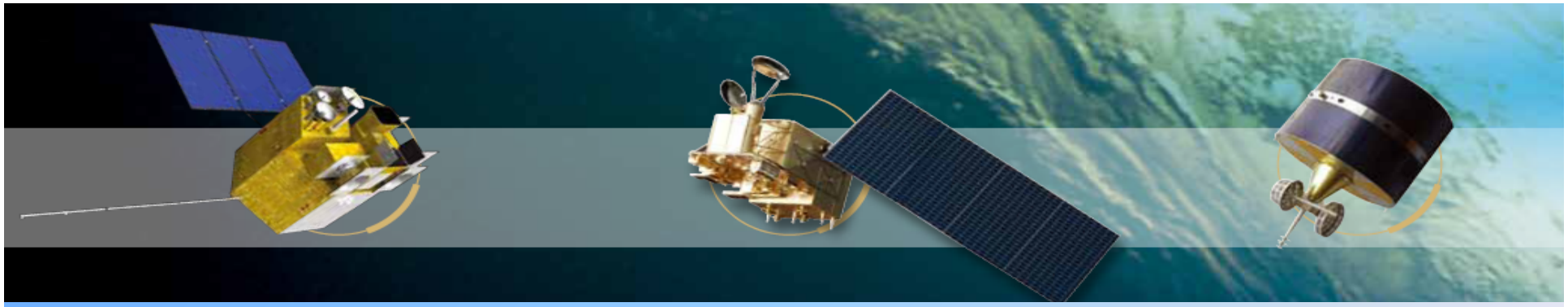


Progress on CMA Meteorological Satellite Programs

Jun Yang

National Satellite Meteorological Center ,CMA

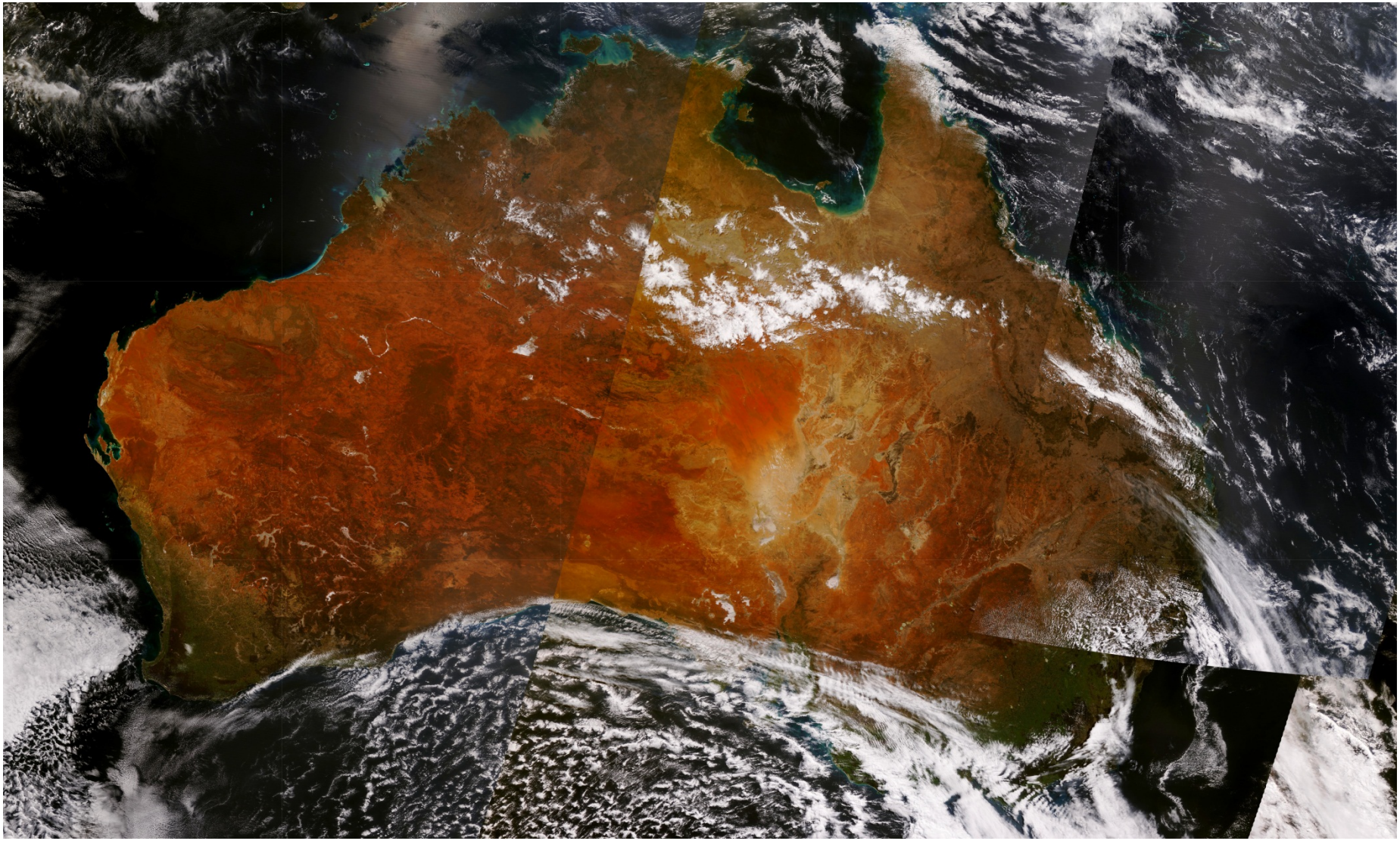
4th Asian-Oceania Meterological Satellite Users Conference
9-11 Oct. 2013, Melbourne, Australia

New baby: FY-3C

Launched on 23, Sept. 2013

FY-3C, as the first operational one of the 2nd generation of FengYun polar-orbiting satellites, is the successor of the R&D satellites FY-3A/B working in orbit

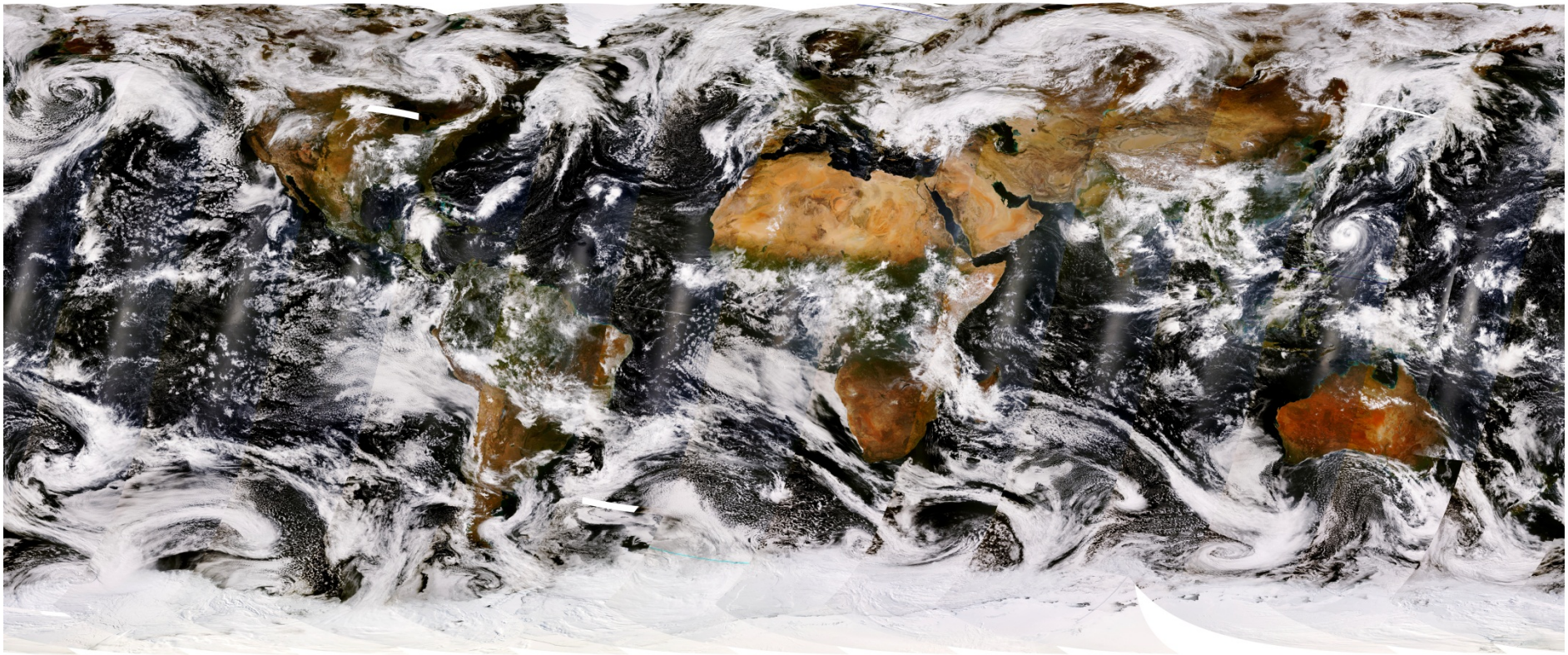
FY-3C MERSI Image, 2,Oct., 2013



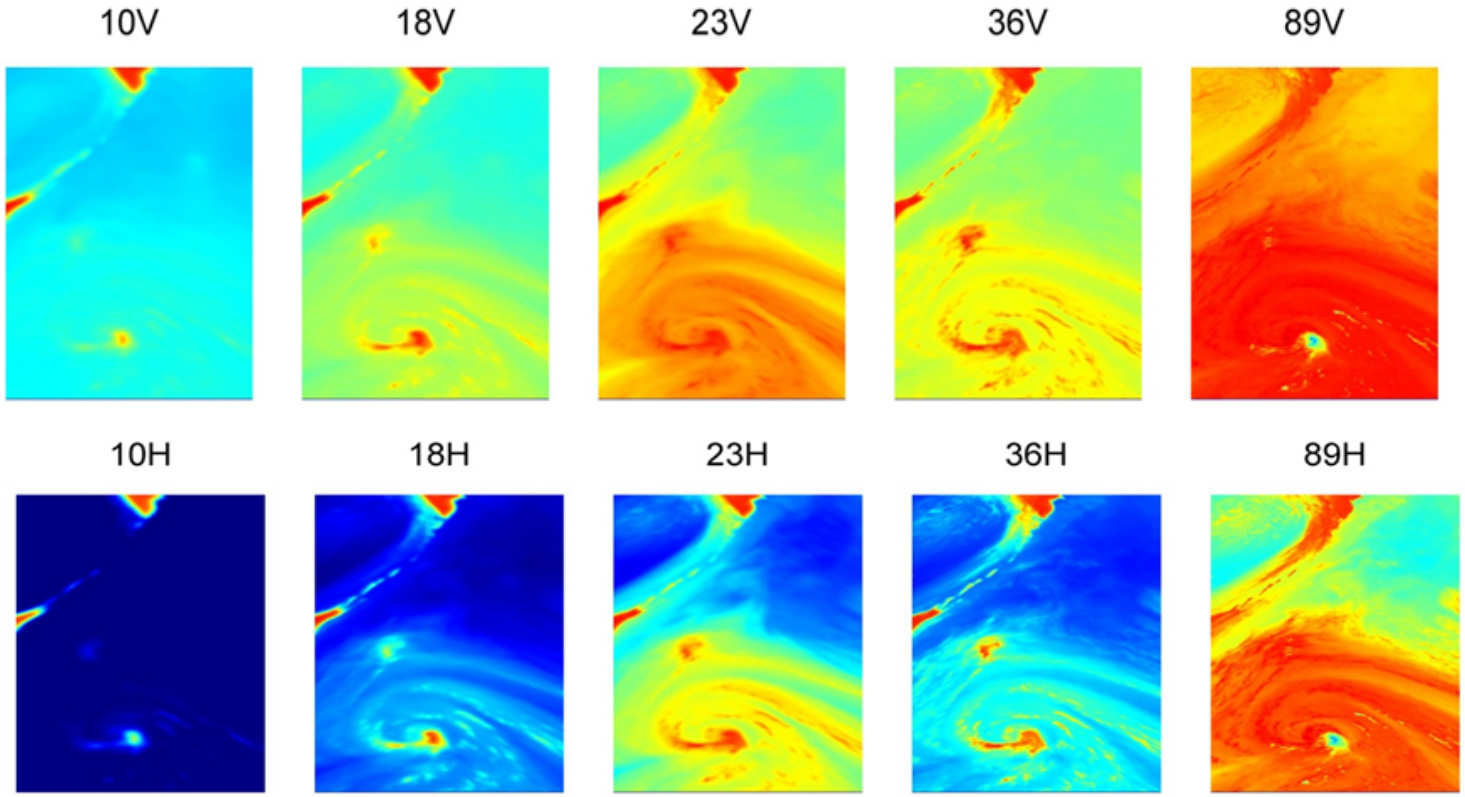
MERSI was opened on 1 Oct., 2013

The First Global Mosaic Image by FY-3C MERSI

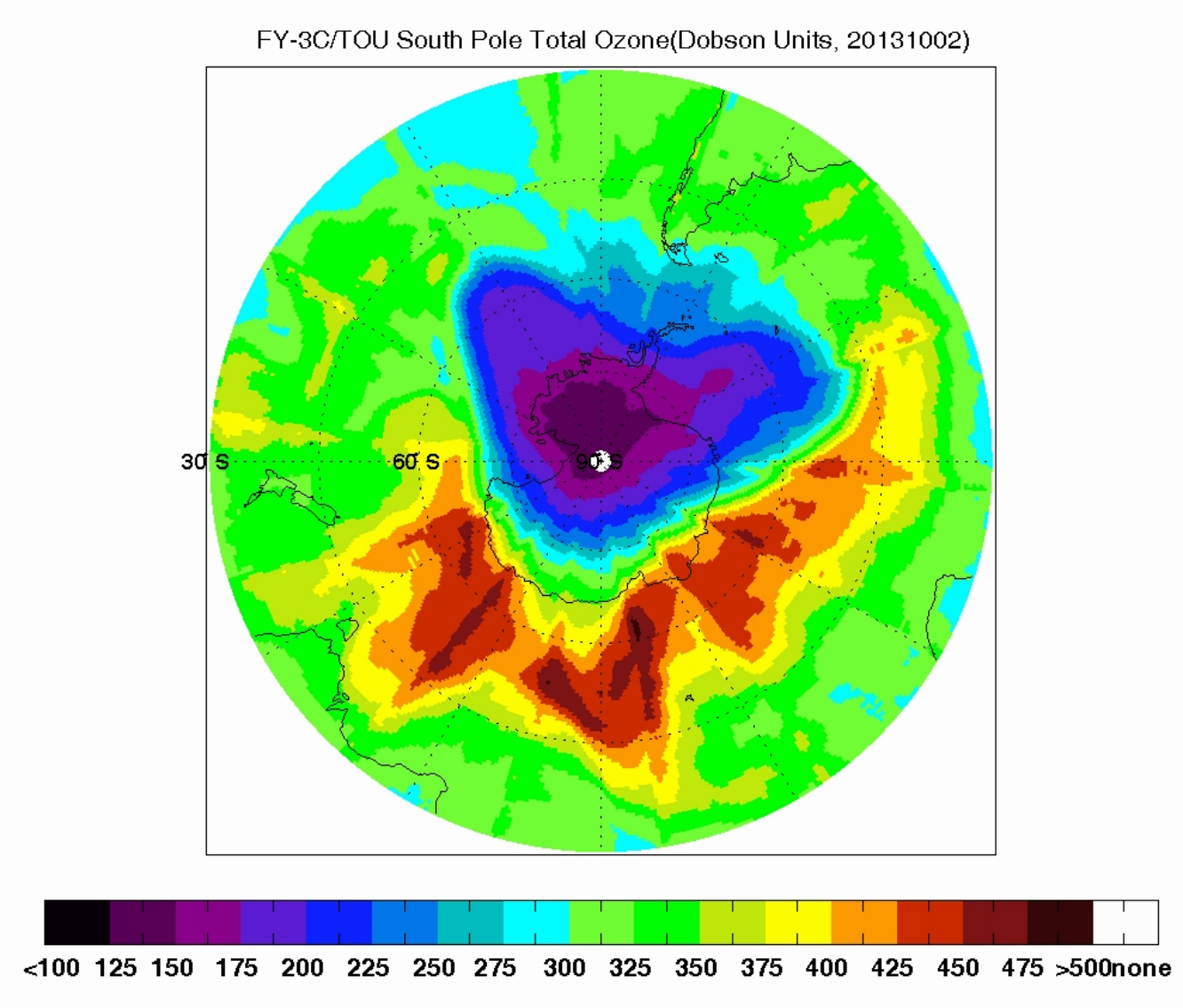
Oct. 2, 2013



Tropical Cyclone SEPAT by FY-3C MWRI,
at 0:29 UTC, 30 Sept. 2013

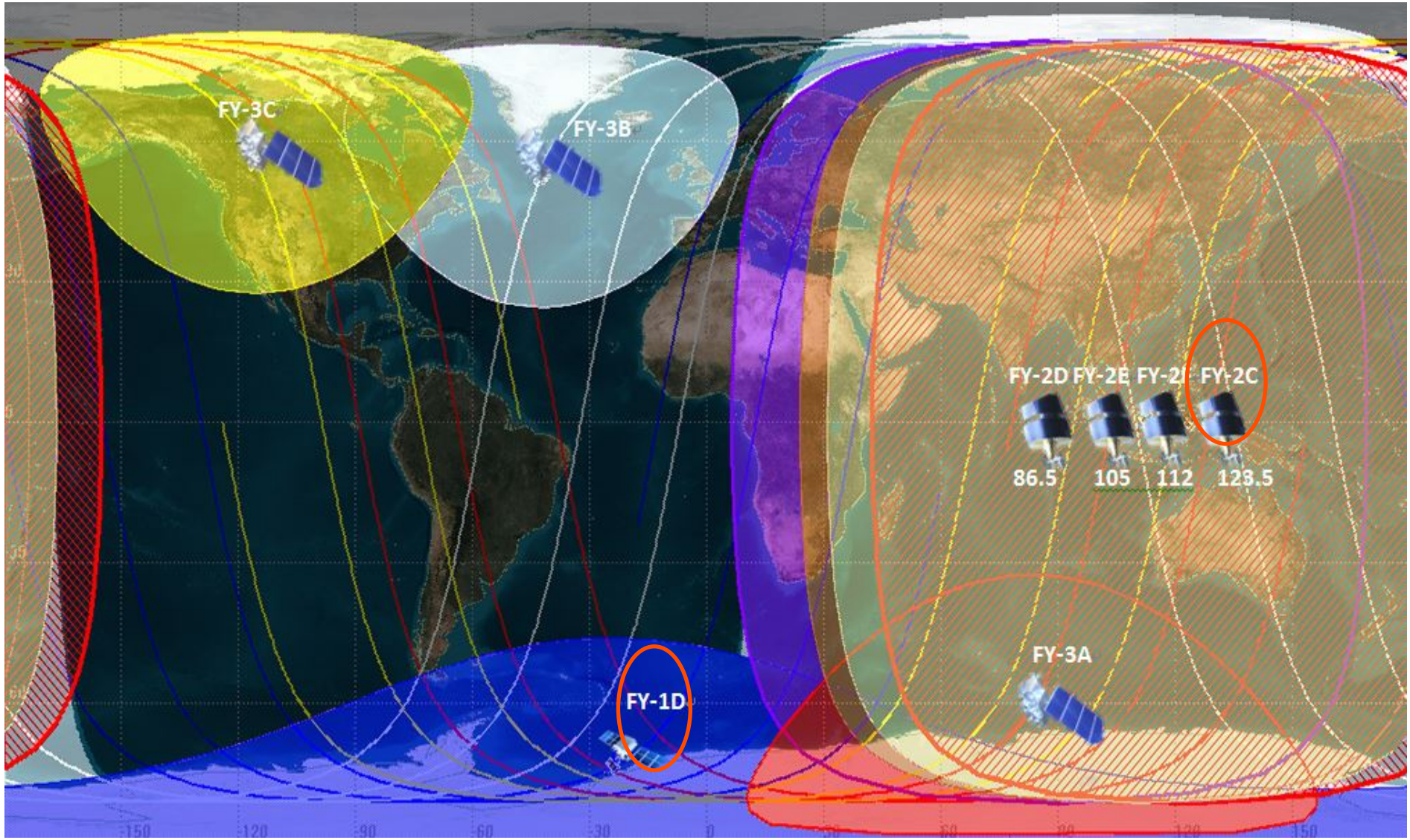


As shown in the images, obvious scattering signal exists only in area of SEPAT in low frequency channel(10GHz) ; With the frequency increasing, the features of typhoon structure become more and more clear.



First Antarctic ozone hole retrieved from radiances of FY-3C/TOU channel 3,5 and 6 (Oct. 2, 2013)

Currently On Orbit Satellites: 6/8



FY-3C instruments(12)

FY-3 OPERATIONAL SATELLITE INSTRUMENTS	FY-3C
MERSI – Medium Resolution Spectral Imager (Ⅰ, Ⅱ)	√(Ⅰ)
MWTS – Microwave Temperature Sounder (Ⅰ, Ⅱ)	√(Ⅱ)
MWHS – Microwave Humidity Sounder (Ⅰ, Ⅱ)	√(Ⅱ)
MWRI – Microwave Radiation Imager	√
WindRAD - Wind Radar	
GAS - Greenhouse Gases Absorption Spectromete	
HIRAS – Hyperspectral Infrared Atmospheric Sounder	
OMS – Ozone Mapping Spectrometer	
GNOS – GNSS Occultation Sounder	√
ERM – Earth Radiation Measurement (Ⅰ, Ⅱ)	√(Ⅰ)
SIM – Solar irritation Monitor (Ⅰ, Ⅱ)	√(Ⅱ)
SES – Space Environment Suite	√
IRAS – Infrared Atmospheric Sounder	√
VIRR – visible and Infrared Radiometer	√
SBUS – Solar Backscattered Ultraviolet Sounder	√
TOU – Total Ozone Unit	√

Major Improvements compared with FY-3A/B:

- A GNSS Occultation Sounder added for GPS sounding
- MWTS sounding channels increased from 4 to 13, while spatial resolution from 70Km to 20Km
- MWHS sounding channels increased from 5 to 15, with 118GHz O2 absorbing band new added
- Auto solar-tracking capability for SIM to improve measurement accurcy
- Better performance for at least 60% of instrument specifications
- Longer design life, more reliable for operational guarantee

Four FY-3 operational satellites planned by 2020

No.	Launch	Orbit	Status
FY-3C	2013	AM	launched
FY-3D	2015	PM	under manufacture
FY-3E	2017	AM	planned
FY-3F	2019	PM	planned

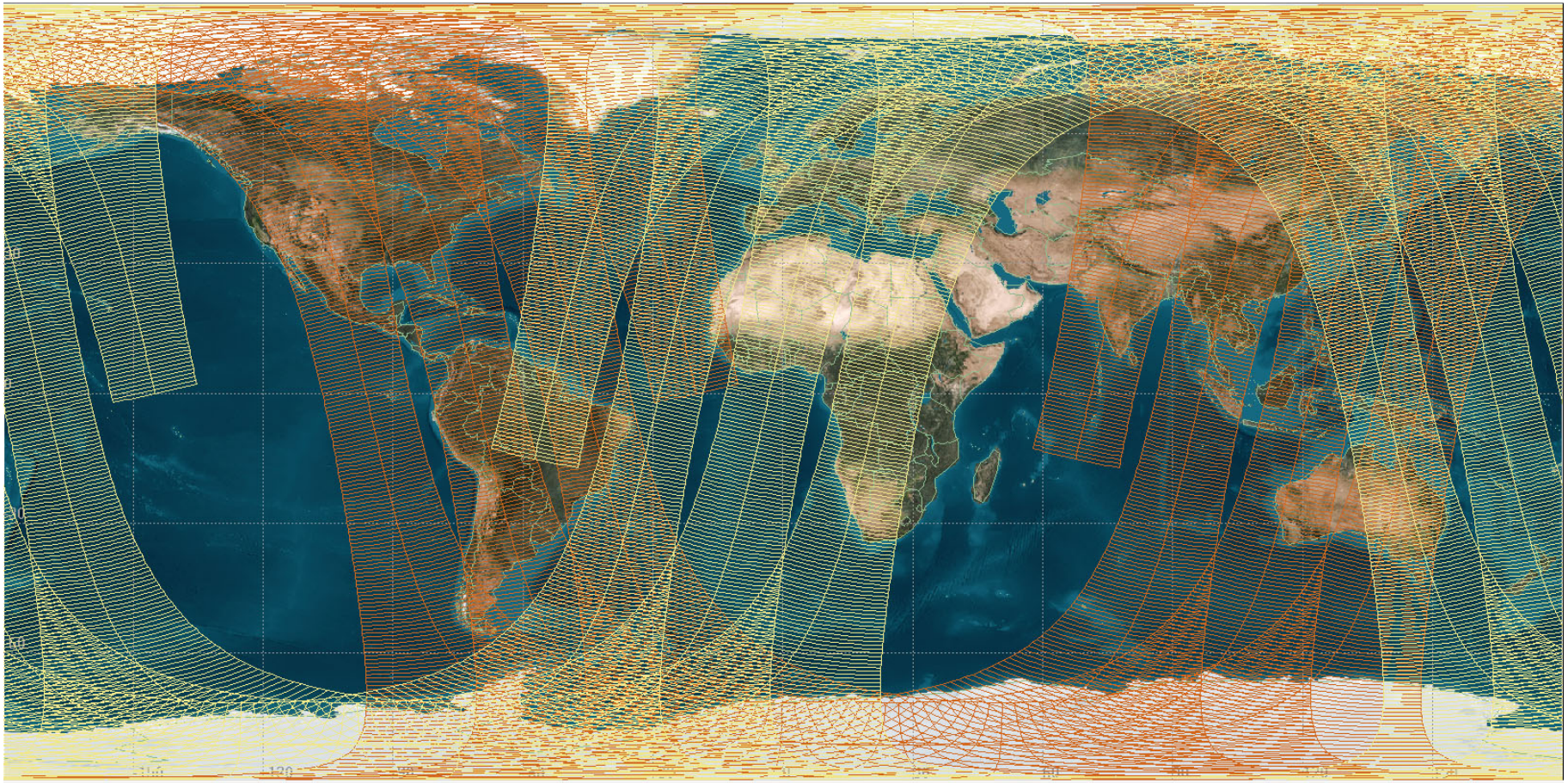
New capabilities in FY-3C follow-ons

FY-3 OPERATIONAL SATELLITE INSTRUMENTS	FY-3C	FY-3D	FY-3E	FY-3F
MERSI – Medium Resolution Spectral Imager (I, II)	√(I)	√(II)	√(II)	√(II)
MWTS – Microwave Temperature Sounder (II)	√	√	√	√
MWHS – Microwave Humidity Sounder (II)	√	√	√	√
MWRI – Microwave Radiation Imager	√	√		√
WindRAD - Wind Radar			√	
GAS - Greenhouse Gases Absorption Spectrometer		√		√
HIRAS – Hyper spectral Infrared Atmospheric Sounder		√	√	√
OMS – Ozone Mapping Spectrometer			√	
GNOS – GNSS Occultation Sounder	√	√	√	√
ERM – Earth Radiation Measurement (I, II)	√(I)		√(II)	
SIM – Solar irritation Monitor (I, II)	√(I)		√(II)	
SES – Space Environment Suite	√	√	√	√
IRAS – Infrared Atmospheric Sounder	√			
VIRR – visible and Infrared Radiometer	√			
SBUS – Solar Backscattered Ultraviolet Sounder	√			
TOU – Total Ozone Unit	√			

- Improved Medium Resolution Spectrum Imager (MERSI II) in FY-3D, 3E, 3F
- Greenhouse Gases Absorption Spectrometer (GAS) in FY-3D,3F
- Hyper-Spectral Infrared Sounder (HIRAS) will take replace of current IRAS in FY-3D,F
- Sea Surface Wind Radar (WindRAD) in FY-3E

Fengyun Polar Satellites: AM+PM

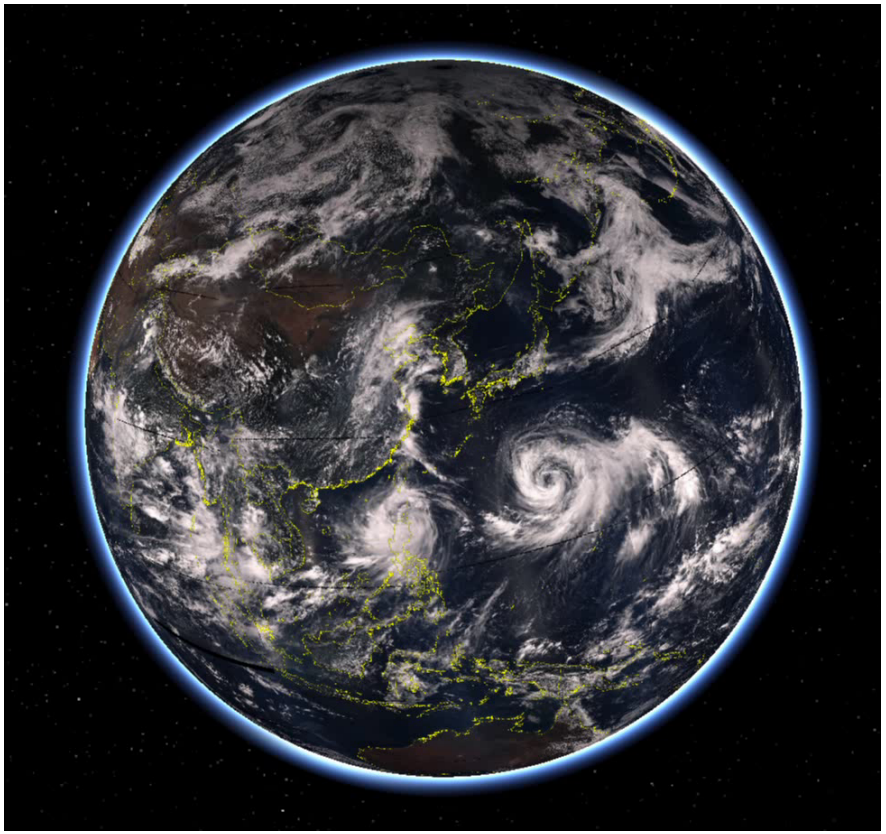
- **FY-3A(AM) + FY-3B(PM)** Global Coverage per 6 hours

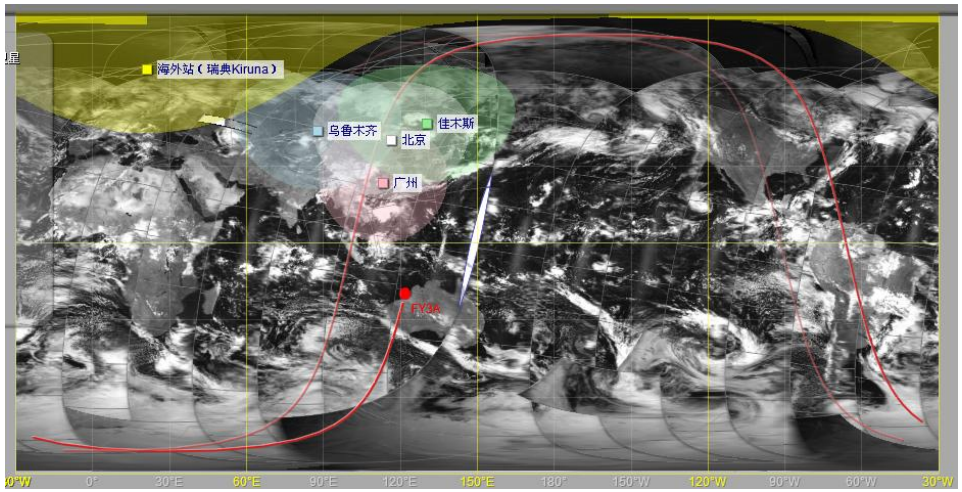


FY-3A (AM) LTC 10:00 AM

FY-3B (PM) LTC 13:40 PM

Global Data Latency within 4 hrs,
2 hrs expected



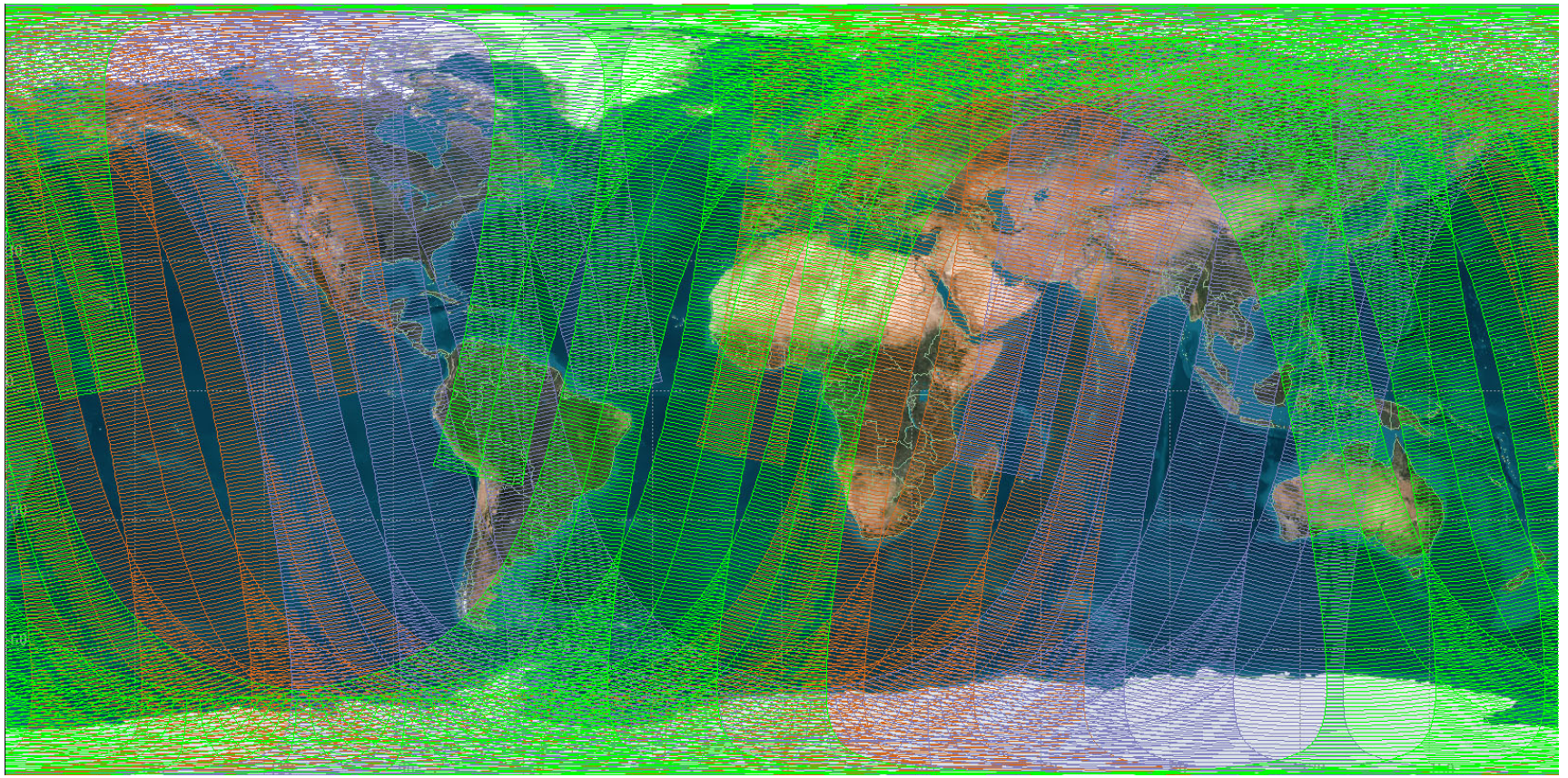


Station Name	Longitude	Latitude
Beijing Station	116° 16′ 36″ E	40° 03′ 06″ N
Guangzhou Station	113° 20′ 20″ E	23° 09′ 52″ N
Wulumuqi Station	87° 34′ 08″ E	43° 52′ 17″ N
Jiamusi Station	130° 22′ 48″ E	46° 45′ 20″ N
Kiruna Station	21° 02′ E	67° 32′ N

To optimize the current global polar constellation

Orbital Option: Metop+NPP+FY-3

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

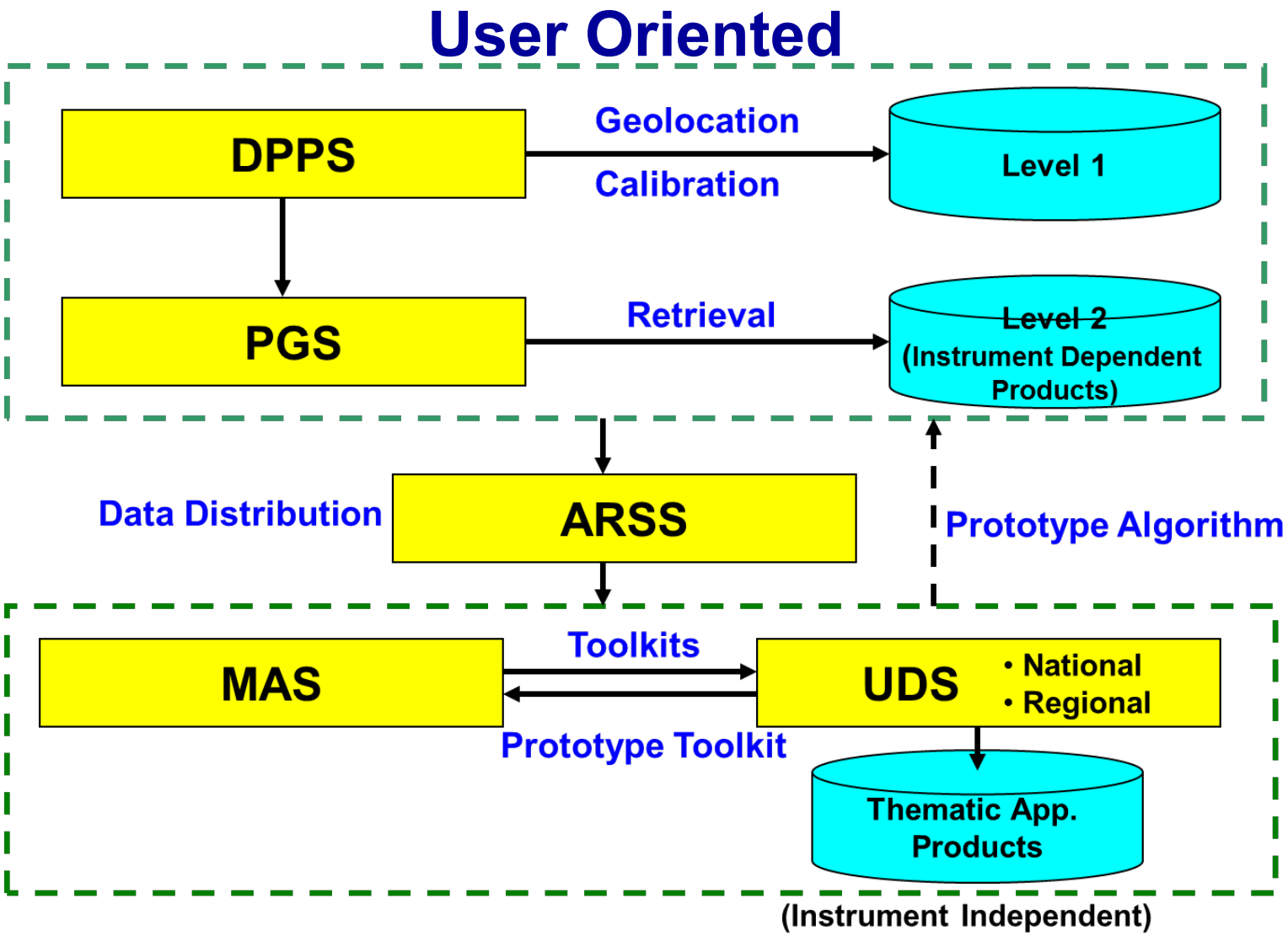
NPP 13:30 PM

Four FY-3 operational satellites planned by 2020

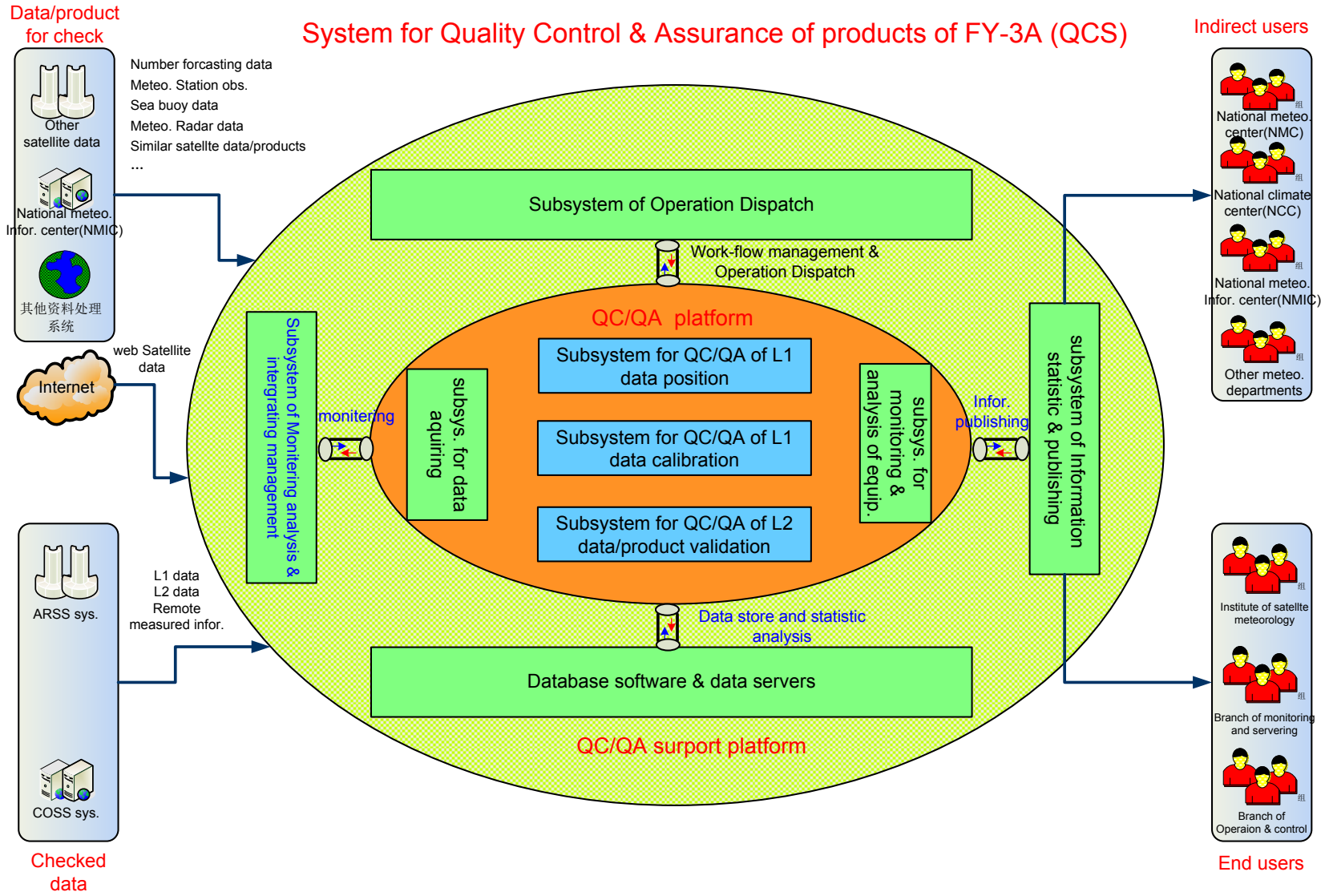
No.	Launch	Orbit	Status
FY-3C	2013	AM	launched
FY-3D	2015	PM	under manufacturer
FY-3E	2017	EM?	under evaluation
FY-3F	2019	PM	planned

Change is expected in FY-3E, 2017

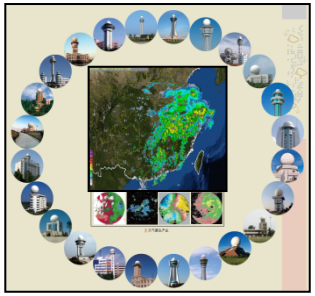
User Preparedness for FY-3 operational satellites



Products Quality Control



Products Validation



120 upper-air stations

164 new generation Doppler Radars

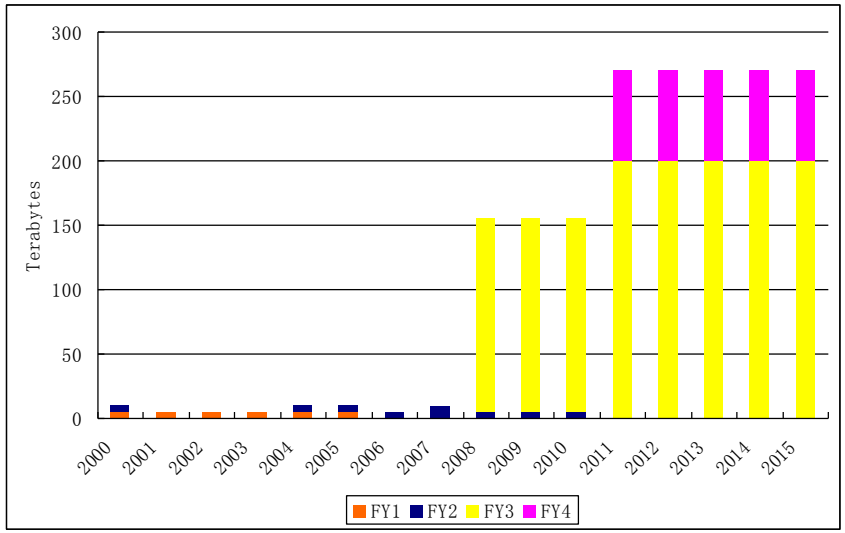
Application Demonstration

— Satellite Application Facilities in China

- 11 Application Demonstration Center
- 17 Regional DB users

Data Delivery Services

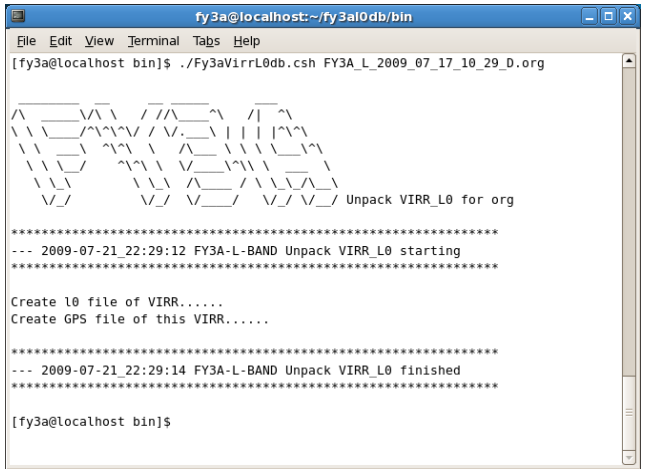
1) Web-based Service（registered users）
2) CMACast （registered users）
3) FTP Push & Pull （VIP users）
4) Artificial Service （applicants only）
5) DB Users （any）

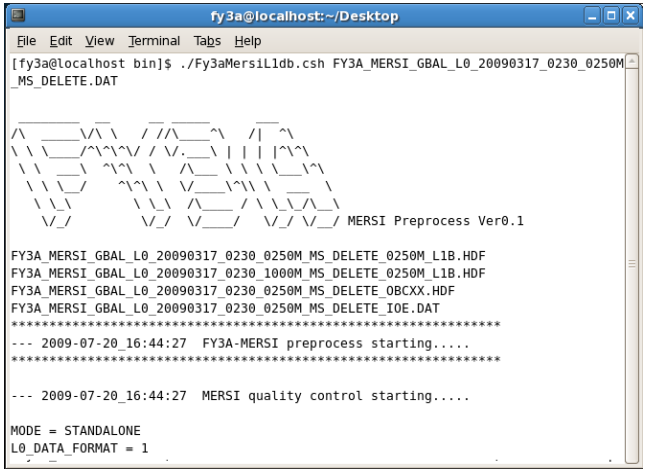


FY-3 DB Users – free access to software package

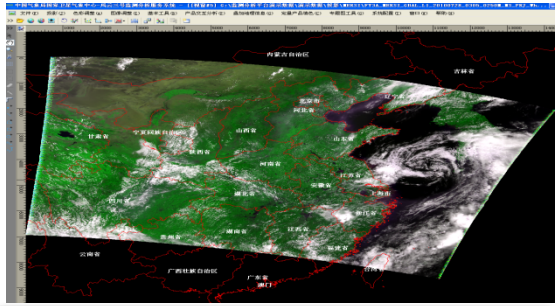
FY-3 International Pre-processing Package

- 5 Instruments available
  - ✓MERSI, VIRR, MWTS, MWHT, IRAS
- Hardware recommended
  - ✓CPU: Intel Pentium Duo Core processor (>3.0Ghz)
  - ✓Hard disk: >200GB
- Operating system tested
  - ✓RedHat Fedora Linux 6.0/8.0/10.0
- Software packages released
  - ✓FY3L0pp: unpack raw data in both X/L bands to generate level-0 data from the 5 instruments
  - ✓FY3L1pp: processes level-0 data to generate corresponding level-1 data respectively.

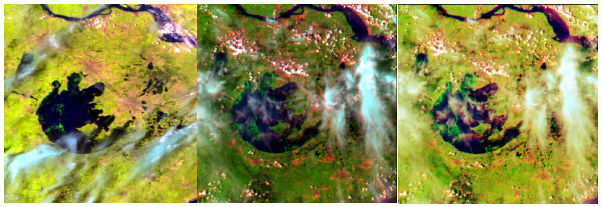




Satellite Monitoring Analysis Remote-sensing Toolkit (SMART) - for FY-3



- Reading and displaying Satellite data
- Reading and displaying GIS data
- Customizable color palette for data displaying



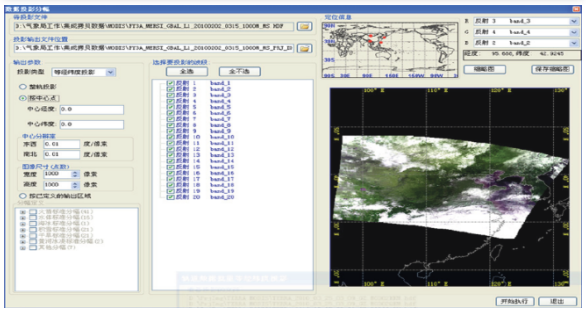
Source image | Objective image | Matched image

- Multiple functions of color adjustment
- Multiple image adjustment functions
- Multiple auxiliary tools including magnetic lasso etc.

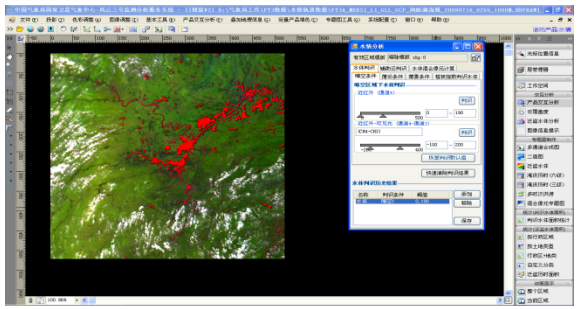
- Customization of thematic map templates
- Label for thematic map

Multi-source data reading and displaying | **Specialized toolkit in remote sensing** | **Common toolkit in image processing** | **Thematic products analyzing** | **Thematic products generation** | **Public service**

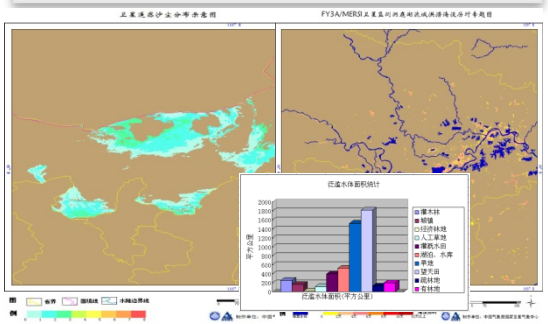
- map projections in multiple windows
- Image geometrical correction
- Image split or and mosaic



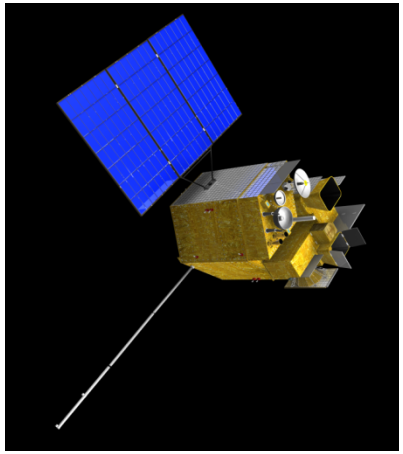
- Analyzing and processing of environmental change monitoring
- Temporal analysis function of monitoring products

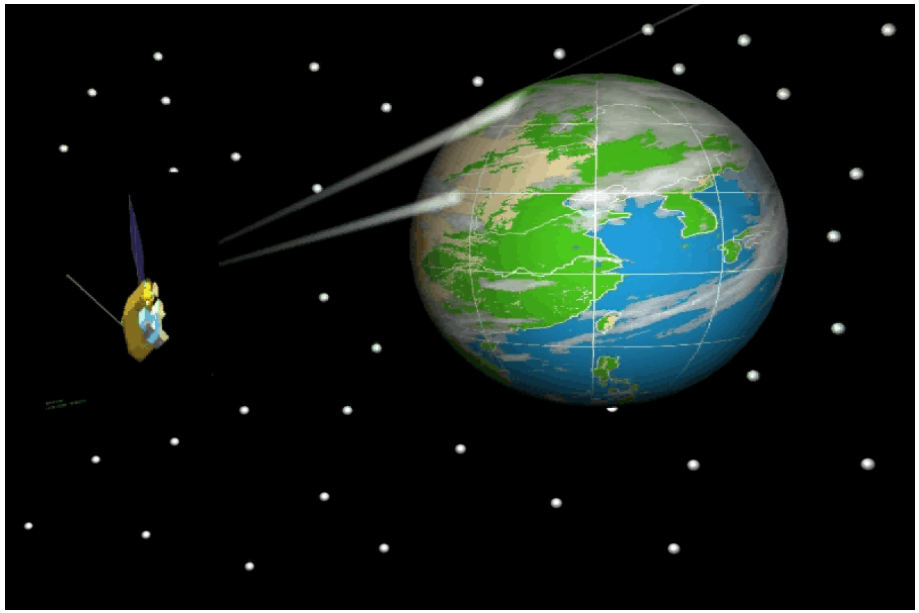


- Thematic products
- Statistic table
- Operational reports, etc.



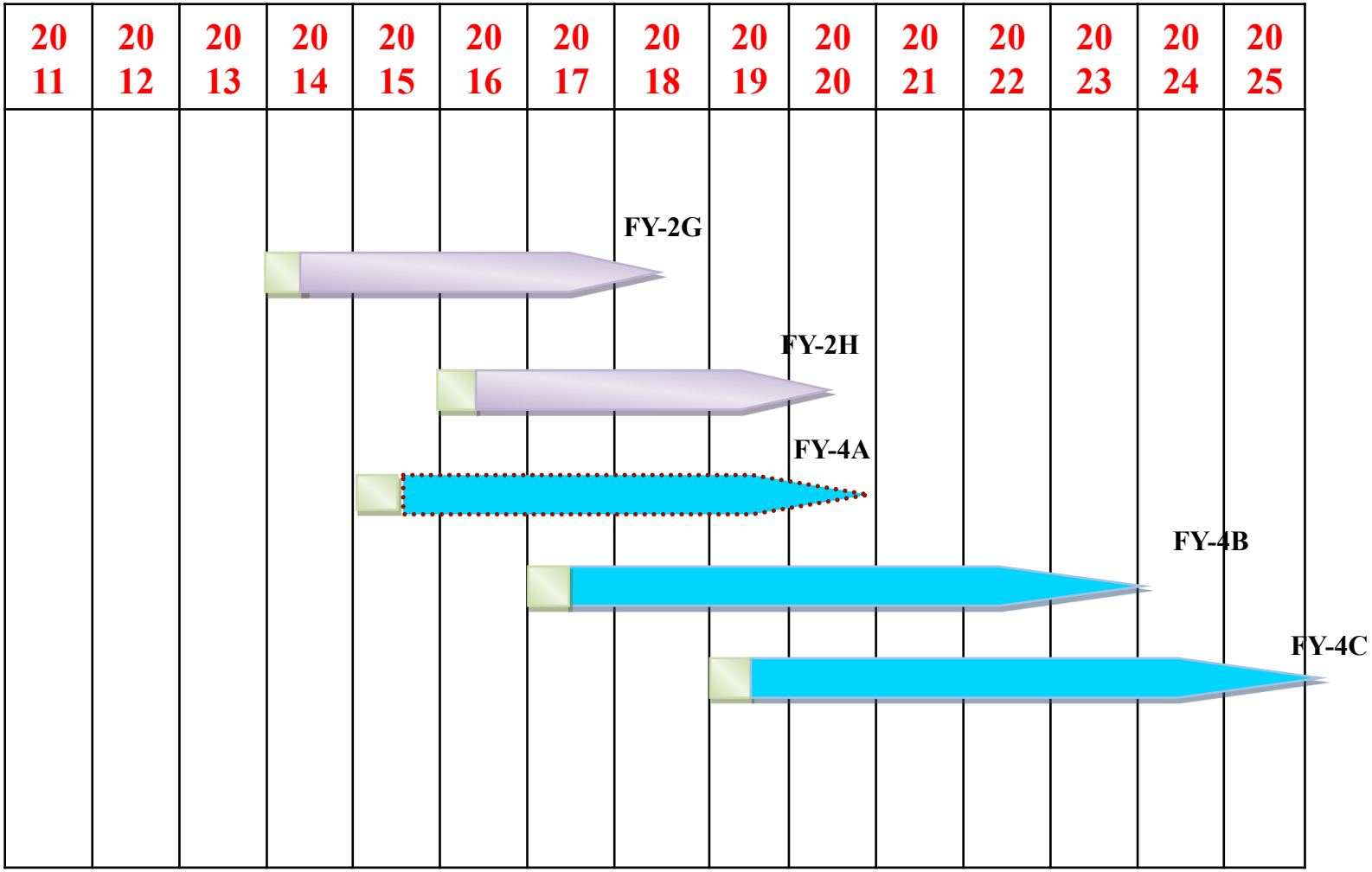
FY-4: New generation of FengYun GEO.



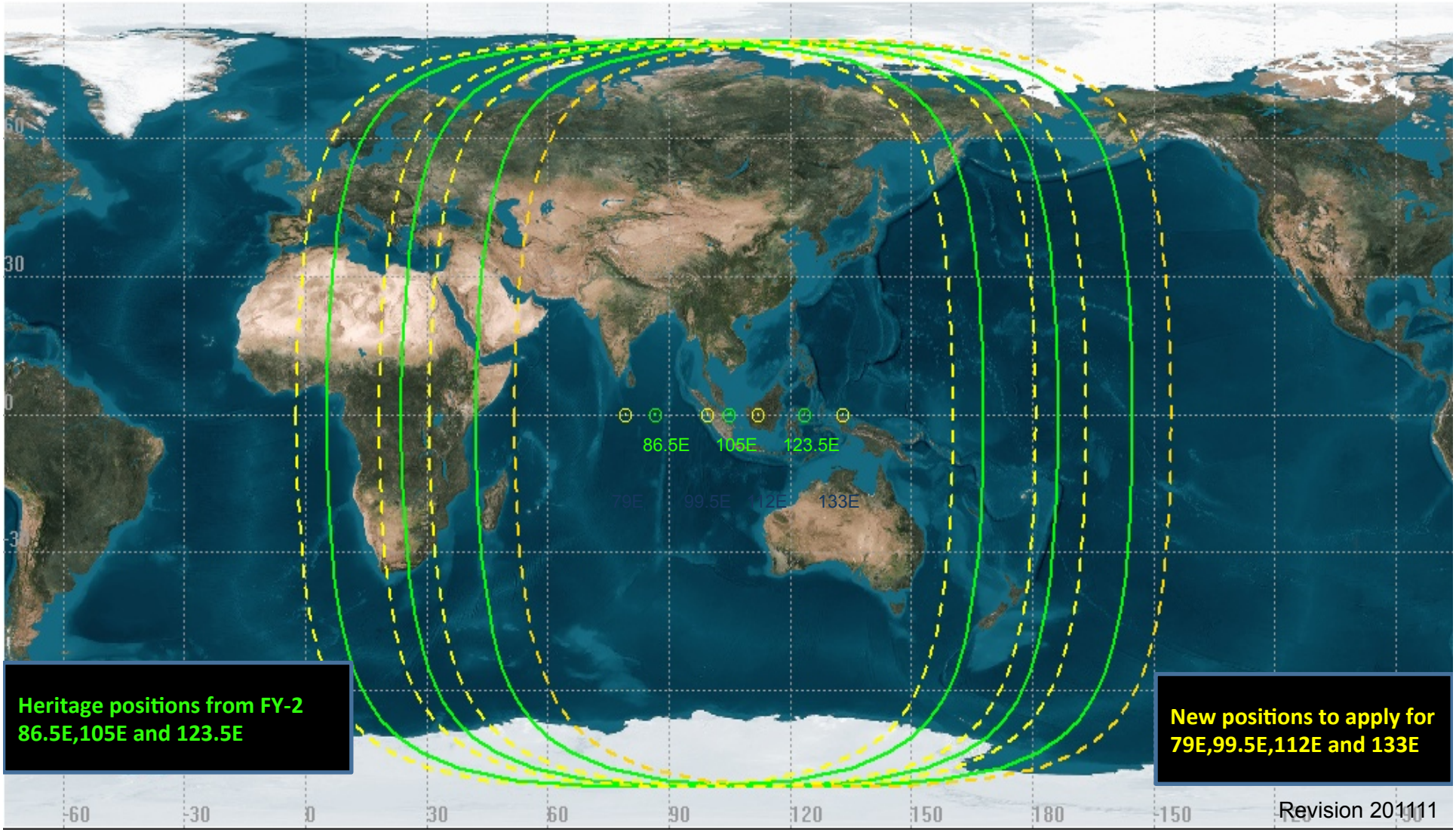


No.	Planed Launch	Designed Life	Status
FY-4A	2015	5 years	Under manufacture
FY-4B	2017	7 years	Planned
FY-4C	2019	7 years	Planned

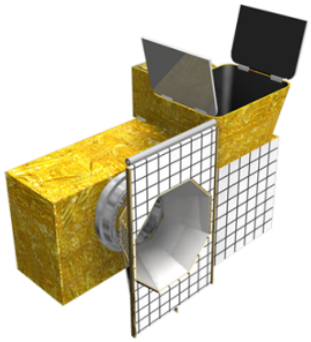
FengYun Geostationary Satellites Launch Plan

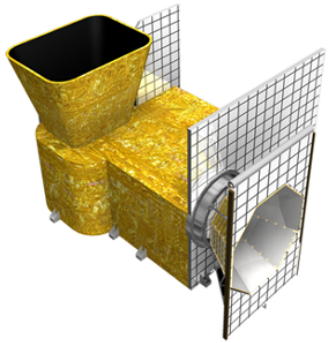


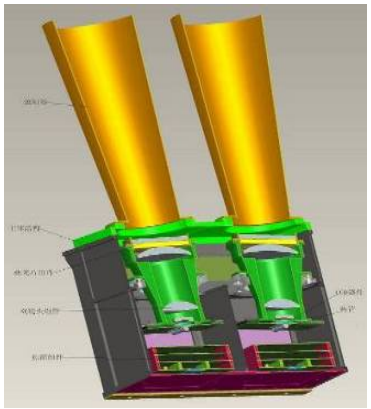
FY-4 Orbital positions to apply for



FY-4A Instruments







AGRI	GIIRS	LMI
Advanced Geo. Radiation Imager	**Geo. Interferometric Infrared Sounder**	**Lighting Mapping Imager**
14 Channels within 0.55~13.8μm	538 LWIR Channels 375 S/MIR Channels	Central Frequency: 777.4nm
500mx1;1Kmx2 2Kmx4; 4Kmx7	16Km	7.8Km
S/N : 90 ~ 200 NEΔT : 0.2 ~ 0.7K	Radiometric Calibration accuracy: 1K Spectral Calibration accuracy:10ppm	S/N > =6
Full Disk < =15min	Meso-scale : 35min(1000x1000km) China area: 67min(5000x5000km)	2ms

Advancement of FY-4A compared with FY-2

	FY-4A	FY-2
Stabilization	**Three-axis**	**Spin**
Designed Life	**5~7 Years**	**4 Years**
Observation Efficiency	**85%**	**5%**
Observation Mode	**Imaging +Sounding + Lightning Mapping**	**Imaging Only**
Main Instruments	**AGRI :14 channels** SSP Resolution：0.5~4Km Global imaging：15min Flexible imaging ： 2D	**VISSR: 5 channels** SSP Resolution：1.25~5Km Global imaging：30min Flexible imaging ： 1D
	GIIRS:913 channels Spectral Resolution: 0.8,1.6cm-1 SSP Resolution:16Km	**N/A**
	LMI SSP Resolution:7.8Km	**N/A**
	SEMS High energy particles Magnetic field	**SEM** High energy particles Solar X ray fluxes

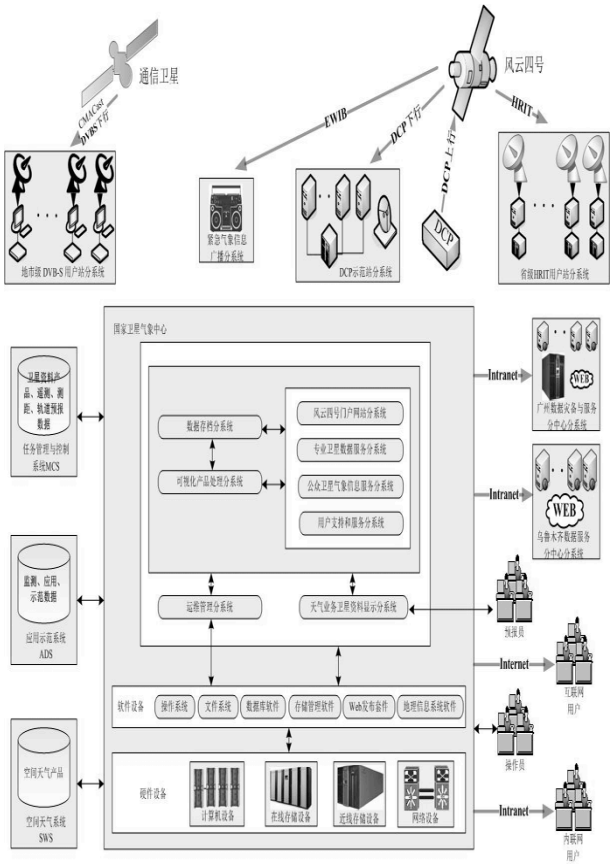
FY-4 Direct Broadcast Capabilities:

No	Channel	Band Width	Max. Data daily
1	HRIT 1	8Mbps	93.3GB
2	HRIT 2a/b	3Mbps/1Mbps	38.9GB/11.67GB
3	LRIT	150Kbps	1.67GB
4	DCP	600bps	6MB

HRIT1: all 14 channel data of AGRI, LMI data
HRIT2a/b: a)resampled data of AGRI, b) GIIRS data
LRIT: low resolution information transmission
DCP： data collection platform

FY-4 User preparedness:

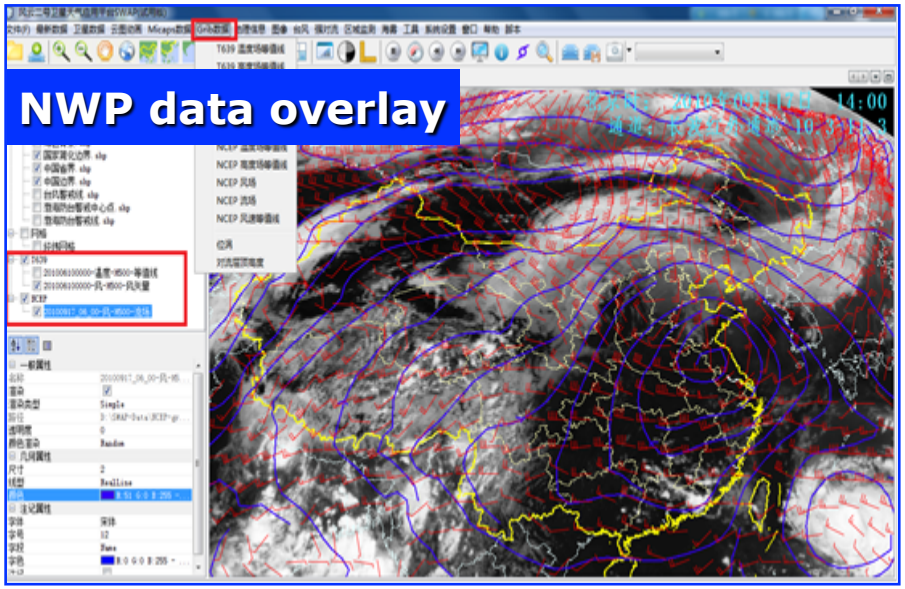
Data Distribution and Service System

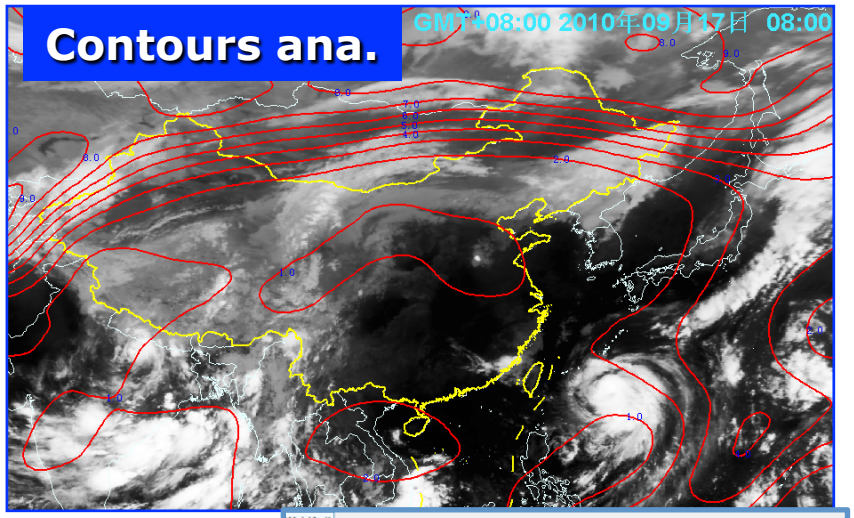


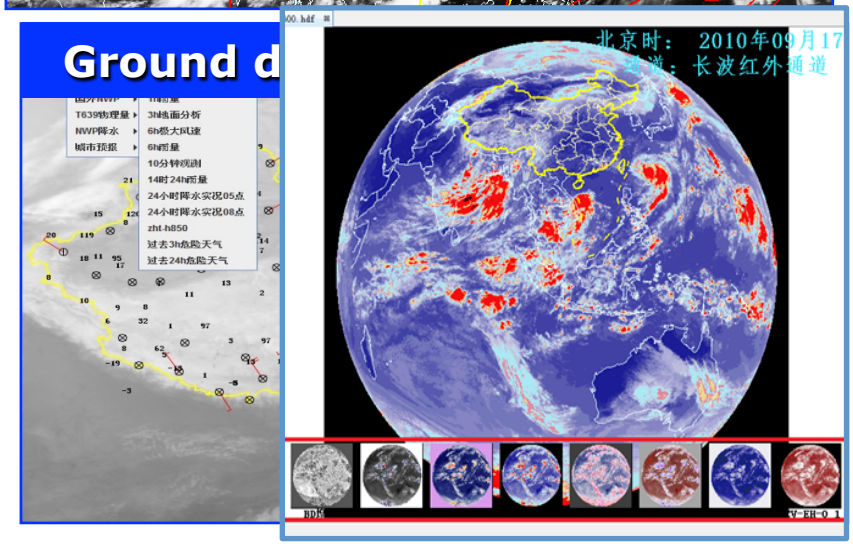
Main functions：

1. To provide downlink data for DB users
2. To make FY-4 data and products available via CMACast，Internet, and dedicated links
3. To establish a stable and reliable data archiving and management system
4. To build an EWIB system to response to emergency weather events

Preparing Users to FY-4







- Efficient and professional analysis tools for forecasters
- supporting multiple data, including polar satellite data, conventional data and NWP products etc.

SWAP --

Development, Promotion and Training

- ✓ SWAP development and test was finished in March, 2013
- ✓ Current version(SWAP 1.0) works for FY-2, and will be upgraded for FY-4
- ✓ Domestic promotion and training activities have been organized
- ✓ The system has been installed for trial application in more than 30 provincial weather services in China

Way Forward

1. High accuracy of data calibration and navigation of FY-3/4 are crucial to applications, consistent efforts are needed to meet the requirements for operational use before and after launch.
2. In-depth research and demonstration efforts should be highly encouraged for the applications of new data in weather analysis , NWP, etc..
3. In order to ensure the accessibility of FengYun data , the CMACast will be expanded to enable the near real-time data dissemination , and a Web-based product service system will be developed and make products available to users
4. DB data users need to upgrade their utilization stations for new satellites
5. A number of domestic training activities are scheduled by CMA; It is suggested that some international workshops or training courses be organized under the umbrella of WMO space programme via regional training centers or Virtual Lab mechanism
6. CMA will keep its commitment to open data policy for Fengyun satellites, Engagement of regional and global users in the application of FY-3/4 data are welcome.

Thank you