



6th Asia/Oceania Meteorological Satellite Users' Conference

Updates on Chinese Meteorological Satellite Programs

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



Tokyo, Japan 10 November, 2015



CMA satellite programs by 2025

Current Satellite Programs

- FY-2E/F/G(operational, geo.)
- FY-3A/B(R&D, polar)
- FY-3C(operational, polar)

Future Satellite Programs

- FY-2H(operational, geo.)
- FY-3D/E/F/G/H (operational, polar)
- FY-3 Rainfall 1&2
- FY-4A(R&D, geo)
- FY-4B/C/D (operational, geo.)
- FY-4 Microwave

Others

- TANSAT(R&D, Atmosphere Composition)
- GF-4 (R&D, High Spatial Res. Imaging In GEO)



Outline

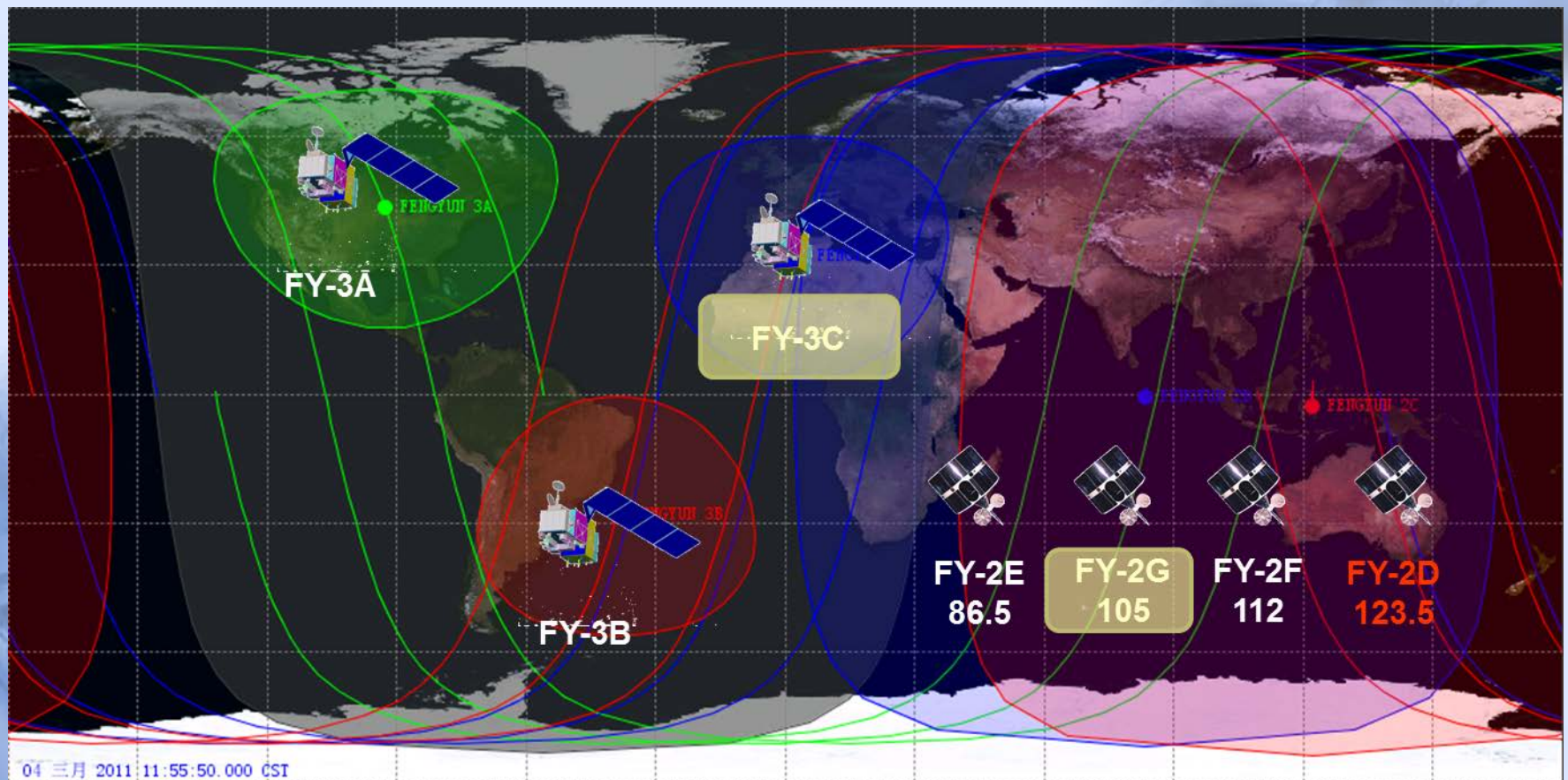
- **Current Satellite Status**
- **Latest Progress of Fengyun Satellite Series**
- **Future Satellite Program**
- **Summary**



Current Satellite Status

1、 Currently In-orbit FengYun Satellites(6/7)

(6 operational, 1 retired)



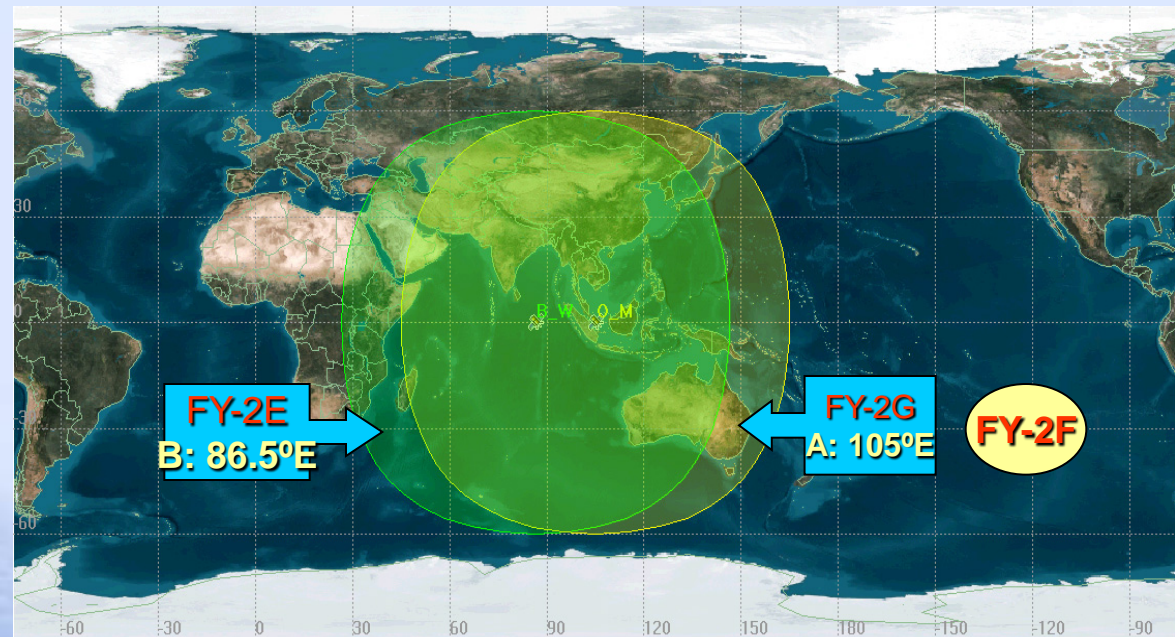
- The first operational satellite **FY-3C** began to provide service since the end of 2014.
- **FY-2G** has been in operation at 105E, **FY-2E** at 86.5E since June, 2015.

FY-2: Current GEO. Constellation

No.	Position	Status	Launch
FY-2E	86.5E	Operational	Dec.23, 2008
FY-2F	112E	Operational	Jan. 14, 2012
FY-2G	105E	Operational	Dec.31, 2014

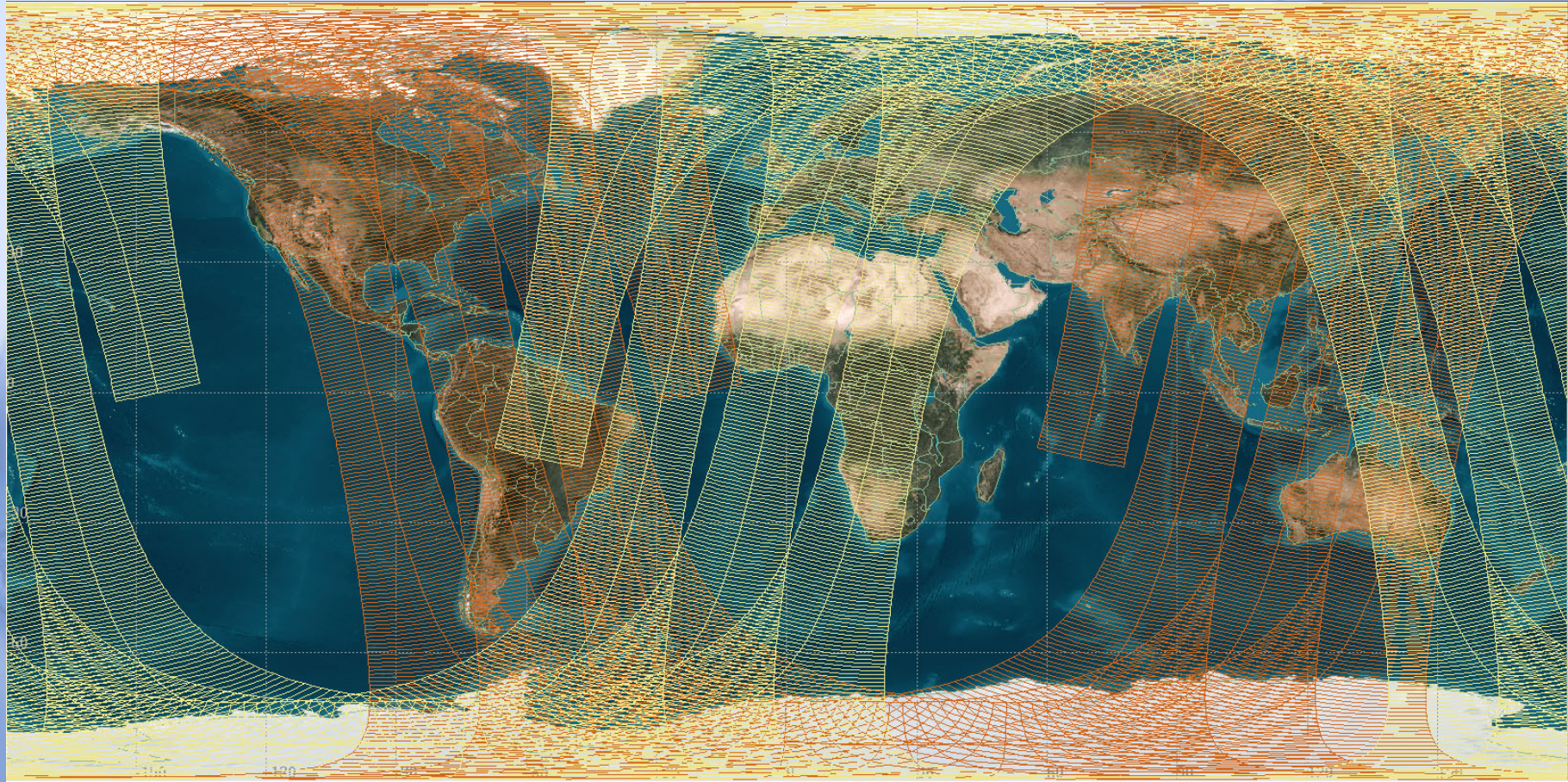
Platform: Spin stabilization
Payload: 5 chl. VISSR
Disc Obs: Every 30/60 min.

- ✓ FY-2G was positioned in primary position 105E Since June 1st, 2015, while FY-2E was moved to 86.5E to support IOC cooperated with EUMETSAT in July this year.
- ✓ FY-2E & FY-2G are working together to implement 15 min. interval obs., and backup each other
- ✓ FY-2F stands specially for 6 min. flexible rapid scan in case of needs



FY-3: Current LEO Constellation

- To be decommission: FY-3A
- In operation: FY-3B + FY-3C **global coverage 4 times per day**



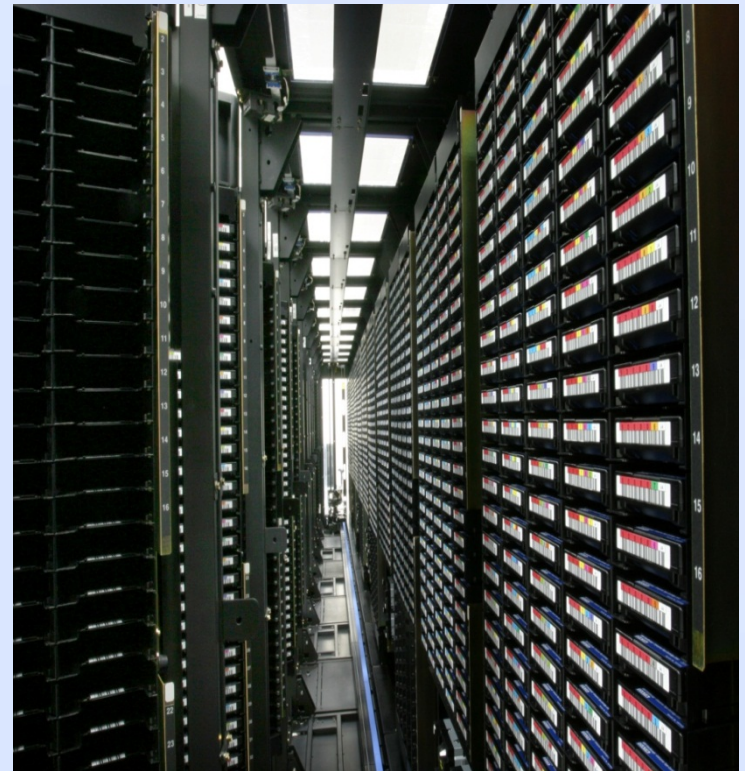
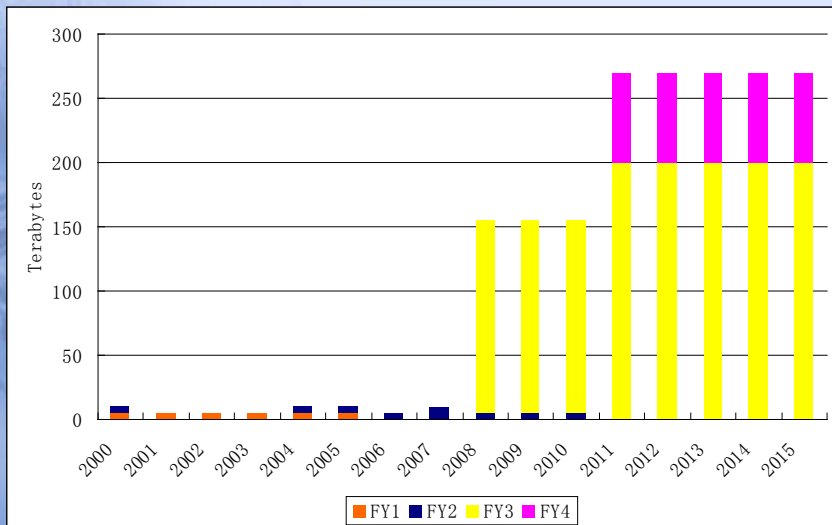
FY-3C LTC 10:30 AM



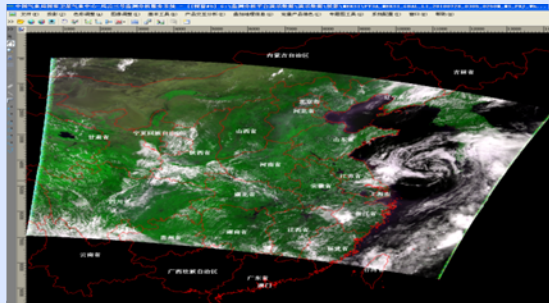
FY-3B LTC 13:40 PM

Data Delivery Services

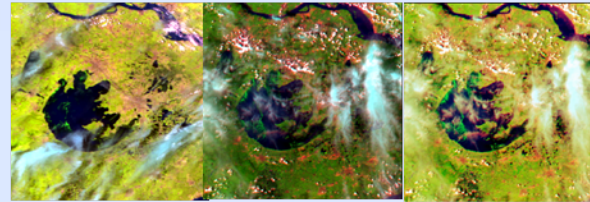
- 1) Web-based Service (**register user**)
- 2) FTP Push (**important user**)
- 3) FTP Pull (**register user**)
- 4) Manual Service (**emergency**)
- 5) FengyunCAST (**register user**)
- 6) DB Users (**register user**)



SMART: Satellite Monitoring Analysis Remote-sensing Toolkit

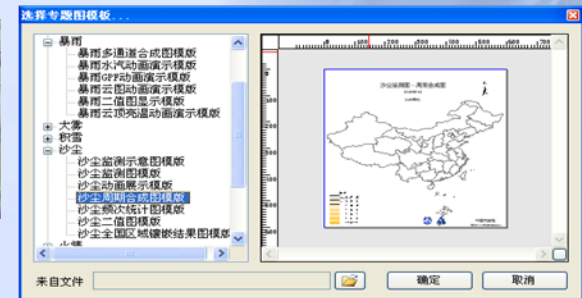


- Reading and displaying Satellite data
- Reading and displaying GIS data
- Customizable color palette for data displaying



Source image Objective image Matched image

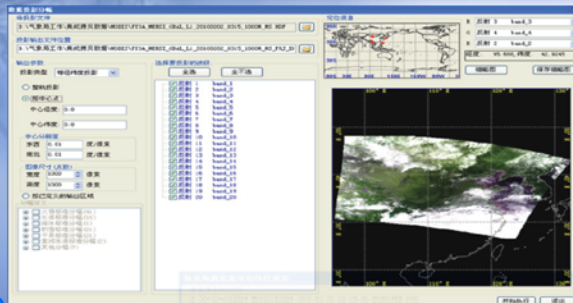
- Multiple functions of color adjustment
- Multiple image adjustment functions
- Multiple auxiliary tools including magnetic lasso etc.



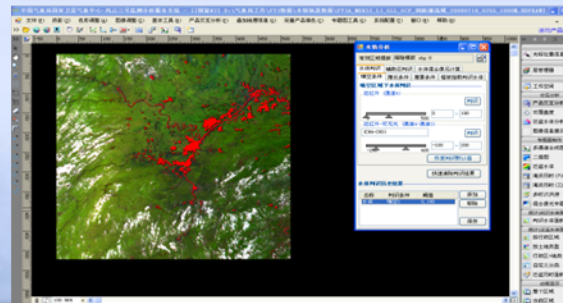
- Customization of thematic map templates
- Label for thematic map



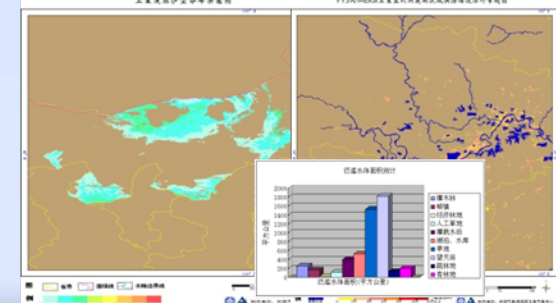
- map projections in multiple windows
- Image geometrical correction
- Image split or and mosaic



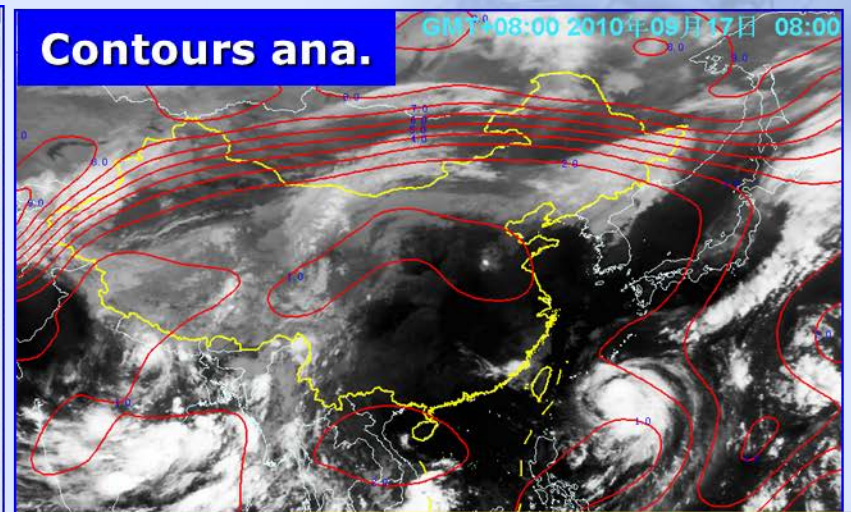
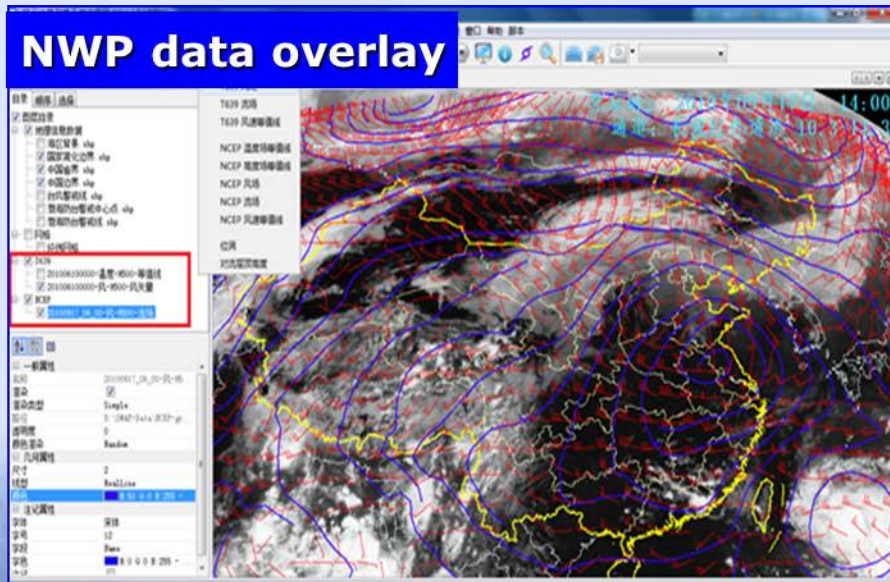
- Analyzing and processing of environmental change monitoring
- Temporal analysis function of monitoring products



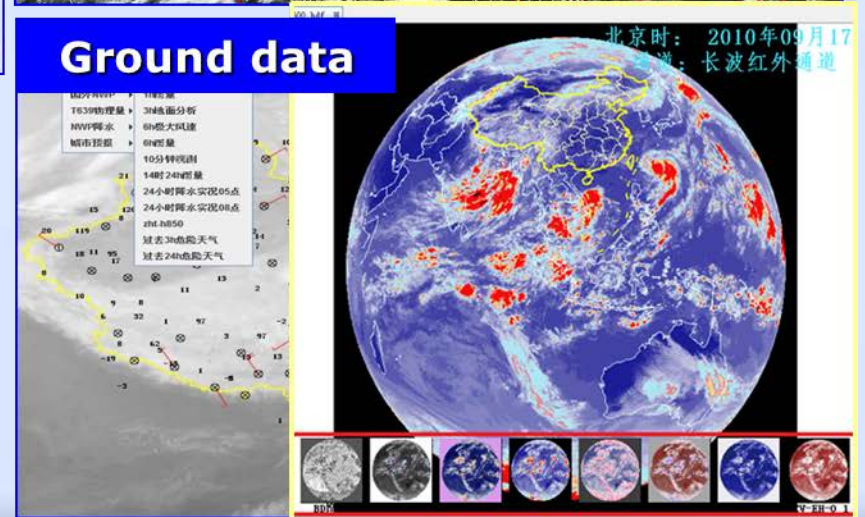
- Thematic products
- Statistic table
- Operational reports, etc.



SWAP: Satellite Weather App. Platform



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



China and Oversea User Utilizations

- **25** CMACast data receivers in Asia and Oceania Region;
- **More than 100** users attended SWAP international training;
- SWAP & SMART have been installed for application in **more than 30** provincial weather services in China;
- **5** countries has successfully installed SWAP for trial using in operation: Nepal, Malaysia, Thailand, Bengal, Pakistan.



● data receivers ● SWAP users ★ Training courses



The background of the slide is a light blue gradient with a faint, semi-transparent image of a satellite structure. The satellite is shown from a perspective that highlights its rectangular body and various protruding components, including what appears to be a solar panel array or antenna structure. The image is centered and occupies most of the slide's area.

Latest Progress of Fengyun Satellite Series

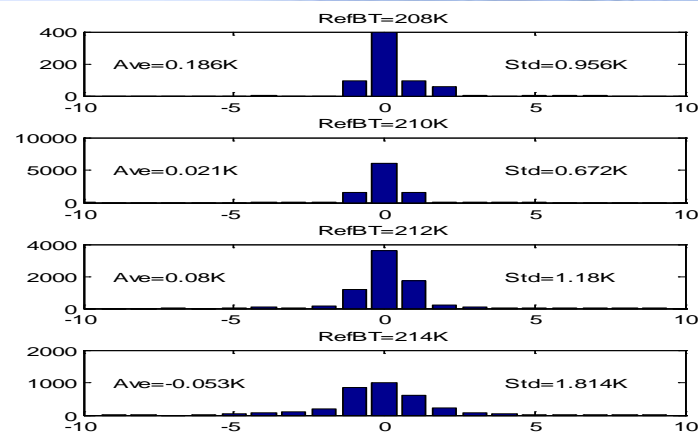
2、FY-2G : Significant Improvements

On-orbit IR CAL Performance

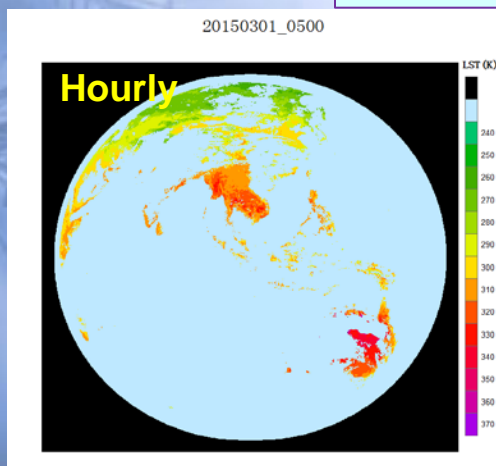
CAL Assessment: develop 3 ways, e.g. radiation, product & application

CAL Accuracy: < 0.7K@300K for main IR bands

CAL Performance: comparable with GOES-N required specification ($\leq 1K$)



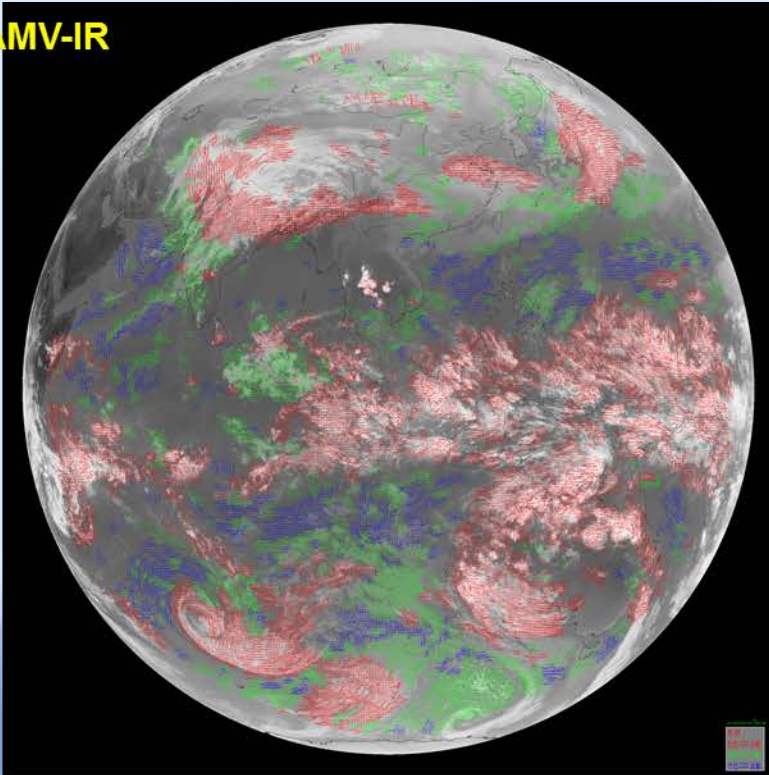
Product Validation: LST



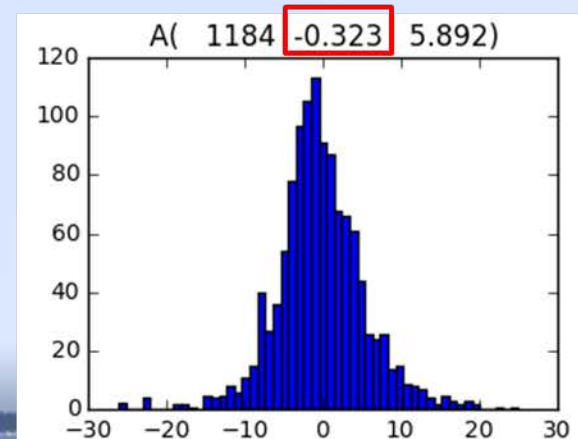
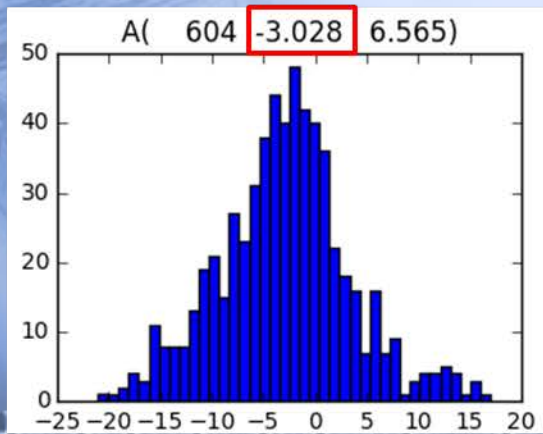
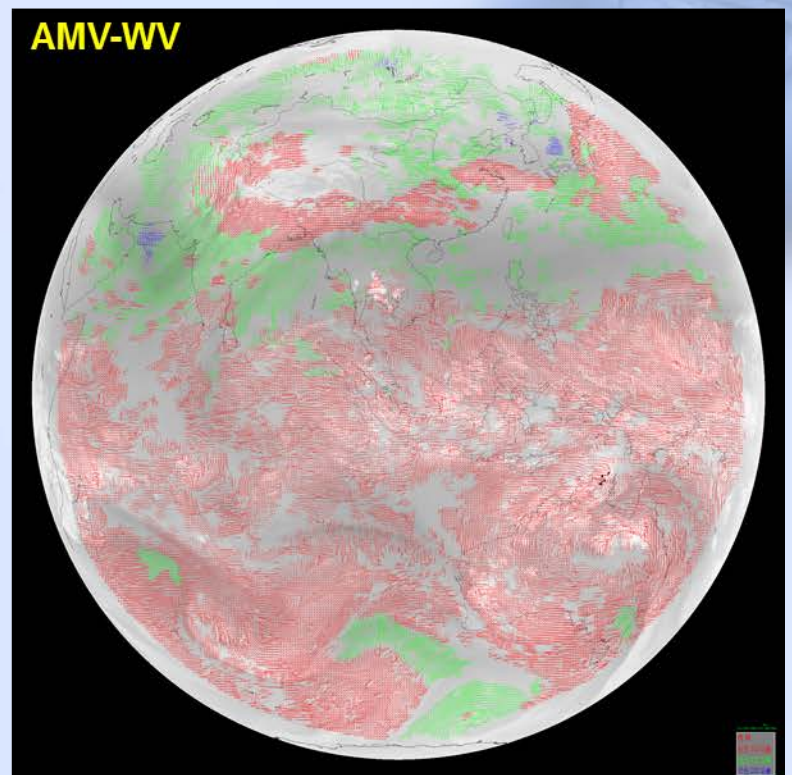
		MODIS LST		
		Ave. Bias(K)	RMSE(K)	Correlation
FY2G	LST	1.4319	3.1754	0.9809

Main Product Validation: AMV

AMV-IR



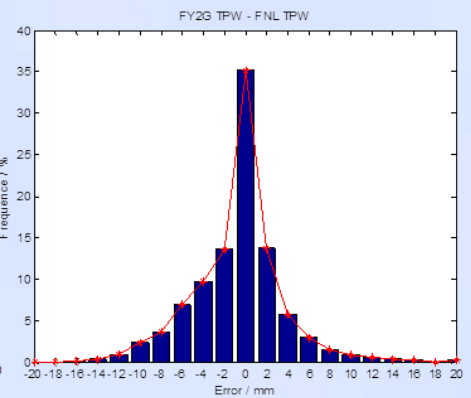
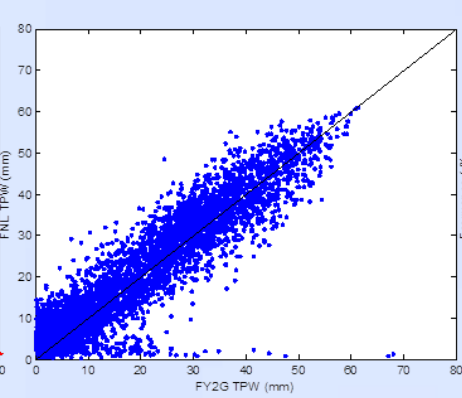
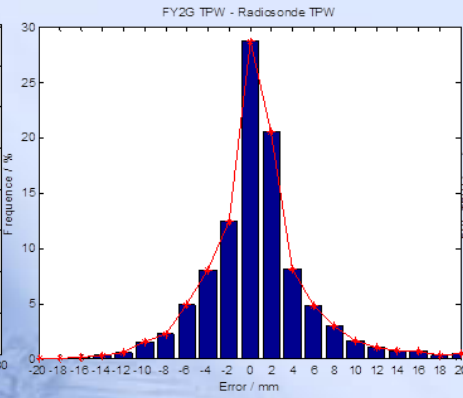
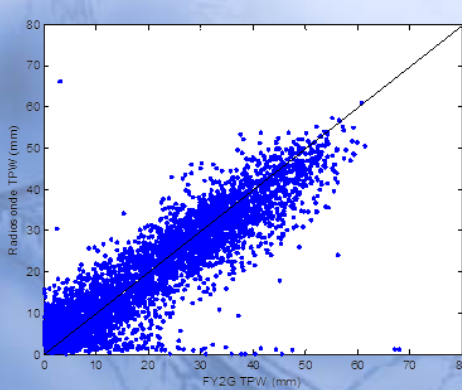
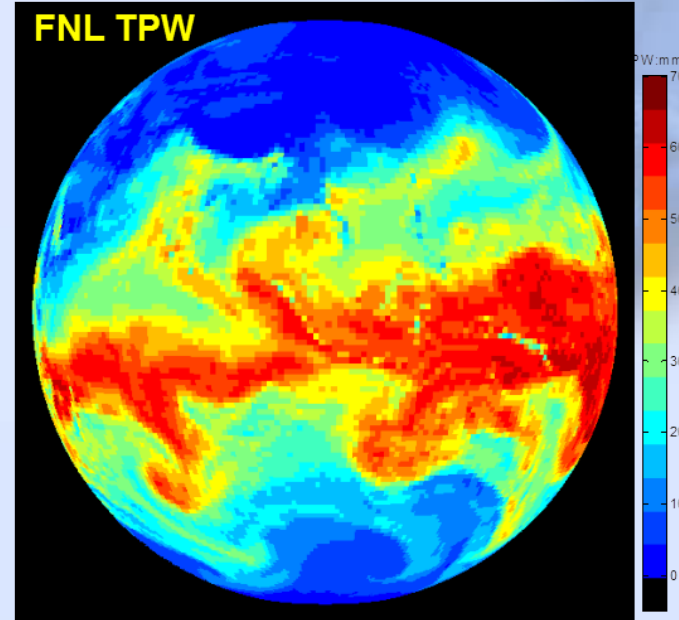
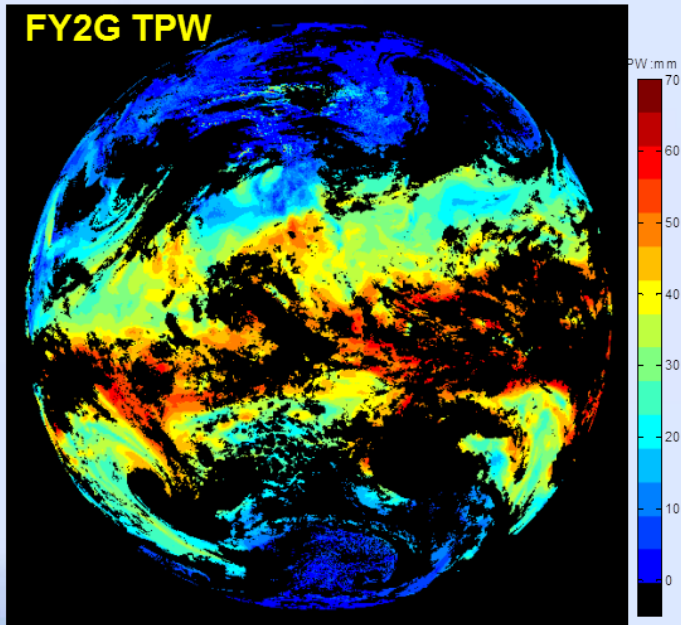
AMV-WV



Main Product Validation: TPW

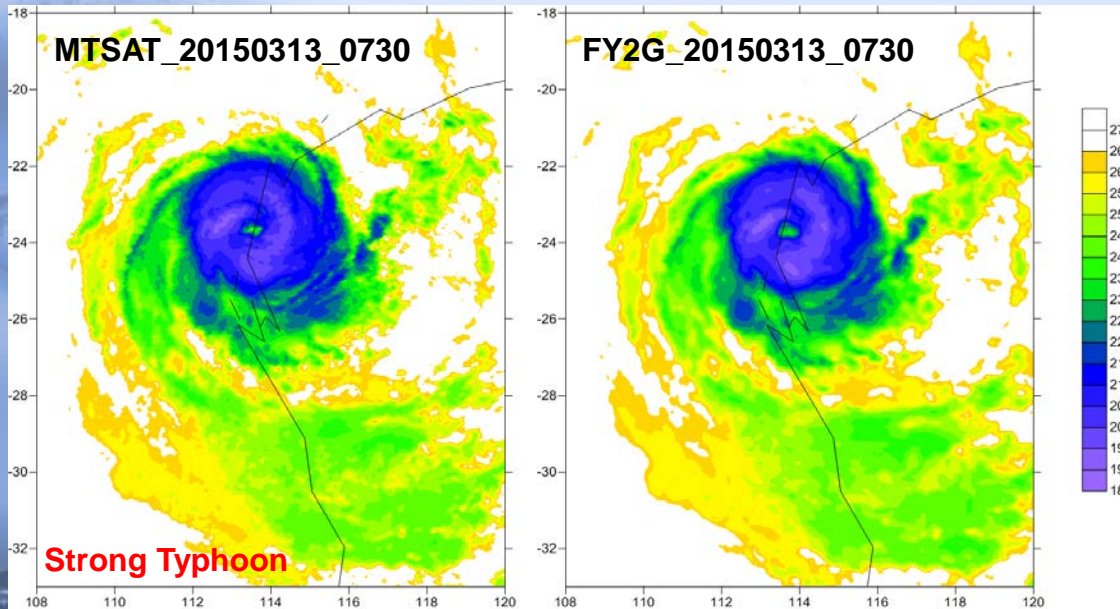
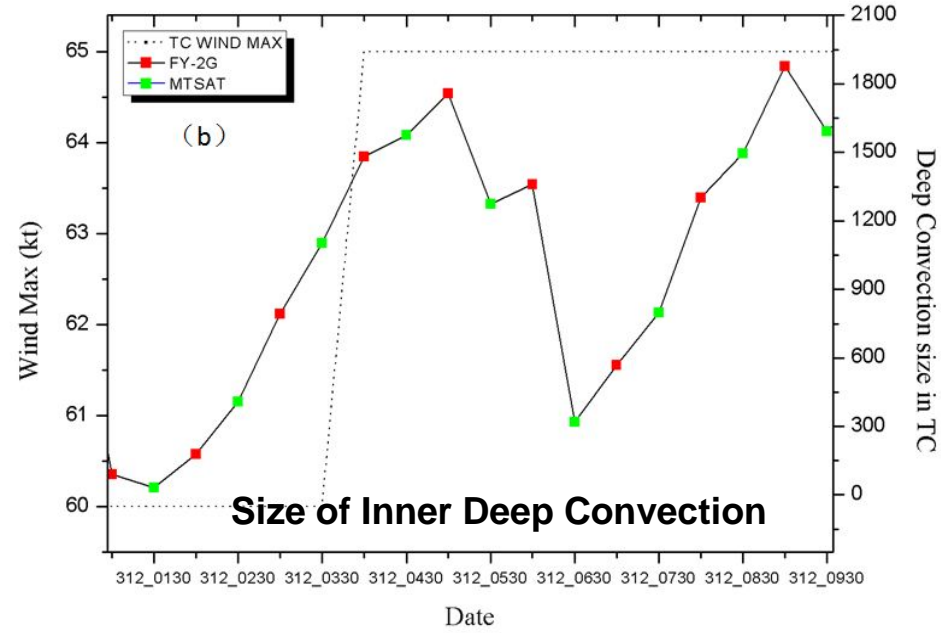
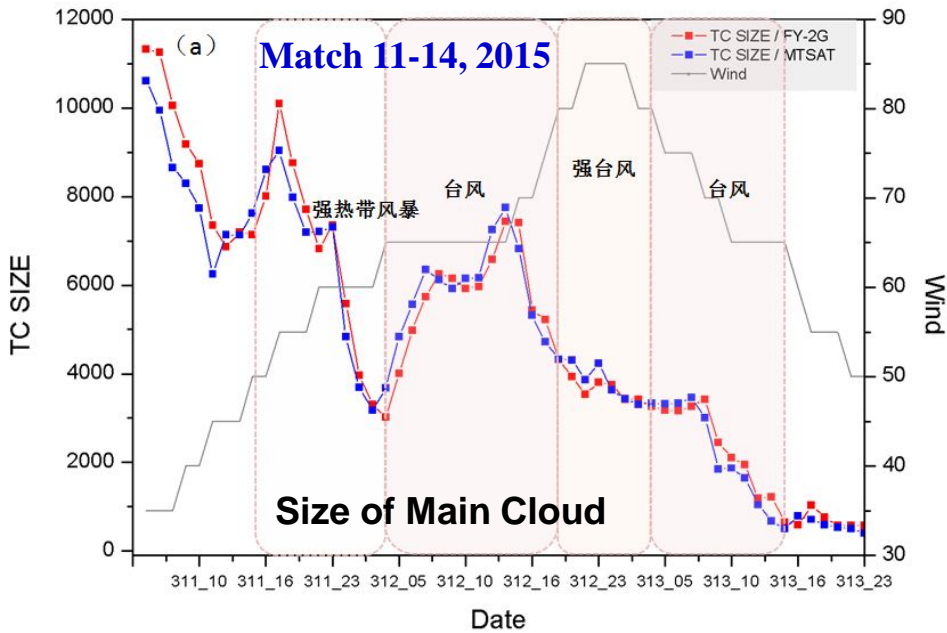
20150301-0000

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	Sounding		
	Mean Bias(mm)	RMSE(mm)	Correlation
FY2G TPW	0.6170	5.2353	0.9312

Typical Application: Typhoon Monitor (Olwyn)



Important Results:

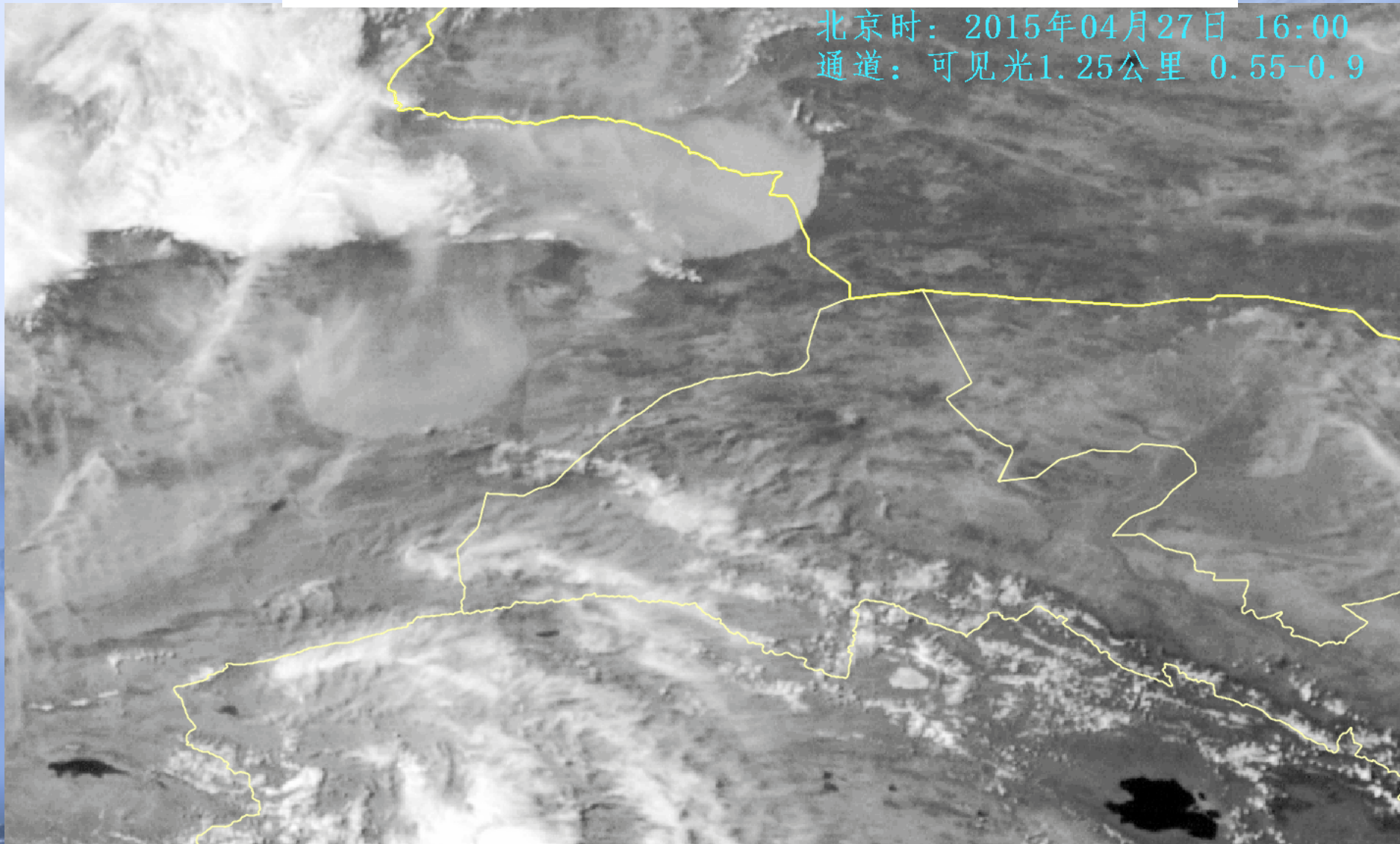
■ The radiometric performance of FY-2G and MTSAT-2 is **comparable** and could be used **interchangeably**

■ The averaged BT difference between FY-2G and MTSAT-2 is less than **1K@200K**

Temporal Resolution: FY-2F->2G RRS, 6->3 minutes

FY-2G Dust Storm (April 27 16:00-18:00)

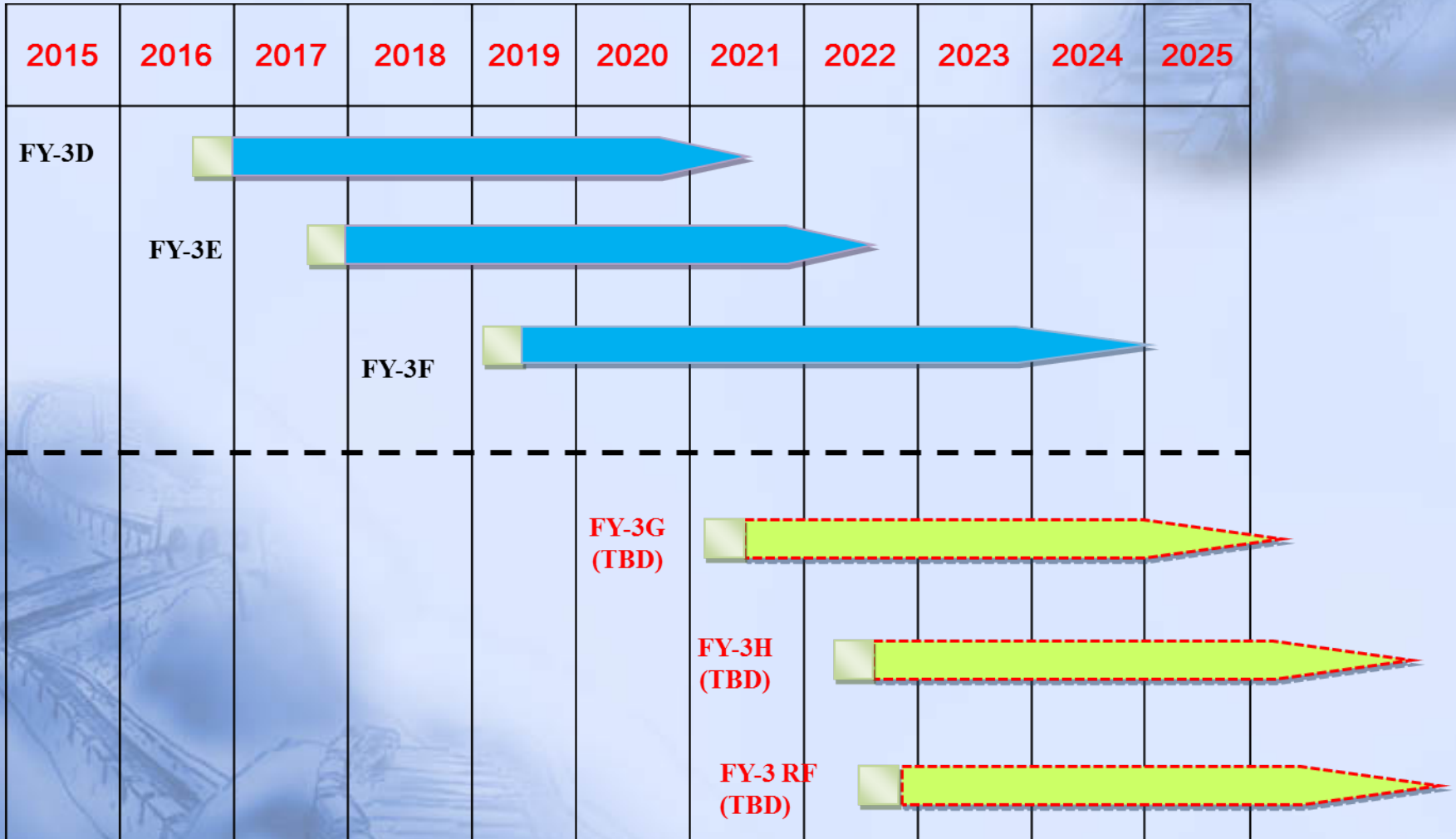
北京时：2015年04月27日 16:00
通道：可见光1.25公里 0.55-0.9





Future Satellite Program

3、FengYun LEO Satellites Launch Plan by 2025



FY-3: New Generation of CMA LEO. Constellation



No.	Orbit	Status	Launch
FY-3A	AM	R&D, working	May 27, 2008
FY-3B	PM	R&D, working	Nov.5, 2010
FY-3C	AM	Op., working	Sep. 23, 2013
FY-3D	PM	Op. planed	2016
FY-3E	EM	Op, planed	2017
FY-3F	PM	op., planed	2019
FY-3 RF1/2	Inclined	R&D, Planed	2019-2025,TBD
FY-3G	TBD	Op., planed	2021-2025,TBD
FY-3H	EM	Op., planed	2021-2025,TBD

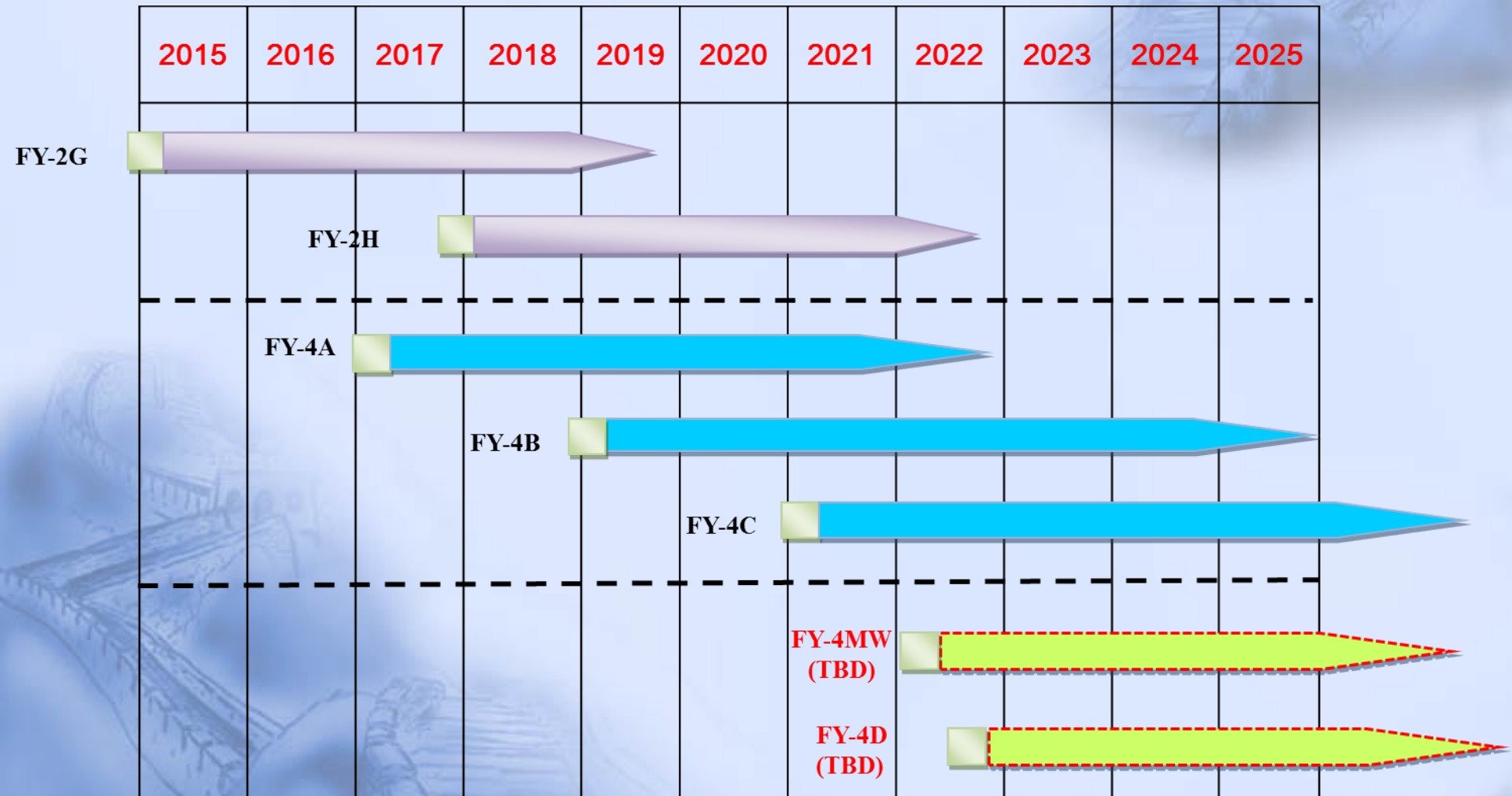
Significant Change: To support global NWP, within the coordination framework of CGMS, CMA made a commitment to develop an early morning orbit mission, FY-3E is now changed as a early morning orbit satellite rather than previous morning orbit one. It will be possible to constitute a three orbital fleet including **Metop** (Mid. Morning) + **NPP** (Afternoon) + **FY-3** (Early Morning) to get even distribution of sounding data.

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 irradiation 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	√			

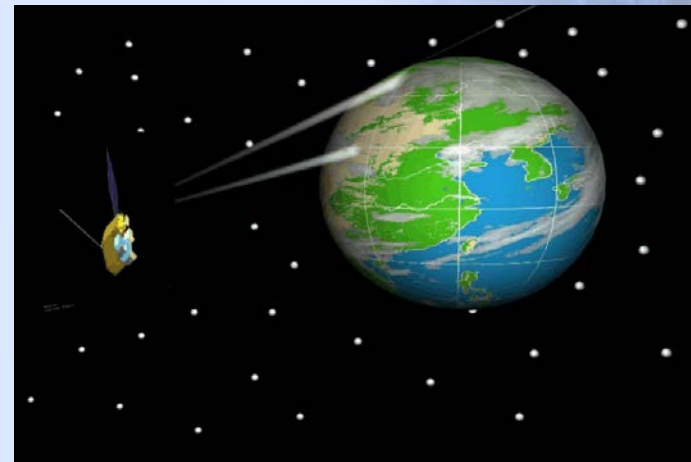
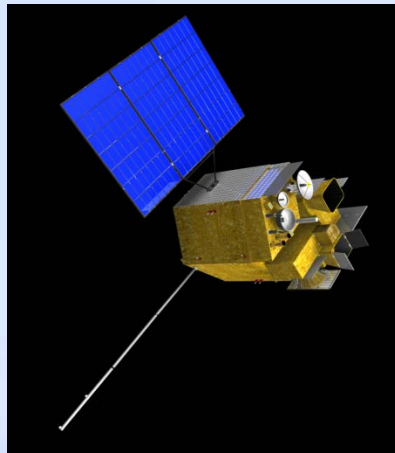
- Improved Medium Resolution Spectrum Imager in FY-3D, E, F
- Greenhouse Gases Absorption Spectrometer, and Hyper-Spectral Infrared Sounder in FY-3D,F
- Sea Surface Wind Radar in FY-3E

FengYun GEO Satellites Launch Plan by 2025



FY-4: New generation of FengYun GEO.

together with GOES-R, MTG, Himawari-8. Launch is scheduled in the end of 2016



AGRI	GIIRS	LMI
Advanced Geo. Radiation Imager	Geo. Interferometric Infrared Sounder	Lighting Mapping Imager
14 Channels within 0.55~13.8 μ m	538 LWIR Channels 375 S/MIR Channels	Central Frequency: 777.4nm
500mx1; 1Kmx2 2Kmx4; 4Kmx7	16Km	7.8Km
Full Disk < =15min	Meso-scale: 35min(1000x1000km) China area: 67min(5000x5000km)	2ms



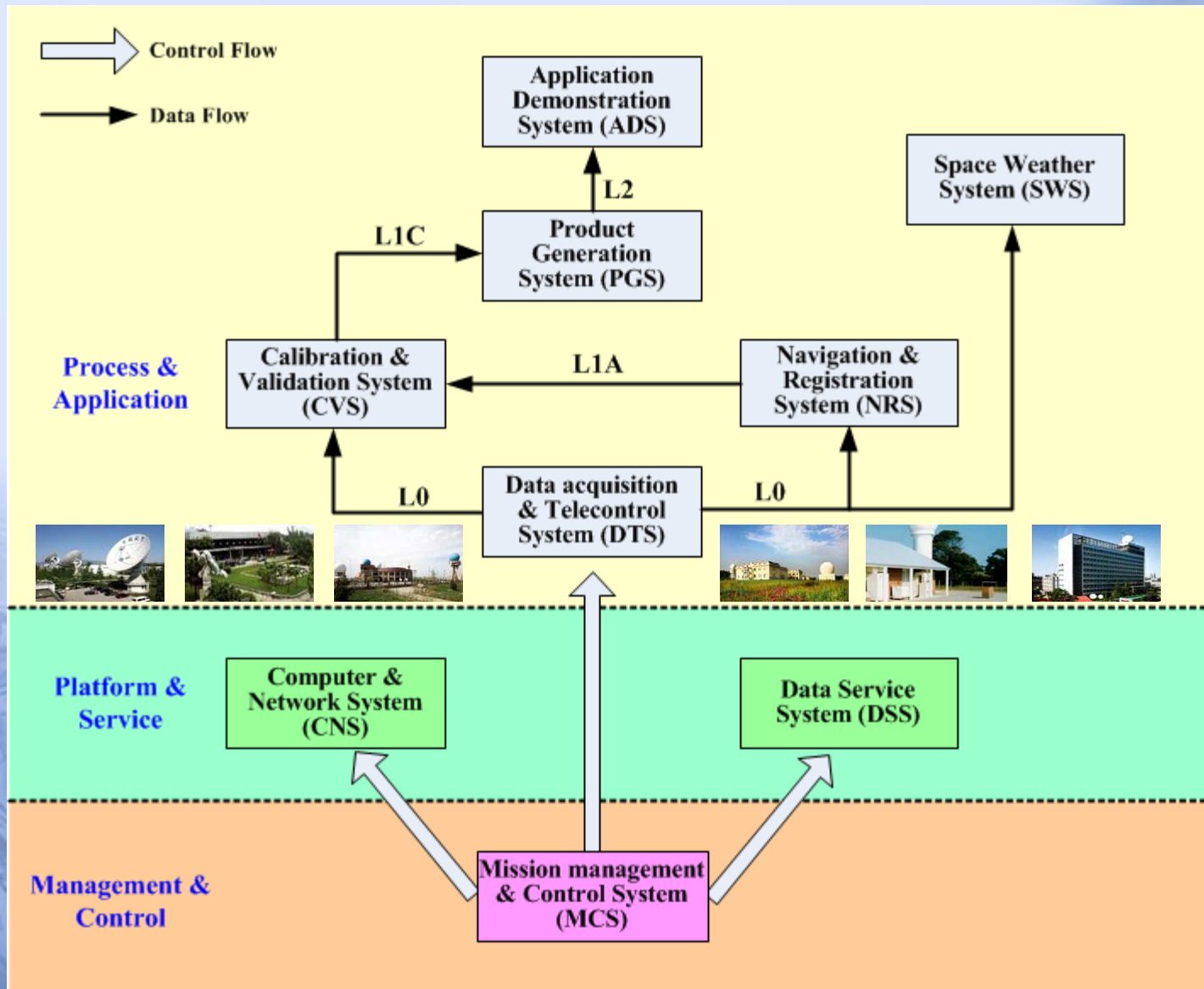
2nd ISCC Meeting was held during Oct. 14-17, 2015 in Beijing, China; to optimize the constellation of FY-4 series satellites and payloads.

Preliminary proposal of configuration about follow-up satellites

Instruments	FY-4B	FY-4C	FY-4D	FY-4MW
Imager	AGRI+✓	AGRI++✓	AGRI++✓	
Sounder	GIIRS+✓	GIIRS++✓	GIIRS++✓	
Lightning Imager		LMI+✓	LMI+✓	
UVN (Geostationay UV-VIS Air Quality Monitor)				✓
Geo.High-speed Imager (GHI)	✓			
Microwave Sounder				✓

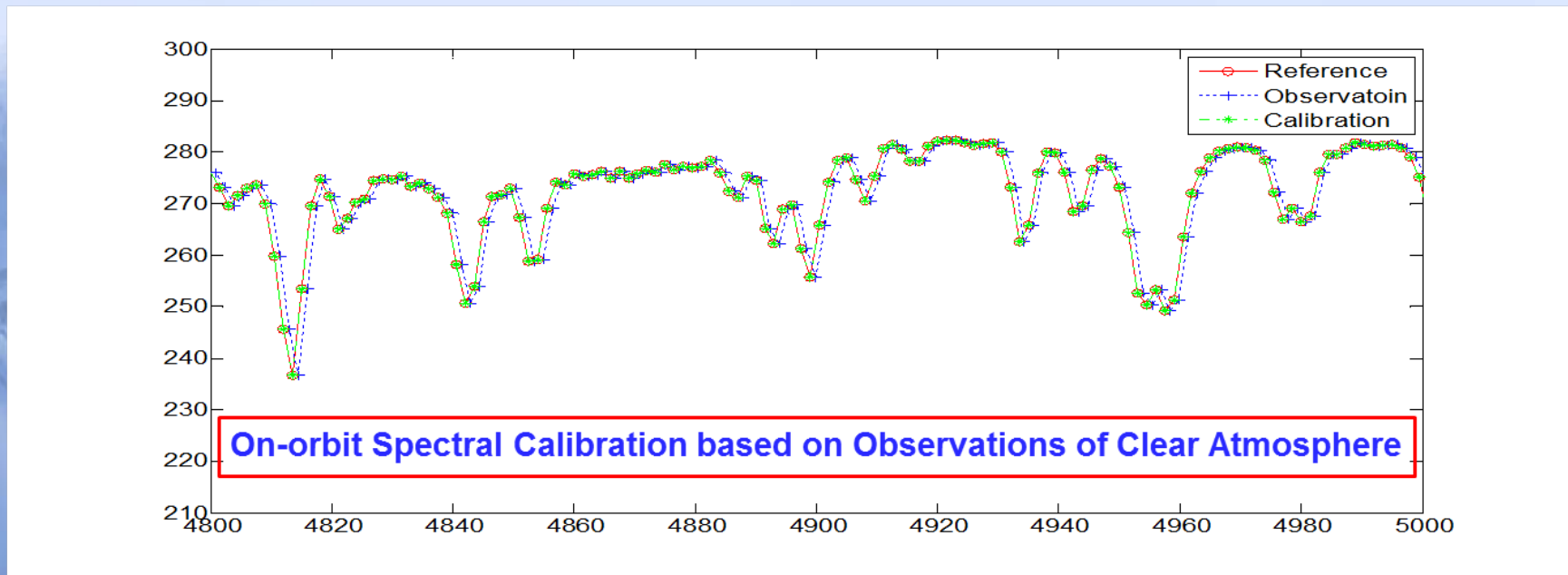
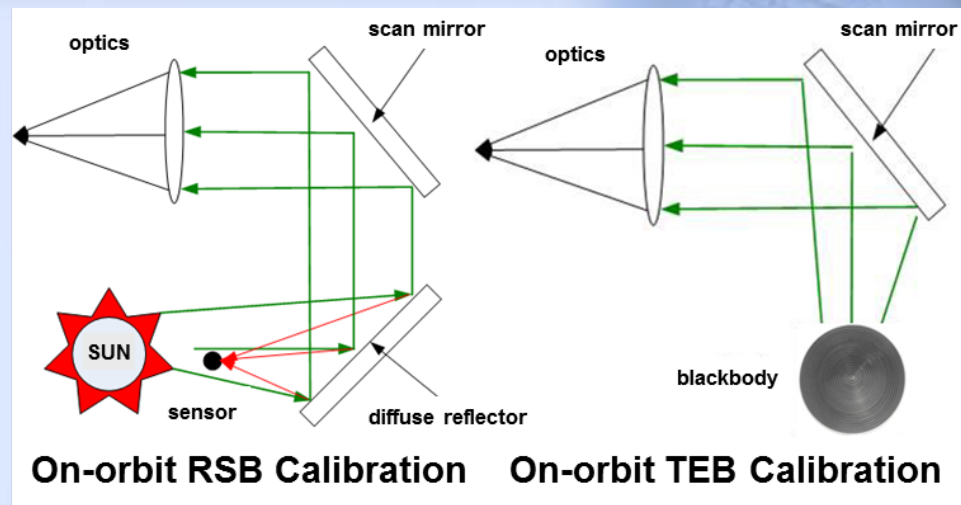
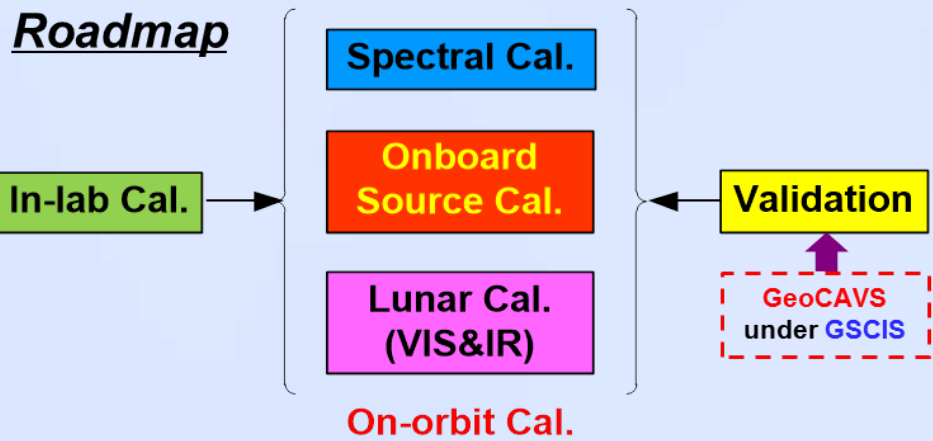
Geo.High-speed Imager (GHI) : 2000×2000km per min.

New FY-4A Ground Segment: Elements & Layout

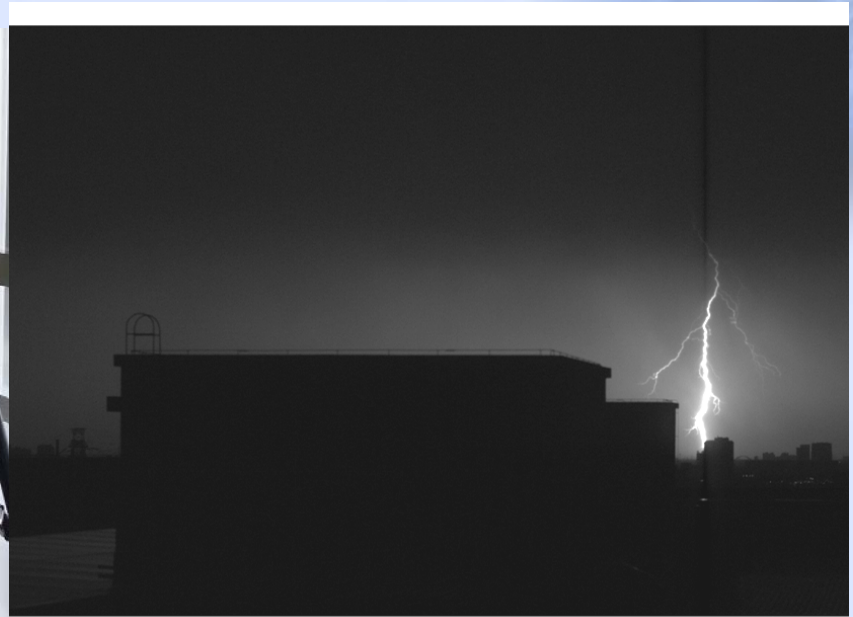
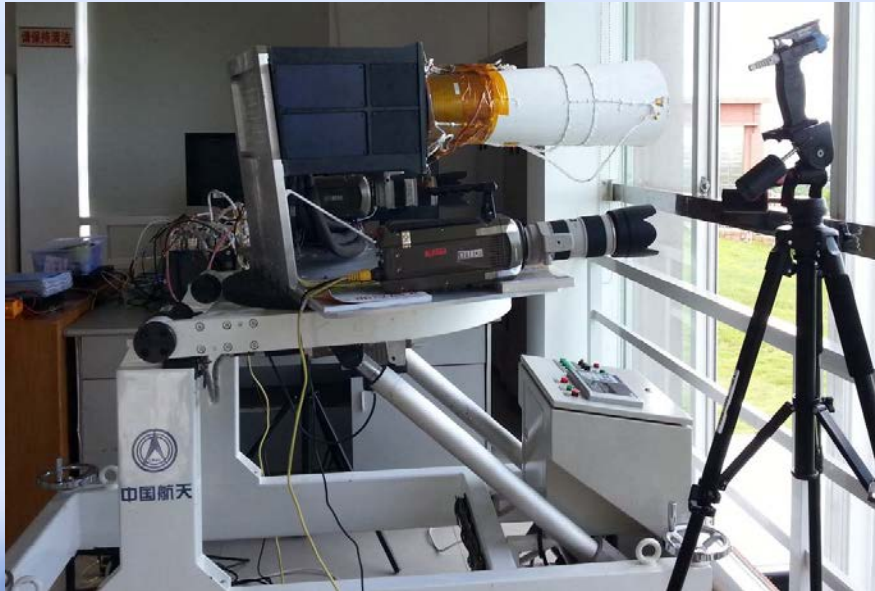


Radiometric & Spectral Calibration

Roadmap



Lightning observation with LMI on the ground



- The field of view of LMI was expanded before observation experiment
- The natural Lightning was “captured” during the day and light
- Validation :
 - Processing algorithm on board
 - Algorithm of Lightning products by the ground segment

Products Development

Baseline Products of imager(AGRI) & LMI

No .	Products	No.	Products
1	Cloud Mask	13	Downward Shortwave Radiation: Surface
2	Cloud Type	14	Derived Motion Winds
3	Cloud Top Temperature	15	Lightning Detection
4	Cloud Top Pressure	16	Rainfall Rate/QPE
5	Cloud Optical Depth	17	Convective Initiation
6	Cloud Liquid Water	18	Tropopause Folding Turbulence Prediction
7	Cloud Particle Size Distribution	19	Sea Surface Temperature (skin)
8	Aerosol Detection	20	Fire/Hot Spot Characterization
9	Aerosol Optical Depth	21	Land Surface (Skin) Temperature
10	Downward Longwave Radiation: Surface	22	Land Surface Emissivity
11	Upward Longwave Radiation: TOA	23	Snow Cover
12	Upward Longwave Radiation: Surface		

Baseline Products of sounder(GIIRS)

No .	Products
24	Atmospheric Temperature, Humidity and Ozone Profiles (Clear)
25	Atmospheric Temperature and Humidity Profiles (Cloudy)

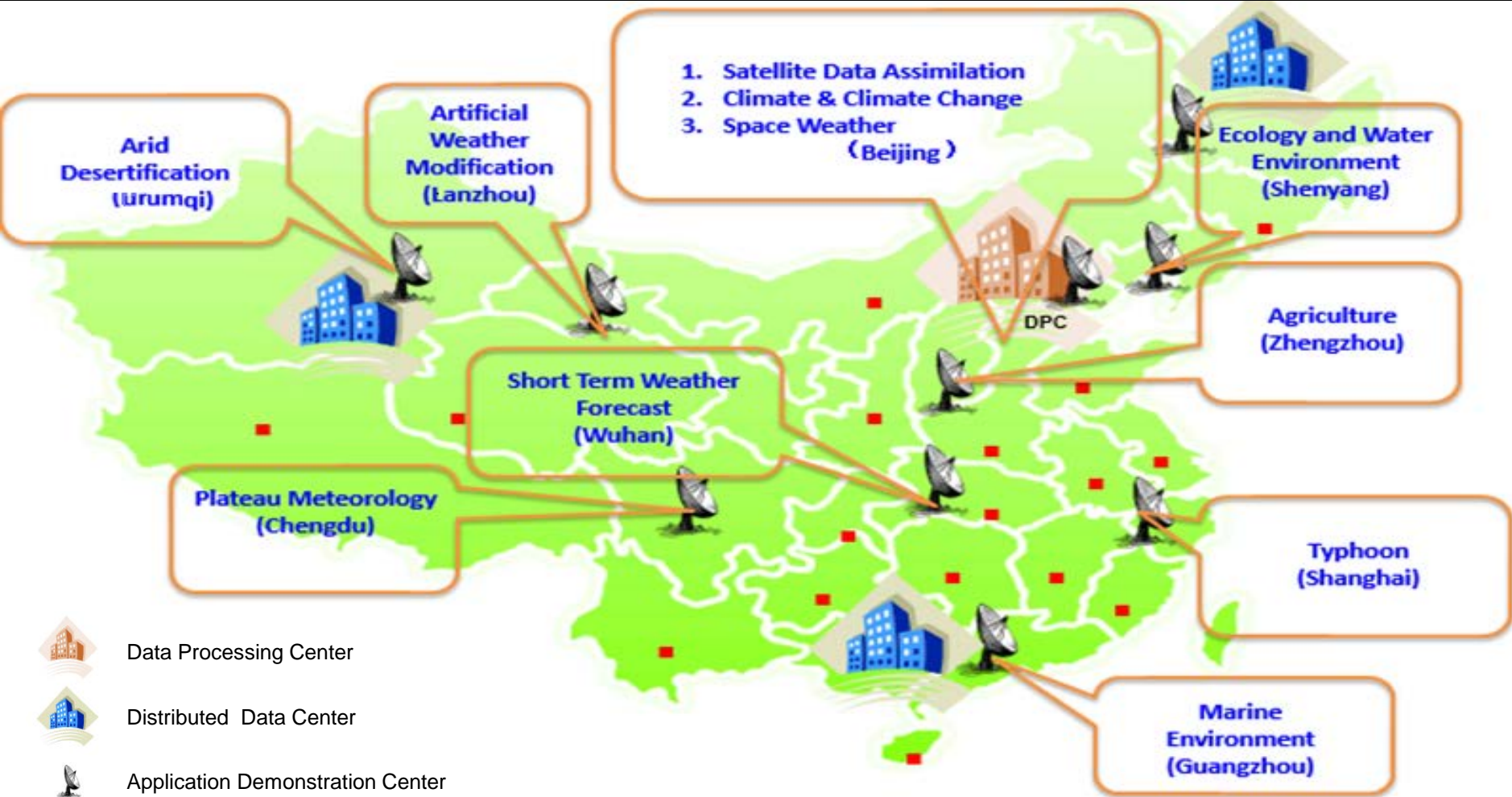
Baseline Products of SEP

No .	Products
26	Distribution of High Energy Particle
27	Intensity of Magnetic Field
28	Effects of Spatial Environment

Data access supports for end users

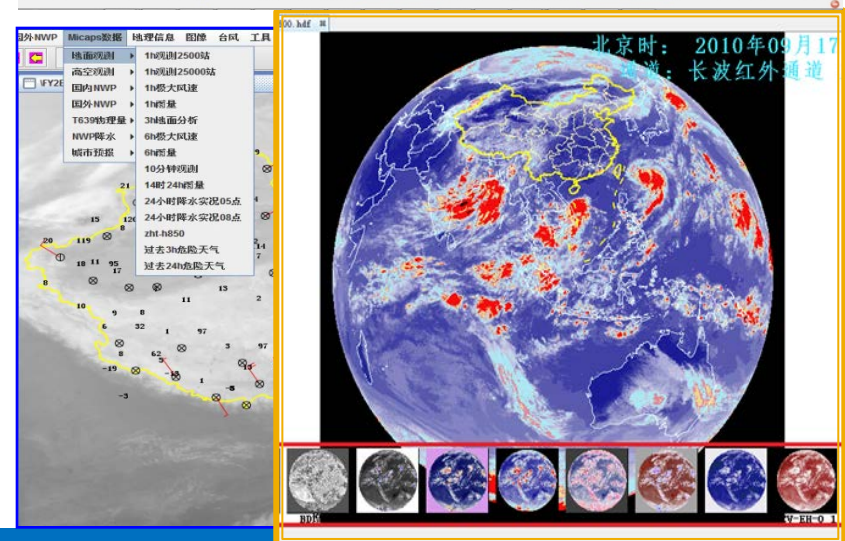
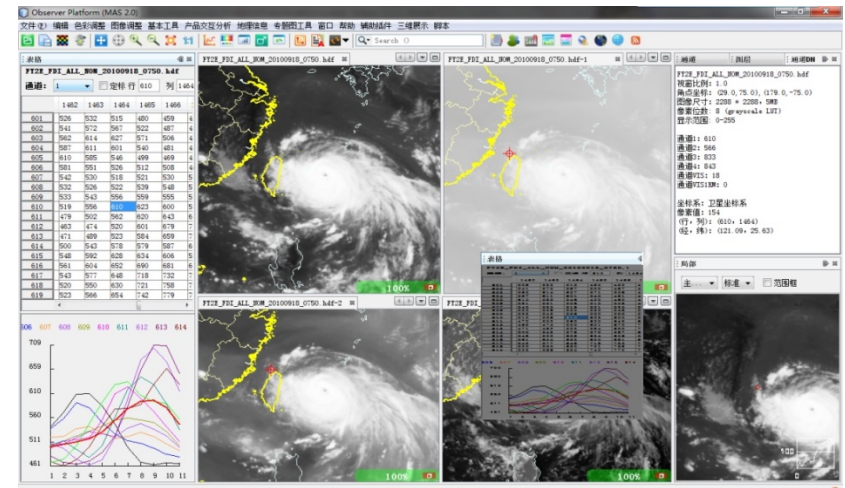
1. **HRPT** : 34 stations at provincial level receiving FY-3 HRPT data in real time
2. **HRIT** : 34 stations at provincial level receiving FY-4 DB data in real time
3. **CMACast** : 2600 user terminals at prefectural level receiving FY-3&FY-4 data and products
4. **EWAIB** : 2400 user terminals at county-level receiving emergency weather information from FY-4
5. **Web-based & Cloud-based Services**

Satellite application facilities in China



User readiness for new generation satellites

- ADS: More than 50 FY-3&FY-4 application projects were open to encourage user community involvement
- SWAP & SMART : user platforms developed as analysis tools for use of FY-3&FY-4 data and products
- The two systems have been promoted to nation-wide local weather services.
- A number of training activities were organized by CMA

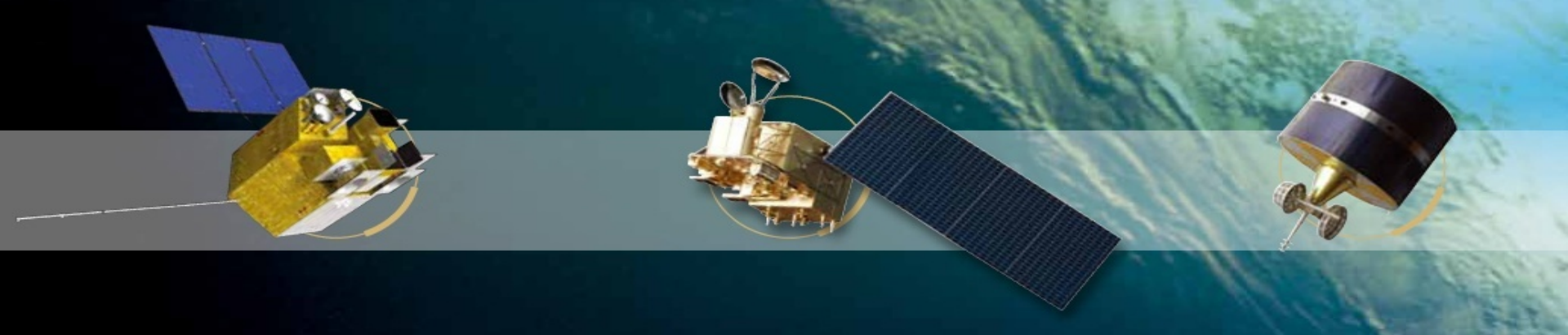




Summary

4、 Summary

- FY-2G has been in operation at 105E since June, 2015 with **significant** improvement in both **calibration** and **application**.
- The first operational satellite of FY-3 series (**FY-3C**) began to provide service since the end of 2014.
- The future plans of FY-3 & FY-4 series have been **officially** established to be of benefit to the community in the near **10** years.
- The first experimental satellite of FY-4 series (**FY-4A**) has made great progress in both space and ground segments and will be **readiness** at the end of 2016 for launch.
-



Thank you for your attention!

