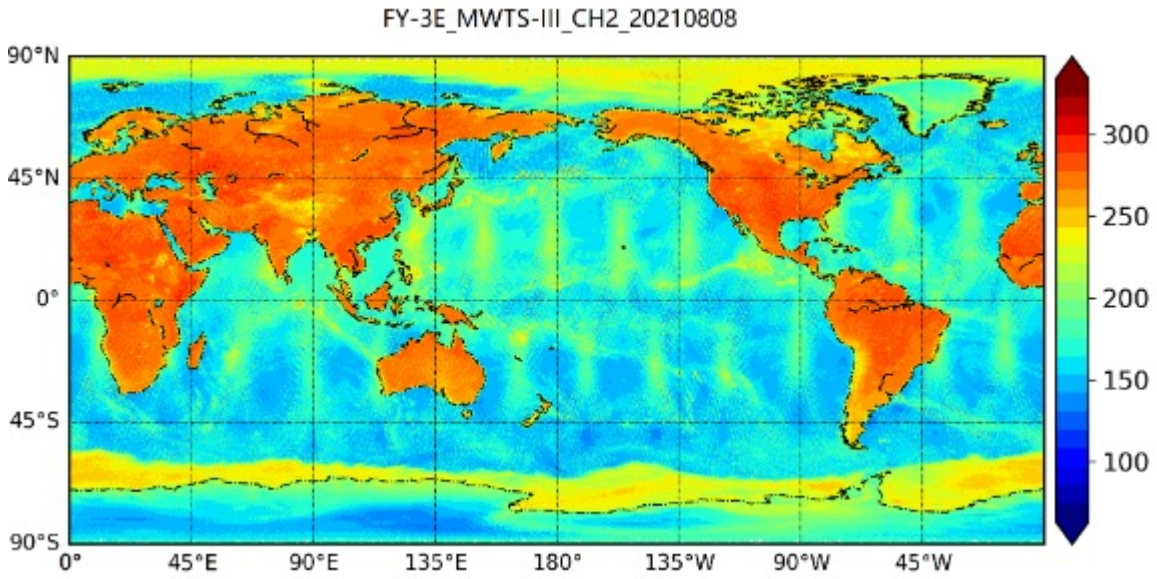
Refined structure of solar captured by FY-3E satellite

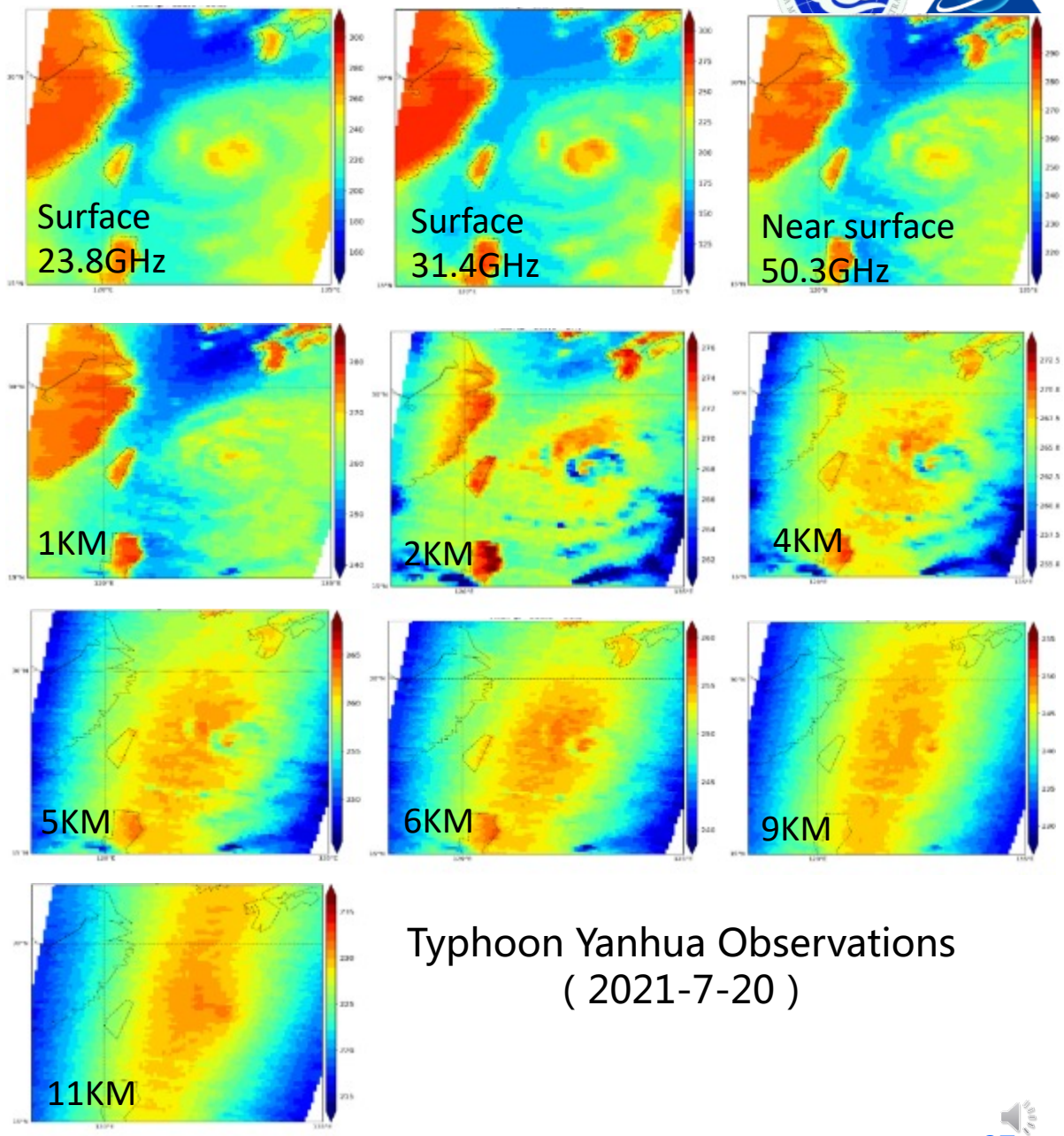
Monthly Wind from WindRAD/FY-3E (Sept., 2021)



Vertical Atmospheric Temperature

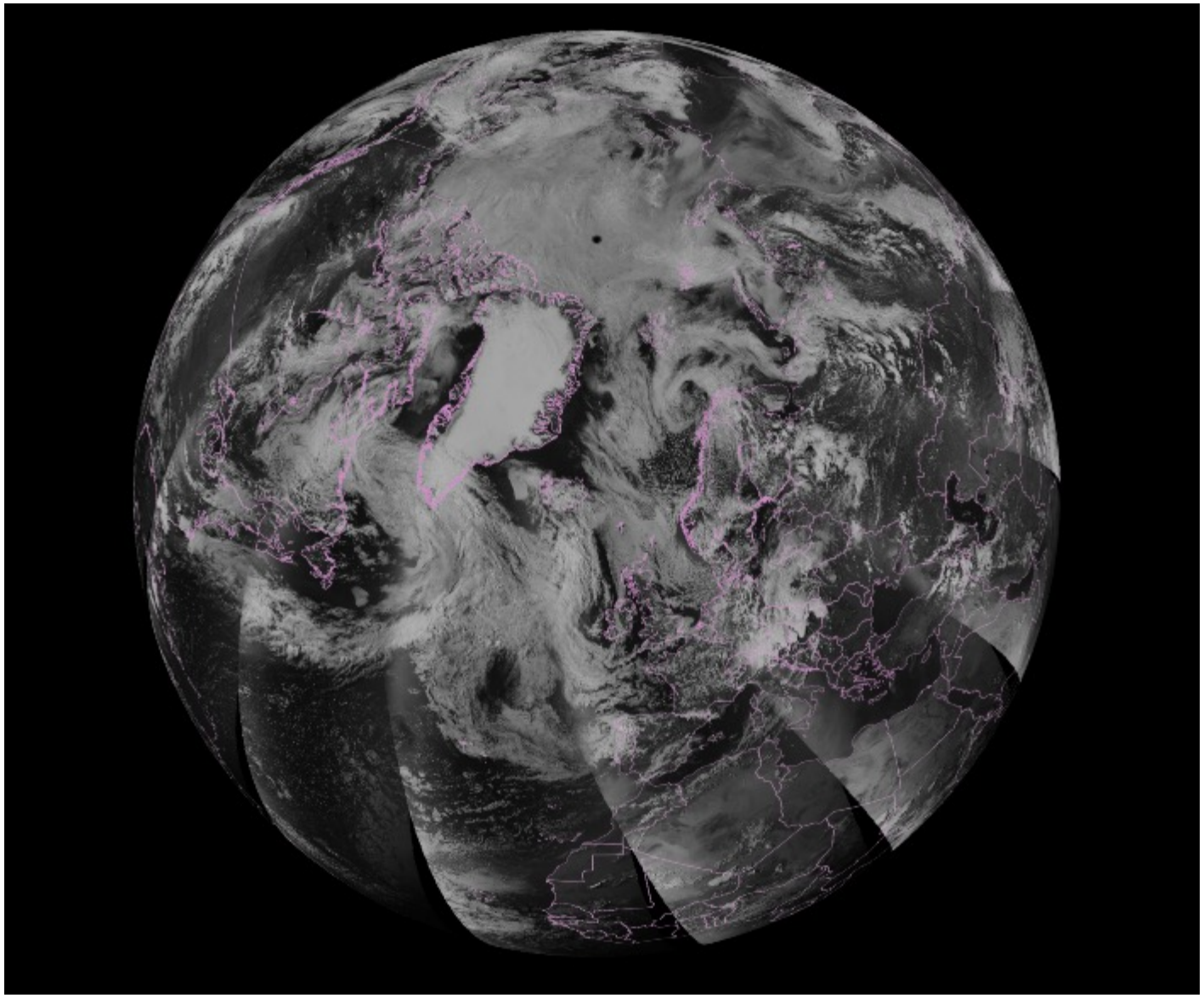




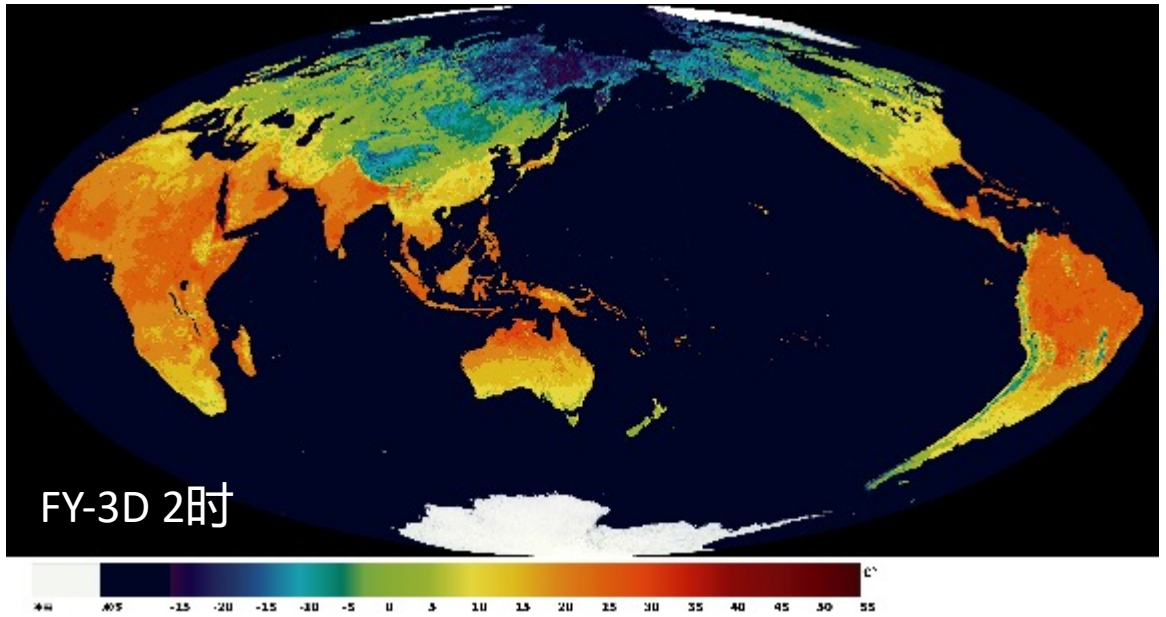


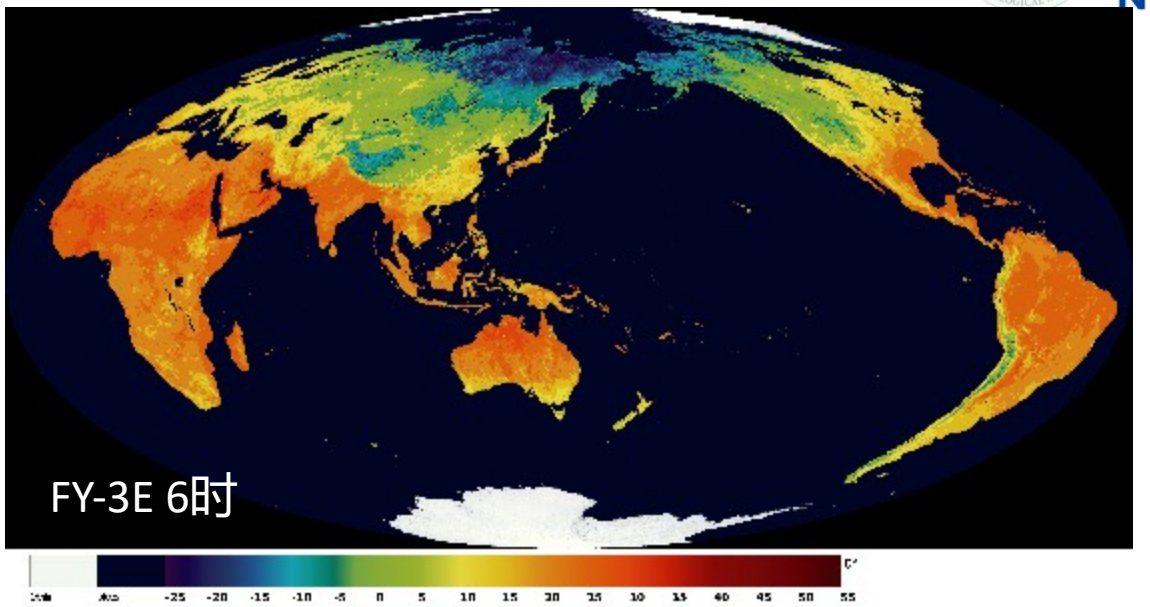
Typhoon Yanhua Observations
(2021-7-20)

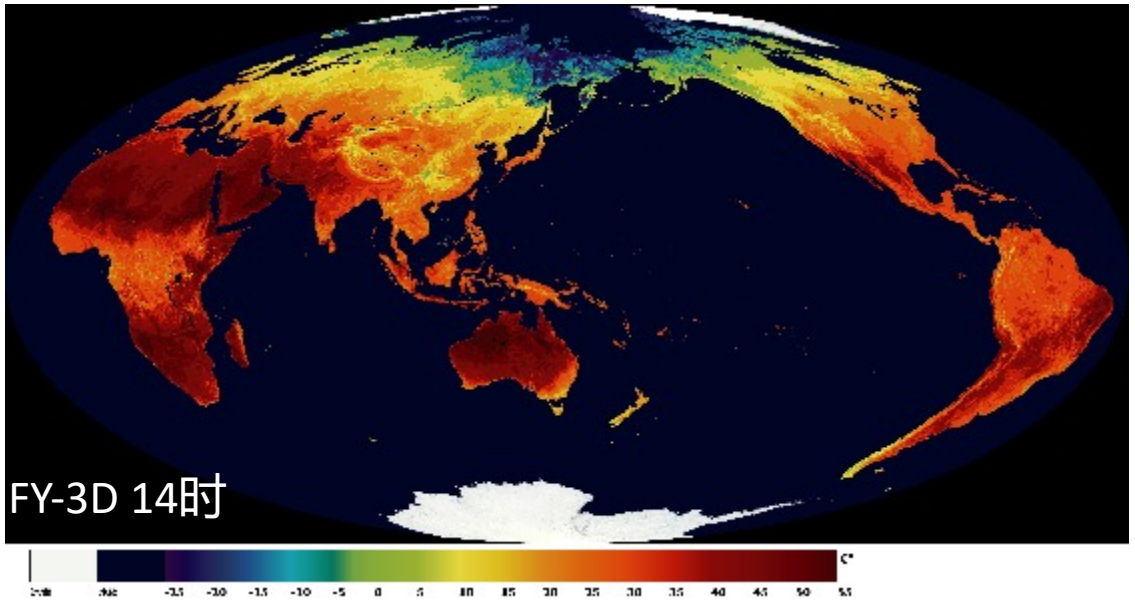
FY-3E MERSI-LL image and city light map

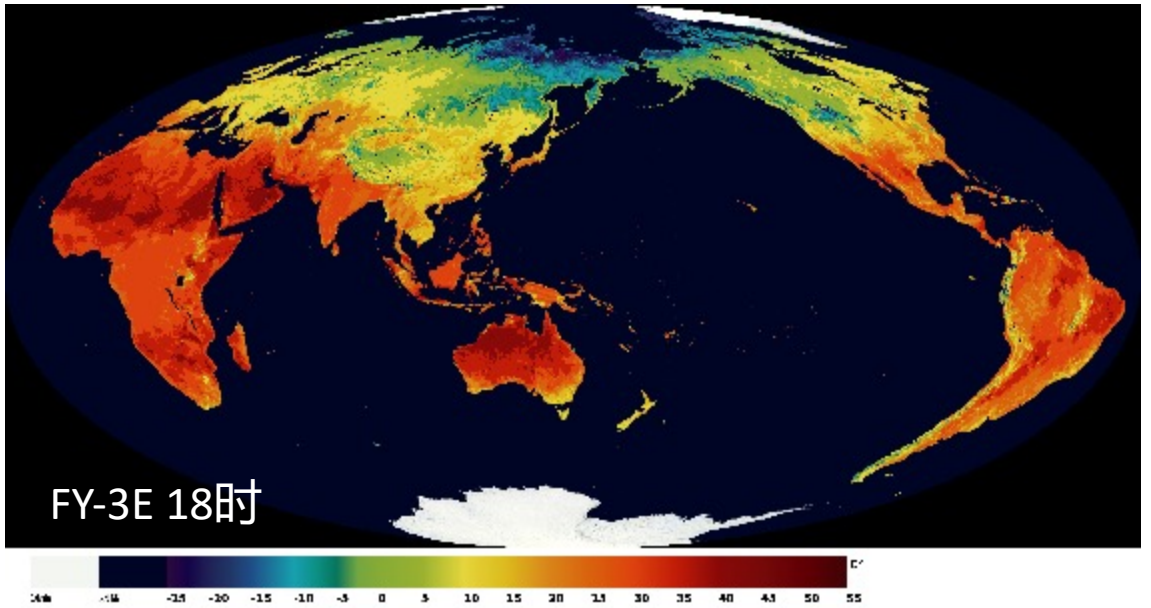


Global Land Surface Temperature from FY-3D + FY-3E









Outline

1. Fengyun Program Overview
2. Current Missions and Data Services
3. Latest Launch
4. Future Program
5. DB Service of FY-3E
6. Summarization

Vision for WMO Integrated Global Observing System in 2040

Tier 1 Backbone system with specified orbital configuration and measurement approaches

- Basis for Members' commitments, should respond to the vital data needs;
- Building on the current CGMS baseline, but with fully deployed (global) coverage, and with addition of newly maturing capabilities.

Tier 2 Backbone system with open orbit configuration and flexibility to optimize the implementation

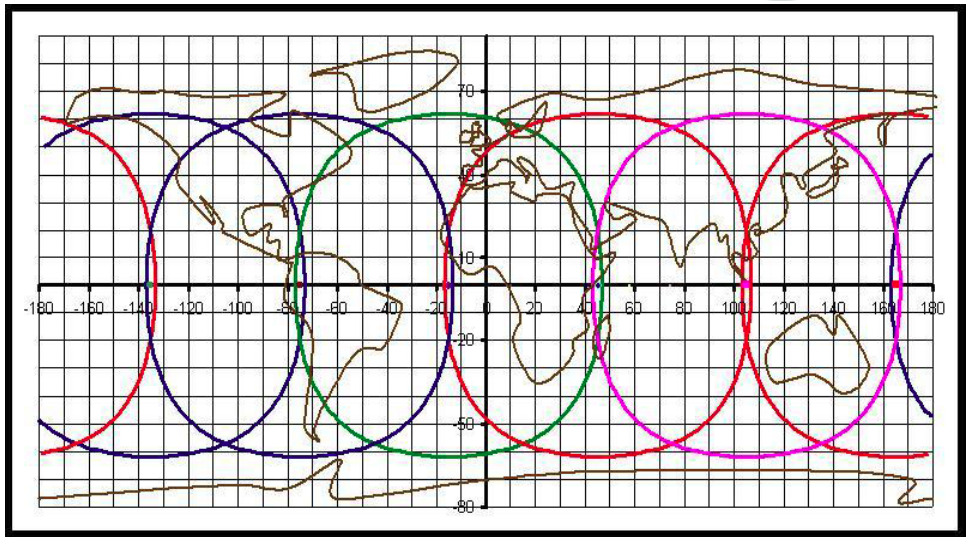
- Basis for open contributions of WMO Members, responding to target data goals.

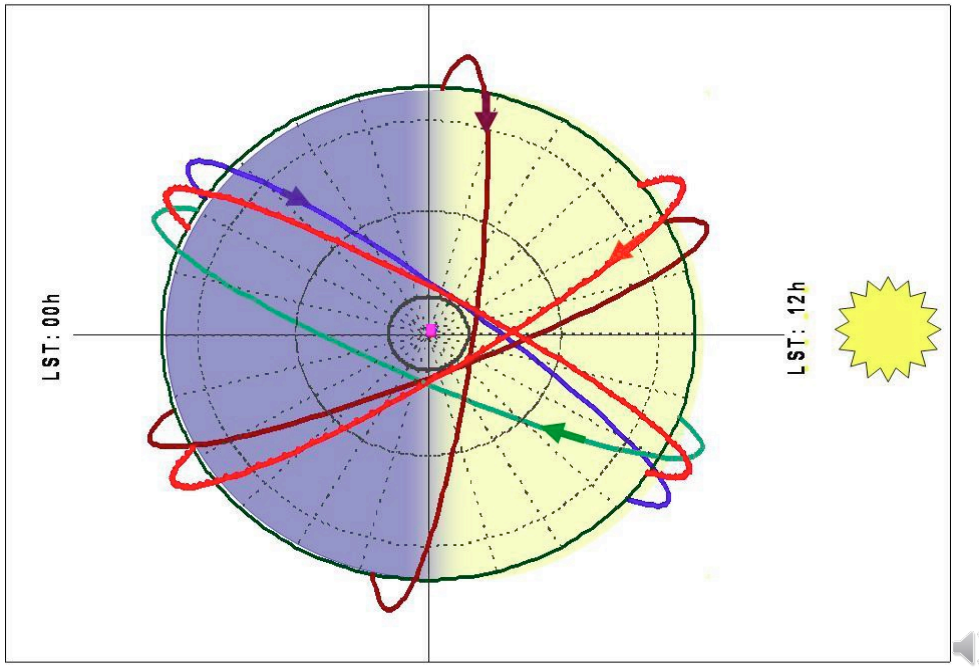
Tier 3 Operational pathfinders, and technology and science demonstrators

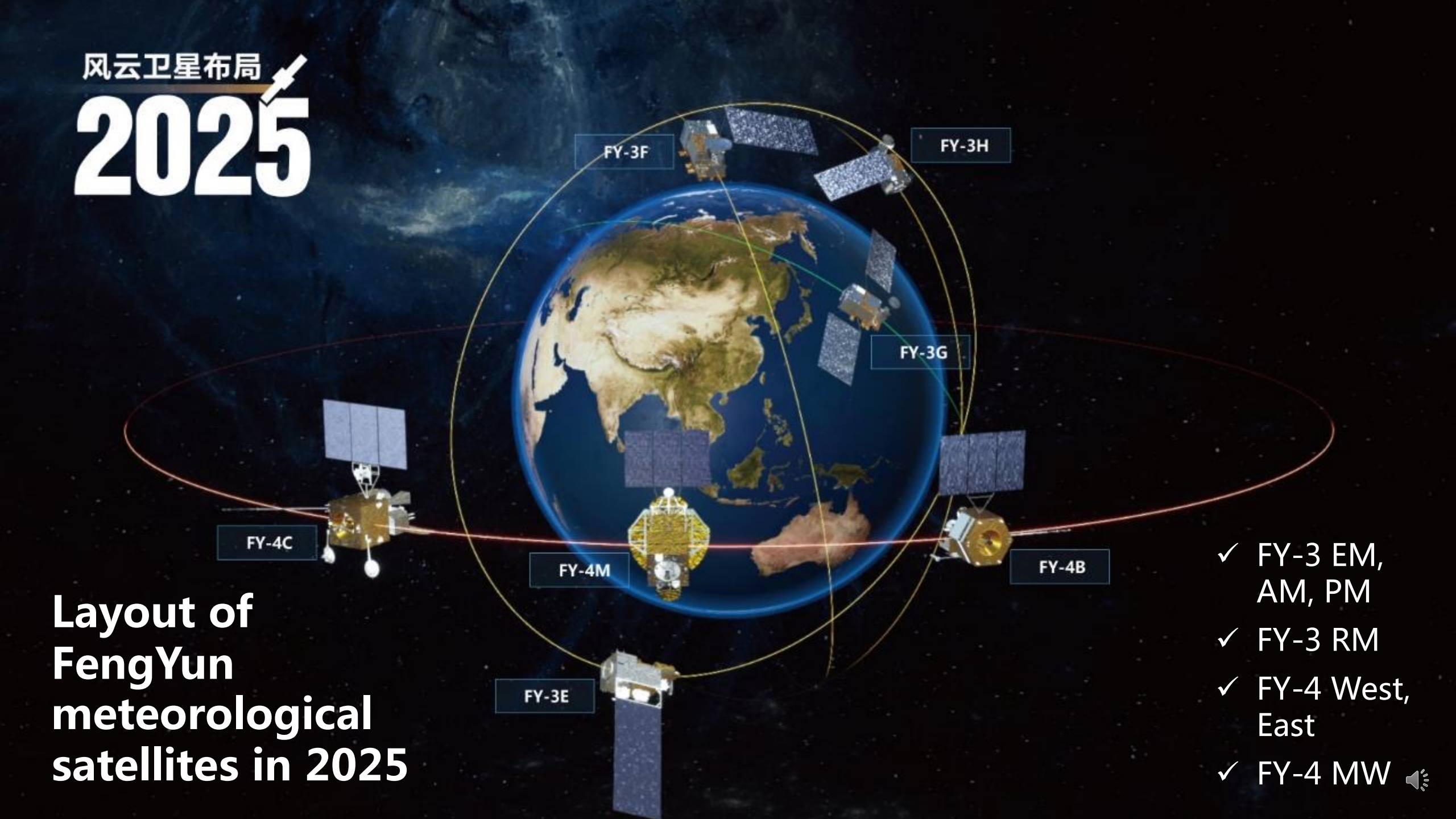
- Responding to R&D needs.

Tier 4 Additional capabilities

- Contributed by WMO Members and third parties including governmental and non-governmental actors (including from the academic and commercial sectors).

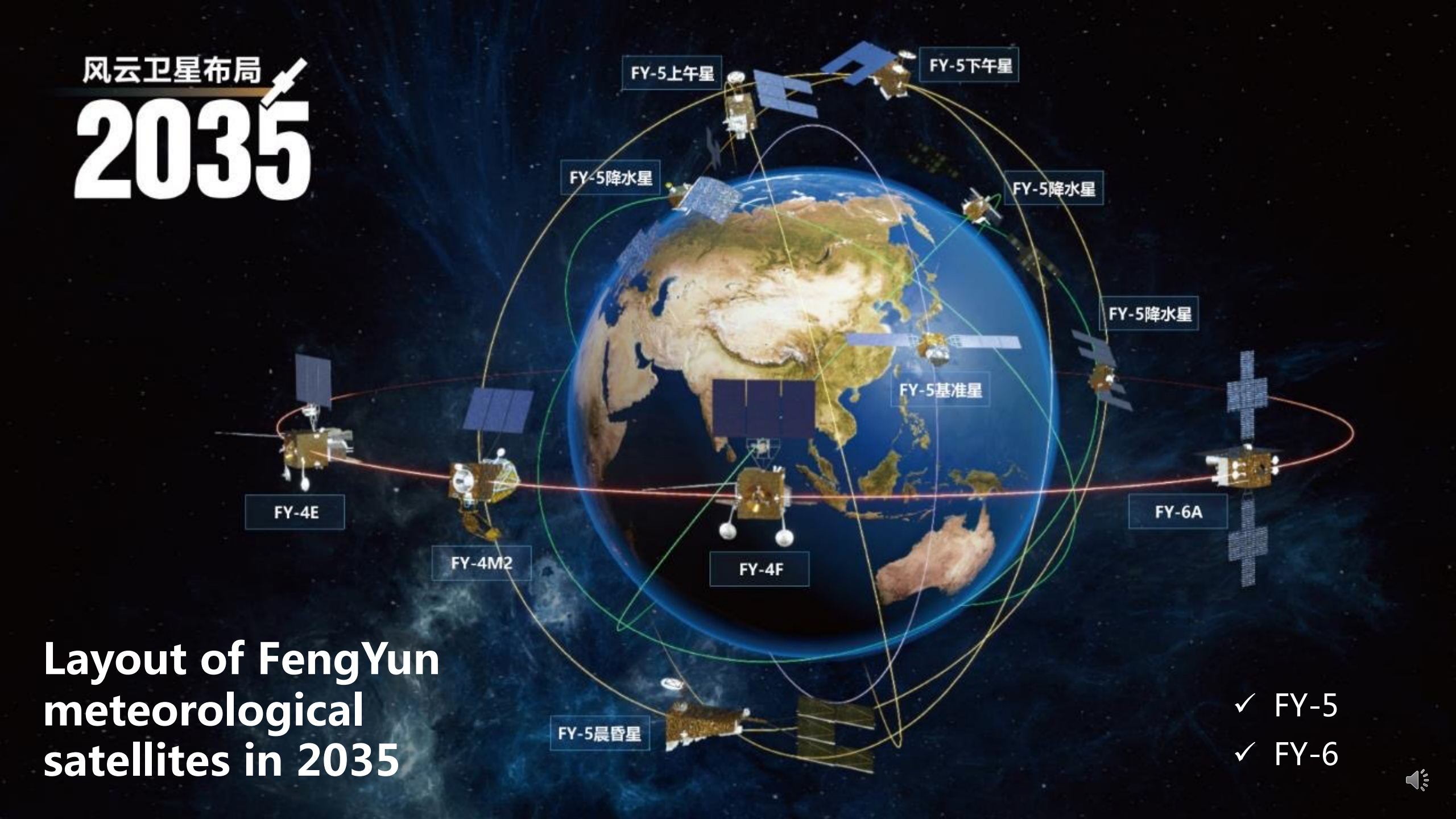






Layout of FengYun meteorological satellites in 2025

- ✓ FY-3 EM, AM, PM
- ✓ FY-3 RM
- ✓ FY-4 West, East
- ✓ FY-4 MW



Layout of FengYun meteorological satellites in 2035

- ✓ FY-5
- ✓ FY-6

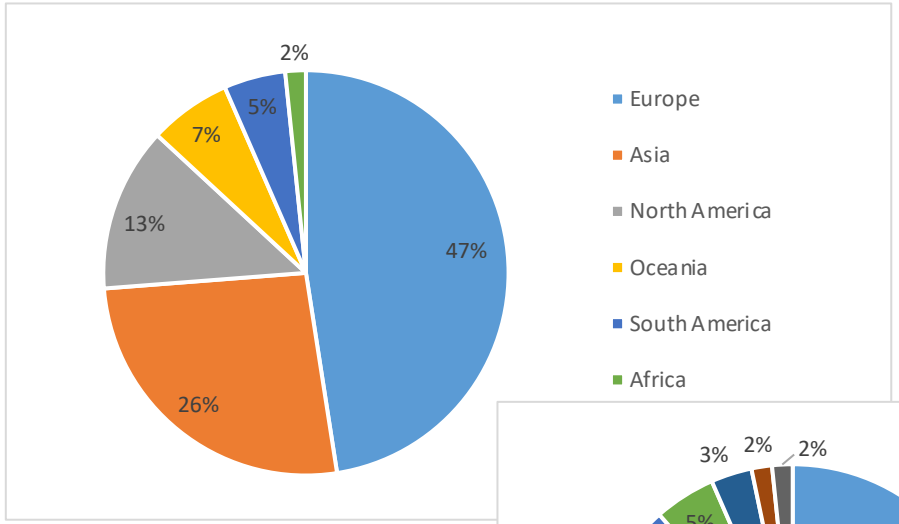
Outline

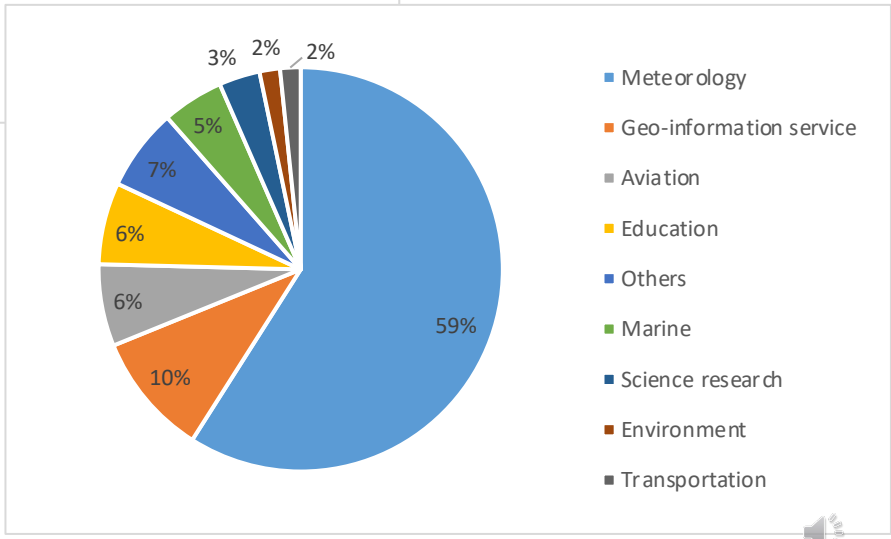
1. Fengyun Program Overview
2. Current Missions and Data Services
3. Latest Launch
4. Future Program
5. DB Service of FY-3E
6. Summarization

Current Status of DB Users

- The users distributed in 30 countries around the world.
- The users are mainly from meteorological departments, and some are from universities, research institutions, companies, etc.

	Country	Users		Country	Users
1	USA	7	16	Bolivia	1
2	Germany	5	17	France	1
3	Russia	5	18	Philippines	1
4	Australia	4	19	Finland	1
5	UK	4	20	Netherlands	1
6	Republic of Korea	3	21	Canada	1
7	Indonesia	3	22	Malaysia	1
8	Brazil	2	23	Mongolia	1
9	Norway	2	24	Niger	1
10	Thailand	2	25	Japan	1
11	Spain	2	26	Sweden	1
12	The United Arab Emirates	1	27	Ukraine	1
13	Oman	1	28	Greece	1
14	Belarus	1	29	Singapore	1
15	Poland	1	30	Vietnam	1



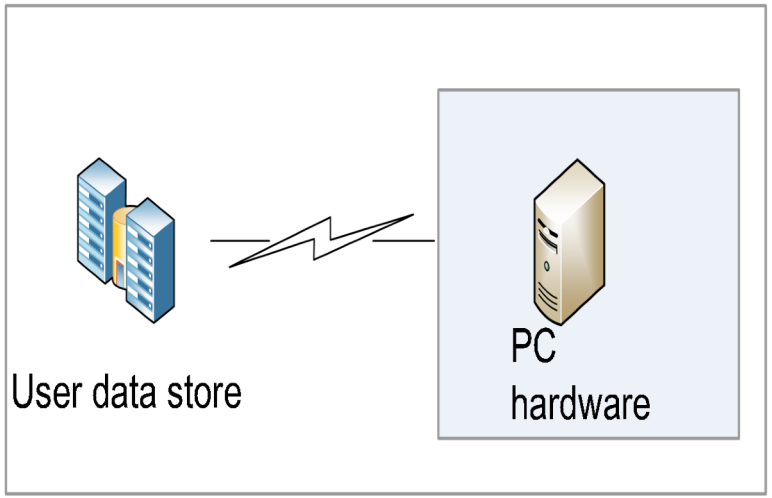


Parameters for FY-3E Direct Broadcasting

Parameter	Unit	Design Value	Note
Frequency	MHz	7860	
Satellite EIRP	dBW	19.92	
Propagation Path Length	Km	2846.00	Alt=831 Km, Elev Angle=5°
Free Space Loss	dB	179.50	
Polarisation Loss (a)	dB	1.00	
Rain & Atmospheric Loss (b)	dB	4.50	
Multipath Loss (c)	dB	0.20	
Ground Antenna Pointing Loss (d)	dB	0.50	
Ground Station G/T	dB/K	22.70	Antenna diameter: 3M（CGMS DB standard configuration）
Boltzmann's Constant	dBW/Hz-K	-228.60	
DATA CHANNEL (QPSK)			
Data Power/No	dBm/Hz	85.52	
Information Rate	dB-Hz	78.86	77MHz， after Reed Solomon (255/223) + Convolutional rate 3/4
Available Eb/No	dB	6.66	
Required Eb/No for 10^{-6}FER	dB	6.4	
Implementation Loss (e)	dB	1.8	
Available Signal Margin (f)	dB	-1.54 (3M) 1.26(4.2M)	For CGMS DB standard configuration, the antenna diameter is 3M, in low elevation or heavy rainfall situation, the available signal margin may be not enough, we suggest using 4.2M antenna for FY-3E DB data receiving.

The Preparation of FY-3E DB Software packages

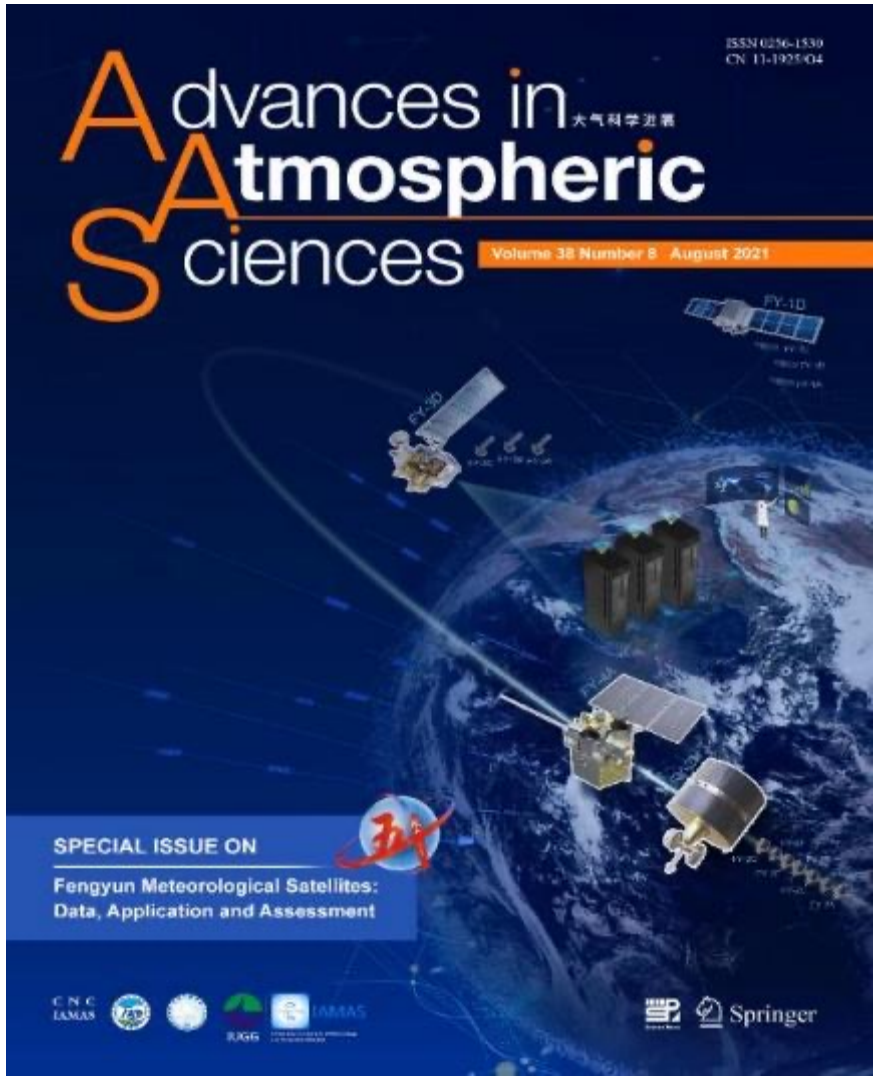
- The FY-3E DB software includes a complete L0~L1 data processing flow, the main functions include: L0 data unpacking and collecting, L0 data quality control, geolocation and radiometric calibration, L1 products generation.
- The FY-3E DB software package has completed development，precision comparison test and preparation of user required documents.
- DB software package will be released, 4 instruments: MWHS -II, MWTS-III, MERSI-LL and HIRAS-II will be released for the international DB users.
- Release date: July, 2022 for 1st batch, TBD for the 2nd bath.



Summarization

- With the open data policy, reliable and sustained satellite, good data accuracy, FY series have be one important components of global observation system.
- Current FY-3 series are expected to work until 2030 with Early Morning orbit, Morning orbit, and Afternoon orbit and Rainfall mission.
- Current FY-4 series are expected to work until 2035 with FY-4 East (133E) and FY-4 West (79E).
- Future FY-5 and FY-6 are expected to provide service since 2030 and 2035 respectively.
- Fengyun Meteorological Satellites will contribute to WMO members and support DB users continuously.

Special Issue has been published



The First Fengyun Satellite International User Conference

Di XIAN, Peng ZHANG, Meng FANG, Chang LIU, Xu JIA
Accepted Manuscript, Available online 11 March 2020 , Manuscript accepted 09 March 2020, doi: 10.1007/s00376-020-2011-5
[Abstract](434) [FullText HTML] (167) [PDF 1536KB](63)

Insights into the Microwave Instruments Onboard the Fengyun 3D Satellite: Data Quality and Assimilation in the Met Office NWP System

Fabien CARMINATI, Nigel ATKINSON, Brett CANDY, Qifeng LU
Accepted Manuscript, Available online 04 June 2020 , Manuscript accepted 28 May 2020, doi: 10.1007/s00376-020-0010-1
[Abstract](474) [FullText HTML] (188) [PDF 2395KB](54)

Water Vapor Retrievals from Near-infrared Channels of the Advanced Medium Resolution Spectral Imager Instrument onboard the Fengyun-3D Satellite

Ling WANG, Xiuqing HU, Na XU, Lin CHEN
Accepted Manuscript, Available online 08 September 2020 , Manuscript accepted 07 September 2020, doi: 10.1007/s00376-020-0174-8
[Abstract](83) [FullText HTML] (34) [PDF 3047KB](46)

Growing operational use of FY-3 data in the ECMWF system

Niels Bormann, David Duncan, Stephen English, Sean Healy, Katrin Lonitz, Keyi Chen, Heather Lawrence, Qifeng Lu
Accepted Manuscript, Available online 05 November 2020 , Manuscript accepted 04 November 2020, doi: 10.1007/s00376-020-0207-3
[Abstract](34) [FullText HTML] (18) [PDF 1312KB](7)

Rainfall Algorithms Using Oceanic Satellite Observations from MWHS-2

Ruiyao Chen, Ralf Bennartz
Accepted Manuscript, Available online 17 November 2020 , Manuscript accepted 13 November 2020, doi: 10.1007/s00376-020-0258-5
[Abstract](24) [FullText HTML] (12) [PDF 1638KB](6)

https://link.springer.com/journal/376/volumes-and-issues/38-8

Recent Publication for FY Satellites

Ph.D, Senior Scientist. Deputy Director–General of National Satellite Meteorological Center (NSMC/CMA) since 2013, Chief Director of FY-3 ground segment since 2013, Chair of Global Space Inter-Calibration System (GSICS) Executive Panel from 2014 to 2017, Chief Director of Chinese TanSat satellite ground segment since 2015, IEEE Senior Member since 2016

P. Zhang, X. Q. Hu, Q. F. Lu, A. J. Zhu, M. Y. Lin, L. Sun, L. Chen, and N. Xu, 2021: FY-3E: The first operational meteorological satellite mission in an early morning orbit. Adv. Atmos. Sci., https://doi.org/10.1007/s00376-021-1304-

D. Xian, **P. Zhang**, L. Gao, R.J. Sun, H.Z. Zhang, X. Jia, 2021: Fengyun Meteorological Satellite Products for Earth System Science Applications. Adv. Atmos. Sci., https://doi.org/10.1007/s00376-021-0425-3.

P. Zhang, L. Chen, D. Xian, Z. Xu, 2020: Recent progress of Fengyun meteorology satellites. Chin. J. Space Sci., 40(5): 788-796, DOI:10.11728/cjss2018.05.788.

P. Zhang, Q. F. Lu, X. Q. Hu, S.Y. Gu, L. Yang, M. Min, L. Chen, N. Xu, L. Sun, W.G. Bai, G. Ma, and D. Xian, 2019: Latest progress of the Chinese meteorological satellite program and core data processing technologies. Adv. Atmos. Sci., 36(9), 1027–1045. https://doi.org/10.1007/s00376-019-8215-x.

P. Zhang, L. Zhu, S. Tang, L. Gao, L. Chen, W. Zheng, X. Han, J. Chen and J. Shao, 2019: General Comparison of FY-4A/AGRI With Other GEO/LEO Instruments and Its Potential and Challenges in Non-meteorological Applications. Front. Earth Sci. 6:224. doi: 10.3389/feart.2018.00224

Make the data better and easier to use !