CMA report on the current and future satellite systems

Presented to CGMS-42 plenary session, agenda item [D.1]

Feng LU
National Satellite Meteorological Center, CMA

Coordination Group for Meteorological Satellites

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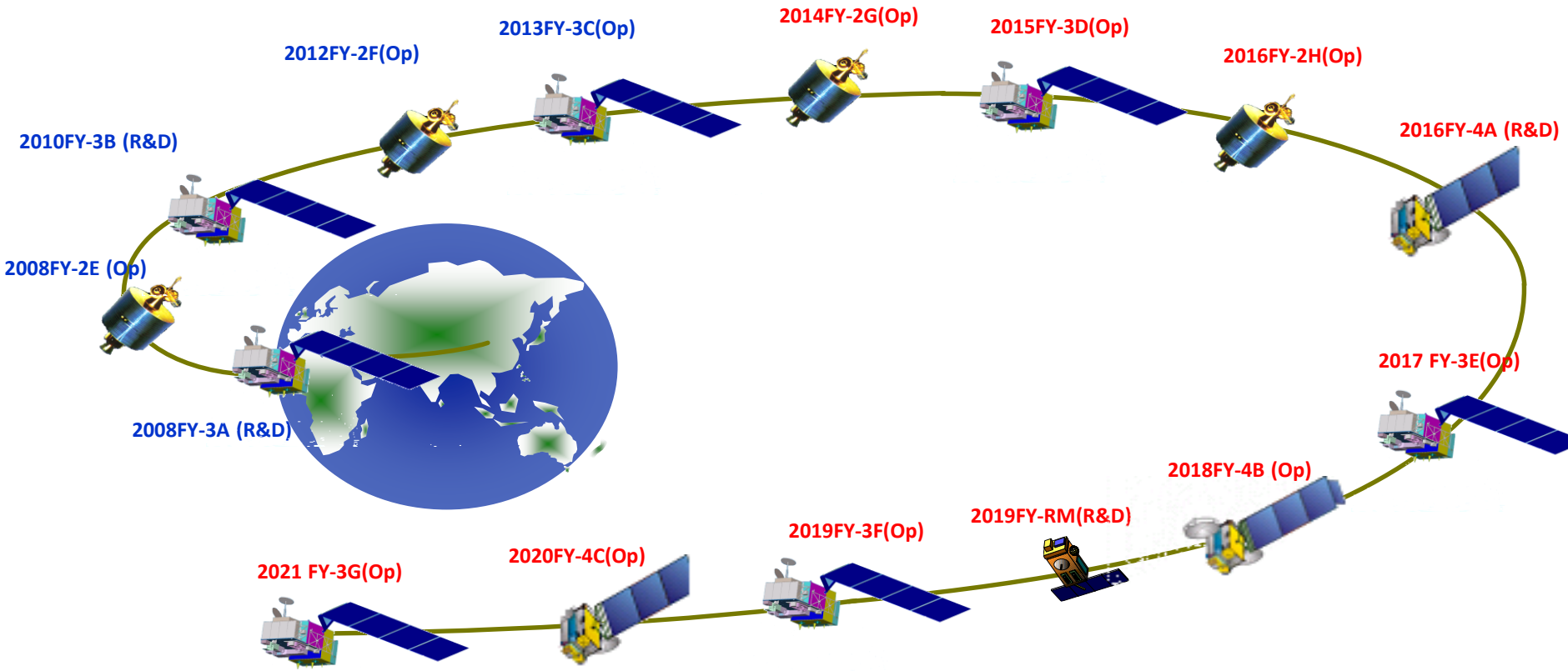
Overview - Planning of CMA satellite systems by year 2020



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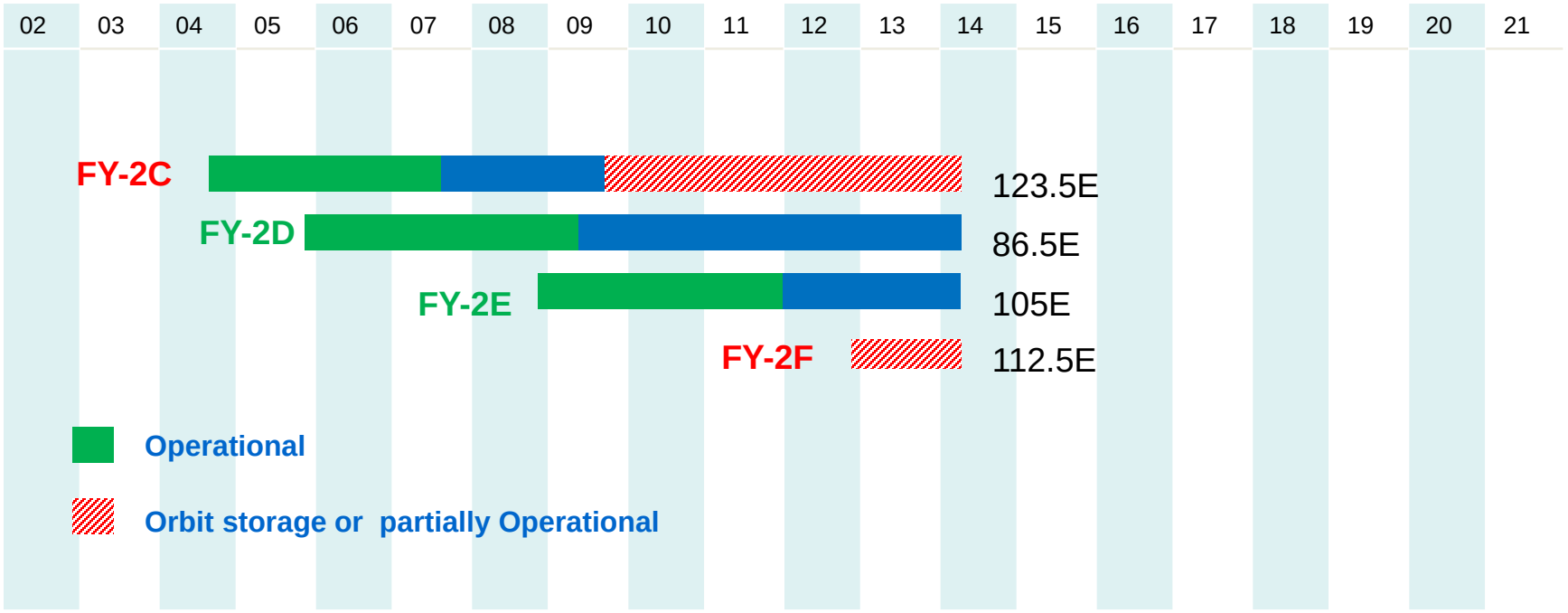
CURRENT CMA GEO SATELLITES

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



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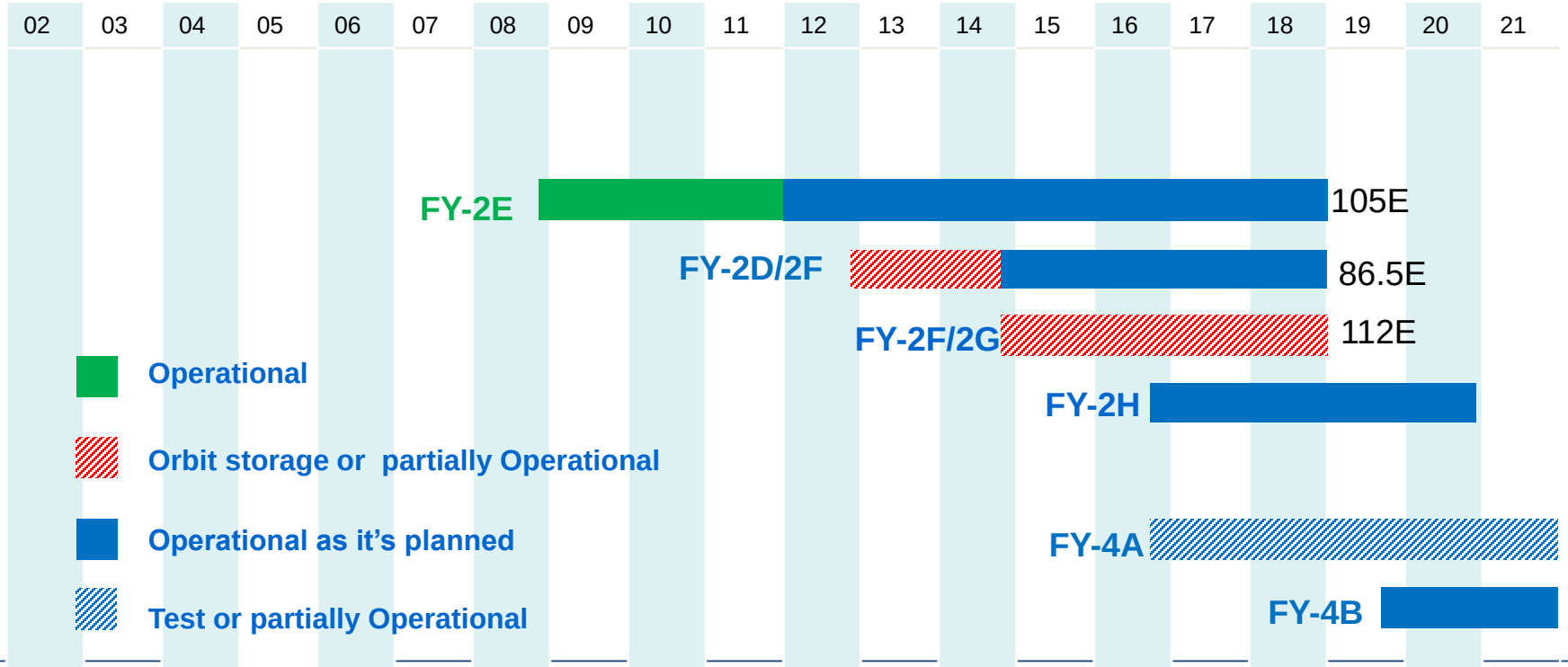
FY-2F/G/H

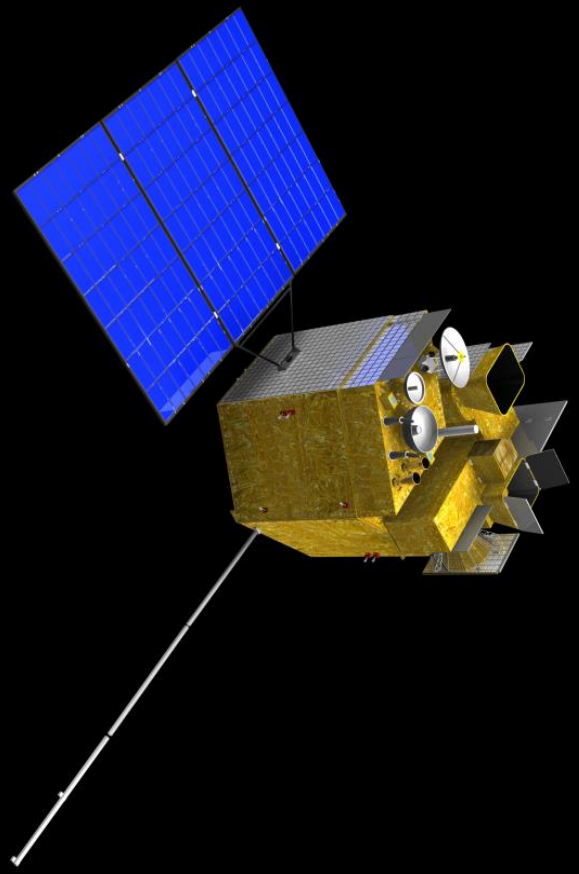
S-VISSR --- 5 channel visible and infrared spin scan radiometer		
VIS	0.50-0.75 μm	Changed! FY-C/D/E 0.50-0.9 μm
IR	6.3-7.6 μm	
WV	0.62-0.76 μm	
IR(Split windows)	10.3-11.3 μm、11.5-12.5 μm	Improved SRF function
Space Environment Monitoring – solar particle in immediate vicinity of satellite		
SEM	Space Environment Monitor	
DCPS – data collection service for 4,000 platforms at present capability		
Domestic	401.1-401.4 MHz	
International	402.0-402.1 MHz	

CMA GEO SATELLITES AFTER 2014

FY-2G will be launched in 2014, FY-2C/D is coming to the end of fuel life.



FUTURE CMA GEO SATELLITES: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

FY-4 Products

27 key products ATBD delivered to NSMC

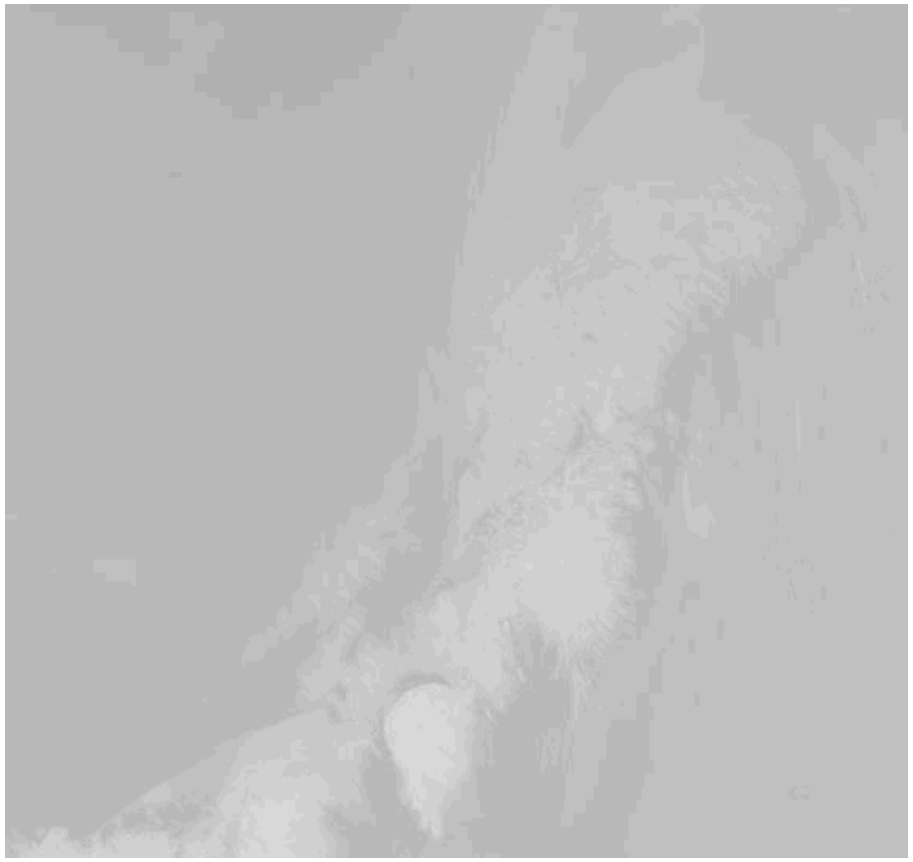
FY-2 C/D/E operational products	FY-2 F/G/H operational products	FY-4A baseline products
Upper Tropospheric Humidity	Upper Tropospheric Humidity	
Precipitation Estimation	Precipitation Estimation	Rainfall Rate/QPE
	Atmospheric Motion Vector	Atmospheric Motion Vector
		Lightning Detection
Surface Solar 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

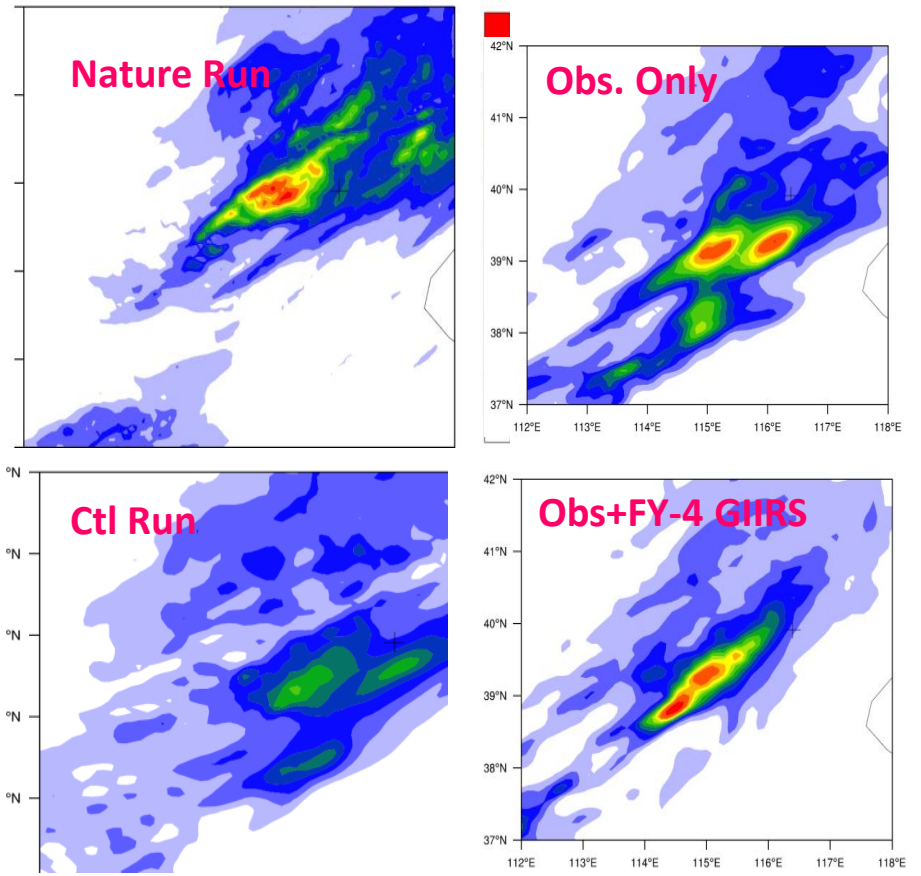
FY-4 Products

27 key products ATBD delivered to NSMC

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	

FY-4A GIIRS Applications





GIIRS simulation Jul.21,2012

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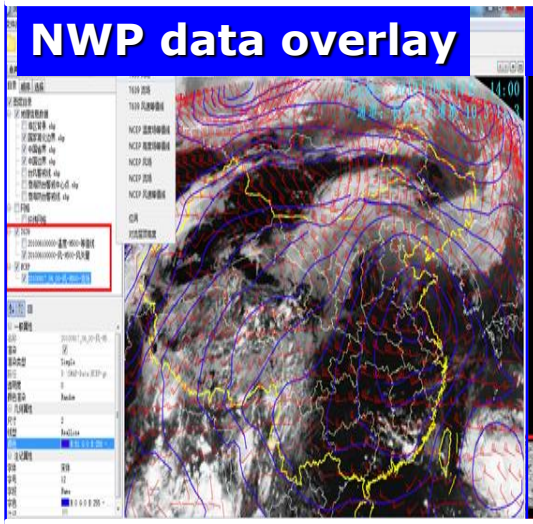
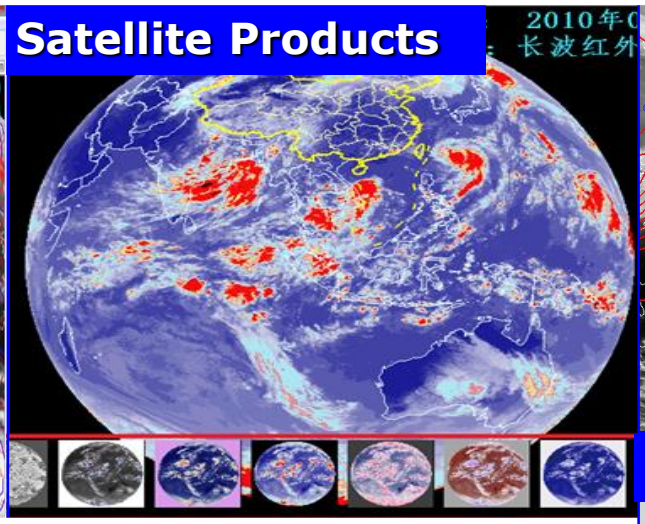
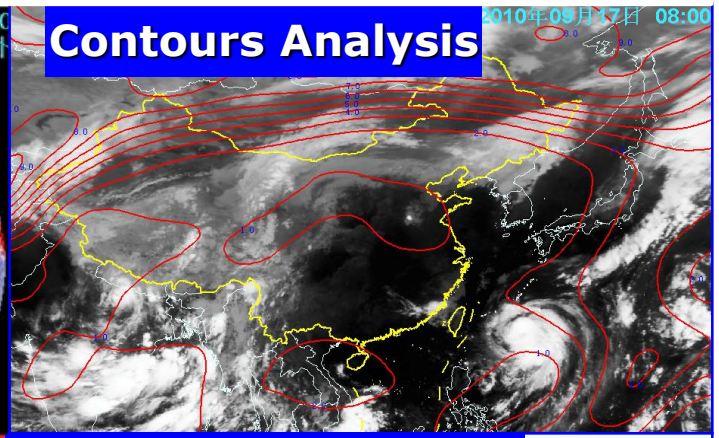
Courtesy of Dr. Jun Li-NSMC FY-4 AWG

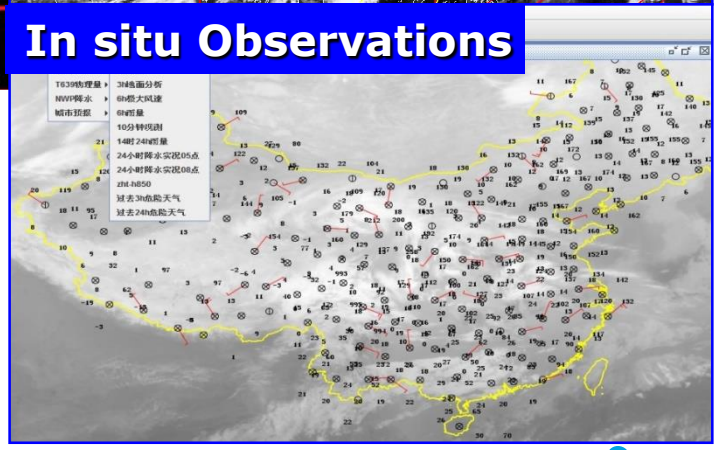
Preparing Users to FY-4

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.

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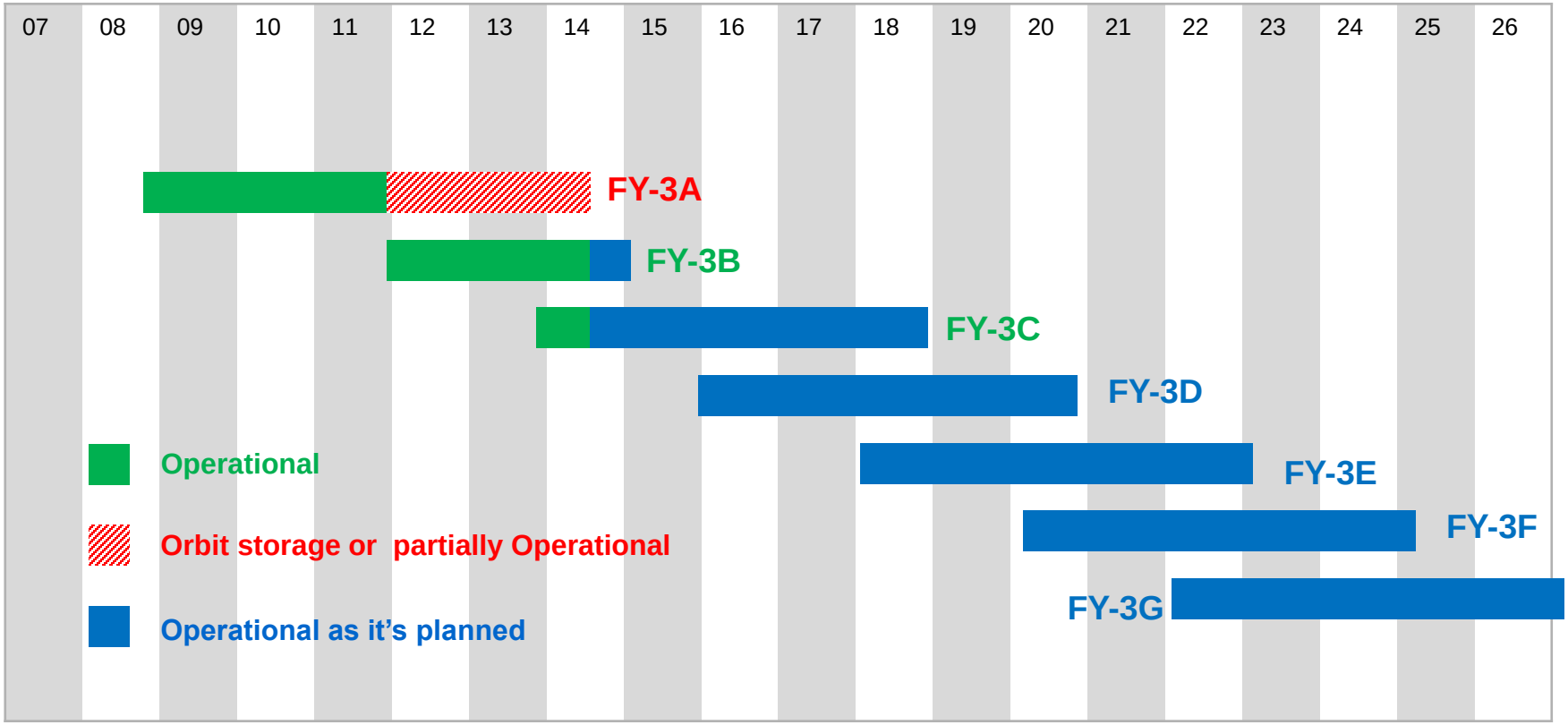
FY-4 Ground System Developing Schedule

PrePhase：	
End user requirement analysis	2006-2009
Instrument requirement	2006-2009
Phase A: Science(Algorithm Development)	
Product requirement analysis & tradeoff study	2008-2011
Algorithm Development	2009-2013
Phase B:	
R&D system design	2011-2013
R&D system integration & test	2012-2014
Phase C: Enginnering (System Integration)	
Operational system Design	2013-2015
Operational system integration & test	2014-2015
Satellite Launch: On orbit test	2016

CURRENT CMA LEO SATELLITES

Since the latest CGMS plenary meeting, CMA FY-3C have been operational



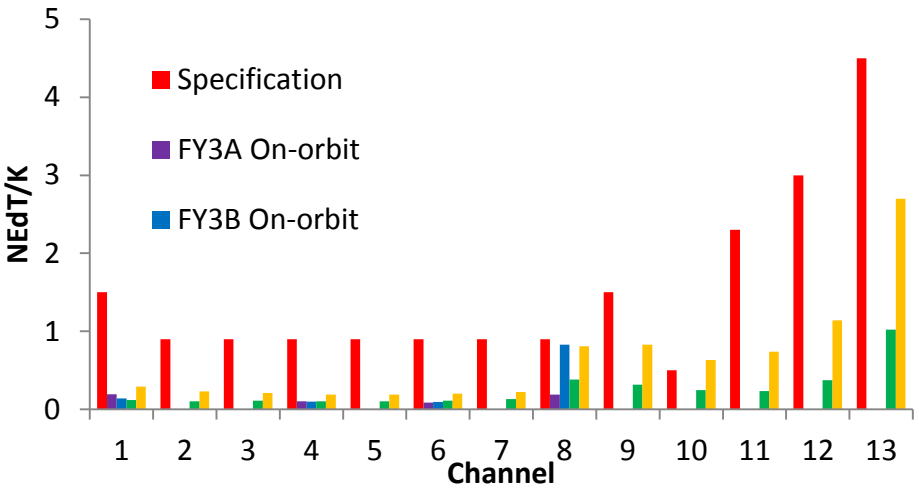
Improvements on FY-3C:

1)New instrument: GNOS: GNSS radio-Occultation Sounder

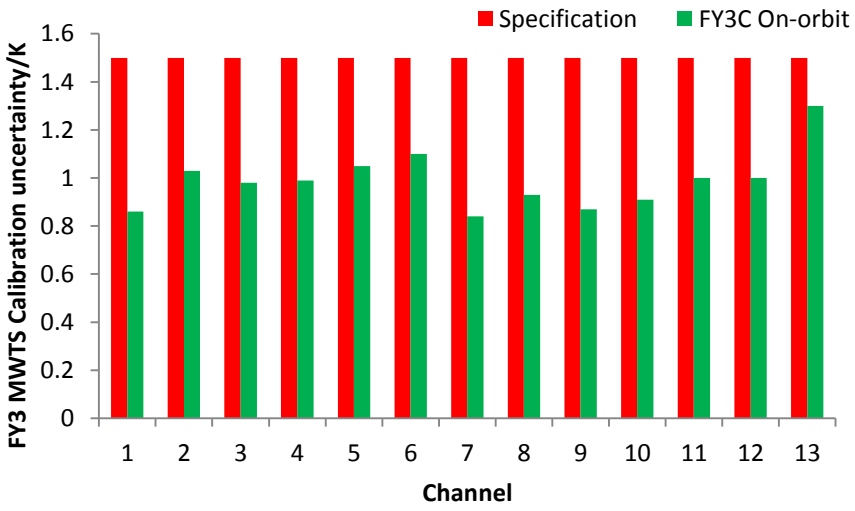
2)Of the specifications for instrument heritage from FY-3A/B, 60% are improved by twice as much as the requirement.

3)improved version of microwave sounder: MWTS-II, MWHS-II

4)Improved solar measurement: SIM-II



FY3C MWTS/MWTS-II NEdT

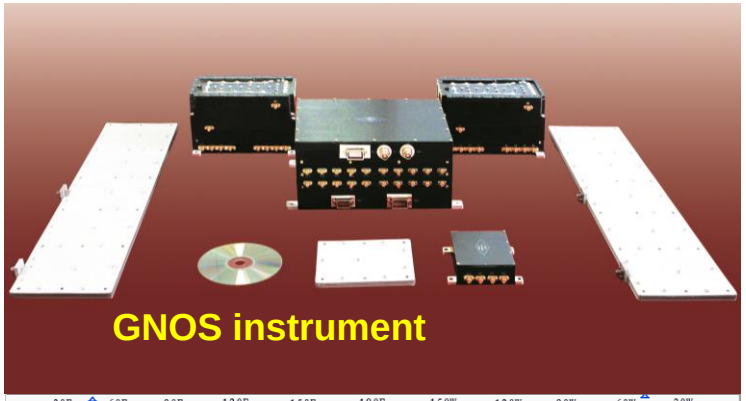


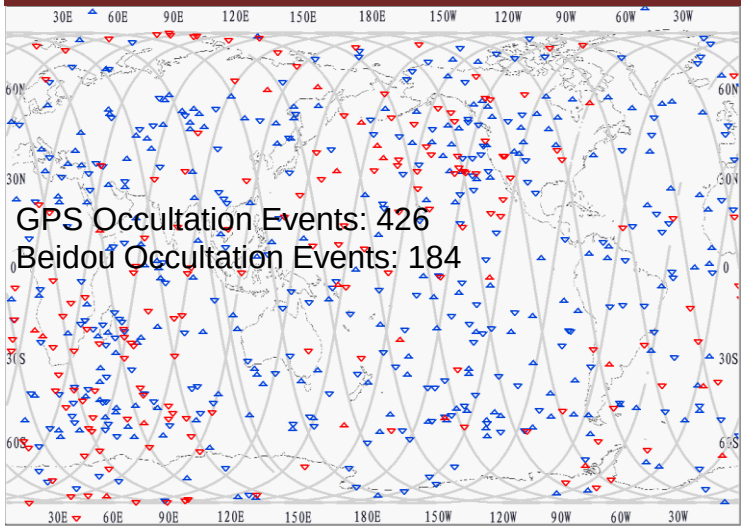
FY3 MWTS-II Calibration uncertainty

GNOS receives signal from GPS and BeiDou-2, obtains measurement from over 1000 occultation per day with GPS and Beidou satellites,

Frequency	GPS L1/L2; BD2
Receiver Channels	8 (Navigation) 4 (Occultation)
Sampling rate	1 ~ 50 Hz
Crystal oscillator	1e-11 (100s)
Real-time position	10m（RMS）
Real-time velocity	0.1m/s(RMS)
Phase center accuracy	2 mm (RMS)
Antenna number	1 (Navigation) 2 (Occultation)

		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%	





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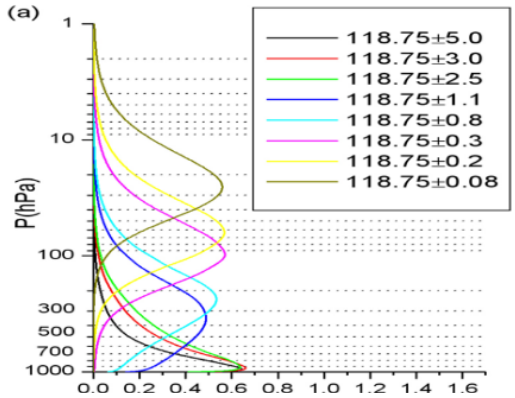
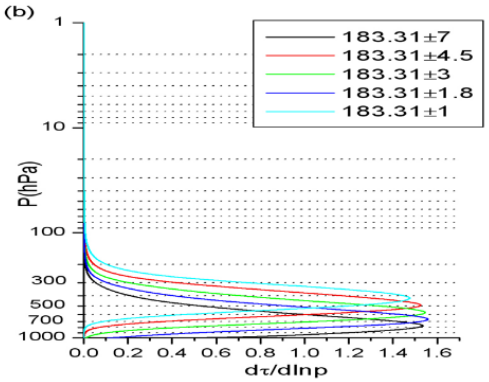
MWHS-II





Ch No.	Central Frequency (GHz)	Polarization	Bandwidth (MHz)	Freq. Stability (MHz)	Dynamic Range (K)	NE ΔT (K)	Cal. Acc. (K)	Main Beam Width	Main Beam Eff.	Purpose
1	89.0	V	1500	50	3—340	1.0	1.3	2.0°	>92%	Surface and Precipitation
2	118.75±0.08	H	20	30	3 – 340	3.6	2.0	2.0°	>92%	Atmospheric Temperature Profile
3	118.75±0.2	H	100	30	3 – 340	2.0	2.0	2.0°	>92%	
4	118.75±0.3	H	165	30	3 – 340	1.6	2.0	2.0°	>92%	
5	118.75±0.8	H	200	30	3 – 340	1.6	2.0	2.0°	>92%	
6	118.75±1.1	H	200	30	3 – 340	1.6	2.0	2.0°	>92%	
7	118.75±2.5	H	200	30	3 – 340	1.6	2.0	2.0°	>92%	
8	118.75±3.0	H	1000	30	3 – 340	1.0	2.0	2.0°	>92%	
9	118.75± 5.0	H	2000	30	3 – 340	1.0	2.0	2.0°	>92%	
10	150.0*	V	1500	50	3 – 340	1.0	1.3	1.1°	>95%	Surface and Precipitation
11	183.31±1	H	500	30	3 – 340	1.0	1.3	1.1°	>95%	Atmospheric Moisture Profile
12	183.31±1.8	H	700	30	3 – 340	1.0	1.3	1.1°	>95%	
13	183.31±3	H	1000	30	3 – 340	1.0	1.3	1.1°	>95%	
14	183.31±4.5	H	2000	30	3 – 340	1.0	1.3	1.1°	>95%	
15	183.31±7	H	2000	30	3 – 340	1.0	1.3	1.1°	>95%	

* For 150Ghz, H removed

Parameter	Specification
Scan Angle	±53.35°
Pixels Per Scan Line	98
Quantization	14 bits

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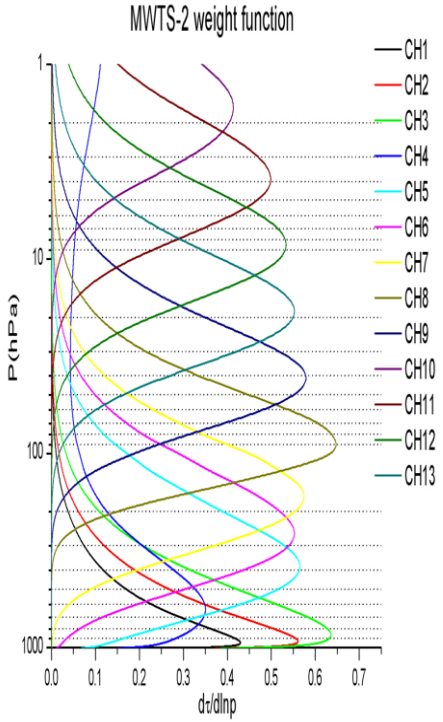
MWTS-II



Ch No.	Central Frequency（GHz）	3dB Bandwidth（MHz）	NEΔT（K）	Main Beam Eff.	Dynamic Range（K）	Cal. Acc.（K）	Purpose
1	50.3	180	1.20	>90%	3～340	1.5	Surface Emiss.
2	51.76	400	0.75	>90%	3～340	1.5	Atmospheric Temperature Profile
3	52.8	400	0.75	>90%	3～340	1.5	
4	53.596	400	0.75	>90%	3～340	1.5	
5	54.40	400	0.75	>90%	3～340	1.5	
6	54.94	400	0.75	>90%	3～340	1.5	
7	55.50	330	0.75	>90%	3～340	1.5	
8	57.290344(fo)	330	0.75	>90%	3～340	1.5	
9	fo±0.217	78	1.20	>90%	3～340	1.5	
10	fo±0.3222±0.048	36	1.20	>90%	3～340	1.5	
11	fo±0.3222±0.022	16	1.70	>90%	3～340	1.5	
12	fo±0.3222±0.010	8	2.40	>90%	3～340	1.5	
13	fo±0.3222±0.0045	3	3.60	>90%	3～340	1.5	

Parameter	Specification
Scan Angle	±49.5°
Pixels Per Scan Line	90
Quantization	13 bits

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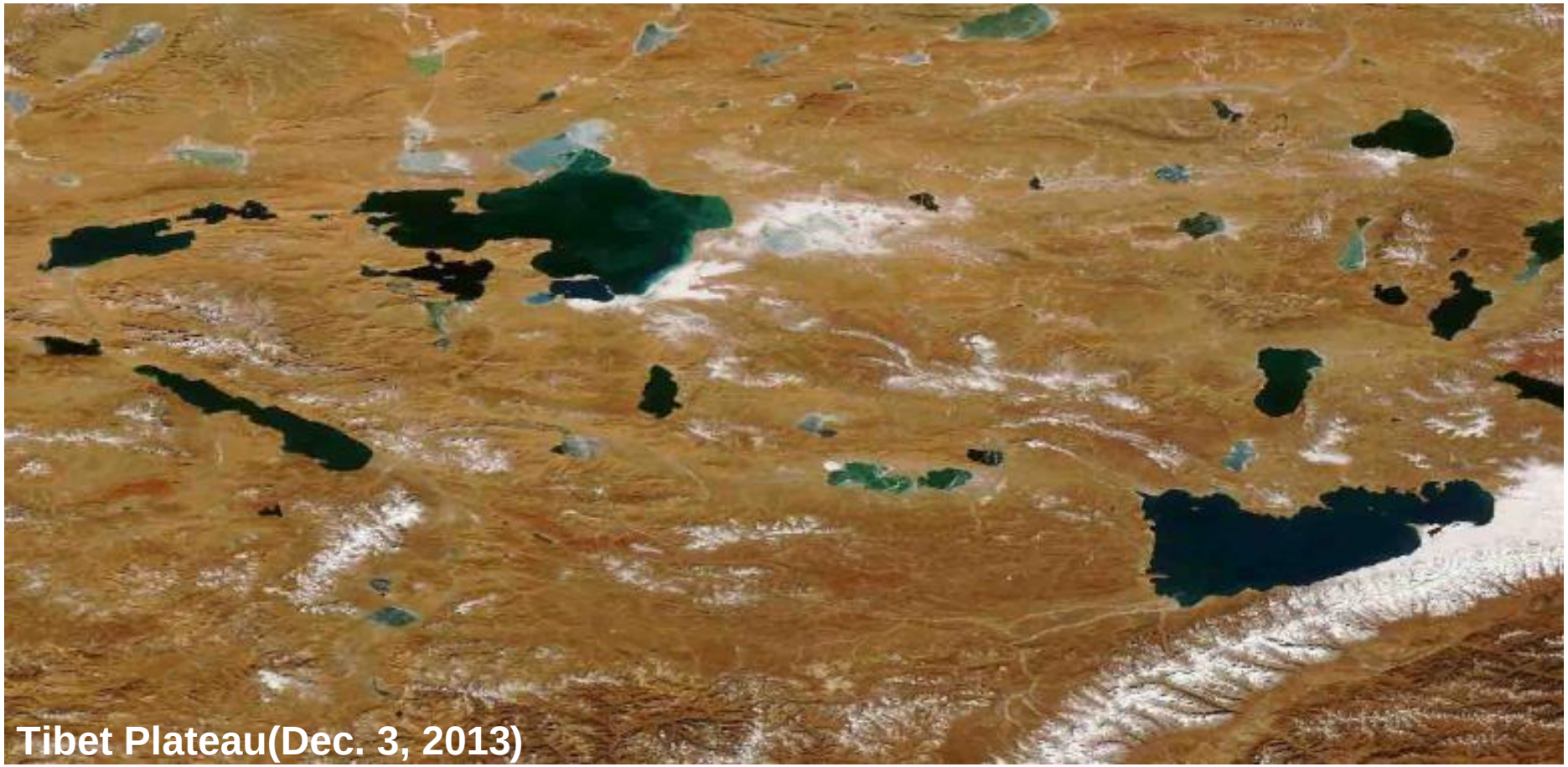
MERSI/FY-3C Images



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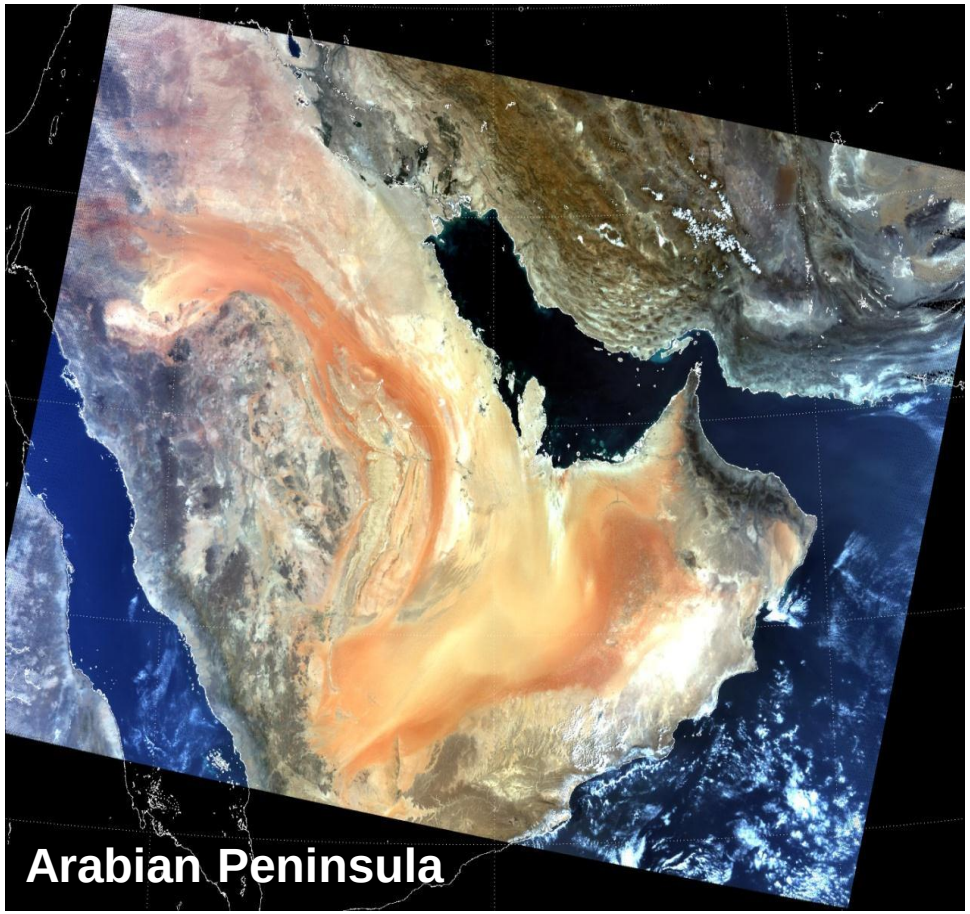
MERSI/FY-3C Images



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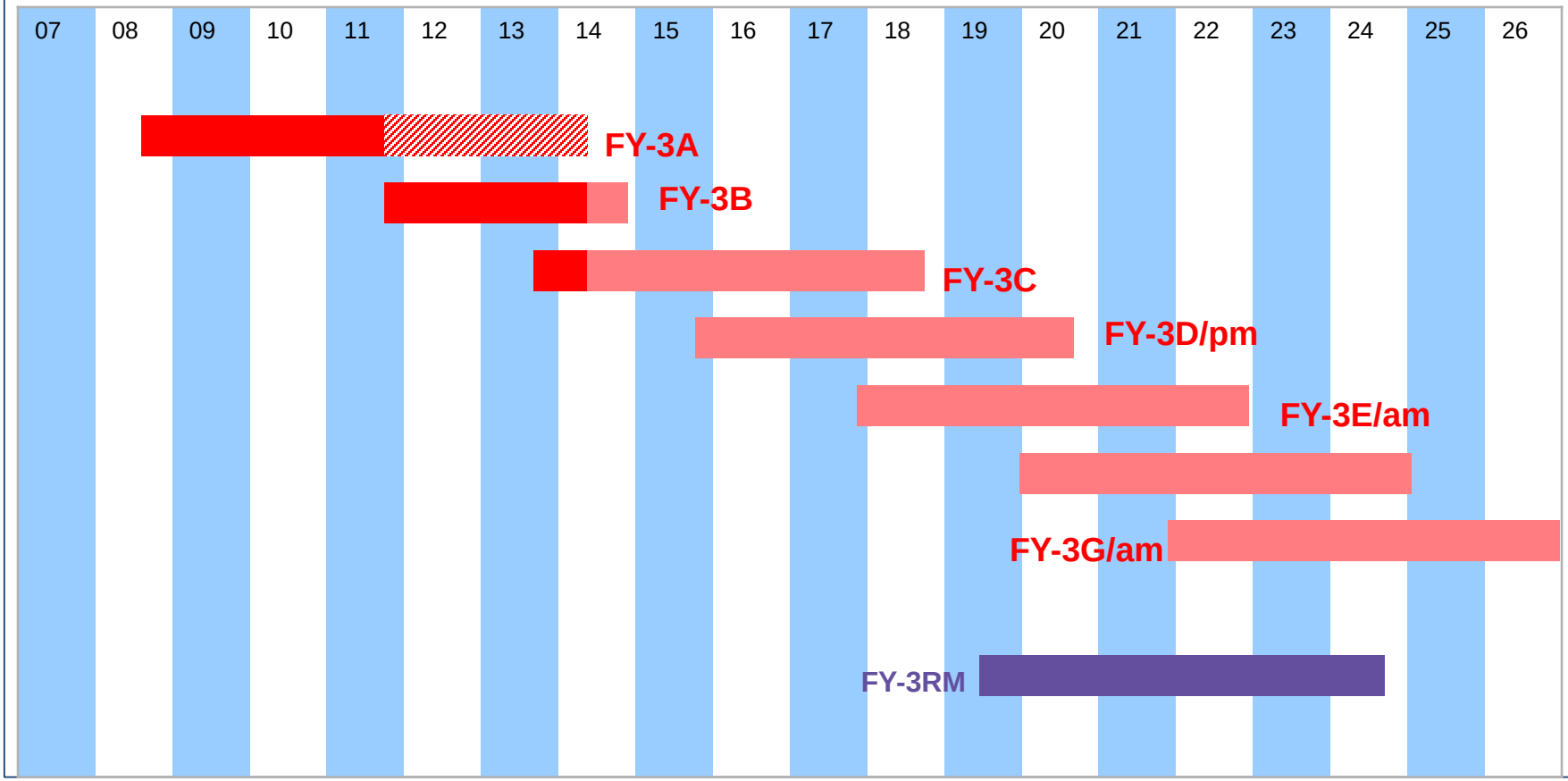
CMA operational polar satellites—FY3C

- Satellite Launch : 23 Sept, 2013
- On-orbit test : Till Feb. 2014
- Trail Operation : March to May
- Product Validation : March to May
- Operation : From June 2014

FY-3C pre-processing software package is available now

FUTURE CMA LEO SATELLITES



Following FY-3C, FY-3D/E/F/G will be launched at the pace of one satellite every two years. The life time for each satellite is 5 years. Also, CMA is developing plan for rain observation satellite, FY-3RM. The first scheduled launch of FY-3RM is in 2019, life time 5 years.

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Instruments planned for FY-3s

Payloads \ Satellite	FY-3A	FY-3B	FY-3C	FY-3D	FY-3E	FY-3F
MERSI - I/II(Medium Resolution Spectral Imager)	√ (MERSI - I)	√ (MERSI - I)	√ (MERSI - I)	√ (MERSI - II)	√ (MERSI - II)	√ (MERSI - II)
MWTS - I/II(Micro-Wave Temperature Sounder)	√ (MWTS - I)	√ (MWTS - I)	√ (MWTS - II)	√ (MWTS - II)	√ (MWTS - II)	√ (MWTS - II)
MWHS - I/II(Micro-Wave Humidity Sounder)	√ (MWHS - I)	√ (MWHS - I)	√ (MWHS - II)	√ (MWHS - II)	√ (MWHS - II)	√ (MWHS - II)
MWRI (Micro-Wave Radiation Imager)	√	√	√	√		√
WindRAD (Wind Radar)					√	
HIRAS (Hyperspectral Infrared Atmospheric Sounder)				√	√	√
GAS (Greenhouse gases Absorption Spectrometer)				√		√
OMS (Ozone Monitoring Suite)					√	
GNOS (GNSS Occultation Sounder)			√	√	√	√
ERM - I/II(Earth Radiation Monitor - I/II)	√ (ERM - I)	√ (ERM - I)	√(ERM - I)		√(ERM - II)	
SIM- I/II(Solar Irritation Monitor)	√ (SIM - I)	√ (SIM - I)	√(SIM - II)		√(SIM - II)	
SES(Space Environment Suite)	√	√	√			
SEM (Space Environment Monitor)				√	√	√
WAI (Wide-field Auroral Imager)				√	√	√
IPM (Ionospheric PhotoMeter)				√	√	√
IRAS (Infrared Atmospheric Sounder)	√	√	√			
VIRR (Visible and Infra-Red Radiometer)	√	√	√			
TOU (Total Ozone Unit)	√	√	√			
SBUS (Solar Backscatter Ultraviolet Sounder)	√	√	√			

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Data Broadcast Service from FY-3D changed

The X-band transmission will be used to broadcast real-time data of all instruments in AHRPT 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.

■**AHRPT (Advanced High Rate Picture Transmission)**

7820MHz – All instruments' data

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

1704.5MHz – Data of selected MERSI channels

■**DPT (Delayed Picture Transmission)**

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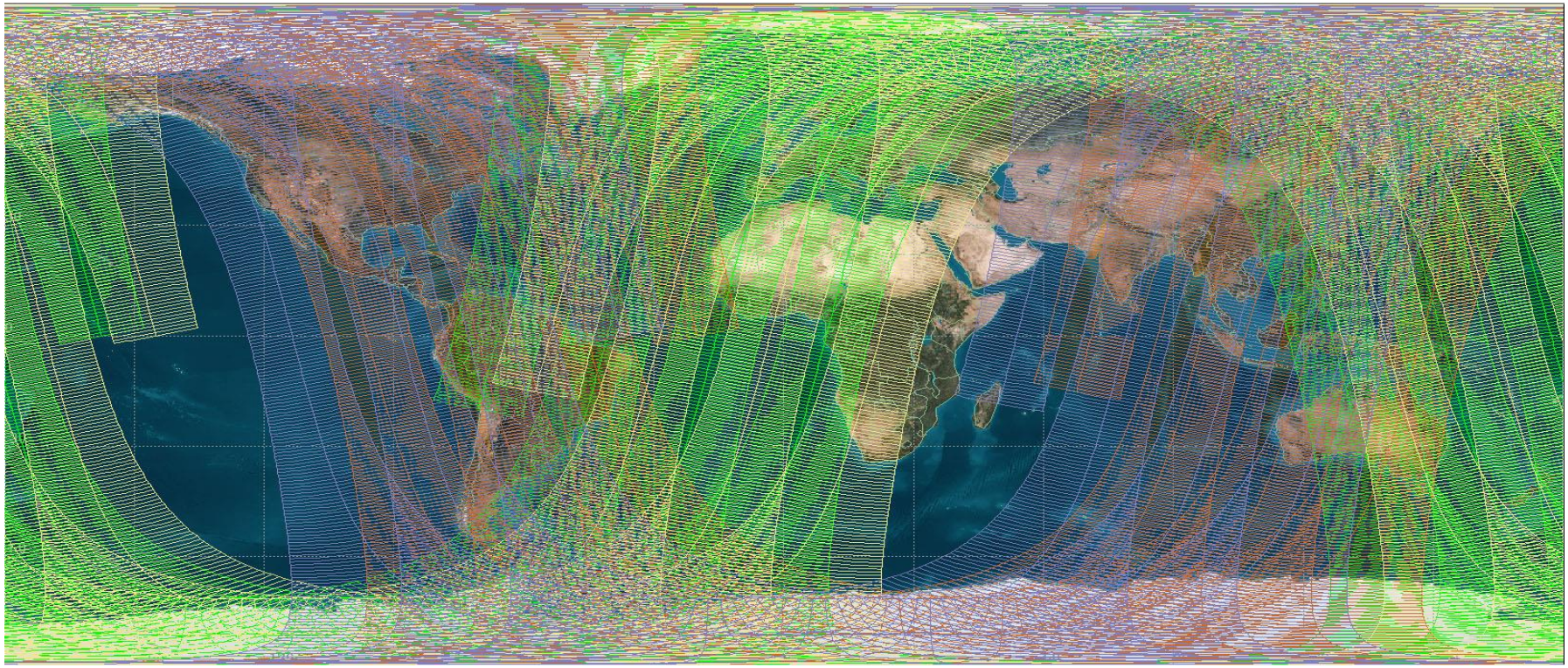
FY-3 Early-morning Orbit

CMA is investigating the possibility of deploying a FY-3 satellite in early morning orbit. The result from NWP Centers show it will improve impact of NWP by filling up the data gap.



FY-3A 10:00 AM

FY-3B 13:40 PM

Metop-A 9:30 AM

SNPP 13:30 PM

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Investigating Possibility for FY-3 Early-morning Orbit

1. Potential User Workshop

- Beijing, March 11, 2013
- CMA Headquarter,
- NWPC, NNWPC, NCC, CAMS

2. Engineering Feasibility Seminar

- Shanghai, Nov. 8, 2012
- Shanghai, Jan. 10, 2013
- Beijing, March 12, 2013
- SAST/CAST

3. Financial Support Discussion

- Jan., 2013
- CMA, CNSA,
- National Development and Reform Commission

4. Tiger Team Meeting

- April,2013
- CMA

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Tiger Team Meeting

April 25 ~ 26, Beijing

Assessment of the benefits of a satellite mission in an early morning orbit

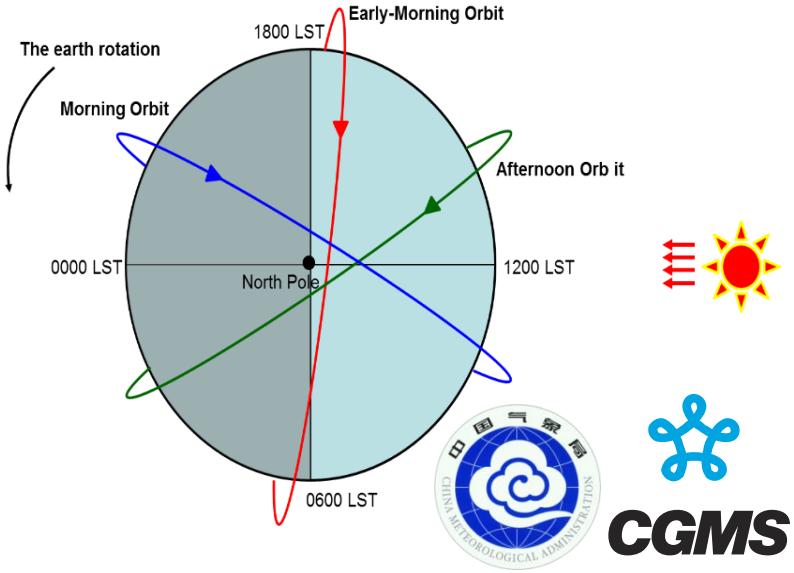
Report from the WMO-CGMS Tiger Team

April 2013

1. BENEFITS OF AN EARLY MORNING MISSION FOR NWP

2. BENEFITS FOR OTHER APPLICATIONS

- Diurnal cycle and daily operations schedule
- Tropical cyclones and other severe events
- Climate monitoring
- Air quality
- Solar observations



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Outlook of Future CMA LEO Constellation

Sun-Synchronous

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

Non-Sun-Synchronous

- FY-3 RM 2019

Thank you for your attention