



Satellite Activities at CMA



Di XIAN, Jian LIU

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

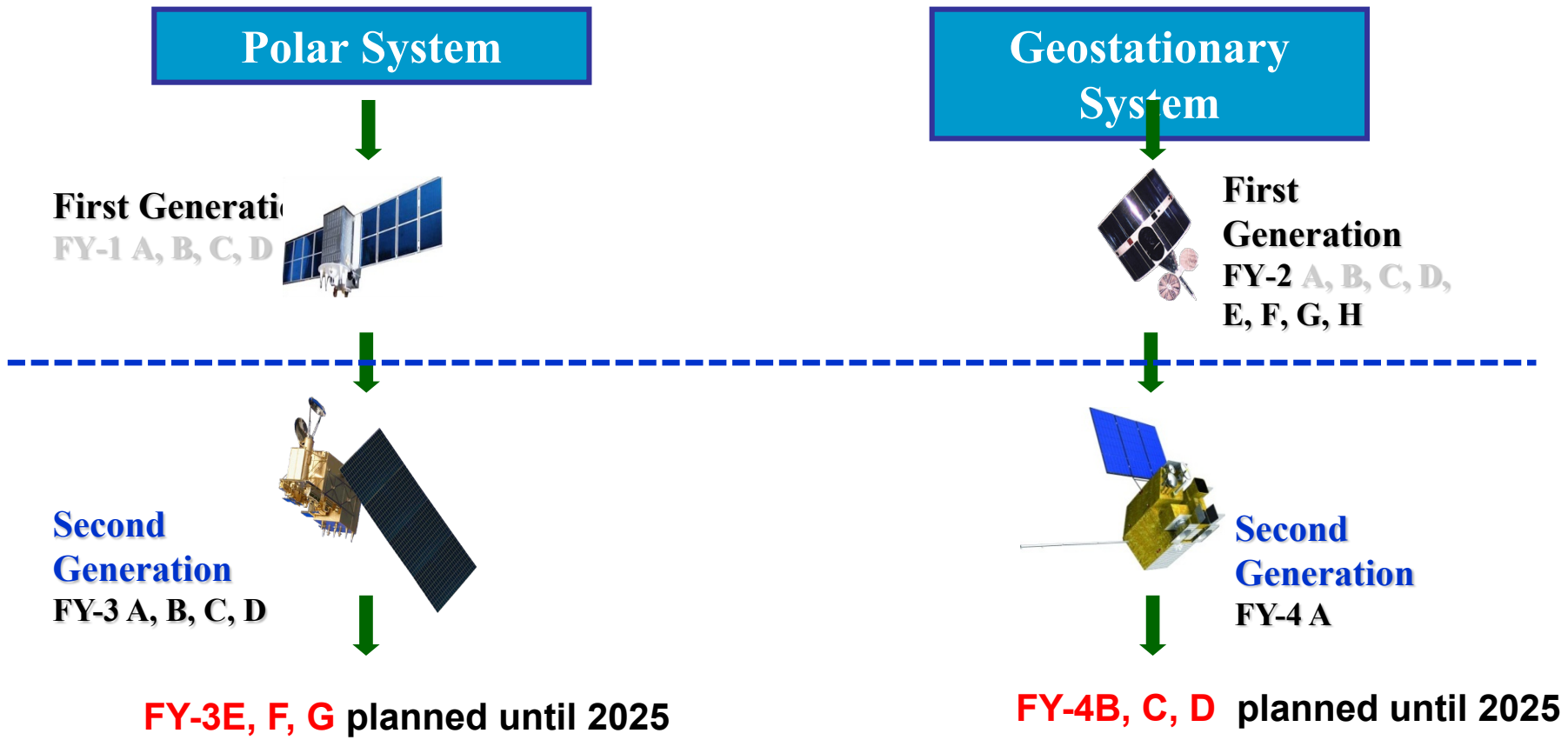


Outline

- **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

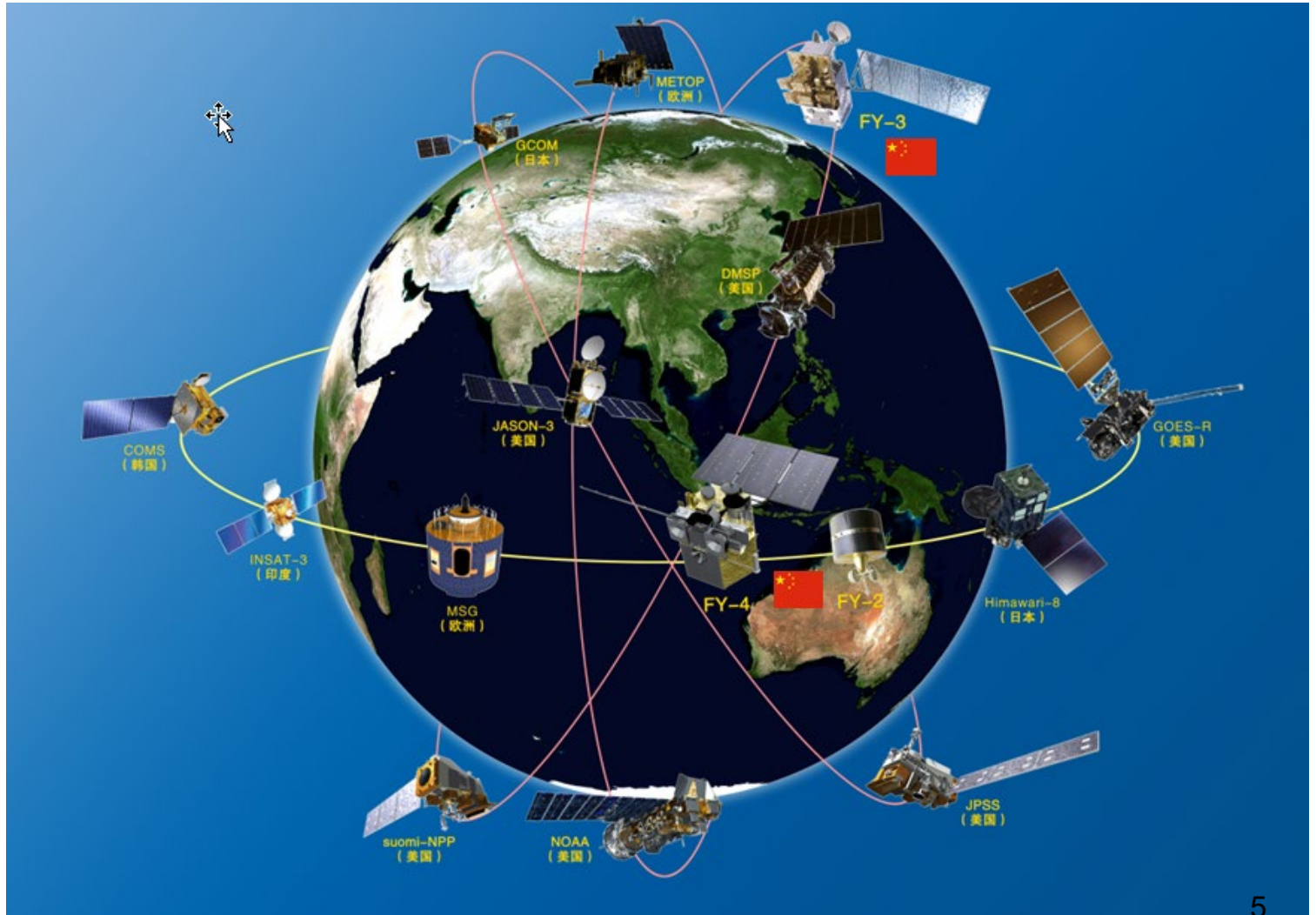
Leo	Launch Data		Geo	Launch Data
FY-1A	Sept. 7, 1988		FY-2A	Jun. 10, 1997
FY-1B	Sept. 3, 1990		FY-2B	Jun. 25, 2000
FY-1C	May 10, 1999		FY-2C	Oct. 18, 2004
FY-1D	May 15, 2002		FY-2D	Dec. 8, 2006
FY-3A	May 27, 2008		FY-2E	Dec. 23, 2008
FY-3B	Nov. 5, 2010		FY-2F	Jan. 13, 2012
FY-3C	Sept. 23, 2013		FY-2G	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 1st generation to 2nd generation
- 4) **2010 - 2020:** Pursuing accuracy and precision of satellite measurements

Important Component of WMO Space Program

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

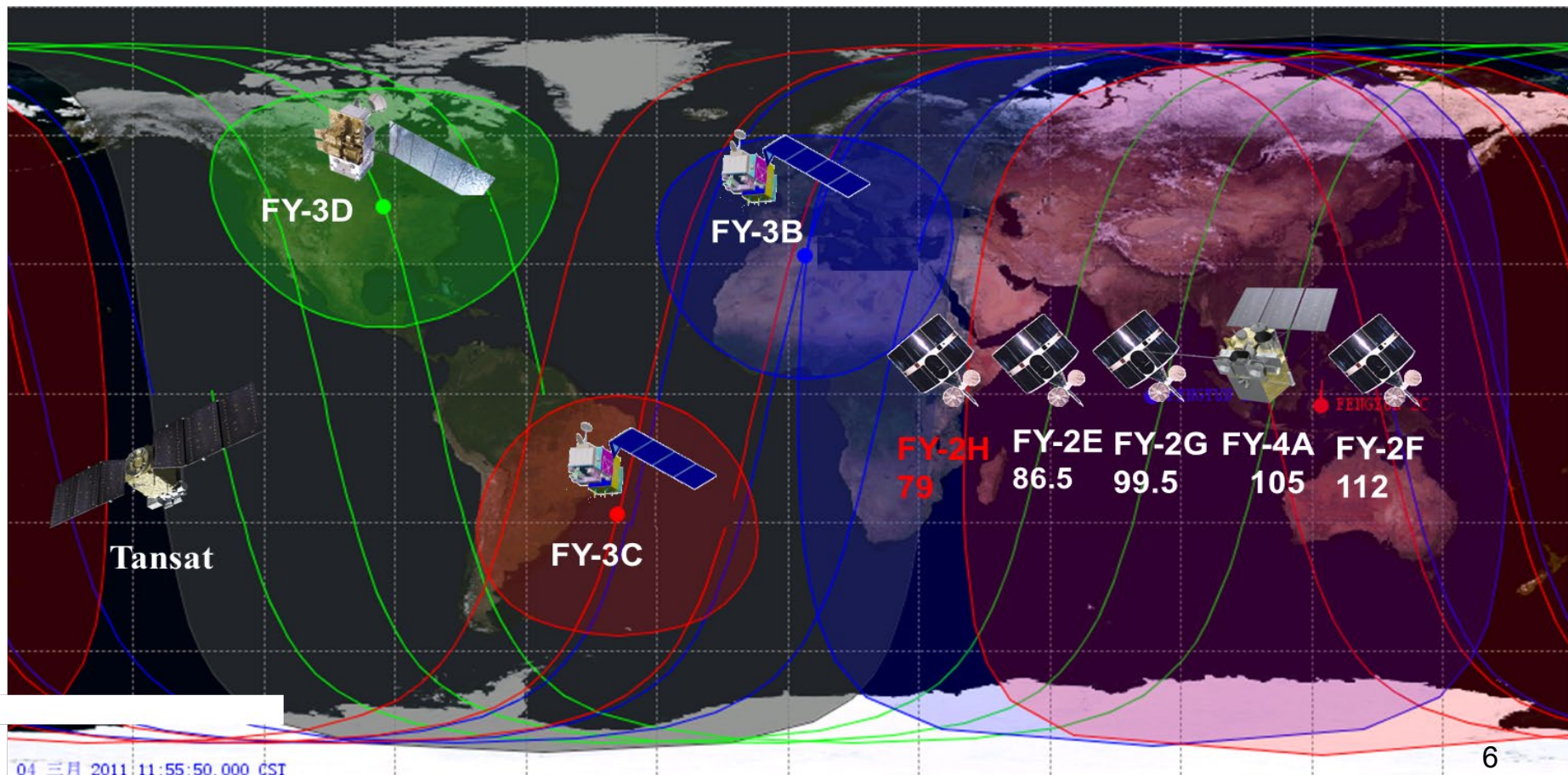


2. Current Missions and Services

Current FengYun Constellation

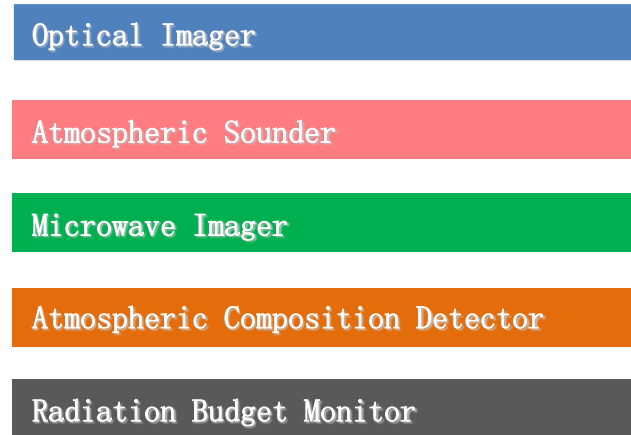
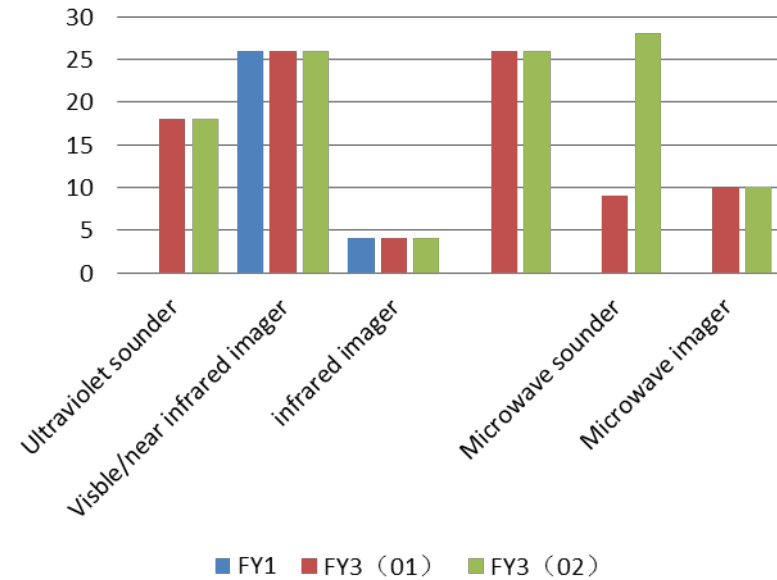
FengYun Programs: 8 in orbit, 7 in operation, 1 in orbital testing (FY-2H)

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-3D	10	HIRAS	
		GAS	
FY-4	FY-4A	3	AGRI
			GIIRS
			LMI



Fengyun GEO Constellation

■ 4 in operation

FY-2E: Full Disk (86.5° E)

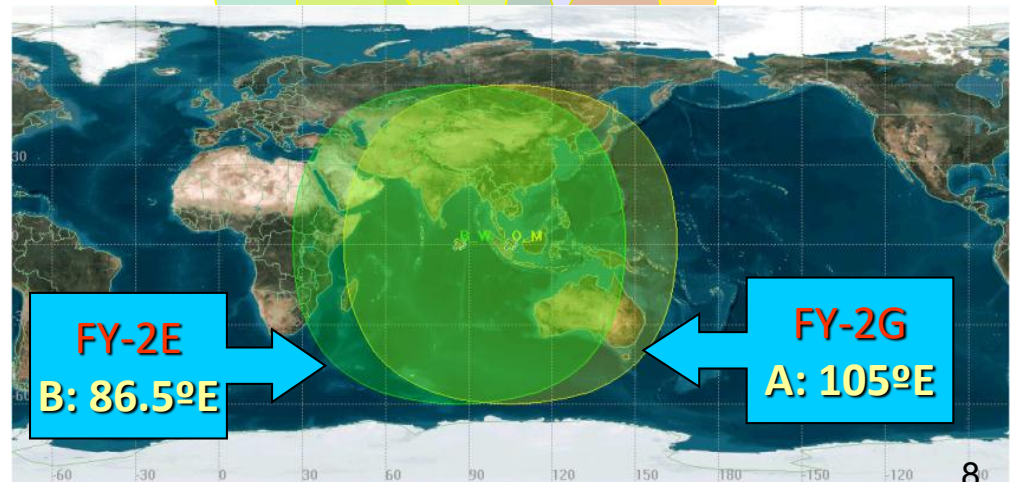
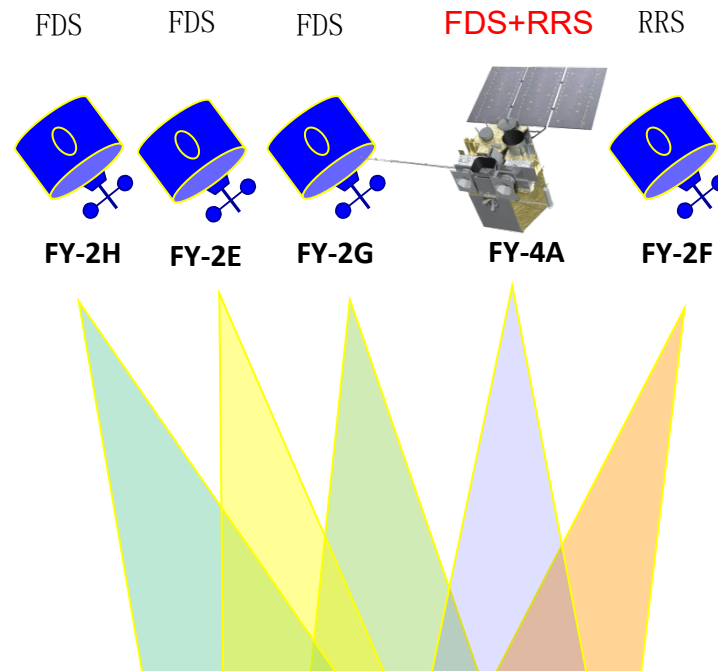
FY-2G: Full Disk (99.5° E)

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

FY-2F: Regional (112° E)

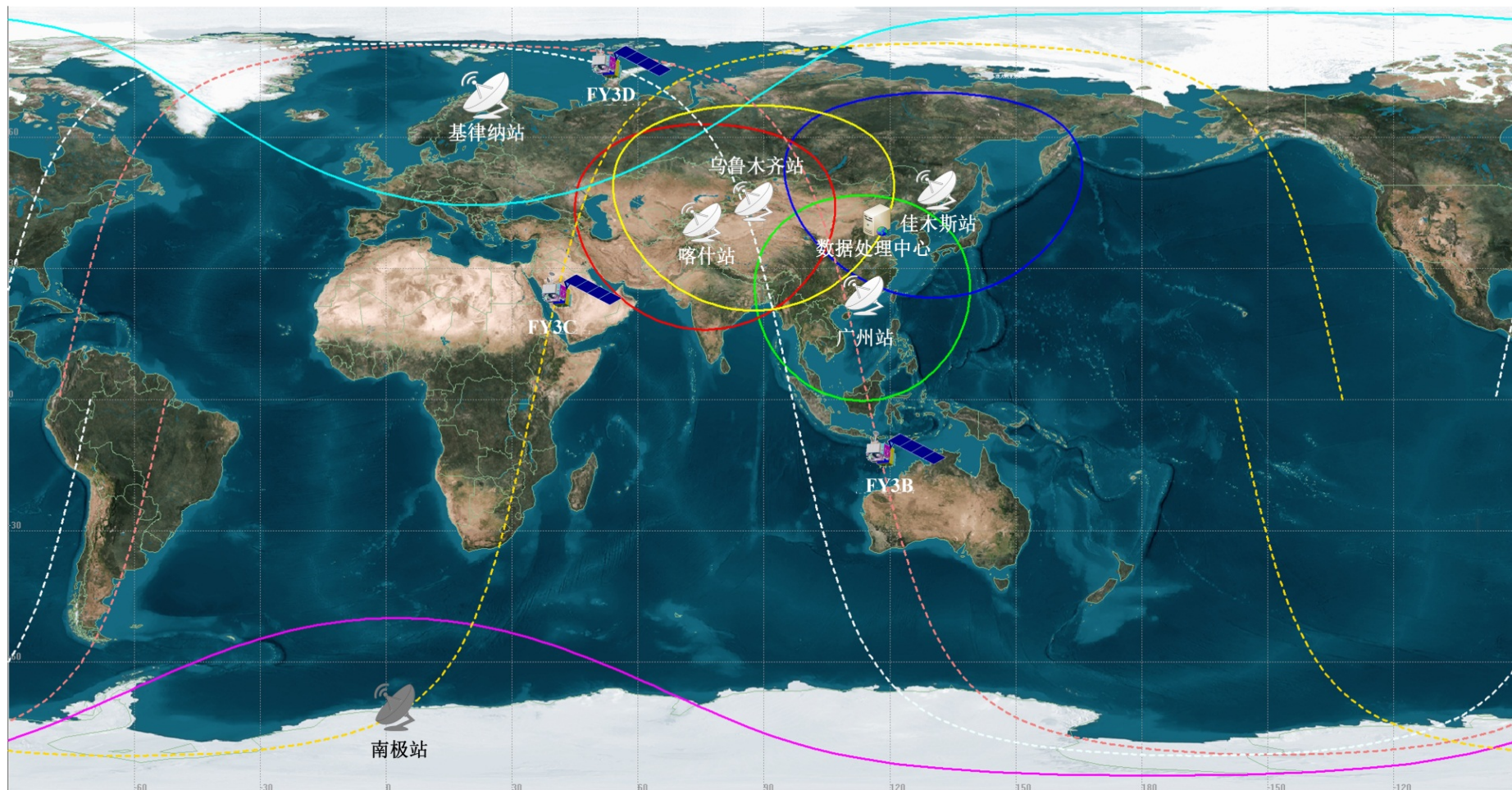
■ 1 in orbit test

FY-2H (79° E)



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[Ⓟ]

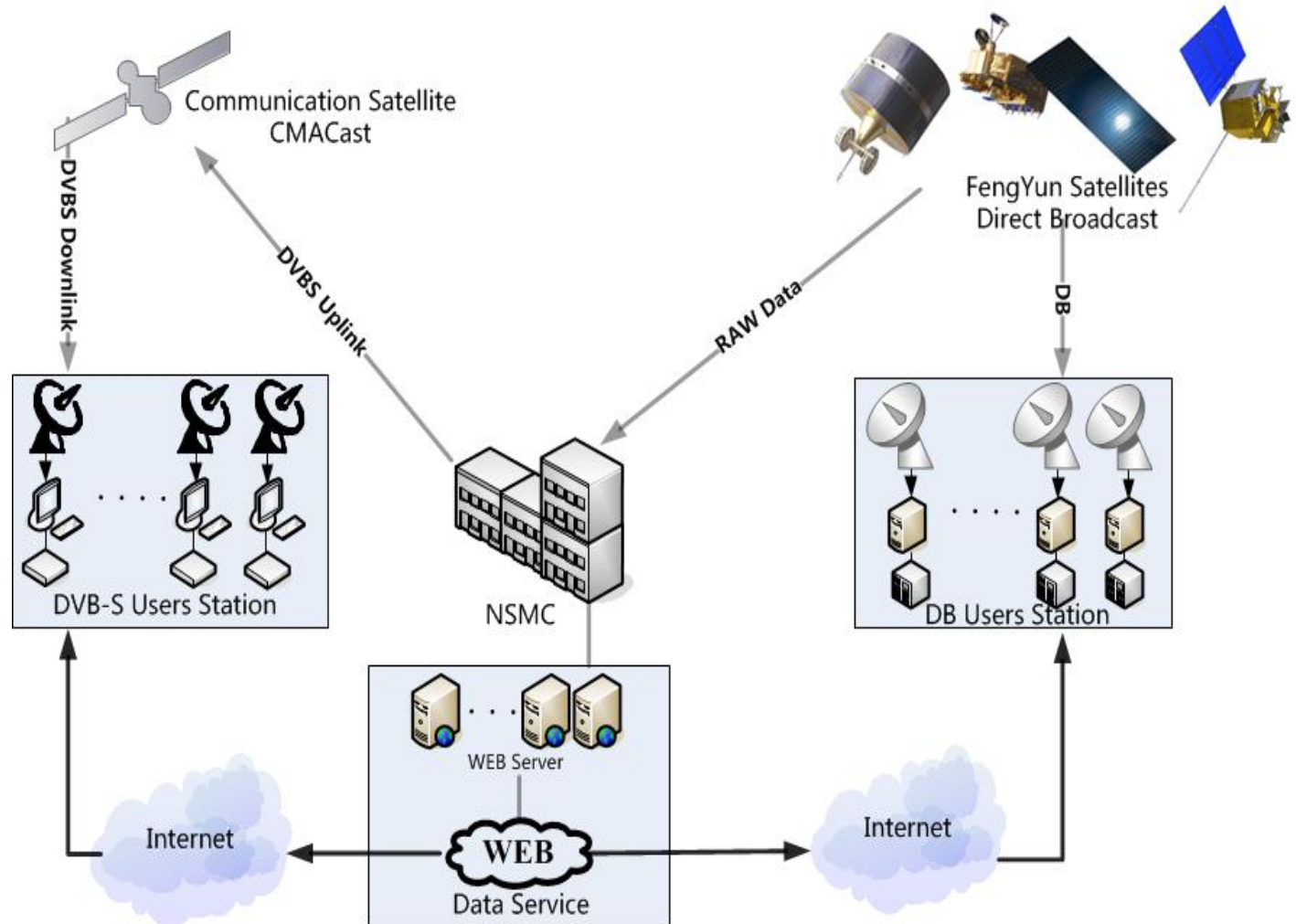
FengYun Satellite Data Service

❖ Real time

- Direct Broadcast
- CMACast

❖ Non-Real Time

- Website
- Cloud Service
- FTP Service
- Manual Service



Fengyun DB Users



More than 45 International DB Users

Web Portal Service

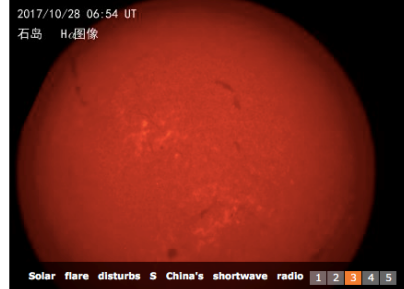
Home About NSMC Satellite Program Operation Imagery and Product Data Access Support

Position: Home

Fengyun Satellites

Legend

FY-3A	TBUS	⬇	⊖
LEO	FY-3B	TBUS	⬆
	FY-3C	TBUS	⬆
	FY-2E	Time Table	⬆
GEO	FY-2F	Time Table	⬆
	FY-2G	Time Table	⬆



Space Weather NSMC Forecasts

Updated at: 29 October 2017 UTC

Solar Flare

Time	0-24H	24-48H	48-72H
CLASS M:	20%	20%	10%
CLASS X:	1%	1%	1%

Geomagnetic Storm

Time	0-24H	24-48H	48-72H
minor	1%	1%	1%
major	1%	1%	1%

Solar Proton Events

Time	0-24H	24-48H	48-72H
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Valid for: 18 October 2013 02:22 UTC

Announcements

- TanSat Data Opened to Public Use
- Announcement of FY-2G East-West Station Keeping
- A Notification on FY2F's Orbital Control
- FY-3B Solar Irradiance Monitor Switched off

Highlights

TanSat Data Opened to Public Use
 August 31, 2017, after in-orbit checkout had been conducted for 8 months, the Summary Report on TanSat Commissioning Tests was received and reviewed by CMA. The review committee unanimously...

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FENGYUN Satellite Data Center

NATIONAL SATELLITE METEOROLOGICAL CENTER

SATELLITES DATA IMAGES PRODUCTS DOCUMENTS TOOLS

Fengyun Satellite Data and Application Service Survey (2017)

Your response to this survey will be rewarded with upgraded maximum daily download of 30GB. Don't hesitate, join now!

Archive

Satellite	File count	Volume(TB)
FY-3C	14895688	486.1
TANSAT	235342	25.1
FY-3B	31017932	1902.2
FY-3A	31753847	1613.9
FY-2G	2128117	19.0
FY-2F	3559028	35.8
FY-2E	5101881	47.5
FY-2D	4759430	58.3
FY-2C	2879072	39.8
FY-1D	270941	6.5

Data Overview>>

FY-LEO TANSAT FY-GEO

FY-3C FY-3B FY-3A FY-1D FY-1C

More...

Data Name:

Start Date: 2017-10-28 Start Time: 00:00:00

End Date: 2017-10-29 End Time: 23:59:59

Time Range: Each Day

Spatial Sel:

Coverage: Intersect Entirely Within

Availability Search

Sign In

User ID:

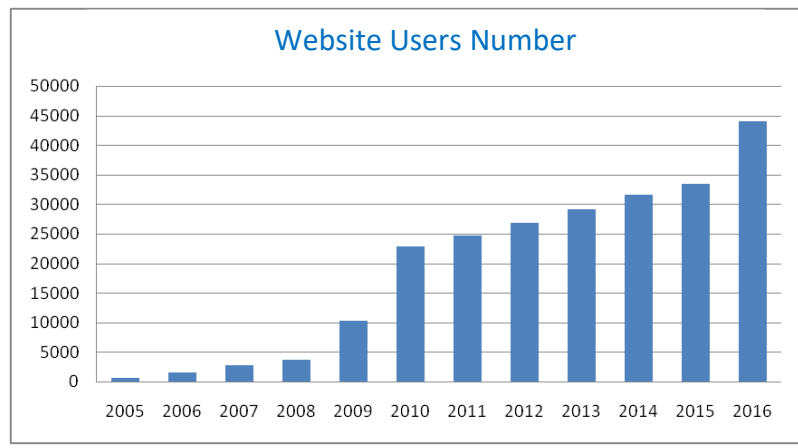
Password:

Verify: BF86

Stay Signed In

Forget Password? SIGN UP

Sign In

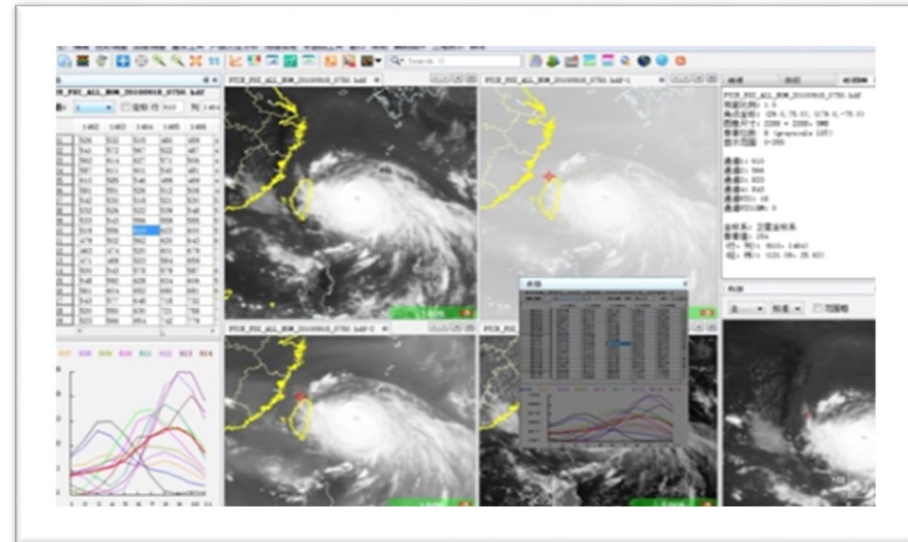


Application Tools

SATs: New Observation Capability

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

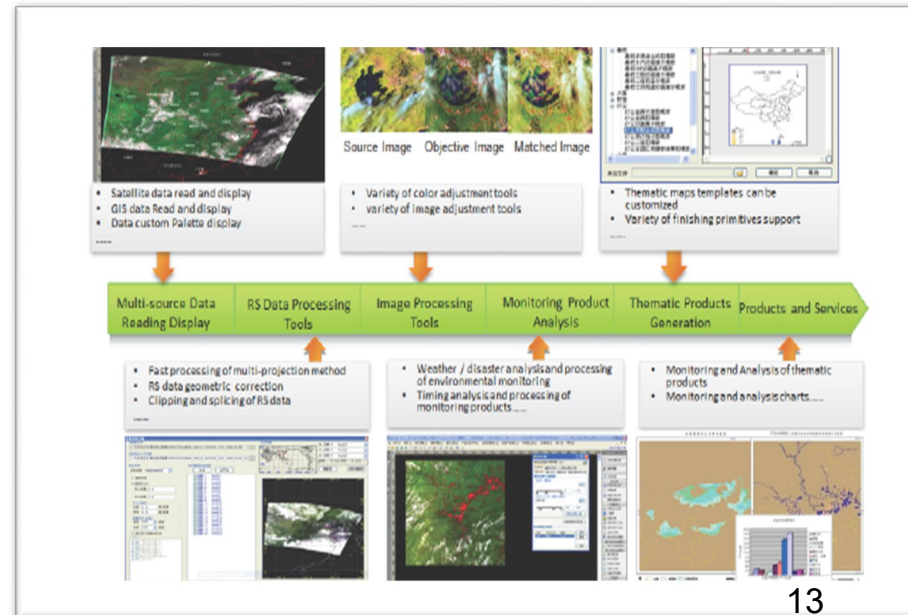
Satellite Weather Application Platform
SWAP



Application tools

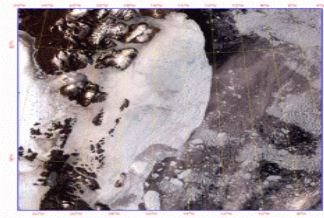
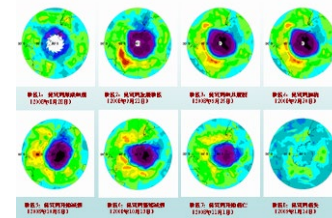
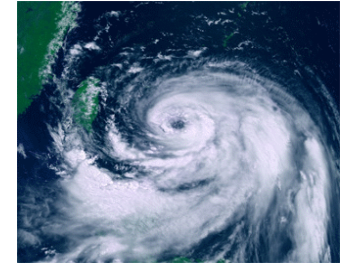
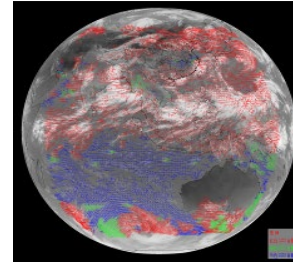
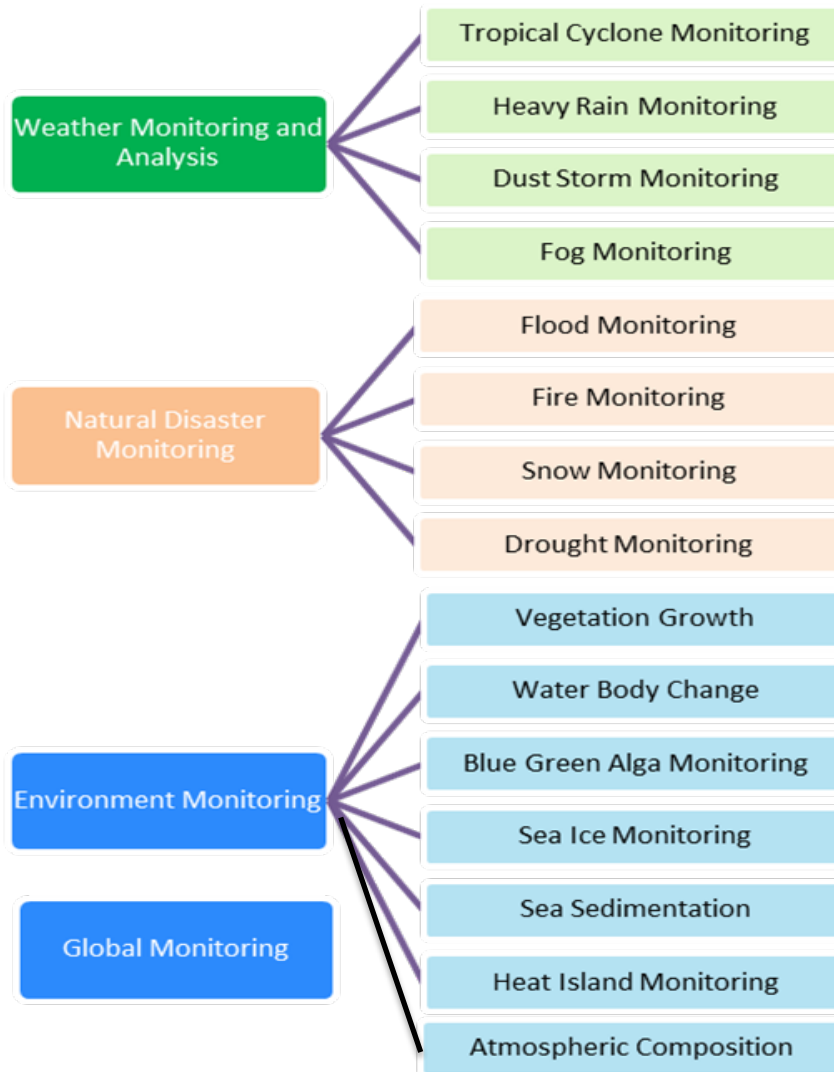
Natural disaster and environment monitoring and analysis
---polar orbiting Satellite data

Satellite Monitoring Application Remote sensing Toolkit
SMART



Users: New Applications

Application Area



3. Latest Progress

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

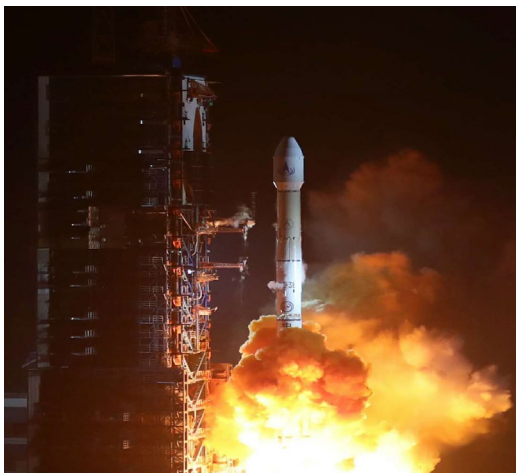
2. FY-2H

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

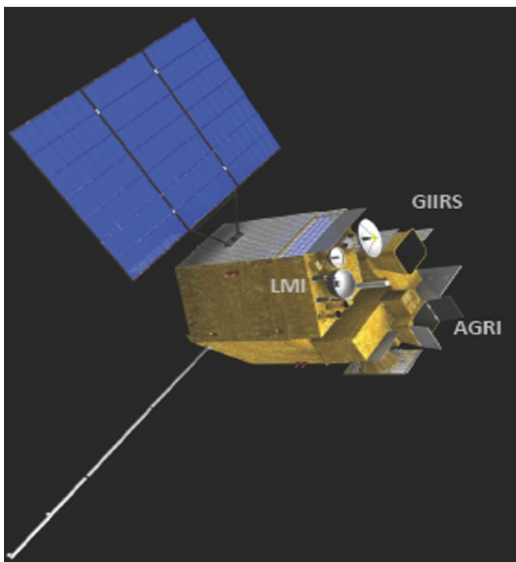
3. FY-3D

- 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

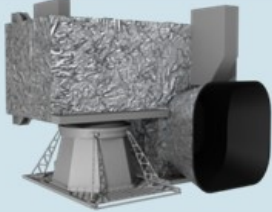
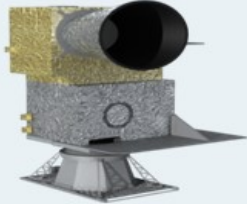




FY-4 is the CMA new generation meteorological geo-satellite series, expected to support various weather-related services, including weather forecasting, disaster prevention and reduction, and monitoring and warning of space weather.



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

FY-4A observation mode

AGRI:

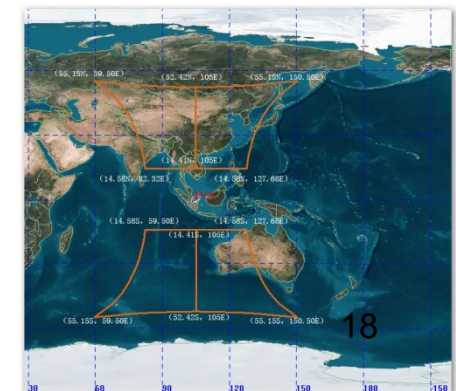
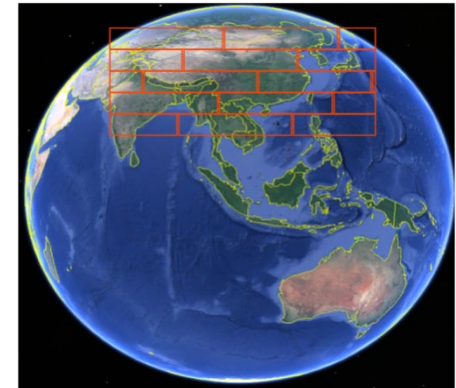
- Every hour: Full disk (00:00/01:00/02:00...23:00)
- Every 3 hour: 3 continuously Full disk(Eg.23:45-00:00-00:15)
- Rest: China area, (every 5 minutes)

GIIRS:

- Every 3 hour: Full disk clear sky observation
- Every 15 minutes: China area clear sky observation

LMI:

- 500 frames per second
- 21 Mar.-22 Sep: Northern Hemisphere
- 22.Sep-Next 21 Mar: Southern Hemisphere



FY-4A Baseline products

	FY-4A	FY-2
Cloud	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
Atmosphere	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
Radiation	Outgoing Long wave Radiation Surface Solar Irradiance Downward Longwave Radiation Upward Longwave Radiation Reflected Shortwave Radiation	Outgoing Long wave Radiation Surface Solar Irradiance
Surface	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
Environment	Dust Smoke Detection Fire/Hot Spot Characterization Fog Detection	Dust Index Fire/Hot Spot Characterization Heavy Fog Detection
Lightning	One Minute Lightning Quantitative Product (including flash group event) Lightning Jump Identification Product Flash Daily Density	
Space	High-energy particle distribution Magnetic Field Intensity Space Environment Effect	

AGRI: Advance Geo. Radiation Imager

FY-4A GEOSTATIONARY METEOROLOGICAL SATELLITE

The First Colour Composite Image of FY-4A AGRI



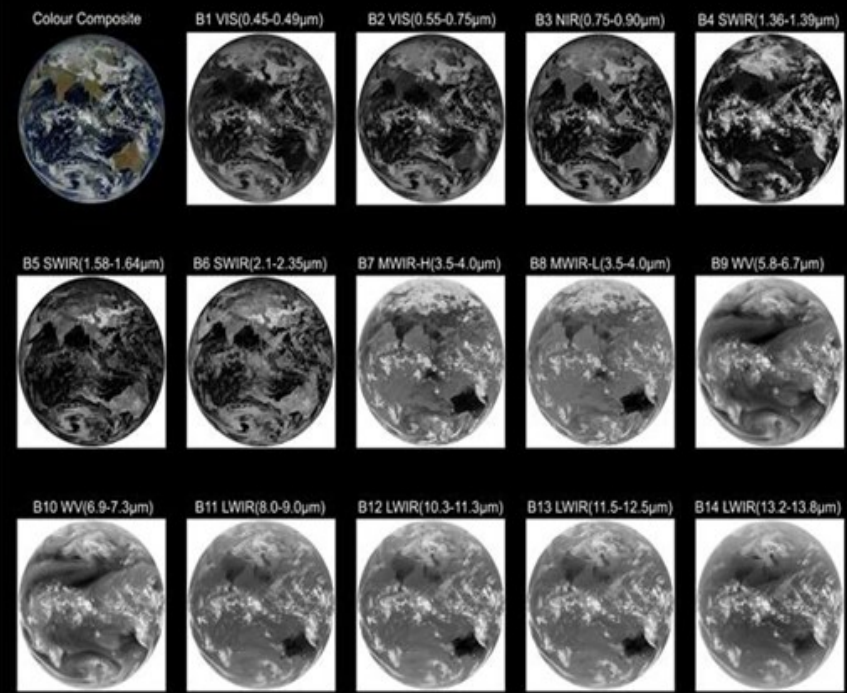
February 20th, 2017 05:15 (UTC)



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FY-4A GEOSTATIONARY METEOROLOGICAL SATELLITE

The First Images of FY-4A AGRI



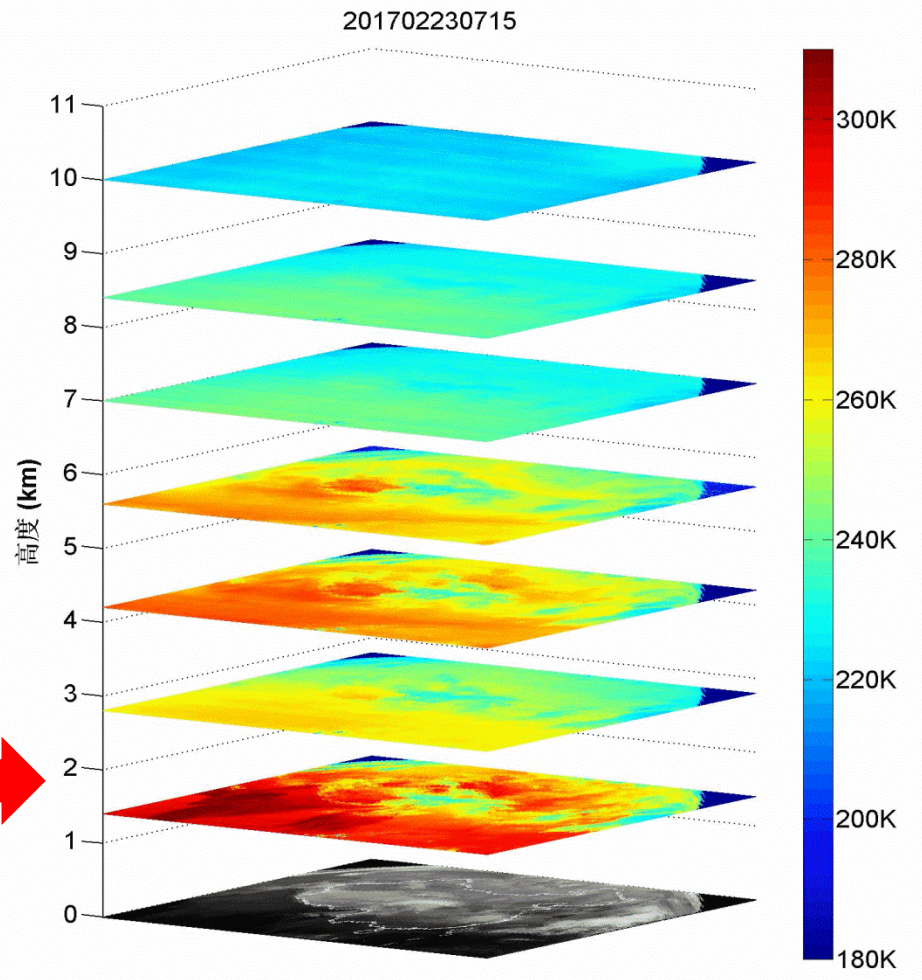
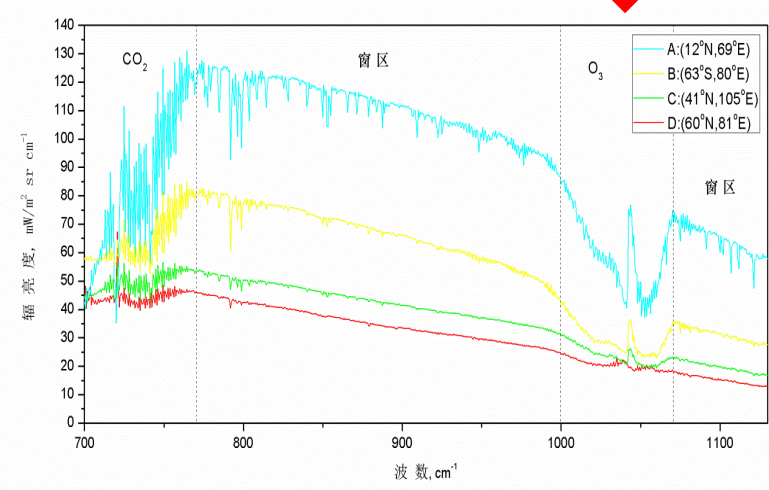
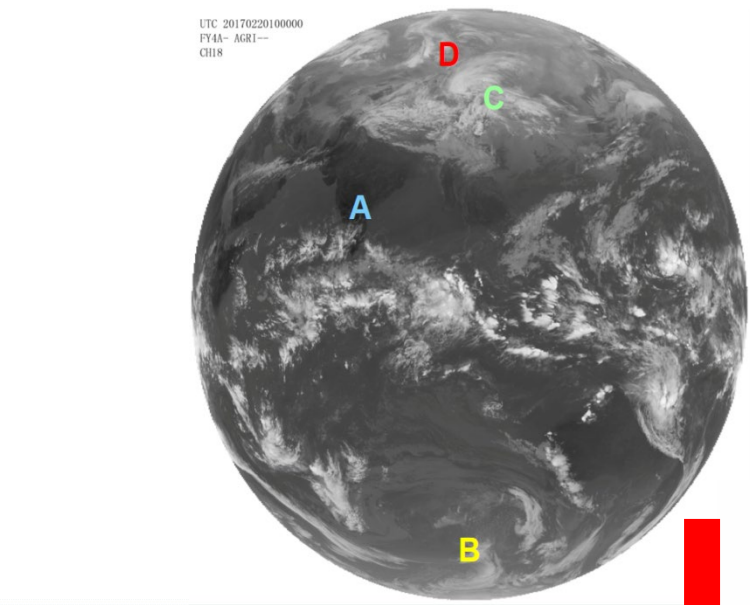
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GIIRS:

First Geo. Interferometric Infrared Sounder

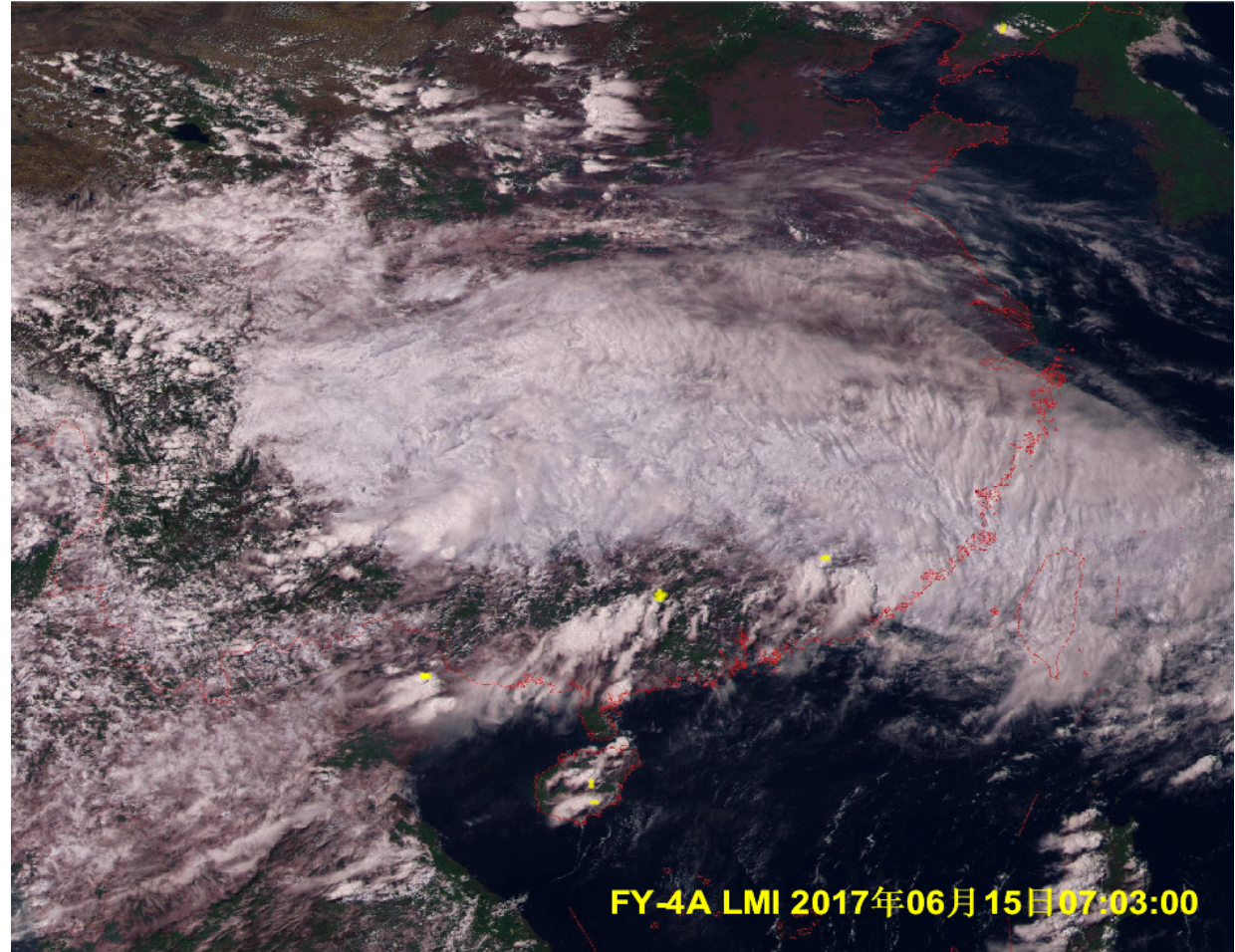


LMI: Lightning Mapping Imager

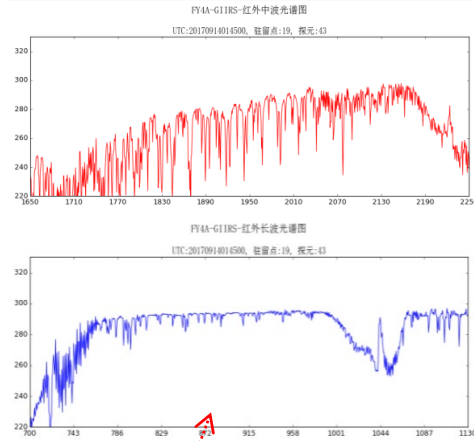
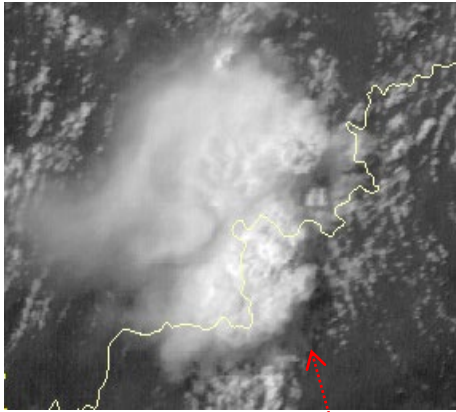


Acquire lightning distribution maps over specific region

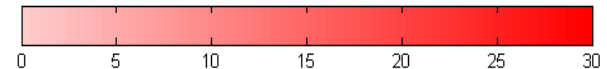
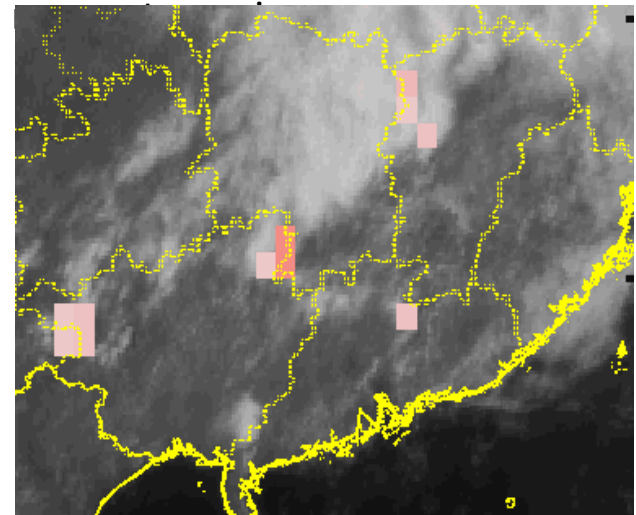
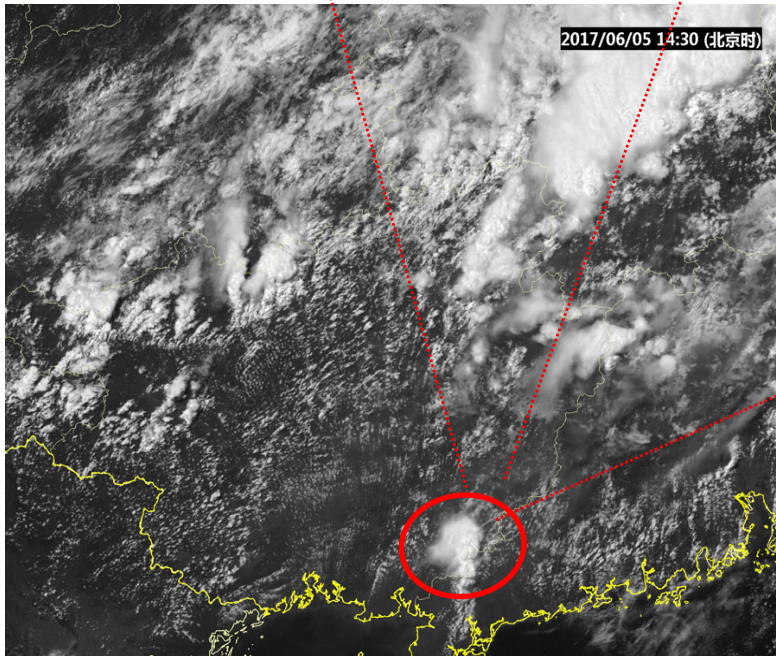
Spatial resolution	about 7.8Km at SSP
Sensor size	400×300 ×2
Wave-length at center	777.4nm
Band-width	1nm ± 0.1nm
Detection efficiency	>90%
False-alarm ratio	<10%
Dynamic range	>100
SNR	>6
Frequency of frames	2ms
Quantization	12 bits
Measurement Error	10%



AGRI + GIIRS + LMI

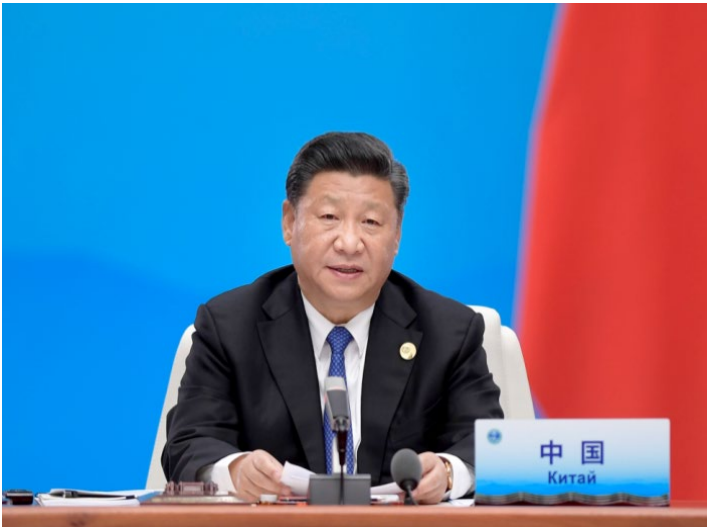


1. FY-4A lightning frequency map: strong convective cloud clusters often accompany with obvious lightnings.
2. FY-4A high spatial resolution imager: finer structure and texture of strong convective cloud cluster; and clearer small scale cumulus line.
3. Cloud free atmospheric profile acquired from GIIRS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



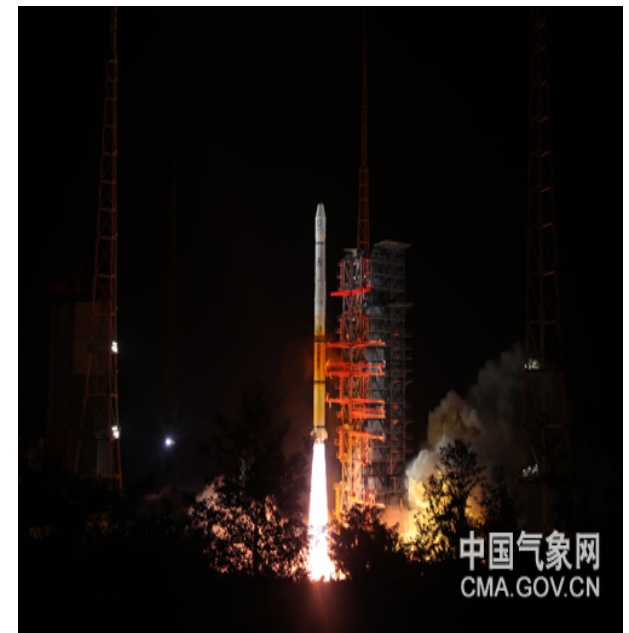
FY-2H: Launched on 5 Jun, 2018

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

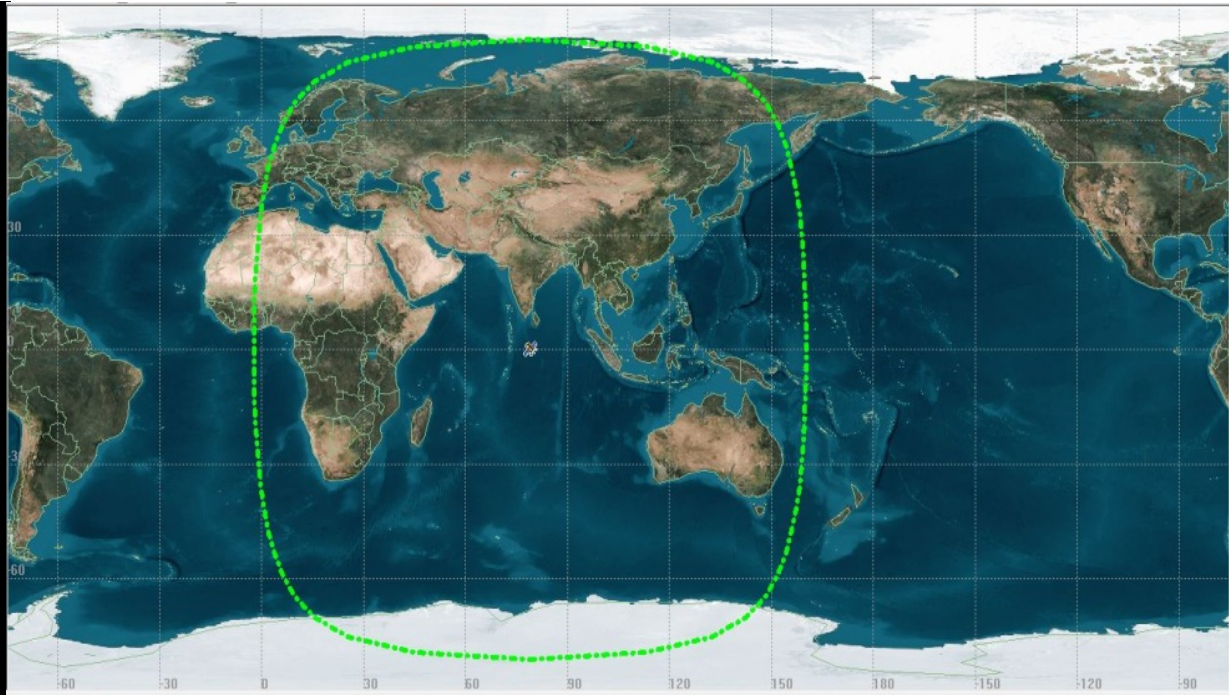
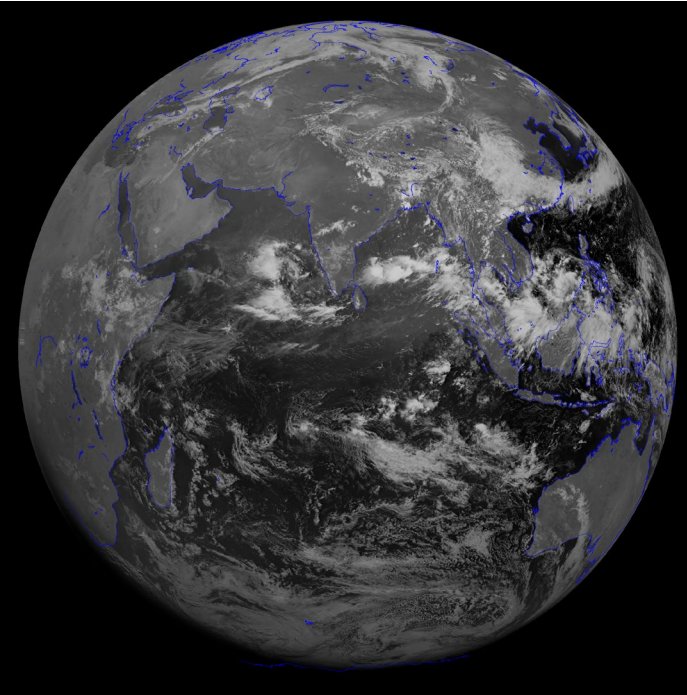


- Launched on June 5, 2018
- positioned at 79° E and operational *by September, 2018*

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.”

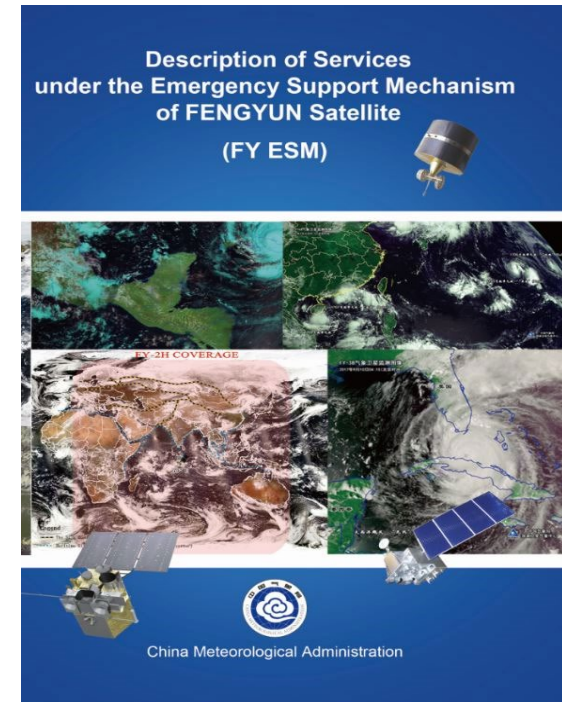


FY-2H coverage at 79° E



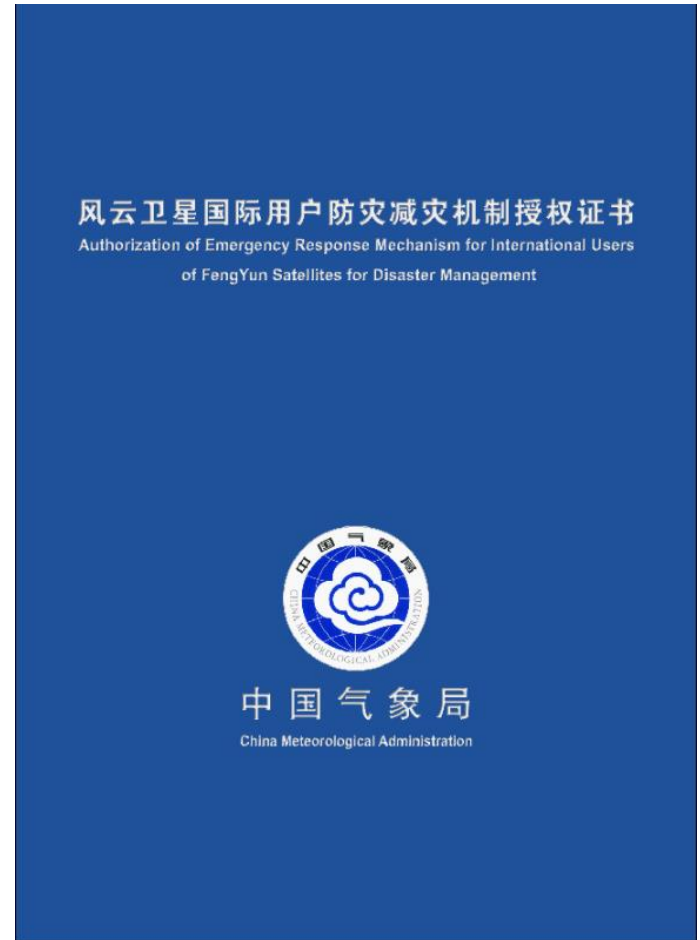
CMA Announced “Emergency Support Mechanism for International Users of Fengyun Meteorological Satellites in Disaster Prevention and Mitigation” on April 24, 2018

- To serve the countries along the “Belt and Road” in a timely manner. These countries may raise a request for the activation of the mechanism through their respective Permanent Representatives with WMO or their designated focal points.
- Once the request is approved, CMA will command the on-duty FY satellite for frequent and targeted observations per 5-6 minutes over affected areas.
- The images and products will be transmitted to the requesting applicant through CMACast, internet and direct satellite broadcast reception.



18 Authorized FY ESM Users

As of September 2018, there are 18 Authorized FY ESM users, including Indonesia, Vietnam, Laos, Myanmar, Thailand, Philippine, Malaysia, Singapore, Kazakhstan, Kyrgyzstan, Pakistan, Russia, Tajikistan, Uzbekistan, Afghanistan, Iran, Mongolia, Sri Lanka

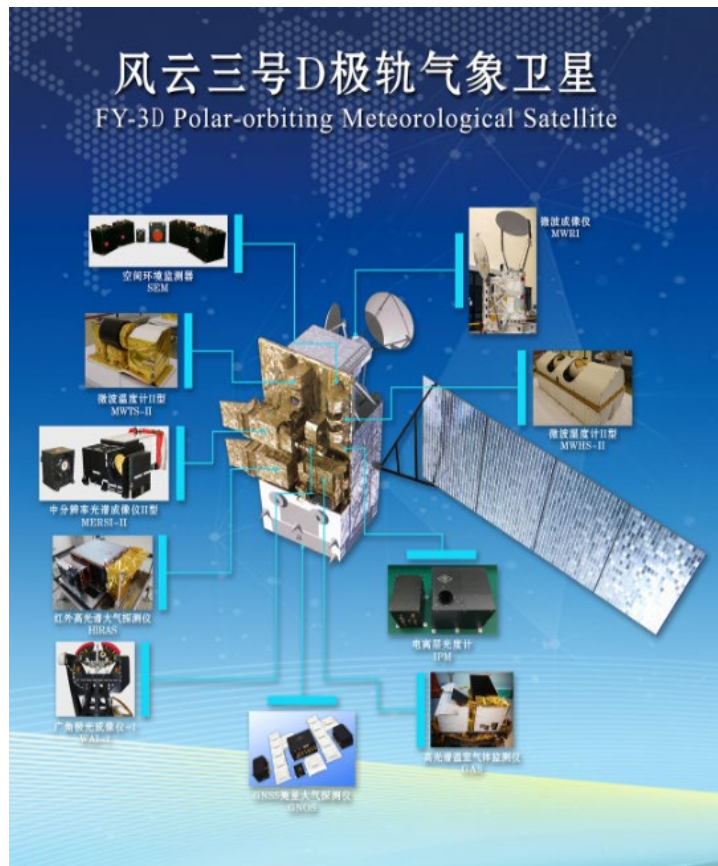


FY-3D: Launched on 15 Nov, 2017



Parameters	Satellite Specification
Orbit type	Near-polar sun-synchronous orbit
Orbital altitude	836 Km
Orbital inclination	98.75°
Precision orbit	Semi-major axis deviation: $ \Delta a \leq 5\text{Km}$
	Orbital inclination deviation: $ \Delta i \leq 0.1^\circ$
	Orbital eccentricity ≤ 0.003
Repeat cycle	5.5d (Design range is in 4-10 d)
Eccentricity	≤ 0.0025
Local time drift at ascending node	15 min within 4 yrs
Launch window	local time at ascending node: 13:40 – 14:00
Design lifetime	5 yrs for design, 4 yrs for assessment

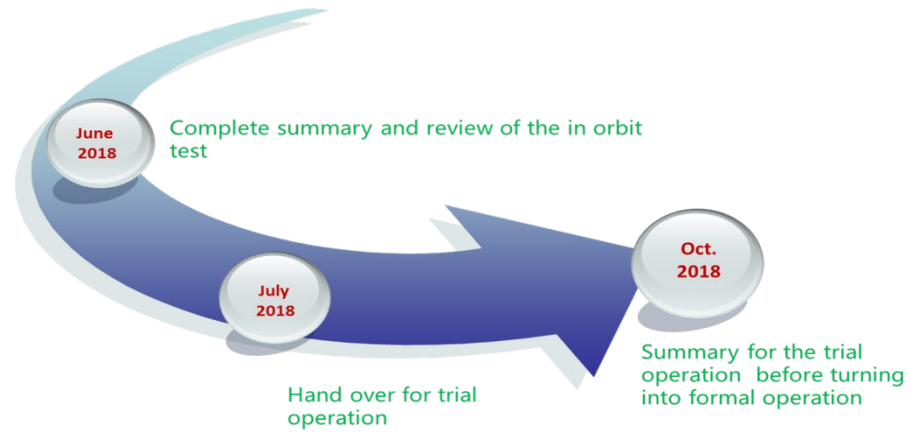
- 4 new instruments (HIRAS, GAS, WAI, IPM)
- 1 important improved instruments (MERSI-2)
- 5 successive Instruments



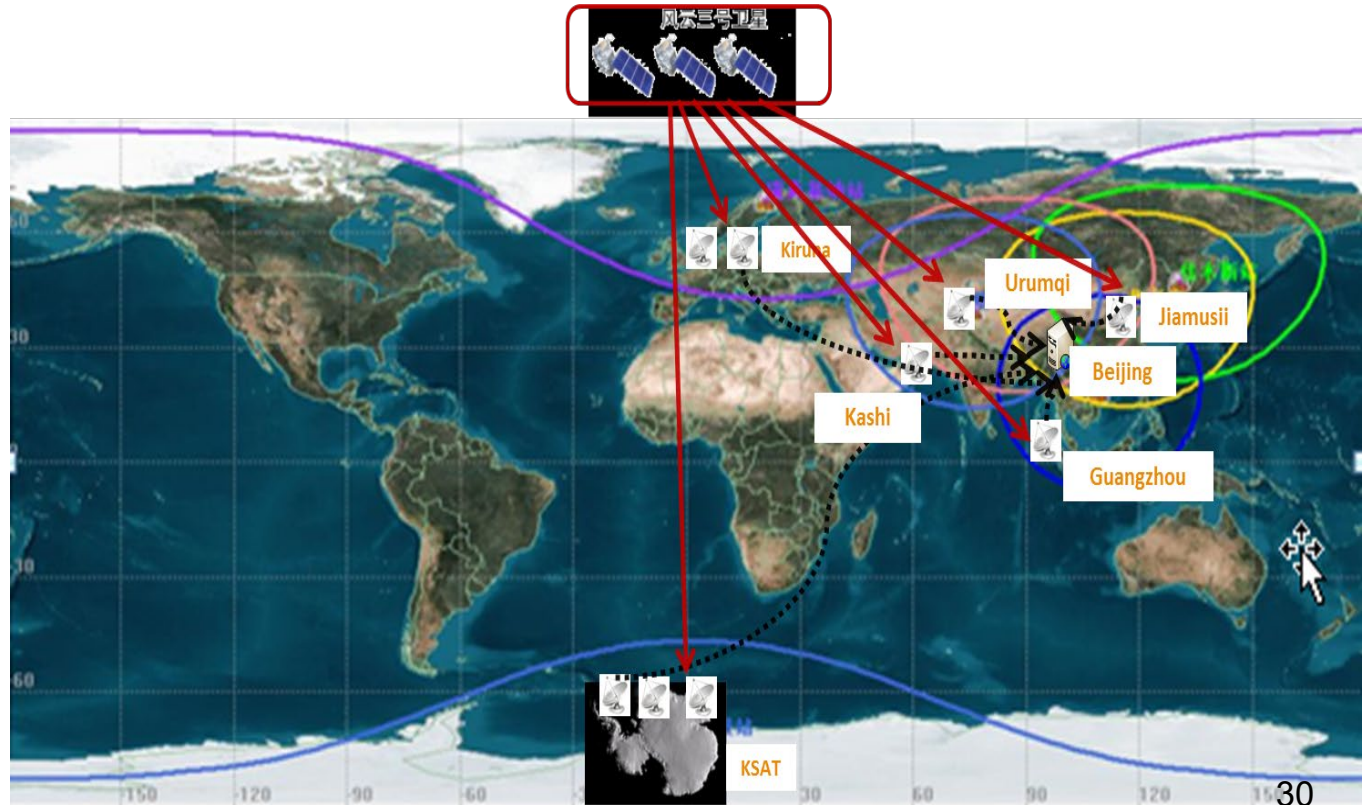
Payload Name	Channel Numbers with Spectral Coverage
MEdium Resolution Spectral Imager (MERSI-2)	25 (0.413 – 12 μm)
Hyperspectral InfraRed Atmospheric Sounder (HIRAS)	1370 (3.92 – 15.38 μm)
MicroWave Radiation Imager (MWRI)	10 (10.65 – 89 GHz)
MicroWave Temperature Sounder (MWTS-2)	13 (50.3 – 57.29 GHz)
MicroWave Humidity Sounder (MWS-2)	15 (89.0 – 183.31 GHz)
GNSS Occultation Sounder (GNOS)	29 (–)
Greenhouse-gases Absorption Spectrometer (GAS)	5540 (0.75 – 2.38 μm)
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.

- ✓ In Orbit testing began on December 12th, 2017;
- ✓ the in orbital testing has been finished. The results show that the satellite platform and main payloads functions well, and meets the requirements;



Global data latency within 2 hours (80%) less than 1 hour

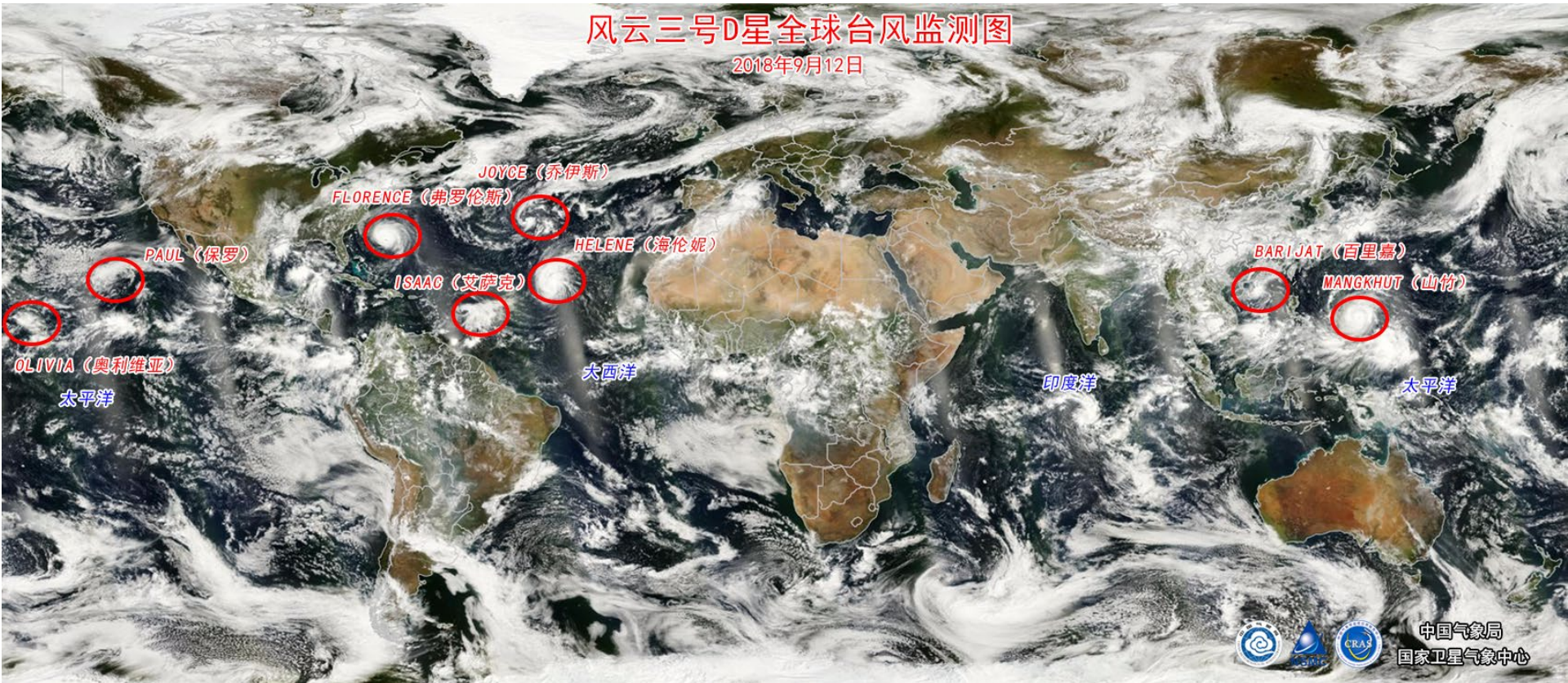


FY-3D Baseline products

Cloud & Radiation	Atmosphere	Land Surface	Sea Surface	Space Weather
<p>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</p>	<p>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</p>	<p>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</p>	<p>SST, Sea-Ice cover, Ocean color, Chlorophyll, Sea surface wind speed</p>	<p>radiation flux of high energy particles, surface electric potential radiation dose, GNOS Electron Density Profile, Ionospheric O/N2 Column Ratio, Aurora Mapping Products</p>

Global True-color Image for Tropical Cyclone Monitoring from FY-3D Satellite

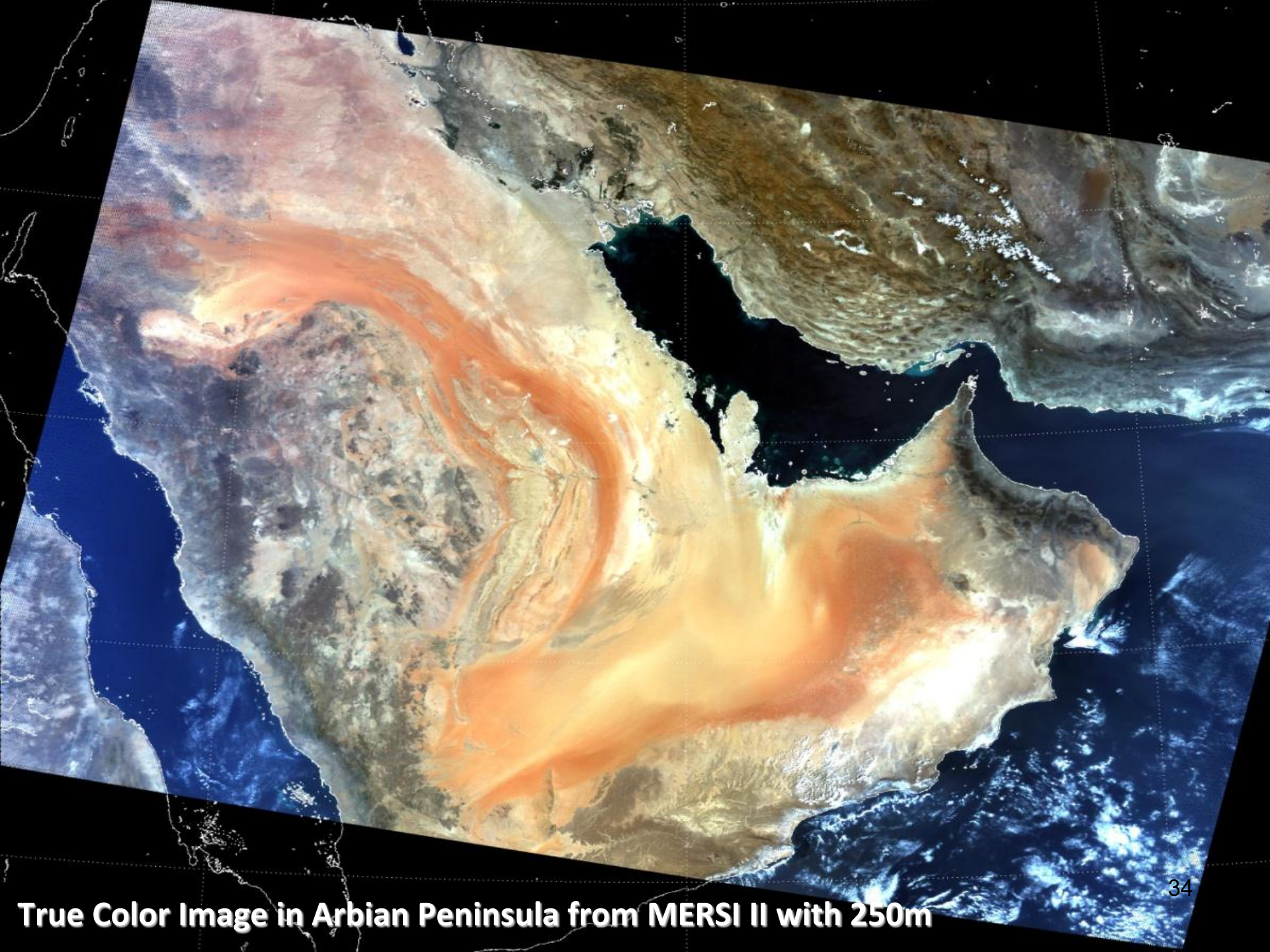
11 September, 2018



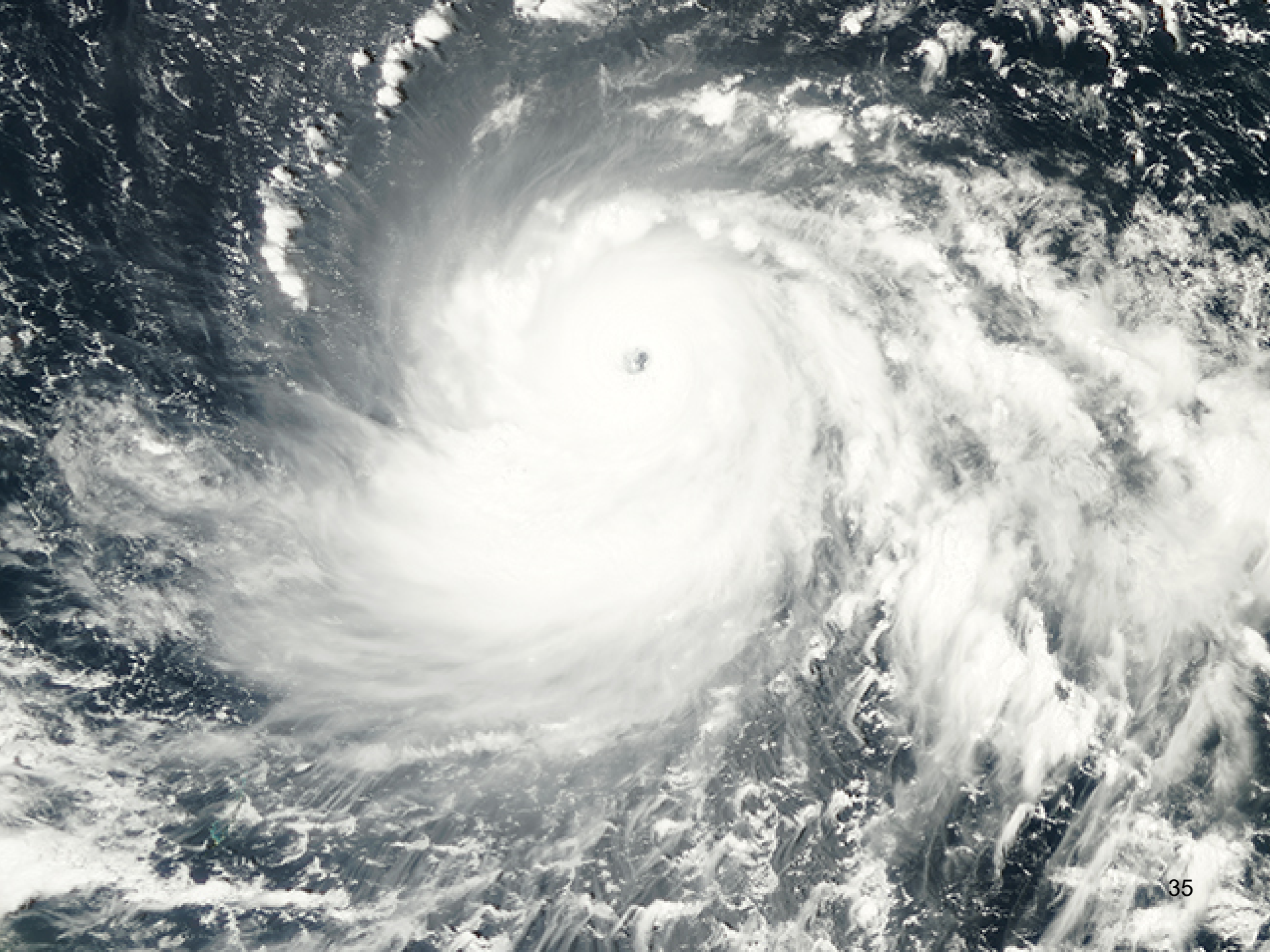
On Sep. 11, 2018, the global tropical cyclones (TCs) initialize and develop actively and all the named ones is eight. In particular, four TCs are within the Pacific and Atlantic Oceans respectively, two of which directly influence China and its surroundings.



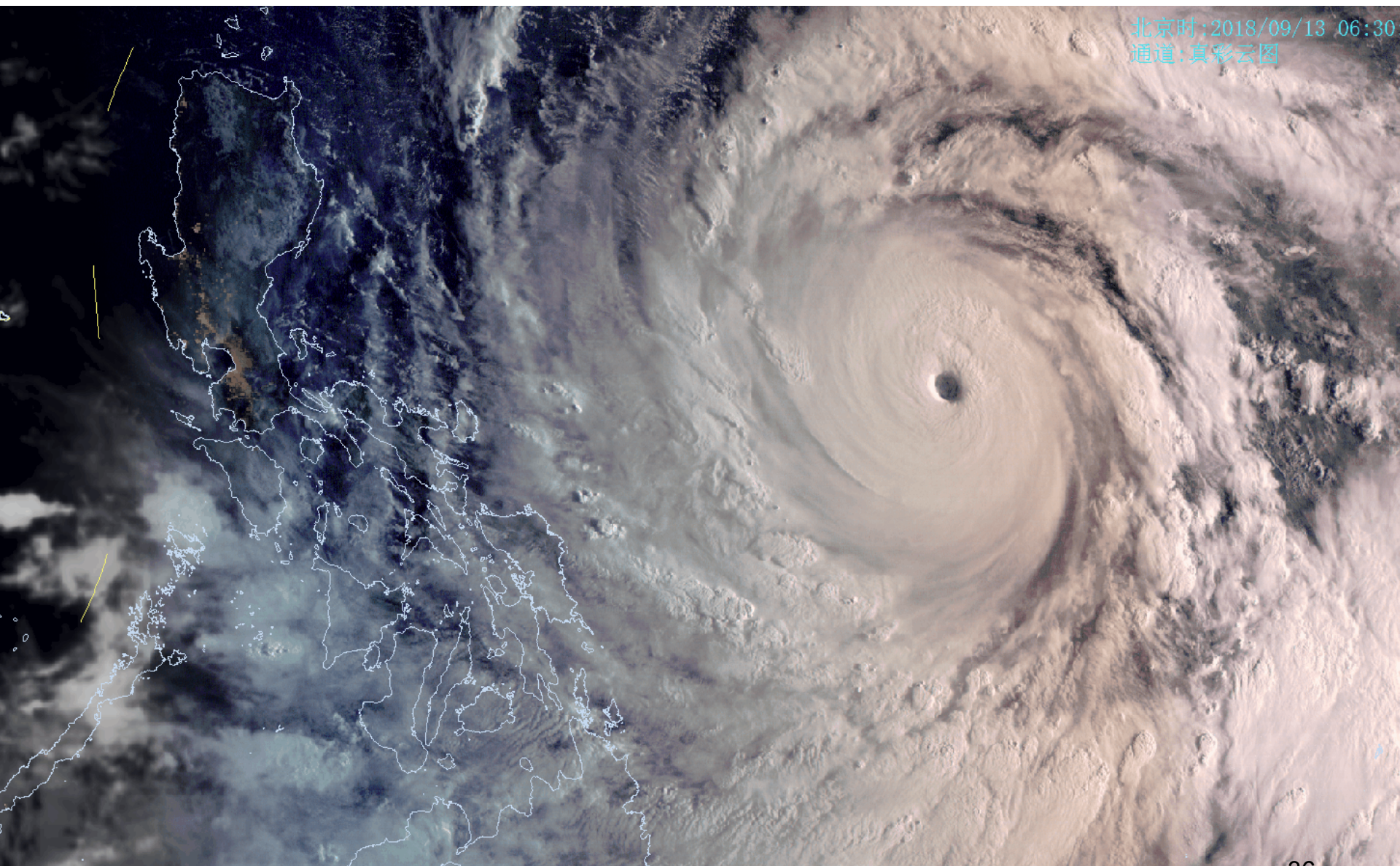
True Color Image in Caribbean Sea from MERIS II with 250m



True Color Image in Arabian Peninsula from MERIS II with 250m



北京时间:2018/09/13 06:30
通道:真彩云图



Temperature Profile from HIRAS-MWTS-WMHS

9月14日23:30

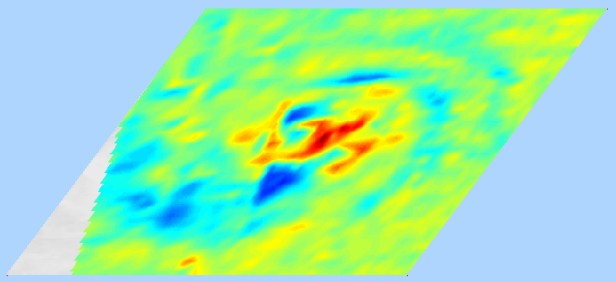
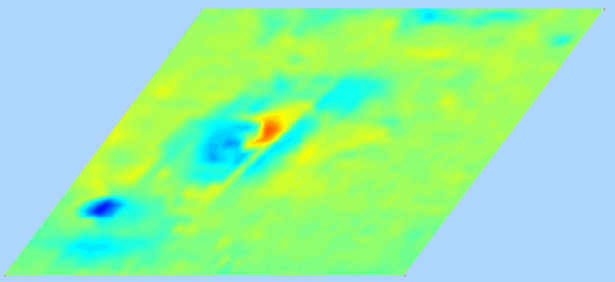
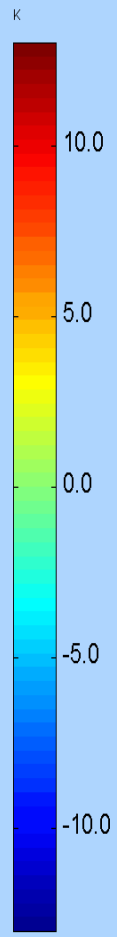
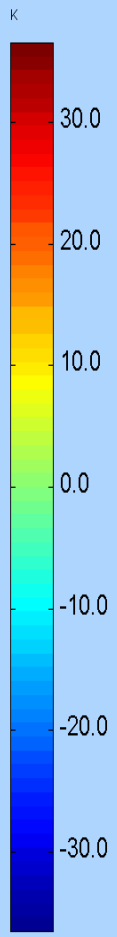
9月14日11:40

FY3D AVP
山竹(MANGKHUT)
8/09/14 15:30 UTC

JD AVP
山竹(MANGKHUT)
4 03:40 UTC

100.0
200.0
500.0
850.0
1000.0

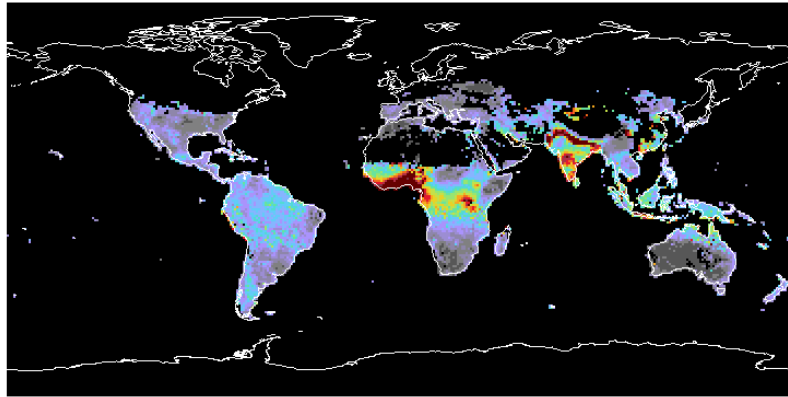
100.0
200.0
500.0
850.0
1000.0



Typhoon Mangkhut (1822) 2 hour before landing

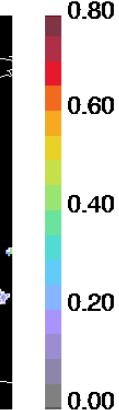
Global 8-day-mean product: MERSI II and MODIS land aerosols

Aerosol_Optical_Depth_Land_Mean_Mean



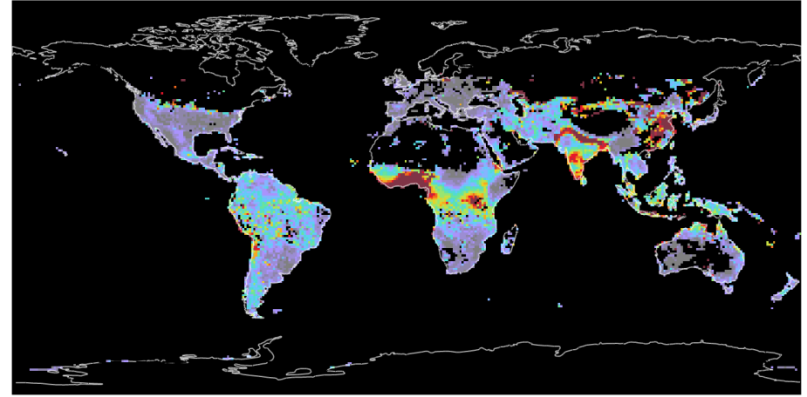
MODIS/Aqua MYD08_E3.A2018001.006.20180111145021.hdf

01 Jan 2018



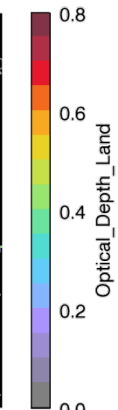
MODIS/Aqua

Aerosol_Optical_Depth_Land_Mean_Mean



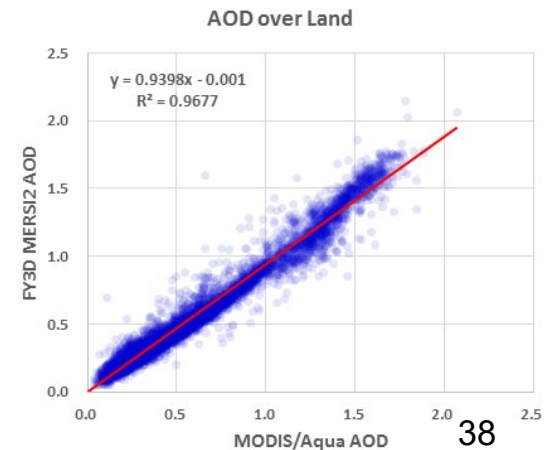
MERSI2/FY3D FY3D_MERAOD_E1d.201801.Beta.hdf

Jan 2018



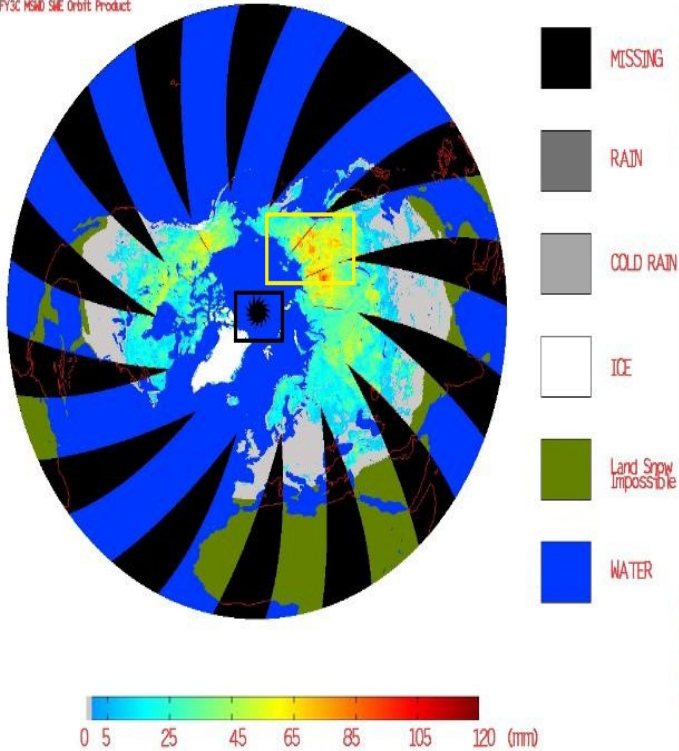
MERSI2/FY3D

Good consistency in global distribution and AOD of pollution sources.



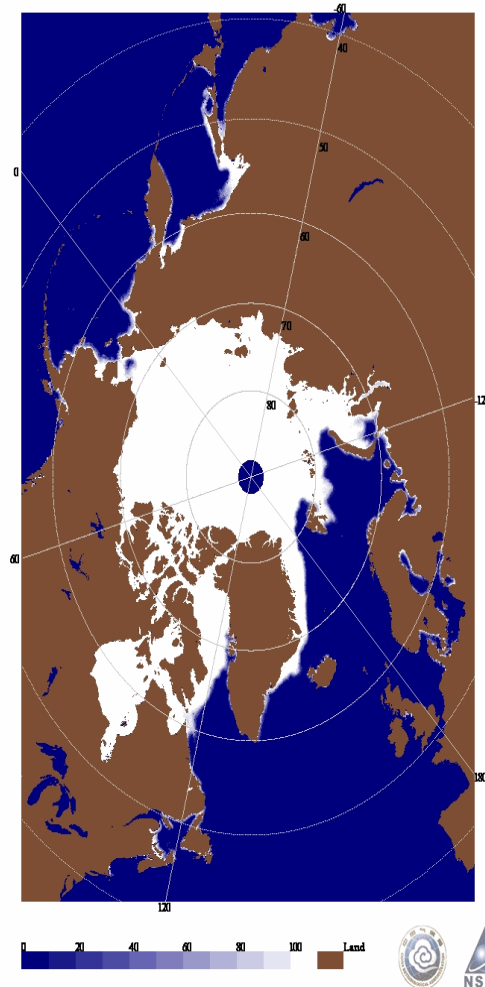
Snow depth/SEW

FY3C MSMD SWE Orbit Product
NSMC

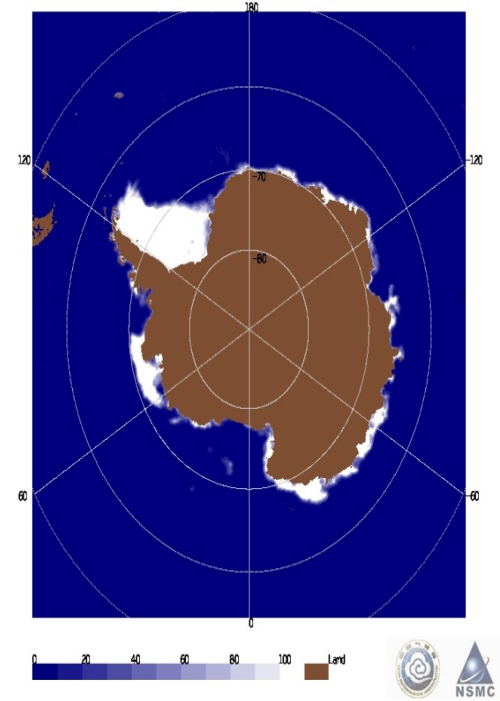


MWRI Sea ice

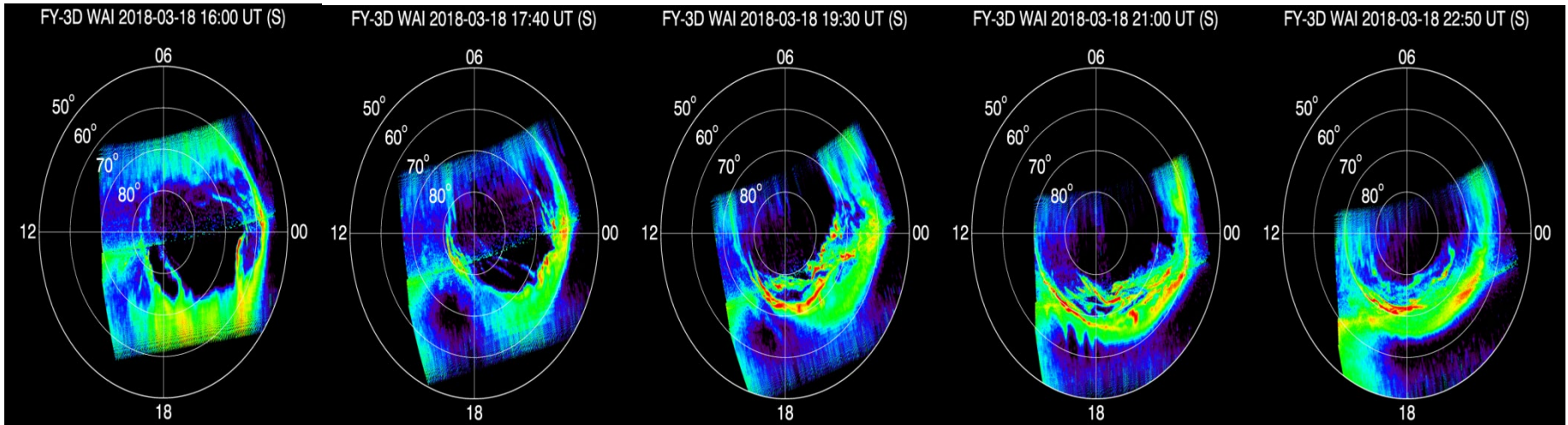
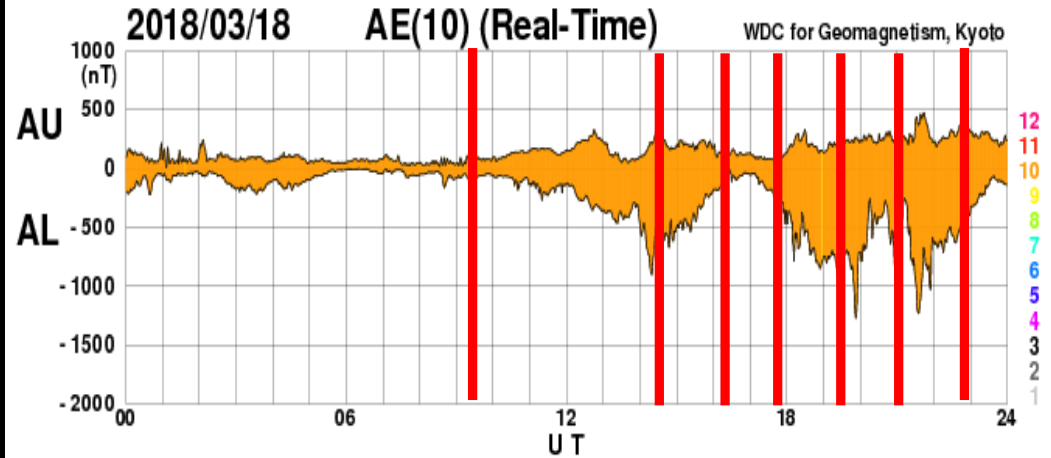
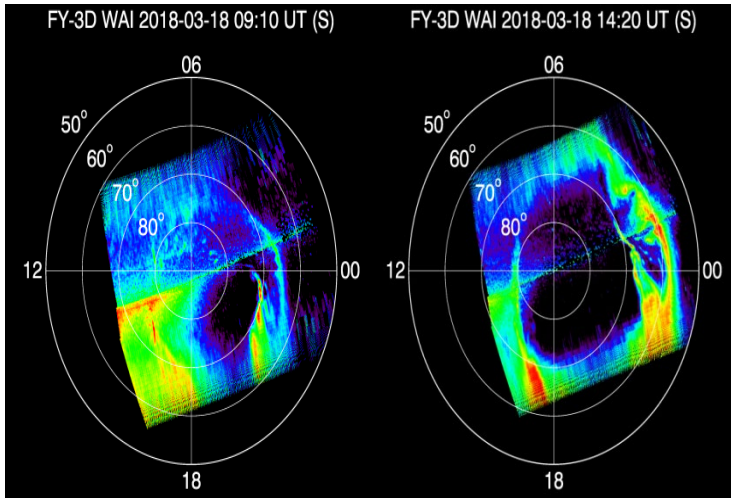
FY-3D MWRI SIC North Daily Product: 2018-01-01



FY-3D MWRI SIC South Daily Product

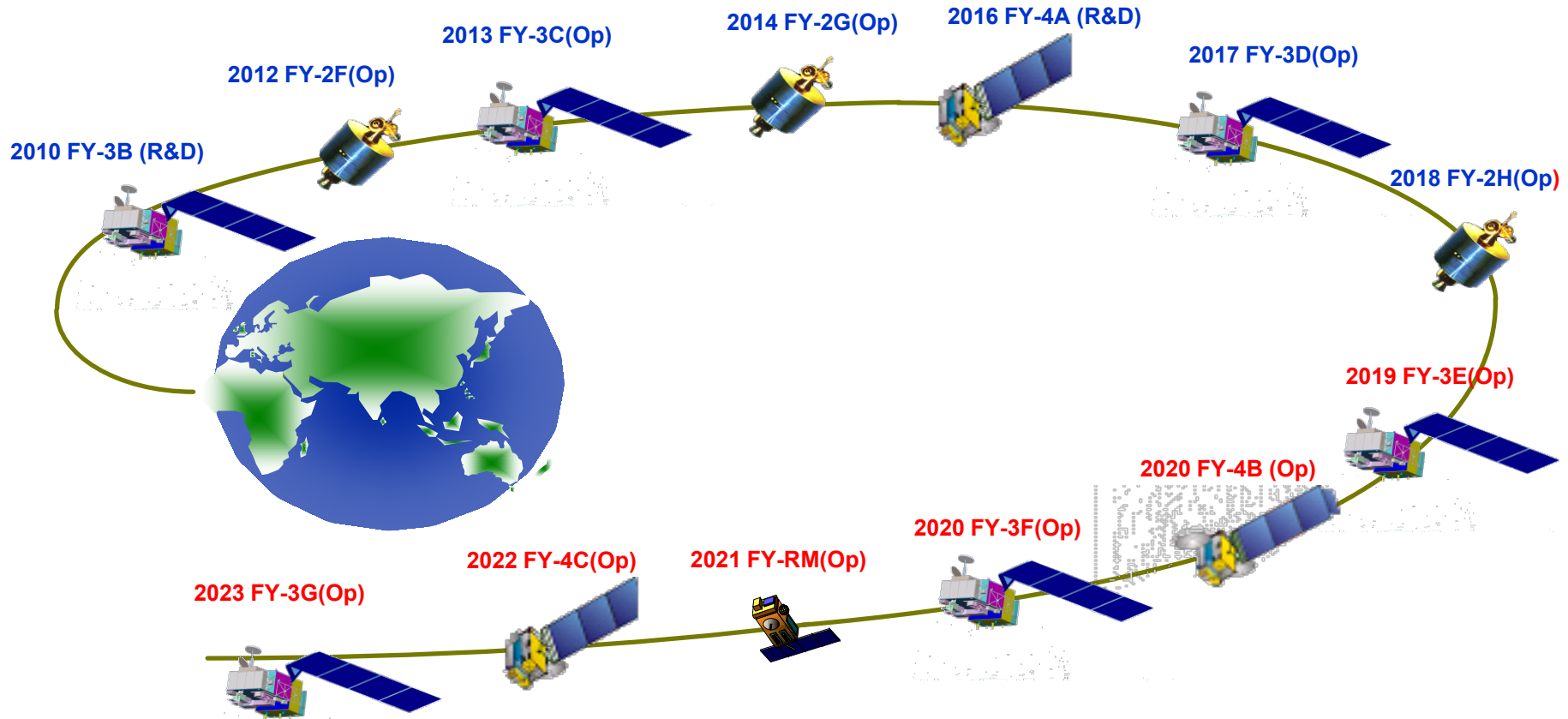


Aurora in the North Polar from WAI



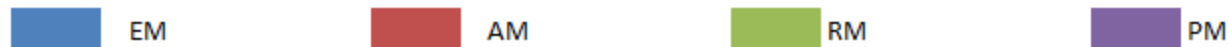
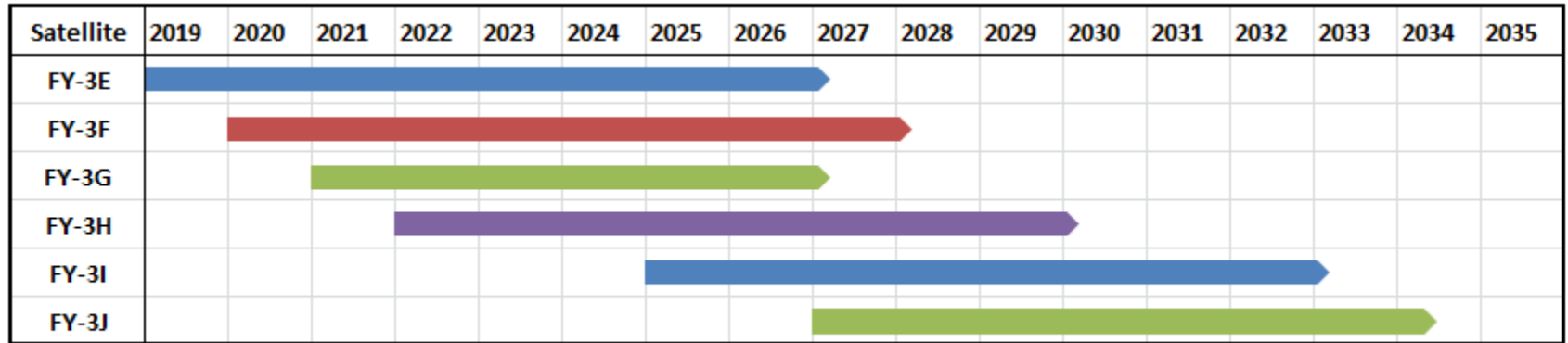
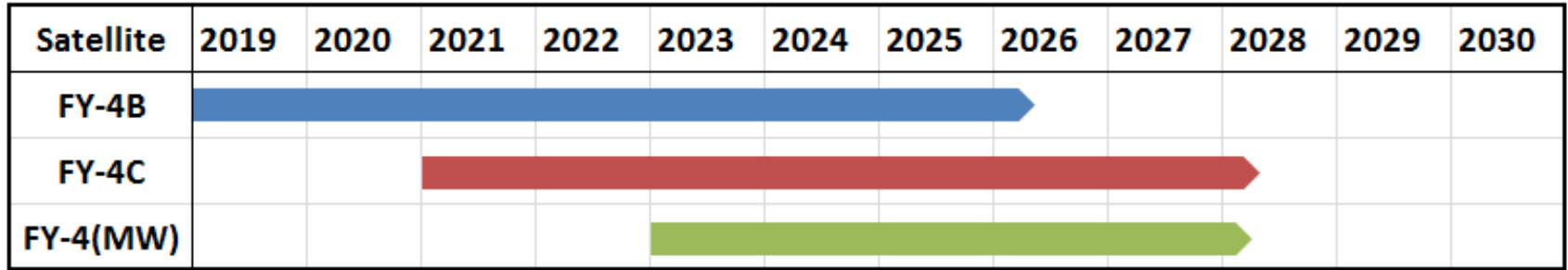
4. Future Programs

National Program for Fengyun Meteorological Satellite from 2011-2020

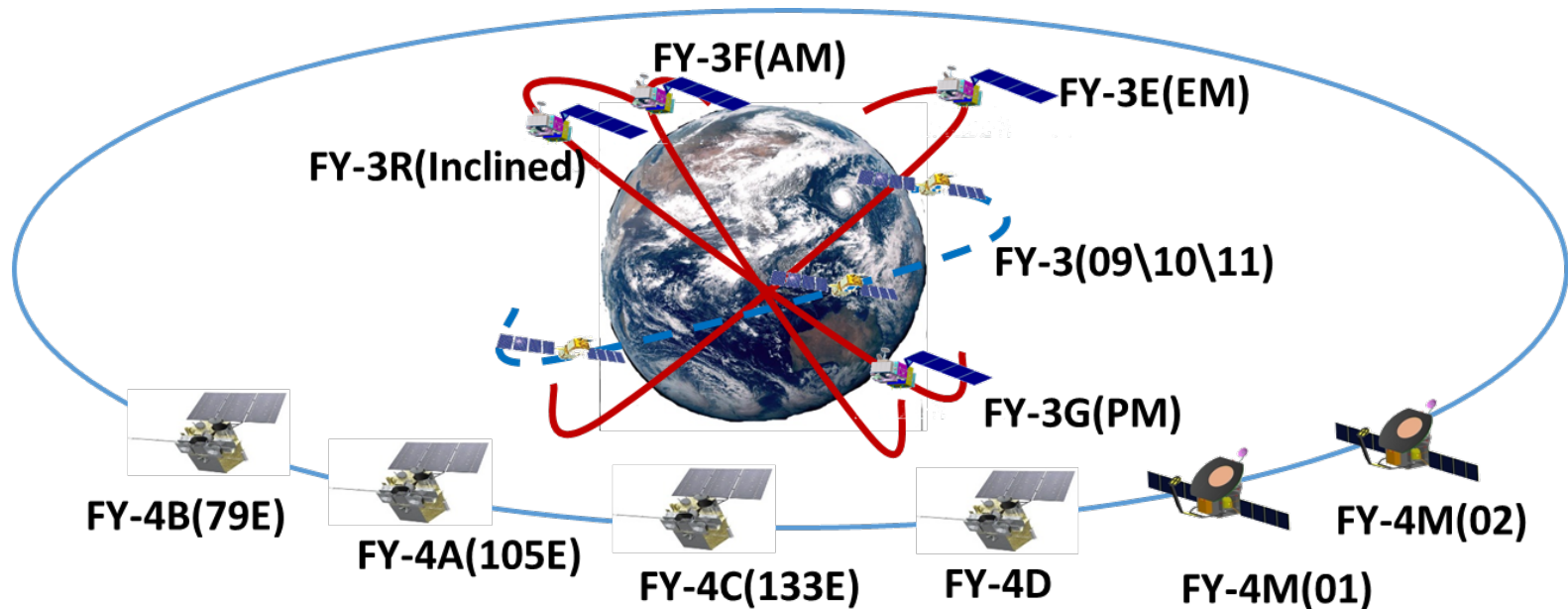


■ 6 satellites will be launched within this decade

National Space Infrastructure Program for Meteorological Satellites (from 2020 to 2025) approved by the State Council



In the next 10 years, CMA will have 6 GEO and 7 LEO main operational satellites, which means the updates for the satellite observation network will be completed.



The LEO realizes the network of covering the EM, AM and PM satellite observation, and the time limit of global data updating has been raised from 6 hours to 3 hours. Fine detection of elements such as precipitation and greenhouse gas.

The new pattern of GEO observation: imaging, hyper-spectral and microwave sounding.
FY-4B: rapid scan(min), FY-4C: five minutes disk image, sounding abilities, whole disk lightning mapper.

Thank You