

# The Progress of Fengyun Satellite Program and Its Applications



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**National Satellite Meteorological Center,**  
**China Meteorological Administration (NSMC/CMA)**

**United Nations/China Forum on Space Solutions:  
Realizing the Sustainable Development Goals**



# Outline

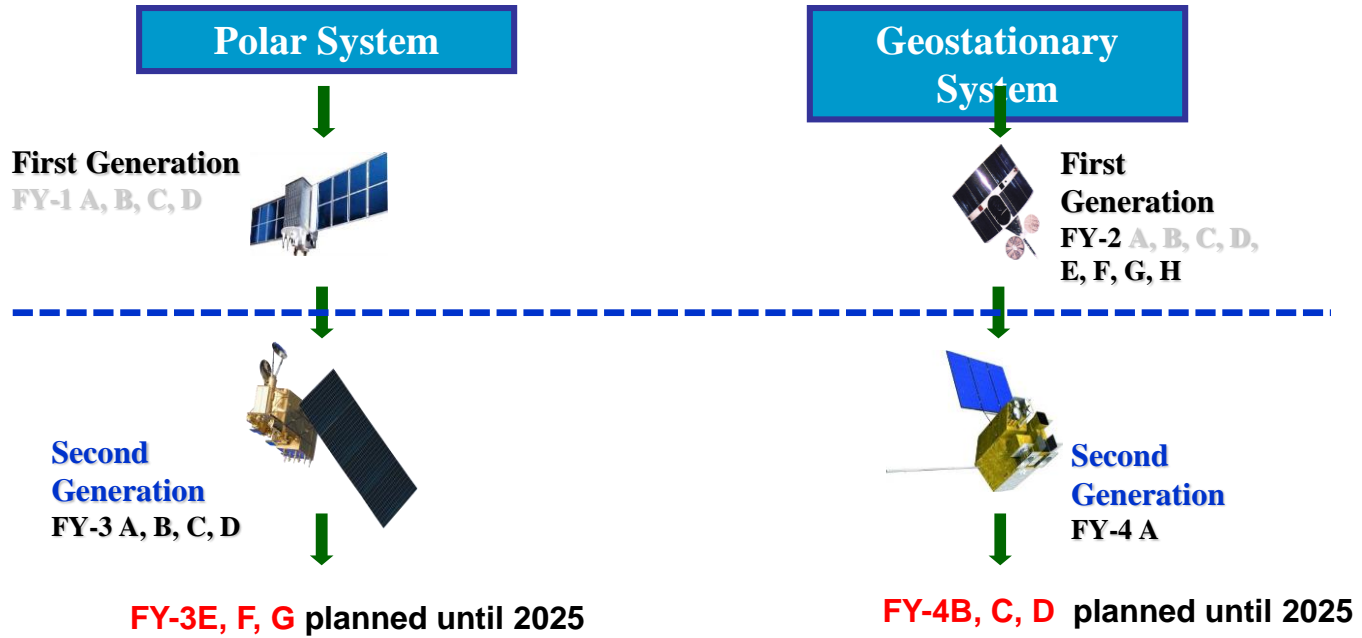
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- ❑ **Fengyun Program Overview**
- ❑ **Current Missions and Services**
- ❑ **Latest Progress**
- ❑ **Future Programs**

# 1. Fengyun Program Overview



## Chinese FENGYUN Meteorological Satellites



# Launched Satellites



**Since Jan. 1969, China began to develop his own meteorological Satellite**

Leo	Launch Data		Geo	Launch Data
FY-1A	Sept. 7, 1988		FY-2A	Jun. 10, 1997
FY-1B	Sept. 3, 1990		FY-2B	Jun. 25, 2000
FY-1C	May 10, 1999		FY-2C	Oct. 18, 2004
FY-1D	May 15, 2002		FY-2D	Dec. 8, 2006
FY-3A	May 27, 2008		FY-2E	Dec. 23, 2008
FY-3B	Nov. 5, 2010		FY-2F	Jan. 13, 2012
FY-3C	Sept. 23, 2013		FY-2G	Dec. 31, 2014
FY-3D	Nov. 15, 2017		FY-4A	Dec. 11, 2016
			FY-2H	Jun. 5, 2018

## Overall Development Strategy (4 stages):

- 1) **1970 - 1990:** Conducting satellite research and development
- 2) **1990 - 2000:** Implementing transition from R&D to operational
- 3) **2000 - 2010:** Implementing transition from 1<sup>st</sup> generation to 2<sup>nd</sup> generation
- 4) **2010 - 2020:** Pursuing accuracy and precision of satellite measurements

# International User Community



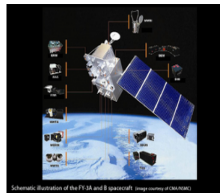
## Global Data



Who we are  
What we do  
Jobs  
News centre  
Suppliers  
Contact us

### ECMWF starts using Chinese satellite data

29 September 2014



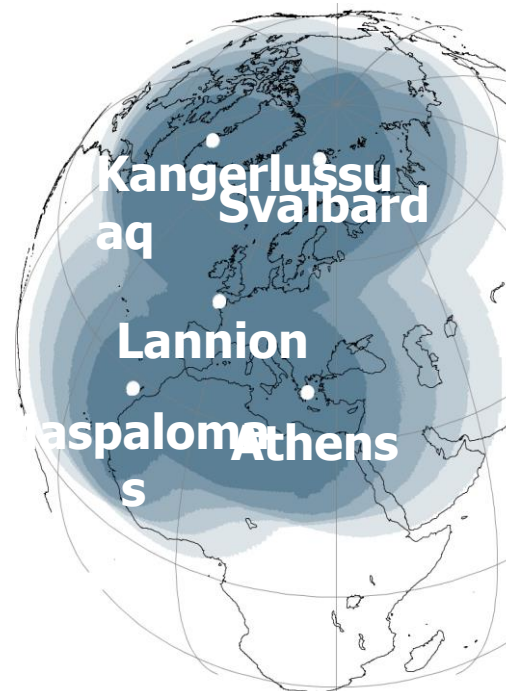
On 24 September 2014, ECMWF actively used Chinese satellite data for the first time in the operational forecasting system. This marks a milestone in ECMWF's fruitful cooperation with the Chinese Meteorological Administration (CMA) and the Chinese Institute of Atmospheric Physics (IAP) in the area of characterisation and use of Chinese satellite data. China is expected to play a leading role in providing meteorological satellite data in the near future, alongside Europe and the US, currently the main

providers of satellite sounding data used operationally. Activating the first Chinese satellite data in the ECMWF system is therefore an important step towards a much greater use of Chinese satellite data in the future.

The new data originates from the Microwave Humidity Sounder (MHS) on-board the Fengyun-3B (FY-3B) satellite. It contributes to an improved analysis of mid- to upper-tropospheric humidity, and adds robustness to the satellite observing system. Although FY-3B is an experimental satellite, the data has been found to be of sufficient quality to further improve ECMWF's atmospheric analysis. Keyi Chen, visiting scientist from IAP, explains: "Our work has shown the data is of reliable quality, and it has an impact comparable to similar European or US satellite instruments that have been used operationally for a long time."

The development is the result of a very constructive partnership with CMA and IAP to characterise Chinese satellite data. During regular visits to ECMWF, Qifeng Lu from CMA has significantly advanced our understanding of the performance of the instruments on the experimental FY-3A and B satellites. This work continues with the analysis of data from the latest Chinese satellite, FY-3C, performed together with CMA, ECMWF, and the UK Met Office. FY-3C is China's first operational meteorological polar-orbiting satellite, and it carries much improved instruments compared to

## Regional Data



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

**EUMETSAT Advanced Retransmission Service**

## Important Component of WMO Space Program



- reliable and sustained observation in operation
- open data policy to free access





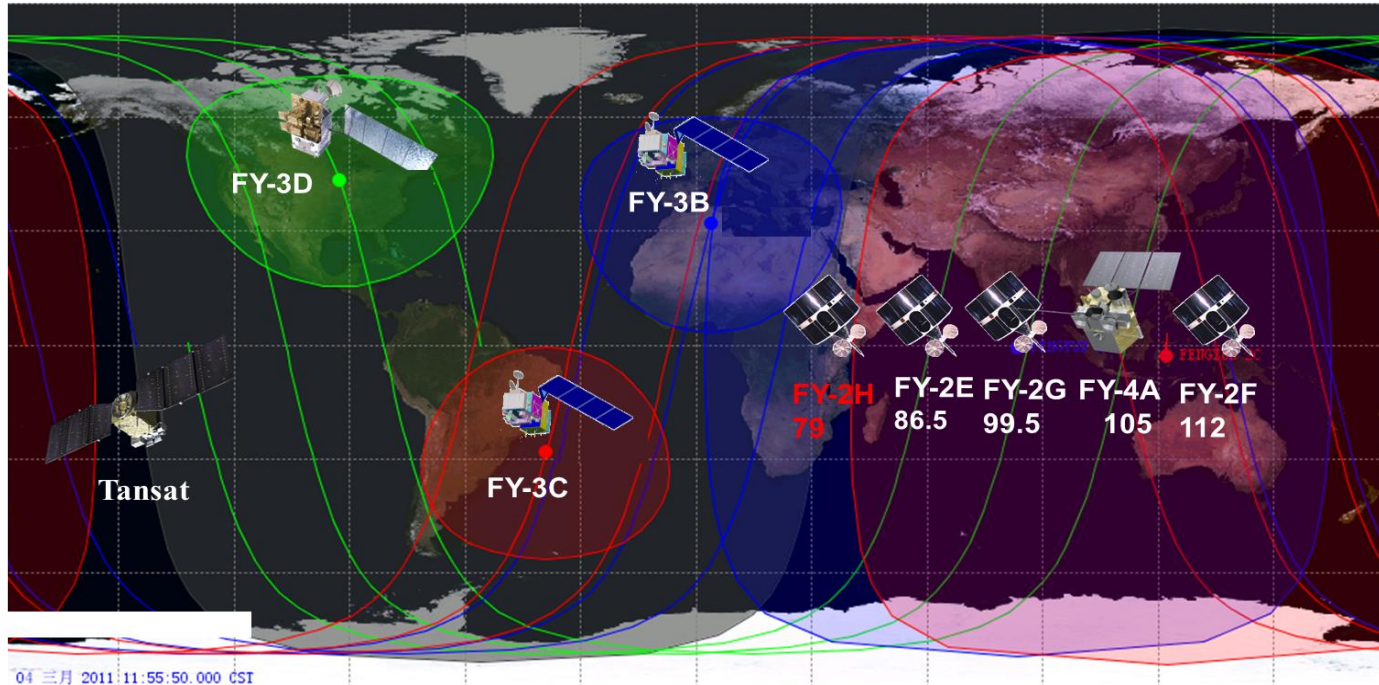
## 2. Current Missions and Services



### Current FengYun Constellation

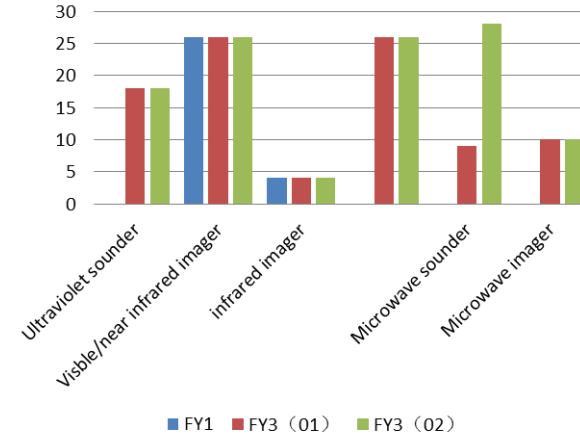
**FengYun Programs:** 8 in orbit, all in operation

**Joint programs:** Tansat, GF-4



# 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-4	FY-4A	3	HIRAS
			GAS
			AGRI
			GIIRS
FY-4	FY-4A	3	LMI



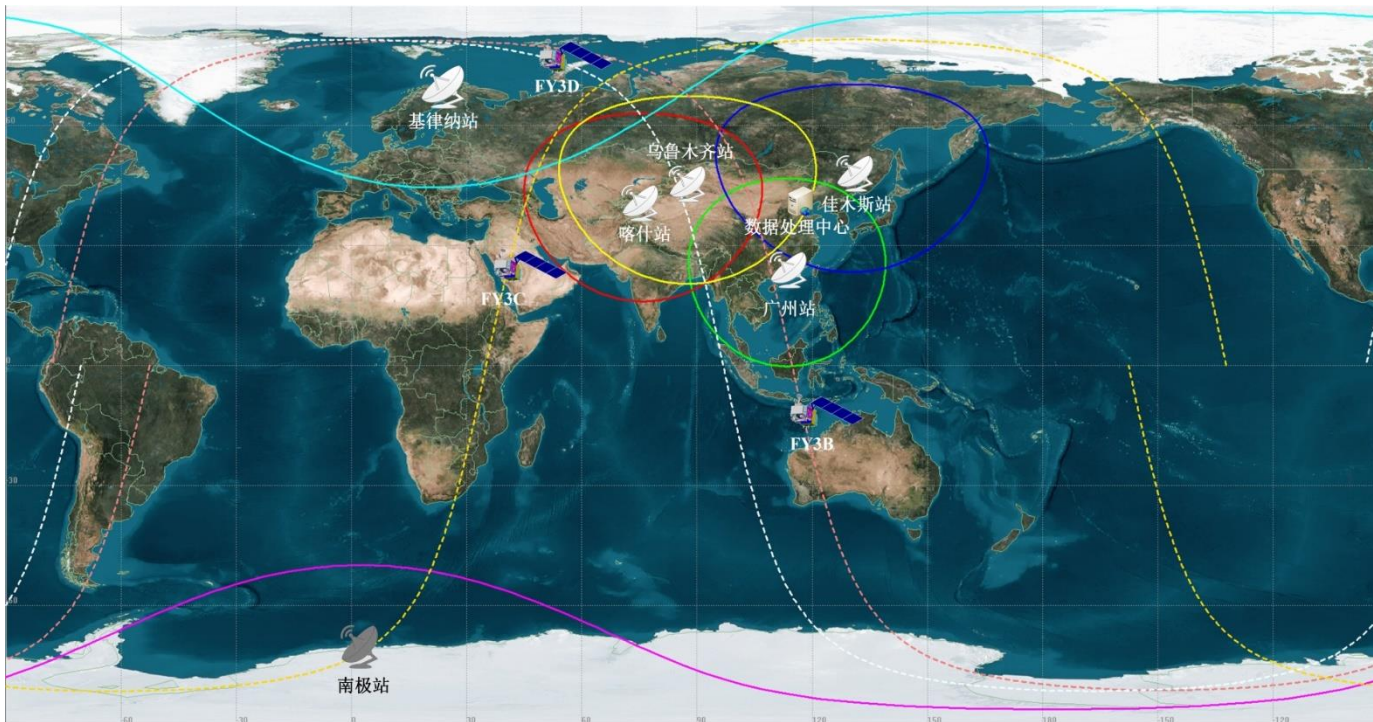
- Optical Imager
- Atmospheric Sounder
- Microwave Imager
- Atmospheric Composition Detector
- Radiation Budget Monitor



# Fengyun Polar Constellation



■ In Primary I Operation (**Global**) : FY-3C + FY-3D, **global coverage 4 times per day**



FY-3C LTC 10:30 AM

FY-3D LTC 13:40 PM

# Fengyun GEO Constellation

## ■ 4 in operation

FY-2E: Full Disk (86.5° E)

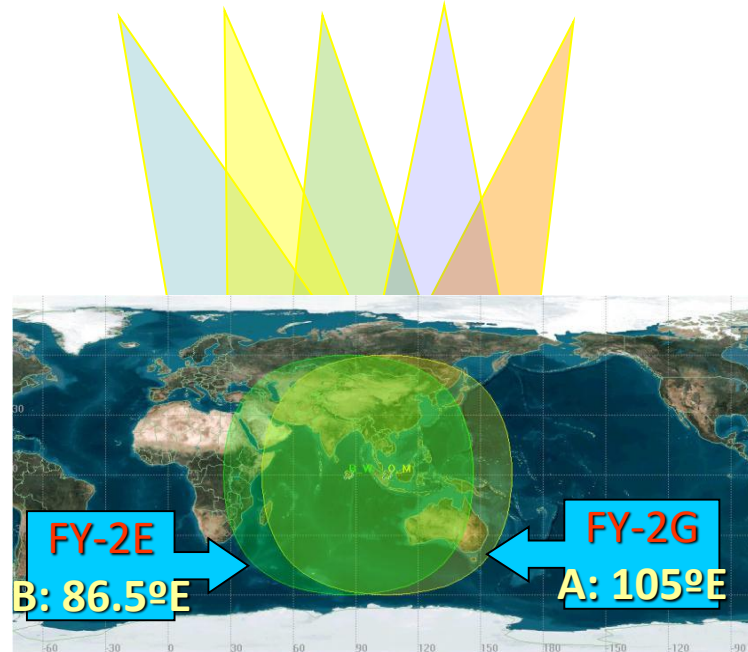
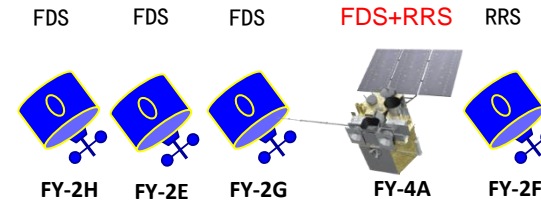
FY-2G: Full Disk (99.5° E)

FY-4A: Full Disk + Regional Rapid (105° E)

FY-2F: Regional (112° E)

## ■ “the Belt and Road” satellite

FY-2H (79° E)



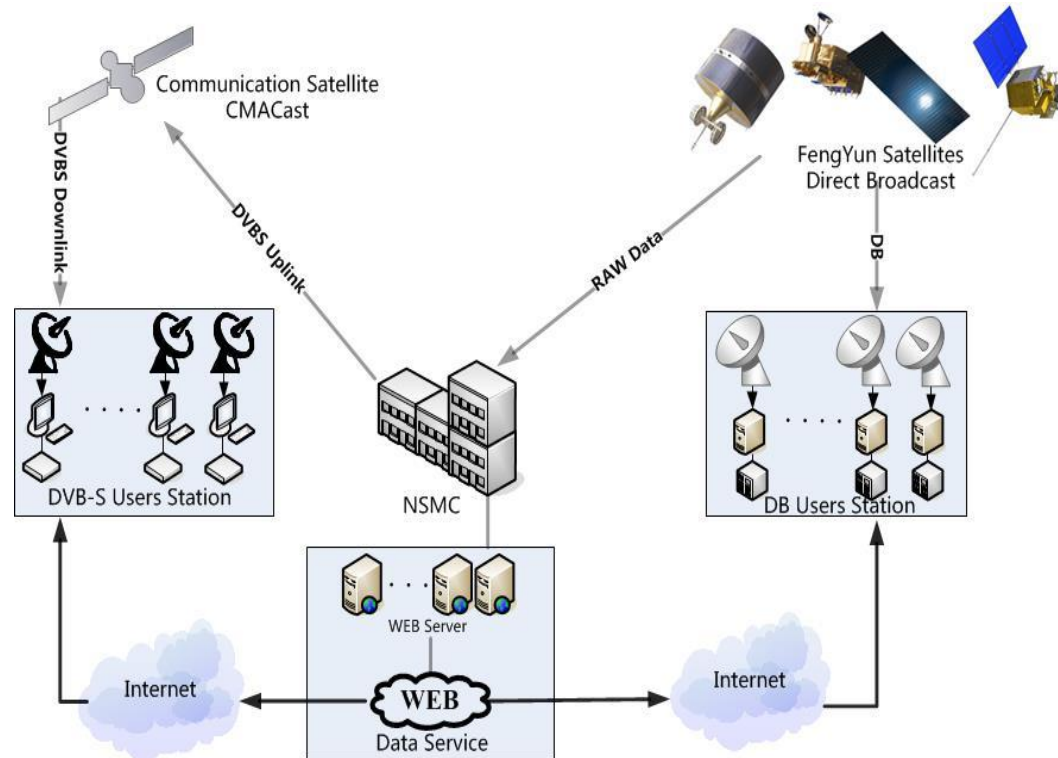
# FengYun Satellite Data Service

## ❖ Real time

- Direct Broadcast
- CMACast

## ❖ Non-Real Time

- Website
- Cloud Service
- FTP Service
- Manual Service



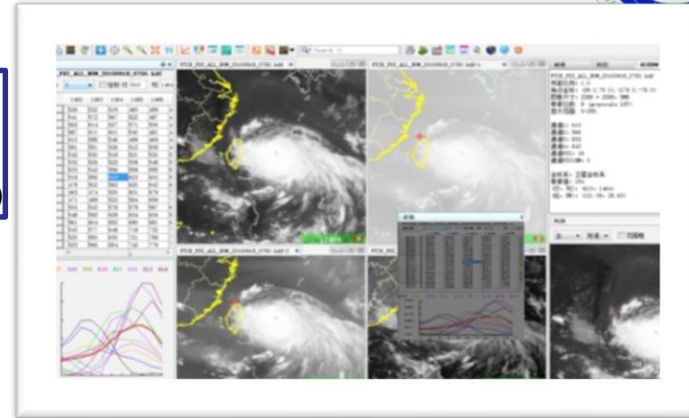
# Application Tools



**SATs:** New  
Observation Capability

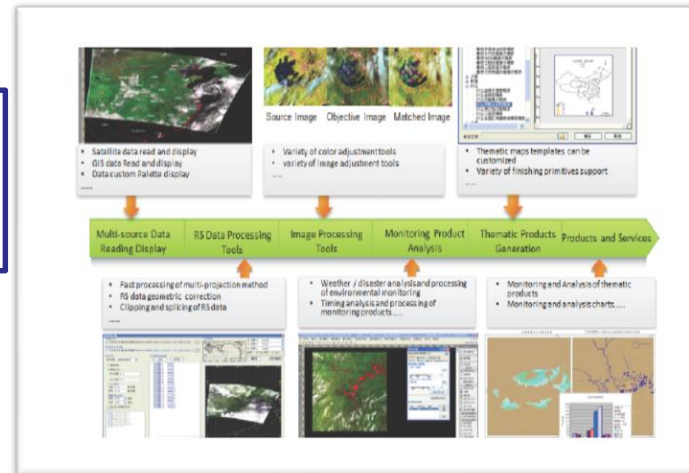
Weather monitoring and  
analysis  
---Geostationary  
Satellite data (FY-2/FY-4)

Satellite Weather  
Application Platform  
**SWAP**



Application  
tools

Natural disaster and  
environment monitoring  
and analysis  
---polar orbiting Satellite  
data

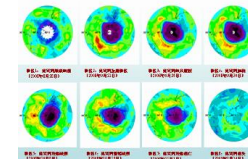
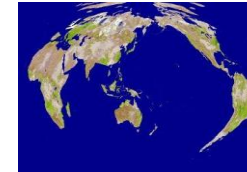
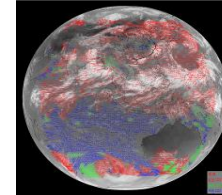
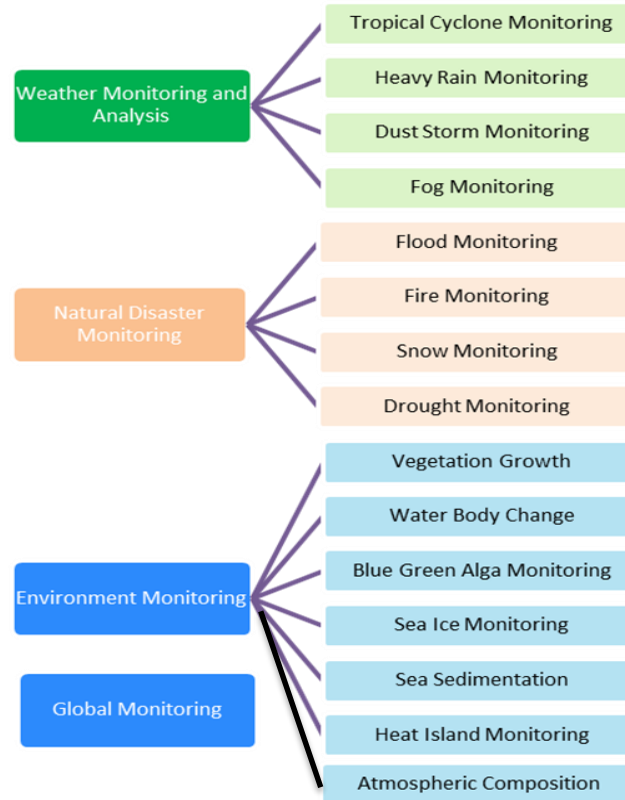


**Users:** New  
Applications

Satellite Monitoring  
Application Remote  
sensing Toolkit  
**SMART**



# Application Area



### 3. Latest Progress

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## Latest progress on CMA satellite programmes

### 1. FY-4A

- The first GEO. meteorological satellite of new generation
- Launched on Dec.11, 2016
- Official operation on May 1, 2018

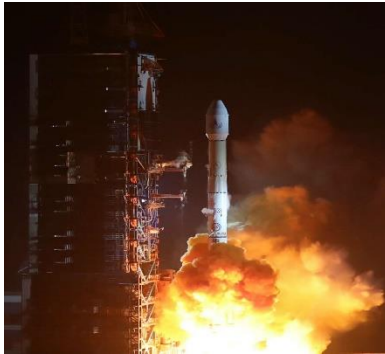
### 2. FY-2H

- The last one of FY-2 series
- Launched on June 5, 2018
- To support IOC and serve for the belt & road countries

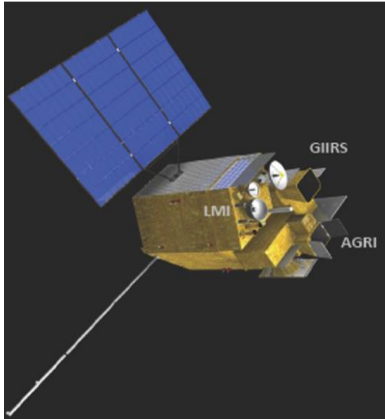
### 3. FY-3D

- A new operational afternoon orbit LEO. satellite, will co-work with FY-3C in morning orbit.
- Launched on Nov. 15, 2017.
- On-orbit commission test completion on Aug. 6, 2018

# FY-4A: Launched on 11 Dec, 2016



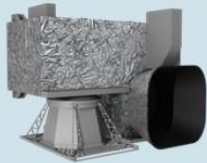
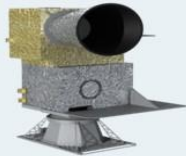
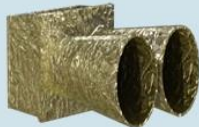

FY-4 is the CMA new generation meteorological geo-satellite series, expected to support various weather-related services, including weather forecasting, disaster prevention and reduction, and monitoring and warning of space weather.



## Spacecraft:

1. Launch Weight: approx 5300kg
2. Stabilization: Three-axis
3. Attitude accuracy: 3"
4. Bus: 1553B+Spacewire
5. Raw data transmission : X band
6. Output power:  $\geq 3200W$
7. Design life: over 7 years



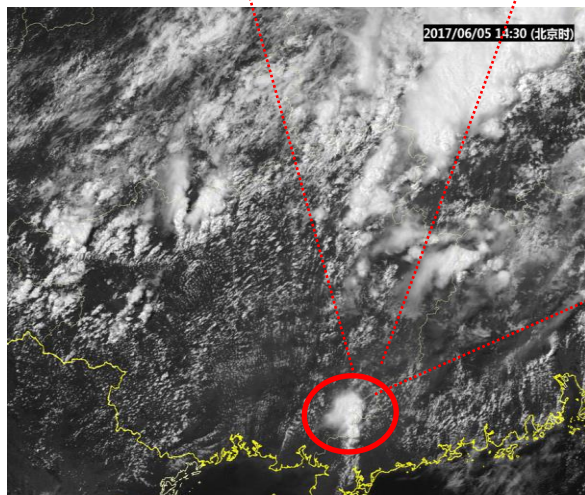
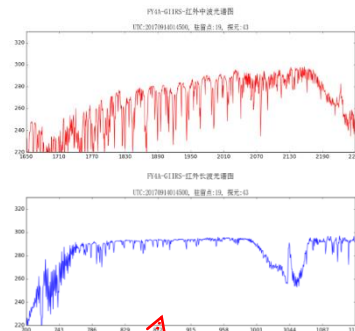
Instrument	Purposes
	<p><b>AGRI:</b> <i>Advanced Geosynchronous Radiation Imager</i></p> <p>14 -channel Earth images</p>
	<p><b>GIIRS:</b> <i>Geostationary Interferometric InfraRed Sounder</i></p> <p>Clear-sky atmospheric temperature and humidity profiles</p>
	<p><b>LMI :</b> <i>Lightning Mapping Imager</i></p> <p>Lightning distribution map in China area</p>
	<p><b>SEP:</b> <i>Space Environment Package</i></p> <p>Space electric and magnetic environment information</p>

# FY-4A Baseline products

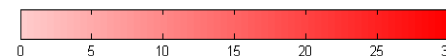
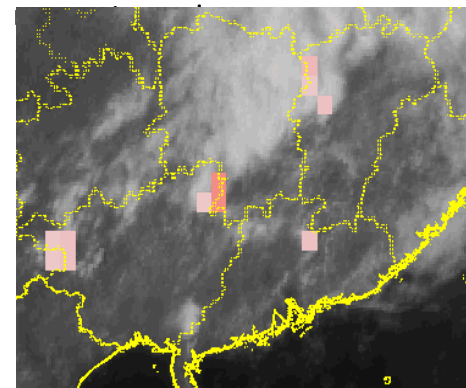


	FY-4A	FY-2
<b>Cloud</b>	Cloud Mask Cloud Top Temperature Cloud Top Height Cloud Top Pressure Cloud Type Cloud Phase Daytime cloud optical and microphysical properties Nighttime cloud optical and microphysical properties	Cloud Mask Cloud Top Temperature Cloud Classification Cloud Cover Ratio Cloud Total Amount
<b>Atmosphere</b>	Quantitative Precipitation Estimate Layer Precipitable Water Atmosphere Motion Vector Atmospheric Temperature Profile Atmospheric Humidity Profile Cloudy Vertical Temperature Profile Cloudy Vertical Moisture Profile Aerosol Detection Atmosphere Instability Index Convective Initiation Tropopause Folding Turbulence Prediction Total Ozone Amount Ozone Profile	Precipitation Index Quantitative Precipitation Estimate Clear sky Total Precipitable Water Atmosphere Motion Vector Cloudy Vertical Moisture Profile Upper Tropopause Humidity
<b>Radiation</b>	Outgoing Long wave Radiation Surface Solar Irradiance Downward Longwave Radiation Upward Longwave Radiation Reflected Shortwave Radiation	Outgoing Long wave Radiation Surface Solar Irradiance
<b>Surface</b>	Sea Surface Temperature (Skin) Land Surface Temperature Snow Cover Land Surface Albedo Land Surface Emissivity Evapotranspiration products	Sea Surface Temperature (Skin) Land Surface Temperature Snow Cover
<b>Environment</b>	Dust Smoke Detection Fire/Hot Spot Characterization Fog Detection	Dust Index Fire/Hot Spot Characterization Heavy Fog Detection
<b>Lightning</b>	One Minute Lightning Quantitative Product (including flash group event) Lightning Jump Identification Product Flash Daily Density	
<b>Space</b>	High-energy particle distribution Magnetic Field Intensity Space Environment Effect	

# AGRI + GIIRS + LMI



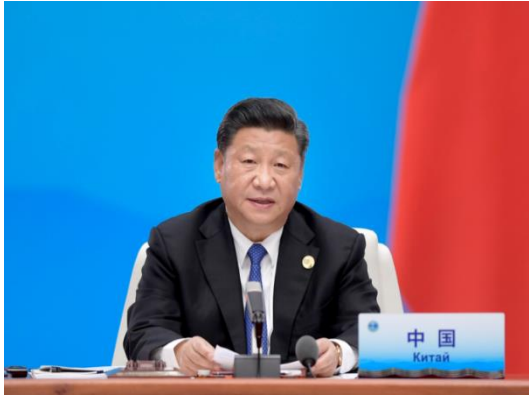
1. FY-4A lightning frequency map: strong convective cloud clusters often accompany with obvious lightnings.
2. FY-4A high spatial resolution imager: finer structure and texture of strong convective cloud cluster; and clearer small scale cumulus line.
3. Cloud free atmospheric profile acquired from GIIRS can be used for



# FY-2H: Launched on 5 Jun, 2018



**FY-2H :** To better support IOC and serve the Belt & Road countries



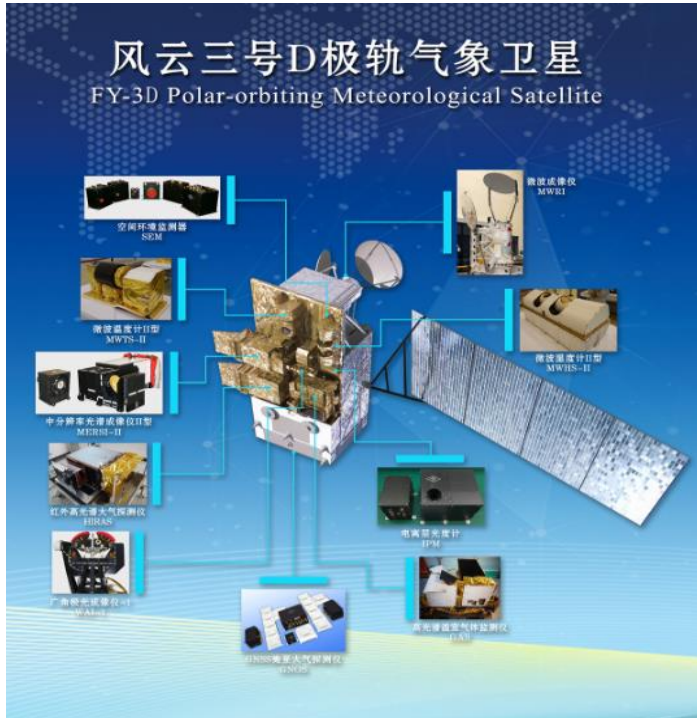
On June 10, at SCO summit in Qingdao, Chinese President Xi Jinping made a commitment that China will provide meteorological services by using FY-2 meteorological satellite.”

- Launched on June 5, 2018
- positioned at  $79^{\circ}$  E and operational *by September, 2018*



# FY-3D: Launched on 15 Nov, 201

- 4 new instruments (HIRAS, GAS, WAI, IPM)
- 1 important improved instruments (MERSI-2)
- 5 successive Instruments



Payload Name	Channel Numbers with Spectral Coverage
MEdium Resolution Spectral Imager (MERSI-2)	25 (0.413 – 12 $\mu\text{m}$ )
Hyperspectral InfraRed Atmospheric Sounder (HIRAS)	1370 (3.92 – 15.38 $\mu\text{m}$ )
MicroWave Radiation Imager (MWRI)	10 (10.65 – 89 GHz)
MicroWave Temperature Sounder (MWTS-2)	13 (50.3 – 57.29 GHz)
MicroWave Humidity Sounder (MWHS-2)	15 (89.0 – 183.31 GHz)
GNSS Occultation Sounder (GNOS)	29 (–)
Greenhouse-gases Absorption Spectrometer (GAS)	5540 (0.75 – 2.38 $\mu\text{m}$ )
Wide angle Aurora Imager (WAI)	1 (140 – 180 nm)
Ionospheric PhotoMeter (IPM)	3 (130 – 180 nm)
Space Environment Monitor (SEM)	25 (–)

- Performance are improved significantly for the key characteristics, such as S/N, calibration accuracy, etc.

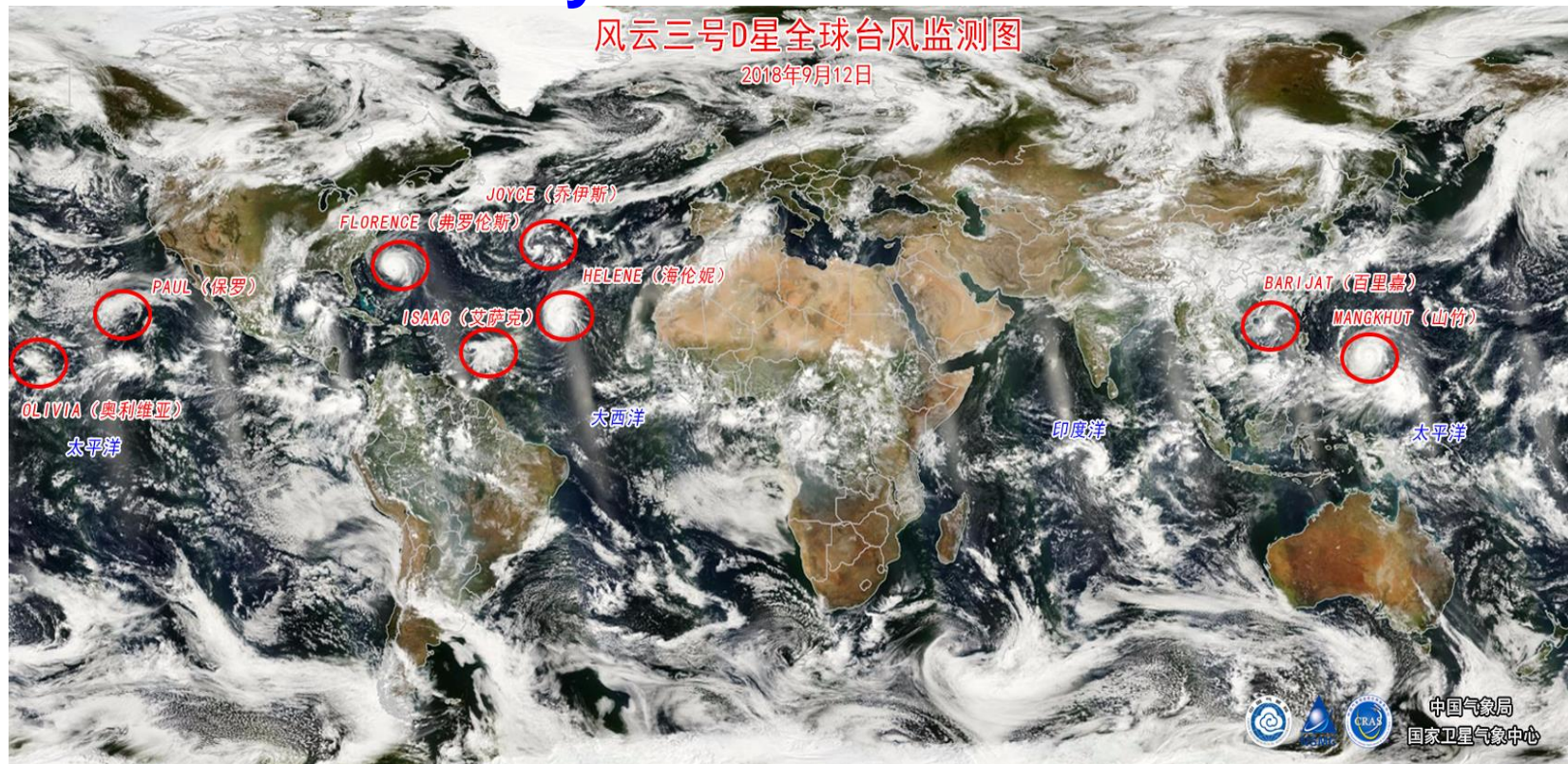


## FY-3D Baseline products

Cloud & Radiation	Atmosphere	Land Surface	Sea Surface	Space Weather
Cloud mask, Cloud amount, Cloud type, Cloud phase, Cloud top temperature, Cloud top height, Cloud optical depth, Cloud physical parameters, Cloud water content, Cloud liquid water, Ice water path, Outgoing longwave radiation	Atmospheric total precipitable water, Dust storm index, Aerosol optical depth, Rain detection, Atmospheric humidity profile (GNOS,VASS), Atmospheric temperature profile (GNOS,VASS), Precipitation, Microwave rain rate, Fog detection	Global fire detection, Land cover, Land surface reflectance, Land surface temperature, Soil moisture, NDVI, Snow cover, Snow cover fraction, LAI, FPAR, NPP, Albedo, Snow depth, Snow water equivalent	SST, Sea-Ice cover, Ocean color, Chlorophyll, Sea surface wind speed	radiation flux of high energy particles, surface electric potential radiation dose, GNOS Electron Density Profile, Ionospheric O/N2 Column Ratio, Aurora Mapping Products

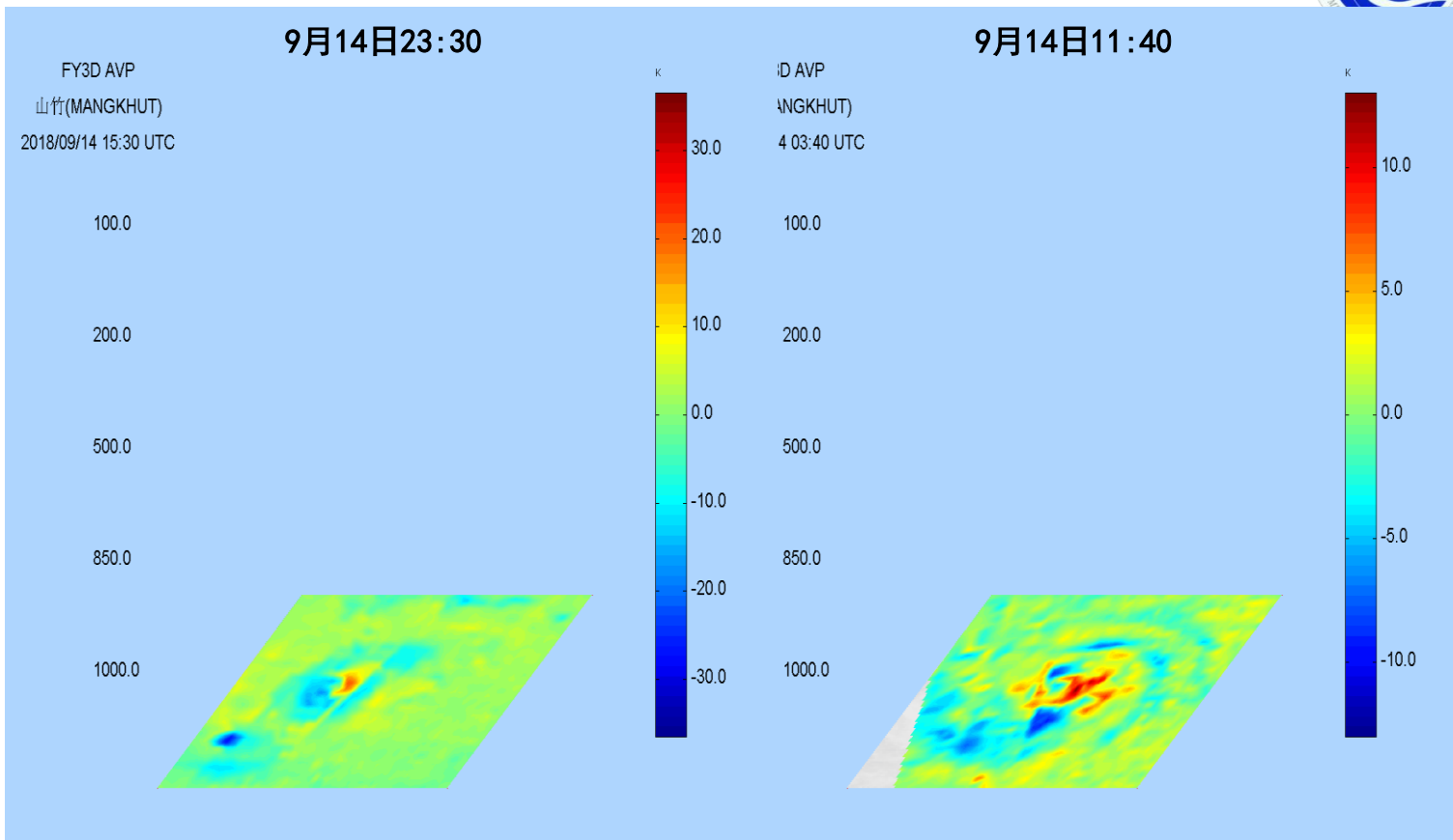


# The global 8 typhoons on 12 Sep 2018 were monitored by FY-3D



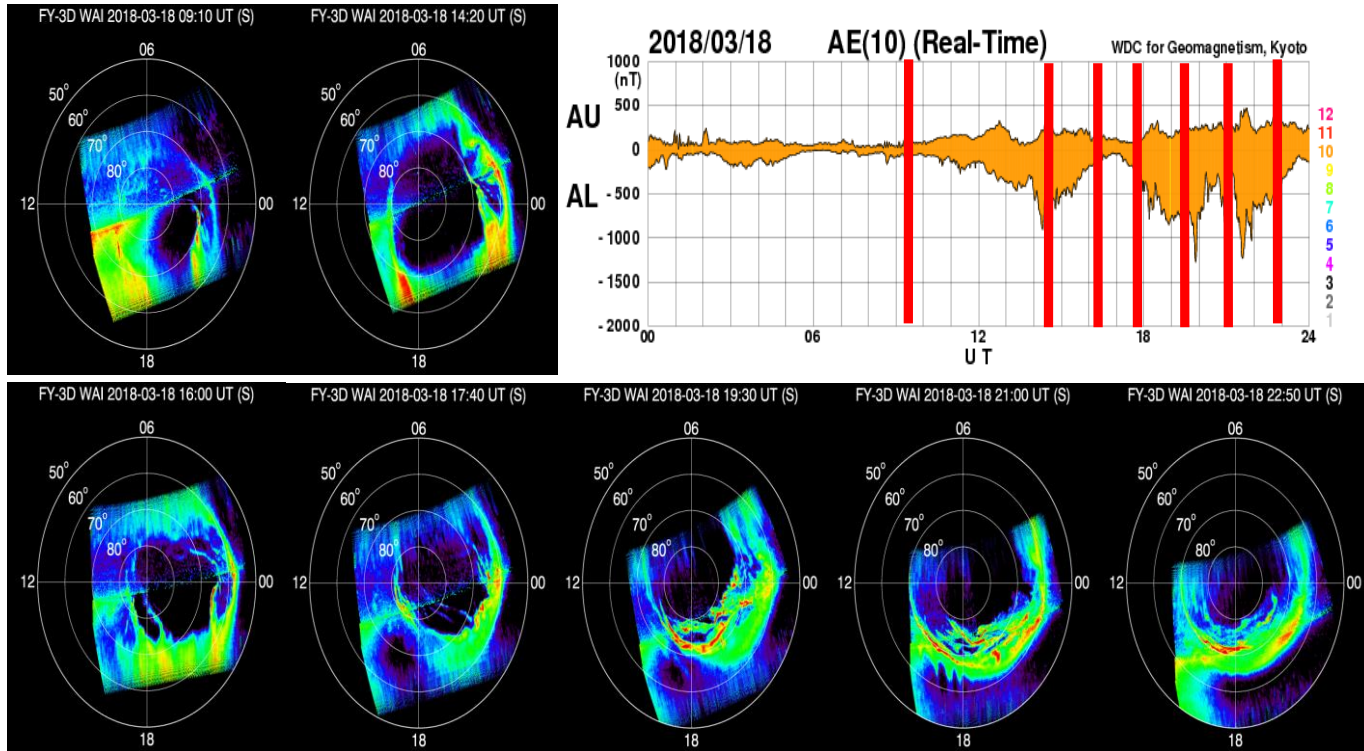


# Temperature Profile from HIRAS-MWTS-WMHS



Typhoon Mangkhut (1822) 2 hour before landing  
United Nations/China Forum on Space Solutions: Realizing the Sustainable Development Goals

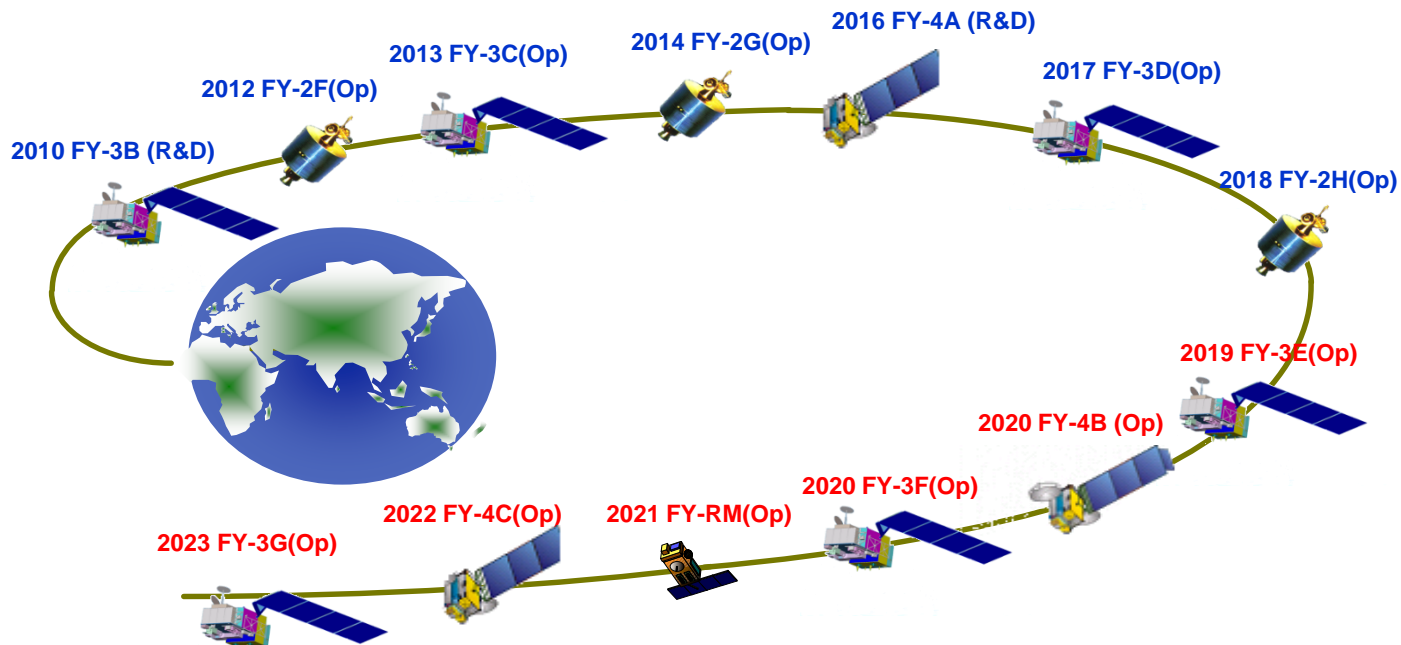
# Aurora in the North Polar from WAI



## 4. Future Programs



### National Program for Fengyun Meteorological Satellite from 2011-2020



■ 6 satellites will be launched within this decade

# Conclusion

- With the improved instrument performance (NE $\Delta$ T), and traceable radiometric measurements, **FY series** can be one important components of global observation to enhance the support for the quantitative application.
- Current **FY-3** series are expected to work until 2035 with Early Morning orbit, Morning orbit, and Afternoon orbit and Rainfall mission.
- Current **FY-4** series are expected to work until 2040 with FY-4 East (133E) and FY-4 West (79E).
- **FY data** can be ordered through website <http://satellite.cma.gov.cn>

