

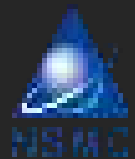
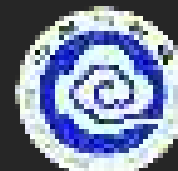


CMA Fengyun Meteorological Satellite Program



Xiang FNAG

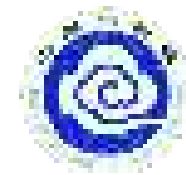
**National Satellite Meteorological Center,
China Meteorological Administration
(NSMC/CMA)**



Outline

- Overview
- Current Missions
- Latest Progress
- Future Programs
- Summarization

1. Overview



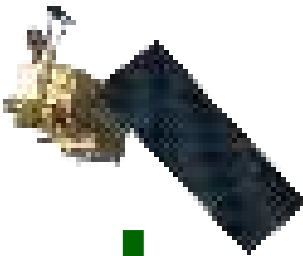
Current FengYun Meteorological Satellites

Polar System

First Generation
FY-1 A, B, C, D



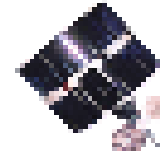
Second Generation
FY-3 A, B, C, D,
E, F, G



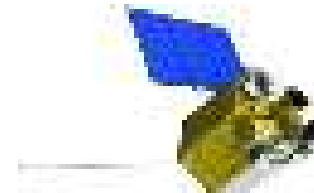
Expected until 2025

Geostationary System

First Generation
FY-2 A, B, C, D,
E, F, G, H

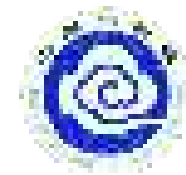


Second Generation
FY-4 A, B, C, D,
E



Expected until 2030

Launched Satellites



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

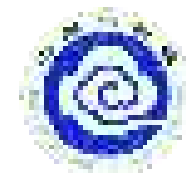
| Leo | Launch Data | | Geo | Launch Data |
|-------|---------------|--|-------|---------------|
| FY-1A | Sept. 7, 1988 | | FY-2A | Jun. 10, 1997 |
| FY-1B | Sept. 3, 1990 | | FY-2B | Jun. 25, 2000 |
| FY-1C | May 10, 1999 | | FY-2C | Oct. 18, 2004 |
| FY-1D | May 15, 2002 | | FY-2D | Dec. 8, 2006 |
| 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-4A | Dec. 11, 2016 |

Before 2000s: emphasizing to develop the satellite

2000 – 2010 : emphasizing the transition from the R&D to the operational satellite

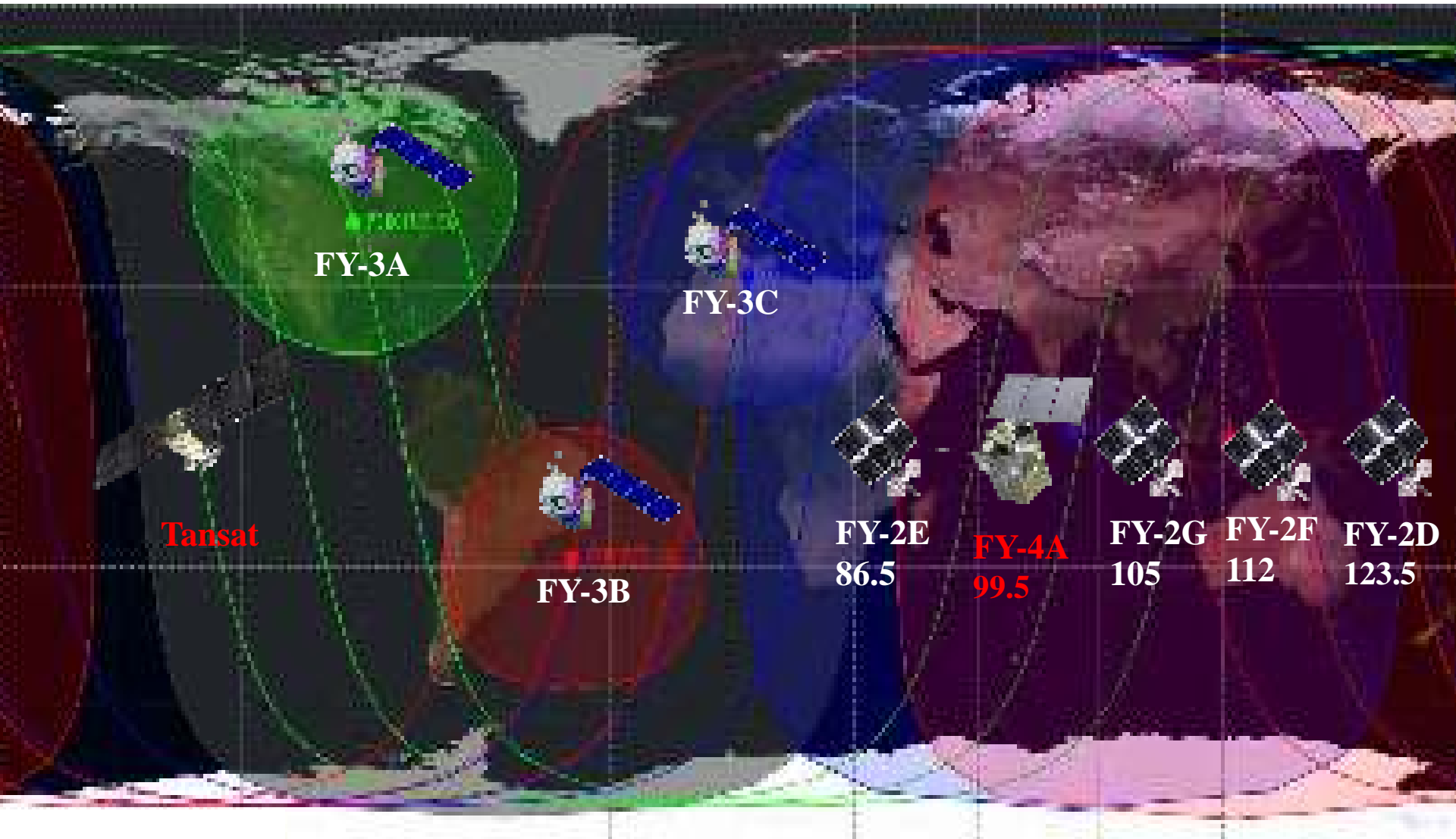
After 2010s : emphasizing the calibration and validation for the operational satellite

2. Current Missions

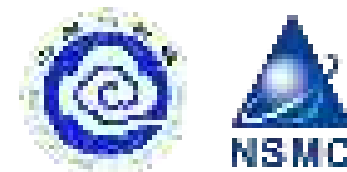


FY Program: 8 on the orbit, 5 in operation, 1 in trial operation

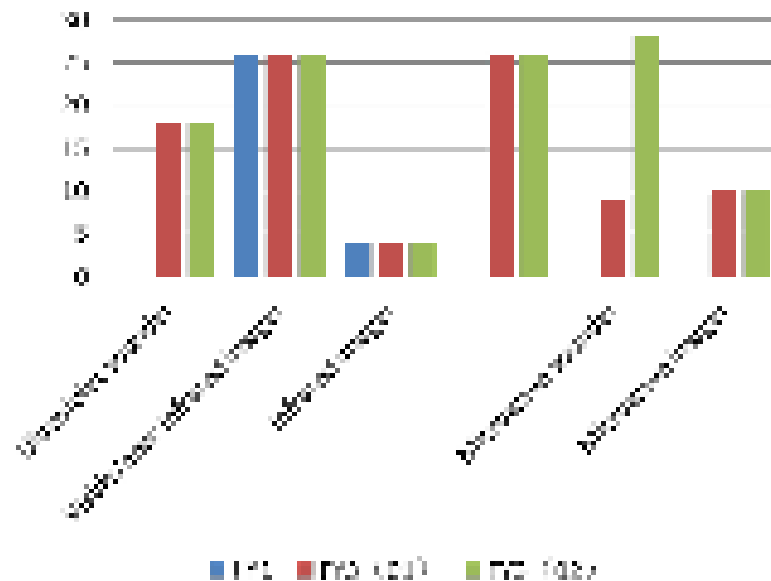
Joint program: TanSat in commission test



Current Instruments for LEO

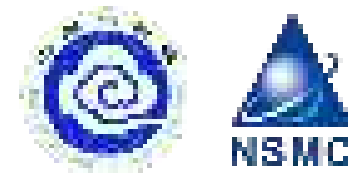


| Satellite | | No. of Instruments | Name in Abbrev. |
|-----------|------------|--------------------|-----------------|
| FY-1 | FY-1 A/B | 2 | 5-channel VIRR |
| | FY-1 C/D | 2 | 10-channel VIRR |
| FY-2 | FY-2 A/B | 1 | 3-channel VISSR |
| | FY-2 C/D/E | 1 | 5-channel VISSR |
| FY-3 | FY-3 A/B | 10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



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

Fengyun GEO Constellation



■ In operation

FY-2G: Full Disk (105° E)

FY-2E: Full Disk (86.5° E)

FY-2F: Regional (112° E)

■ In trial operation

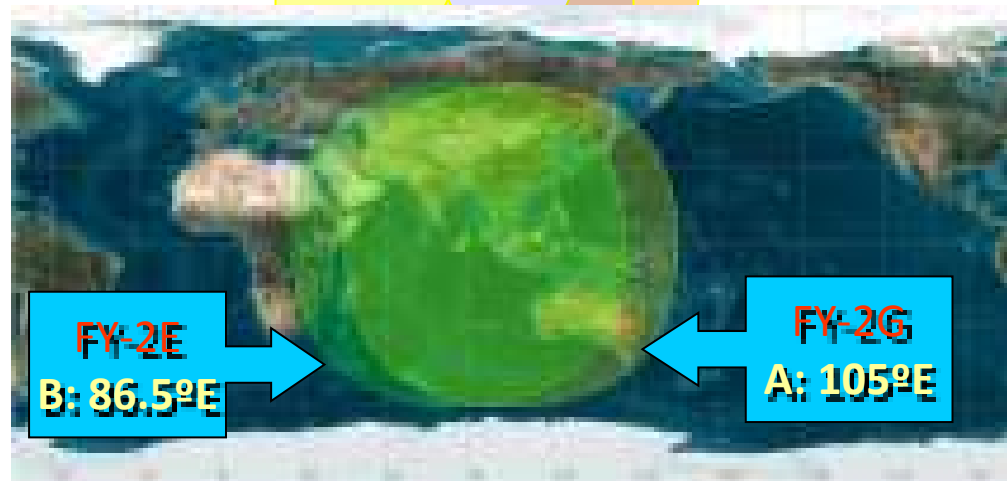
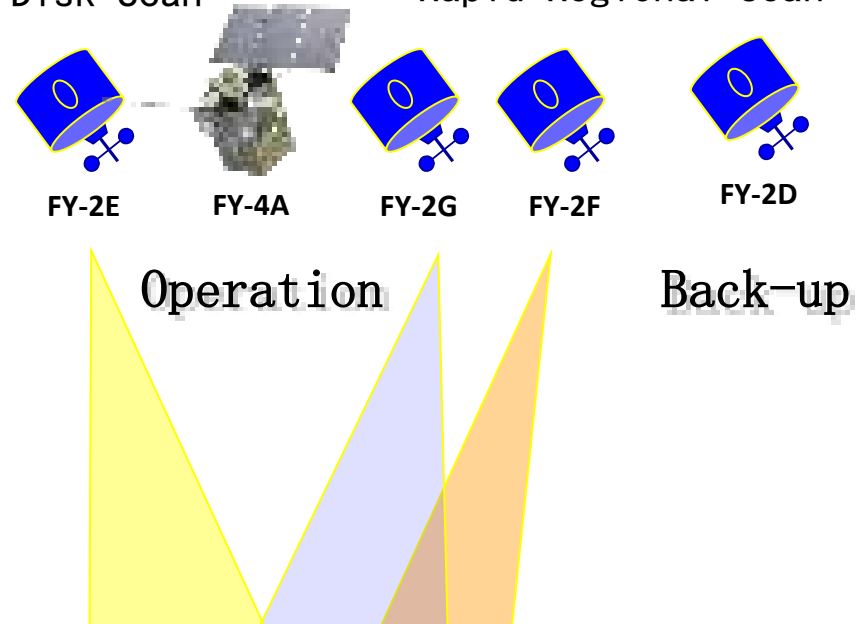
FY-4A: (99.5° E → 105° E)

■ In back-up

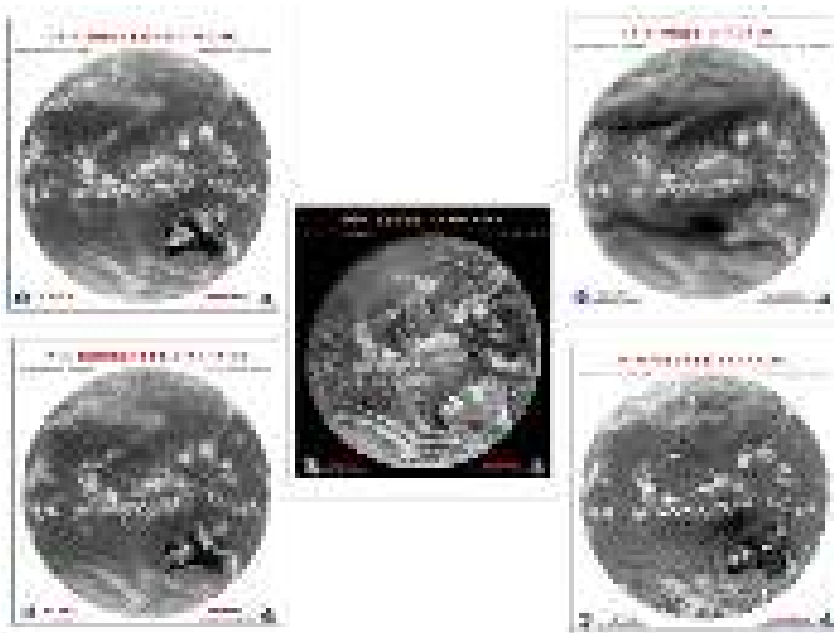
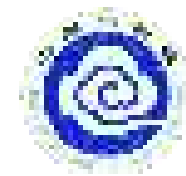
FY-2D (123.5° E)

Full Disk Scan

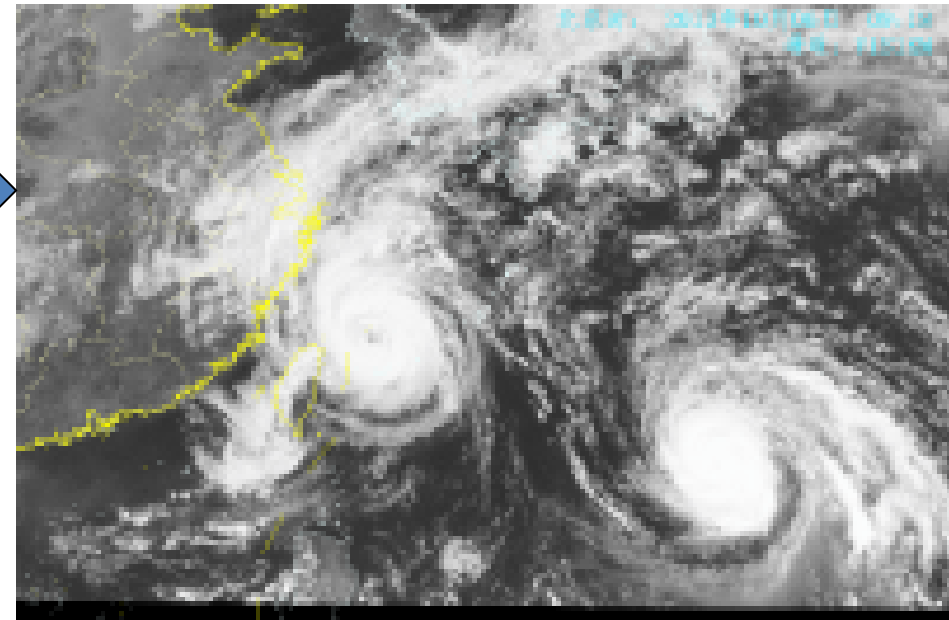
Rapid Regional Scan



Observation capability from FY-2

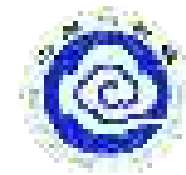


Normal Scan : 1 hour




Region Rapid Scan: 6 min


Fengyun Polar Constellation



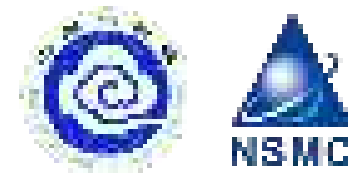
- In limited Operation (**Regional**): FY-3A
- In full Operation (**Global**) : FY-3B + FY-3C, **global coverage 4 times per day**



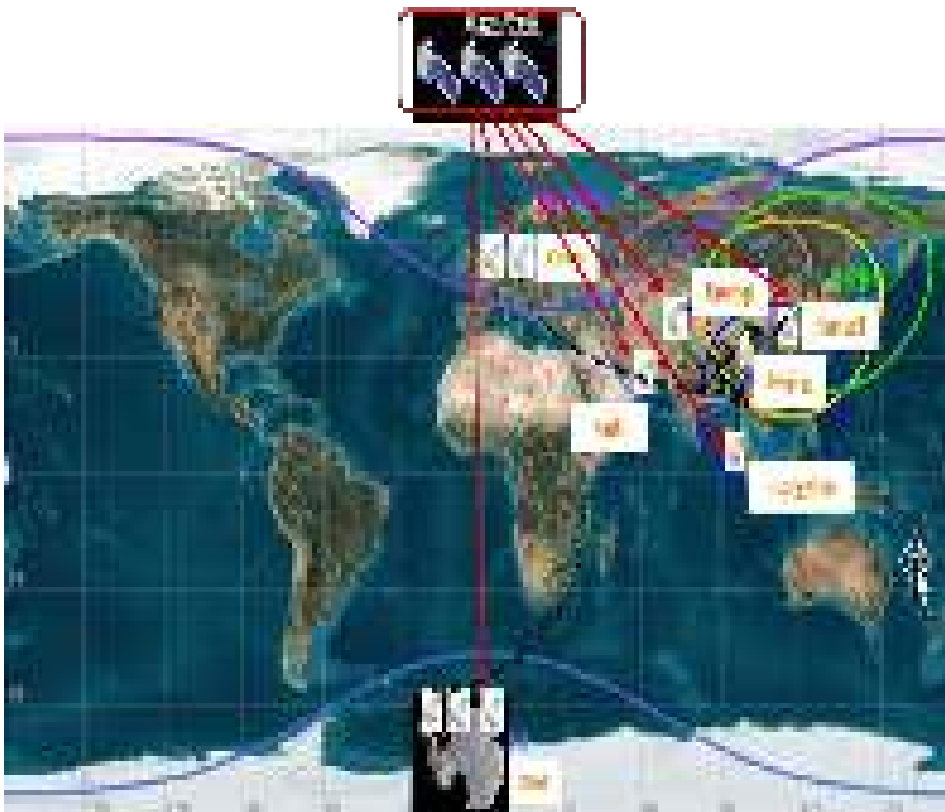
 FY-3C LTC 10:30 AM

 FY-3B LTC 13:40 PM

Observation capability from FY-3

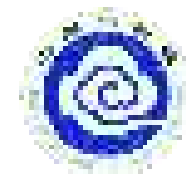


- Global data acquiring latency within 2 hours (80%)
- Global data coverage with 2800 Km swath with per day, 250m spatial resolution in maximum



| Ground Station Name | Longitude | Latitude |
|---------------------|-----------|----------|
| Beijing Station | 116.28E | 40.05N |
| Guangzhou Station | 113.34E | 23.16N |
| Wulumuqi Station | 87.57E | 43.86N |
| Kashi Station | 75.94E | 39.52N |
| Jiamusi Station | 130.36E | 46.90N |
| Kirunna Station | 21.00E | 68.00N |
| Troll Station | 2.50E | 72.00S |

Web-based Data Portal



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FENGYUN Satellite Data Center

NATIONAL SATELLITE METEOROLOGICAL CENTER

[SATELLITES](#) | [DATA](#) | [IMAGES](#) | [PRODUCTS](#) | [DOCUMENTS](#) | [TOOLS](#)

Archive

| Satellite | Data Count | Volume(TB) |
|-----------|------------|------------|
| FY-3C | 881188 | 4.01 |
| FY-3B | 2180276 | 13.61 |
| FY-3A | 2811628 | 15.64 |
| FY-2D | 818884 | 3.1 |
| FY-2E | 841188 | 3.14 |
| FY-2B | 414000 | 1.6 |
| FY-2C | 161011 | 0.6 |
| FY-4B | 21000 | 0.0 |

[Data Overview](#)

FY-3EO
FY-3EO

FY-3C FY-3B FY-3A FY-2E FY-2D FY-2C FY-4B

Filter

Data Name:

Start Date: End Date:

Start Time: End Time:

Time Range: Each Day

Spatial Ref:

Coverage: All Areas Only Visible

Sign In

User ID:

Password:

Code:

Remember Me

[Forgot Password](#) | [Admin](#)

Statistics

DOWNLOAD SINCE 1993 (MB)

2,204,124,612 MB

| | |
|-----------|--------|
| Images | 23 |
| Products | 62 |
| Docs | 2088.3 |
| Tools | 11.881 |
| Documents | 421.7 |

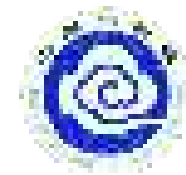
SATELLITE TRACK

[All](#) | [FY-3C](#) | [FY-3B](#) | [FY-3A](#) | [FY-2E](#) | [FY-2D](#) | [FY-2C](#) | [FY-4B](#)

Download

| | | | |
|------------|-------|-------|-------|
| TRAX | 19:00 | 19:00 | 19:00 |
| Two Line | 19:00 | 19:00 | 19:00 |
| One Line | 19:00 | 19:00 | 19:00 |
| Time Table | 19:00 | 19:00 | 19:00 |
| | 19:00 | 19:00 | |
| Cal | 19:00 | 19:00 | 19:00 |
| | | | 19:00 |

3. Latest Progress



■ GF-4

- The 4th satellite in High res. Earth Obs. Satellite Project led by CNSA, while CMA is responsible for GF-4 data reception and transmission, as well as data preprocessing in MET mode.
- Successfully launched in Dec. 29, 2015
- Commissioning test finished and handover declared on June 1st, 2016

■ FY-4A

- Launched in Dec. 11, 2016
- Ground segment construction is still ongoing

■ TANSAT

- Launched in Dec. 22, 2016
- A joint R&D satellite program initiated by MOST and supported by CMA and CAS.
- NSMC is responsible for data reception, processing and distribution, taking advantage of current FY-3 ground segment resources.

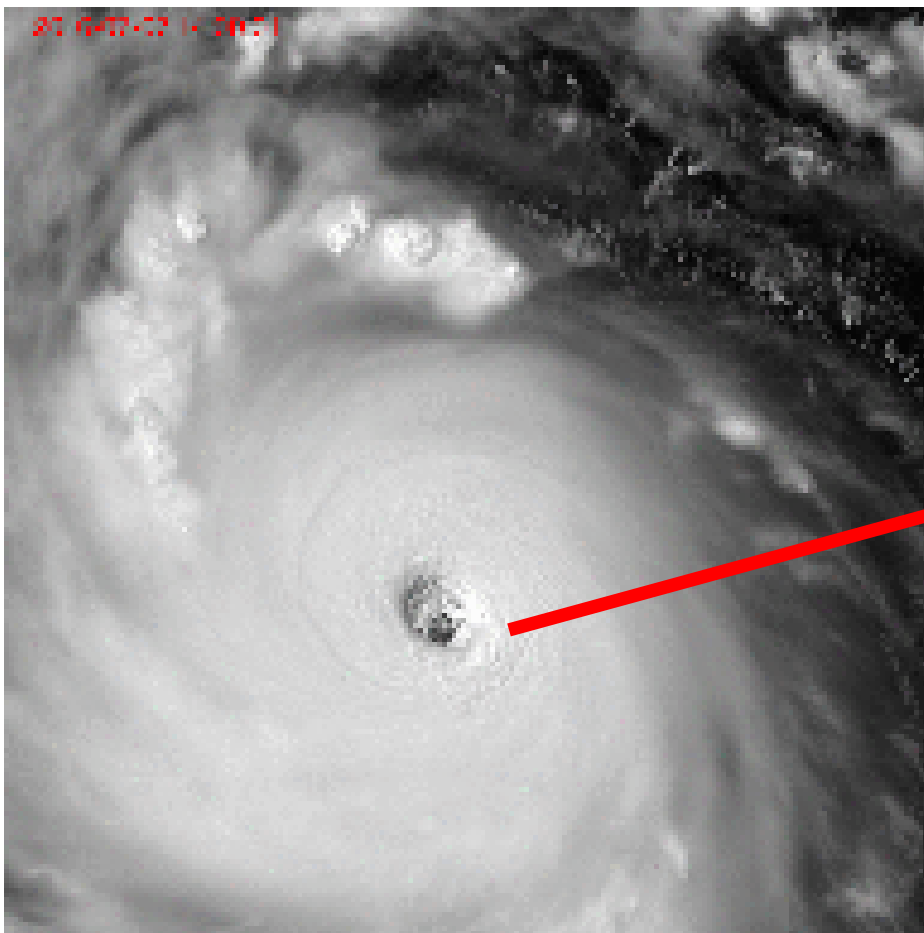
■ FY-3D

- Launch is scheduled in Nov., 2016, and **rescheduled in Nov, 2017**
- Ground segment is under construction by CMA, and will be ready before launch.

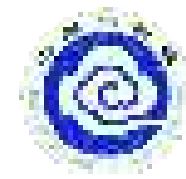
GF-4: New eyesight from GEO orbit

Typhoon NEPARTEK, 07-07-2016

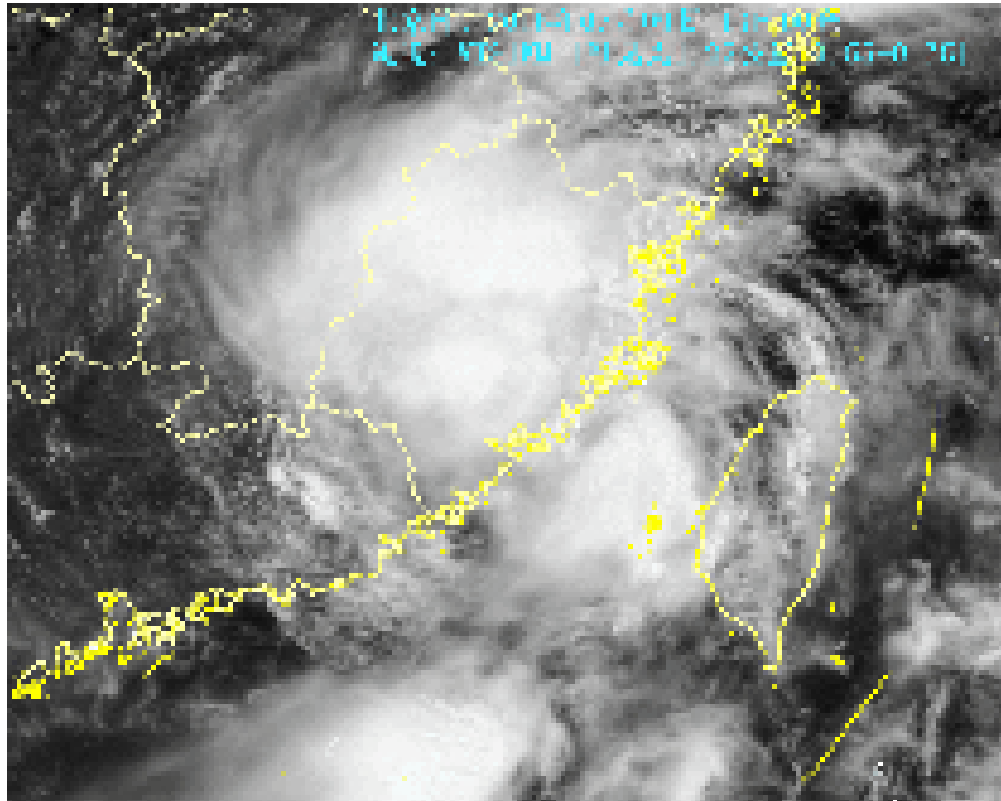
Detector 10,000X10,000
Spatial res. 50 meters
Temporal res. 10, 20, 60s



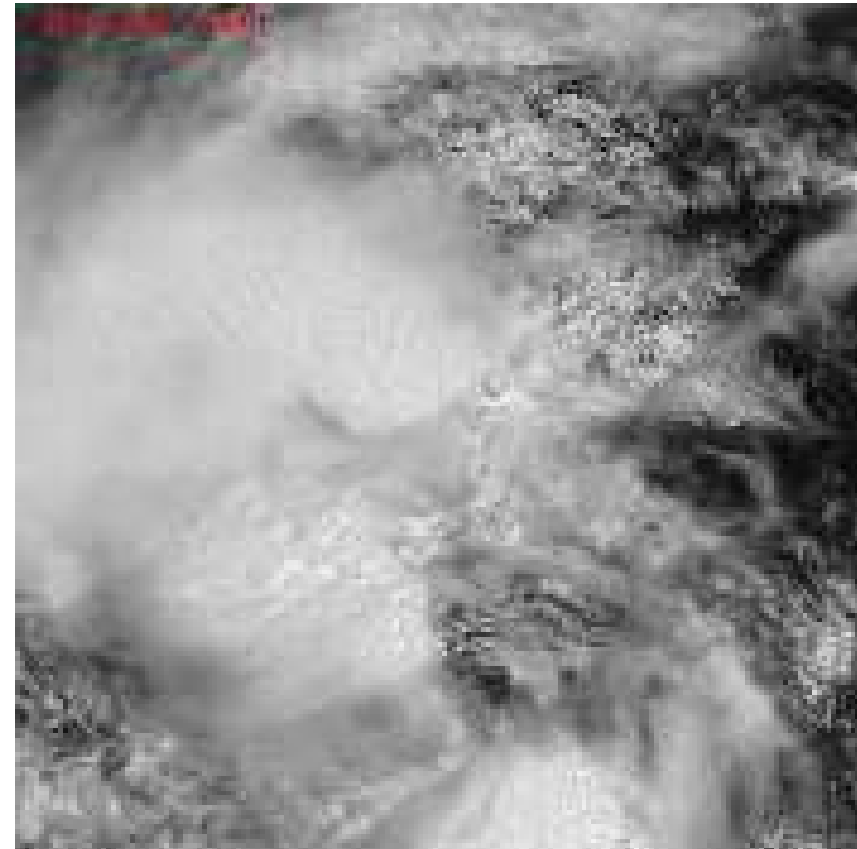
Landing of Typhoon Nepartak



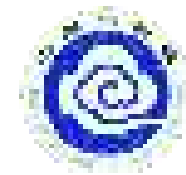
Spatial: 1.25 Km **VS** 50 m
Temporal: 6 min **VS** 9 s



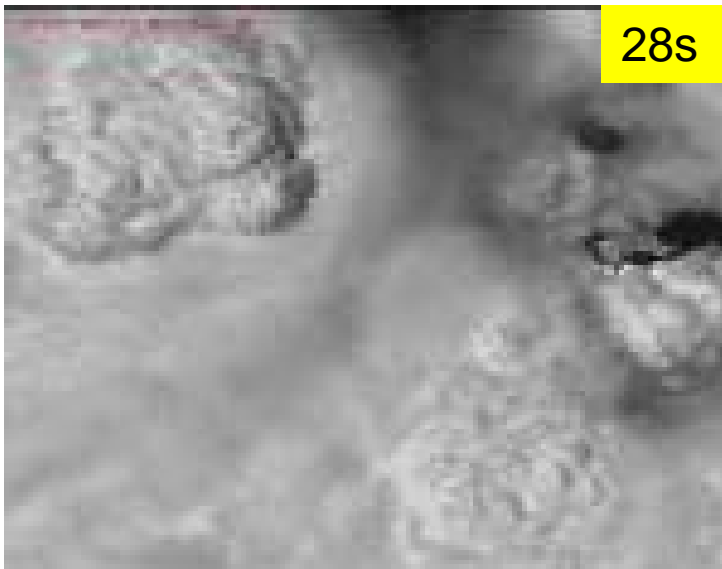
FY-2F



GF-4



Our studies show that to capture the evolution of a rapid growing meco-or small scale convective system, the observation frequency should be less than 1 minute.

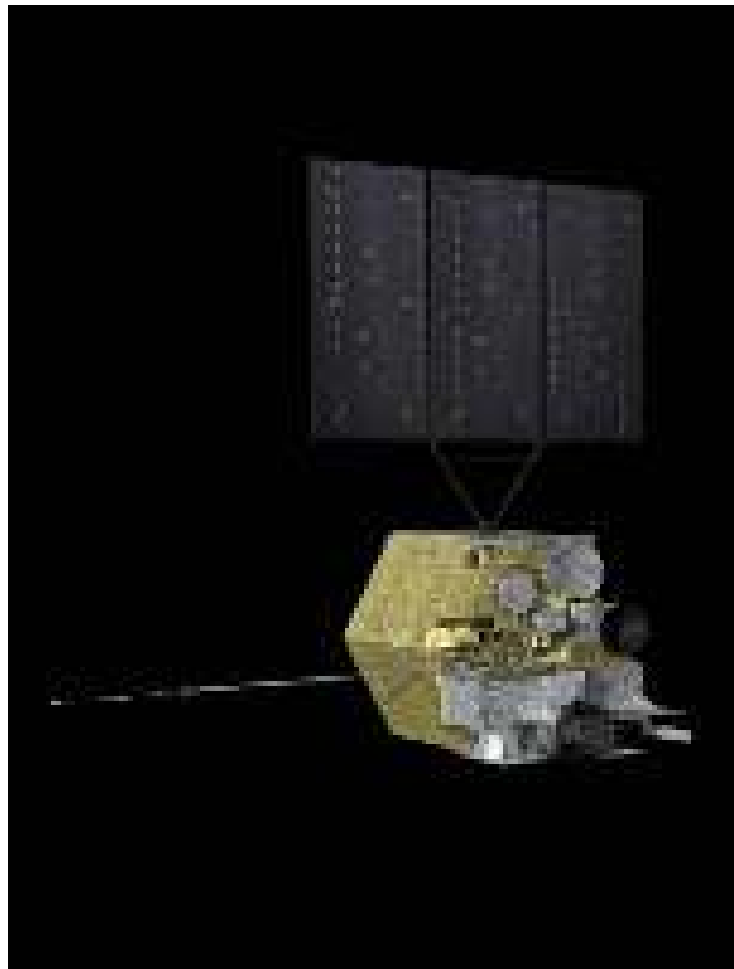


154s



FY-4A:

-- same timeframe with GOES-R



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

FY-4A Instruments:

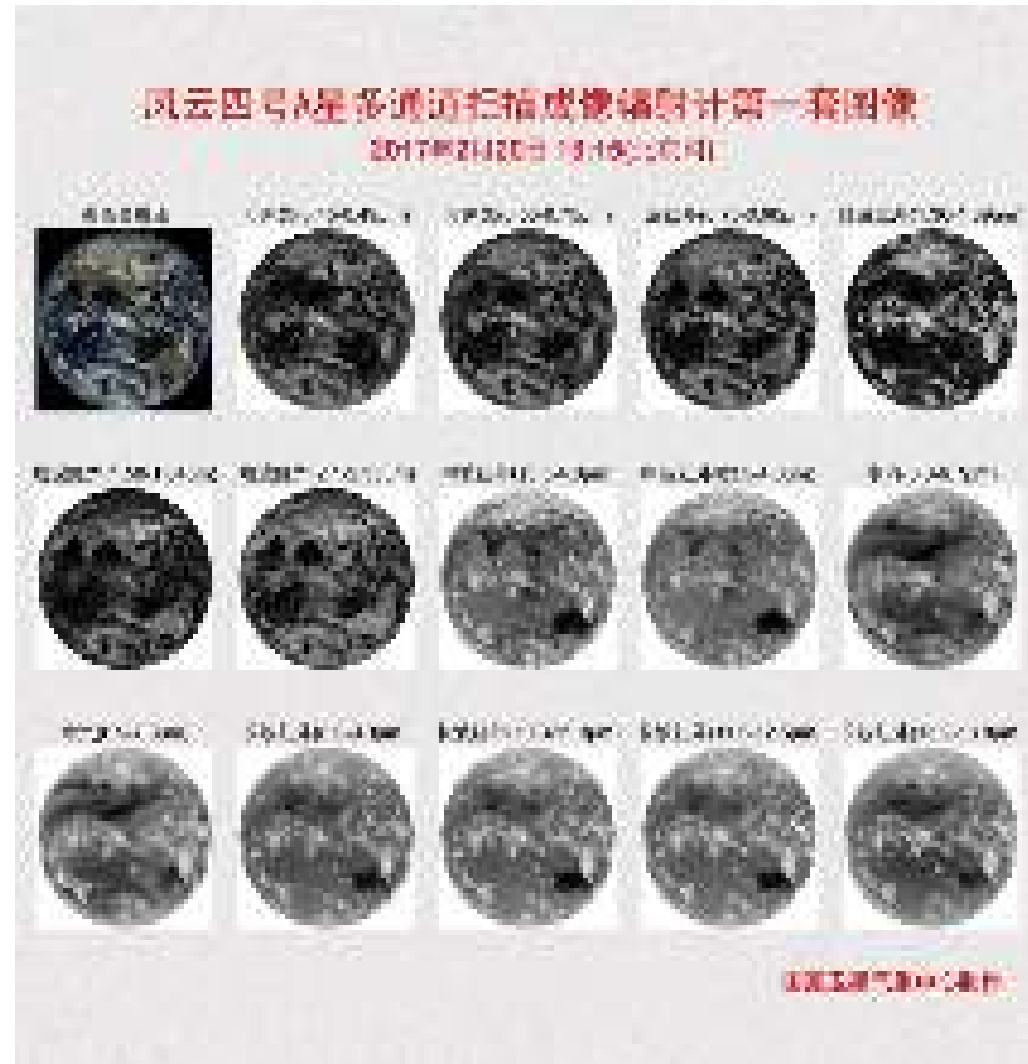
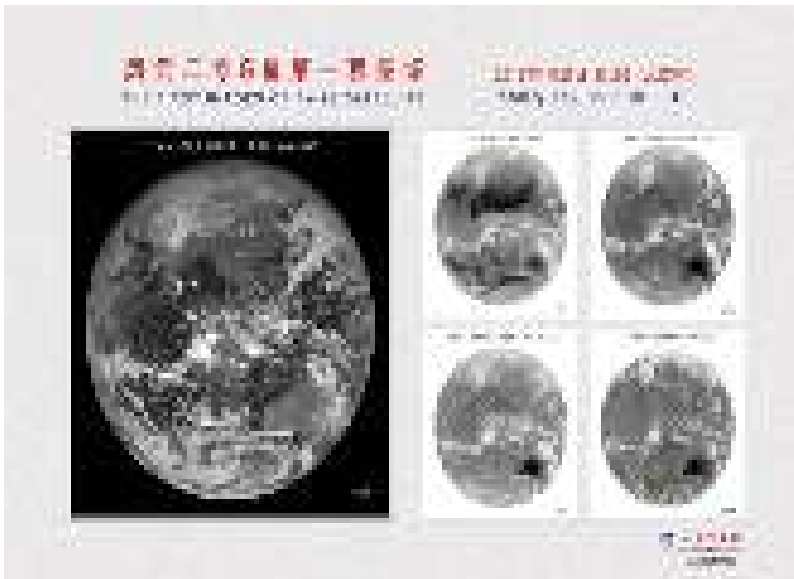
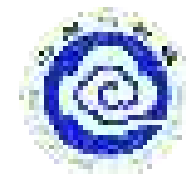
AGRI: Advanced Geosynchronous Radiation Imager

GIIRS: Geo. Interferometric Infrared Sounder (**First interferometer in GEO**)

LMI: Lightning Mapping Imager

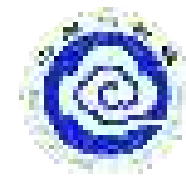
SEP: Space Environment Package

AGRI: Advance Geo. Radiation Imager



Compared with FY-2 VISSR:

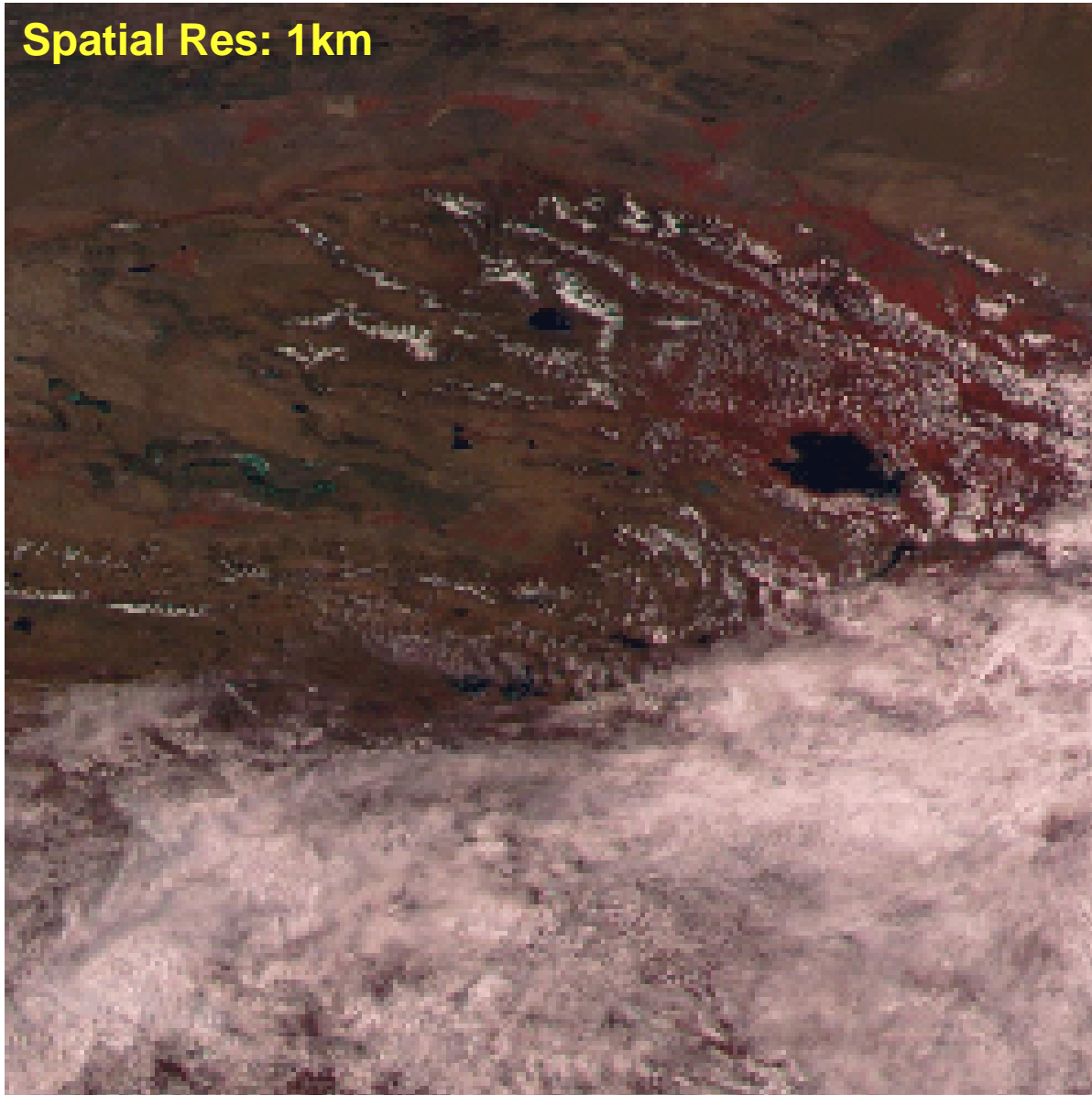
- Higher Spatial Resolution: VIS 1.25km -> 0.5/1km; IR 5km->2/4km
- More Spectral Bands: 5 -> 14 (16)
- More frequent observation: 30 min. -> 15 min. (Full Disc)/ 10min.
- More flexible regional rapid scan: 6min. -> 5/2.5 min.
- More accurate calibration : VIS 10%->5%; IR 1k->0.5K



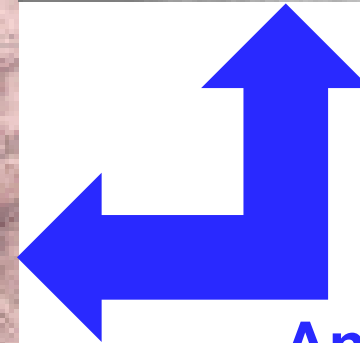
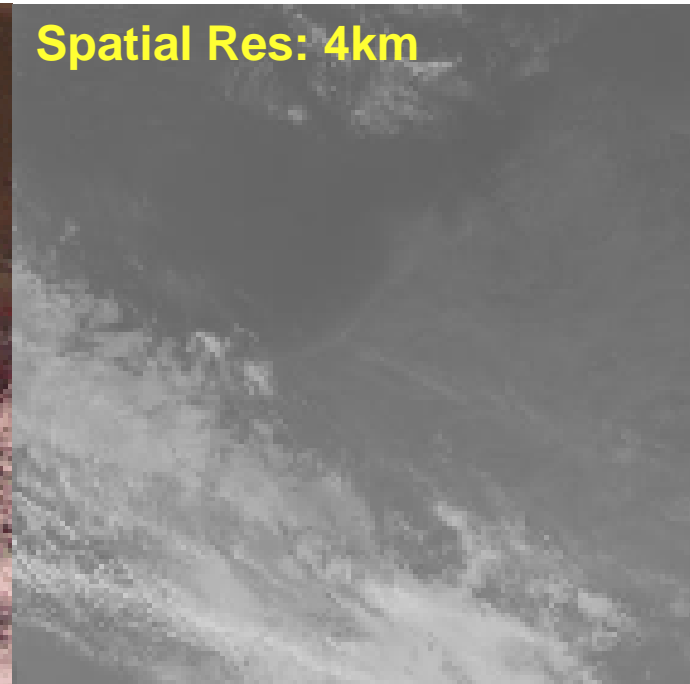
One day RGB
images animation
from AGRI / 15
minutes



Spatial Res: 1km



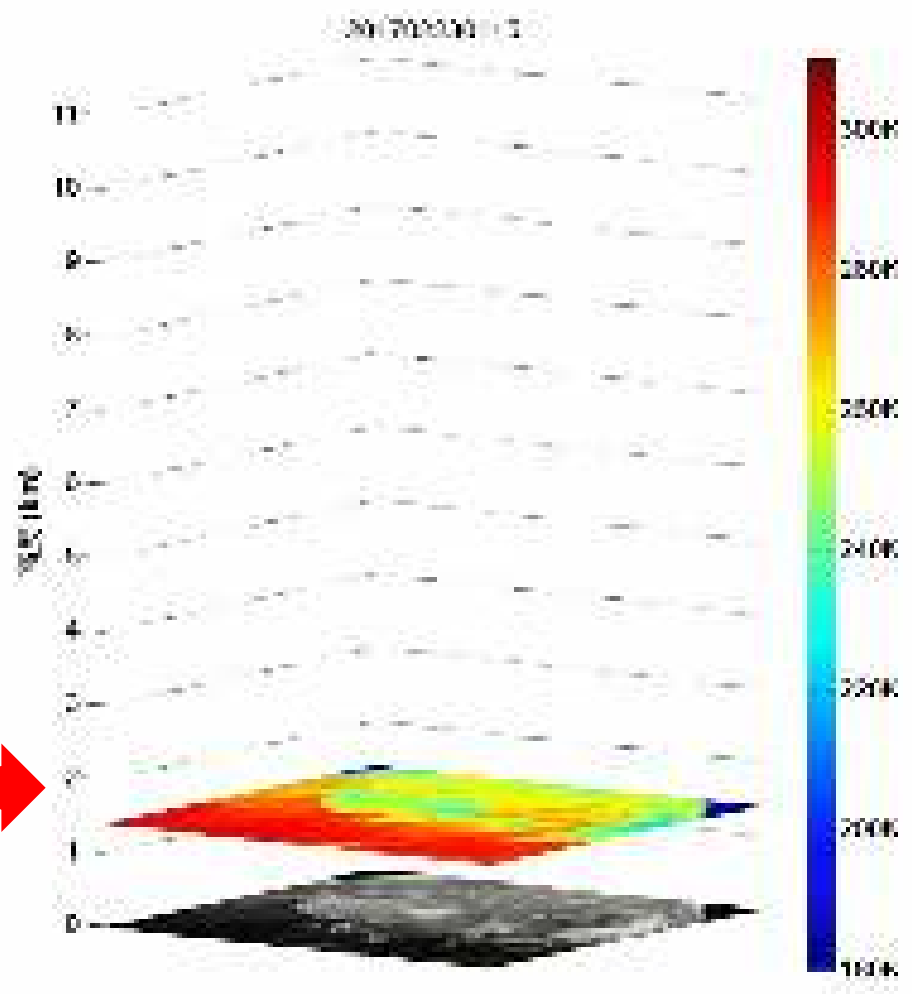
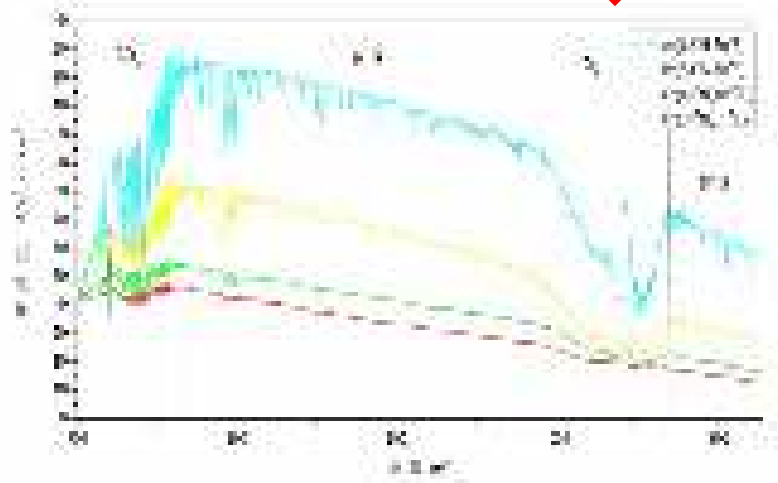
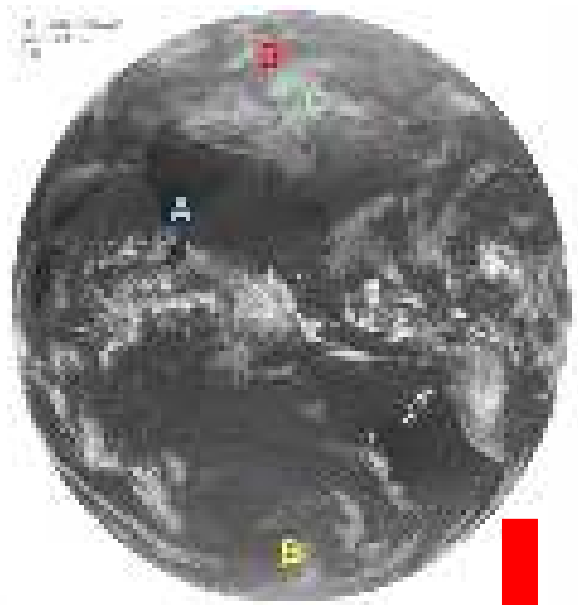
Spatial Res: 4km



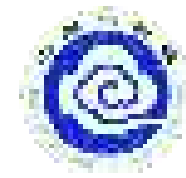
**Animations
of Local Area**

GIIRS:

First Geo. Interferometric Infrared Sounder

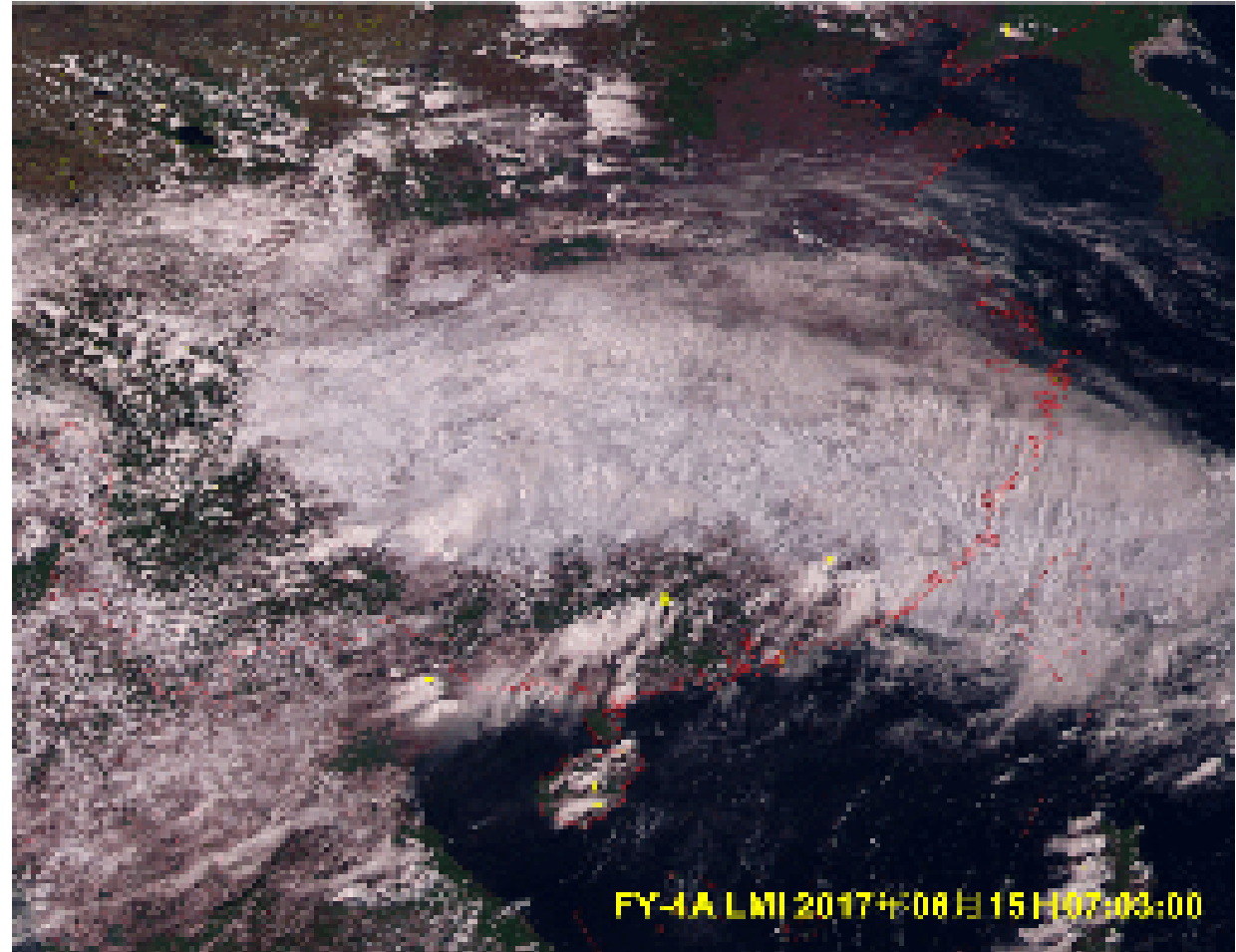


LMI: Lightning Mapping Imager



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% |

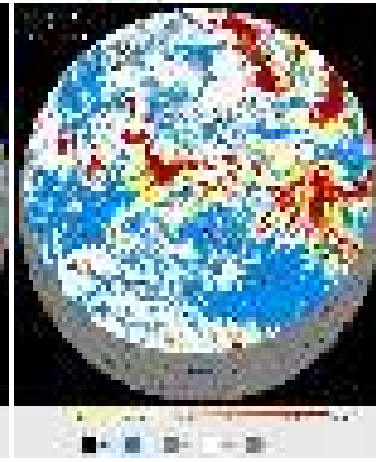
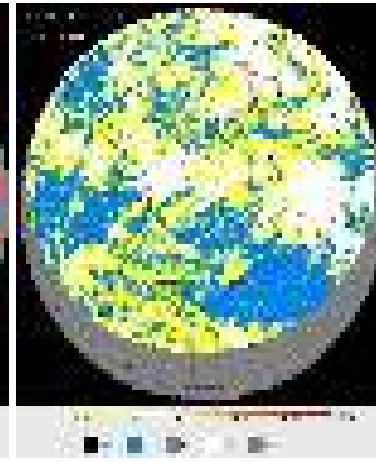
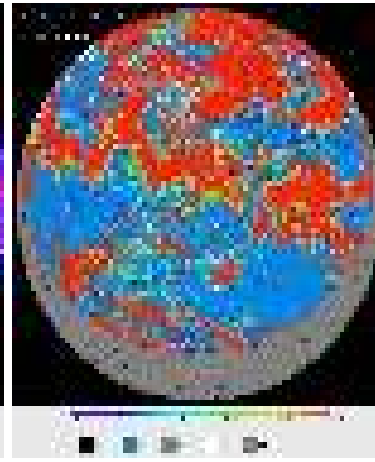
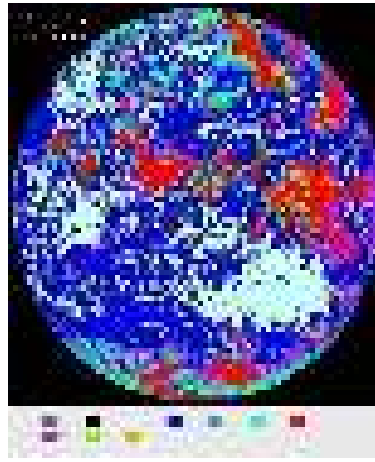
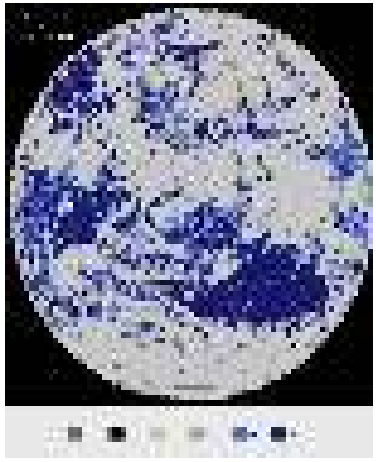


Baseline Products of FY-4A



| Types | FY-4 | FY-2 | GOES-R |
|--------------------|--|---|--|
| 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 | Clear Sky Masks Cloud Top Temperature Cloud Top Height Cloud Top Pressure Cloud Top Phase Cloud Optical Depth Cloud Particle Size Distribution Cloud and Moisture Imagery |
| 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 | Rainfall Rate / Quantitative Precipitation Estimate Total Precipitable Water Derived Motion Winds Legacy Vertical Moisture Profile Legacy Vertical Temperature Profile Aerosol Optical Depth (AOD) Derived Stability Indices |
| Radiance | Outgoing Long wave Radiation Surface Solar Irradiance Downward Longwave Radiation Upward Longwave Radiation Reflected Shortwave Radiation | Outgoing Long wave Radiation Surface Solar Irradiance | Downward Shortwave Radiation: Surface Radiances Reflected Shortwave Radiation: TOA |
| 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 | Sea Surface Temperature (Skin) Land Surface Temperature (Skin) Snow Cover |
| Environment | Dust Smoke Detection Fire/Hot Spot Characterization Fog Detection | Dust Index Fire/Hot Spot Characterization Heavy Fog Detection | Aerosol Detection(Including Smoke and dust) Fire/Hot Spot Characterization Hurricane Intensity Estimation Volcanic Ash: Detection and Height |
| Lightning | One Minute Lightning Quantitative Product (including flash group event) Lightning Jump Identification Product Flash Daily Density | | Lightning Detection: Events, Groups & Flashes |
| Space | High-energy particle distribution Magnetic Field Intensity Space Environment Effect | | Energetic Heavy Ions Magnetospheric Electrons & Protons: Low Energy Magnetospheric Electrons & Protons: Med & High Energy Solar & Galactic Protons Geomagnetic Field Solar Flux: EUV Solar Flux: X-ray Irradiance Solar EUV Imagery |

Cloud Properties



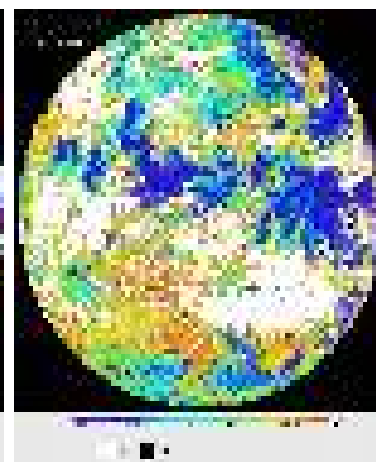
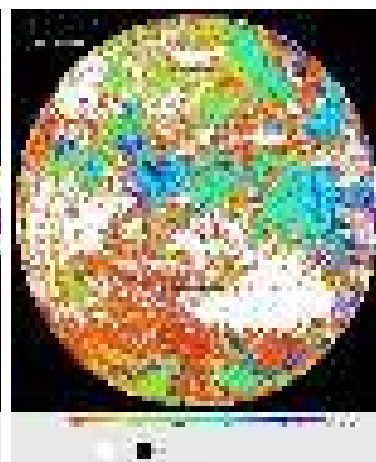
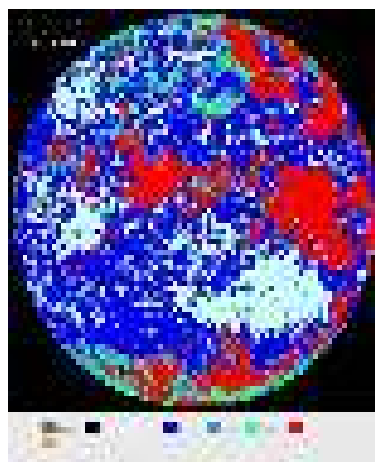
Clear Sky Masks

Cloud Type

Cloud Optical Depth

Cloud Liquid Water Path

Cloud Ice Water Path



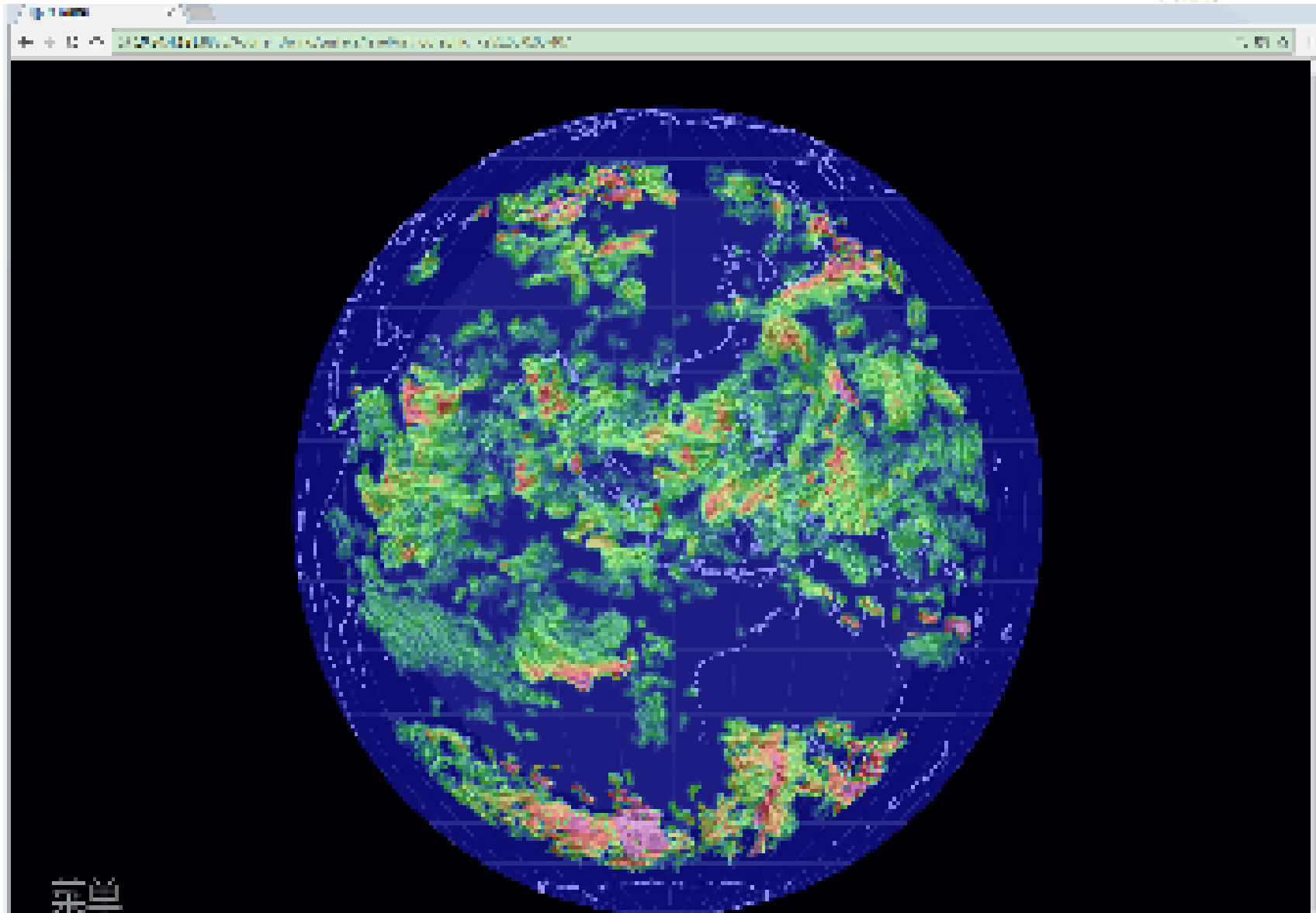
Cloud Particle Size Distribution

Cloud Phase

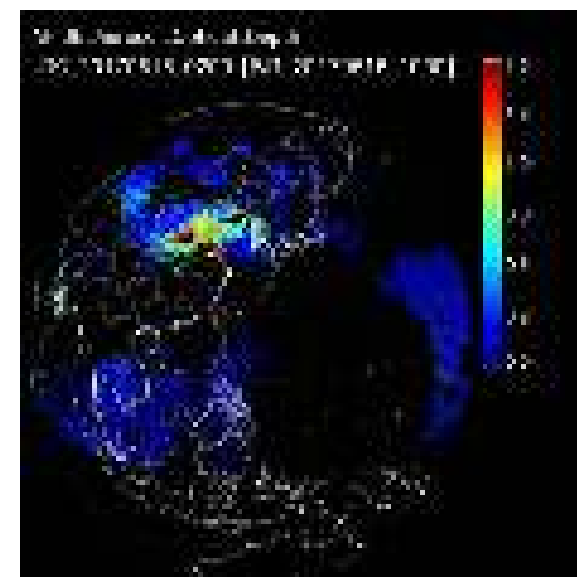
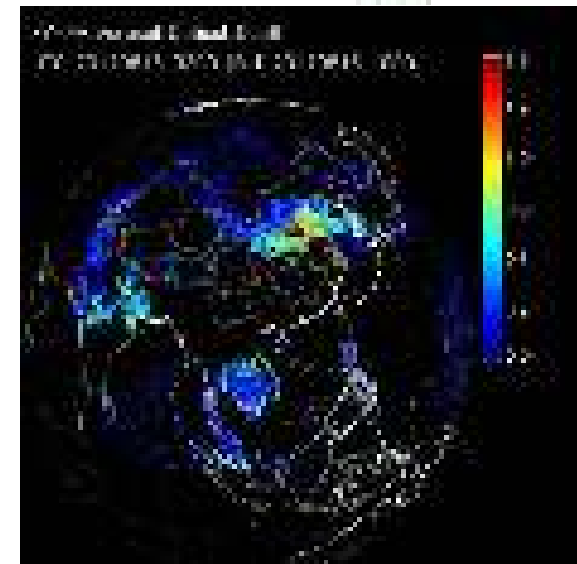
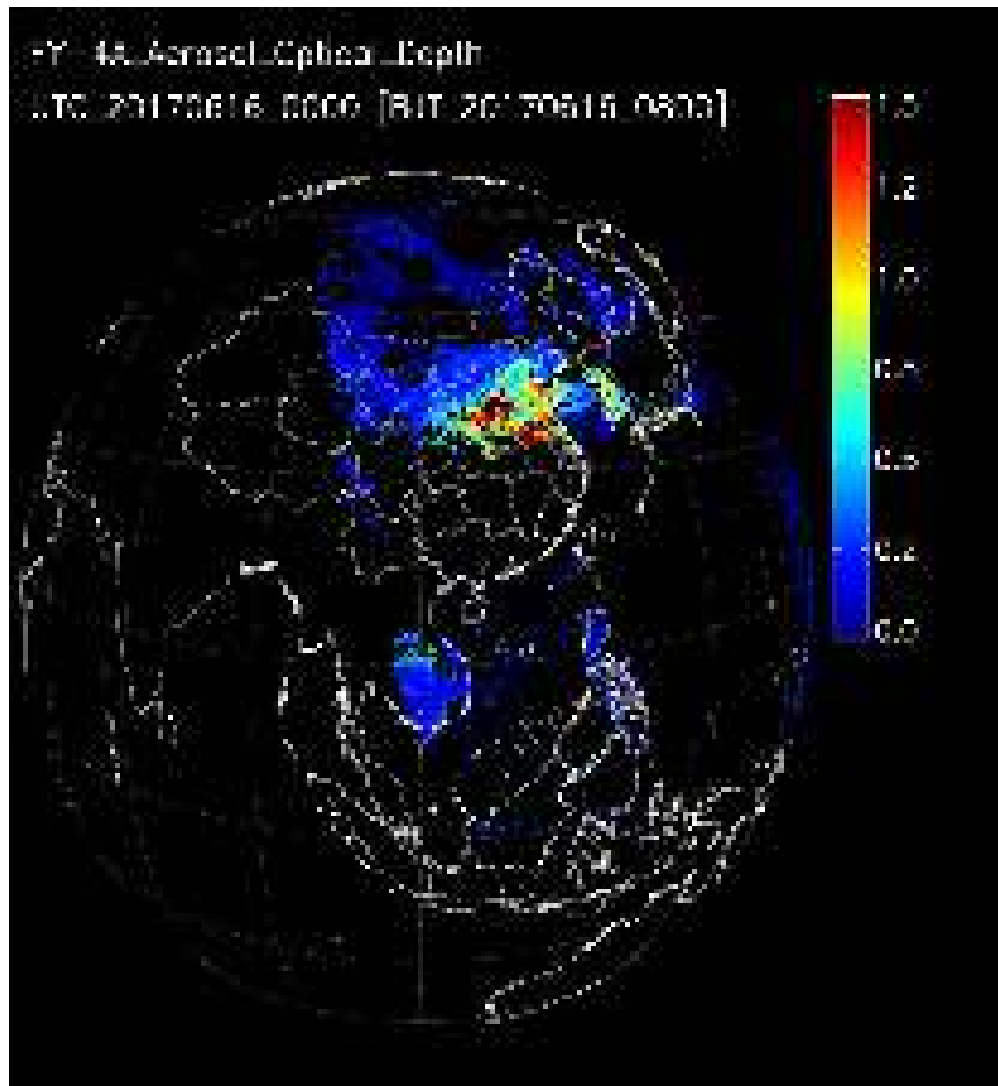
Cloud Top Temperature

Cloud Top Height

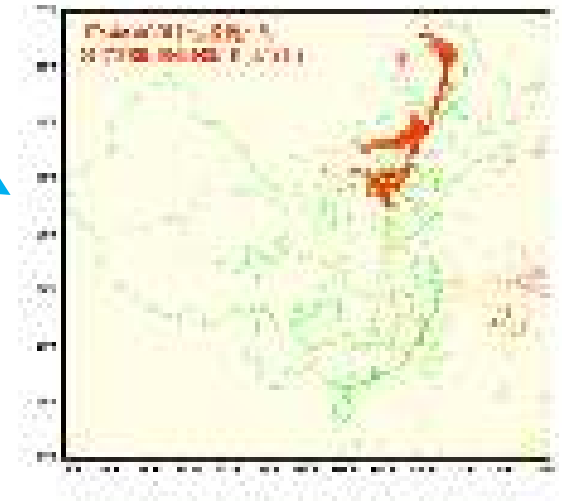
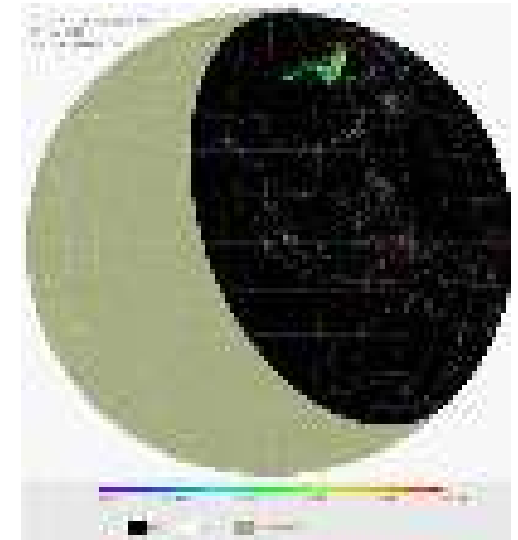
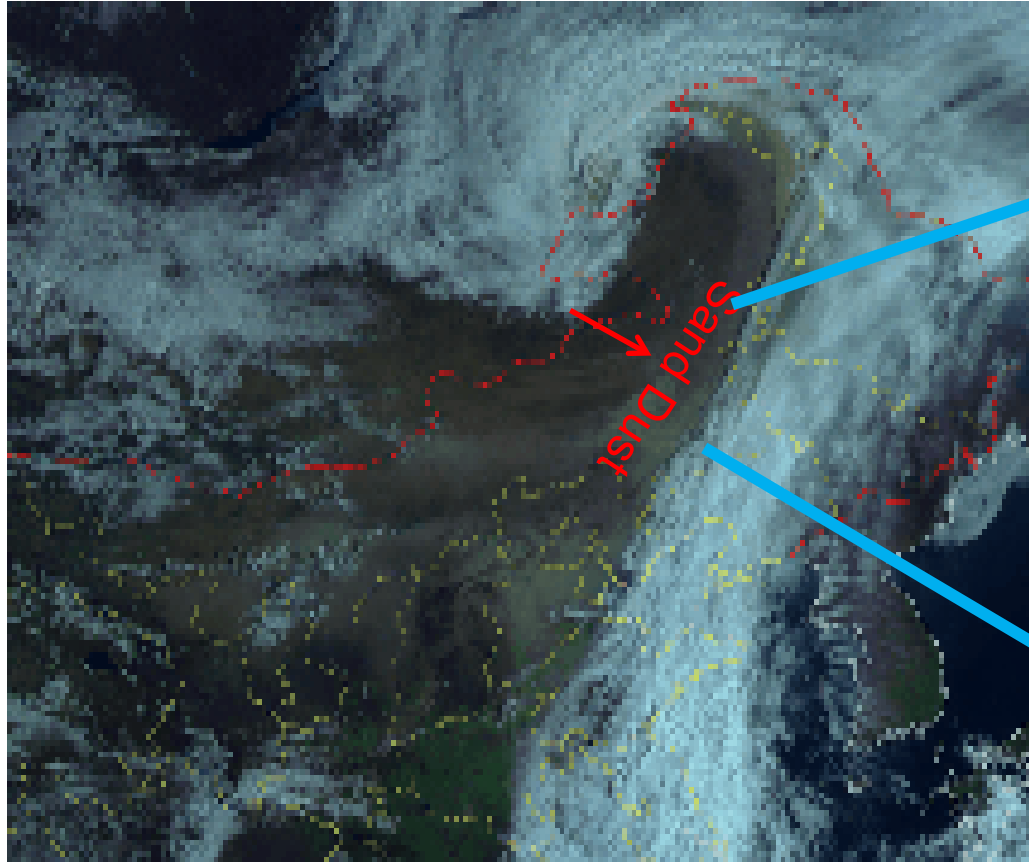
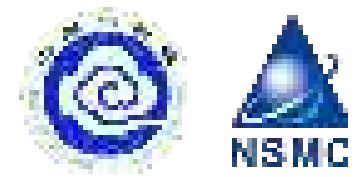
Cloud Top Pressure



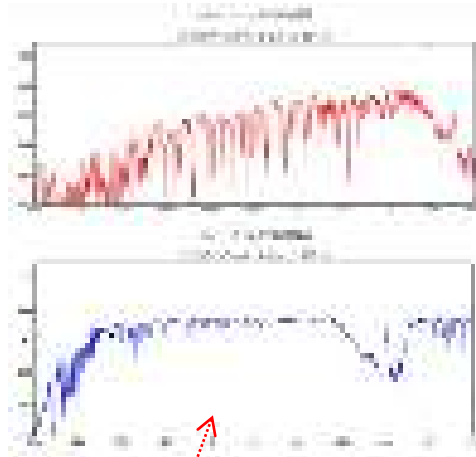
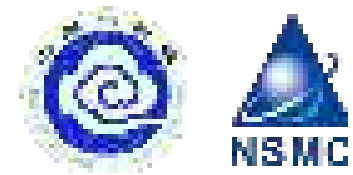
Aerosol



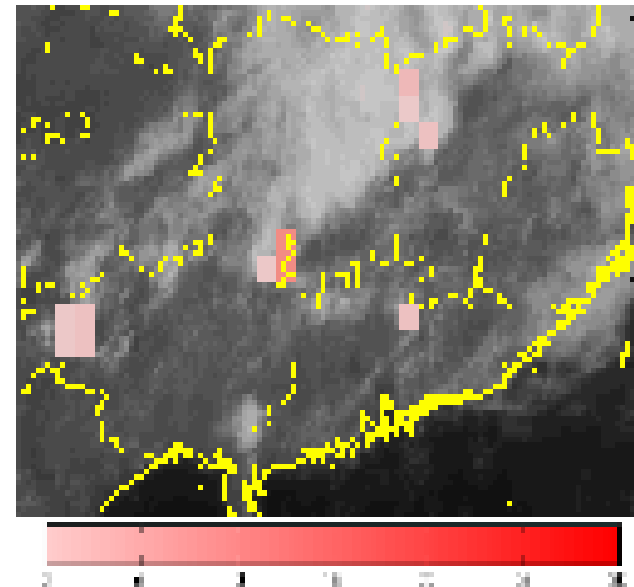
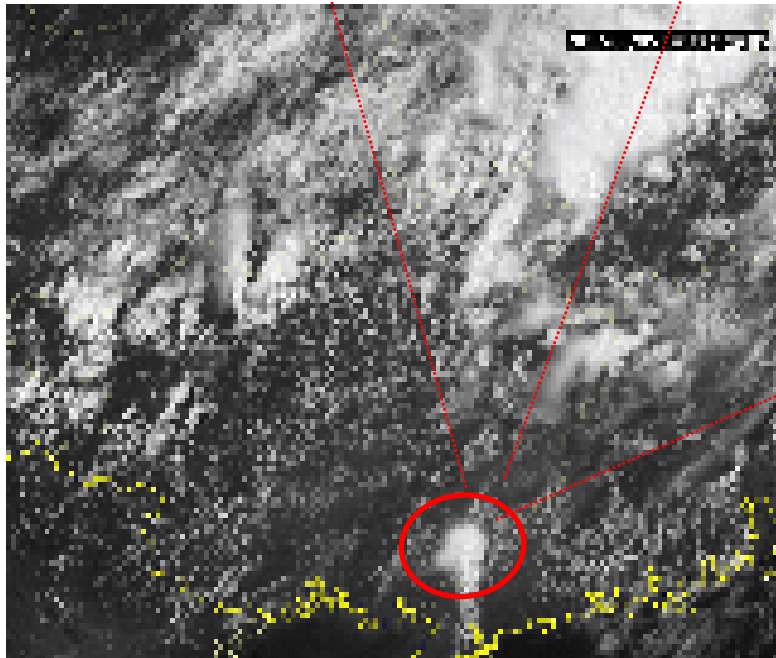
Dust Monitoring



AGRI + GIIRS + LMI

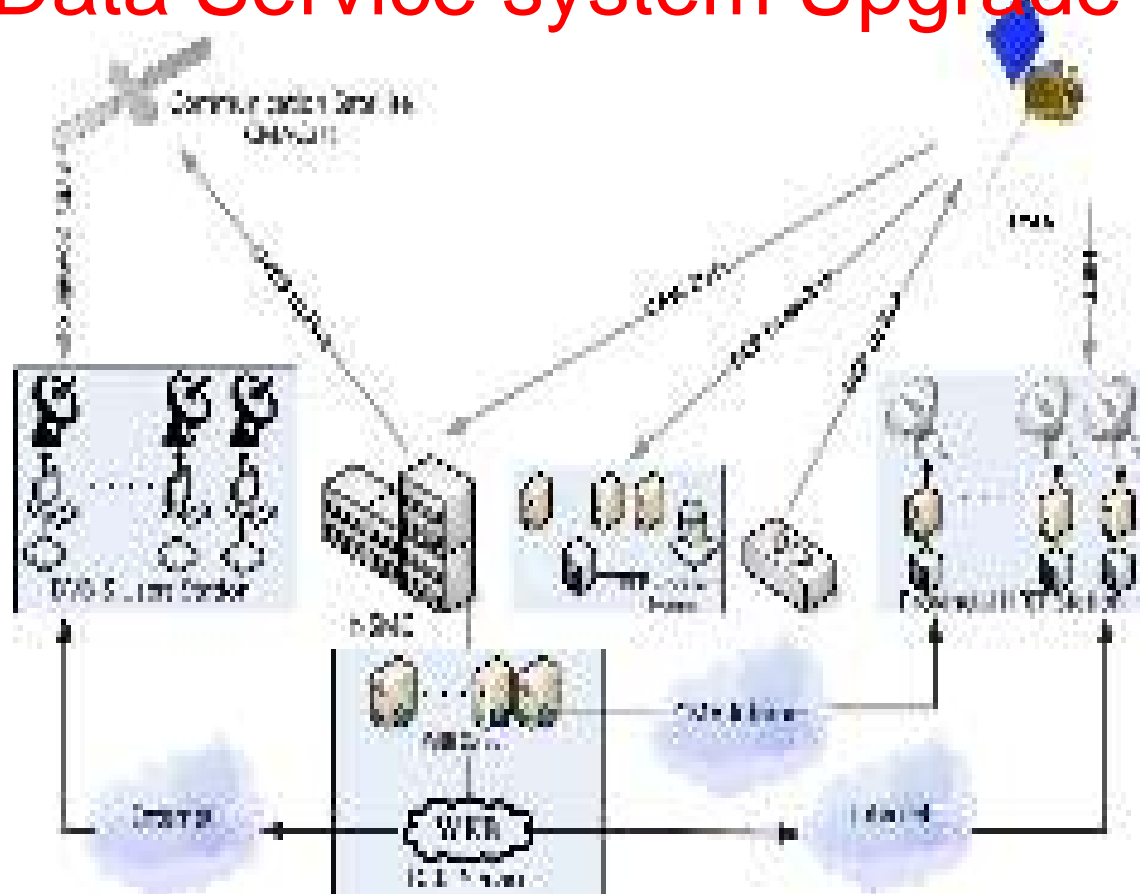
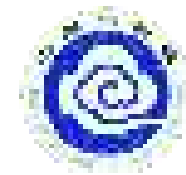


1. FY-4A lightning frequency map: strong convective cloud clusters often accompany with obvious lightnings.
2. FY-4A high spatial resolution imager: finer structure and texture of strong convective cloud cluster; and clearer small scale cumulus line.
3. Cloud free atmospheric profile acquired from GIIRS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



Data Service — Broadcast Mode

Data Service system Upgrade



34 + 5 HRIT Stations:

CMACast Users Stations:

Data Service WebSite:

Data Collection Platform(DCP):

For **Provincial and International** users.

For **International and City-level** users.

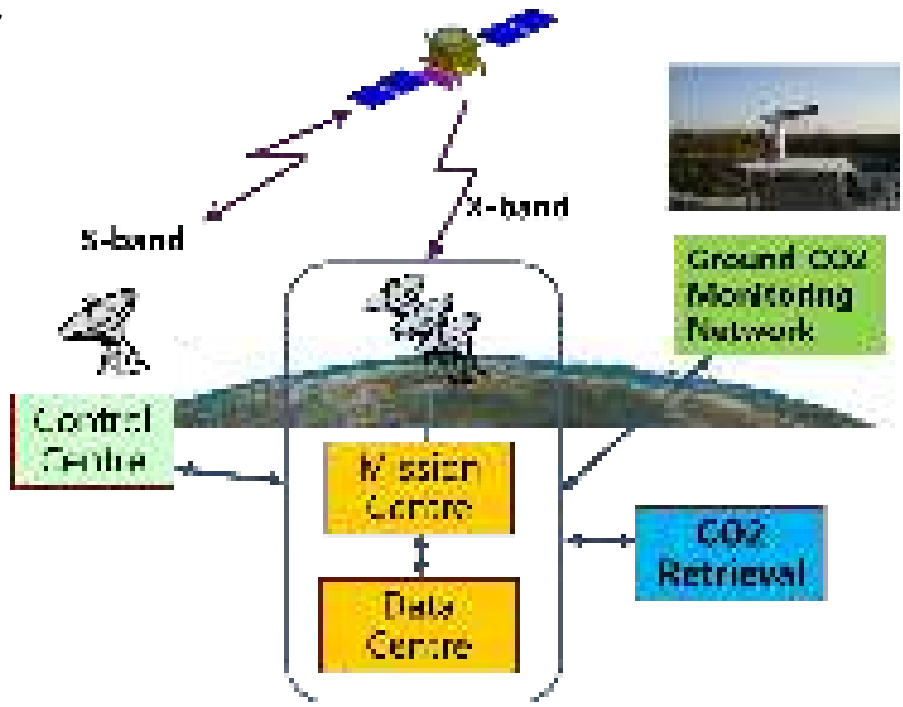
For **All Users**.

For collecting Met. Data from remote areas

TANSAT: Global CO₂ Observation and Monitoring

Mission objectives: to acquire global atmosphere column-averaged CO₂ dry air mole fraction

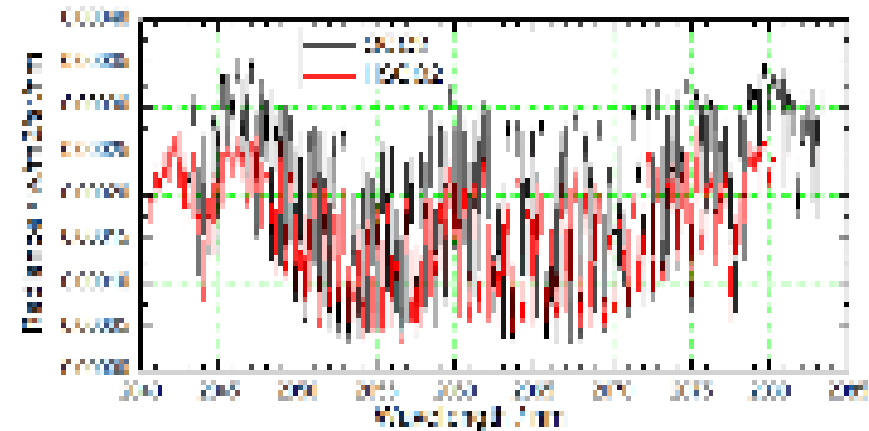
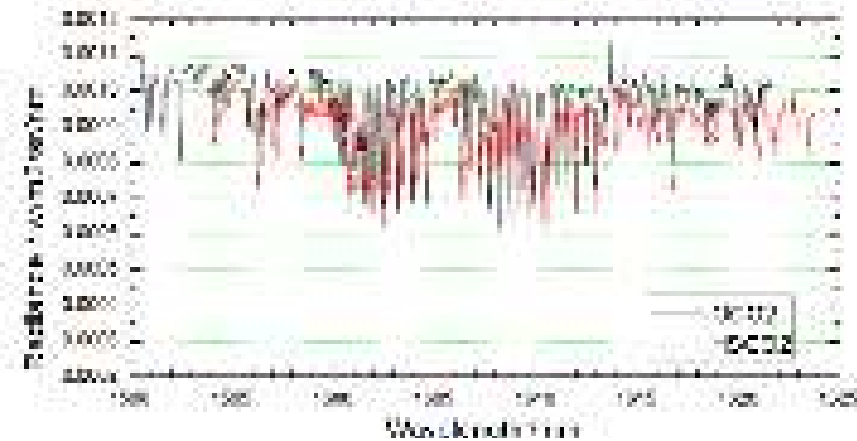
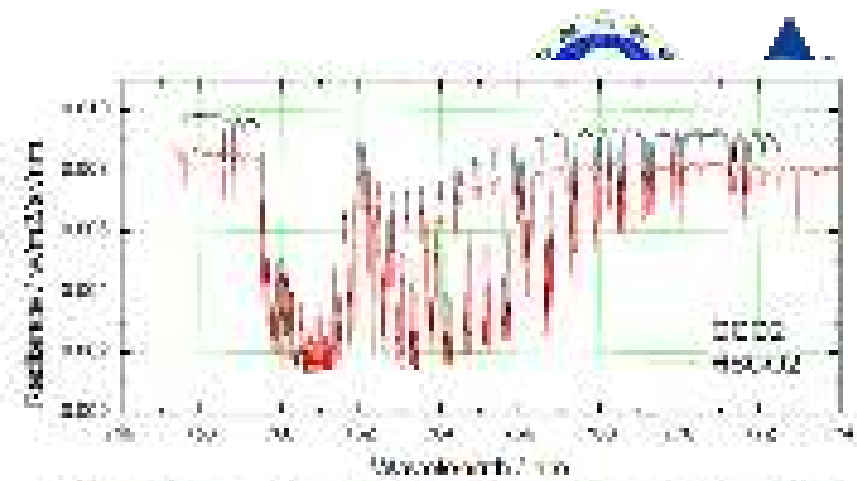
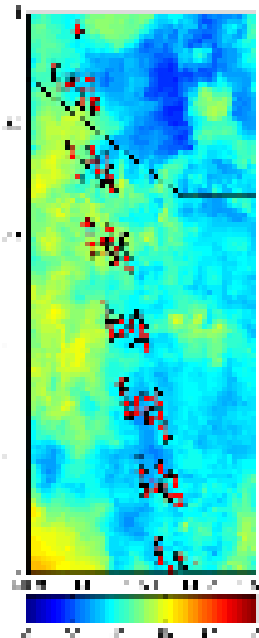
Instruments: 1) CO₂ spectrometer; 2) Cloud and Aerosol Polarize Instrument(CAPI)



TANSAT Ground segment by CMA

CO2 and O2 Absorption Spectra

Comparison with OCO-2



What is new in coming FY-3D?

-- to be deployed in AFTERNOON orbit

Significant improvements compared with FY-3A/B/C:

1) Successive instruments with great enhancements :

MERSI-II: Optical imager improved from MERSI

HIRAS: Hyperspectral IR sounder upgraded from the filter-type IRAS

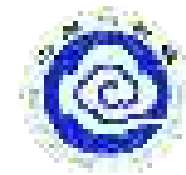
2) Brand New Instruments:

GAS: Greenhouse gases Absorption Spectrometer

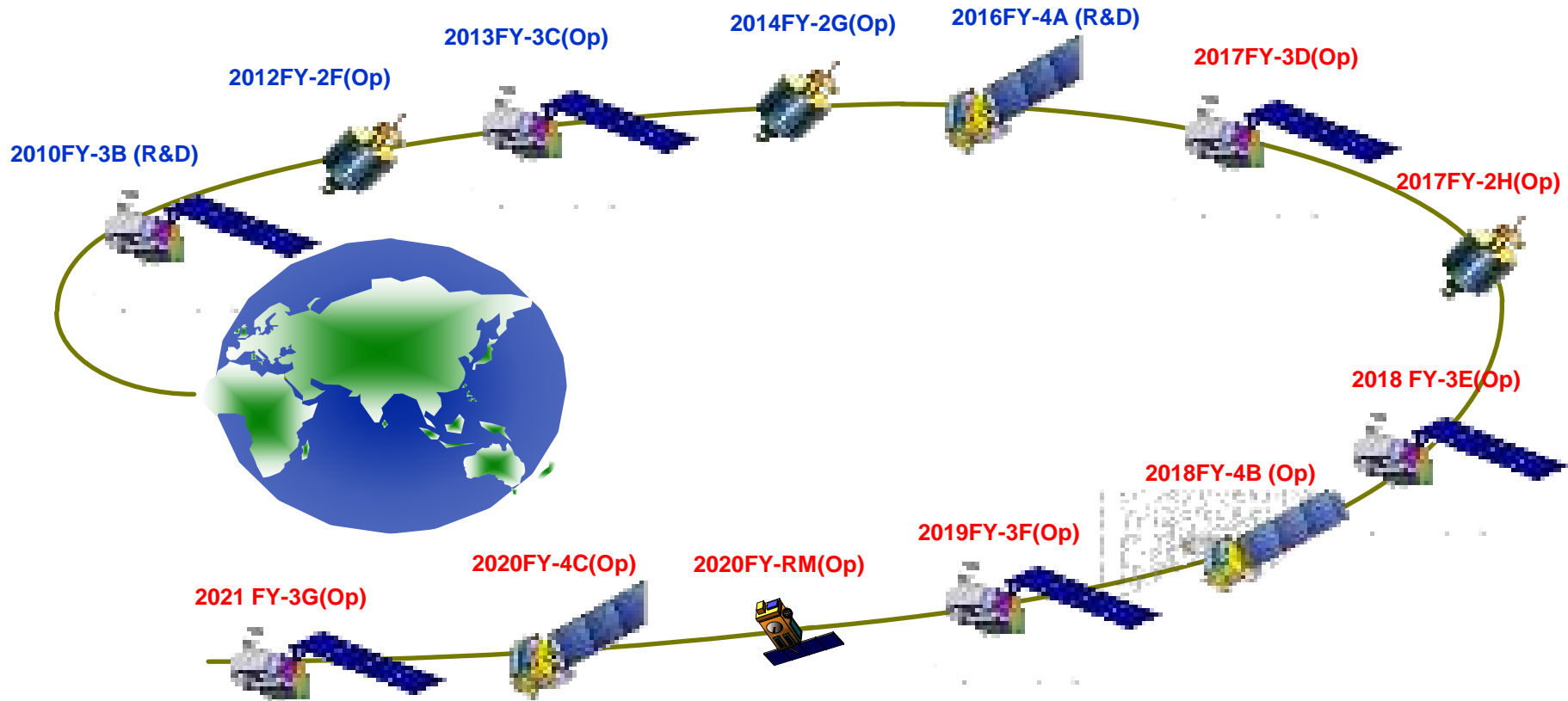
WAI: Wide-angle Aurora Imager (for space weather)

IPM: Ionospheric Photometer (for space weather)

4. Future Programs

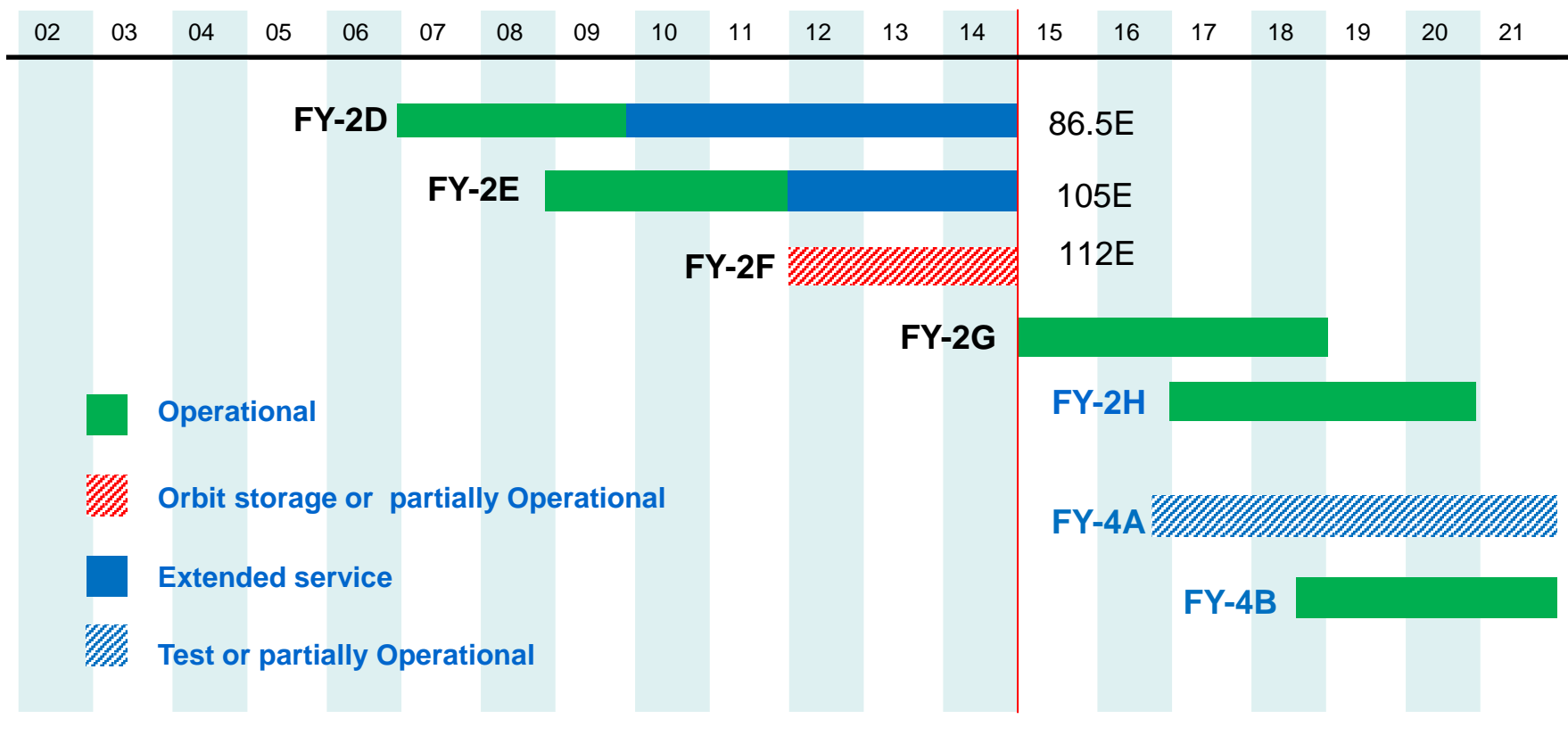


National Program for Fengyun Meteorological Satellite from 2011-2020

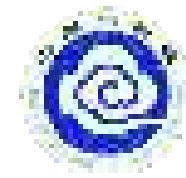


■ 8 satellites will be launched within this decade

FY-2 to FY-4 Transition



FY-4A will be launched in 2016, FY-2H will be launched to mitigate the gap between the FY-2 and FY-4 in operation



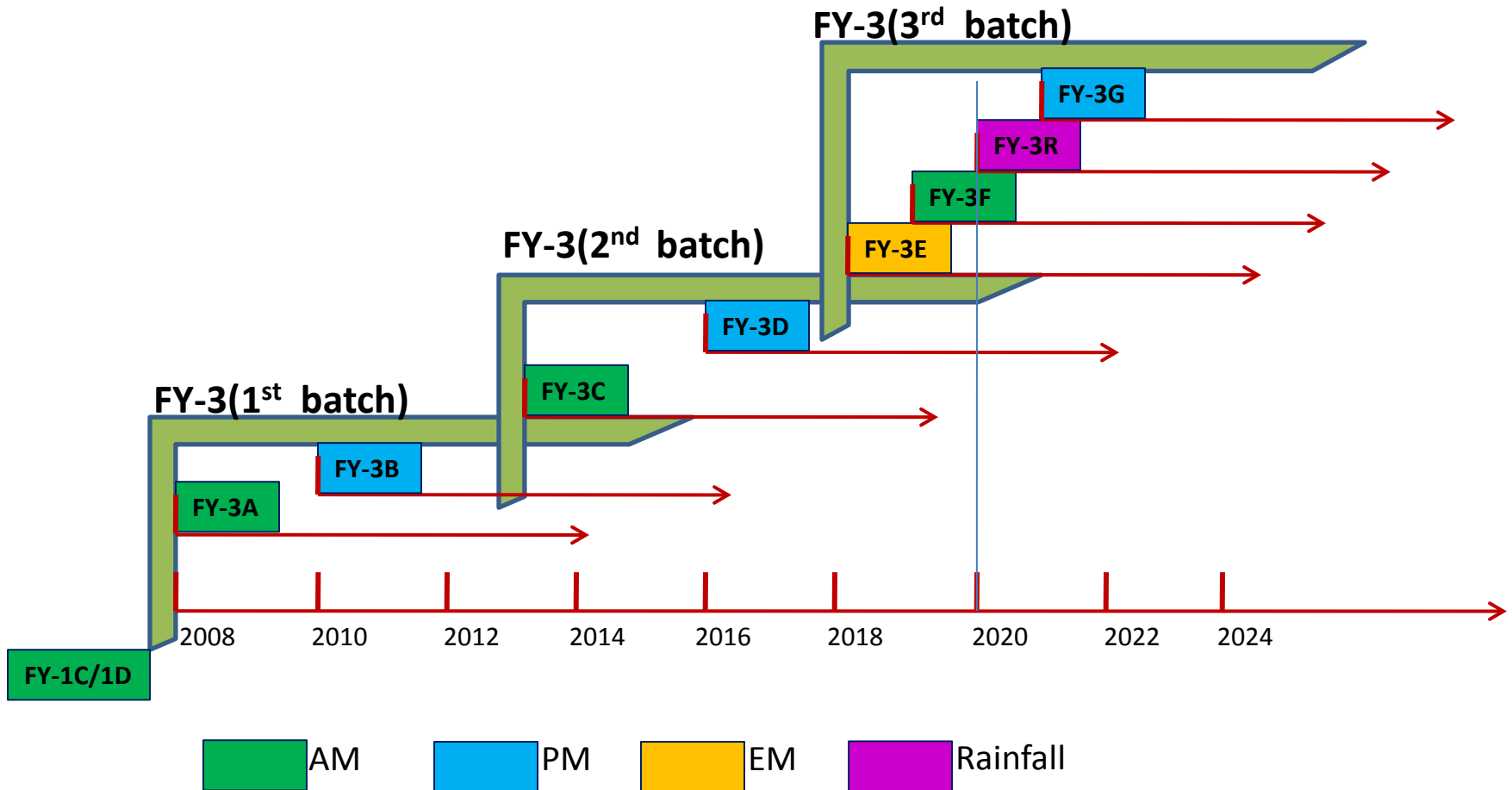
FY-3 02 batch to 03 batch Transition

3 yrs

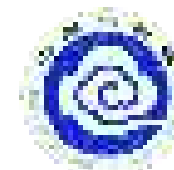
5 yrs

8 yrs

Designing lifetime



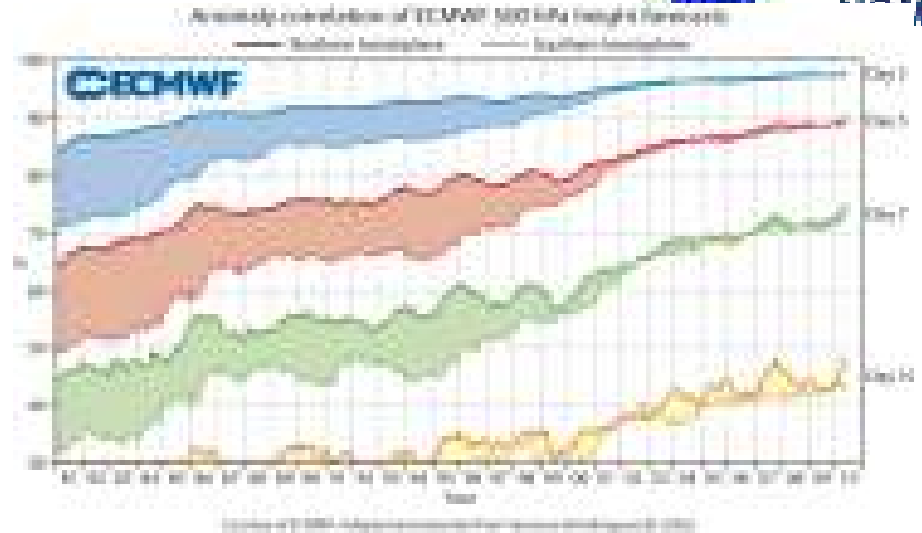
Payloads Configuration for FY-3E/F/G and Rainfall Mission






| NO. | Sensor Suite | Satellite | | FY-3E (05) | FY-3F (06) | FY-3G (07) | FY-3R (08) |
|-----|-----------------------------------|--|-----------------------|-------------------|---------------|---------------|--------------------|
| | | Sensor | Scheduled Launch Date | EM Satellite | AM Satellite | PM Satellite | Rainfall Satellite |
| 1 | Optical Imagers | MERSI | 2018 | √ (III-Low Light) | √ (III) | √ (III) | √ (III-Simplified) |
| 2 | Passive Microwave Sensors | MWTS | 2018 | √ | √ | √ | |
| | | MWHS | 2018 | √ | √ | √ | |
| | | MWRI | 2018 | | √ | √ | √ |
| 3 | Occultation Sounder | GNOS | 2018 | √ | √ | √ | √ |
| 4 | Active Microwave Sensors | WindRAD | 2018 | √ | √ | | |
| | | Rainfall RAD | 2020 | | | | √ |
| 5 | Hyperspectral Sounding Sensors | HIRAS | 2018 | √ | √ | √ | |
| | | GAS (Greenhouse Gases Absorption Spectrometer) | 2021 | | | √ | |
| | | OMS (Ozone Mapping Spectrometer) | 2019 | | √ | | |
| 6 | Radiance Observation Sensor Suite | ERM | 2019 | | √ | | |
| | | SIM | 2019 | √ | √ | | |
| | | SSIM (Solar Spectral Irradiation Monitor) | 2019 | √ | | | |
| 7 | Space Weather Sensor Suite | SEM | 2019 | √ | | | |
| | | Wide Angle Aurora Imager | 2021 | | | √ | |
| | | Ionosphere photometer | 2018 | √(Multi-angle) | | √ | |
| | | Solar X-EUV Imager | 2019 | √ | | | |

Orbit Option: FY-3 Early Morning + NPP + Metop

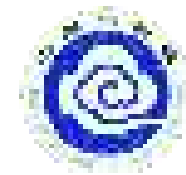
Recognizing that global even distribution of sounding data is of great significance for the 6 hour NWP assimilation window, one approach is to constitute a three orbital fleet including **Metop** (Mid. Morning) + **NPP** (Afternoon) + **FY-3** (Early Morning)



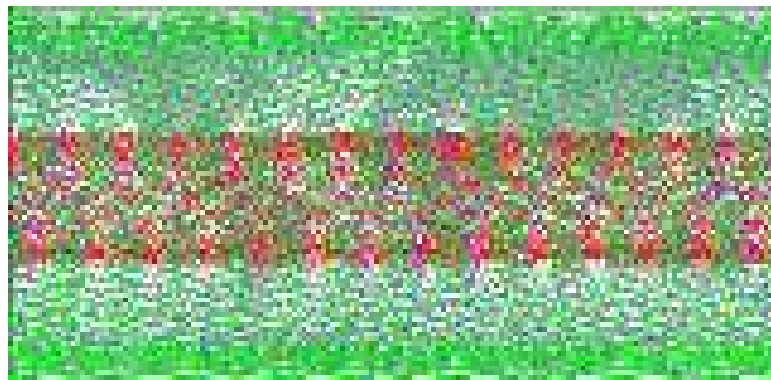
-  **FY-3 Early Morning**
6:00 AM
-  **Metop-A 9:30 AM**
-  **NPP 13:30 PM**



FY-3 Rainfall Mission



- Consist a Global observation constellation system with FY-3 satellites, as well as GPM satellite
- Improve the severe convective system monitoring ability in china together with GPM satellite
- Provide 3D precipitation structure over both ocean and land
- Improve the sensitivity and accuracy of precipitation measurement over china and surrounding area



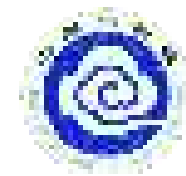
KaPR



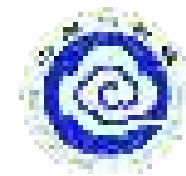
KuPR

| | Ka | Ku |
|-----------------------|----------------------------------|----------------------------------|
| Flight height | 500km | 500km |
| Precipitation | 13.8GHz | 13.8GHz |
| Beam diameter | 2.5km | 3.5km |
| Horizontal resolution | 4km @ 50km ASL | 4km @ 50km ASL |
| Horizontal resolution | 20km | 20km |
| Vertical resolution | 20km | 20km |
| Sensitivity | 1.2mm/h | 1.2mm/h |
| Sample rate | 64 | 64 |
| Measurement | $2.0^{\circ} \times 2.0^{\circ}$ | $2.0^{\circ} \times 2.0^{\circ}$ |
| Scan rate | $\approx 20^{\circ}$ | $\approx 20^{\circ}$ |
| Operational range | 2000K | 2000K |

5. Summarization



- Current **FY-2** constitute the Geo constellation with 3 premier satellites to provide the full disk regular scanning image in every 60 minutes and the regional rapid scanning image in every 6 minutes.
- Current **FY-3** constitute the Leo constellation with 2 premier satellites to provide the global observation of the Earth 4 times per day in AM orbit and PM orbit.
- **FY-4A** and Future **FY-3 beyond** will provide some particular observations for NWP community, such as early-morning orbital observations from LEO, hyperspectral sounding observation from GEO.
- **FY series** can be one important components of global observation with improved instrument performance (NE Δ T), enhanced and traceable calibration procedures.
- **FY data** can be ordered through website <http://satellite.cma.gov.cn>



Together
For Better

谢谢