2022

CMA updates since CGMS-52 and report on the medium to long-term future plans on Earth observation

Presented to CGMS-53 Plenary session
Dr. TANG Shi-Hao
NSMC/CMA

Coordination Group for Meteorological Satellites

NSMC NCSW CGMS

Current FengYun Constellation in orbit

GEO

FY-2G, -2H

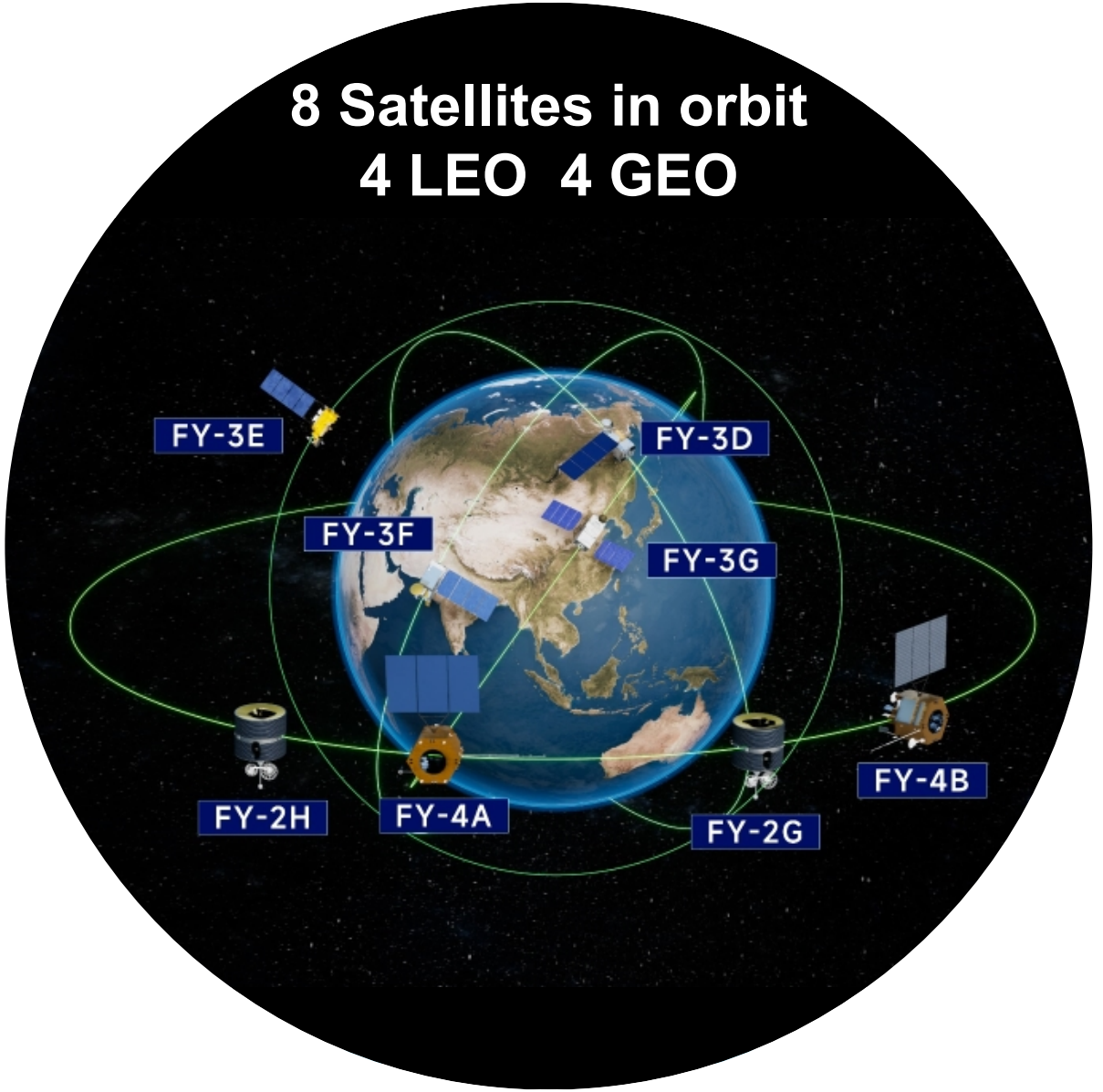
FY-2G (99.5°E) and FY-2H (79°E)
Full disk every 30 min
FY-2H, last flight unit of FY-2 series.

FY-4A

FY-4A (123.5°E) , Full disk every 15 min.

FY-4B

FY-4B (105°E), Full disk every 15 min, partial areas rapid scanning at 1 min.
Operational since 1st December 2022



LEO

FY-3D

Afternoon orbit, ECT 13:45 local time
10 EO instruments

FY-3E

Early-morning orbit, ECT 5:41 local time
11 EO instruments
Operational since 1 Dec. 2022

FY-3F

Mid-morning orbit
10 EO instruments
Launched 3 Aug. 2023

FY-3G

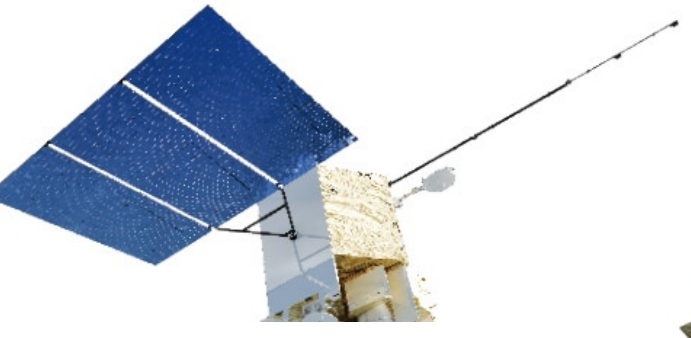
Drifting orbit
6 EO instruments
Launched 16 Apr. 2023
In-orbit testing data released

Satellite status updates

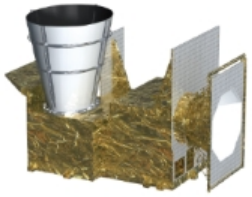
- FY-4B carried out operational service at 105°E on 5 Mar, 2024.
- FY-4A suspended service from 5 Mar, 2024. Drifted from 86.5°E to 123.6°E on Feb, 2025.
- FY-3G Rainfall & FY-3F AM mission in-orbit test were completed and switched to opeational status on May and July 2024 respectively.
- FY-3C retired from operational status on November 20, 2024.
- The "Tianmu-1" constellation with 23 satellites and the "Yunyao-1" series with 12 satellites were integrated into CMA comprehensive meteorological observation system and commenced operational use on December 30.

FengYun GEO Satellites: FY-4B

- FY-4A suspended service from 5 Mar, 2024. Drifted from 86.5°E to 123.6°E on Feb, 2025.
- FY-4B carried out operational service at 105°E on 5 Mar, 2024.



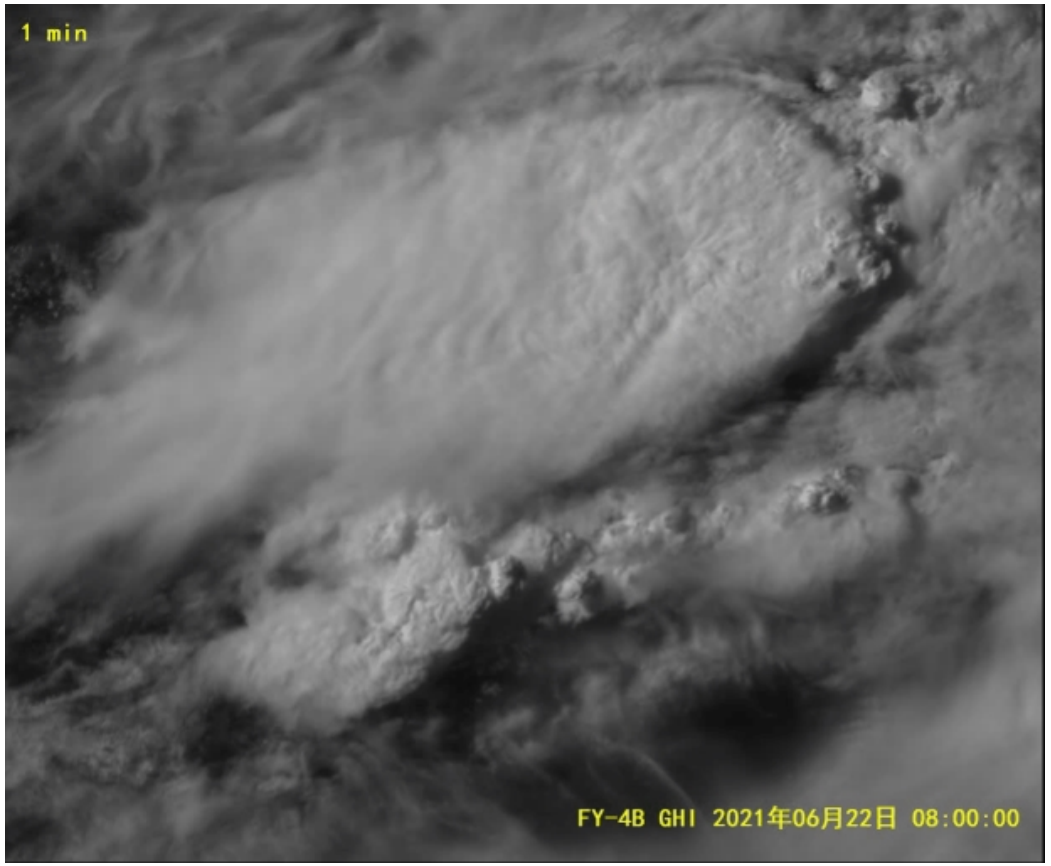
Geostationary High-speed Imager (GHI)



Geostationary Interferometric Infrared Sounder (GIIRS)

Space Environment Monitoring Instrument Package (SEP)

Advanced Geostationary Radiation Imager (AGRI)



FY-4B Geo. High-speed Imager (GHI)

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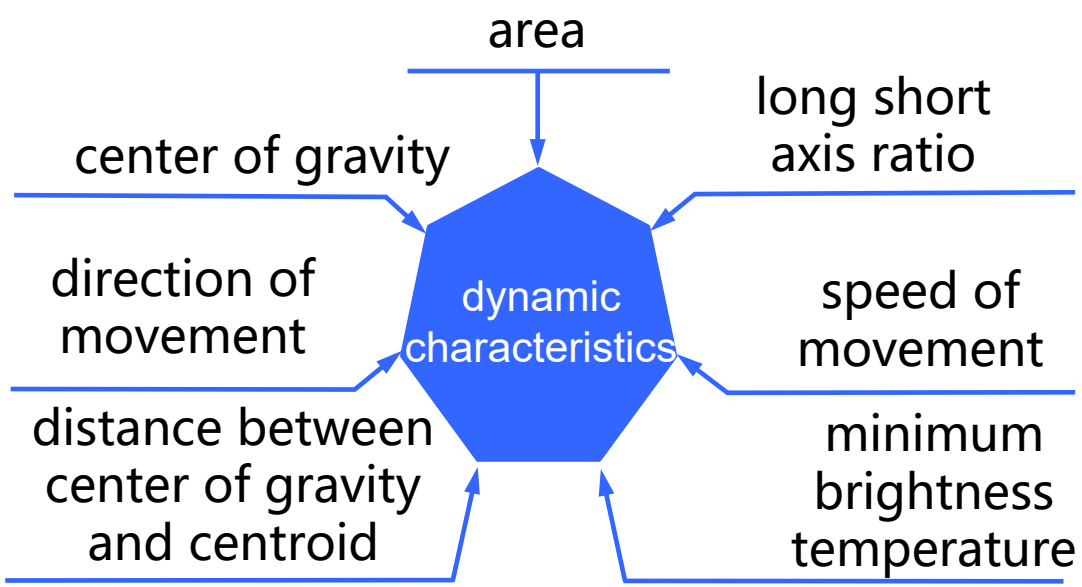
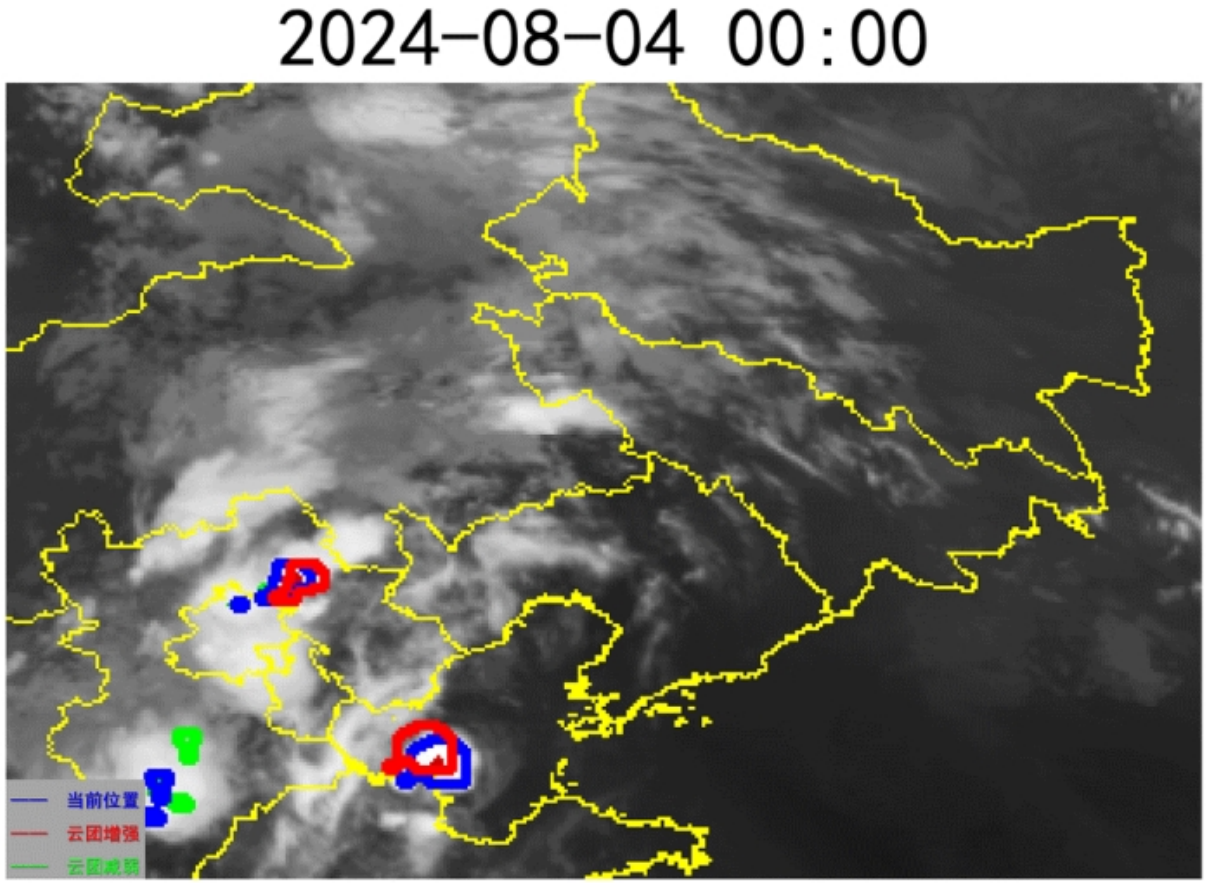
Highlights： Strong convective cloud cluster tracking based on dynamic characteristics

- By calculating the dynamic characteristics of cloud clusters at different times, cloud matching can be achieved to achieve accurate tracking.





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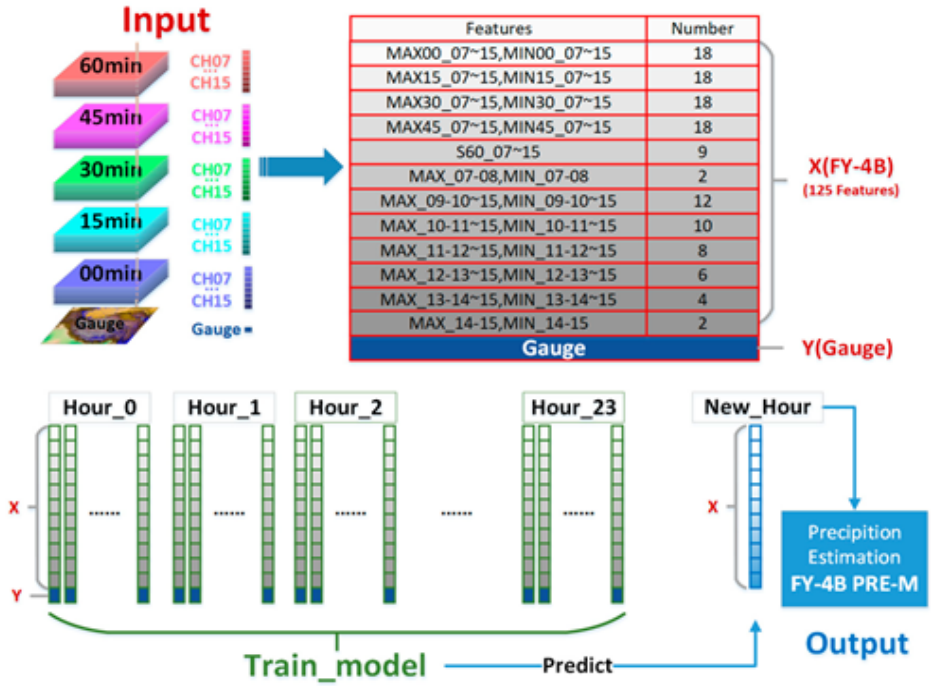
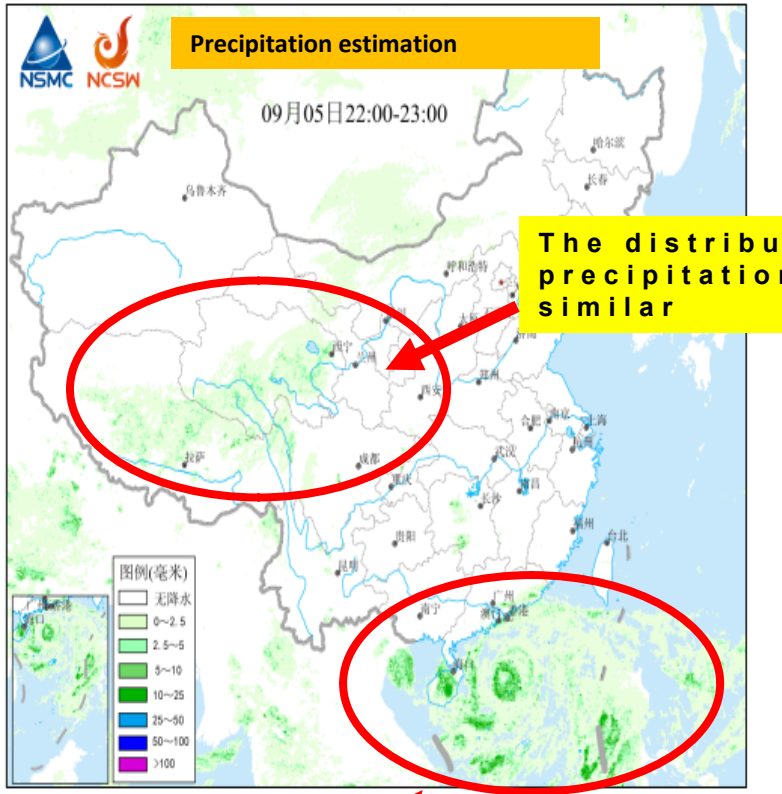
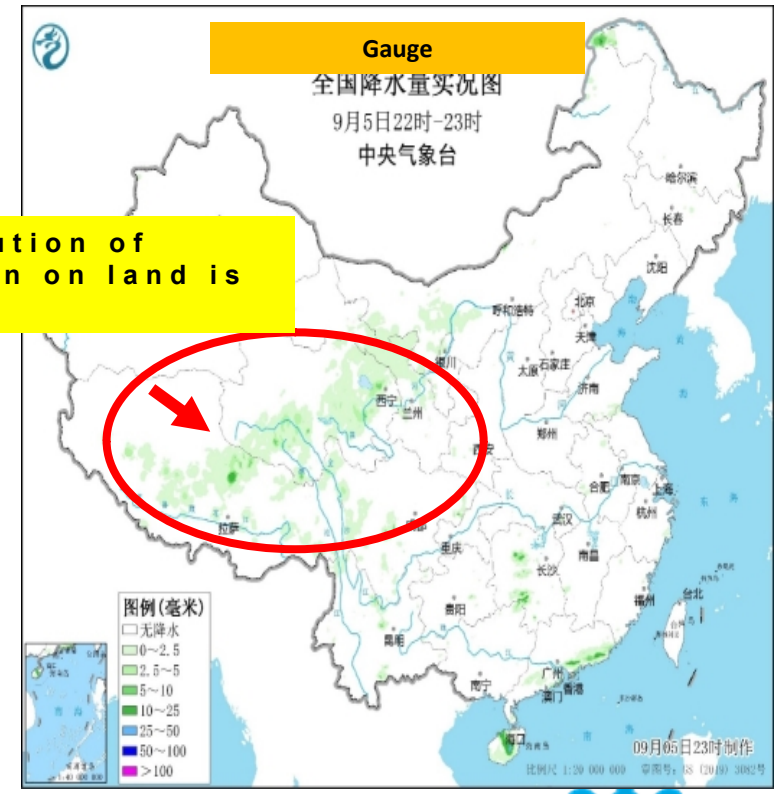
Highlights： Artificial Intelligence-Based Precipitation Estimation Method Using Fengyun-4B Satellite Data







The distribution of precipitation on land is similar

Precipitation estimation can monitor precipitation at sea

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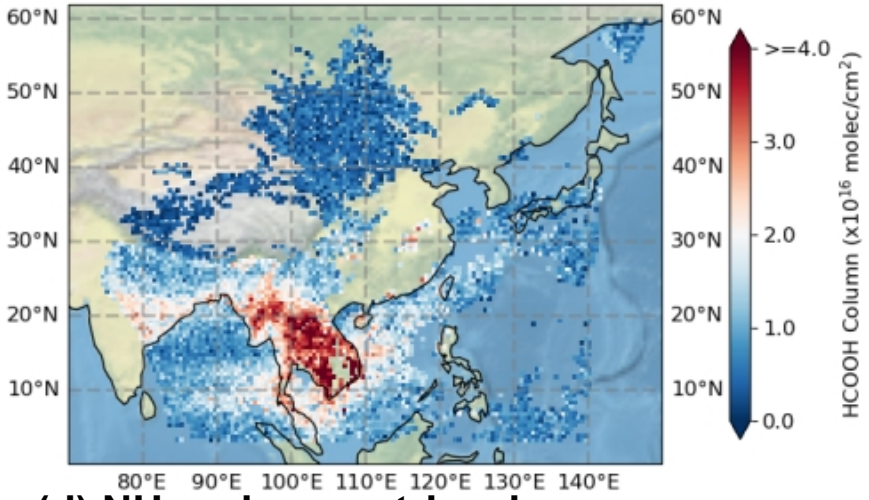
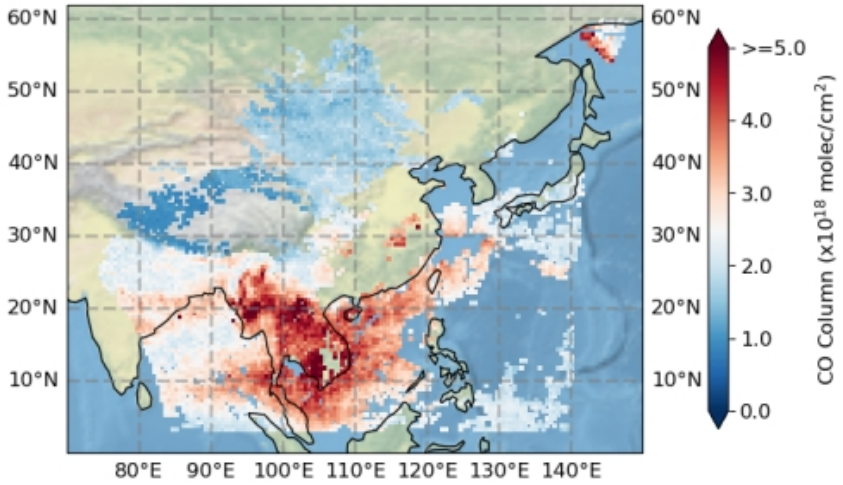
Highlights： Trace Gas Retrieval based on FY-4 IR Sounder

(a) Fire emissions in Southeast Asia

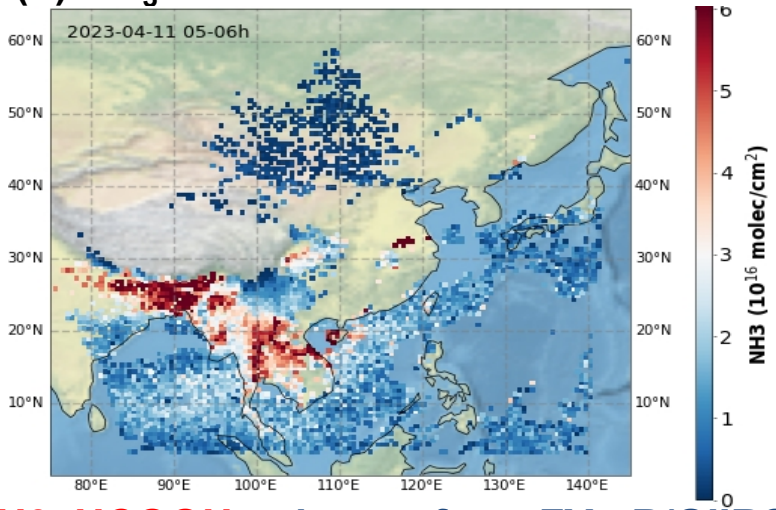
(c) HCOOH column retrievals



(b) CO column retrievals



(d) NH_3 column retrievals



(a) Intense fire emissions in Southeast Asia (Jan to Apr)
#slash-and-burn agriculture;
#loggers use fire to clear roads and lands
#cool and dry weather

Examples: 11 April 2023, local noontime

(b) CO retrievals from GIIRS tracks the long-range transport (lifetime: weeks to months);

(c) and (d): **HCOOH and NH3** emissions show similar patterns, but with shorter range (shorter lifetime)

Co
Meteorological Satellites

Wildfire CO, NH3, HCOOH columns from FY-4B/GIIRS

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FY-3G

First precipitation measurement satellite in China

Successfully launched at 9:36 16 Apr. 2023.

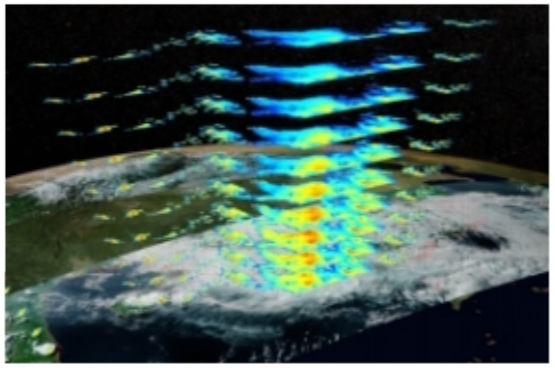
6 instruments: 3 new, 2 upgraded, 1 inherited

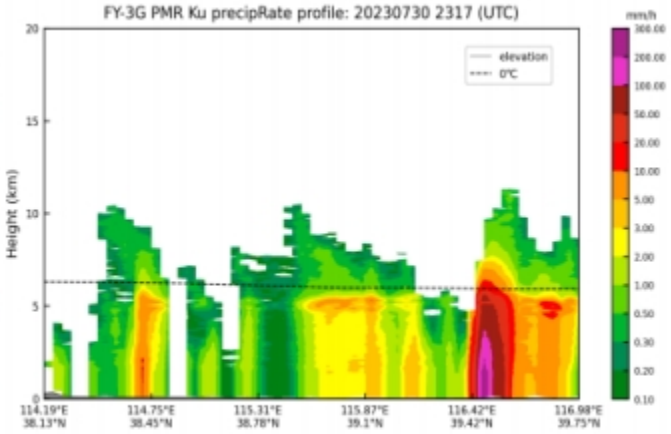
Simulated data released on 16 Apr. 2023

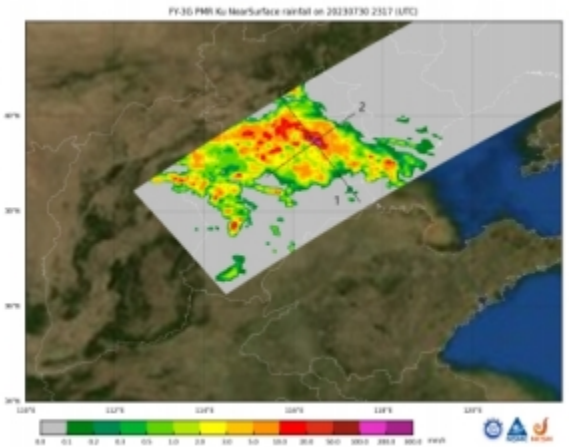
First image released on 15 May 2023

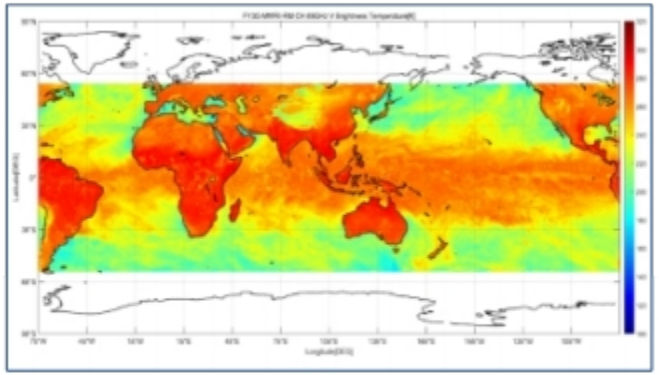
FY-3G offically began operational services since 1st May 2024

Instrument Name	Acronym
Precipitation Measurement Radar	PMR ★
GNSS Radio Occultation Sounder - 2	GNOS-2
MERSI-Rainfall Measurement	MERSI-RM
Micro-Wave Radiation Imager for the Rainfall Mission	MWRI-RM
High Accuracy On-board Calibrator	HAOC ★
Short-wave Infrared Polarized Multi-Angle Imager	PMAI ★









FY-3F

a new morning orbit satellite

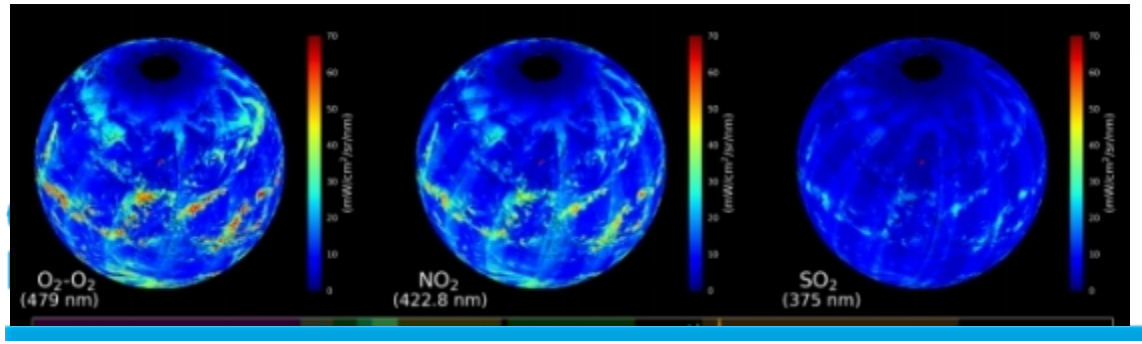
Successfully launched on 3rd Aug. 2023

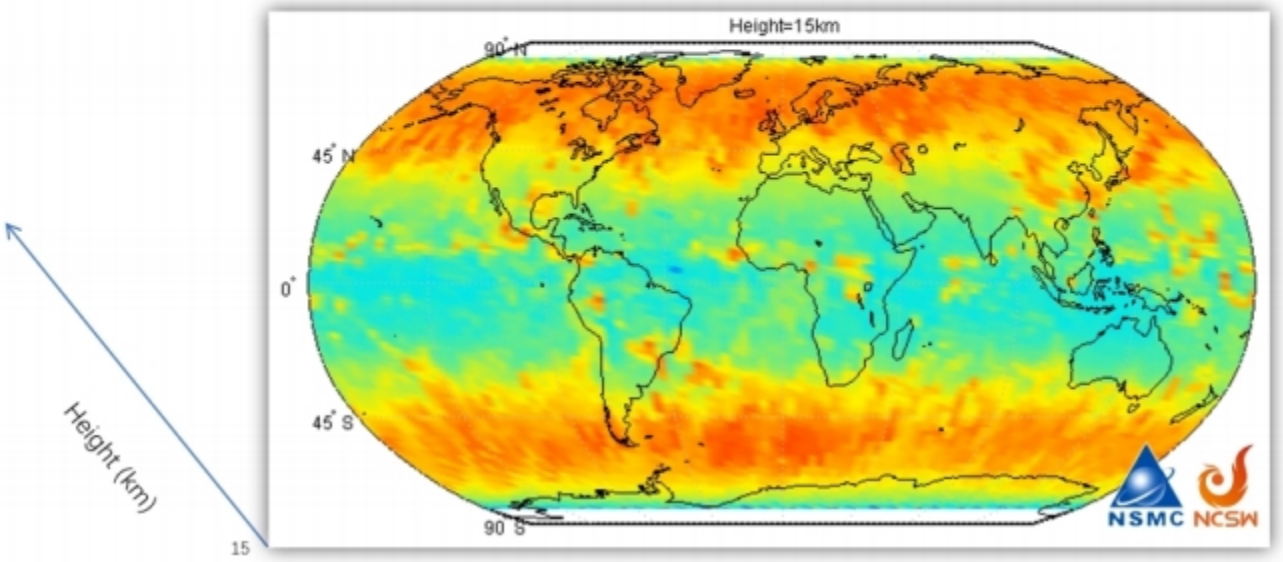
10 instruments, including two new Ozone Monitoring Instruments

FY-3F switched to operation in July,2024.

Continue to provide 3D global atmospheric sounding data for numerical weather prediction models with more than 50 products

Full name	Acronym
Micro-Wave Humidity Sounder -2	MWHS-2
Micro-Wave Temperature Sounder - 3	MWTS-3
Hyperspectral Infrared Atmospheric Sounder - 2	HIRAS-2
GNSS Radio Occultation Sounder - 2	GNOS-2
Ozone Monitoring Suite - nadir scanning unit	**OMS-nadir**
Ozone Monitoring Suite - limb scanning unit	**OMS-limb**
Medium Resolution Spectral Imager - 3	MERSI-3
Micro-Wave Radiation Imager 2	MWRI-2
Earth Radiation Measurement - 2	ERM-2
Solar Irradiance Monitor - 2	SIM-2

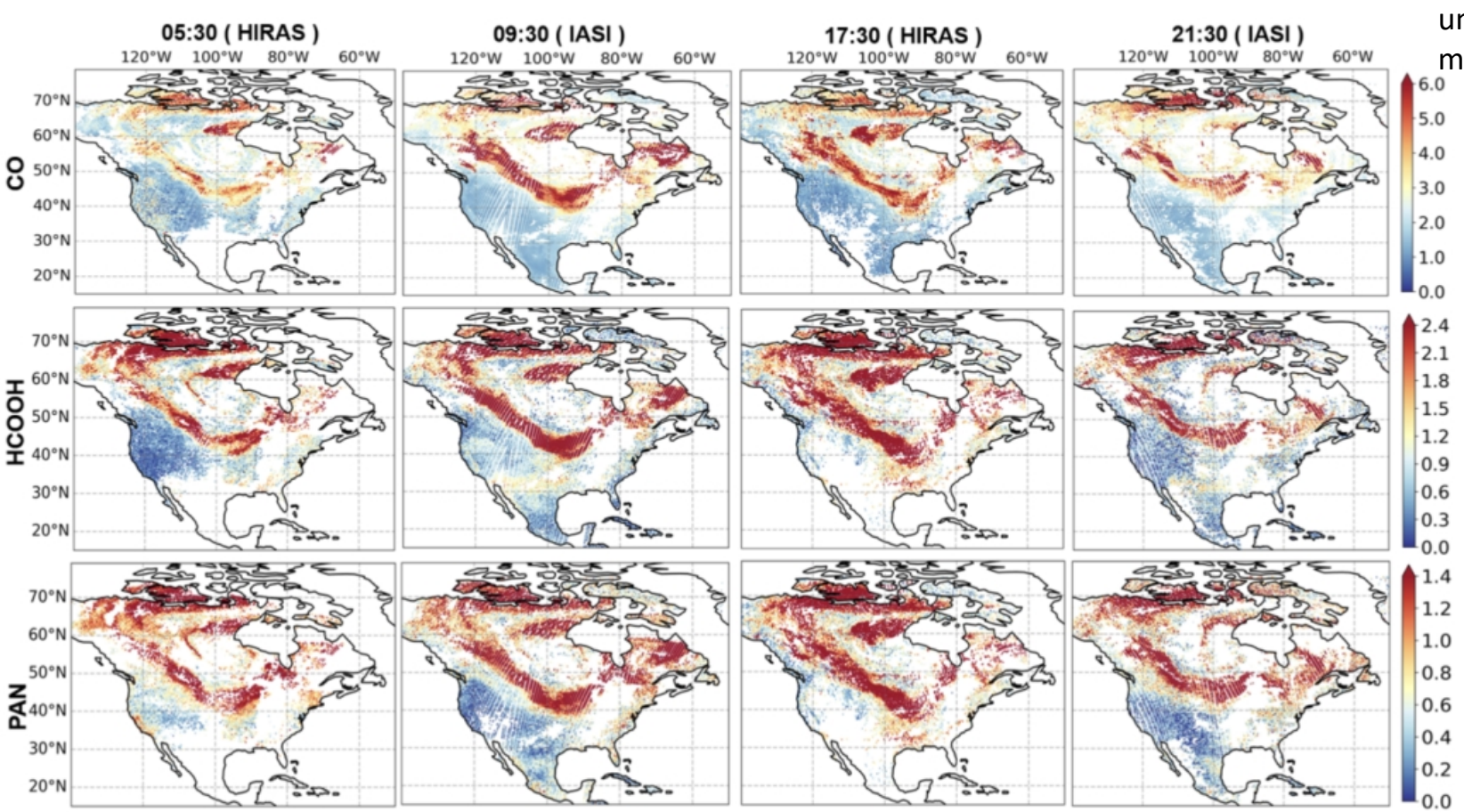




OMS-Limb Atmospheric Composition Sounding

Ultraviolet Hyperspectral Atmospheric Composition Detection (left)

Highlights： Trace Gas Retrieval based on FY-3 IR Sounder



Observing CO and VOCs (PAN and HCOOH) from Canadian wildfires in 2023 from FengYun-3E/HIRAS-II in a dawn-dusk sun-synchronous orbit

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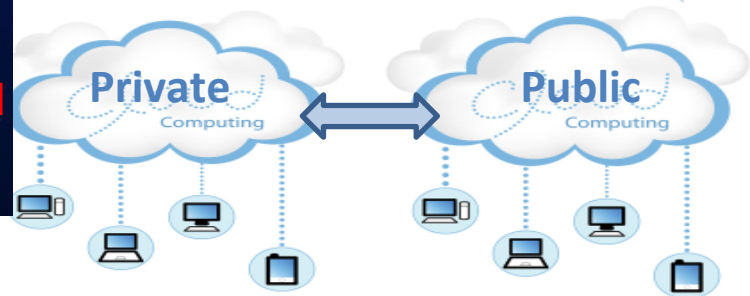
Integrated Data and Computing Platform

Upgrade webpage https://data.nsmc.org.cn

- One-Stop Workflow
- Pre-built Frameworks
- Flexible Algorithm Toolkit

From file management to knowledge management
From data service to knowledge service
From passive service to active service

- Based on hybrid Cloud framework
- Push hot data based on user interests



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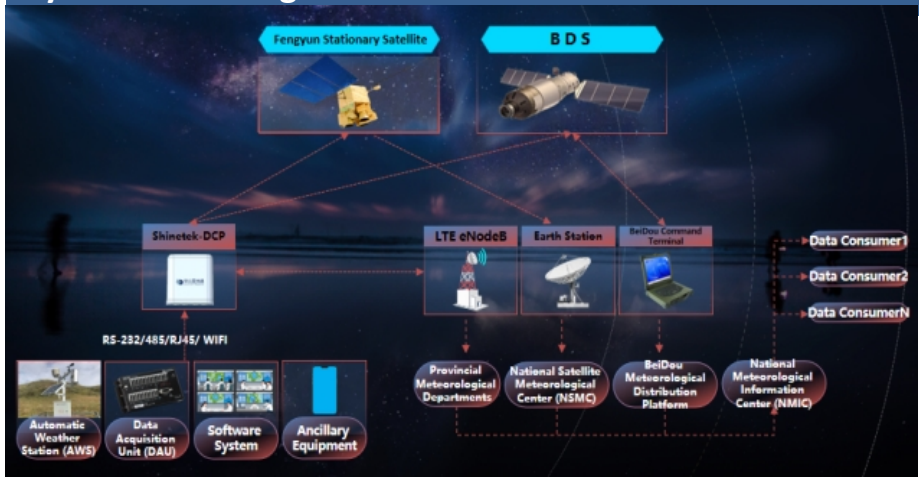
DCS Integrated Terminals

System Flow Diagram



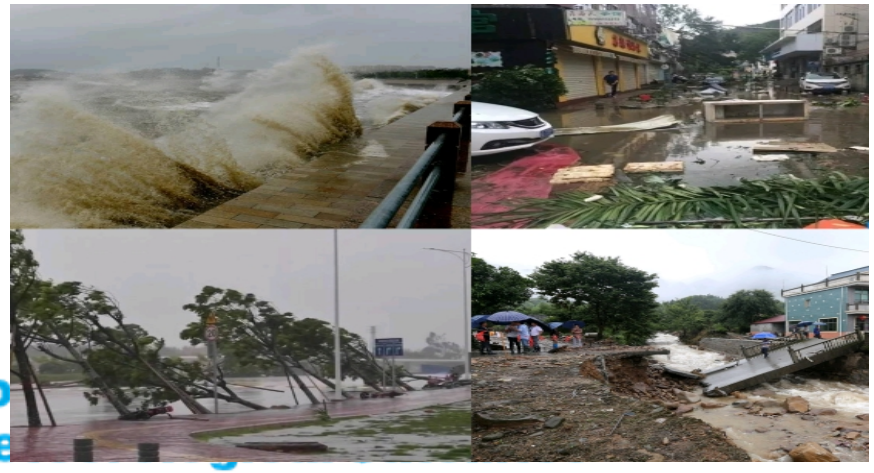
Overview

The integrated terminal is compatible with networks such as Beidou, 4G/5G communication network, and DCP network. In emergency situations, it can transmit ground station observations via DCP.

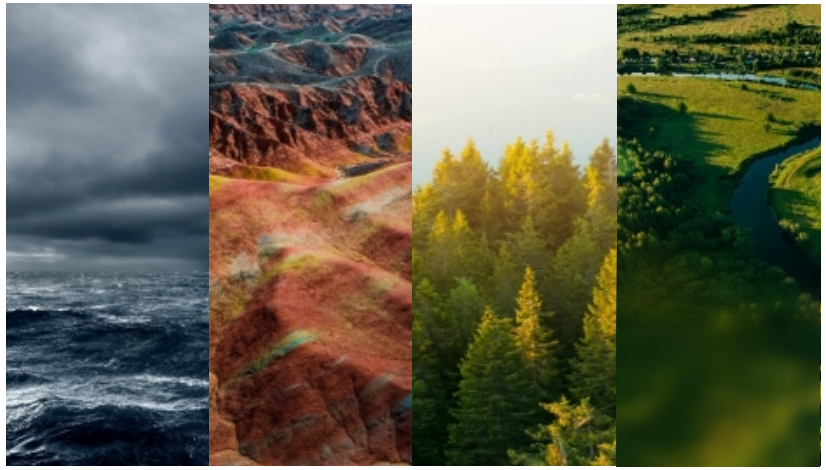
Over 2000 equipments in operational

Application Scenarios

Collection of meteorological data in disaster prone areas



Collection of meteorological data in remote areas



System Structure

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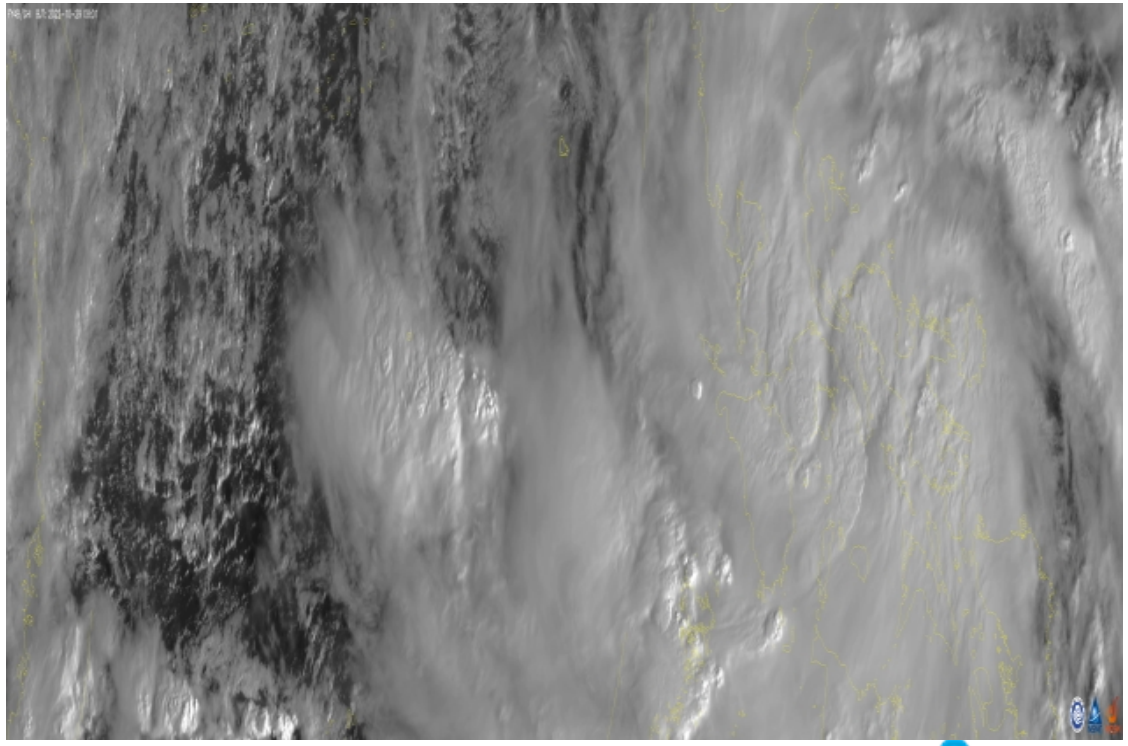
Emergency Support Mechanism for International Users (FY_ESM)

- CMA established the Emergency Support Mechanism of FENGYUN Satellite(FY ESM) for international users on April, 2018.
- Once FY_ESM is activated, highly frequent observation of a given area at an interval of up to 1 minutes will be provided to users.

FY4B-GHI-VIS



- As of December 2024, 36 countries have registered FY_ESM.
- Since 2018, more than 160 emergency support services have been provided to 65 countries worldwide through the FY-ESM and CHARTER mechanisms.

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https://data.nsmc.org.cn/FYESM/en/emergency/index.html

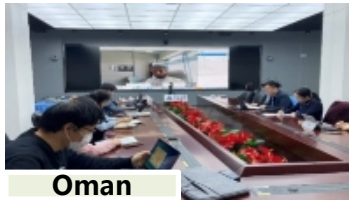
Partnerships for the Goals

Workshop and Training

We have set up many workshops and training, which promotes the use of FengYun satellites for regional and global benefits


Training

Tanzania



Oman

Yemen

Pakistan

FengYun Satellite User Conference

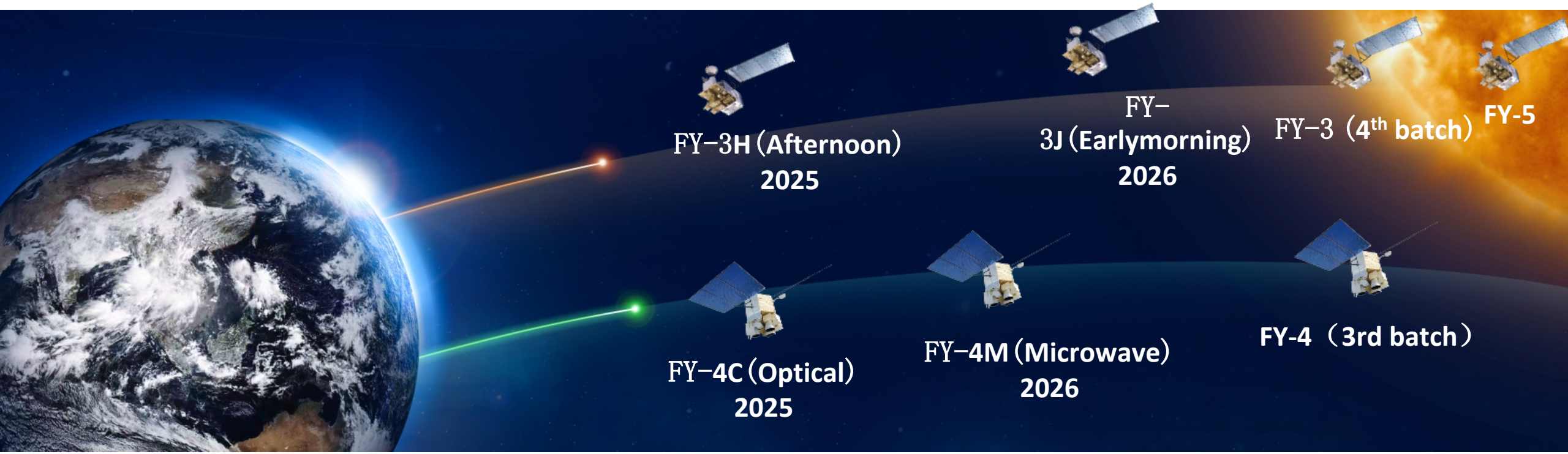
The purpose of the conference is to **establish a platform for international users of FengYun satellites, facilitating in-depth discussions** regarding their applications and requirements, **promoting the global integrated application of FengYun satellites to achieve maximum benefits across various application areas**, and mitigating the impacts of hazardous weather, water, or climate events.


"Belt and Road" Meteorological Visiting Scholars

2023, CMA initiated “Belt and Road” Meteorological Visiting Scholar Program” aiming to improve the countries’ capacity of disaster prevention and mitigation and response to climate change.




Follow-up Launch Plans



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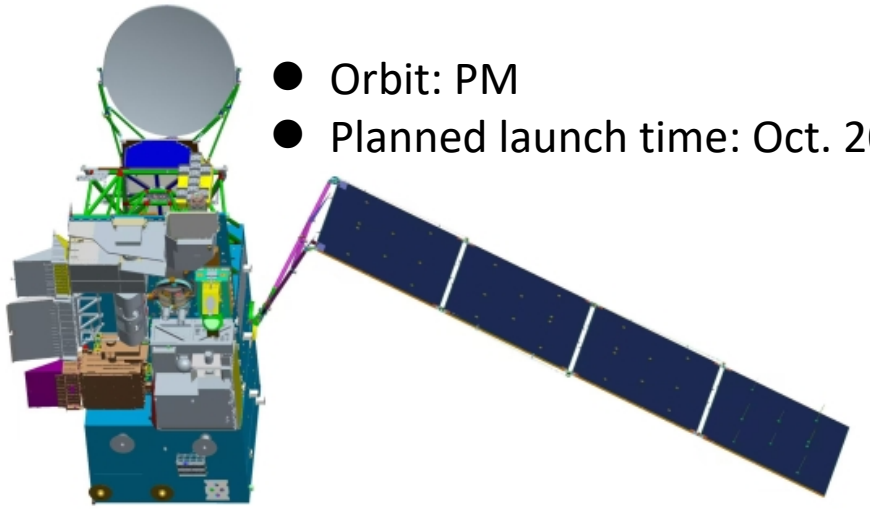
Follow-up Launch Plans

- Plans in 2025 :
  - FY-3H, the 8th LEO satellite in FY-3 series, will be operated in PM orbit. Launch scheduled in Q3 this year.
  - FY-4C, the 3rd GEO satellite in FY-4 series with significant improvement, and will be positione at 133°E, launch scheduled in Q4 this year.

- Plans in 2026:
  - FY-3J, the 2nd Early morning orbit satellite as the succesor of FY-3E
  - FY-4D, the GEO satellite to take replace of FY-4B
  - FY-4M, the brand-new GEO microwave satellite in FY-4 series

■ FY-3H, the 8th LEO satellite in FY-3 series, will be operated in PM orbit. Launch scheduled in Q3 2025.

- **FY-3H is a sun-synchronous afternoon orbit stellite, which will take the place of FY-3D launched in 2017.**
- **There are 9 instruments including HIRAS-II, MERSI-III, MWRI-II, MWTS-III, MWHS-II, GNOS-II, GAS -II, WAI, IPM, of which GAS-II is newly developed.**
- **At present, most of the instruments have finished calibration tests and the satellite is scheduled to complete all tests in the middle of 2025.**



- Orbit: PM
- Planned launch time: Oct. 2025

Acronym	Full name
MWHS-2	Micro-Wave Humidity Sounder -2
MWTS-3	Micro-Wave Temperature Sounder - 3
HIRAS-2	Hyperspectral Infrared Atmospheric Sounder - 2
GNOS-2	GNSS Radio Occultation Sounder - 2
MERSI-3	Medium Resolution Spectral Imager - 3
GAS-2	Greenhouse-gases Absorption Spectrometer - 2
MWRI-2	Micro-Wave Radiation Imager 2
SWS/WAI	Space Weather Suite / Wide-field Auroral Imager
SWS/IPM	Space Weather Suite / Ionospheric PhotoMeter

new

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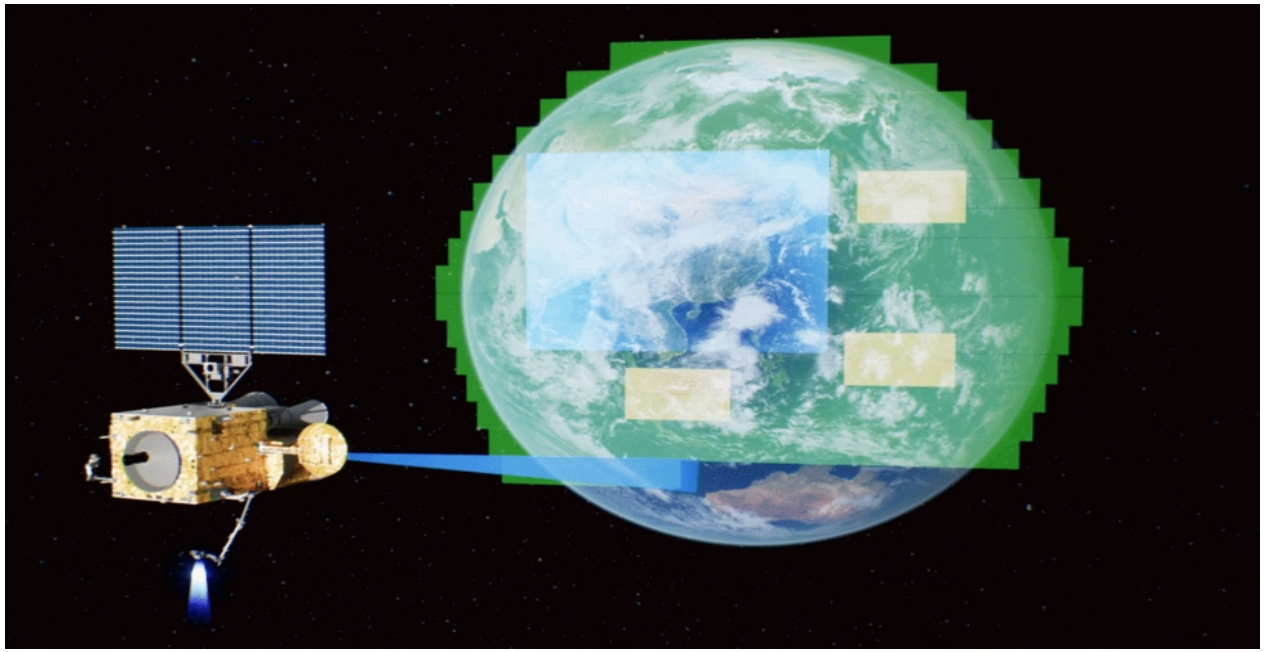
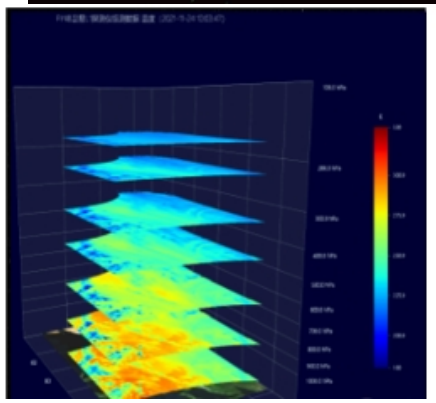
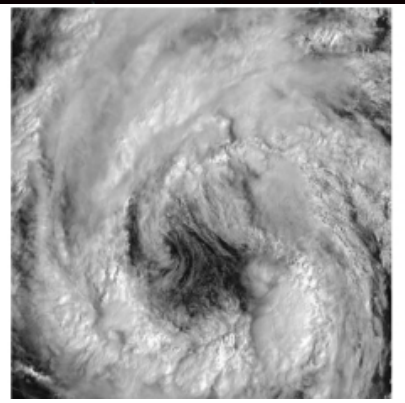
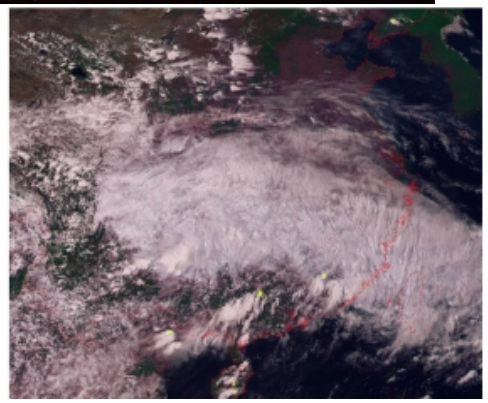
- **FY-4C, the 3rd GEO satellite in FY-4 series with significant improvement, and will be positione at 133°E, launch scheduled in Q4 2025**

Observation Mode	Imaging +Sounding + Lightning Mapping+Solar Imaging
Meteorological Instruments	AGRI :19channels Spatial Resolution：0.25~2Km 10min：one Fulldisk+10regional
	GIIRS: Spational Resolution: 8Km Spectral Resolution: 0.625cm-1
	LMI: Spatioal Resolution: 8Km, Fulldisk imaging
Space weather Instruments	SUVI Solar-Extreme Ultraviolet imager
	SXUS Solar X-EUV Irradiance Sensor
	MUSI Multiband Ionospheric Ultra-Violet Spectrum Imager









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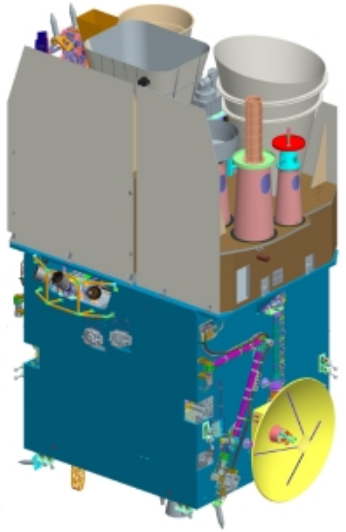
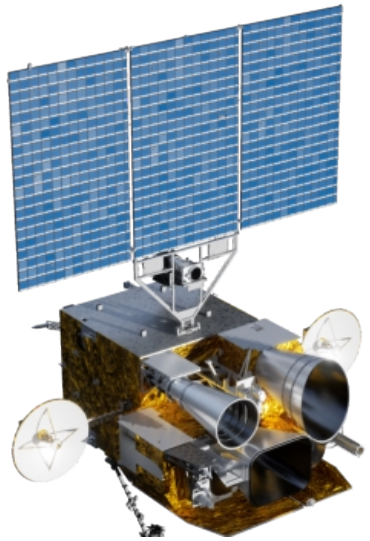
Instruments change from FY-4B to FY-4C



AGRI

- Full disk observation time increased from 15 minutes to 10 minutes;
- The detector is changed from multi-component photovoltaic /photoconductive detector to Long line array photovoltaic focal plane detector;
- Double the spatial resolution;
- Calibration accuracy is improved, 5%->3%,0.7K->0.5K, Add 2%/year stability.



GIIRS

- Regional observation time increased from 1.5h to 1h;
- The detector array from 128->4096, the spatial resolution from 12km->8km, and the visible band from 1km->0.5km;
- Calibration accuracy: Spectral from 10ppm->5ppm, Radiometric from 0.7K->0.5K, Add 0.5K/year stability.

LMI

- The LMI observation range changes from half disk to full disk coverage;
- Detector upgraded from CCD to CMOS (400*600->2560*2016);
- the amount of transmission speed increased by 10 times;

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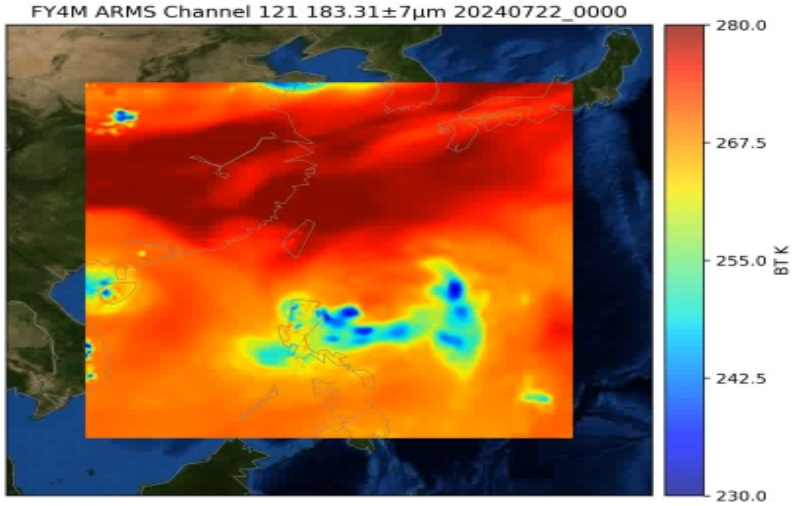
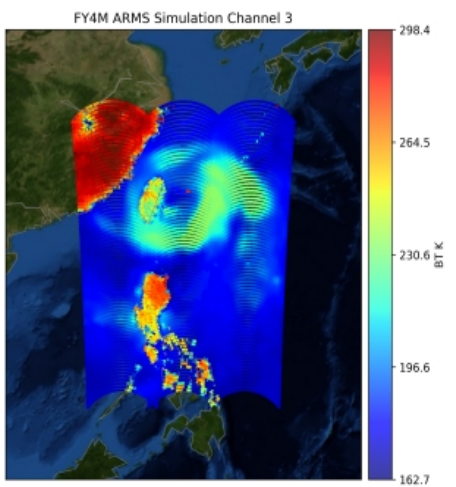
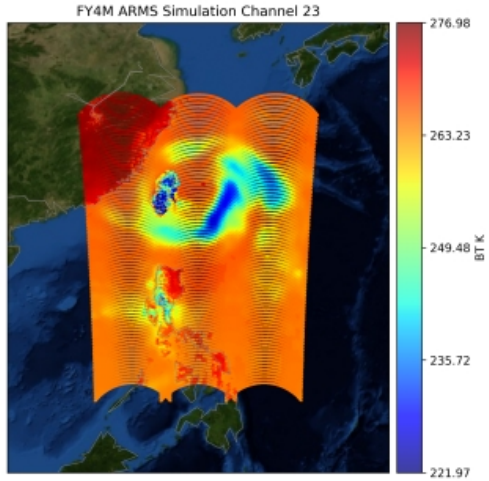
■ FY-4M, the brand-new GEO microwave satellite in FY-4 series, with a multi-frequency mircowave sounder onboard, planed by the end of 2026

- FY-4M employs the whole-satellite maneuvering to achieve continuous 24-hour earth and space target observation.
- The microwave sounder operates in the 23–425 GHz frequency range, with newly added fine-spectrum microwave channels (50–60 GHz) and Thz channels above 200 GHz, totaling 135 channels.
- This enhancement aims to improve NWP accuracy and strengthen severe weather early warning capabilities.

Geostationary Microwave Sounder	
Band	1）Frequency：23-425GHz, 10 Bands 2）Channels：135（with fine-spectrum channels） 3）Band width：3MHz-2000MHz
Required Accuracy	1）Sensitivity：0.5-1.5K 2）Calibration accuracy：<1.5K
Observation Mode	China Region+ Regional + Quick Scan







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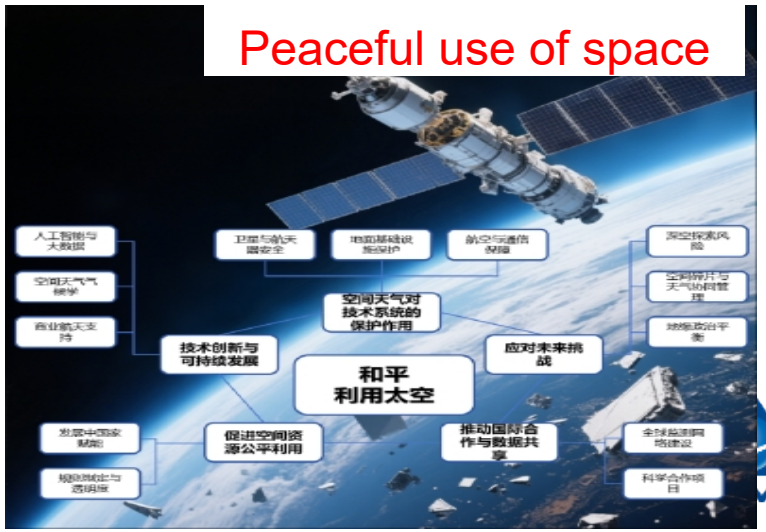
Future Prospects

Towards Sustainable Development Goals

Climate change response

The United Nations' "Early Warnings for All" initiative

Peaceful use of space



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Thanks for your attention

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NSMC NCSW CGMS