Current and future meteorological satellites of the China Meteorological Administration

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(CMA/NSMC/OSD)

Topics

1)Overview of CMA satellite plan

2)Updates of CMA satellite system

3)The future CMA satellite program

4) The products and applications under development

Overview
- Planning of CMA satellite systems by year 2020

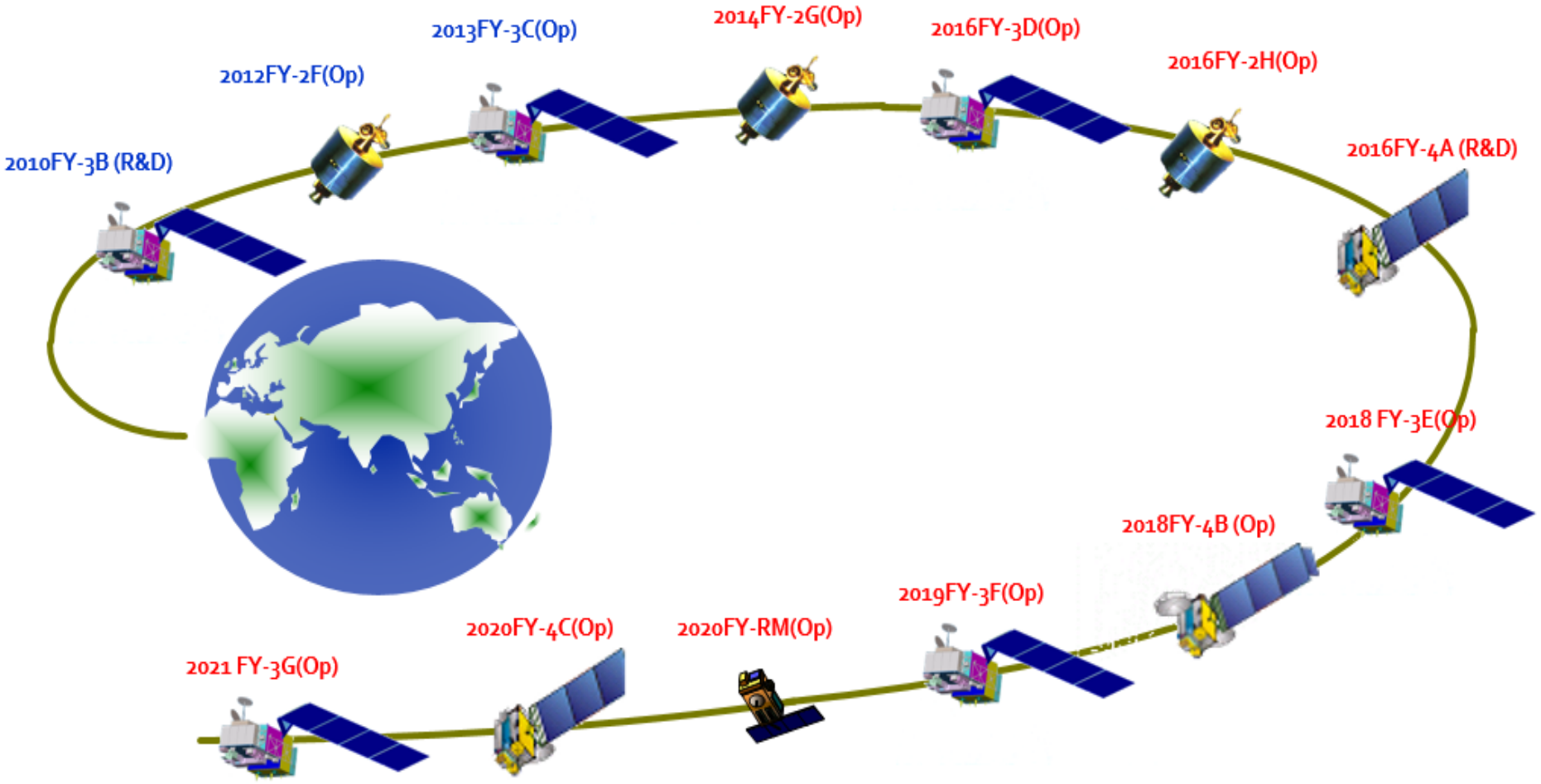
The Chinese government have approve a much more extensive program called **NSI**, which will cover atmosphere, land, and ocean satellites beyond 2020.

Atmosphere

- Weather Monitoring Satellite: FY-4 follow-on until 2025
- Climate Monitoring Satellite: FY-3 follow-on until 2025
- Air Quality Monitoring Satellite: New Series for atmospheric chemistry

NSI: National Space Infrastructure

Overview
- Planning of CMA satellite systems by year 2020



Mission objectives of CMA FengYun Geo.

1、 Support nowcasting and severe weather warning

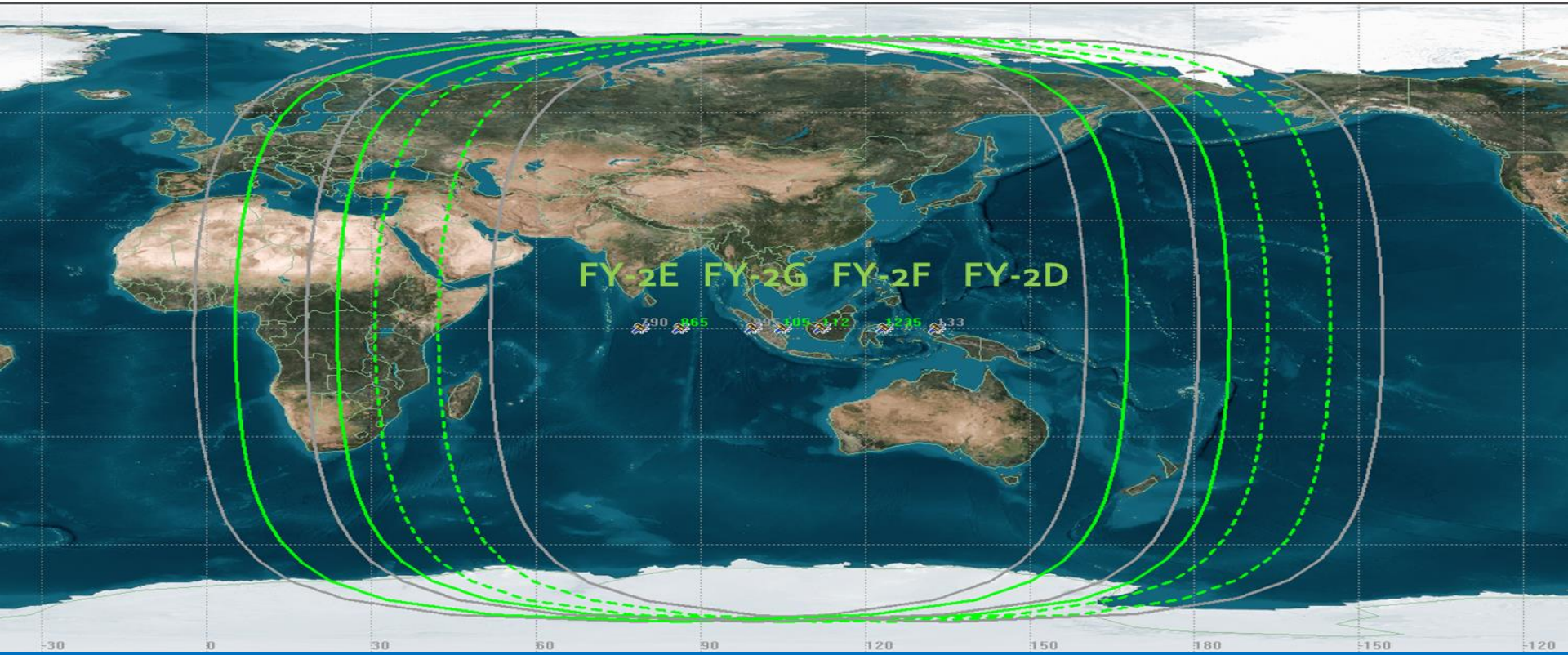
2、 Support NWP, regional and global

3、 Support climate applications

4、 Support environment and disaster monitoring

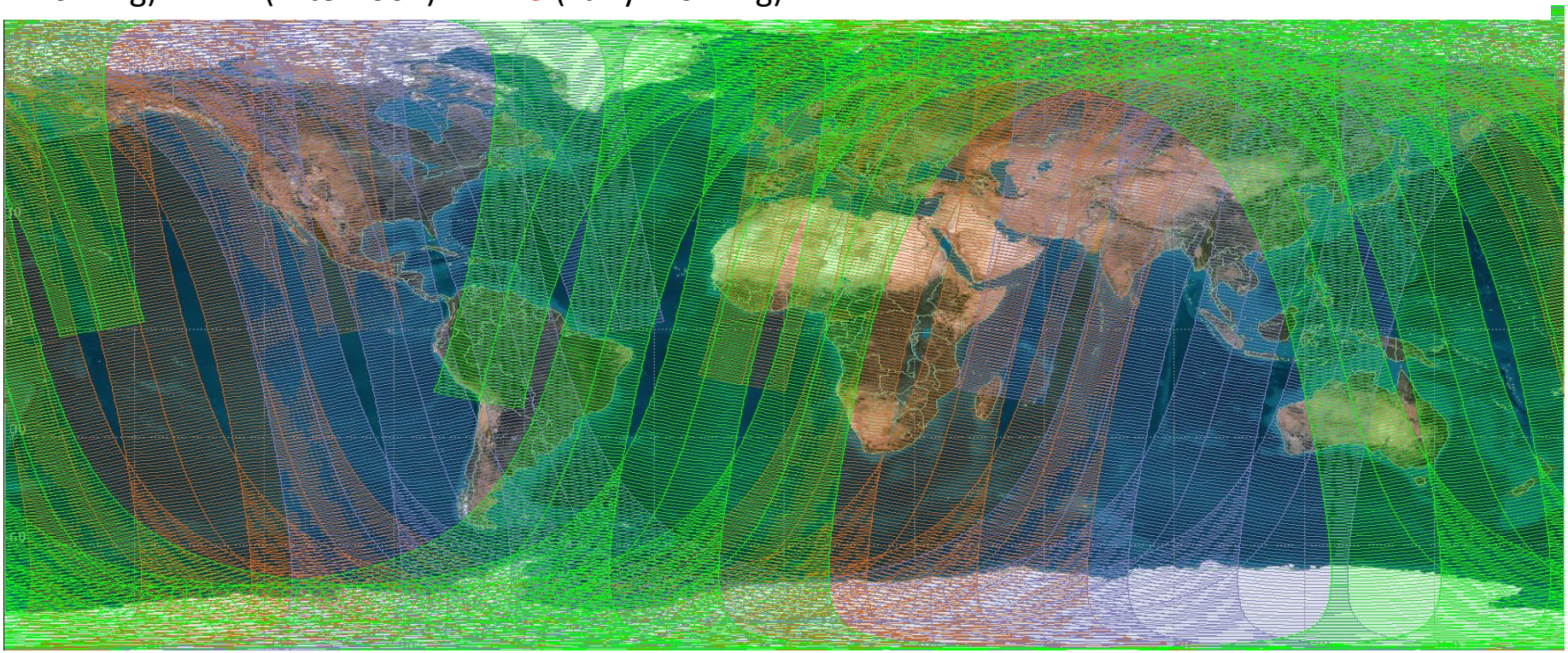
CMA Geo. Satellite constellation

1)Primary observation location: 86.5E&105.0E
2)Hot Backup and Flexible observation: 99.5E&112.0E
3)Post Launch test & On orbit storage: 79.0E,123.5E,133.0E



Mission objectives of CMA FengYun Leo.
---------- FY-3 Early Morning mission

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

Mission objectives of CMA FengYun Leo. ---------- 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

Topics

1)Overview of CMA satellite plan

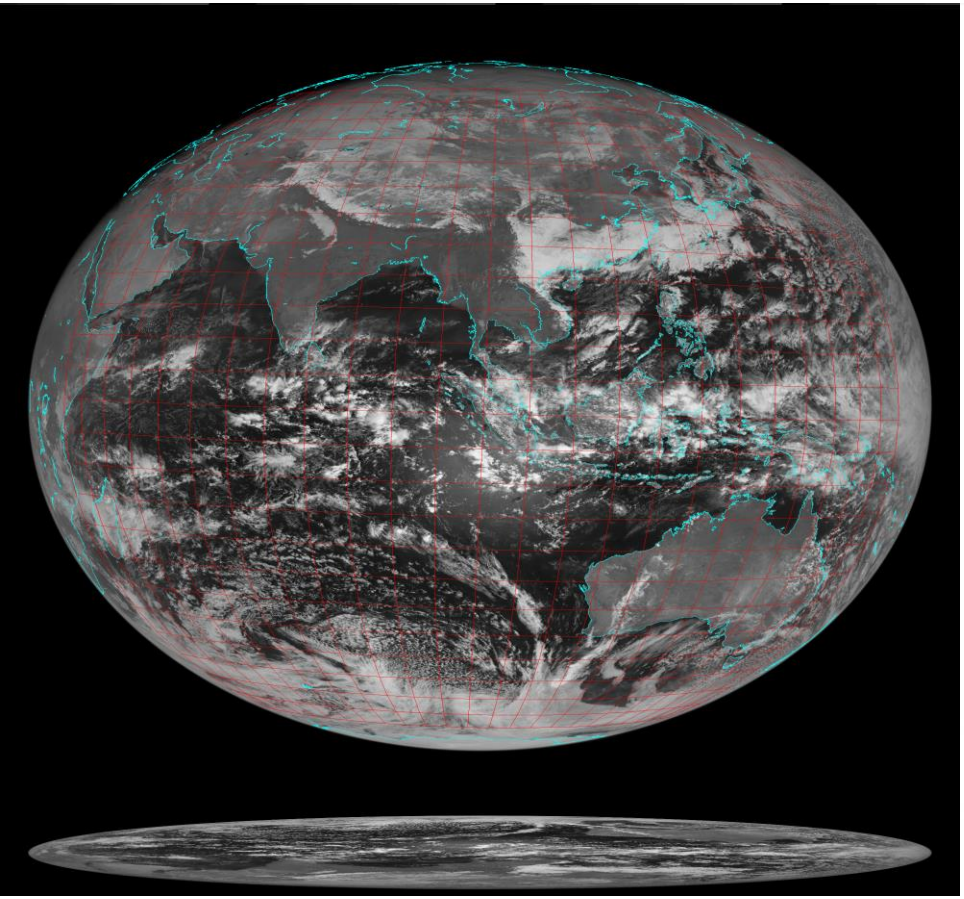
2)Updates of CMA Meteorological satellite system

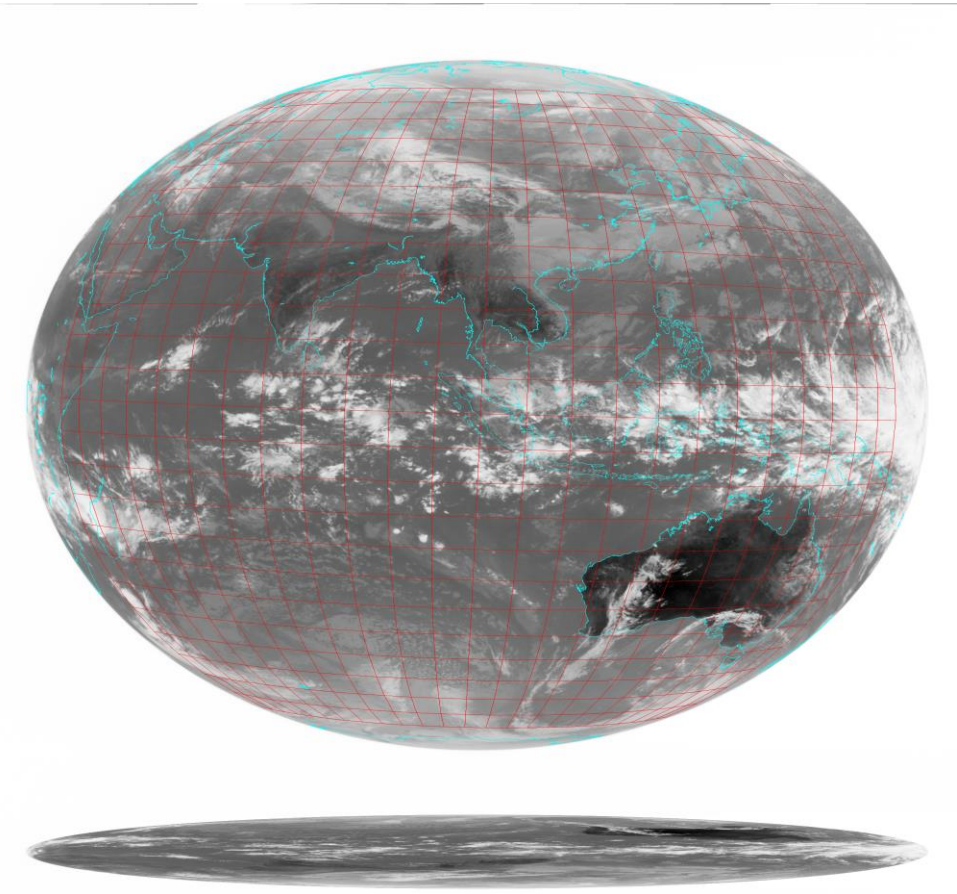
3)The future CMA satellite program

4) The products and applications under development

Updates on FengYun Geo.

FY-2G Launed on Dec 31,2014 have pass the post launch test .



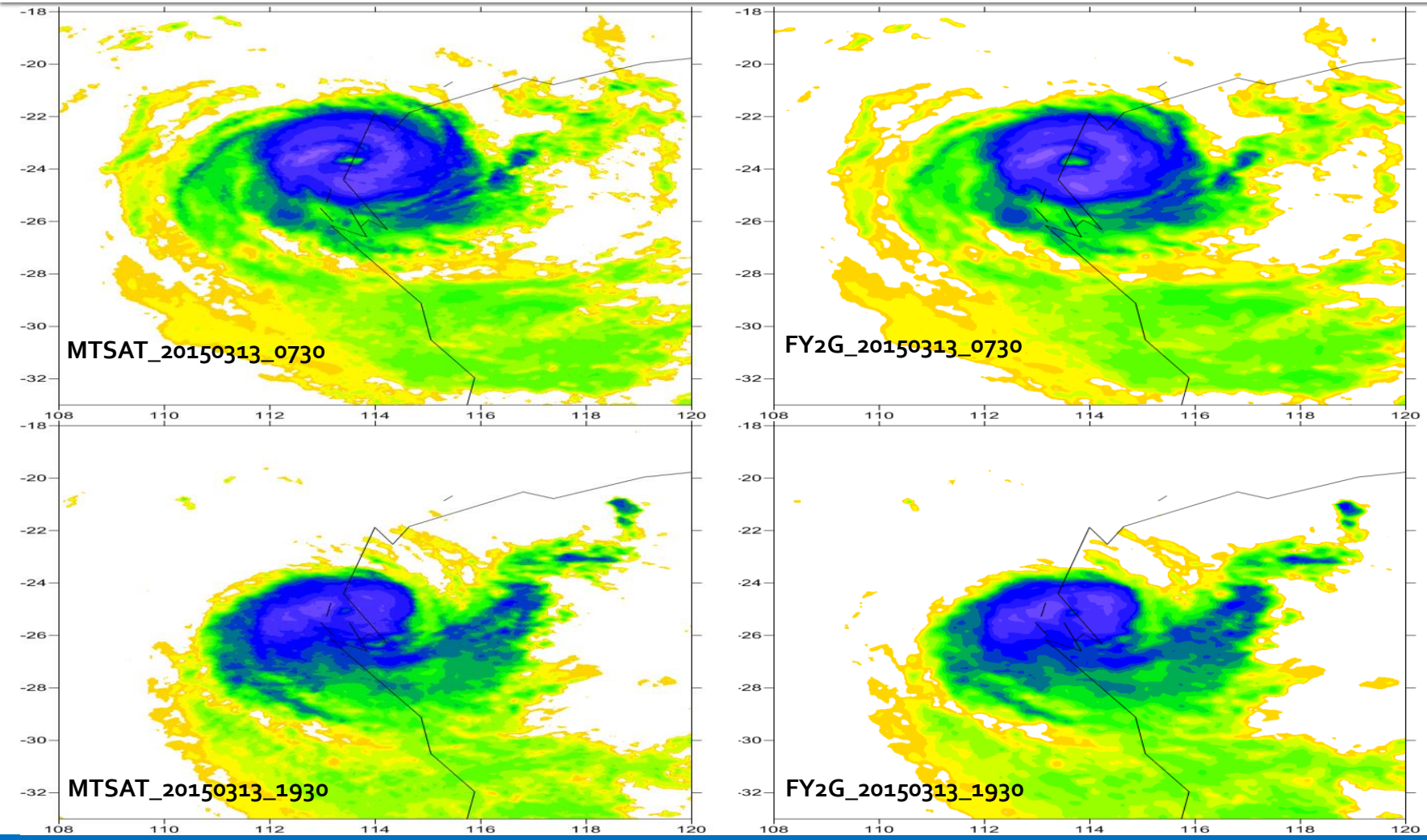


FY-2G image quality: improved

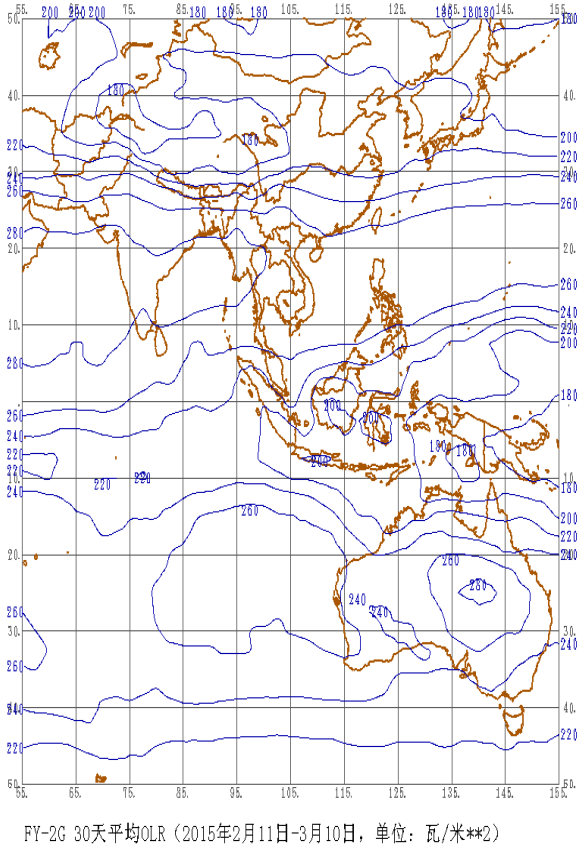
NEΔT	FY-2G		FY-2F	
	A	B	A	B
IR1(10.8μm)	0.10K@300K	0.11K@300K	0.12K@300K	0.14K@300K
IR2(12.0μm)	0.12K@300K	0.13K@300K	0.16K@300K	0.15K@300K
IR3(6.95μm)	0.12K@260K	0.11K@260K	0.30K@260K	0.29K@260K
IR4(3.75μm)	0.26K@300K	0.26K@300K	0.22K@300K	0.20K@300K

Channel	FY-2G Stray light level energy(compare with FY-2F)
IR1	decrease 50%~60%
IR2	decrease 60%~70%
IR3	decrease 50%~60%
IR4	decrease 50%

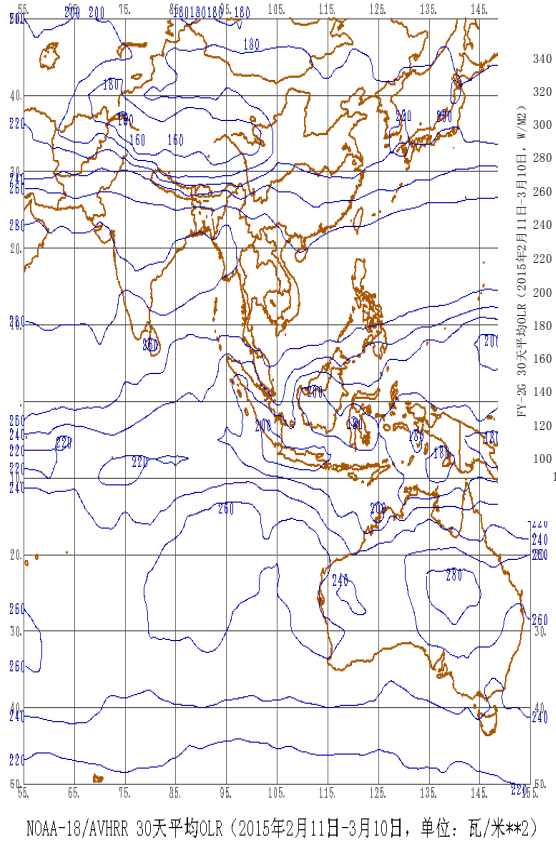
FY-2G Radiometric performance: Improved



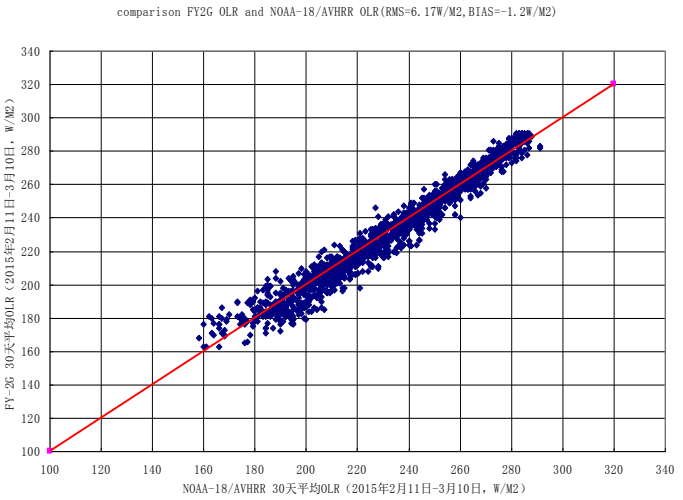
FY-2G Products Quality Control : System Established



FY-2G OLR

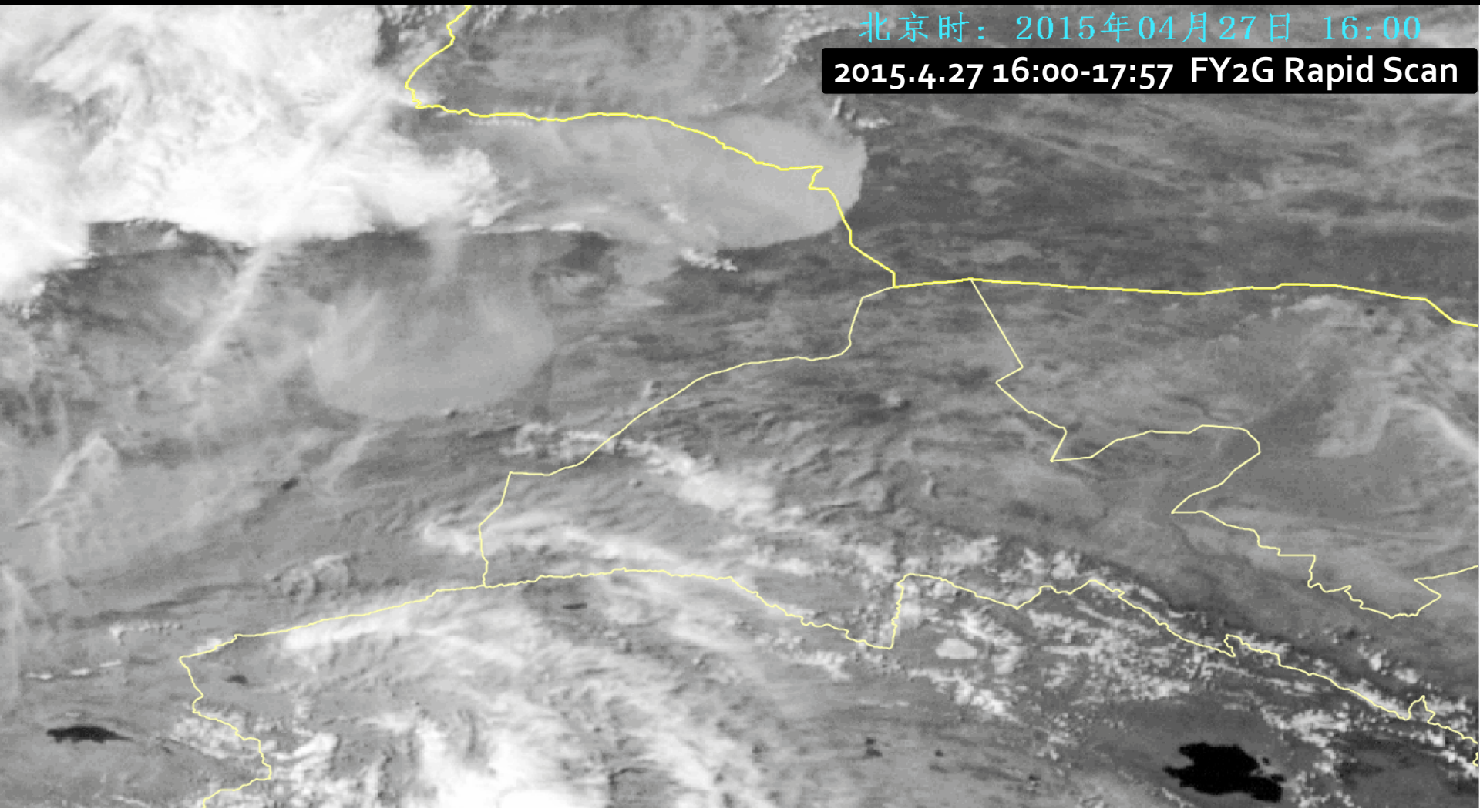


NOAA-18 OLR

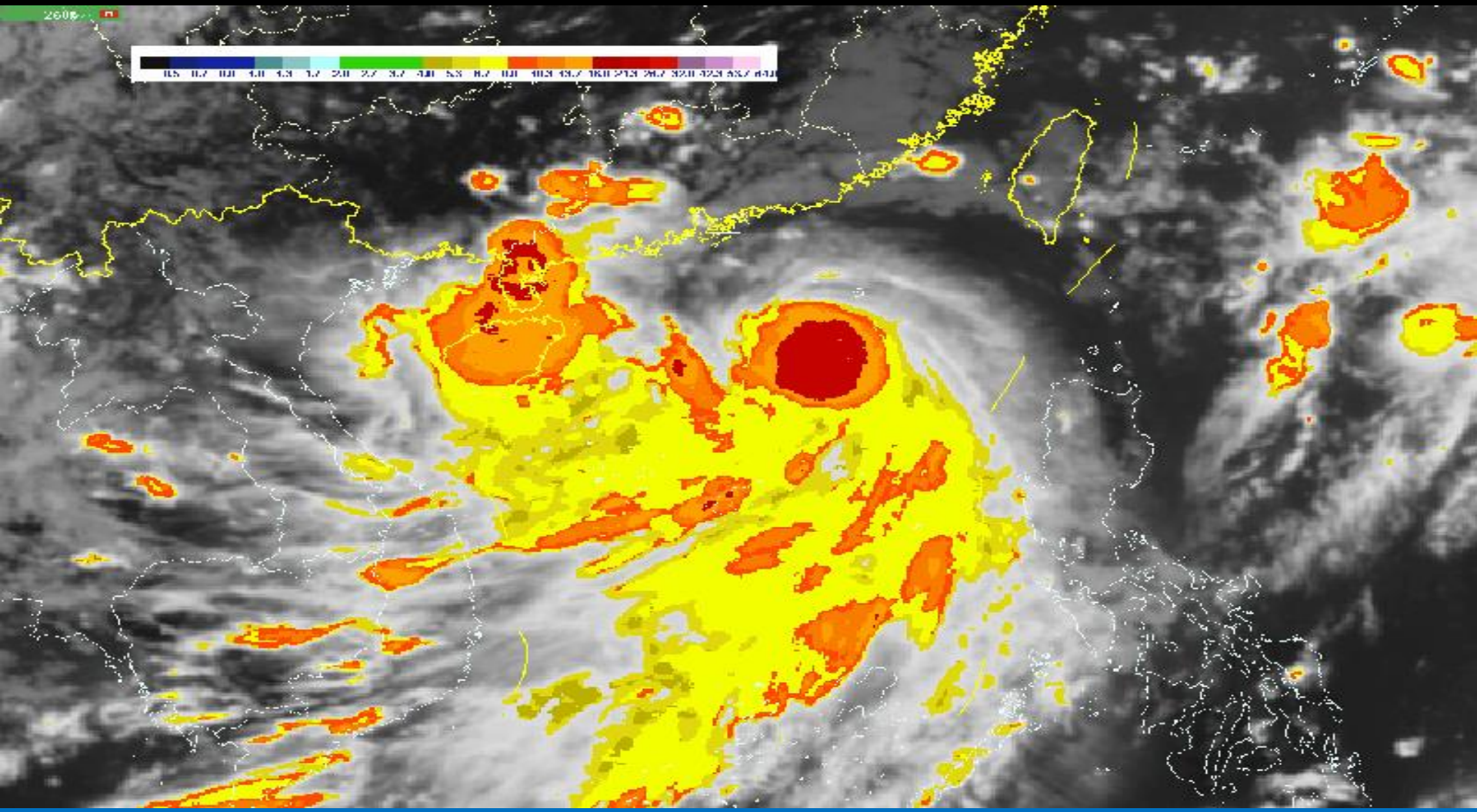


	RMS (W/m2)	R2	BIAS (W/m2)
候平均(20150221-20150225)	7.90	0.9754	-1.56
旬平均(20150221-20150228)	7.36	0.9756	-1.10
月平均(20150211-20150310)	6.17	0.9810	-1.20

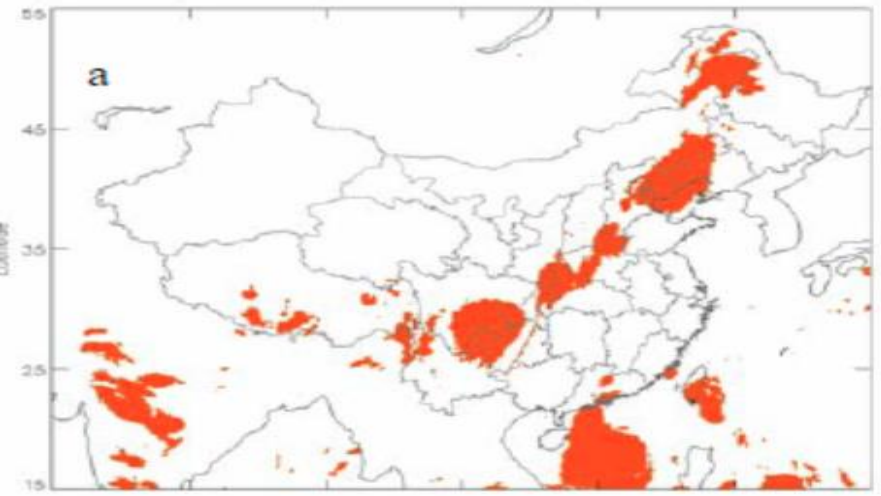
FY-2G Temporal resolution: Enhanced

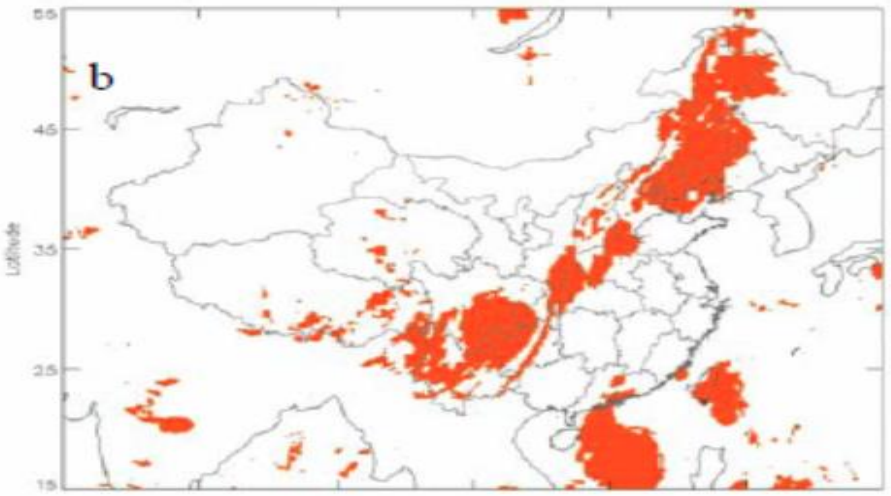


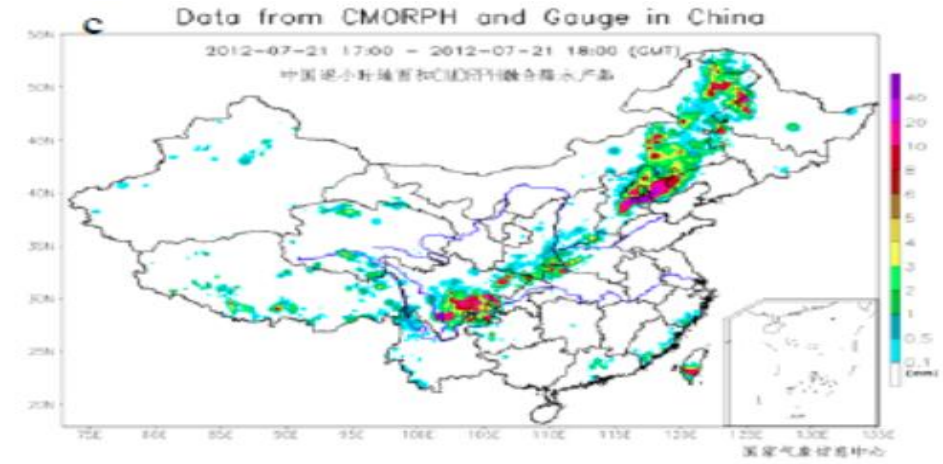
FY-2 rapid scan products: precipitation estimation



probability matching method (PMM) is applied in combining the microwave precipitation with the IR brightness temperature







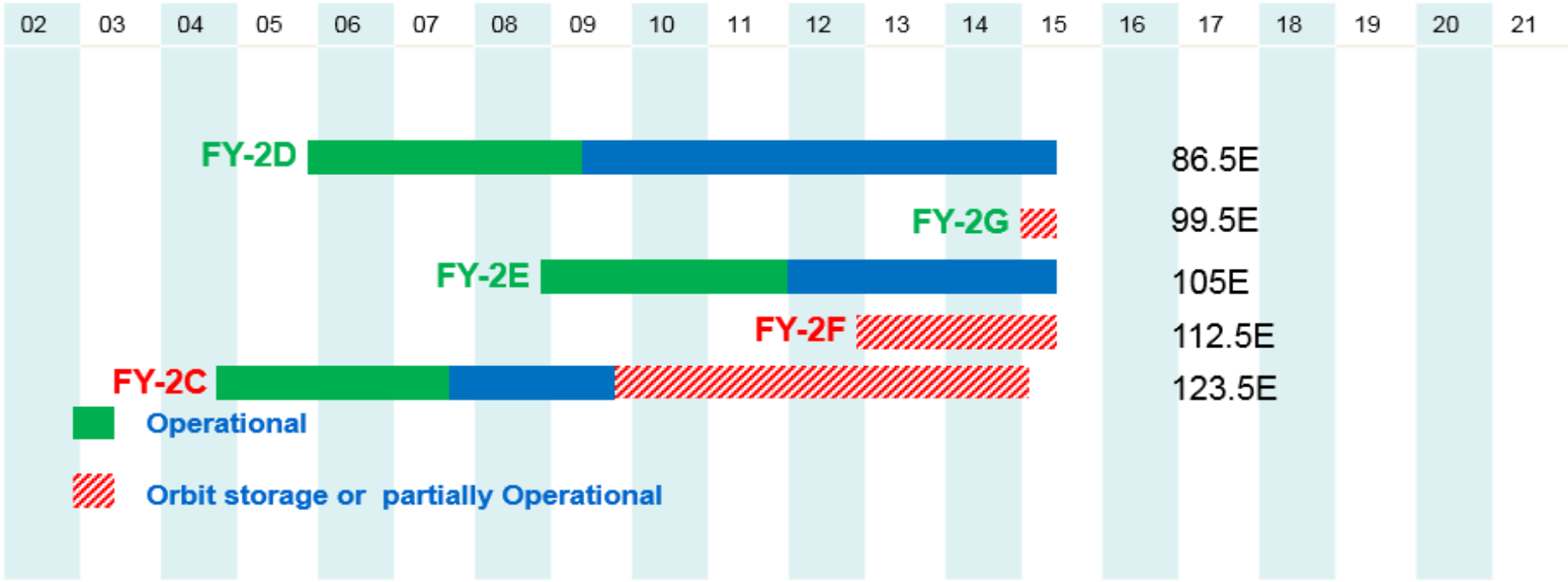
(a)IR-only approach
(b)The combined method ;
(c) Combination with CMORPH and dense rain gauge

STD are mostly among 0 ~ 1.8 mm/hr,
AVG is close to 1mm/hr;
The biases are almost equal to 0;

CMA FengYun Geo. 2014

CURRENT CMA GEO SATELLITES

For CMA GEO satellite system. 105E is primary position and 86.5E secondary.



CMA FengYun Geo. 2015

CURRENT CMA GEO SATELLITES

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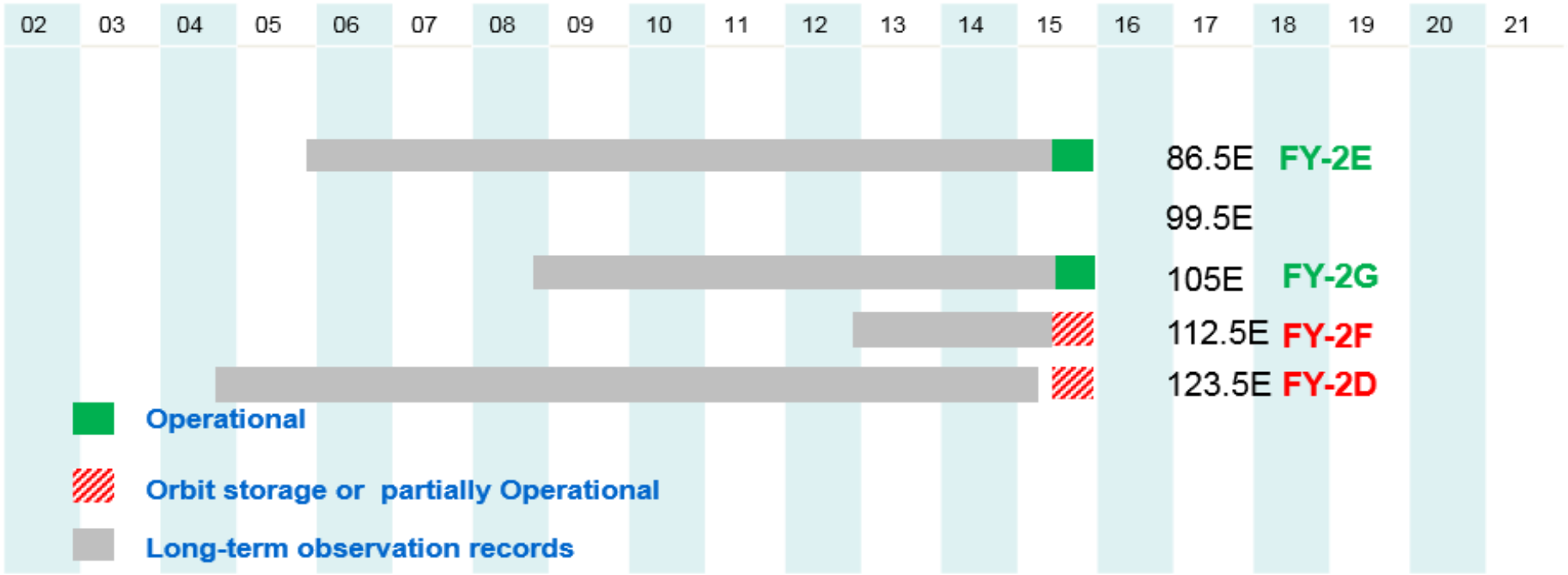
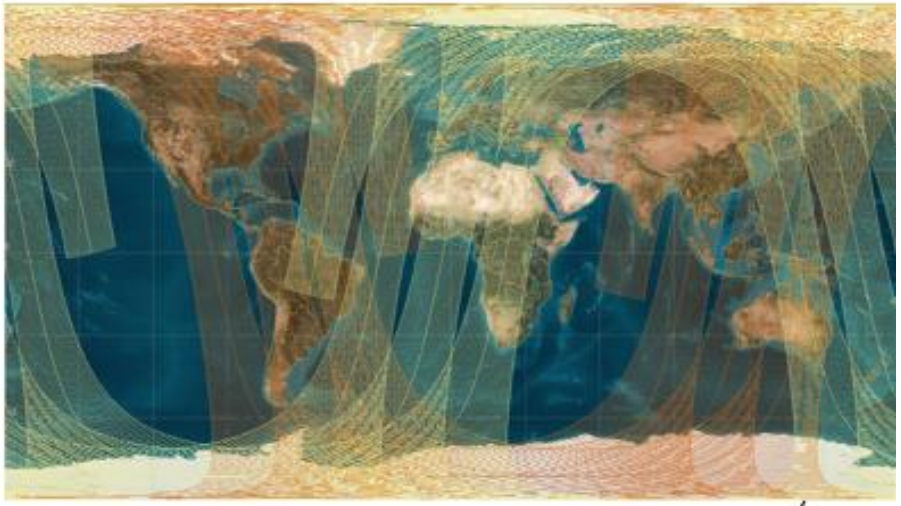


Updates on FengYun Leo.

✓ ***FY-3C*** was launched on Sep 23, 2013

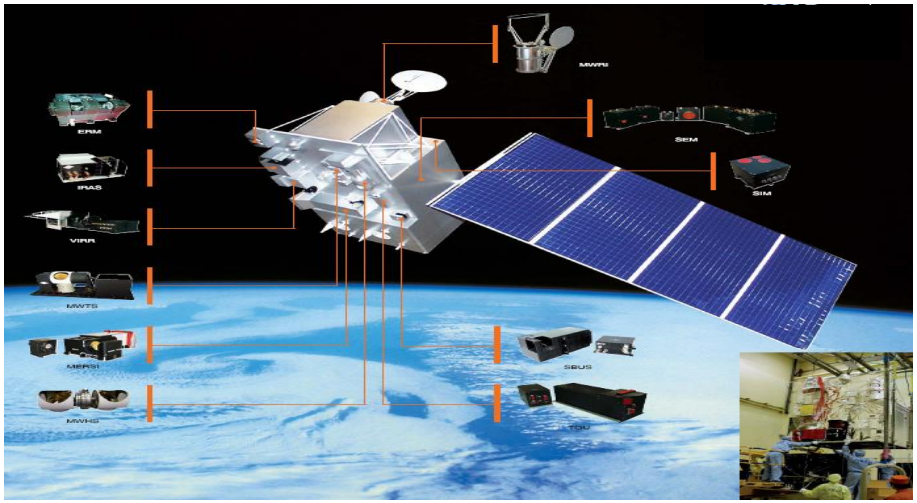
It's china's first operational polar orbit satellite of 2nd generation

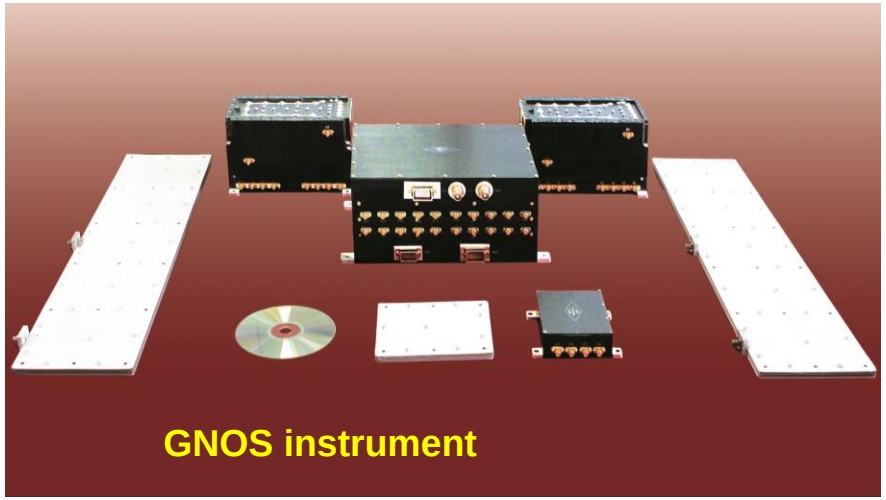


FY-3C LTC 10:30 AM

FY-3B LTC 13:40 PM

Improvement of FY-3C

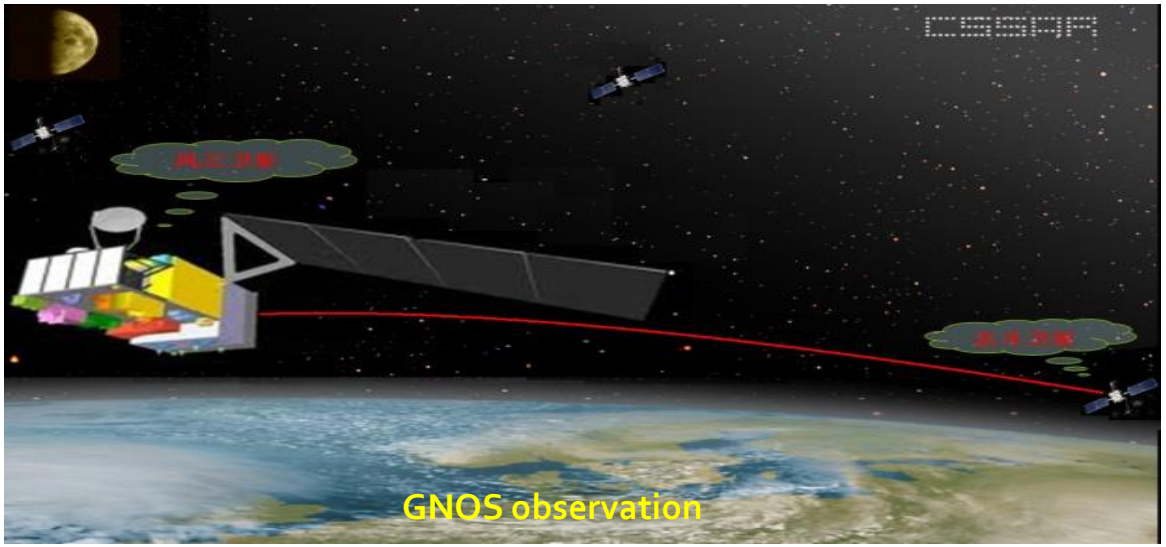




number	FY-3B Payloads	number	FY-3C Payloads
1	MERSI:Medium Resolution Spectral Imager	1	MERSI:Medium Resolution Spectral Imager
2	VIRR:Visible and Infra-Red Radiometer	2	VIRR:Visible and Infra-Red Radiometer
3	IRAS:Infrared Atmospheric Sounder	3	IRAS:Infrared Atmospheric Sounder
4	MWTS:MicroWave Temperature Sounder	4	MWTS(II):MicroWave Temperature Sounder
5	MWHS:MicroWave Humidity Sounder	5	MWHS(II):MicroWave Humidity Sounder
6	MWRI:MicroWave Radiation Imager	6	MWRI:MicroWave Radiation Imager
7	ERM:Earth Radiation Monitor	7	ERM:Earth Radiation Monitor
8	SIM:Solar Irritation Monitor	8	SIM(II):Solar Irritation Monitor
9	SBUS:Solar Backscatter Ultraviolet Sounder	9	SBUS:Solar Backscatter Ultraviolet Sounder
10	TOU:Total Ozone mapping Unit	10	TOU:Total Ozone mapping Unit
11	SEM:Space Environment Monitor	11	SEM:Space Environment Monitor
	/	12	GNOS:GNSS Occultation Sounder

Improvement of FY-3C

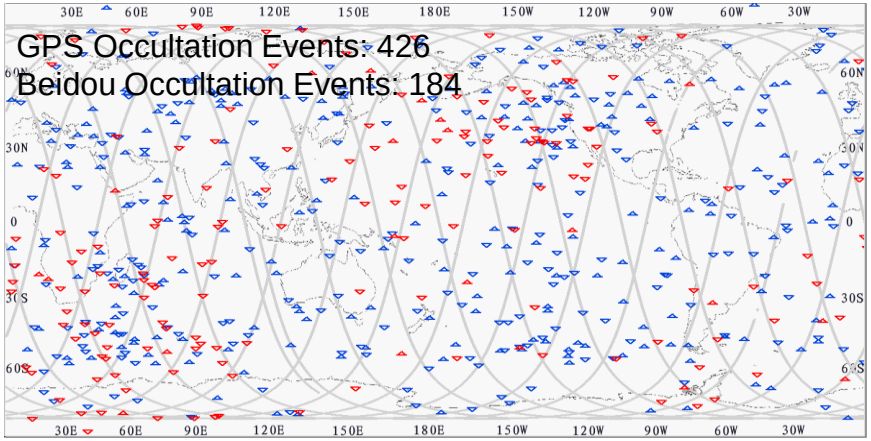
GNOS will receive two types of signal from GPS and China BeiDou-2. GNOS will observe over 1000 occultations per day with GPS and BD satellites



Products

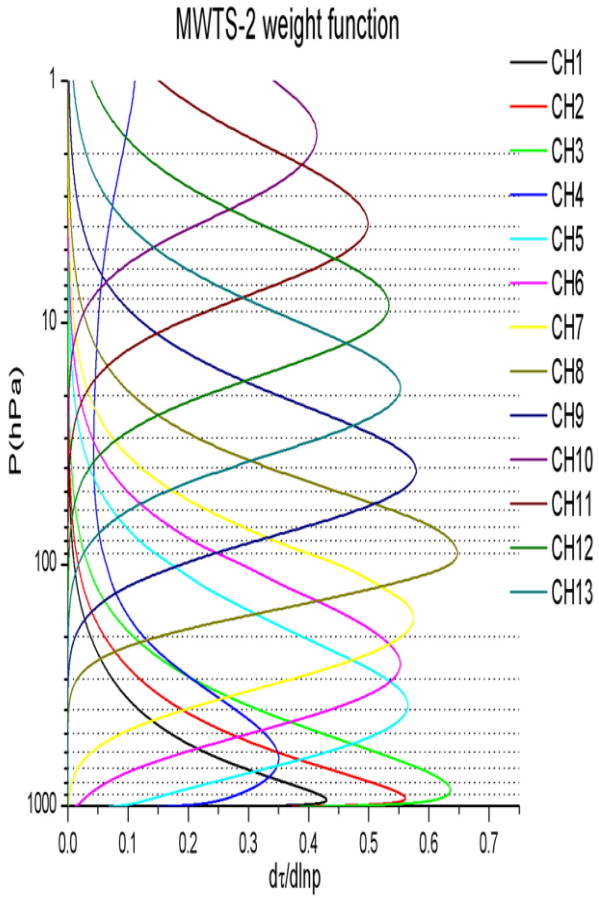
- Temperature profiles
- Humidity profiles
- Refractivity profiles
- Electronic content profiles

		Temperature	Humidity	Refractivity	Electronic Content
RMS Accuracy	Low Tropos.	0.5-3 k	0.25-1.0 g/kg	0.1-0.5%	(100-600 km) < 20%
	High Tropos.	0.5-3 k	0.05-0.2 g/kg	0.1-0.2%	
	Low Stratos.	0.5-3 k	--------	0.1-0.2%	
	High Stratos.	0.5-5 k	--------	0.2-2.0%	



Improvement of FY-3C

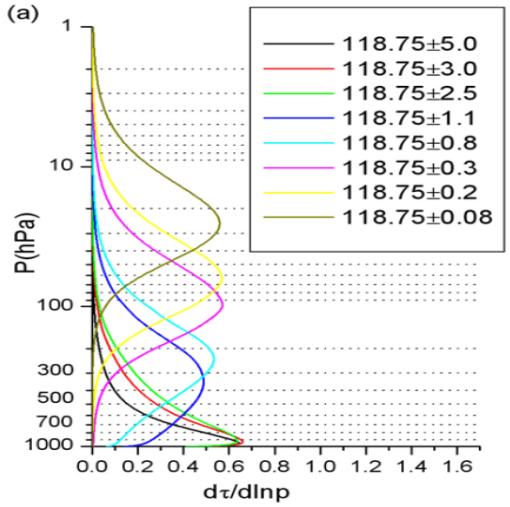
WTS-II: total channel number increased from 4 to 13

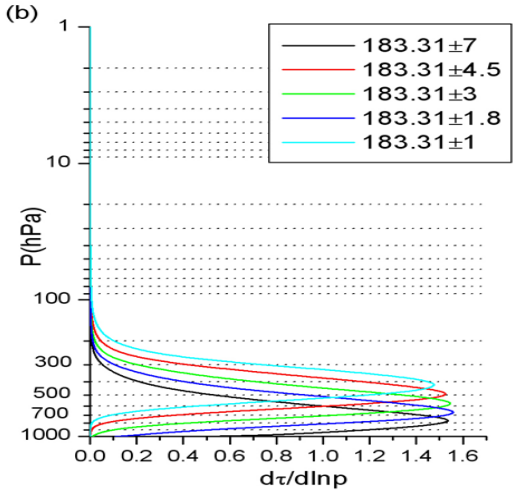


FY-3A/B/ MWTS		FY-3C/ MWTS(II)		
channel	Central frequency (GHz)	channel	Central frequency (GHz)	Purpose
1	50.30	1	50.3	
		2	51.76	Surface Emiss.
		3	52.8	
2	53.596 ± 0.115	4	53.596	
		5	54.40	
3	54.94	6	54.94	
		7	55.50	
4	57.290	8	57.290344(fo)	Atmospheric Temperature Profile
		9	fo ± 0.217	
		10	fo ± 0.3222 ± 0.048	
		11	fo ± 0.3222 ± 0.022	
		12	fo ± 0.3222 ± 0.010	
		13	fo ± 0.3222 ± 0.0045	

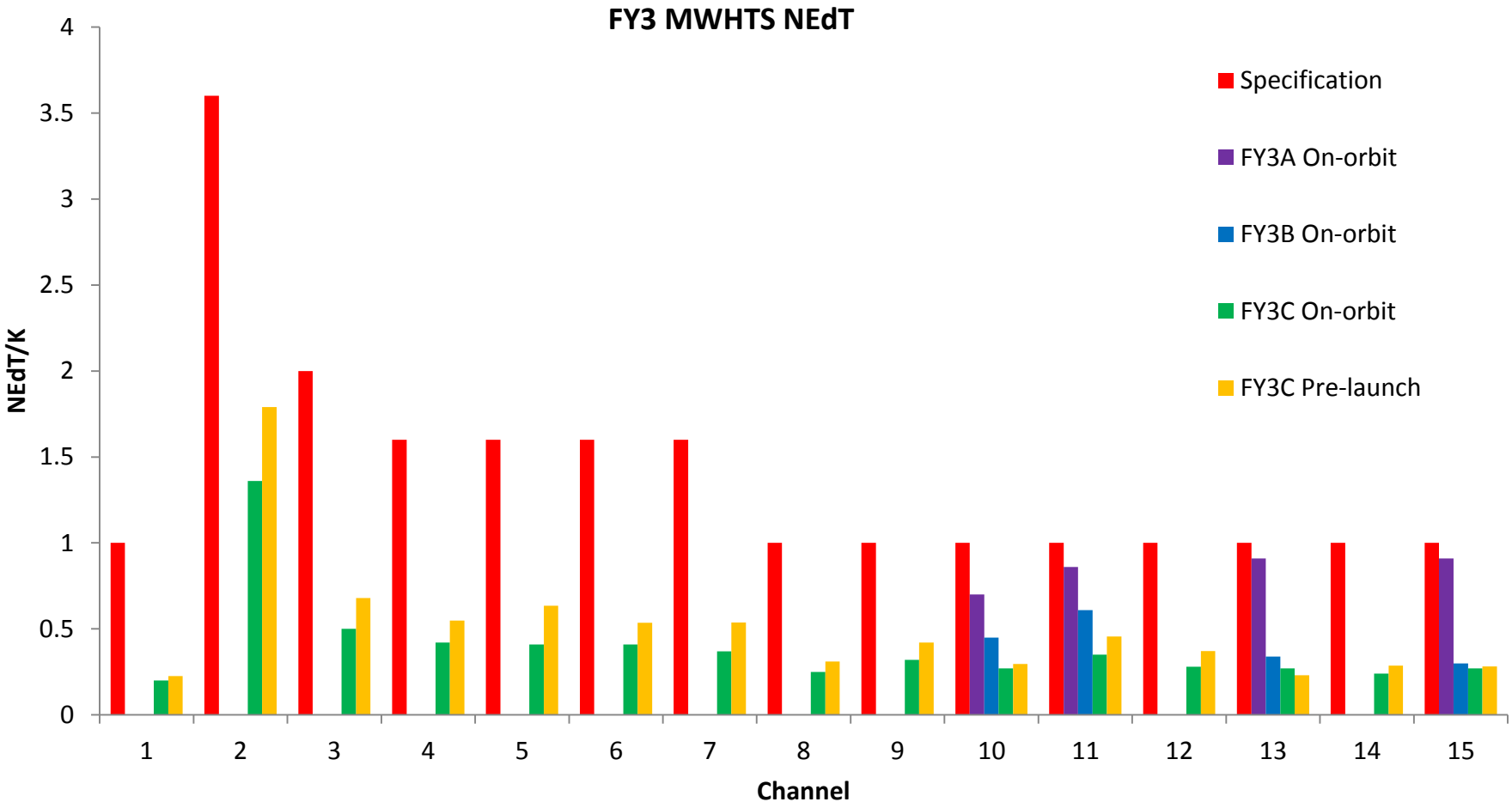
Improvement of FY-3C

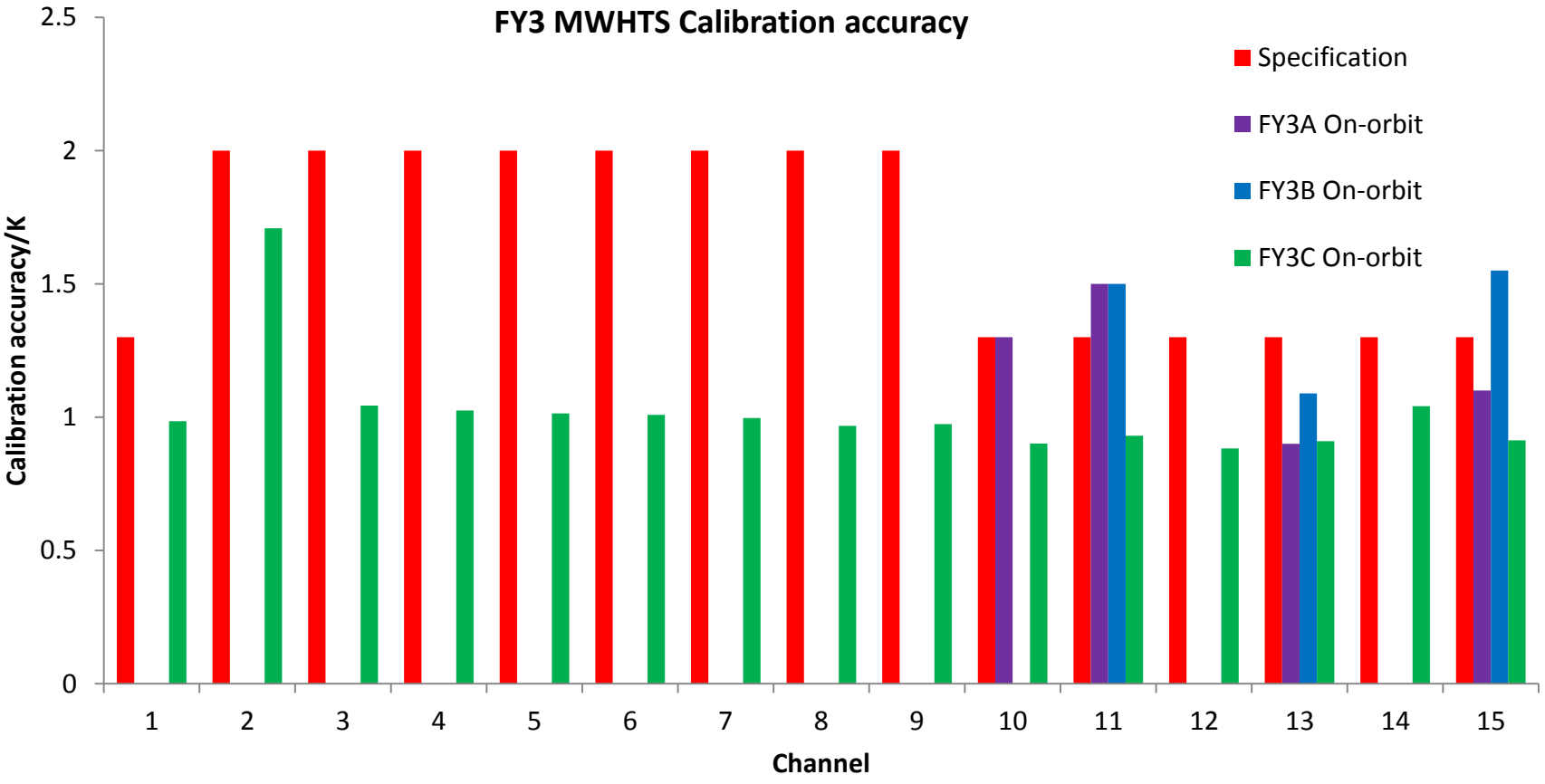
MWHS-II: increase two sounding frequency(89Ghz and 118Ghz), total channel number increase from 5 to 15.



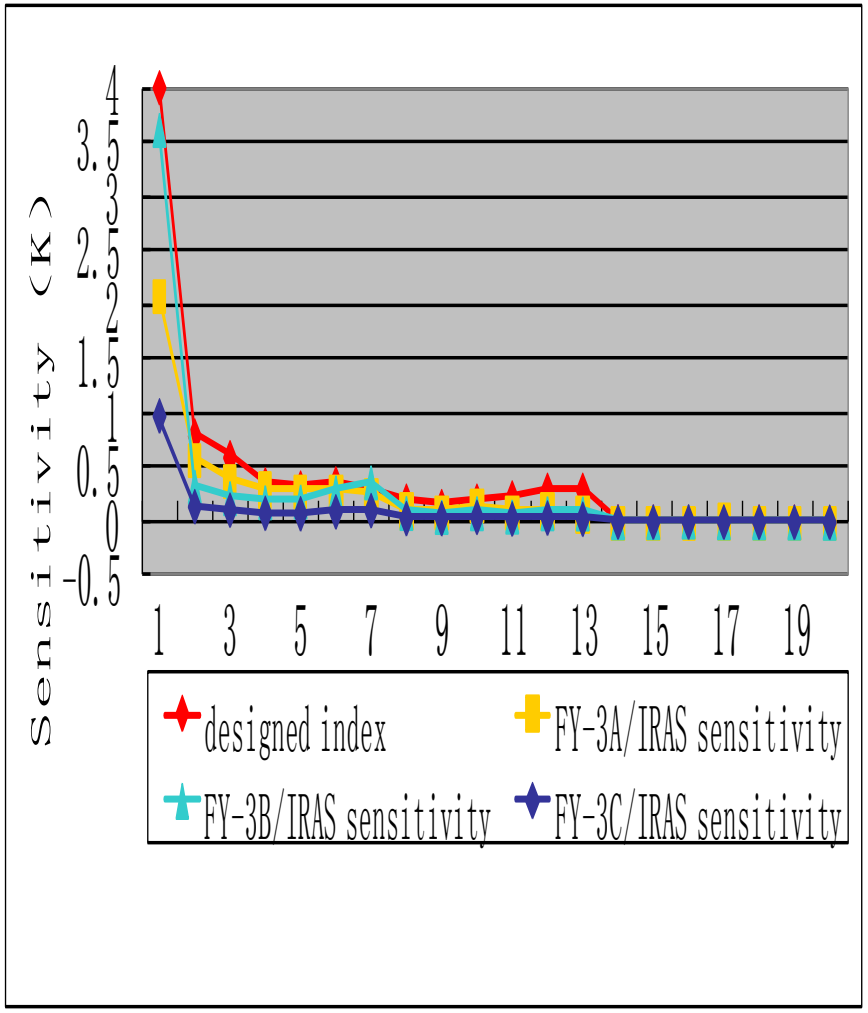


FY-3A/B/ MWHS		FY-3C/ MWHTS		
channel	Central frequency (GHz)	channel	Central frequency (GHz)	Purpose
		1	89.0	Surface and Precipitation
		2	118.75±0.08	
		3	118.75±0.2	
		4	118.75±0.3	
		5	118.75±0.8	Atmospheric Temperature Profile
		6	118.75±1.1	
		7	118.75±2.5	
		8	118.75±3.0	
		9	118.75±5.0	
1	150(V)	10	150.0	Surface and Precipitation
2	150(H)			
3	183.31±1	11	183.31±1	
		12	183.31±1.8	Atmospheric Moisture Profile
4	183.31±3	13	183.31±3	
		14	183.31±4.5	
5	183.31±7	15	183.31±7	

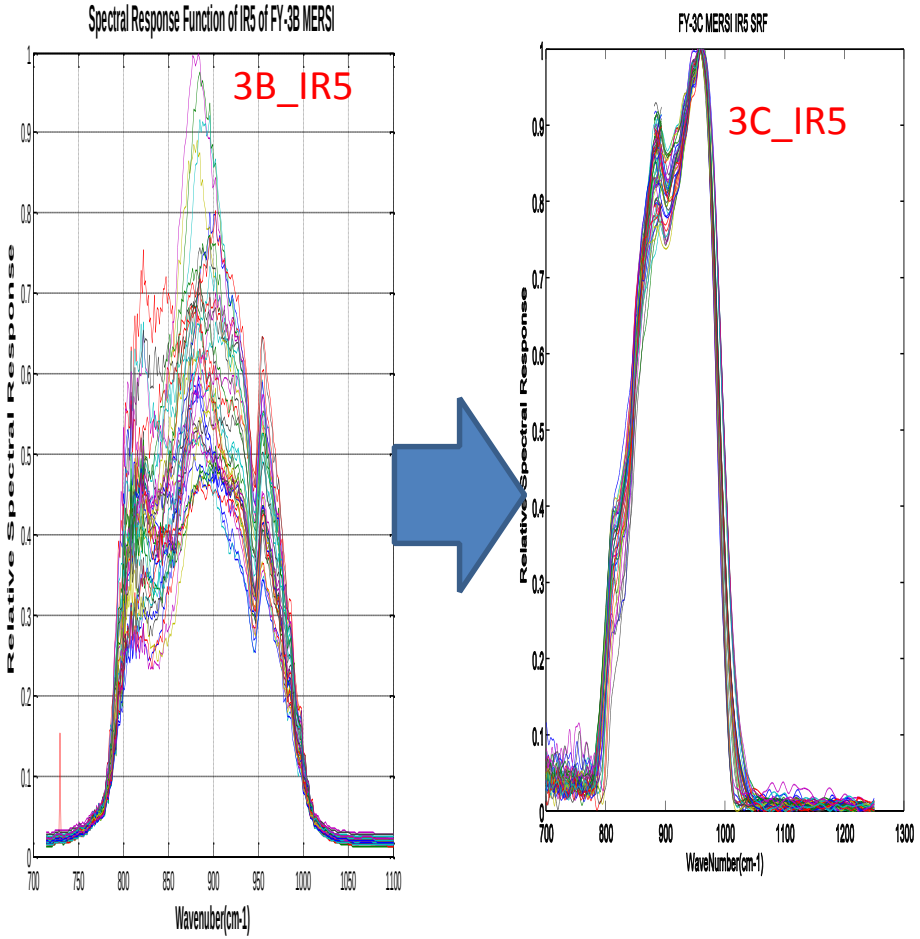

FY3 MWHTS NEdT
NEdT/K
4
3.5
3
2.5
2
1.5
1
0.5
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
Channel
Specification
FY3A On-orbit
FY3B On-orbit
FY3C On-orbit
FY3C Pre-launch


FY3 MWHTS Calibration accuracy
Specification
FY3A On-orbit
FY3B On-orbit
FY3C On-orbit
Calibration accuracy/K
2.5
2
1.5
1
0.5
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
Channel

Improvement of FY-3C

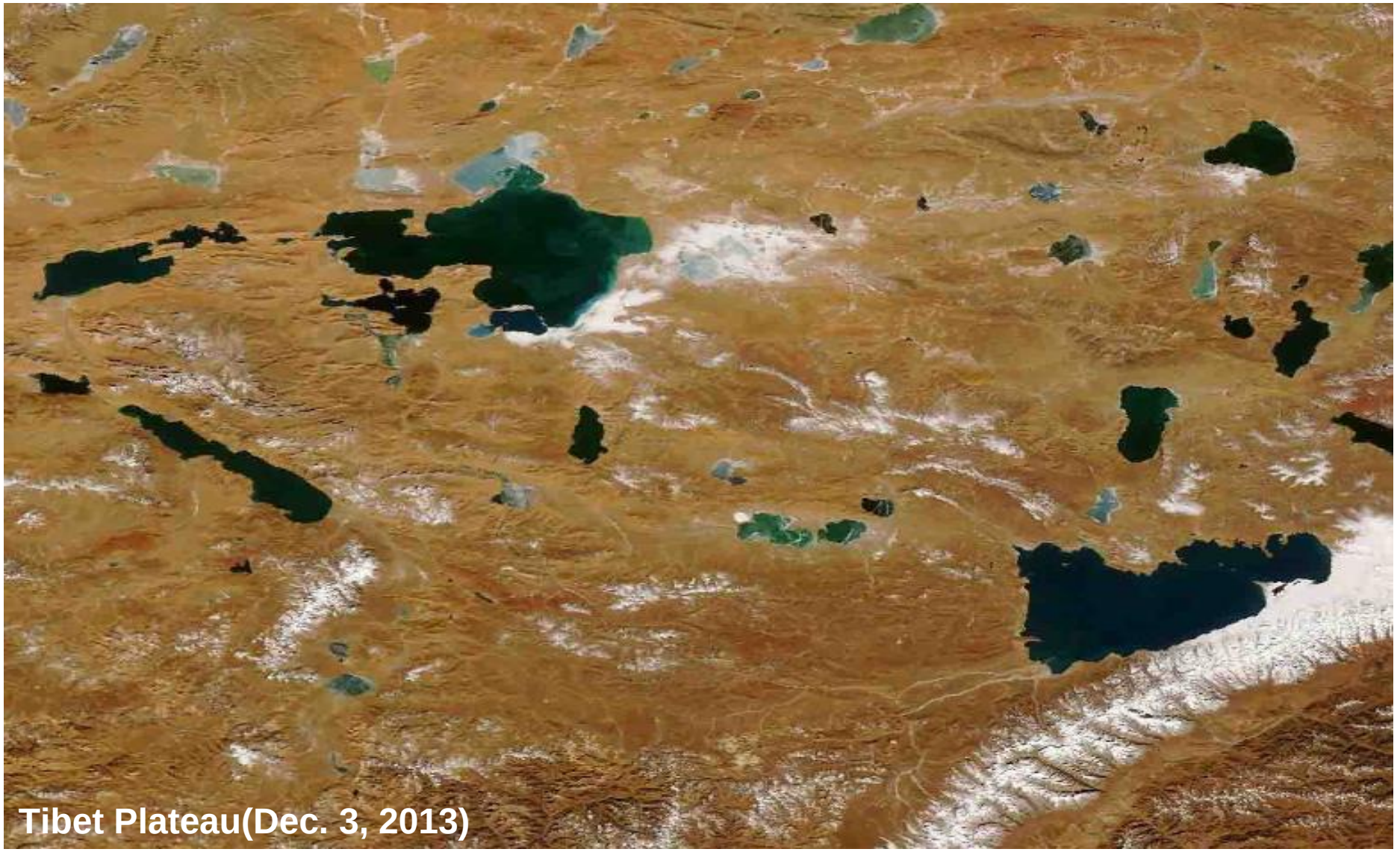


Improvment of instrument Sensitivity



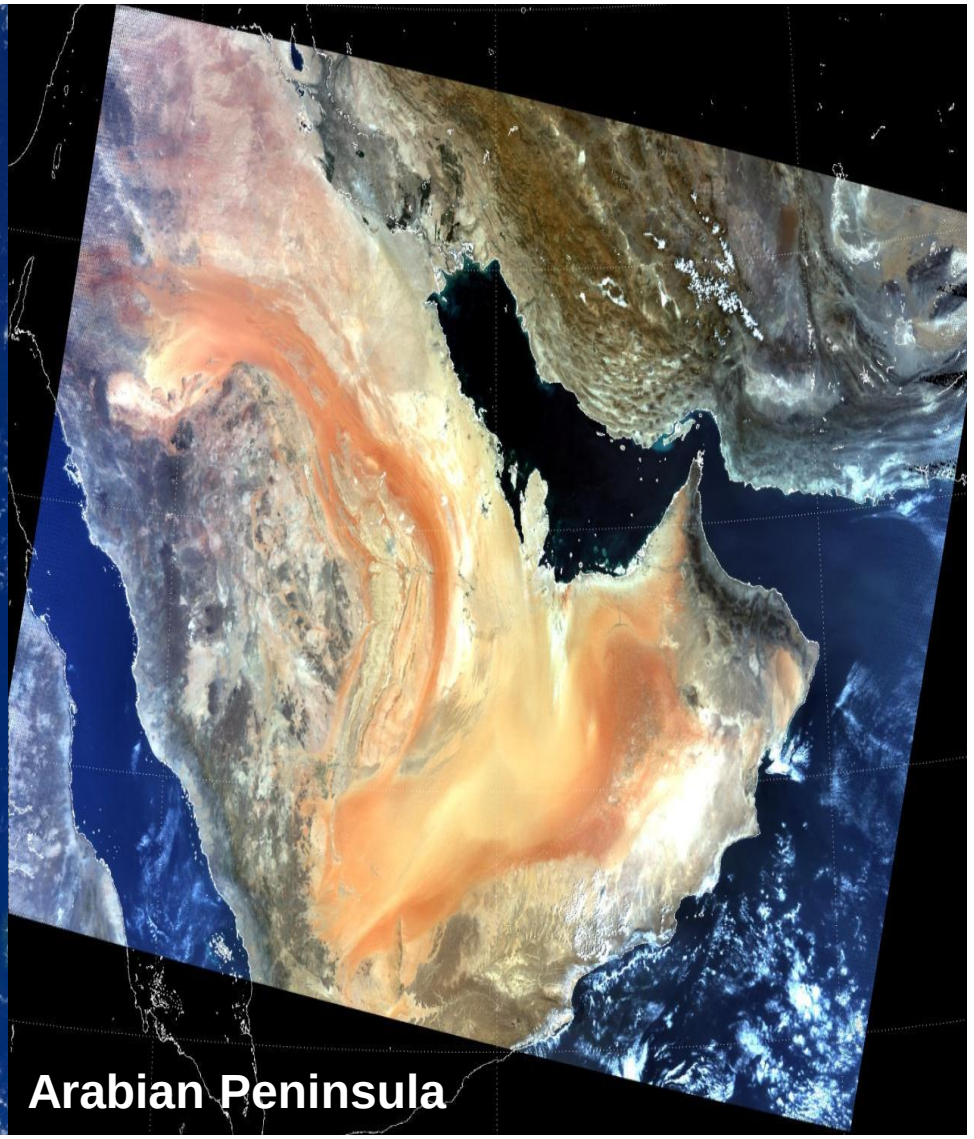
SRF homogeneity of the Multi detectors

MERSI/FY-3C Images



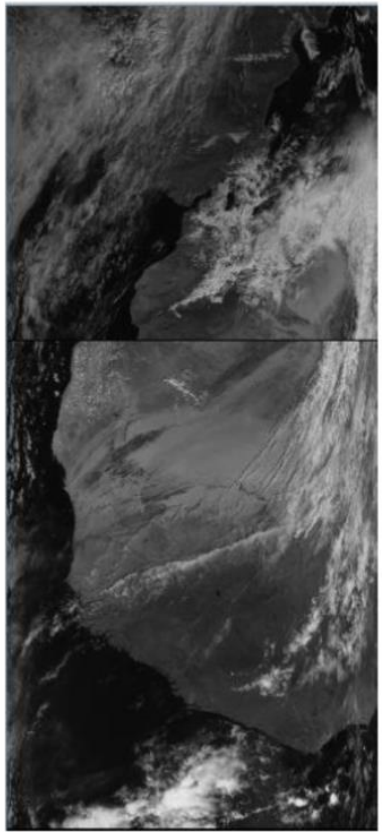
Tibet Plateau(Dec. 3, 2013)

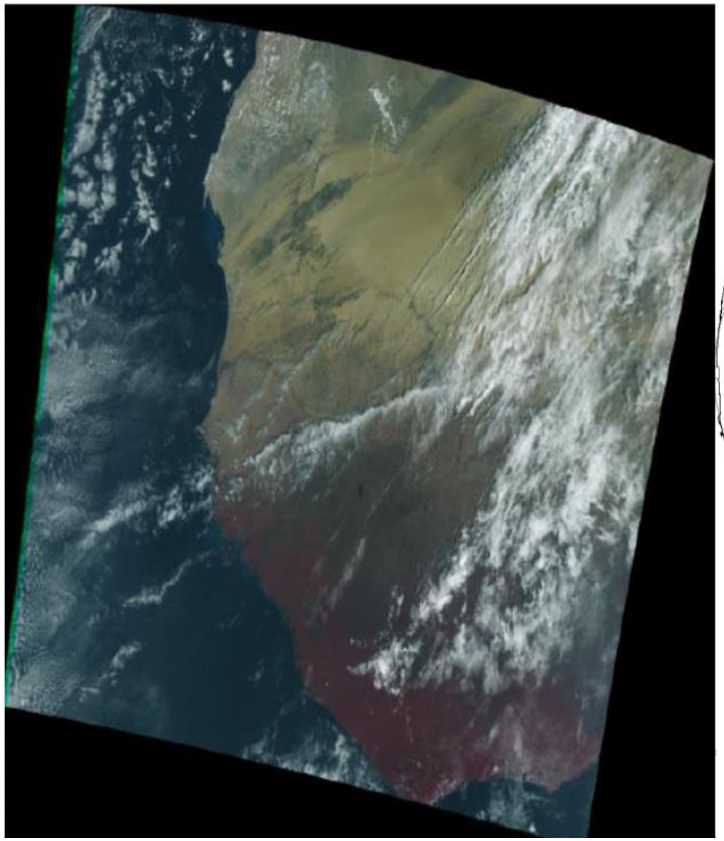
MERSI/FY-3C Images

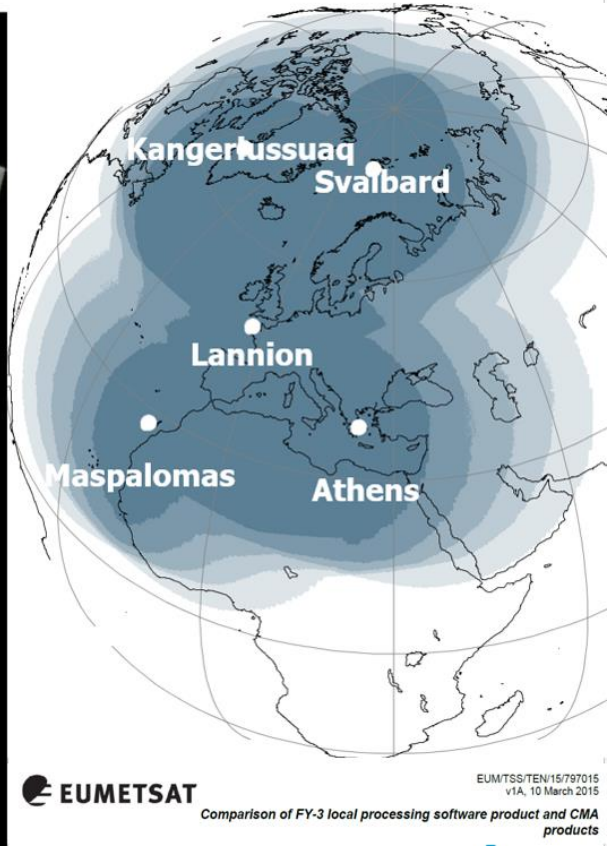


FY-3 D/B Applications worldwide

FY-3 Ready European Direct Broadcast stations



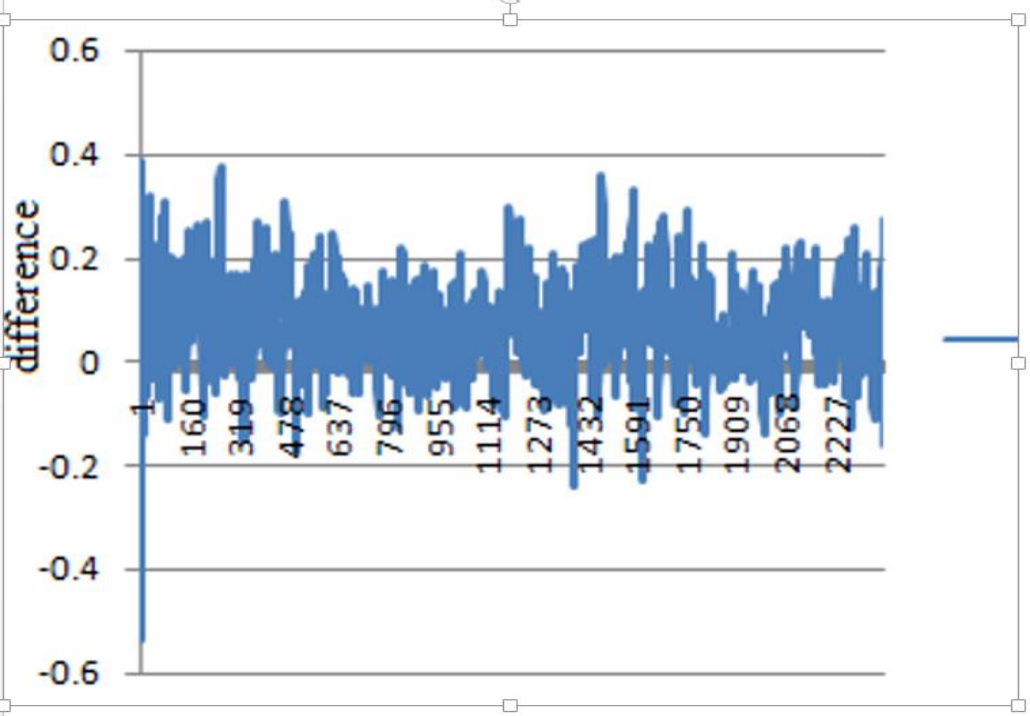




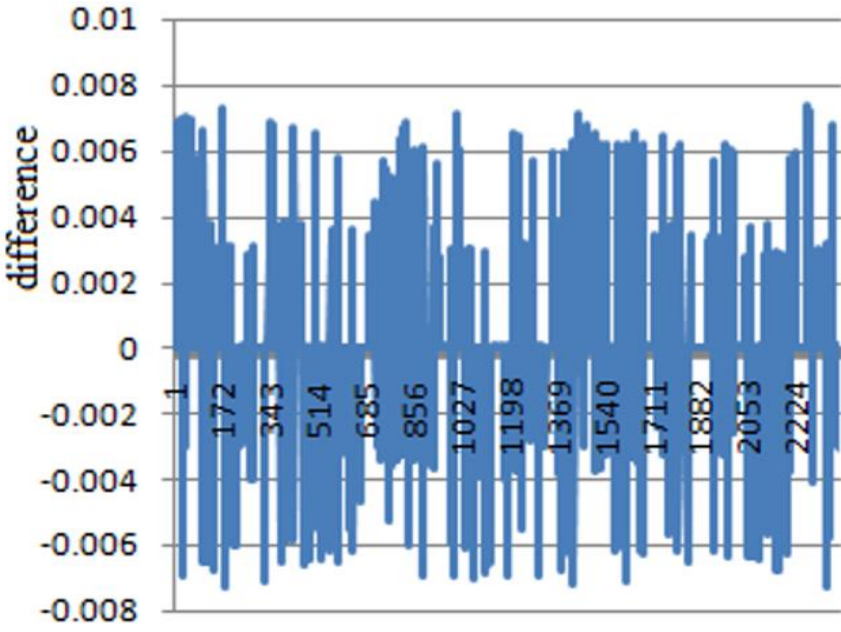
D/B user support for FY-3

FY-3 IPPS SOFTWARE PACKAGE

- Version update for MWHS support
- Support L0 X-Band processing

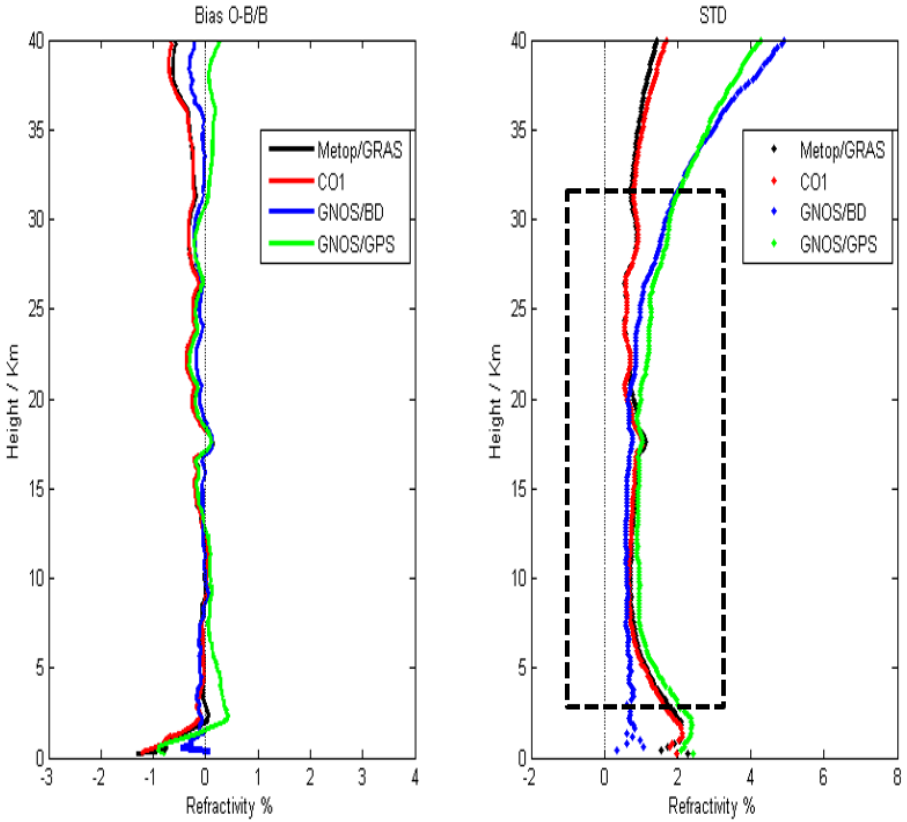


Before Update 2015

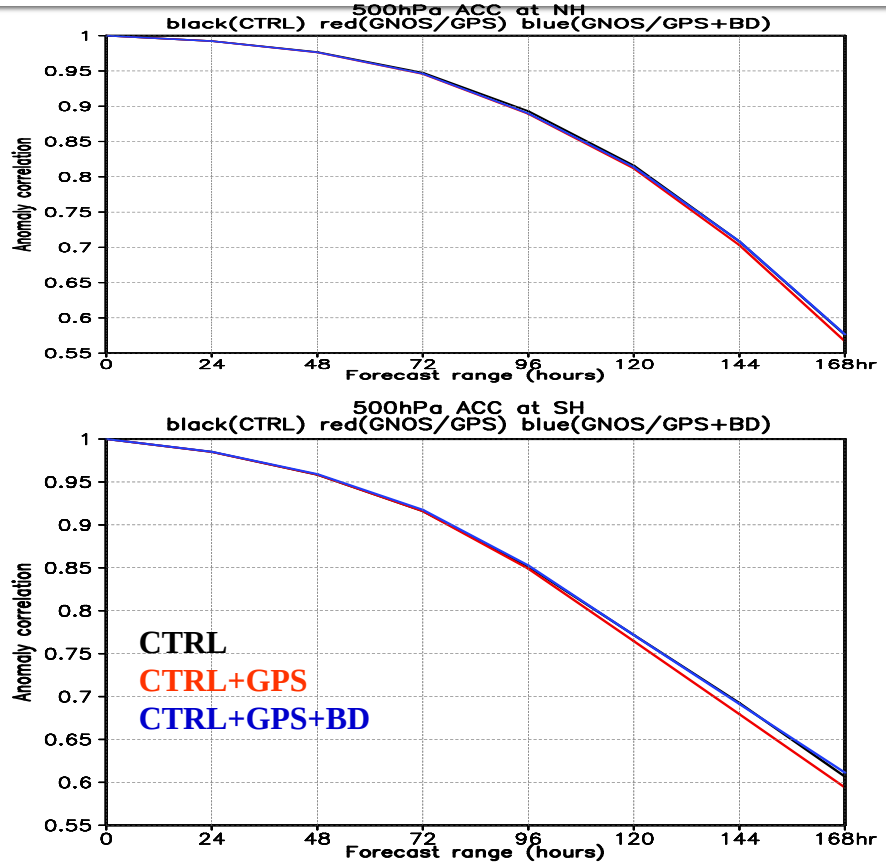


After Update 2015

FY-3 GNOS status



Exhibiting good agreement with ECMWF in terms of bias
Reconfirming the characteristic of non-bias of radio occultation The most excellent sounding height of GNOS is from 5 to 30 kilometers, standard deviation is within1%

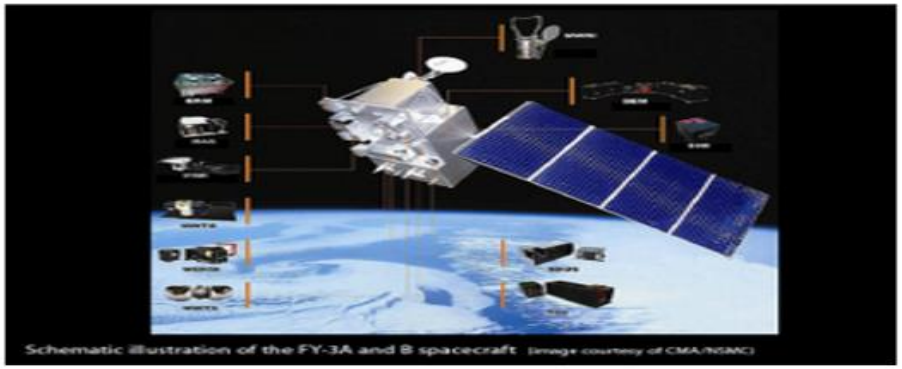


GNOS data has an **neutral and positive** impacts on GRAPES analysis and forecast skill.

Courtesy of Dr.Liao mi&Liu yan CMA

ECMWF starts using Chinese satellite data

29 September 2014

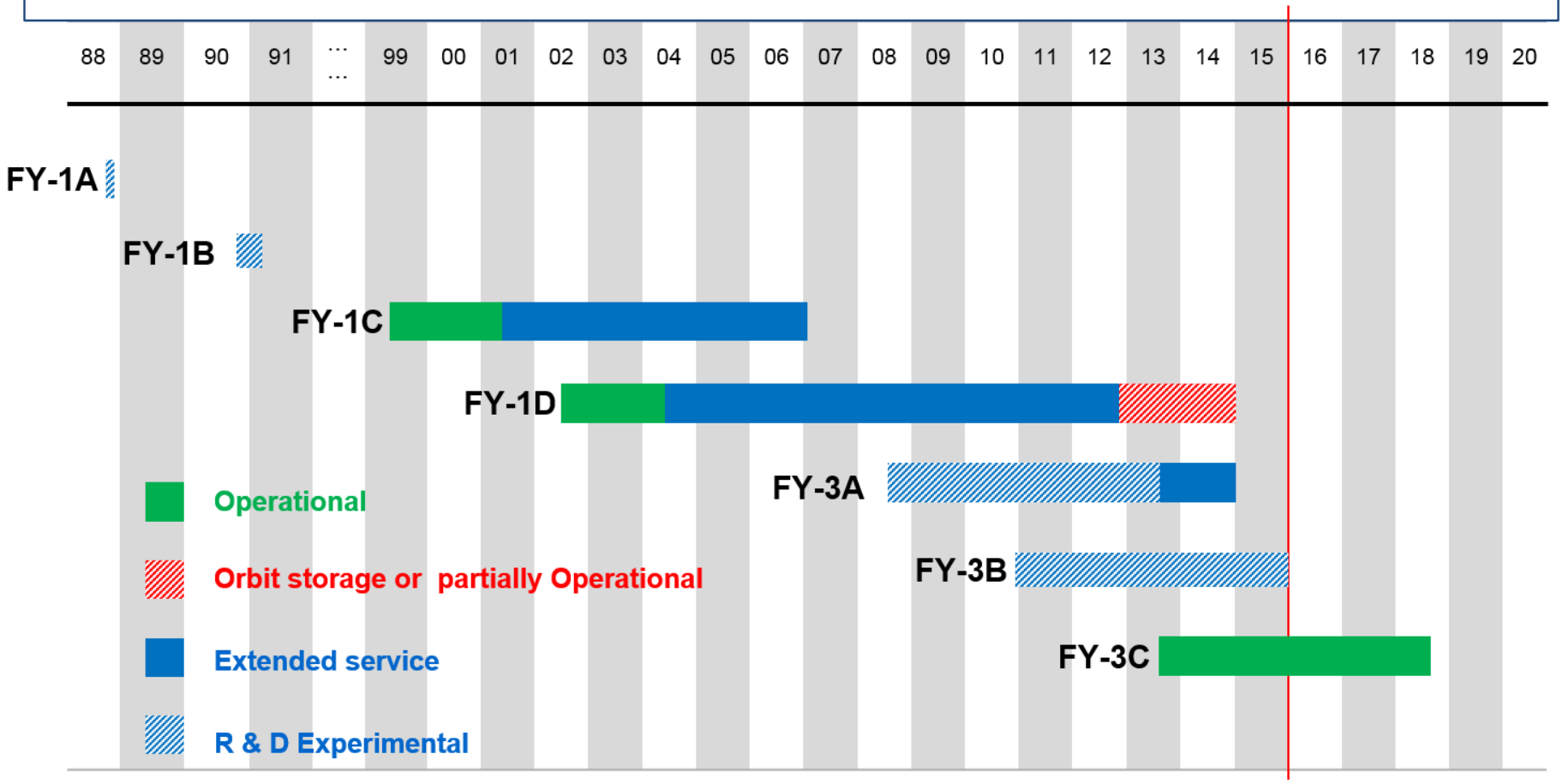

Schematic illustration of the FY-3A and B spacecraft (image courtesy of CMA/NSMC)

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

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

The development is the result of a very constructive partnership with CMA and IAP to characterise Chinese satellite data. During regular visits to ECMWF, Qifeng Lu from CMA has significantly advanced our understanding of the performance of the instruments on the experimental FY-3A and B satellites. This work continues with the analysis of data from the latest Chinese satellite, FY-3C, performed together with CMA, ECMWF, and the UK Met Office. FY-3C is China's first operational meteorological polar-orbiting satellite, and it carries much improved instruments compared to the earlier FY-3A and B satellites. It was launched in September last year and Qifeng Lu is currently visiting ECMWF again. He notes: "The cooperation between CMA, ECMWF and the Met Office is very important to help us evaluate the data and improve its performance. This is also of benefit to the wider community. We very much hope that more Chinese data will be actively assimilated at ECMWF and elsewhere in the future."

CURRENT CMA LEO SATELLITES



Topics

1)Overview of CMA satellite plan

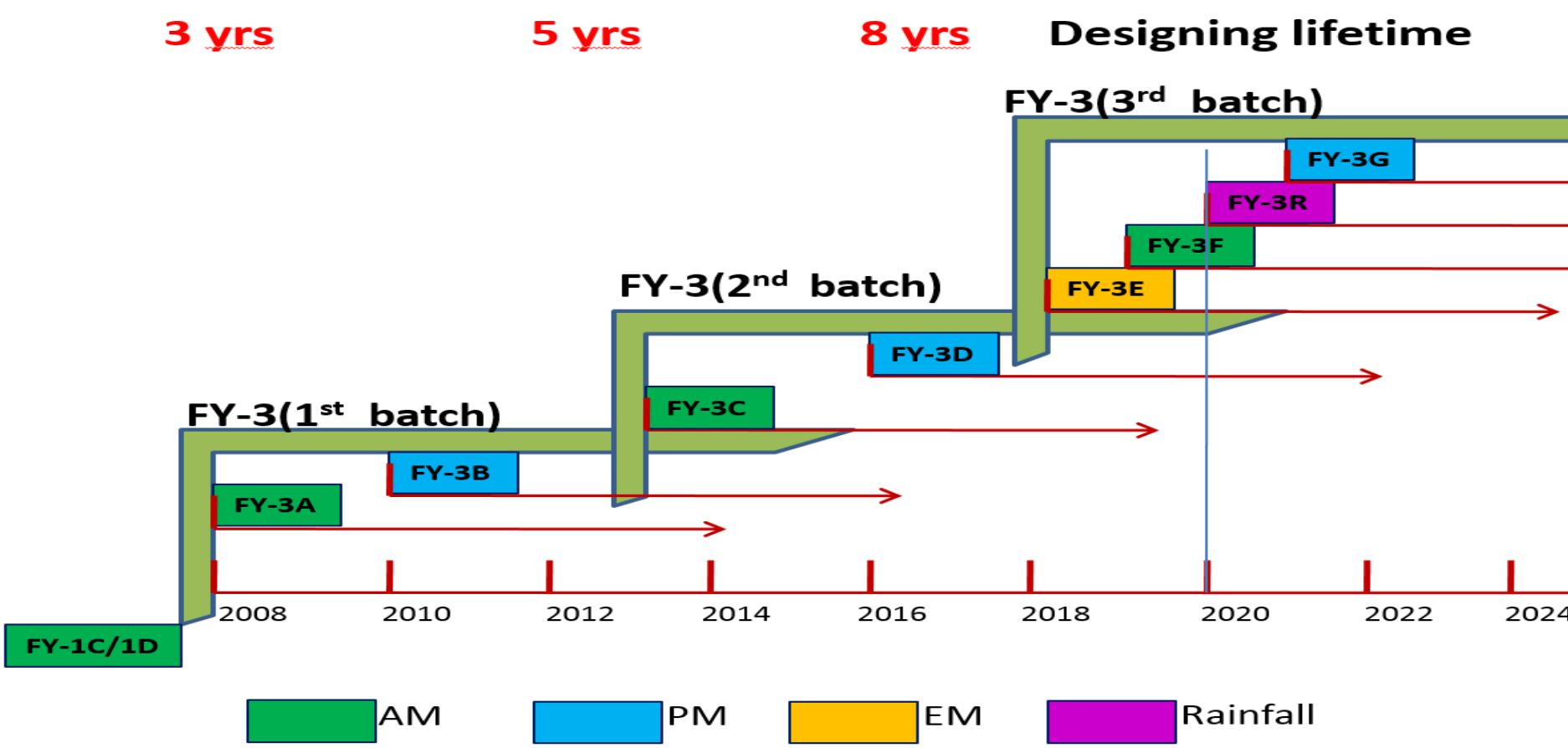
2)Updates of CMA Meteorological satellite system

3)The future CMA satellite program

4) The products and applications under development

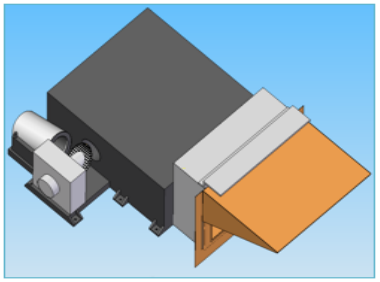
FengYun Leo in the future

FY-3 02 batch to 03 batch Transition

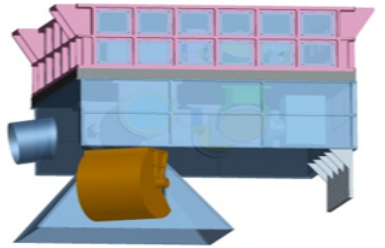


Update status of FY-3D

number	FY-3C Payloads	number	FY-3D Payloads
1	MERSI(I):Medium Resolution Spectral Imager	1	MERSI(II):Medium Resolution Spectral Imager
2	VIRR:Visible and Infra-Red Radiometer		
3	IRAS:Infrared Atmospheric Sounder	2	HIRAS
4	MWTS(II):MicroWave Temperature Sounder	3	MWTS(II):MicroWave Temperature Sounder
5	MWHS(II):MicroWave Humidity Sounder	4	MWHS(II):MicroWave Humidity Sounder
6	MWRI:MicroWave Radiation Imager	5	MWRI:MicroWave Radiation Imager
7	ERM(I):Earth Radiation Monitor		/
8	SIM(II):Solar Irritation Monitor		/
	/	6	GAS
9	SBUS:Solar Backscatter Ultraviolet Sounder		/
10	TOU:Total Ozone mapping Unit		/
11	SEM:Space Environment Monitor	7	SEM:Space Environment Monitor
	/	9	IPM
	/	10	WAI
12	GNOS:GNSS Occultation Sounder	11	GNOS:GNSS Occultation Sounder



HIRAS
(Hyperspectral Infrared Atmospheric Sounder)



GAS
(Greenhouse Gases Absorption Spectrometer)

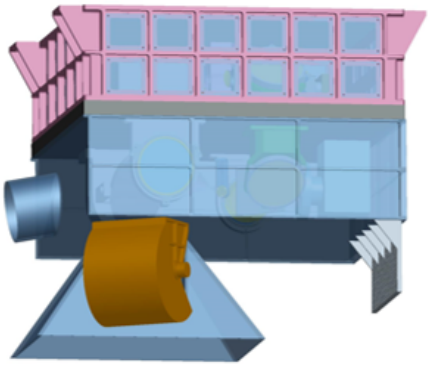
MERSI-II Characteristics

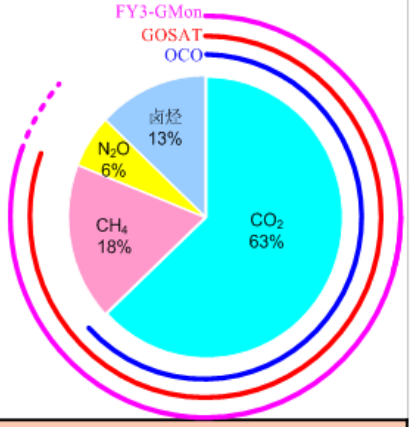
Primary Usage	Band	Band Center (um)	Bandwidth (nm)	Spatial Resolution (m)
Land/Cloud/Aerosols Boundaries	1	0.470	50	250
	2	0.550	50	250
	3	0.650	50	250
	4	0.865	50	250
	5	1.24/1.03	20	1000
	6	1.64	50	1000
	7	2.13	50	1000
Ocean Color/Phytopiankton/Biogeochemistry	8	0.412	20	1000
	9	0.443	20	1000
	10	0.490	20	1000
	11	0.555	20	1000
	12	0.670	20	1000
	13	0.709	20	1000
	14	0.746	20	1000
	15	0.865	20	1000
Water Vapor	16	0.905	20	1000
	17	0.936	20	1000
	18	0.940	50	1000
Cirrus Cloud	19	1.38	20/30	1000
Surface/Cloud Temperature	20	3.8	180	1000
	21	4.050	155	1000
Water vapor	22	7.2	500	1000
	23	8.550	300	1000
Surface/Cloud Temperature	24	10.8	1000	250
	25	12.0	1000	250

GAS/FY-3D

Aims

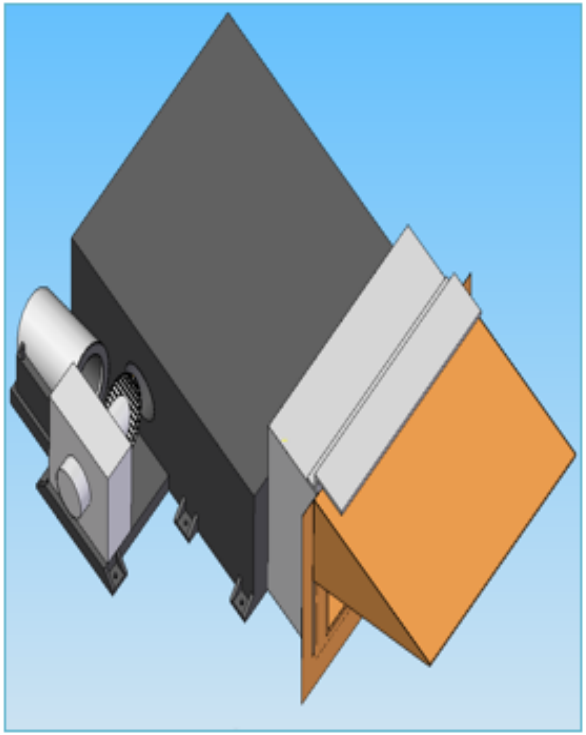
- Improve our understanding on the Spatial & temporal distribution of global CO_2
- Monitoring the CO_2 variation on seasonal scales





Greenhouse gases Absorption Spectrometer				
Band	1	2	3	4
Spectrum	0.75-0.77μm	1.56-1.72μm	1.92-2.08μm	2.20-2.38μm
Center Wavelenth	0.76μm	1.6μm	2.0μm	2.3μm
target	O_2-A	CO_2 CH_4（H_2O）	CO_2（H_2O）	CH_4、CO 、N_2O
Spectrum res.	0.6 cm^{-1}	0.27 cm^{-1}	0.27 cm^{-1}	0.27 cm^{-1}
S/N	＞300:1			
Cal. Error	<2%			
IFOV	0.685°			

HIRAS Specification



Specification	LWIR Band	MWIR Band	SWIR Band
Spectral Range	650 – 1136 cm-1 (15.38-8.8 μm)	1210 – 1750 cm-1 (8.26-5.71 μm)	2155-2550 cm-1 (4.64-3.92 μm)
Spectral Res	0.625 cm-1	1.25 cm-1	2.5 cm-1
NEΔT @250K	0.15~0.4K	0.1~0.7K	0.3~1.2K
Num. of Chan.	778	433	159
pixes per scan line	58		
Scan Angle	±50.4° around nadir		
Spatial Res	1.1 degrees (16.0km) IFOV at arranged in 2×2 array		

HIRAS/FY-3: Michelson interferometer

Aims: global temperature and moisture sounding from the infrared spectrum from 650 to 2550 cm-1

1) retrieving atmospheric temperature and humidity profiles with high accuracies for numerical weather prediction and climate research at high vertical resolution.
2) Trace gases to be derived from HIRAS include ozone columnar amounts in deep layers and columnar amounts of carbon monoxide, nitrous oxide, methane, and carbon dioxide.
3) Cloud parameters .

OMS

total column ozone mapping

- ozone profiler which includes nadir ozone profiler and limb ozone profiler
- the high spectral resolution OMS will replace the former UV ozone instruments TOU and SBUS flown on FY-3A/B/C

Aims: global total column ozone and profile, global total amount of SO2, NO2 and aerosol optical properties such as aerosol index, optical depth

	Nadir detection		Limb detection
	Total column amount	**Vertical profile**	
Spectral range	300~500nm	250~310nm	290-500nm
Scientific purpose	O_3、NO_2、SO_2、HCHO、BrO、OClO、aerosol	O_3 profile	O_3、NO_2、SO_2、HCHO、BrO、OClO、stratospheric aerosol profiles
Spectral resolution	300~365nm×0.4nm 365~500nm×0.6nm	250~310nm×0.4nm	290-500nm×0.6nm
Spatial resolution	15（along track）×25（cross track）km	34（along track）×60（cross track）km	3km
Field of view	112°	2.3°（along track）×0.045°（cross track）	2.3°（along track）×0.045°（cross track）
Dynamic range	10^4	10^5	10^5

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

N0.	Sensor Siute	Satellite / Sensor	FY-3E（05）EM Satellite	FY-3F（06 ）AM Satellite	FY-3G（07）PM Satellite	FY-3R（08）Rainfall Satellite
		Scheduled Launch Date	2018	2019	2021	2020
1	Optical Imagers	MERSI	√（III-Low Light）	√（III）	√（III）	√（III-Simplified）
2	Passive Microwave Sensors	MWTS	√	√	√	√
		MWHS	√	√	√	√
		MWRI		√	√	√
3	Occultation Sounder	GNOS	√	√	√	√
4	Active Microwave Sensors	WindRAD	√	√		
		Rainfall RAD				√
5	Hyperspectral Sounding Sensors	HIRAS	√	√	√	
		GAS (Greenhouse Gases Absorption Spectrometer)			√	
		OMS (Ozone Mapping Spectrometer)		√		
6	Radiance Observation Sensor Suite	ERM		√		
		SIM	√	√		
		SSIM (Solar Spectral Irradiation Monitor)	√			
7	Space Weather Sensor Suite	SEM	√			
		Wide Angle Aurora Imager			√	
		Ionosphere photometer	√(Multi-angle)		√	
		Solar X-EUV Imager	√			

D/B service will chang from FY-3D

The X-band transmission [new] will be used to broadcast real-time data of all instruments in MPT format.

The L-band HRPT format transmission, currently available on FY-3A/B/C, will be used to broadcast data of selected channels of MERSI instrument.

■**MPT (Medium Resolution Picture Transmission)**

7820MHz – All instruments' data

■**HRPT (High Rate Picture Transmission)**

1704.5MHz – Data of selected MERSI channels

Outlook of Future CMA LEO Constellation

Sun-Synchronous Polar-orbiting

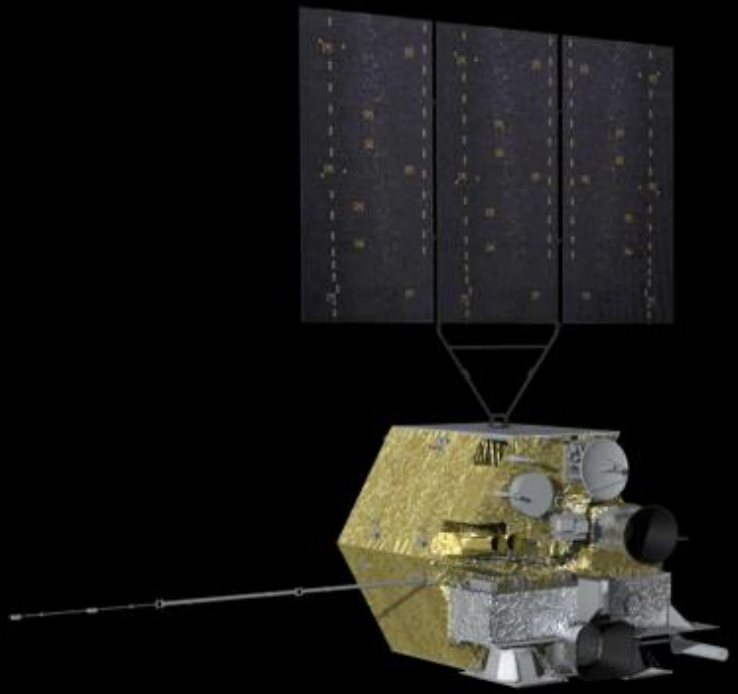
FY-3 AM (or possible early-morning) 2017

FY-3 PM polar-orbiting

Non-Sun-Synchronous

FY-3 RM 2019

China's new generation geostationary meteorological satellite FY-4



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: >= 3200W
7. Design life: over 7 years

GIIRS: Geo. Interferometric Infrared Sounder
AGRI: Advanced Geosynchronous Radiation Imager
LMI: Lightning Mapping Imager
SEP: Space Environment Package

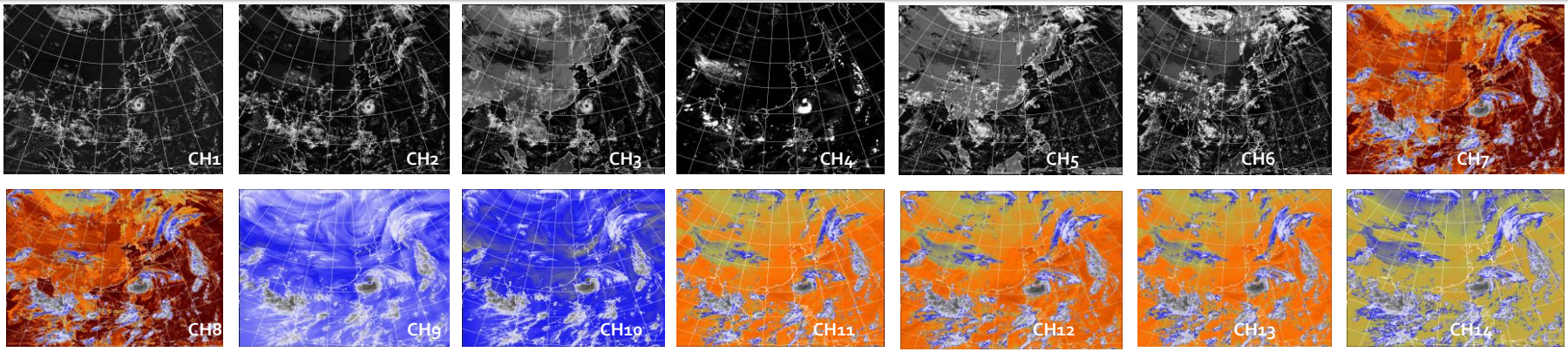
Advancement of FY-4A compared with FY-2

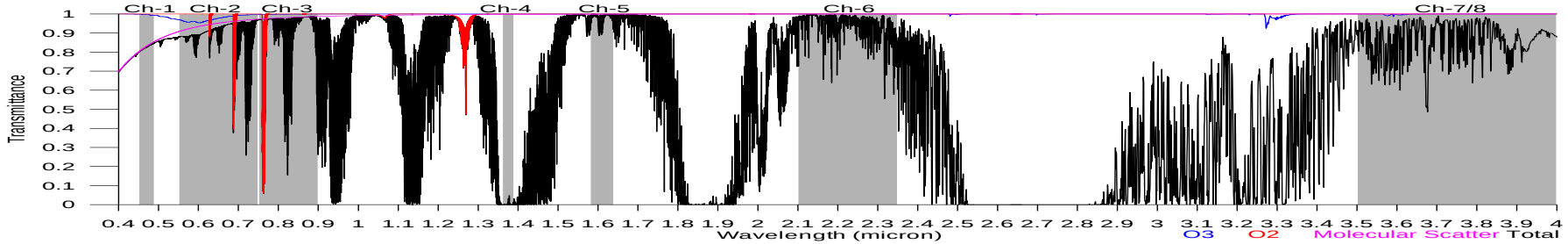
	FY-4A(EXP)	FY-2(OP)
Stabilization	**Three-axis**	**Spin**
Designed Life	**5~7 Years**	**4 Years**
Observation Efficiency	**85%**	**5%**
Observation Mode	**Imaging +Sounding + Lightning Mapping**	**Imaging Only**
Main Instruments	**AGRI :14 channels** SSP Resolution：0.5~4Km Global imaging：15min Flexible 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

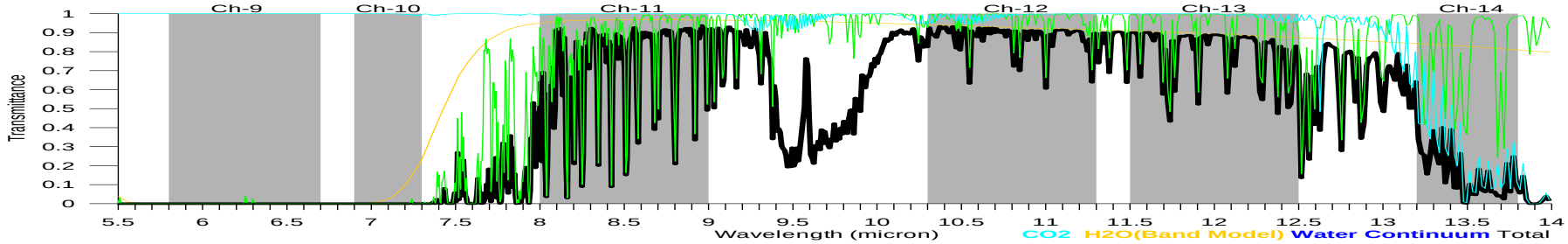
Chinese FengYun Geo. imaging capability

	FY-2 F/G/H VISSR			FY-4A AGRI			
Channel	Band	Spatial Resolution	Sensitivity	Band	Spatial Resolution	Sensitivity	Main Application
Visible & Near-Infrared				0.45～0.49	1	S/N≥90 (ρ=100%)	Aerosol
	0.55～0.75	1.25	2.3 @ρ=1%	0.55～0.75	0.5～1	S/N≥200 (ρ=100%)	Fog, Clound
				0.75～0.90	1	S/N≥5(ρ=1%)@0.5Km	Vegetation
Short-wave Infrared				1.36～1.39	2	S/N≥200 (ρ=100%)	Cirrus
				1.58～1.64	2	S/N≥200 (ρ=100%)	Cloud,Snow
				2.1～2.35	2～4		Cirrus,Aerosol
Mid-wave Infrared				3.5～4.0(High)	2	NEΔT≤0.7K(300K)	Fire
	3.5～4.0	5	0.22K@300K	3.5～4.0(Low) *	4	NEΔT≤0.2K(300K)	Land surface
Water Vapor				5.8～6.7	4	NEΔT≤0.3K(260K)	WV
	6.3～7.6	5	0.30K@260K	6.9～7.3	4	NEΔT≤0.3K(260K)	WV
Long-wave Infrared				8.0～9.0*	4	NEΔT≤0.2K(300K)	WV,Cloud
	10.3～11.3	5	0.12K@300K	10.3～11.3*	4	NEΔT≤0.2K(300K)	SST
	11.5～12.5	5	0.16K@300K	11.5～12.5*	4	NEΔT≤0.2K(300K)	SST
				13.2～13.8*	4	NEΔT≤0.5K(300K)	CTH

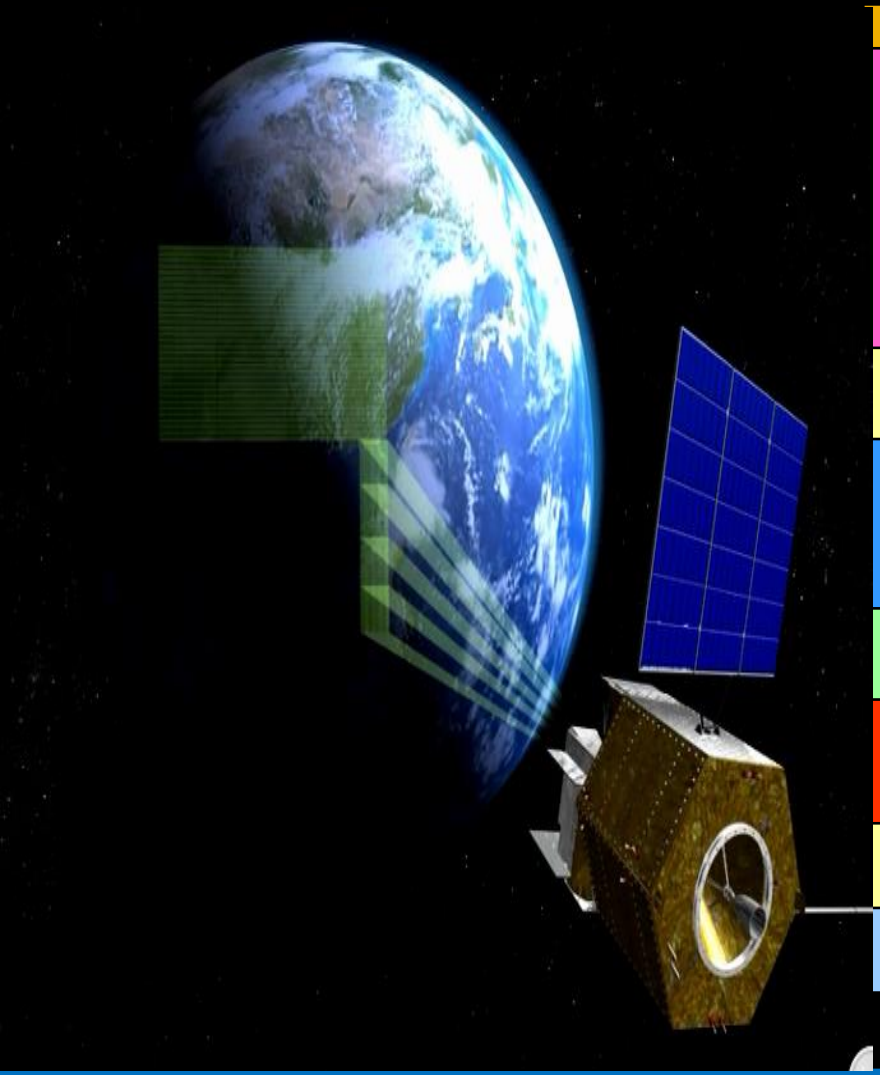
FY-4A AGRI:


CH1
CH2
CH3
CH4
CH5
CH6
CH7
CH8
CH9
CH10
CH11
CH12
CH13
CH14


Ch-1 Ch-2 Ch-3 Ch-4 Ch-5 Ch-6 Ch-7/8
Transmittance
Wavelength (micron)
O3 O2 Molecular Scatter Total

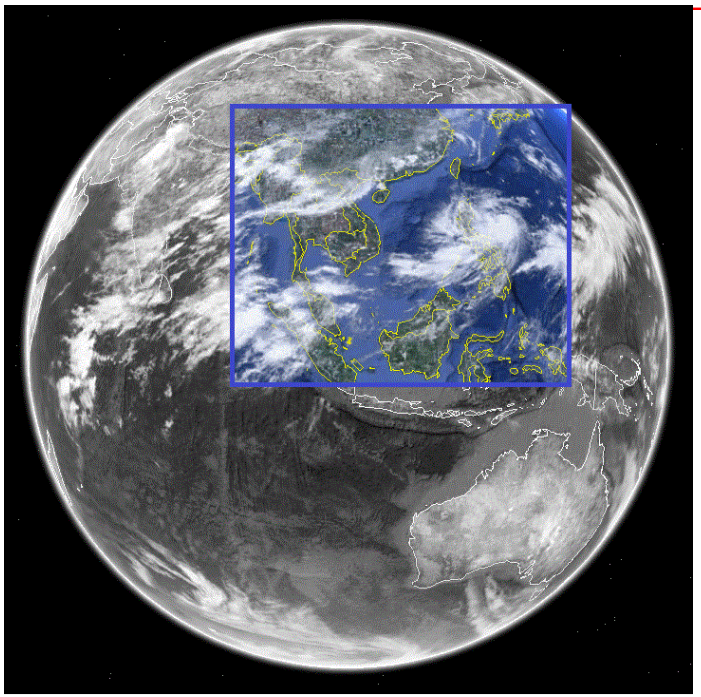

Ch-9 Ch-10 Ch-11 Ch-12 Ch-13 Ch-14
Transmittance
Wavelength (micron)
CO2 H2O(Band Model) Water Continuum Total

FY-4 GIIRS:
Geo. Interferometric Infrared Sounder

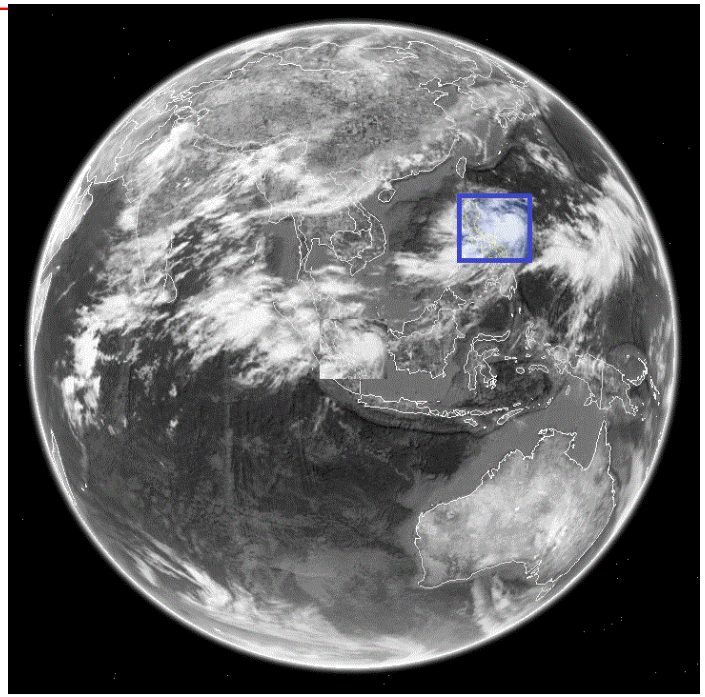


	FY-4A (R&D)	FY-4B (Operational)
Spectral Parameters (Normal mode)	Range Resolution Channels LWIR: 700-1130 Cm -1 0.8 538 S/MIR:1 650-2250Cm -1 1.6 375 VIS : 0.55-0.75 μm 1	Range Resolution Channels LWIR: 700-1130 0.625 688 S/MIR:1 650-2250 1.2 500 VIS : 0.55-0.75 μm 1
Spatial Resolution	LWIR/S/MIR : 16Km SSP VIS : 2Km SSP	LWIR/S/MIR : 8Km SSP
Operational Mode	China area 5000 × 5000 Km2 Mesoscale area 1000 × 1000 Km2	China area 5000 × 5000 Km2 Mesoscale area 1000 × 1000 Km2
Temporal Resolution	China area <1 hr Mesoscale area <½ hr	China area <1 hr Mesoscale area <½ hr
Sensitivity (mW/m2sr cm-1)	LWIR: 0.5 -1.1 S/MIR: 0.1-0.14 VIS: S/N>200(ρ=100%)	LWIR: 0.3 S/MIR: 0.06
Calibration accuracy	1.5k (3σ) radiation	1.0k (3σ)
Calibration accuracy	10 ppm (3σ) spectrum	5 ppm (3σ)
Quantization Bits	13 bits	13 bits

FY-4A GIIRS Normal observation mode

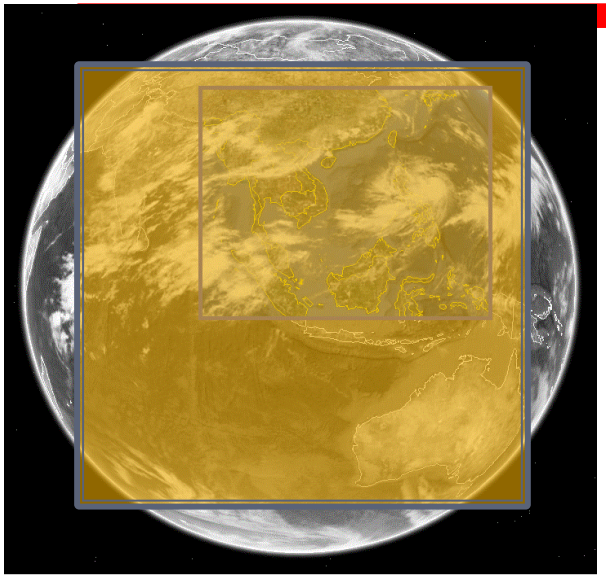


Regional:55 min 4500KMx4500KM



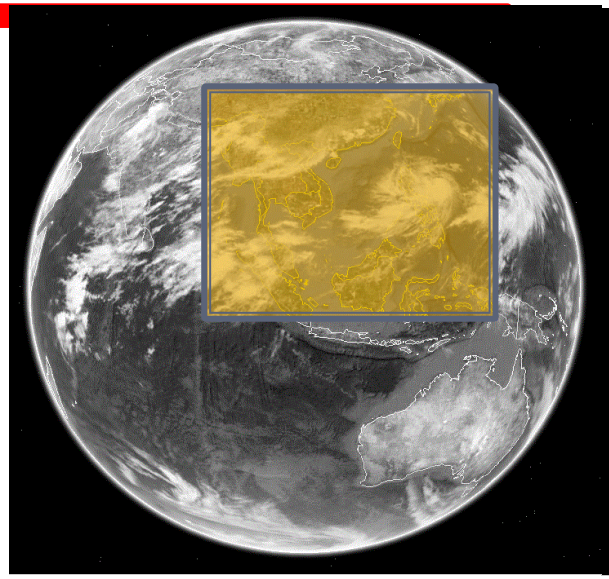
Meso-scale:30 min 1000KMx1000KM

Special Consideration on FY-4A GIIRS

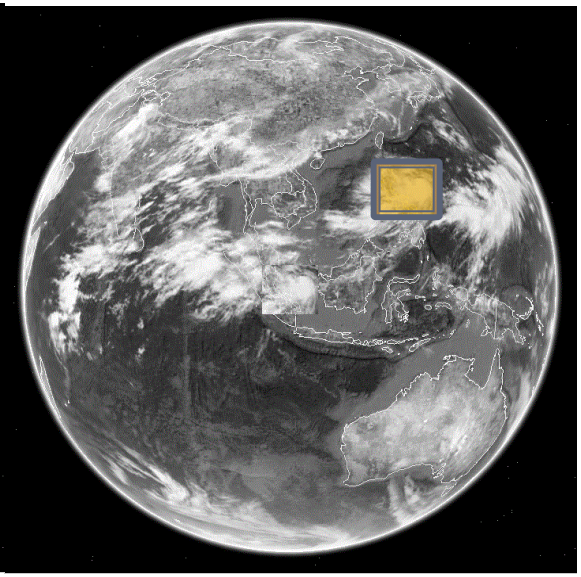


Time sensitive mode

For Global Observation



Normal mode
55 min intervals
4500KMx4500KM



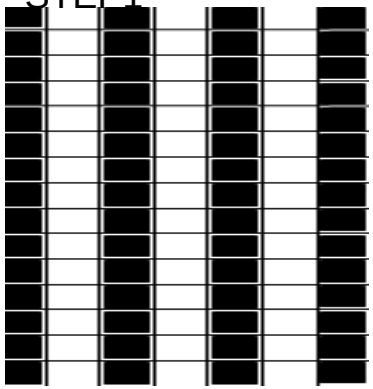
HQ mode :
55 min intervals
1250X1500Km

Special Consideration on FY-4A GIIRS

HQ mode				
Spectral Parameters (Normal mode)		Range	Resolution	Channels
	LWIR:	700-1130 Cm $^{-1}$	0.8	538
	S/MIR:1	650-2250Cm $^{-1}$	1.6	375
	VIS :	0.55-0.75 μm		1
Spectral Parameters (High Quality mode)		Range	Resolution	Channels
	LWIR:	700-1130 Cm $^{-1}$	1.6	538
	S/MIR:1	650-2250Cm $^{-1}$	3.2	375
	VIS :	0.55-0.75 μm		1

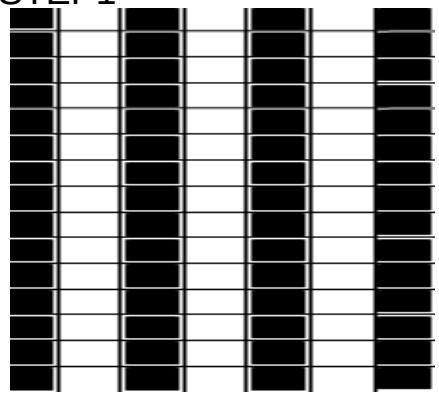
Time sensitive mode

STEP1



Normal mode

STEP1

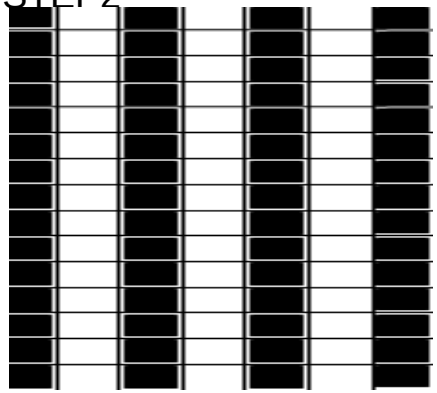


Special Consideration on FY-4A GIIRS

HQ mode				
Spectral Parameters (Normal mode)		Range	Resolution	Channels
	LWIR:	700-1130 Cm $^{-1}$	0.8	538
	S/MIR:1	650-2250Cm $^{-1}$	1.6	375
	VIS :	0.55-0.75 μm		1
Spectral Parameters (High Quality mode)		Range	Resolution	Channels
	LWIR:	700-1130 Cm $^{-1}$	1.6	538
	S/MIR:1	650-2250Cm $^{-1}$	3.2	375
	VIS :	0.55-0.75 μm		1

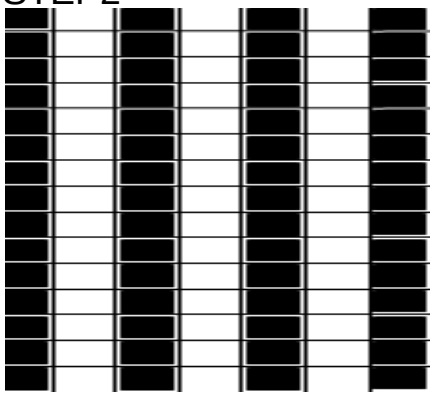
Time sensitive mode

STEP2



Normal mode

STEP2

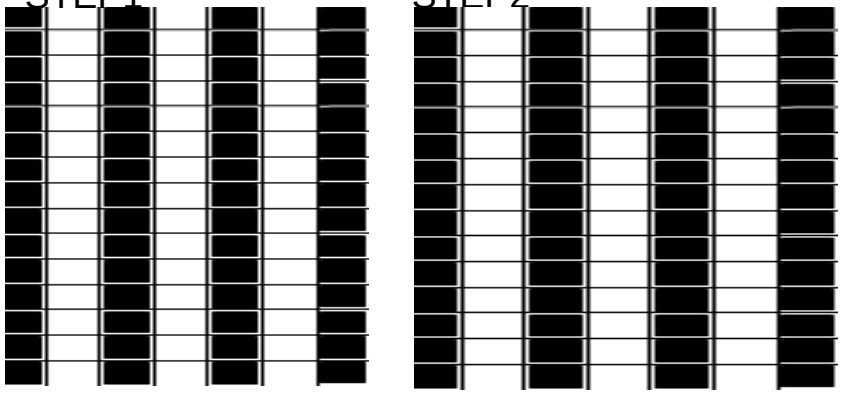


Special Consideration on FY-4A GIIRS

HQ mode				
Spectral Parameters (Normal mode)		Range	Resolution	Channels
	LWIR:	700-1130 Cm $^{-1}$	0.8	538
	S/MIR:1	650-2250Cm $^{-1}$	1.6	375
	VIS :	0.55-0.75 μm		1
Spectral Parameters (High Quality mode)		Range	Resolution	Channels
	LWIR:	700-1130 Cm $^{-1}$	1.6	538
	S/MIR:1	650-2250Cm $^{-1}$	3.2	375
	VIS :	0.55-0.75 μm		1

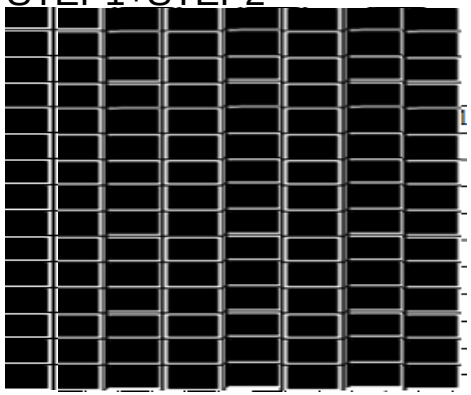
Time sensitive mode

STEP1 STEP2

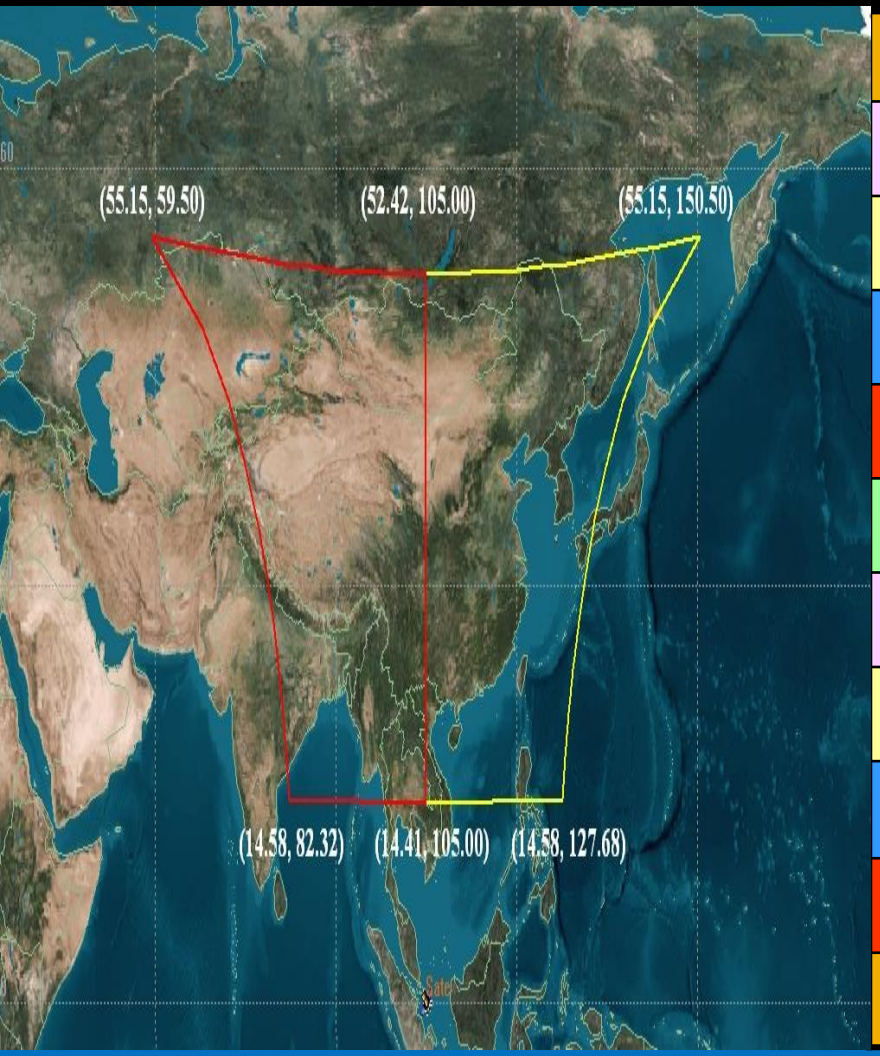


Normal mode

STEP1+STEP2



FY-4A LMI: Lighting Mapping Imager



Spatial resolution	about 6 km 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 (500 Frames per sec.)
Quantization	12 bits
Measurement Error	10%

FY-4A observation mode

AGRI : Baseline observation is every 3 hours , make 3 FD observation, each observation last 15 minutes. Deriving AMV ,Cloud, Precipitation, Radiance products, and support global NWP.

- **FOM(Fundamental Observation Mode):**
  40FD,56NH/Day

- **ROM(Reinforced Observation Mode): Jun-September**
  40FD,112NH/Day, Provide 7.5min interval NH observation

- **EOM(Emergency Observation Mode): thunderstorms and severe weather**
  24FD , Other time for 2.5/5/7.5 min RRS upon user order.

FY-4A observation mode(cont.)

GIIRS: Continuous observation, Hourly-Renewal

LMI: Continuous observation

SEP: Continuous observation

Outlook of Future CMA GEO Constellation

1st Genereation Operational
FY-2H 2017

2nd Genereation R&T
FY-4A 2016

2nd Genereation Operational
FY-4B /C 2018 …

Topics

1)Overview of CMA satellite plan

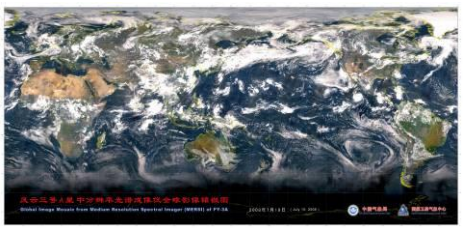
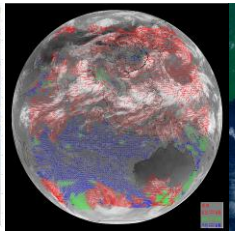
2)Updates of CMA Meteorological satellite system

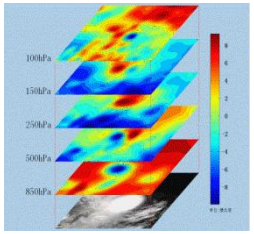
3)The future CMA satellite program

4) The products and applications under developmet

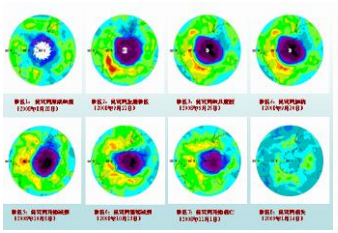
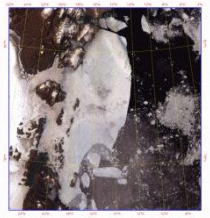
Fengyun satellite Applications

Weather

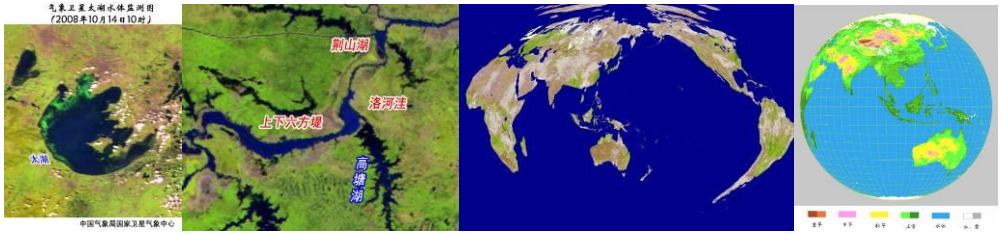





Climate

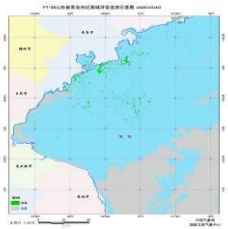
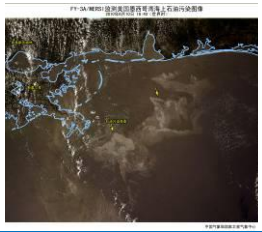
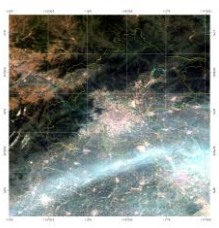
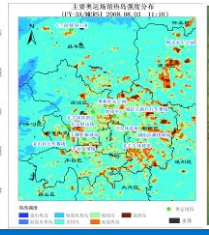
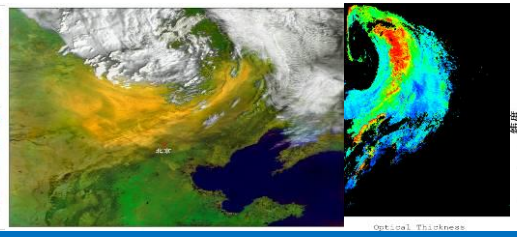



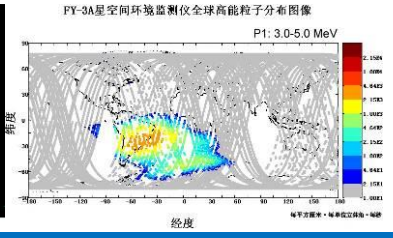
Resource



Disaster

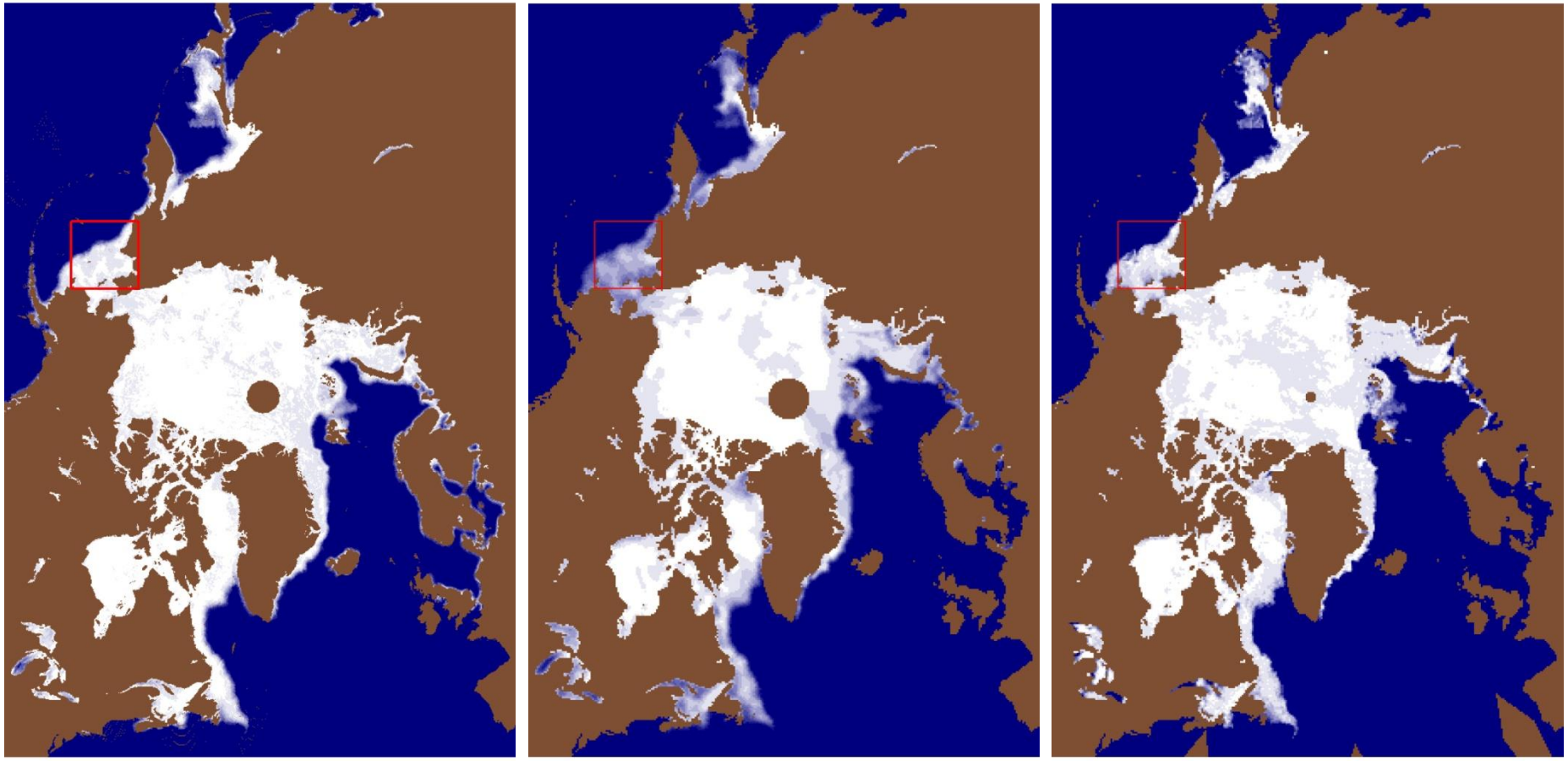
Environment

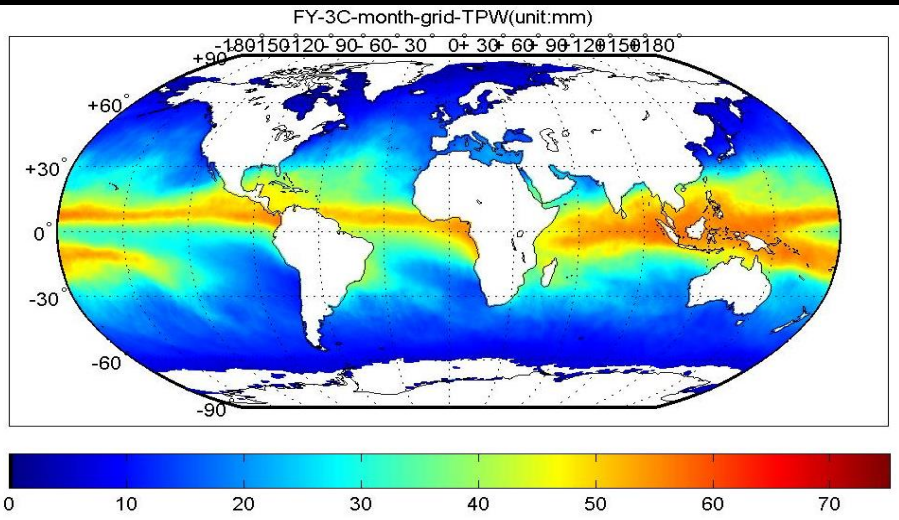


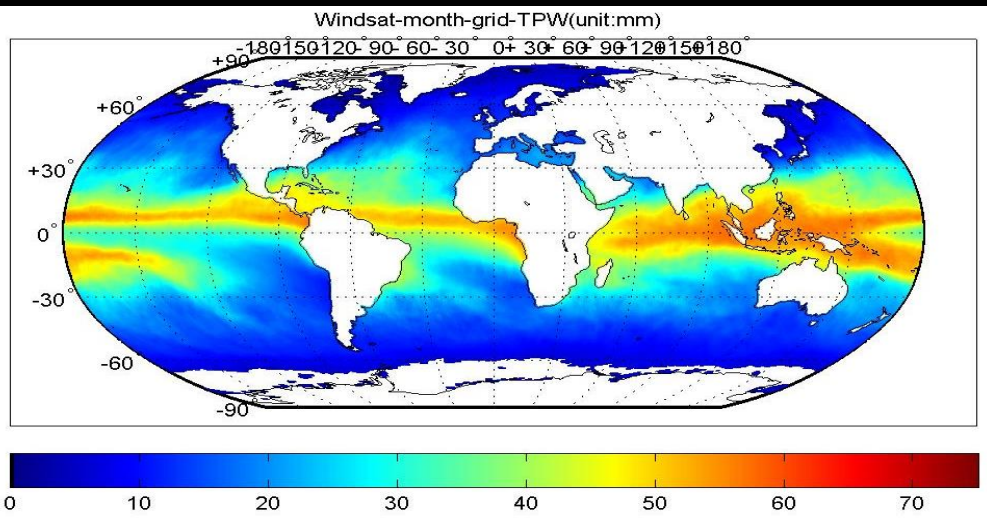
Fy-3C products by example

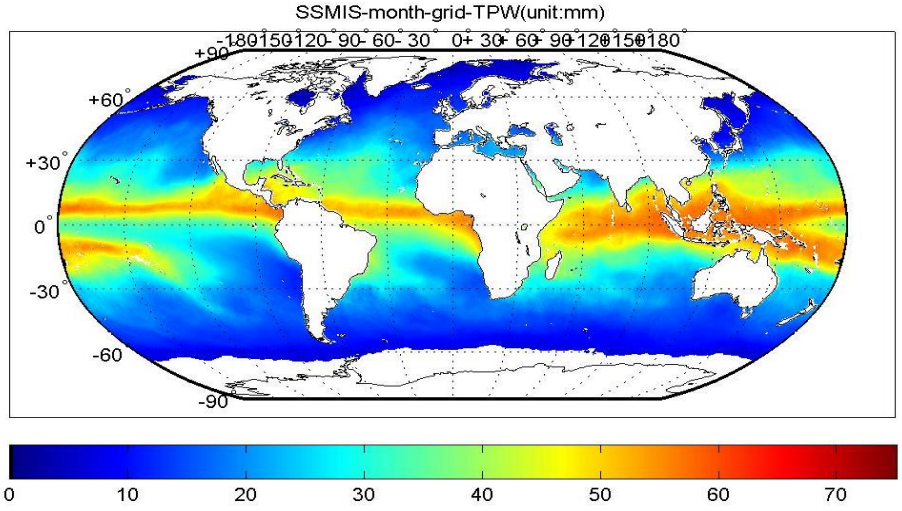
FY3 SSMI AMSR2



Fy-3C products by example

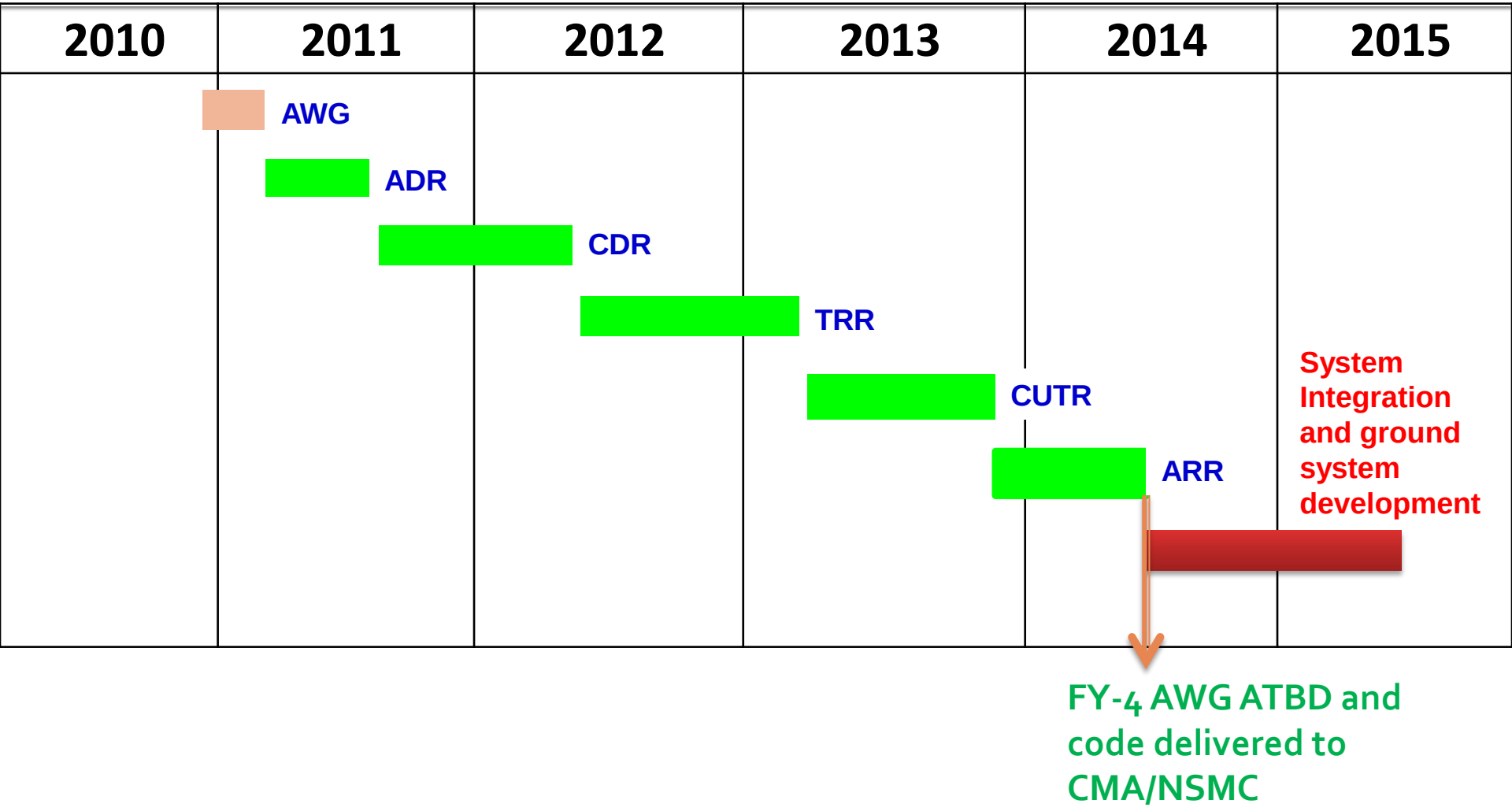






satellite		samples	bias (mm)	RMSE (mm)	Correlation coefficient
FY3C	SSMIS	510763	0.3760	1.2812	0.9965
FY3C	Windsat	515952	0.4654	1.3293	0.9963
Windsat	SSMIS	505349	-0.0685	1.2476	0.9963

FY-4A algorithm development finished



Products: Imager based

FY-2 C/D/E operational products	FY-2 F/G/H operational products	FY-4A baseline products
Cloud Detection	Cloud Detection	Clear Sky Masks
Cloud Classification	Cloud Classification	Cloud Type
Total Cloud Amount	Total Cloud Amount	
		Cloud Optical Depth
		Cloud Liquid Water
		Cloud Particle Size Distribution
		Cloud Phase
	Cloud Top Temperature	Cloud Top Temperature
		Cloud Top Height/Pressure
		Fog Detection
Dust Detection	Dust Detection	Aerosol Detection
		Aerosol Optical Depth
Humidity product	Humidity product	
		Tropopause Folding

Products: Imager based(cont.)

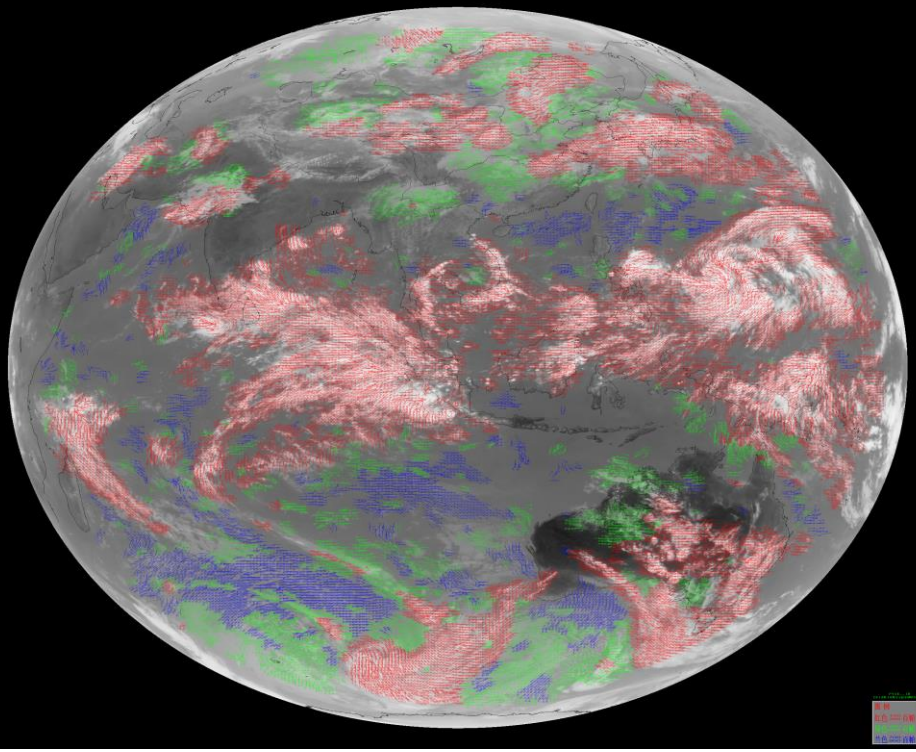
FY-2 C/D/E operational products	FY-2 F/G/H operational products	FY-4A baseline products
Upper Tropospheric Humidity	Upper Tropospheric Humidity	
Precipitation Estimation	Precipitation Estimation	Rainfall Rate/QPE
	Atmospheric Motion Vector	Atmospheric Motion Vector
Surface Solar Irradiance	Surface Solar Irradiance	Surface Solar Irradiance
Blackbody brightness temperature	Blackbody brightness temperature	Blackbody brightness temperature
Outgoing Long wave Radiation	Outgoing Long wave Radiation	Outgoing Long wave Radiation
		Downward Long wave Radiation: Surface
		Upward Long wave Radiation: Surface
		Reflected Shortwave Radiation: TOA
	Land Surface Temperature	Land Surface (Skin) Temperature
Sea Surface Temperature	Sea Surface Temperature	Sea Surface Temperature (skin)
		Land Surface Temperature
		Land Surface Albedo
		Land Surface Emissivity
Snow Cover	Snow Cover	Snow Cover
		Fire/Hot Spot Characterization

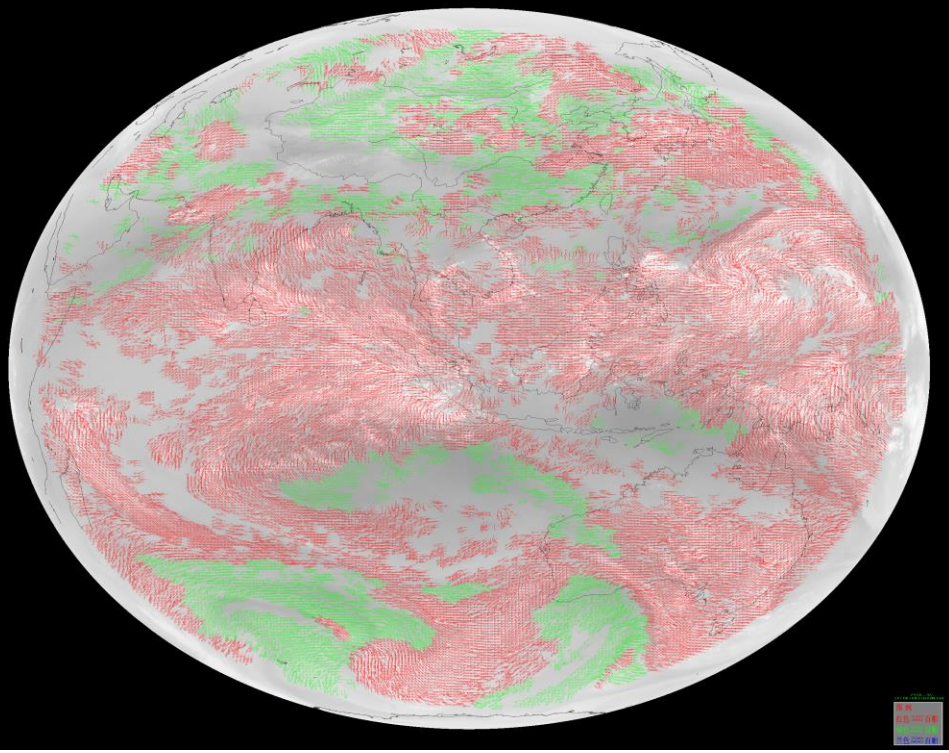
FY-4 Products: Sounder or Lightning Mapper based

FY-2 C/D/E operational products	FY-2 F/G/H operational products	FY-4A baseline products
		Temperature Profile
		Moisture Profile
		Ozone Profile
		Total Ozone
		Total preceptible water
		Lifted Index
		CAPE index
		K index
		SI index
		TT index

FY-2 C/D/E operational products	FY-2 F/G/H operational products	FY-4A baseline products
		Flash
		Group
		Event

FY-4A AGRI products by example





CH12	10.3～11.3	64km
CH10	6.9～7.3	64km
CH09	5.8～6.7	64km
CH02	0.55～0.75	16km

Long-wave IR Cloud-drift Winds

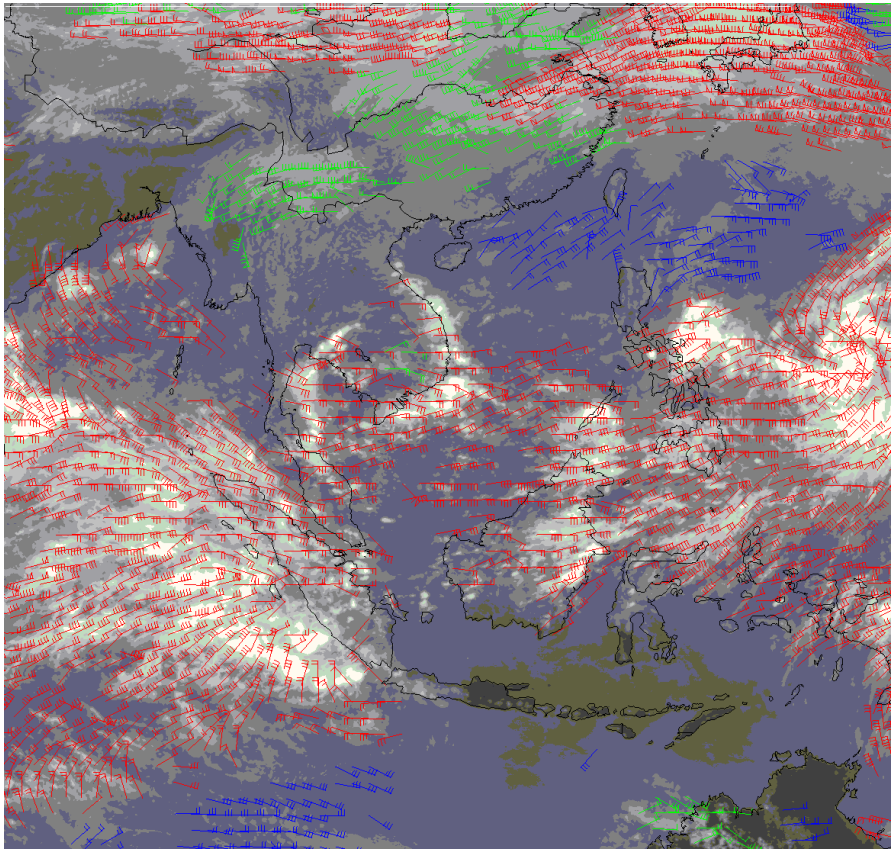
- Day and night; Lower, mid, and upper troposphere

Water Vapor Winds

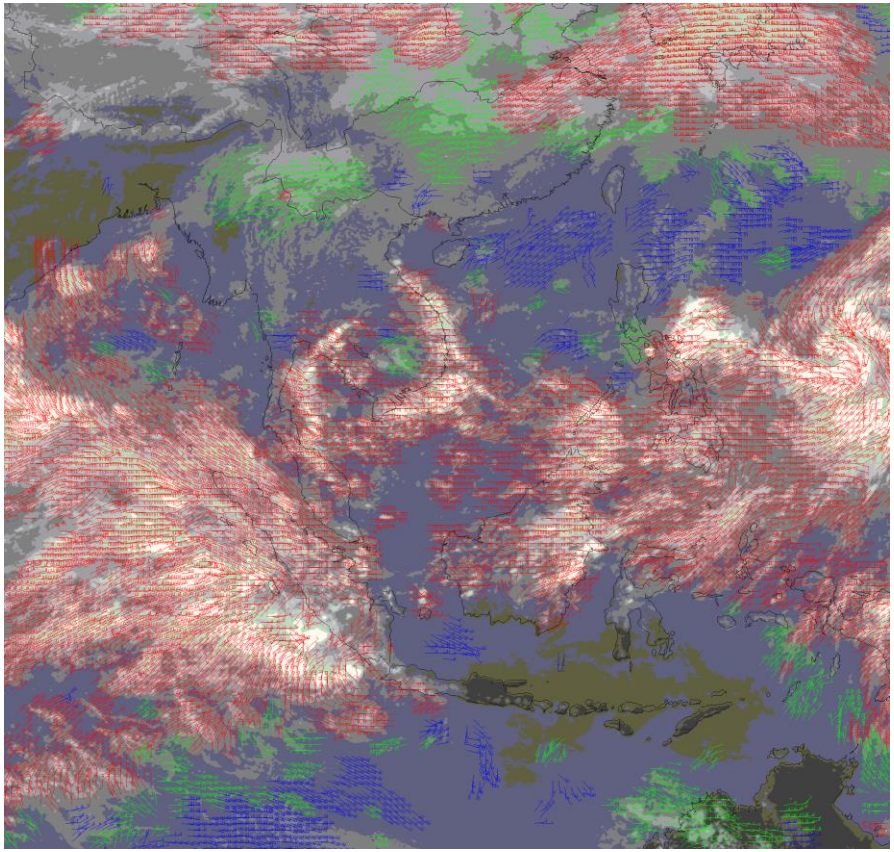
- Cloud-top and Clear-sky; Mid and Upper troposphere

Courtesy of Prof. Jianmin Xu &Xiaohu Zhang-NSMC FY-4 AWG

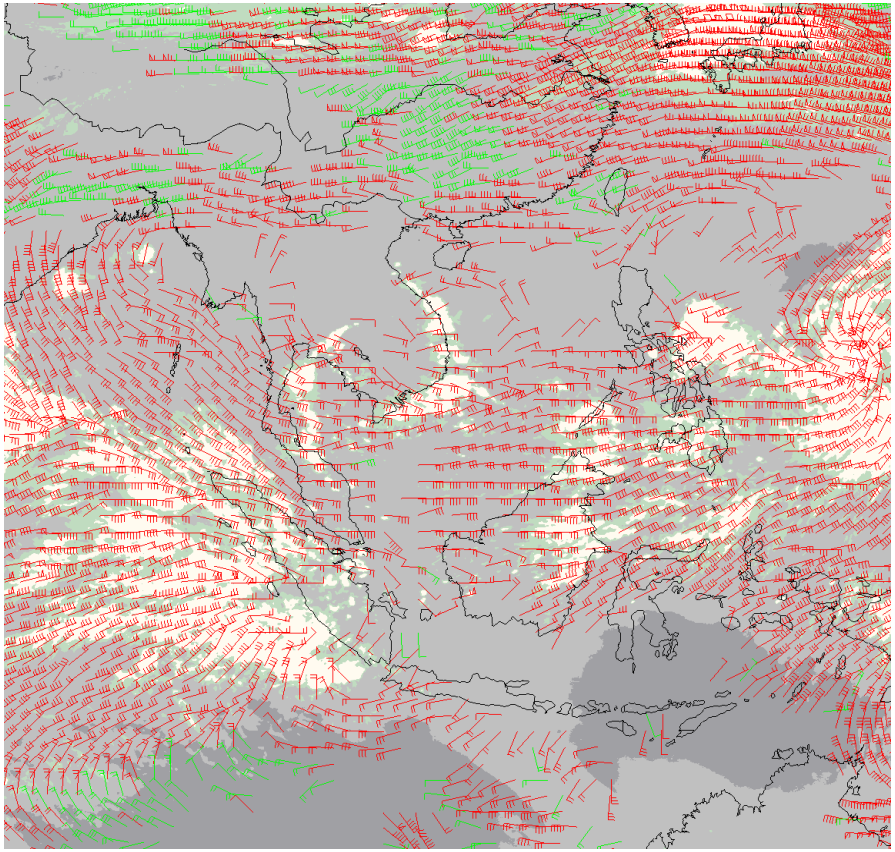
CMA current operational IR AMV



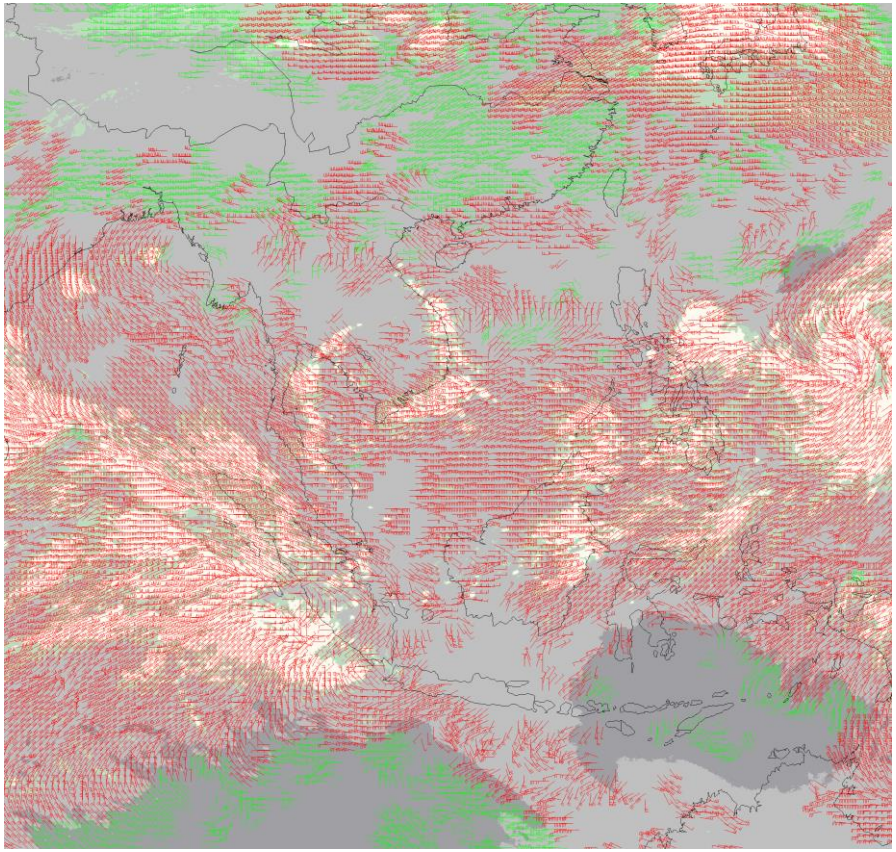
CMA next generation IR AMV



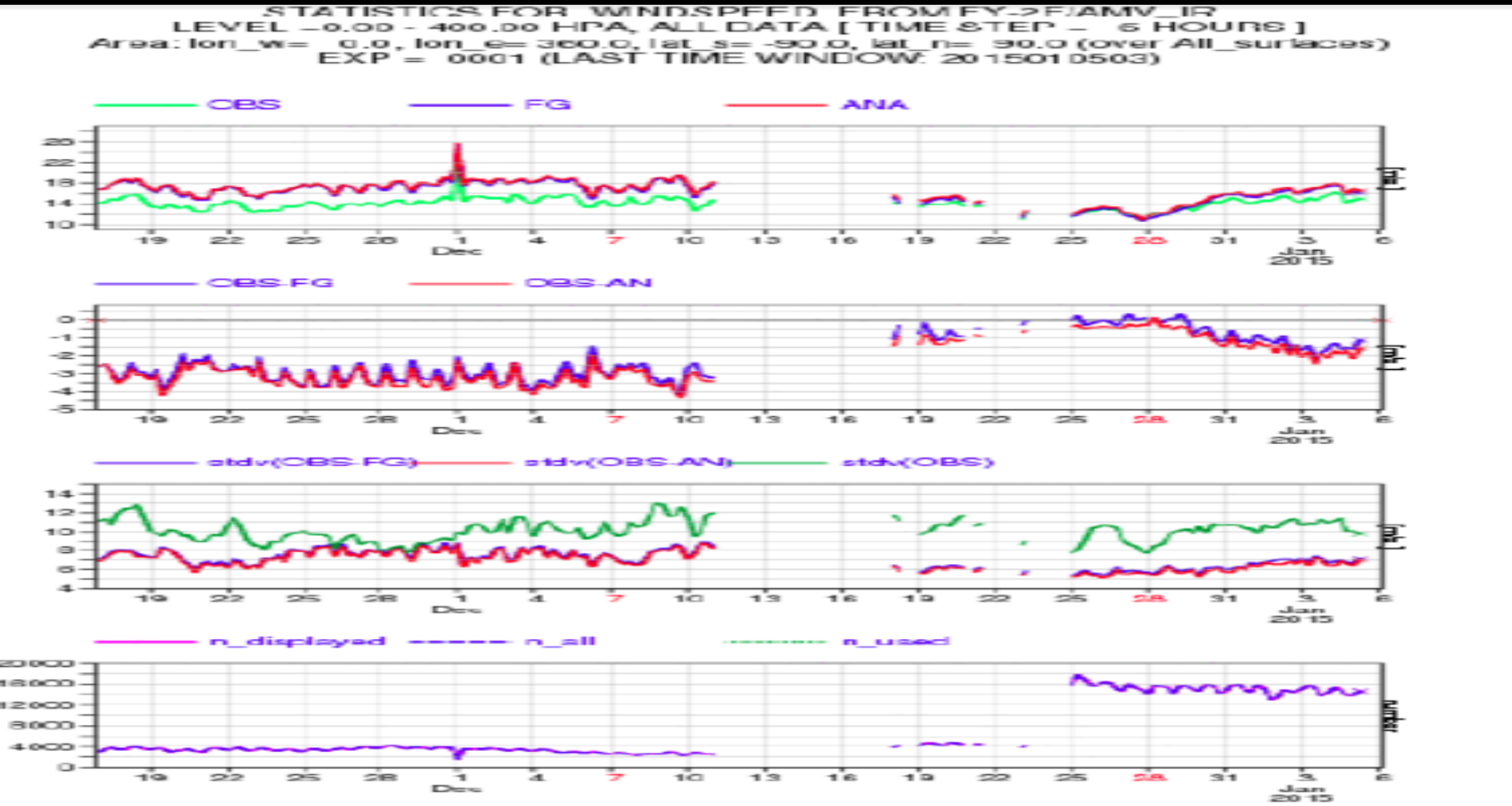
CMA current operational WV AMV



CMA next generation WV AMV

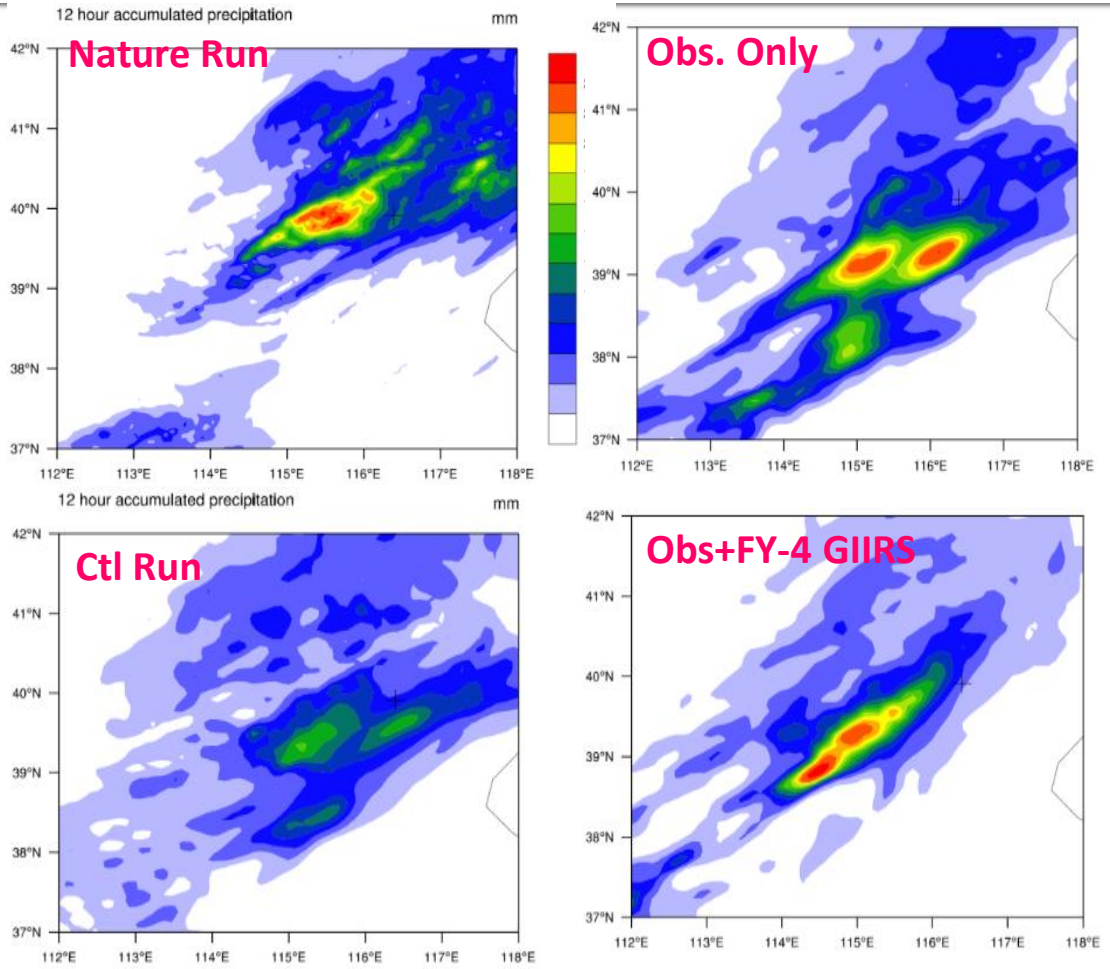


Validation on FengYun Geo AMVs



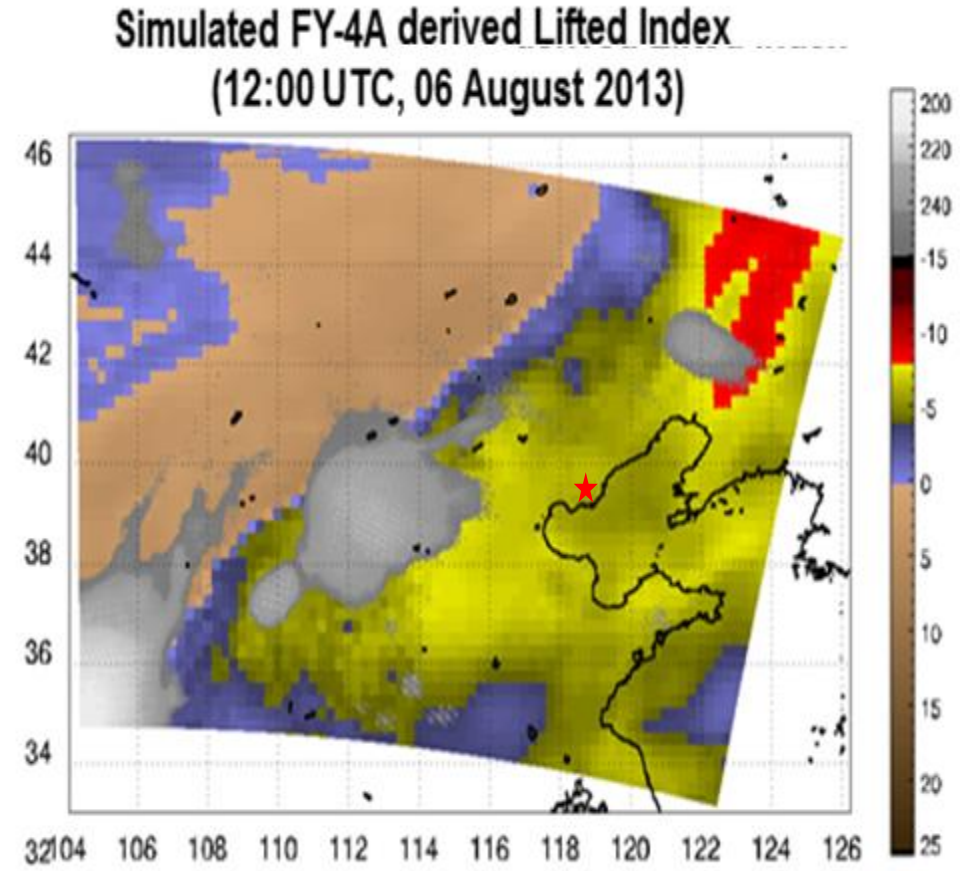
(statistics for windspeed from ECMWF website)

FY-4A GIIRS product Validation(OSSE)

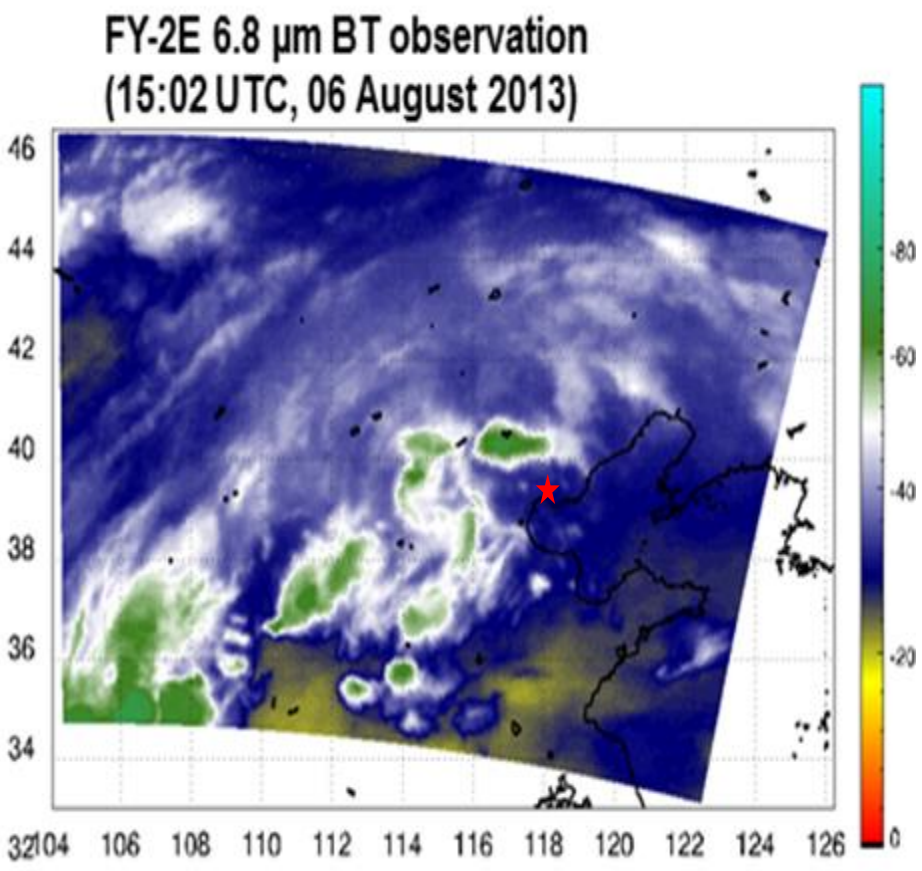


Courtesy of Dr. Jun Li-NSMC FY-4 AWG

Supporting now casting: Lifted index products

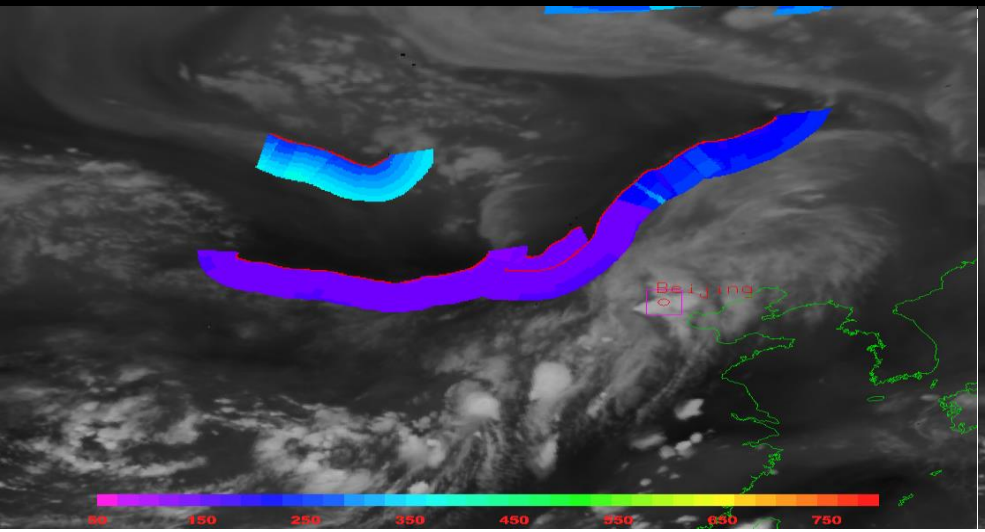


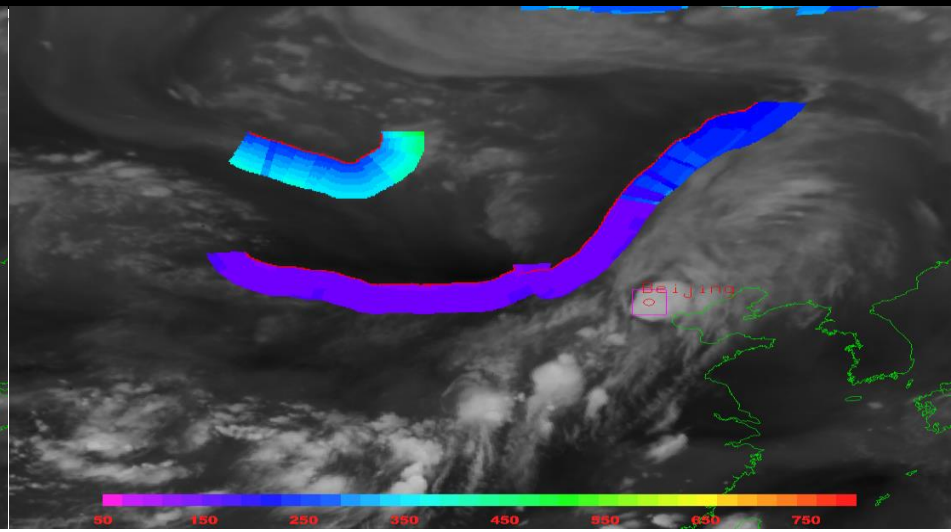
FY-4 GIIRS LIFTED INDEX 12 UTC



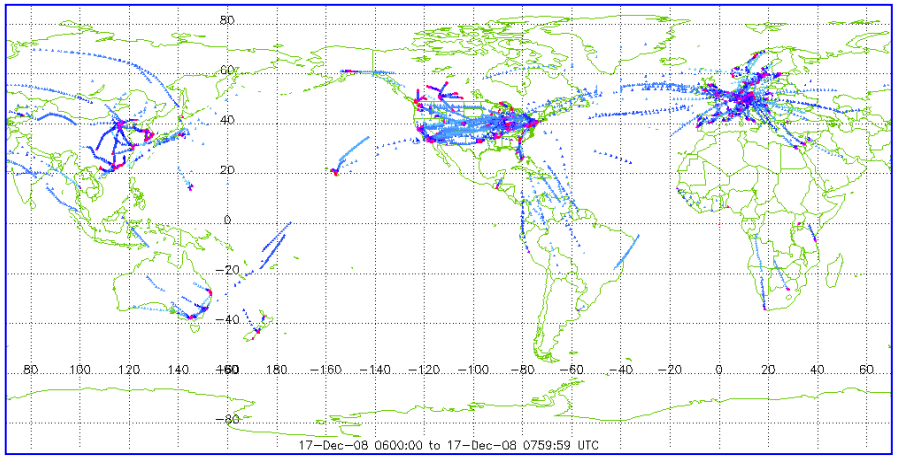
FY-2E WV IMAGES 15 UTC

Supporting now casting &aviation Service: TFTP

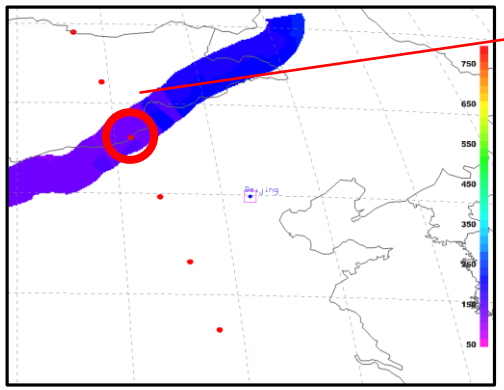




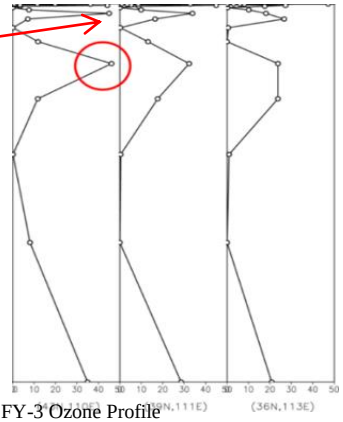
2012 0721 10UTC



2012 0721 12UTC



2012 0721 0500UTC TFTP

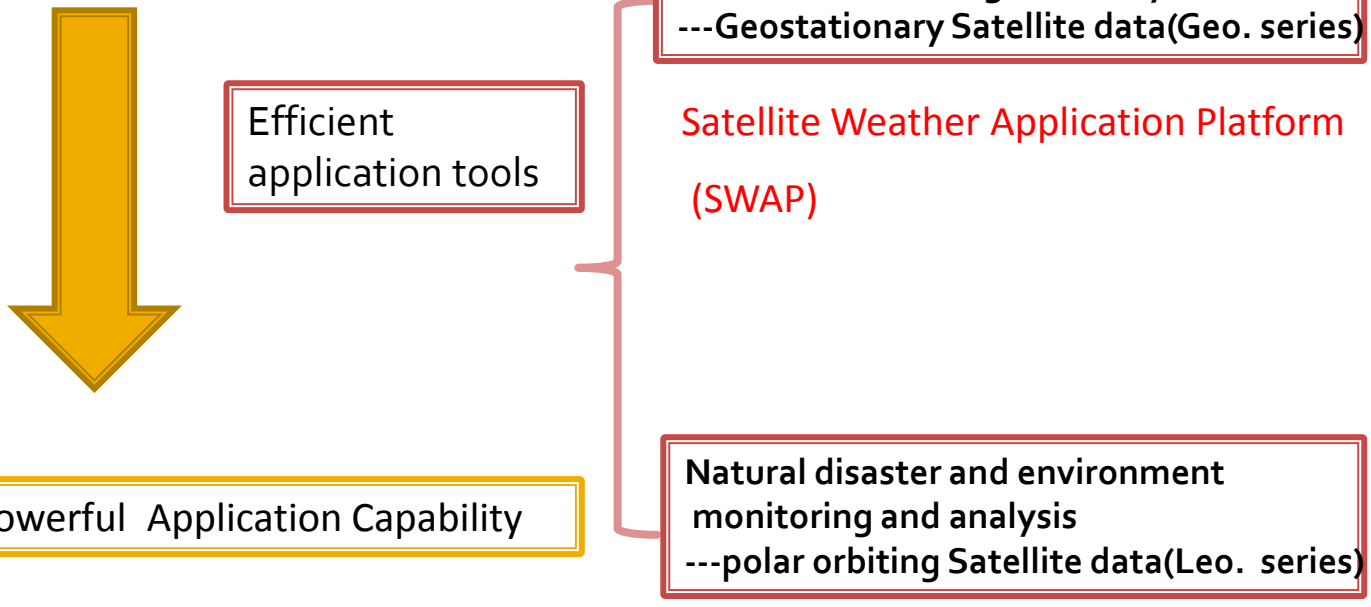


FY-3 Ozone Profile

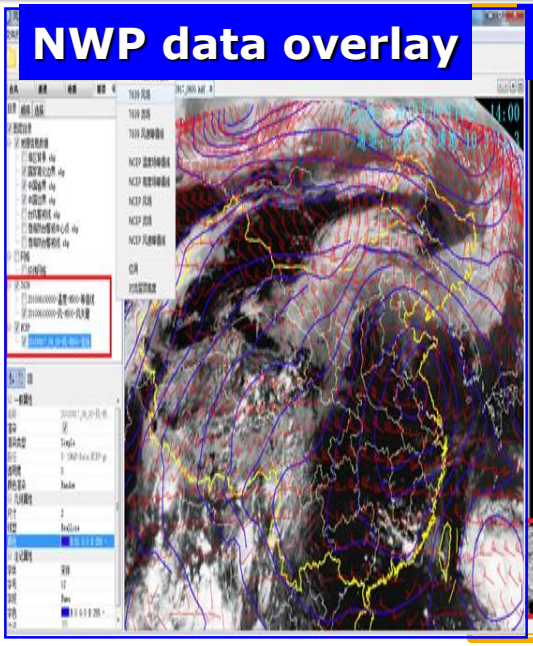
Courtesy of Dr. Yixuan Shou–NSMC FY-4 AWG

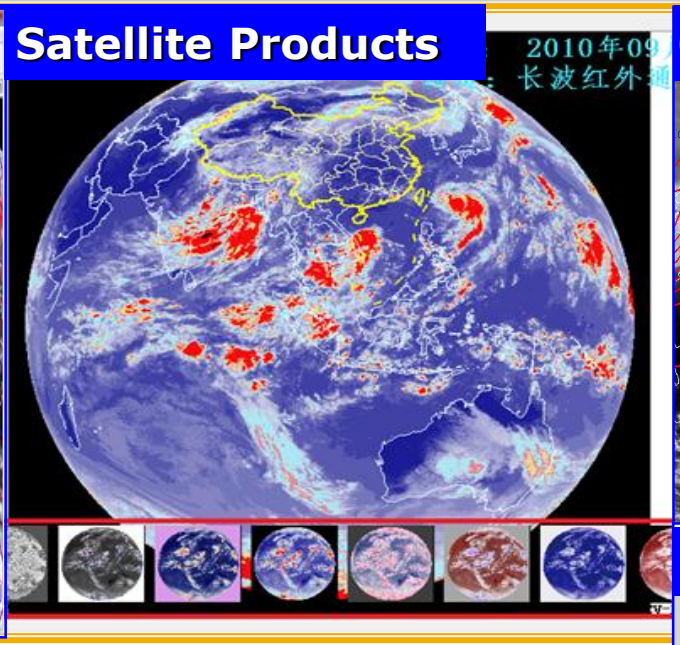
Satellite Application Facility

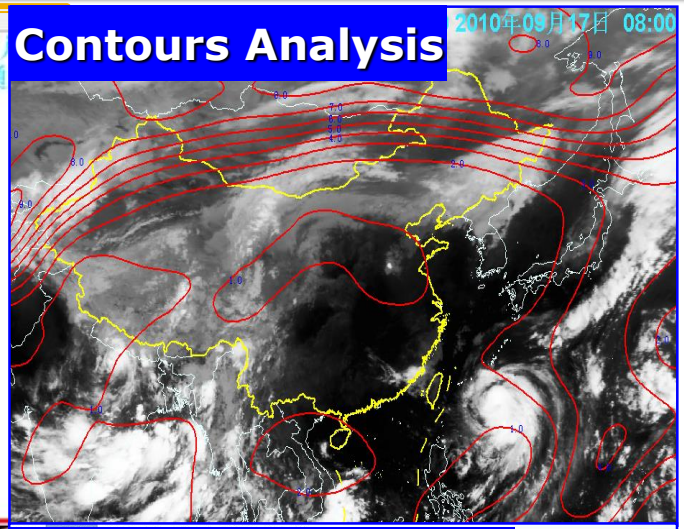
CMA Concerns on Satellite Application Platforms

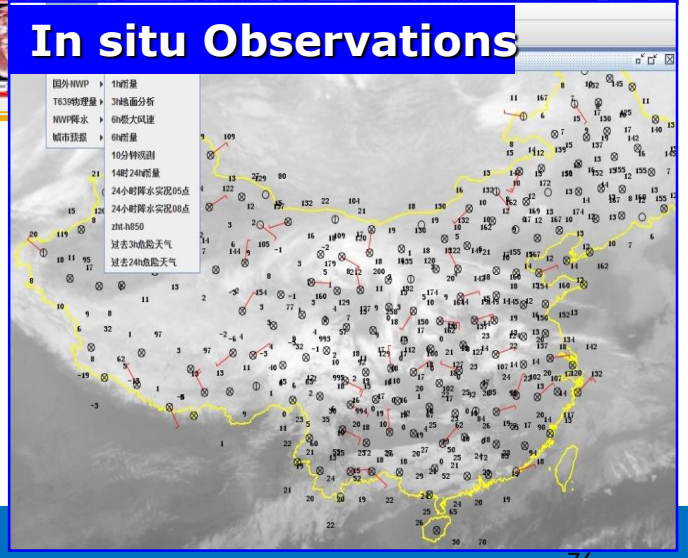


Preparing Users to FY-4:Upgrade Satellite Weather Application Platform(SWAP) support FY-4









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

How to Access?

1) DB Users （registed user）

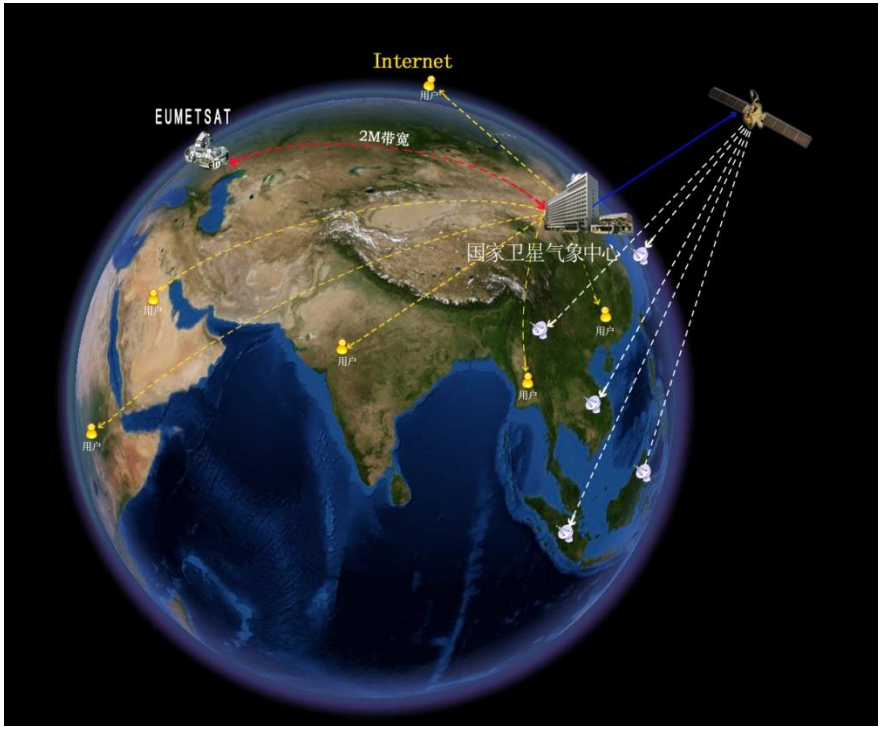
2) CMACAST （registed user）

3) Web-based Service（registed user）

4) FTP Push （ specific applications ）

5) FTP Pull （registed user）

6) Manual Service （ specific applications)

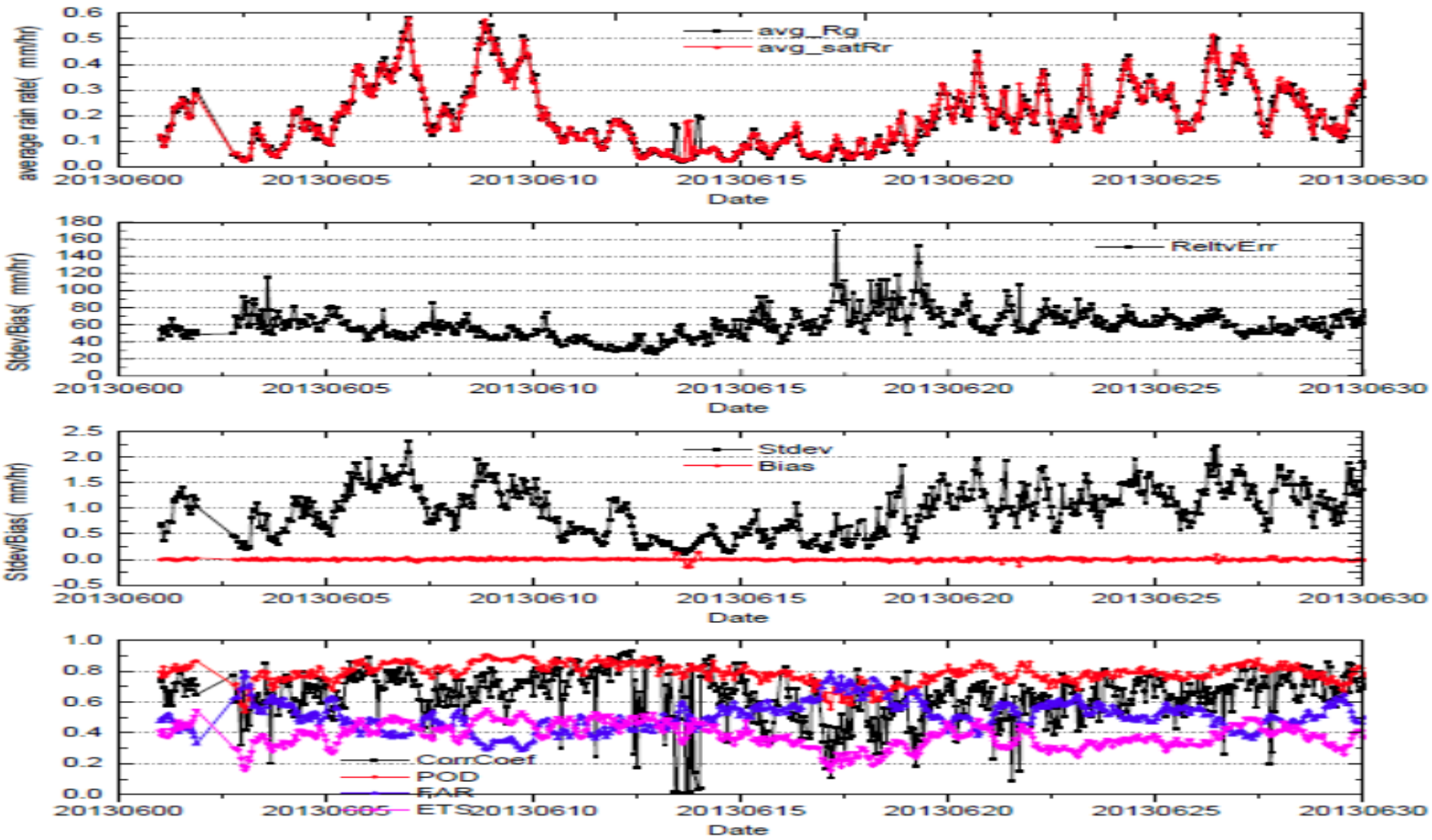


Lufeng@cma.gov.cn

Fy-2 precipitation products

The FY-2 precipitation product is generated by combining FY-2, FY-3 observations and the rain gauge data. It is produced at one hour, 3-hr, 6-hr, and 24-hr intervals. Only the hourly product is assessed in the study. One tenth of gauges are not used in combination but used as the independent.

The daily averages of hourly rain estimates have the following features:
1) The daily rainfall averages are close for the whole month;
2) The relative errors are between 30% ~ 100%, the mostly seen is 60%;
3) The standard deviations are mostly among 0 ~ 1.8 mm/hr, average values close to 1mm/hr;
4) The biases are almost equal to 0;
5) The relative coefficients fluctuate near 0.7;
6) PODs are high and mostly above 0.8, with some near 0.7;
7) FARs are varied between 0.3 ~ 0.8, mostly close to 0.5;
8) ETSs are varied between 0.2 ~ 0.5, mostly among 0.3 ~ 0.5.



Assessment for combined precipitation estimation – daily mean statistics in June 2013, including rainfall averages (a), relative coefficients (b), standard deviation and bias (c), and correlation coefficient, POD, FAR and ETS (e).