



FY-USERCON 2021

1-5 November 2021  
Beijing, China



# Update on CMA FY-4 Satellite programs

**Feng LU**

**National Satellite Meteorological Center  
(CMA/NSMC)**

Many thanks to Xiaohu Zhang, Lei Yang, Xiangang Zhao, Chengbao Liu, Qi Han, Jianguang Guo, Jing Wang, Zhuoya Ni, Na Xu, Jingli Xia, Yixuan Shou, Ran You, Lan Wei and other contributors from FY-4B Ground segment development team

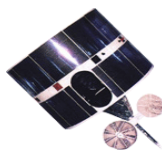


## Outline

- 1) Current status of CMA Fengyun GEO**
- 2) Major improvements of FY-4B**
- 3) FY-4B Pre-launch testing (PLT) progress**
- 4) FY-4B Post-launch testing (PLT) progress**
- 5) Future work**

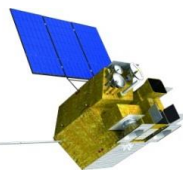


## 1) Current status of CMA Fengyun GEO



### First Generation

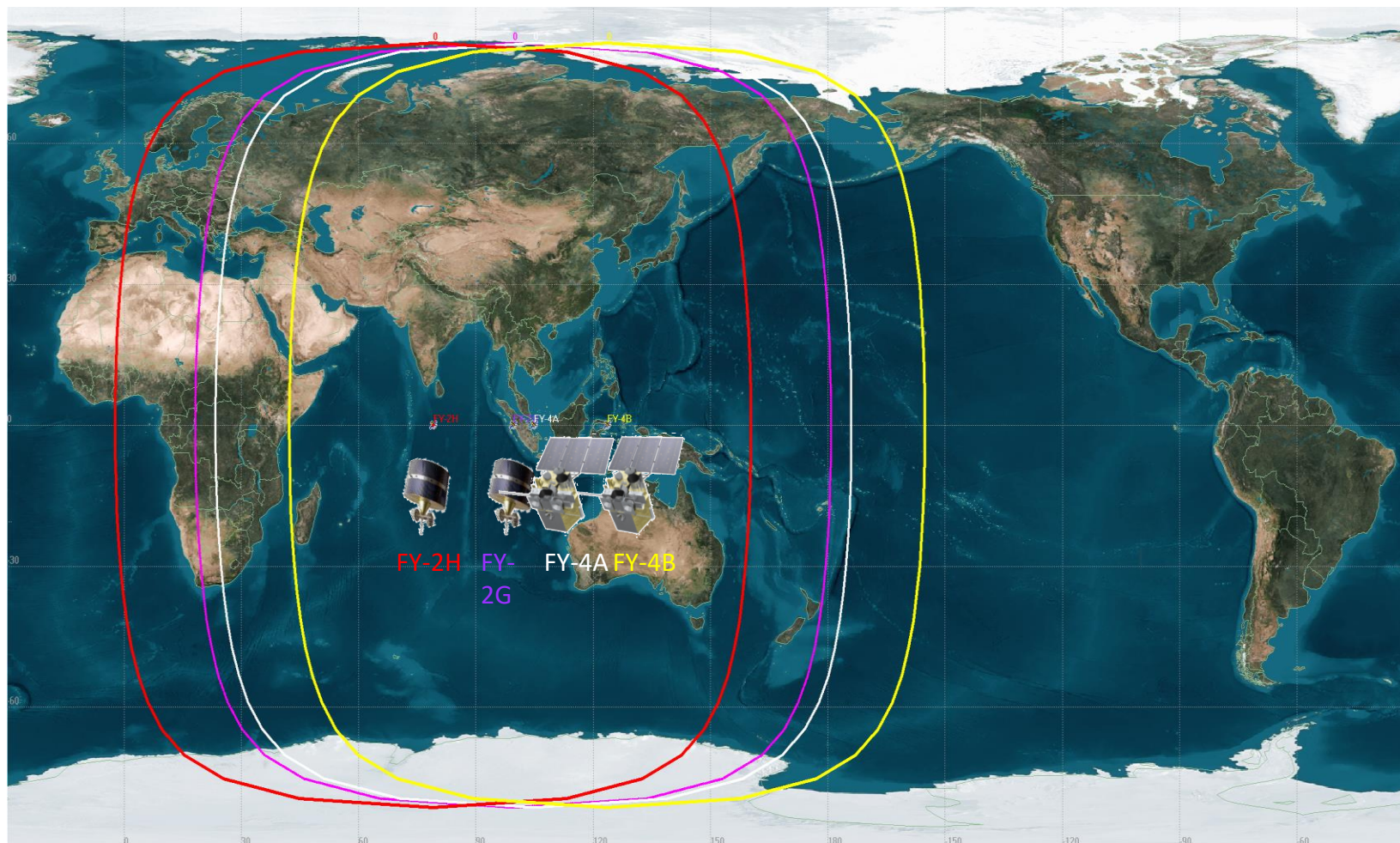
FY-2H	79.0E	2012
FY-2G	99.5E	2014
FY-2F	79.0E	2018



### Second Generation

FY-4A	105E	2016
FY-4B	123.5E	2021

- 1、 Support **nowcasting** and severe weather **warning**
- 2、 Support **NWP**, regional and global
- 3、 Support **climate** applications
- 4、 Support environment **monitoring** and disaster mitigation





**FY-4A was successfully launched on Dec 11, 1996, it was located at 104.7 E.**

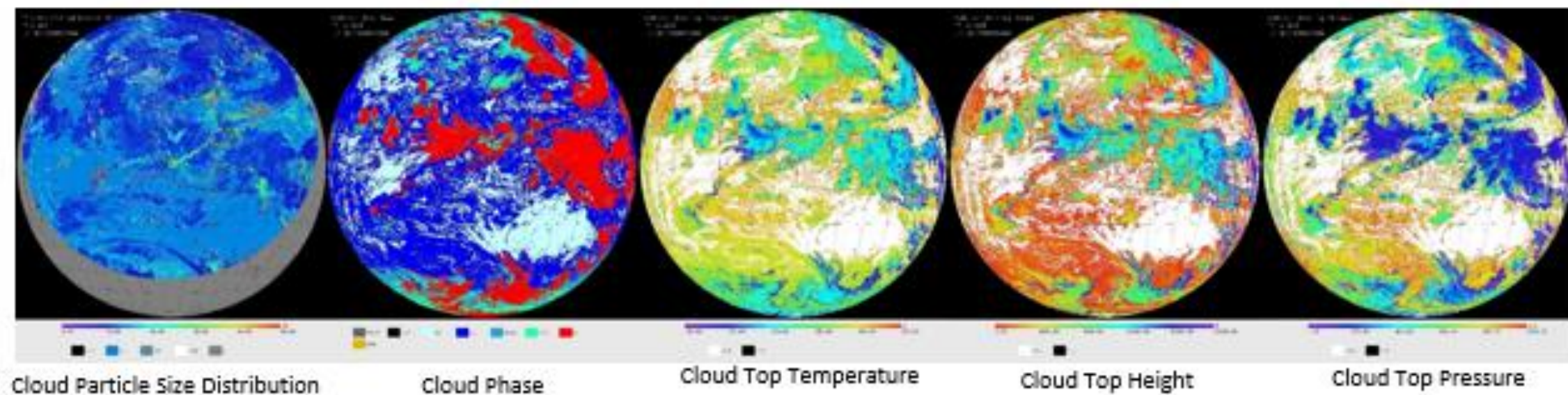
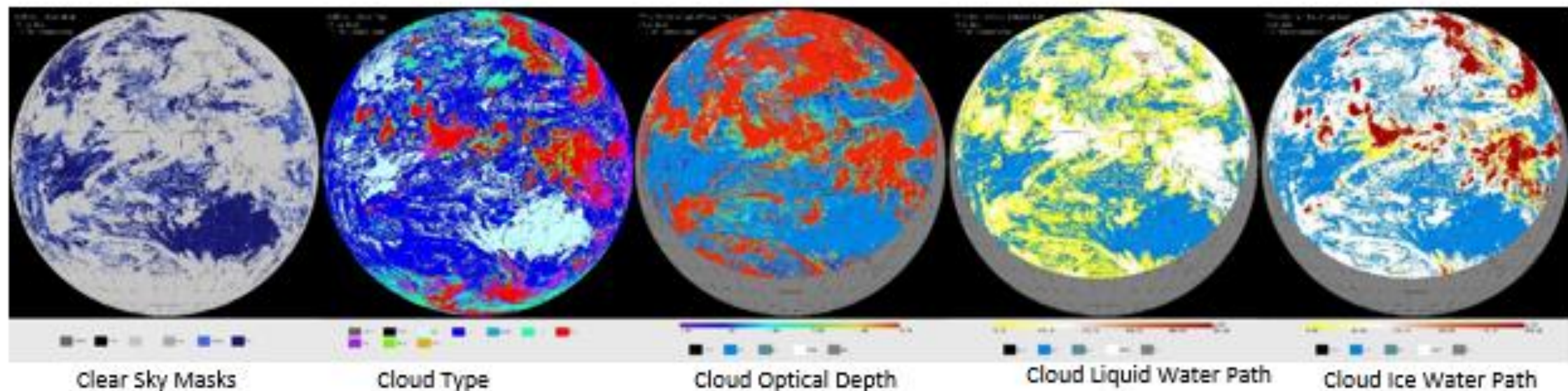


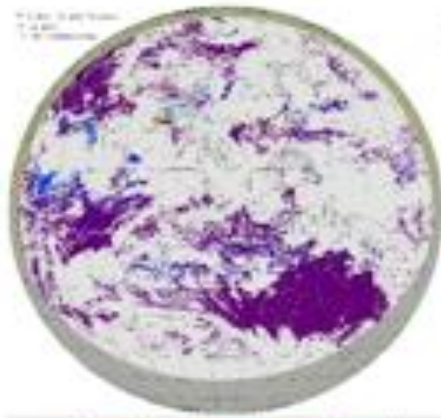
# FY-4A L2 Product details

Product	Instrument	Format	Resolution
Atmosphere Instability Index, Disk	GIIRS	NC	16KM
Atmospheric Correction Image	AGRI	NC	1000M
Atmospheric Motion Vector, High Level	AGRI	NC	64KM
Atmospheric Motion Vector, Infrared	AGRI	NC	64KM
Atmospheric Motion Vector, Low Level	AGRI	NC	64KM
Cloud Mask	AGRI	NC	4000M
Cloud Phase	AGRI	NC	4000M
Cloud Top Height	AGRI	NC	4000M
Cloud Top Pressure	AGRI	NC	4000M
Cloud Top Temperature	AGRI	NC	4000M
Cloud Type	AGRI	NC	4000M
Convection Index	AGRI	NC	4000M
Downgoing Longwave Radiation	AGRI	NC	4000M

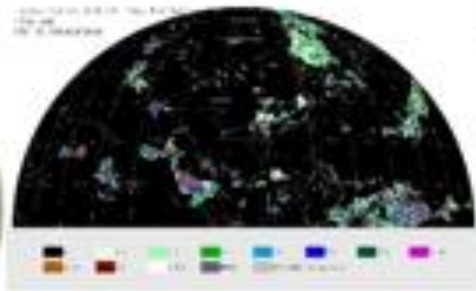
Product	Instrument	Format	Resolution
Fire Hot Spot Detection	AGRI	NC	2000M
Fog Detection, Full Disk	AGRI	NC	4000M
Land Surface Emissivity	AGRI	NC	12KM
Land Surface Temperature	AGRI	NC	4000M
Liquid Percentage Water	AGRI	NC	4000M
Outgoing Longwave Radiation	AGRI	NC	4000M
Quantitative Precipitation Estimation, Northern Hemisphere	AGRI	NC	4000M
Reflective Shortwave Radiation	AGRI	NC	4000M
Sea Surface Temperature	AGRI	NC	4000M
Surface Solar Incidence Radiation	AGRI	NC	4000M
Tropopause Folding	AGRI	NC	4000M
Upgoing Longwave Radiation	AGRI	NC	4000M

<http://satellite.nsmc.org.cn/portalsite/Data/DataView.aspx>

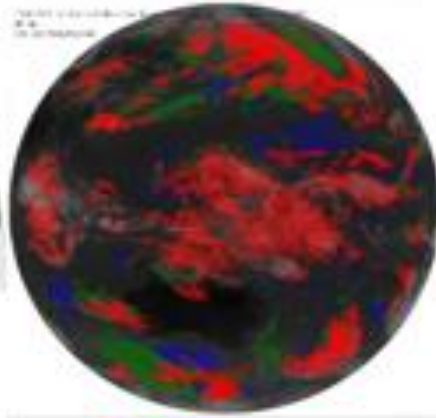




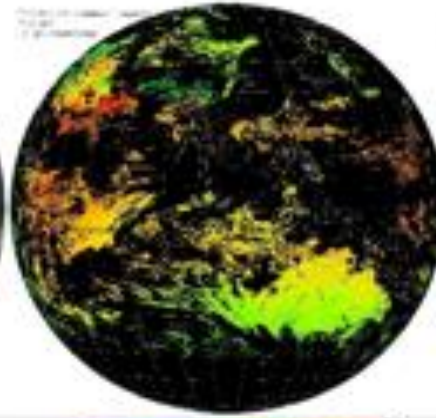
Aerosol Detection



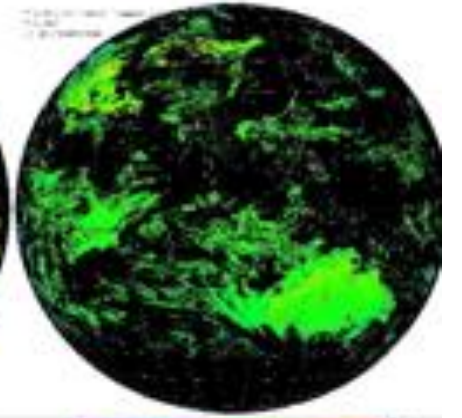
Rainfall Rate/QPE



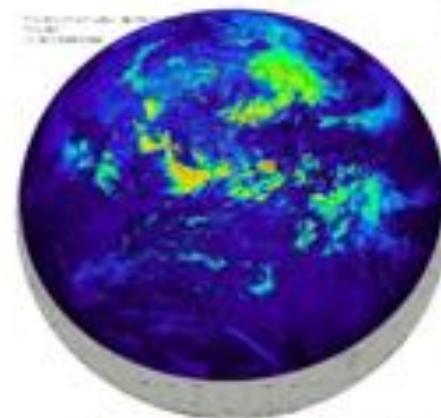
Atmospheric Motion Vector



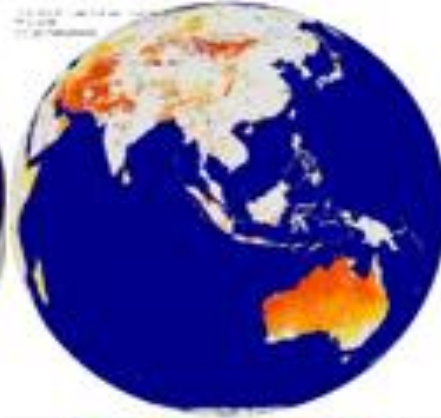
Downward Long wave Radiation:Surface



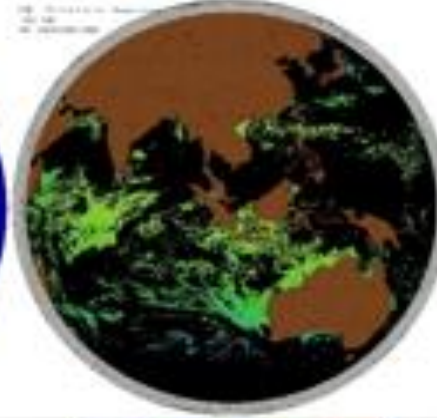
Upward Long wave Radiation:Surface



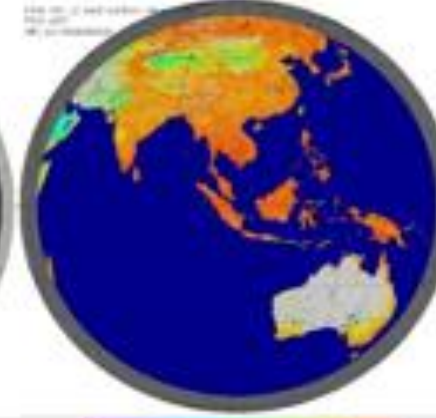
Reflected Shortwave Radiation



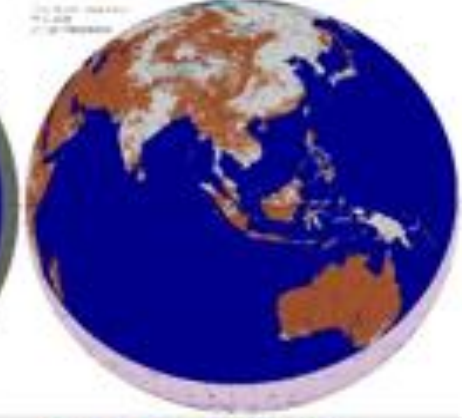
Land Surface (Skin) Temperature



Sea Surface (Skin) Temperature



Land Surface Emissivity

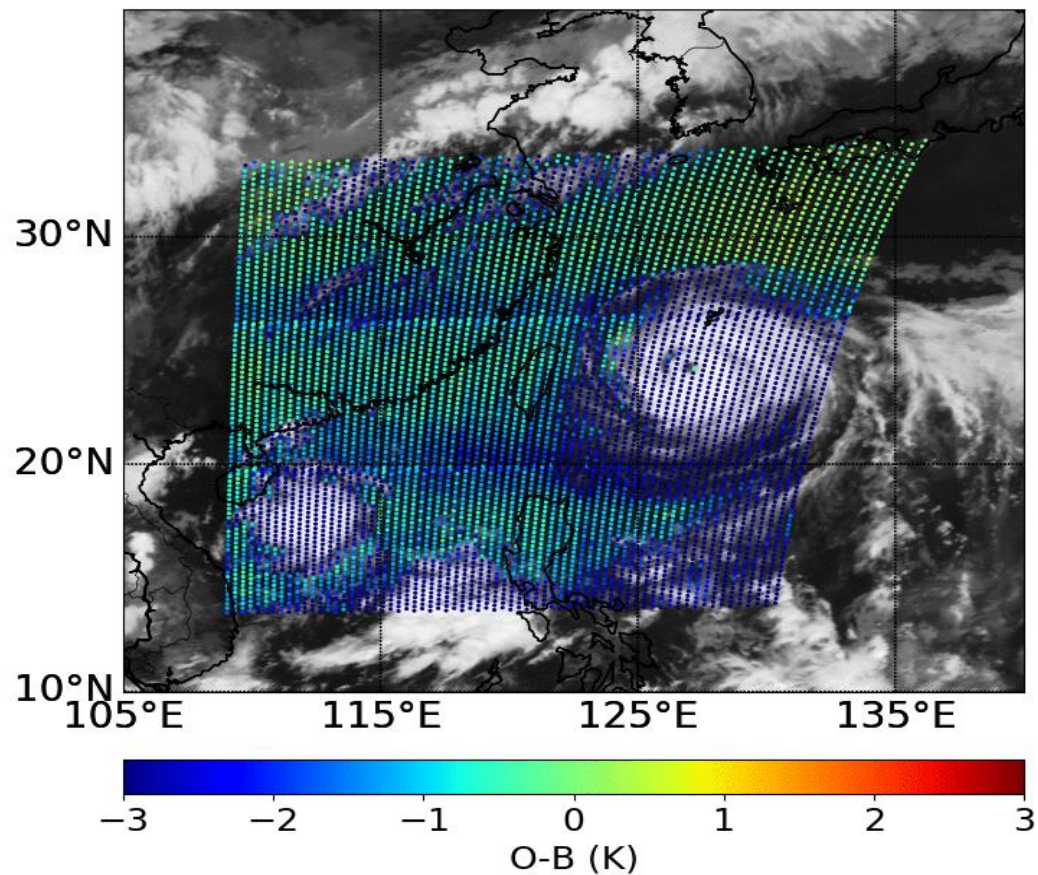


Land Surface Emissivity

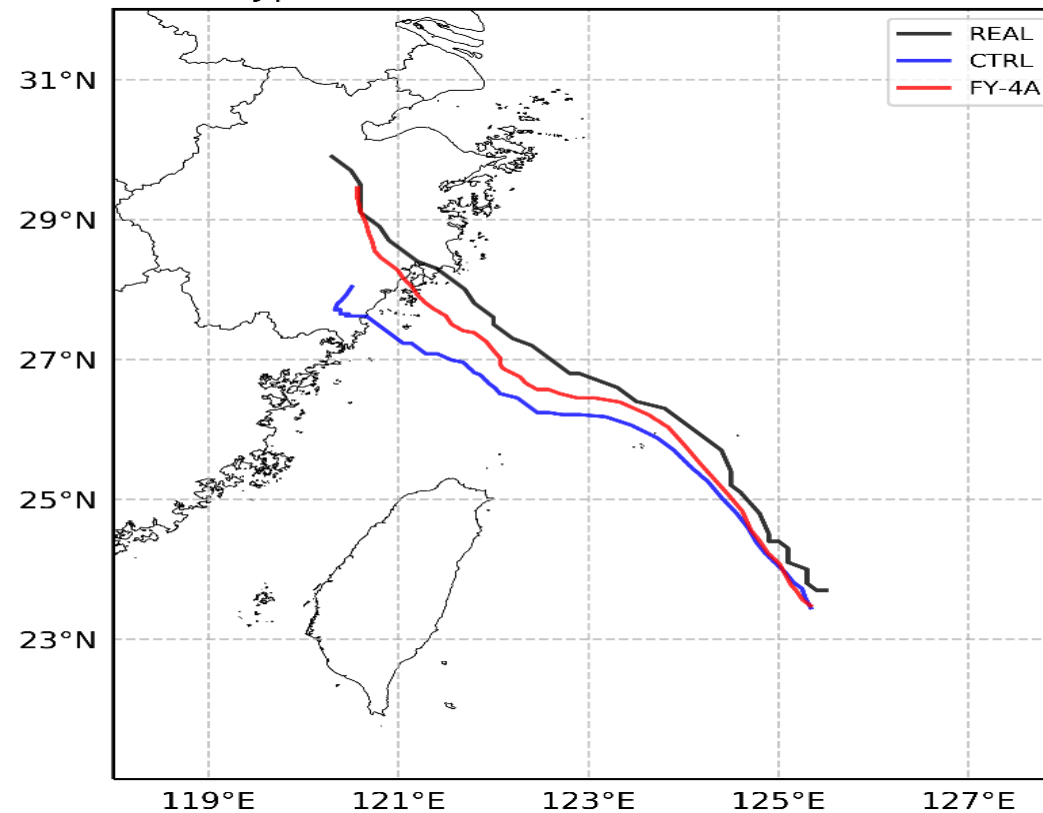


## NWP Case : FY-4A GIRS used in NWP assimilation

FY4A GIRS O-B Channel:6 Time:UTC201807100045



Typhoon:Lekima Path 080806-081006





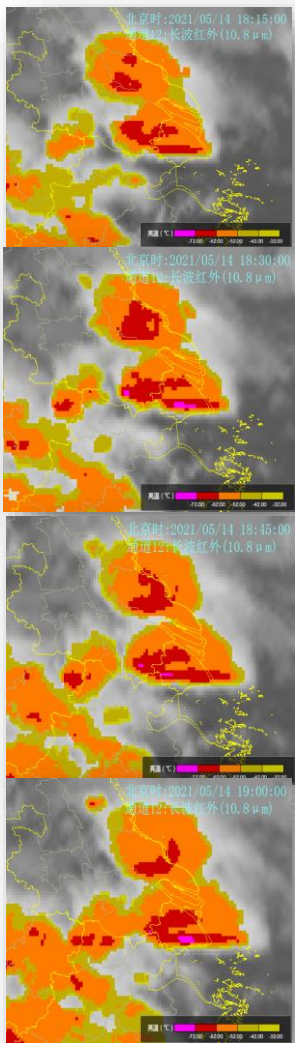


## nowcasting and severe weather warning Case : May,11 Tornado in Jiangshu, China

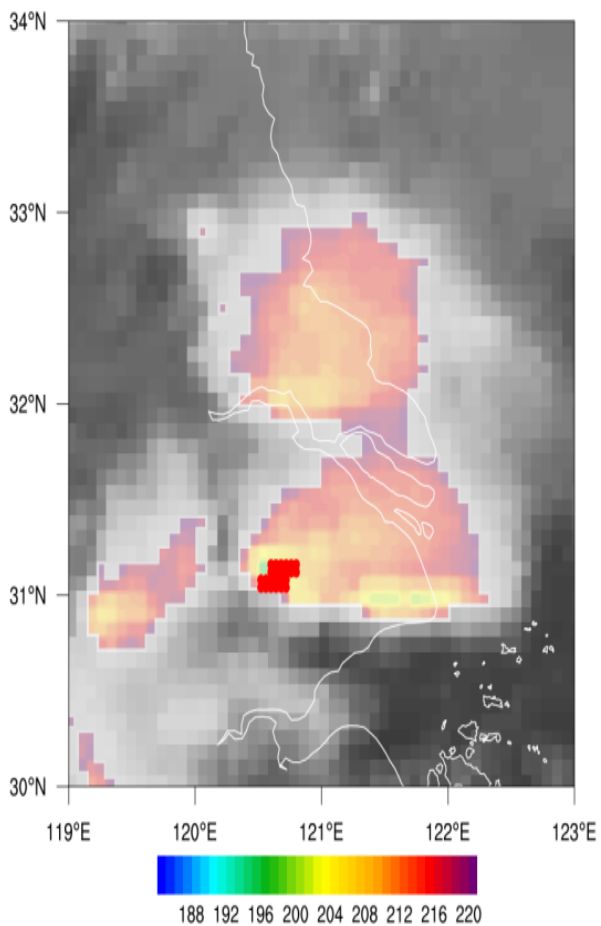




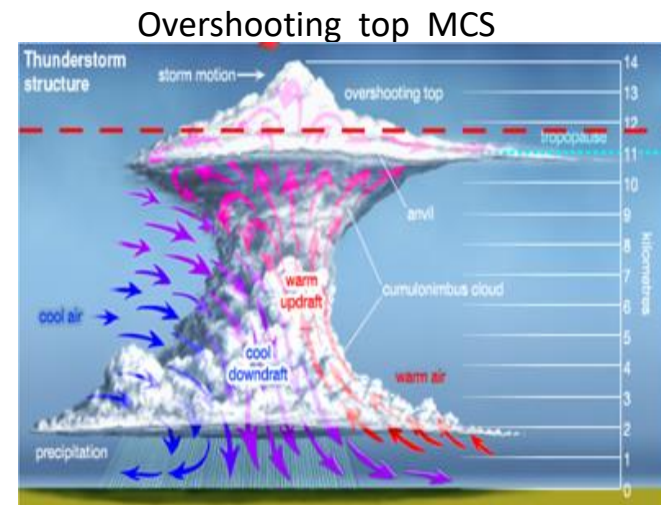
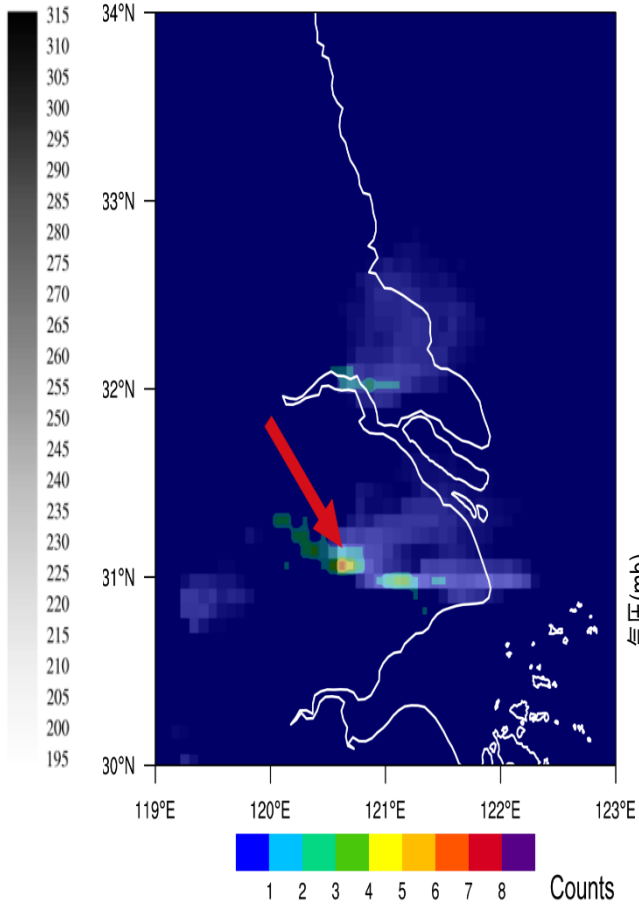
# nowcasting and severe weather warning Case : May,11 Tornado in Jiangshu,China



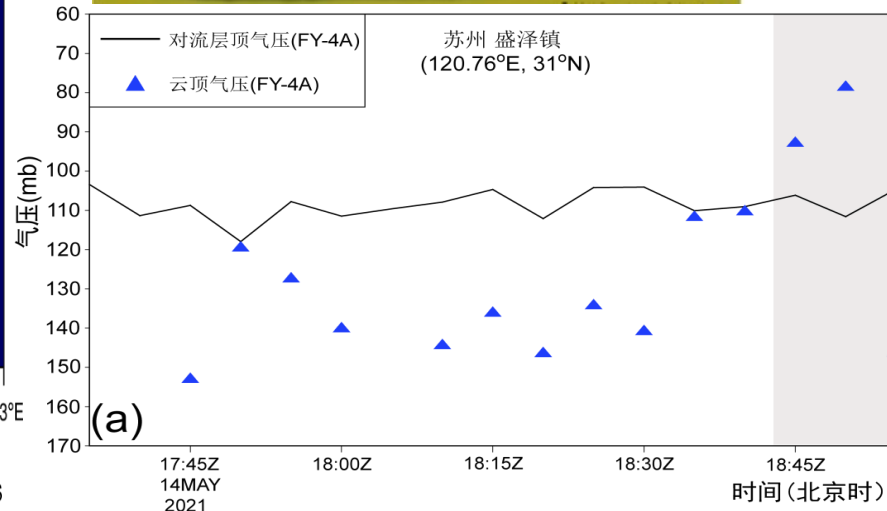
2021-05-14 10:40-10:45UTC



Overshootings frequency  
2021-05-14 18:00-19:00LST

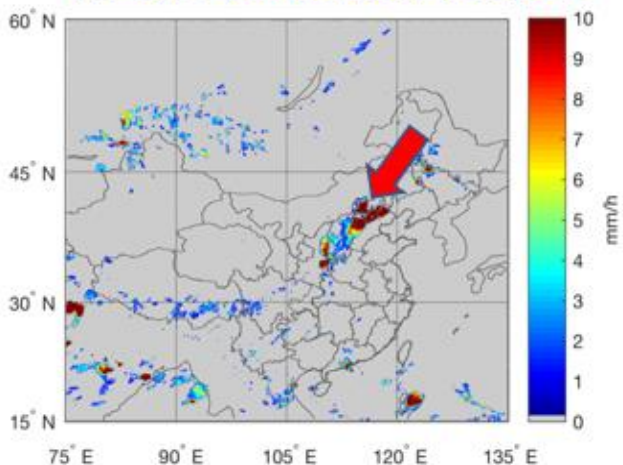


对流层顶  
“5.14”苏州

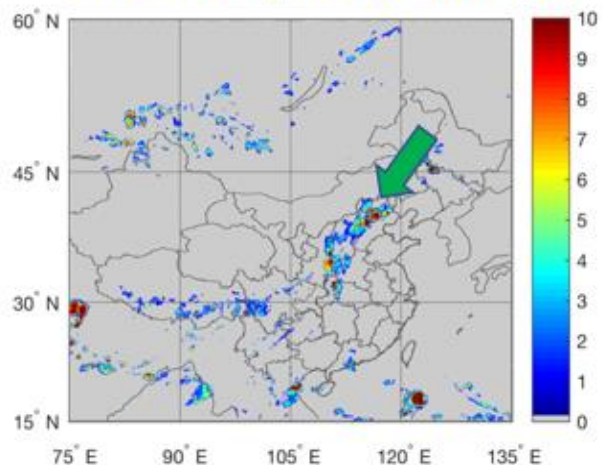




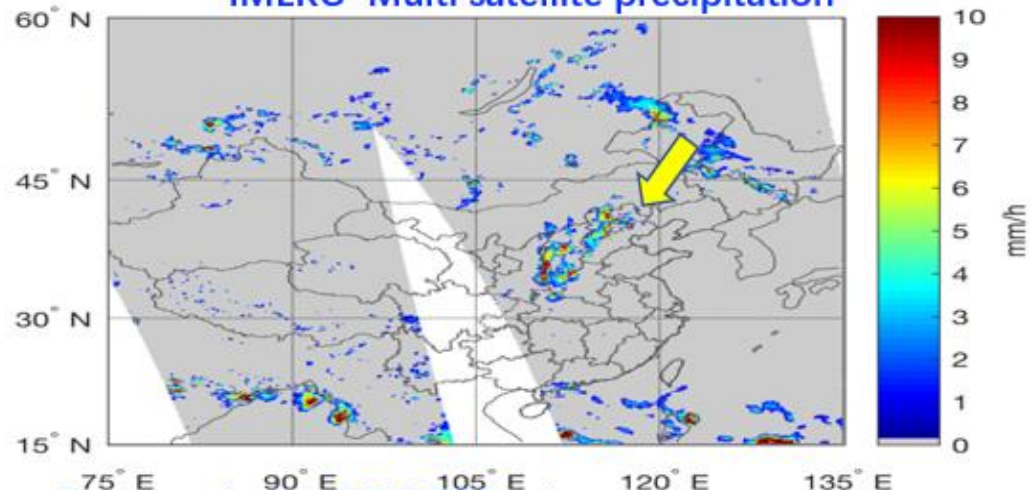
**FY-4A Precipitation Ver.2018**



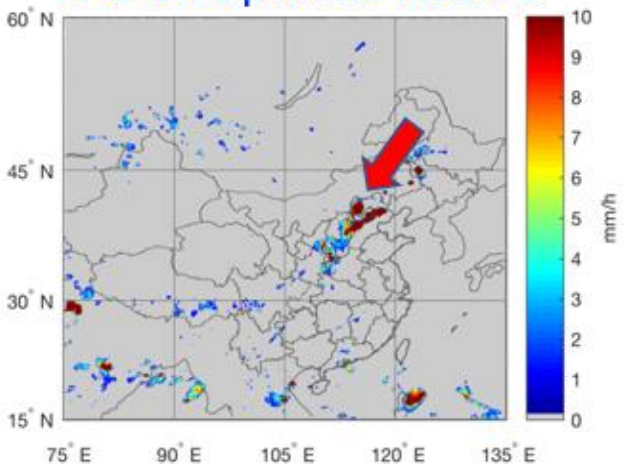
**FY-4A Precipitation Ver. 2019**



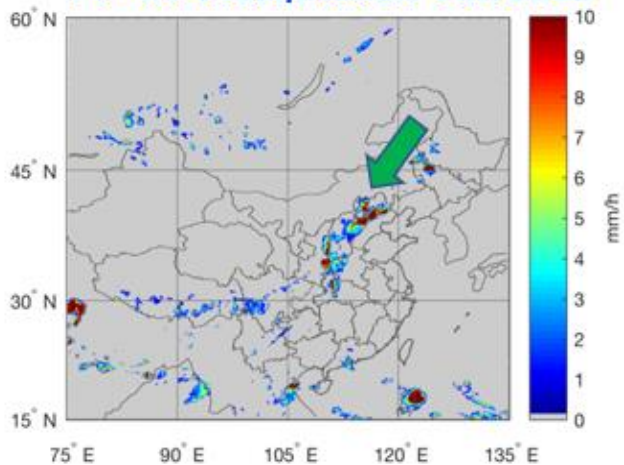
**IMERG Multi satellite precipitation**



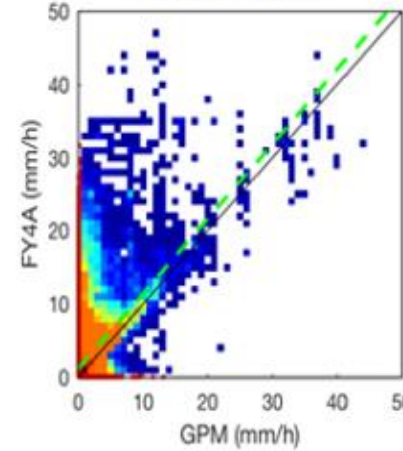
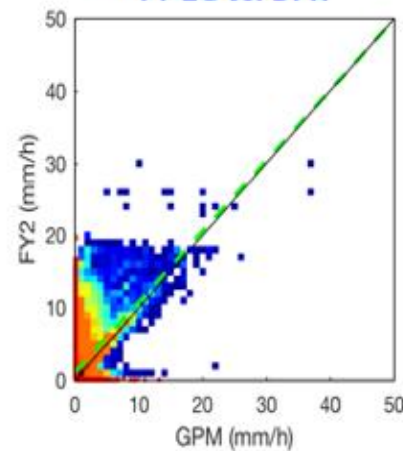
**FY-2 Precipitation Ver.2018**



**FY-4A Precipitation Ver. 2019**



**Compared with GPM DPR rainrate**  
FY-2G vs. DPR      FY-4A vs. DPR



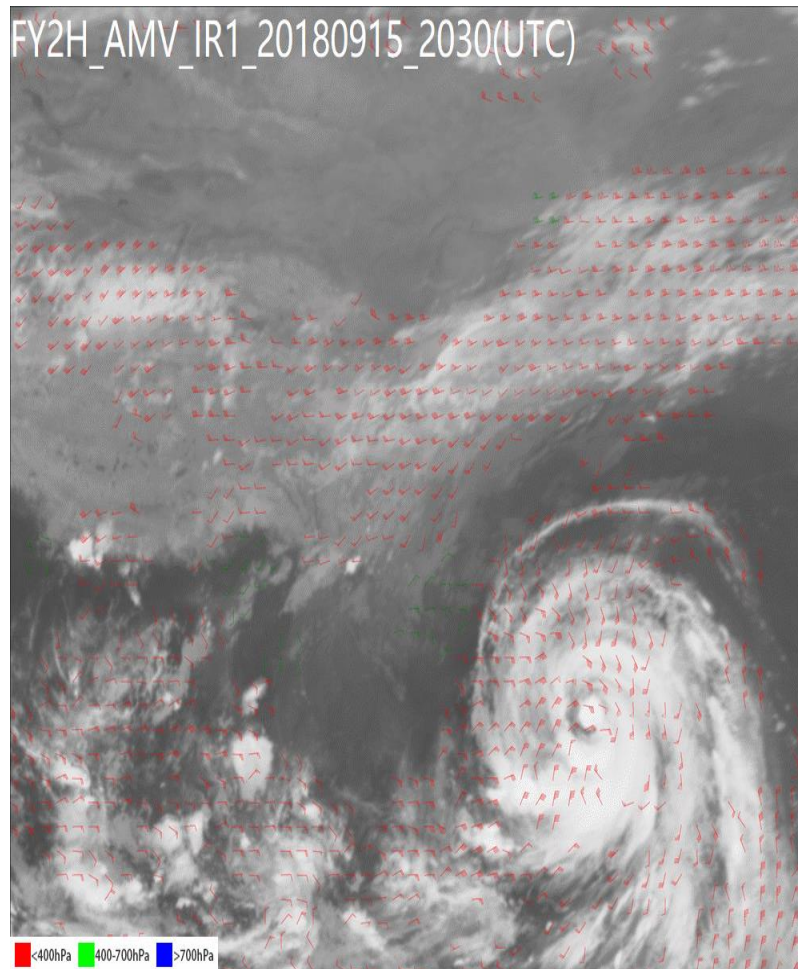
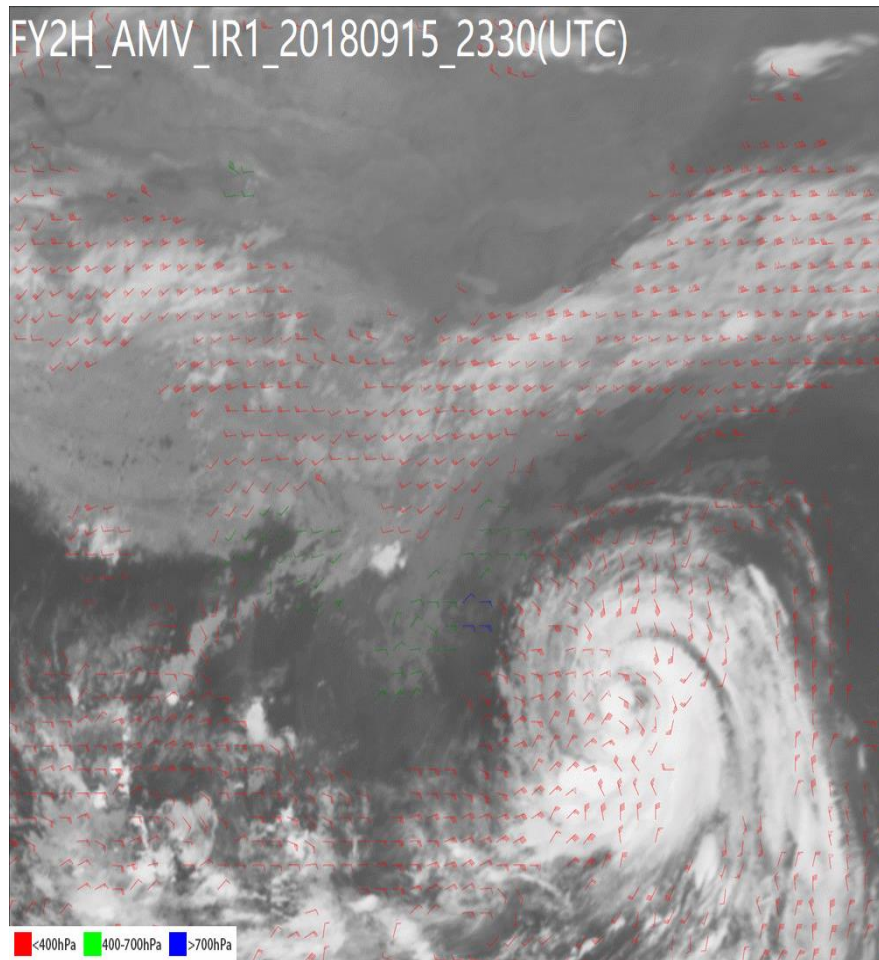
**CMA/NSMC FY-4A Precipitation products have be operational at Q4 2019**

Courtesy of Dr.Ran You CMA/NSMC



**FY-2F/G Every 6 hours**

**FY-2H Every half hours**



<b>OSCAR</b> Observing Systems Capability Analysis and Review Tool													
Variable	Layer	App Area	Uncertainty	Stability / decade	Hor Res	Ver Res	Obs Cyc	Time lines	Coverage	Conf Level	Valid Date	Source	
3 1 0	Wind (horizontal)	HS & M	Global NWP	1 m.s <sup>-1</sup> 5 m.s <sup>-1</sup> 10 m.s <sup>-1</sup>	50 km 100 km 500 km	1 km 2 km 3 km	60 min 6 h 12 h	6 min 30 min 6 h	Global	firm	2009-02-10	John Eyre	
4 5 3	Wind (horizontal)	LT	Nowcasting / VSRE	1 m.s <sup>-1</sup> 2 m.s <sup>-1</sup> 5 m.s <sup>-1</sup>	1 km 5 km 20 km	0.2 km 0.5 km 1 km	5 min 30 min 3 h	5 min 15 min 60 min	Global	firm	2013-04-08	P. Ambrosetti	
7 8 1	Wind (horizontal)	HS & M LS HT LT	Climat e Monitoring (GCOS)	2 m.s <sup>-1</sup>	0.5 km 1 km	0.5 km	60 min		Global	reasonable	2019-09-25	GCOS-200:	

**CMA/NSMC provide FY-2H AMV covering North Hemisphere every half hour**

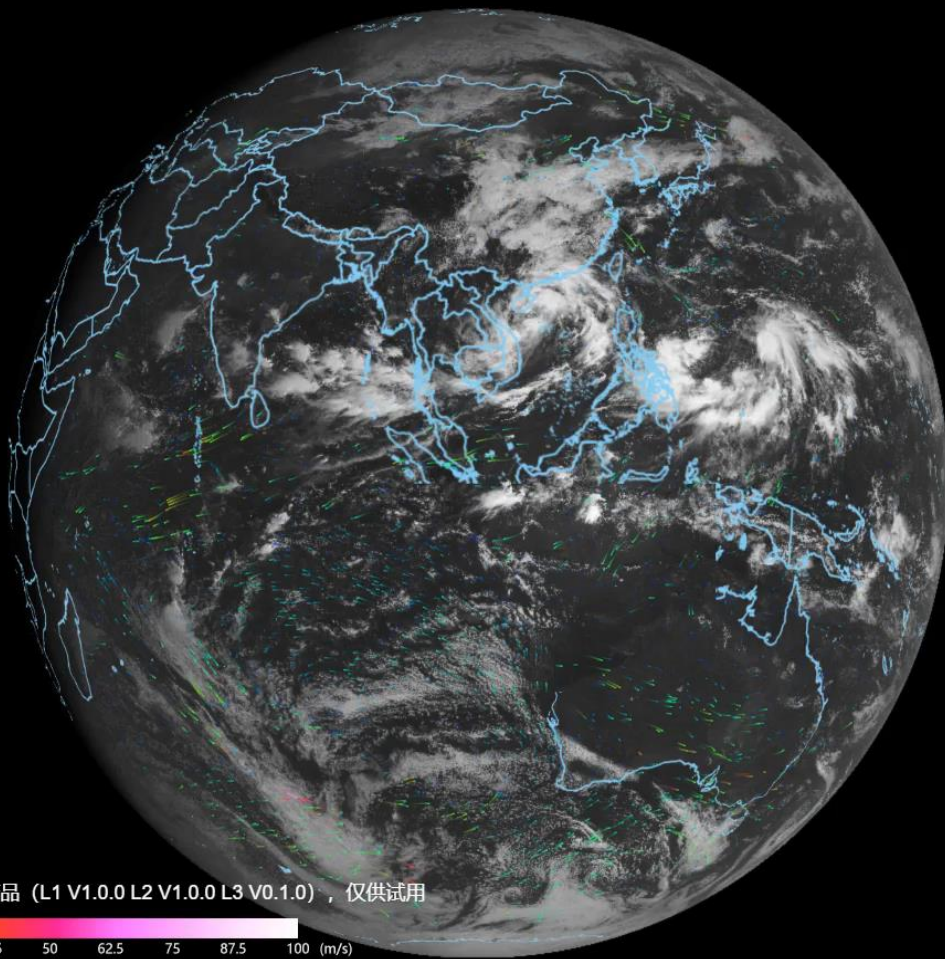
**Quick response to NWP and nowcasting requirement, according to WMO OSCAR capability analysis** Courtesy of Prof Xiaohu Zhang CMA/NSMC



### Low Level

2021-10-08

低层



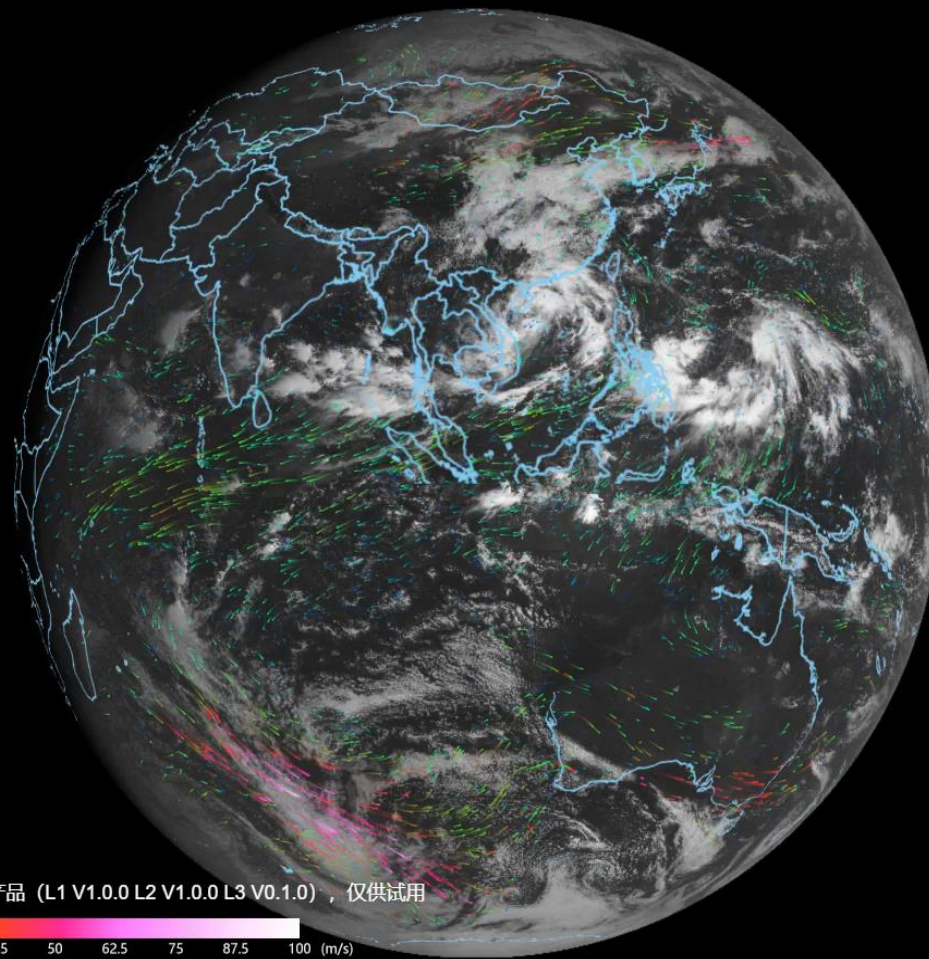
FY-4A地面系统测试产品 (L1 V1.0.0 L2 V1.0.0 L3 V0.1.0), 仅供试用



### High Level

2021-10-08

高层



FY-4A地面系统测试产品 (L1 V1.0.0 L2 V1.0.0 L3 V0.1.0), 仅供试用



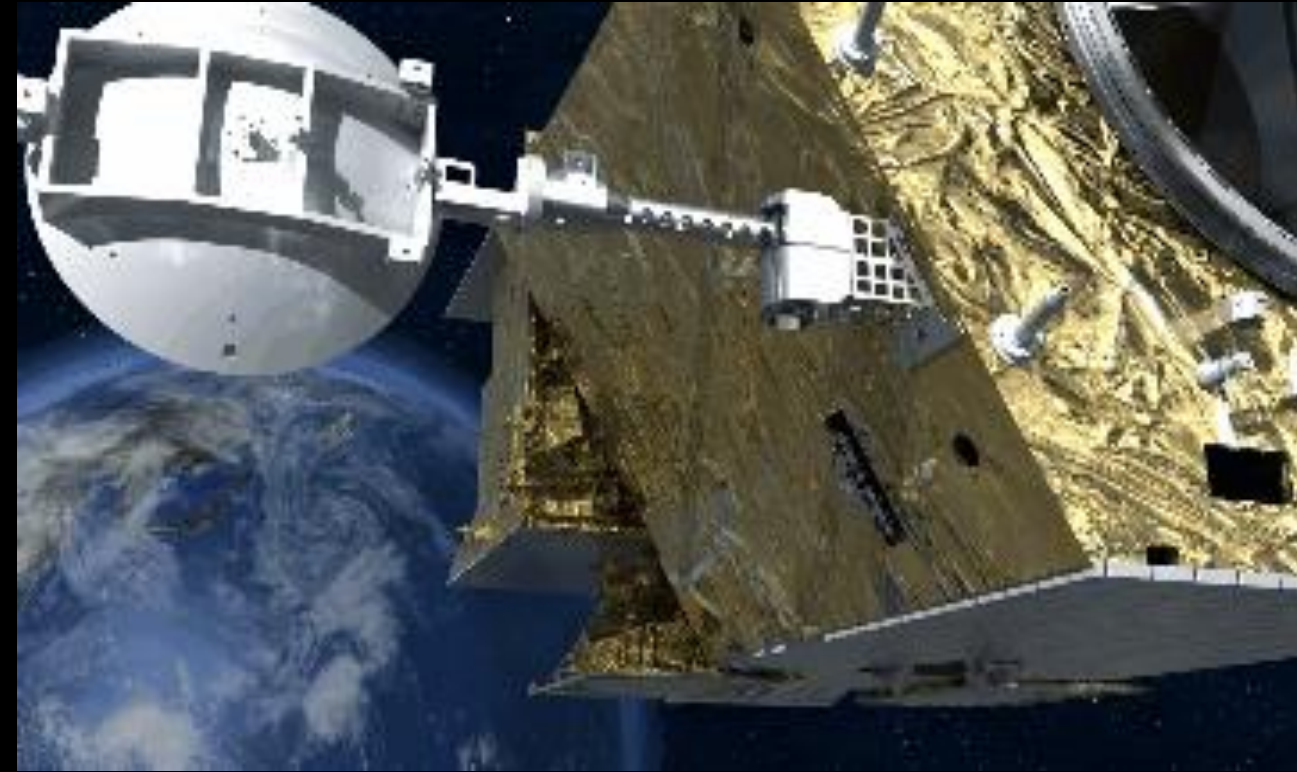


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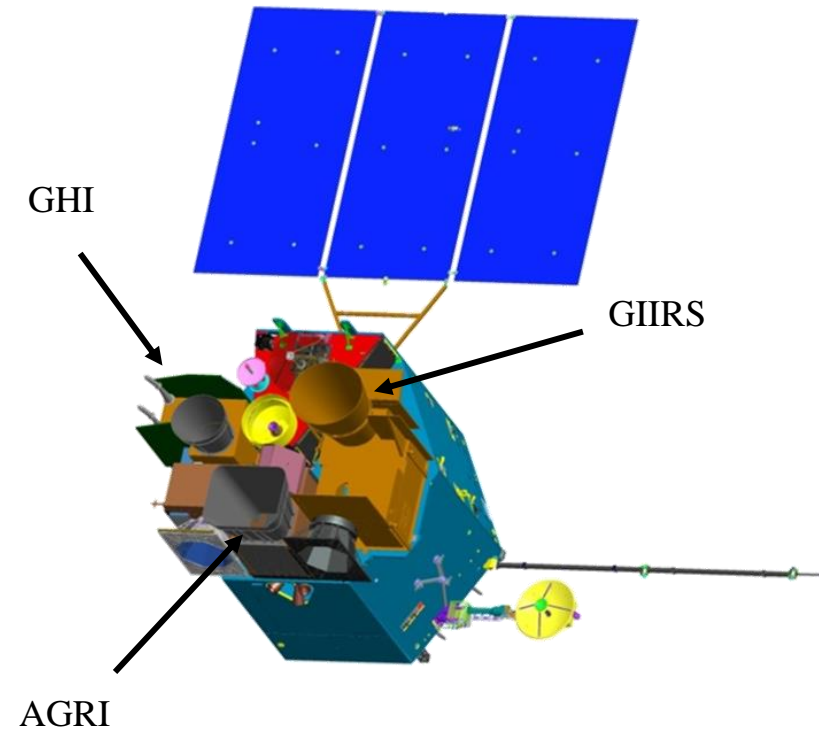


**FY-4B was successfully launched on Jun 3, 2021, it was located at 123.5 E.**





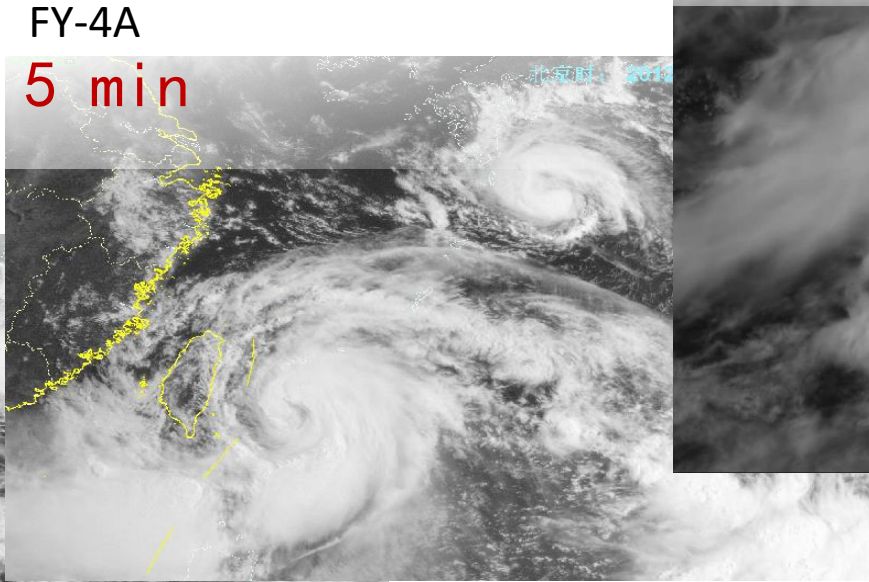
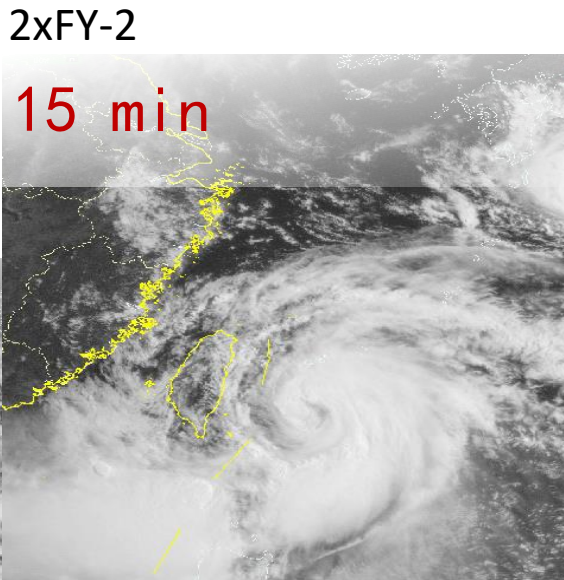
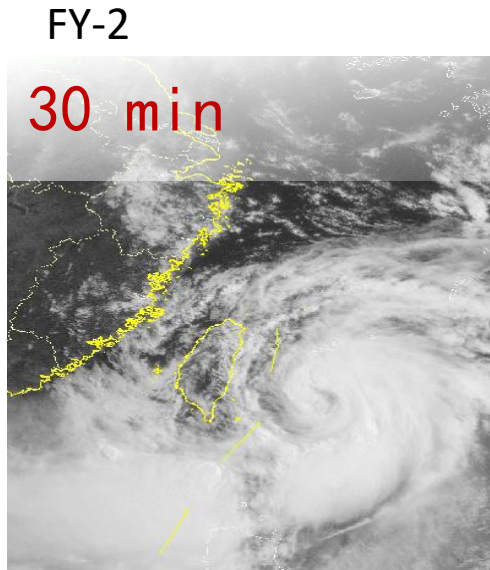
## 2) Major improvements of FY-4B



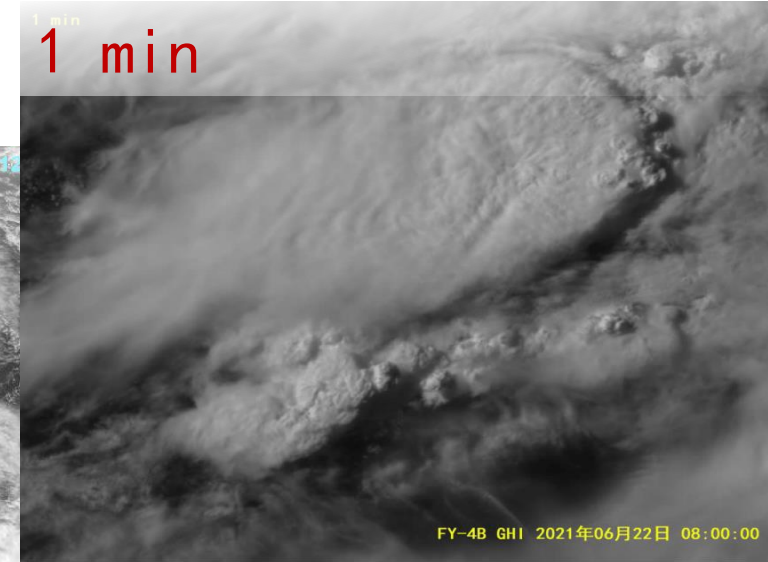
	FY-4A(EXP)	FY-4B(OP)
<b>Stabilization</b>	Three-axis	Three-axis
<b>Designed Life</b>	5~7 Years	7-10 Years
<b>Observation efficiency</b>	85%	85%
<b>Observation Mode</b>	Imaging +Sounding + Lightning Mapping	Imaging +Sounding
<b>Main Instruments</b>	<b>AGRI :14 channels</b> SSP Resolution: 0.5~4Km Global imaging: 15min Flexible imaging : 2D	<b>AGRI :15 channels</b> SSP Resolution: 0.5~4Km Global imaging: 15min Flexible imaging : 2D
	<b>GIIRS:</b> SSP Resolution:16Km Spectral Resolution: 0.625cm-1	<b>GIIRS:</b> SSP Resolution:12Km Spectral Resolution: 0.625cm-1
	<b>LMI:</b> SSP Resolution:7.8Km	<b>GHI: 7 channels</b> SSP Resolution:0.25-2Km
	<b>SEP</b> High energy particles	<b>SEP</b> High energy particles <b>Magnetic field</b>



## 2) Major improvements of FY-4B



FY-4B







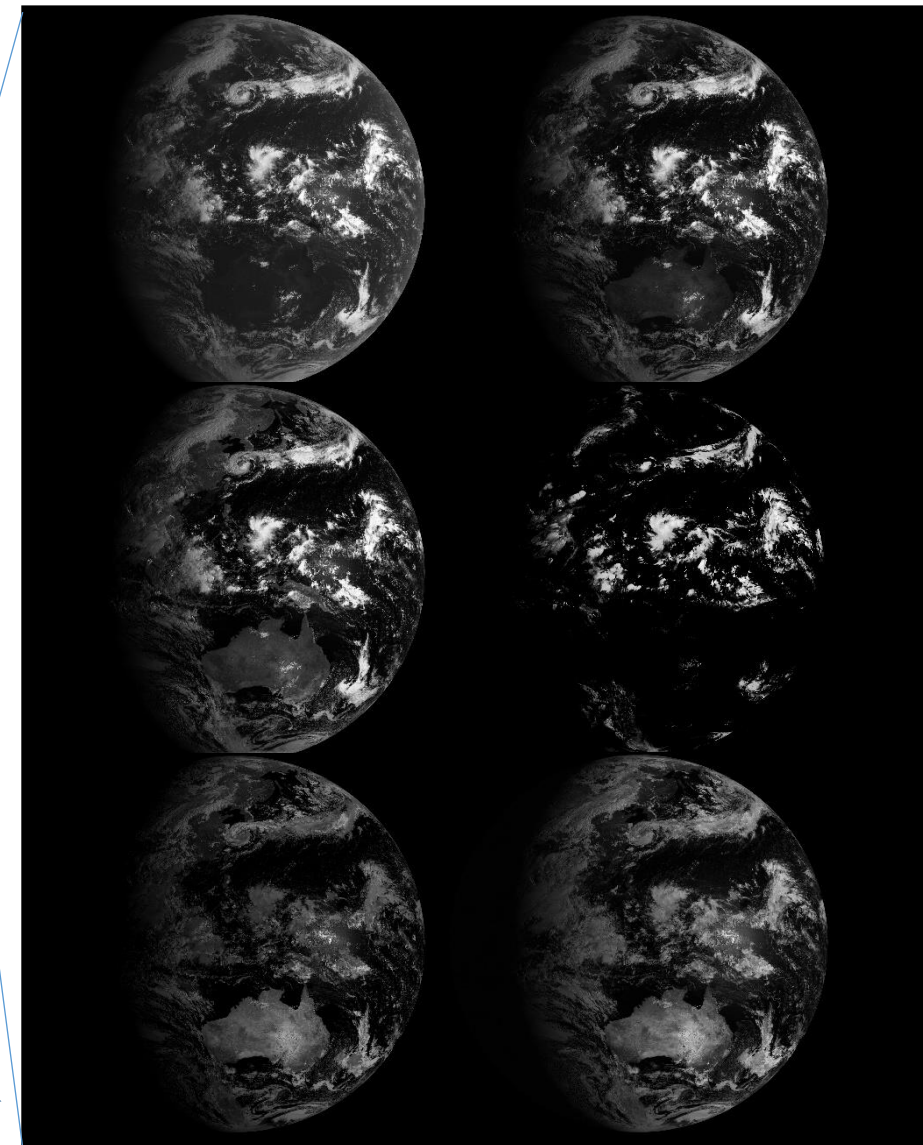
### 3)FY-4B post launching test progress

#### Advanced Geostationary Radiation Imager(AGRI)

Central wavelength	Spectral interval	SNR or NEΔT @ specified input	IFOV at s.s.p.
0.47 μm	0.45-0.49 μm	≥90 @ 100% albedo	1 km
0.65 μm	0.55-0.75 μm	≥150 @ 100% albedo	0.5 km
0.825 μm	0.75-0.90 μm	≥200 @ 100% albedo or ≥3 @ 1% albedo	1 km
1.378 μm	1.371~1.386 μm	≥120 @ 100% albedo or ≥2 @ 1% albedo	2 km
1.61 μm	1.58-1.64 μm	≥200 @ 100% albedo or ≥3 @ 1% albedo	2 km
2.25 μm	2.10-2.35 μm	≥200 @ 100% albedo or ≥2 @ 1% albedo	2 km
3.75 μm (high)	3.50-4.00 μm	≤ 0.7 K @ 315 K	2 km
3.75 μm (low)	3.50-4.00 μm	0.2 K @ 300 K or 2.0 K @ 240 K	4 km
6.25 μm	5.80-6.70 μm	0.2 K @ 300 K or 0.9 K @ 240 K	4 km
6.95 μm	6.75-7.15 μm	0.25 K @ 300 K or 0.9 K @ 240 K	4 km
<b>7.92 μm</b>	<b>7.24-7.60 μm</b>	<b>0.25 K @ 300 K or 0.9 K @ 240 K</b>	<b>4 km</b>
8.55 μm	8.30-8.80 μm	0.2 K @ 300 K or 0.4 K @ 240 K	4 km
10.80 μm	10.30-11.30 μm	0.2 K @ 300 K or 0.4 K @ 240 K	4 km
12.00 μm	11.50-12.50 μm	0.2 K @ 300 K or 0.4 K @ 240 K	4 km
13.30 μm	13.00-13.60 μm	<b>0.5 K @ 300 K or 0.9 K @ 240 K</b>	4 km

new

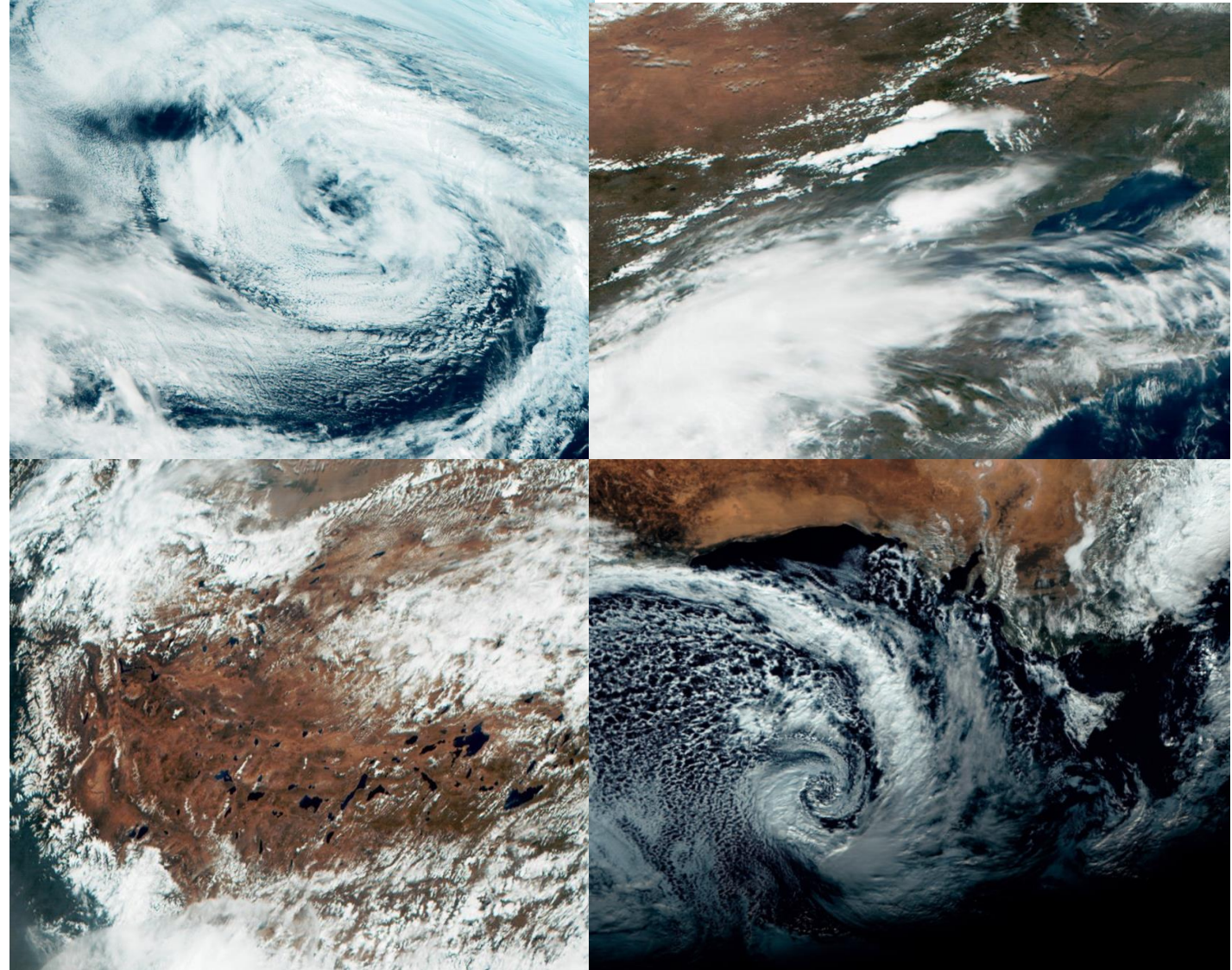
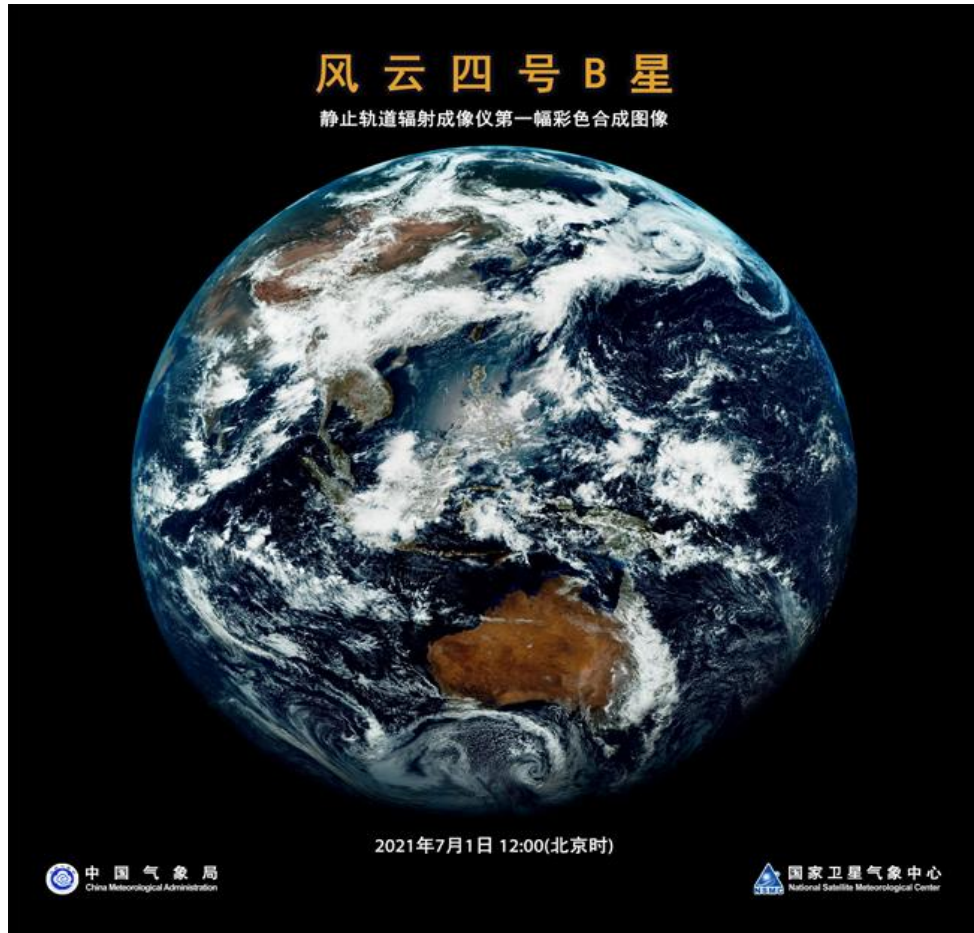
Better  
NEDT





### 3)FY-4B post launching test progress

#### Advanced Geostationary Radiation Imager(AGRI)

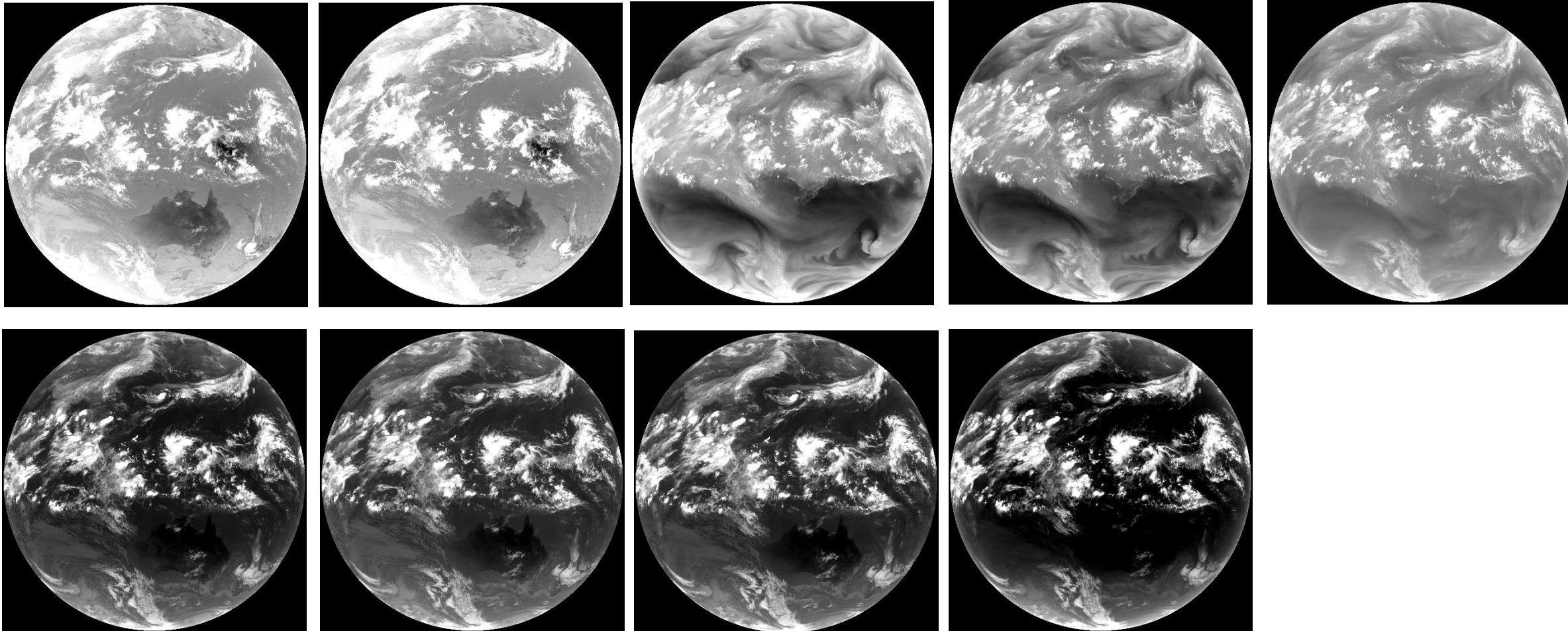




### 3)FY-4B post launching test progress

Advanced Geostationary Radiation Imager(AGRI)

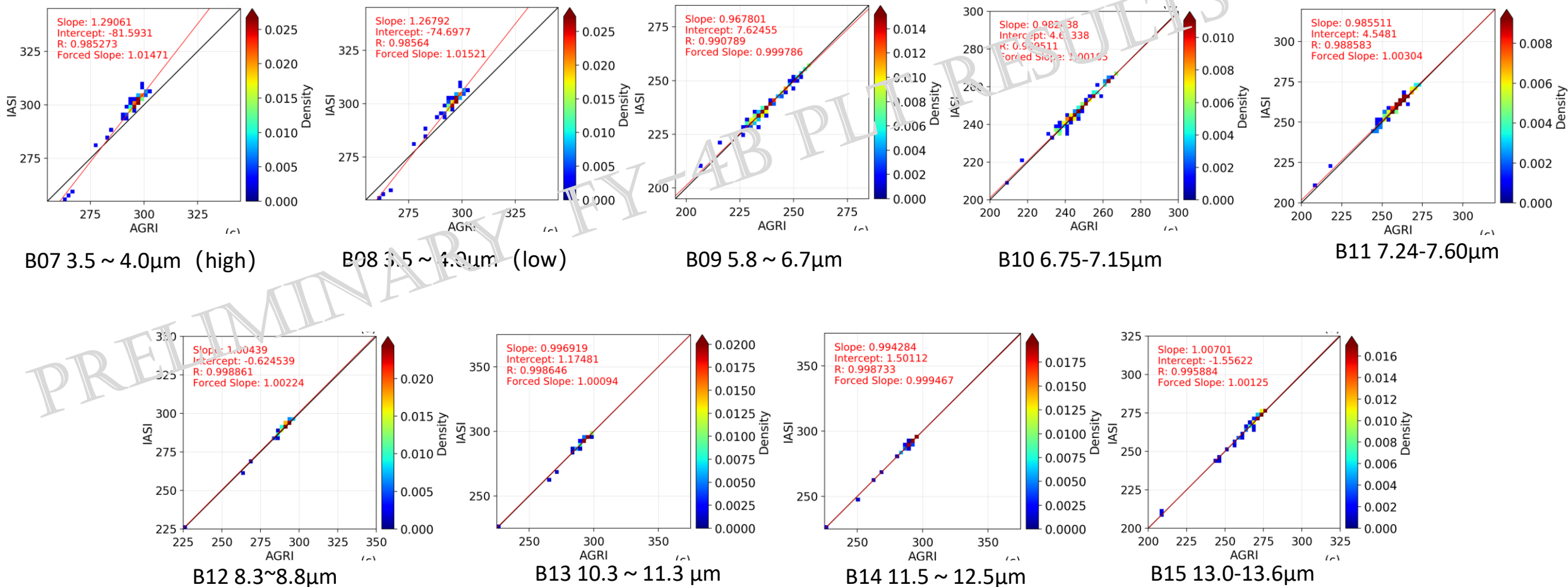
All of the FY-4B AGRI IR channel works fine





### 3)FY-4B post launching test progress

#### Advanced Geostationary Radiation Imager(AGRI)





### 3)FY-4B post launching test progress

#### Advanced Geostationary Radiation Imager(AGRI)

晴空检测	Cloud Mask	CLM	大气湿度廓线	Atmospheric Humidity Profile	AHP
云顶高度	Cloud Top Height	CTH	有云大气温度廓线	Cloudy Vertical Temperature Profile	CVT
云顶温度	Cloud Top Temperature	CTT	有云大气湿度廓线	Cloudy Vertical Moisture Profile	CVM
云顶气压	Cloud Top Pressure	CTP	大气不稳定指数	Atmosphere Instability Index	AII
云类型	Cloud Type	CLT	大气运动导风	Atmosphere Motion Vector	AMV
云相态	Cloud Phase	CLP	降水率	Quantitative Precipitation Estimate	QPE
云覆盖率	Cloud Fraction Ratio	CFR	对流初生	Convective Initiation	CI
晴空辐射	Clear Sky Radiation	CSR	对流层顶折叠检测	Tropopause Folding Turbulence Prediction	TFTP
白天云微物理和光学性质	Daytime cloud optical and microphysical properties	CPD	海表温度	Sea Surface Temperature (Skin)	SST
夜间云微物理和光学性质	Nighttime cloud optical and microphysical properties	CPN	火点/热点检测	Fire/Hot Spot Monitoring	FHS
沙尘和烟雾检测	Dust Smoke Detection	DSD	地表比辐射率	Land Surface Emissivity	LSE
气溶胶	Aerosol Detection	AOD	积雪覆盖	Snow Cover	SNC
射出长波辐射	Outgoing Long wave Radiation	OLR	雾检测	Fog Detection	FOG
地表下行长波辐射	Downward Longwave Radiation	DLR	地表温度	Land Surface Temperature	LST
地表上行长波辐射	Upward Longwave Radiation	ULR	反照率	Land Surface Albedo	LSA
地表太阳入射辐射	Surface Solar Irradiance	SSI	大气分层水汽	Layer Precipitable Water	LPW
反射短波辐射	Reflected Shortwave Radiation	RSR	大气温湿度廓线	Atmospheric Vertical Profile	AVP
大气温度廓线	Atmospheric Temperature Profile	ATP			

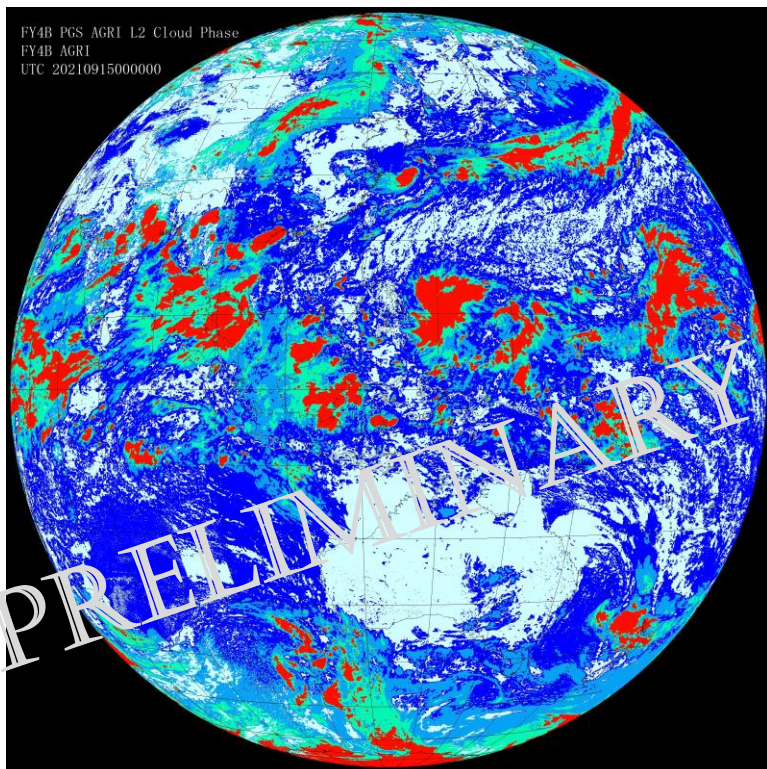
23/35 baseline products are under validation

All of FY-4B L2 products will finish validation in Q1 2022



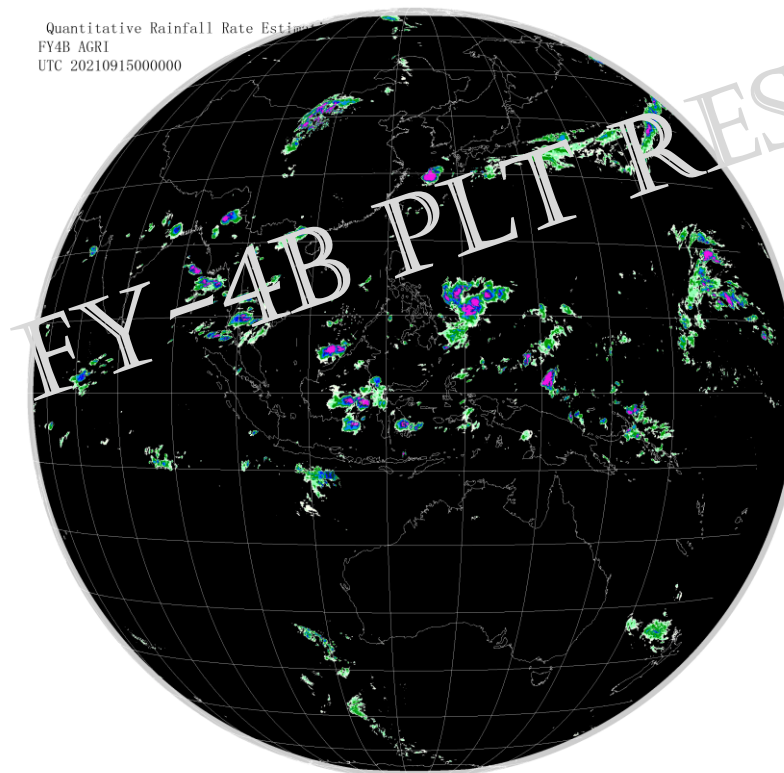
### 3)FY-4B post launching test progress

#### Advanced Geostationary Radiation Imager(AGRI)



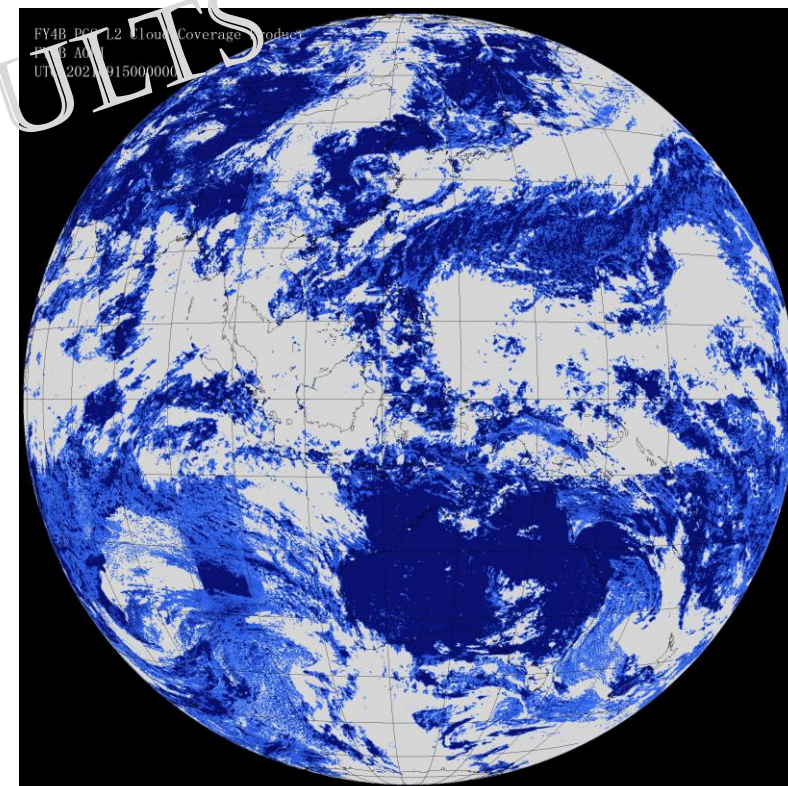
Fillvalue SPACE Clear Water Type Super-Cooled Mixed Type Ice Type  
Uncertain

Cloud Phase



0 0.1 1.2 2.4 4.6 6.8 8.10 10.20  
20.50 50 外太空 缺省值 卫星天顶角>90 umls:mm

QPE



0.00 0.20 0.40 0.60 0.80 1.00  
太空 无效值

Cloud coverage



### 3)FY-4B post launching test progress

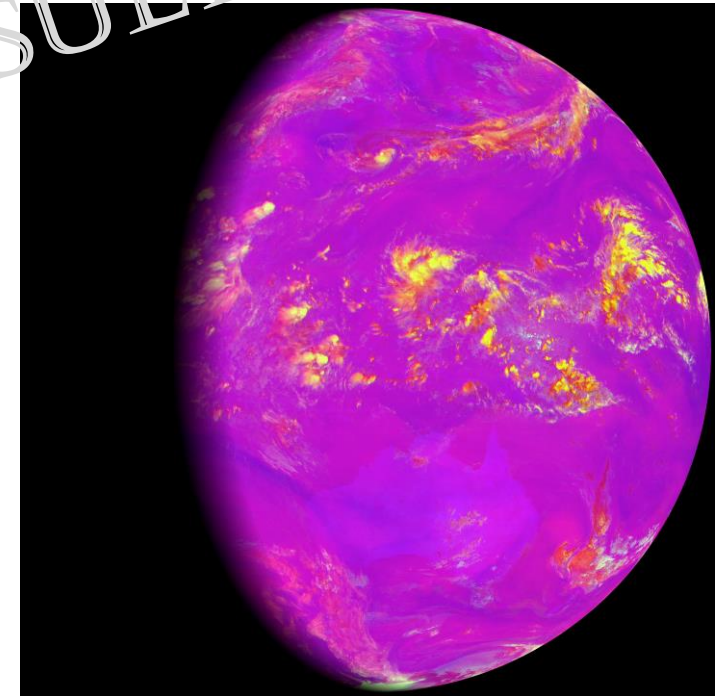
#### Advanced Geostationary Radiation Imager(AGRI)



HRV-CLOUD



HRV-FOG



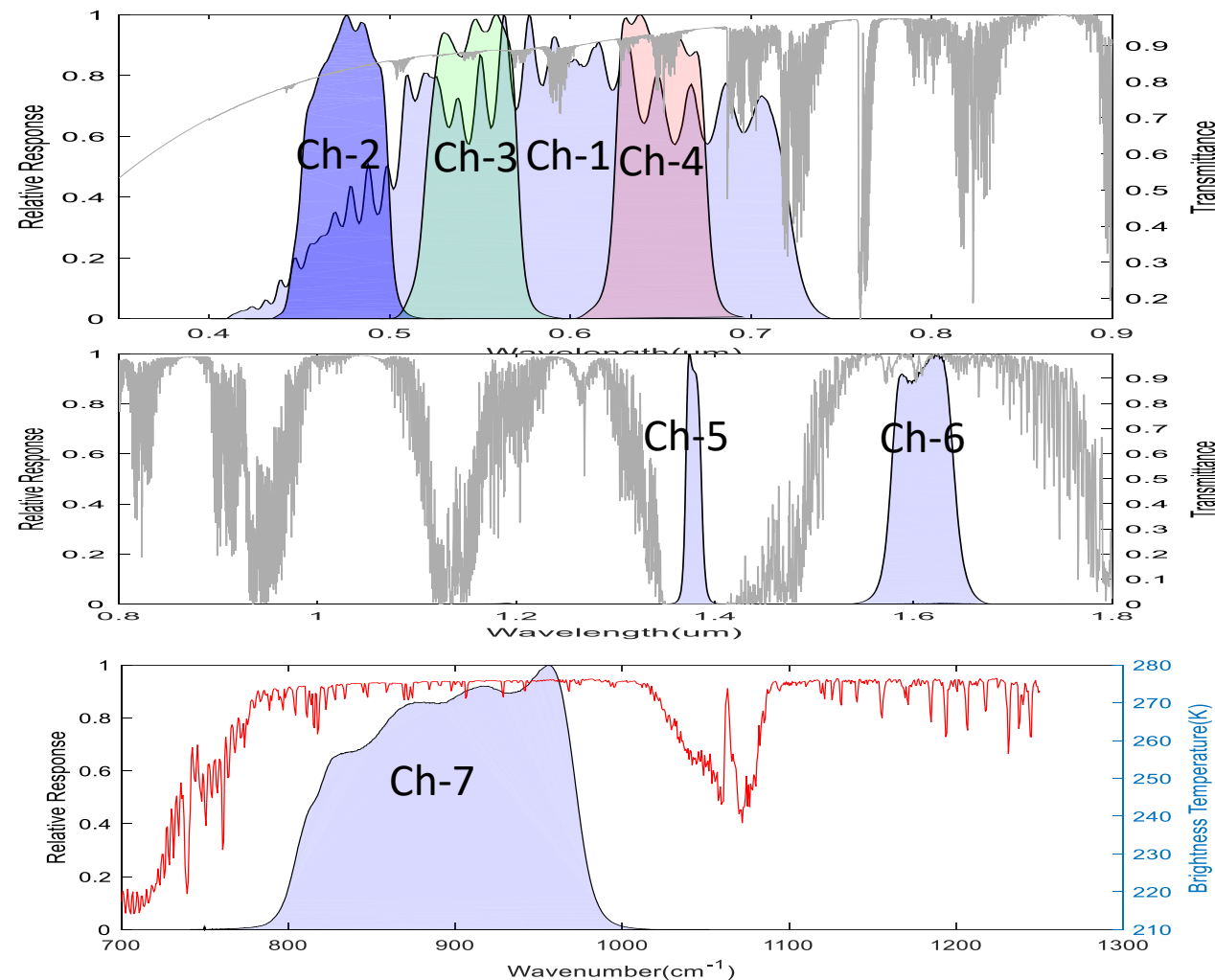
Severe storms



### 3)FY-4B post launching test progress

#### Geosynchronous High-speed Imager (GHI)

Central wavelength	Spectral interval	SNR or NE $\Delta$ T @ specified input	IFOV at s.s.p.
0.675 $\mu$ m	0.45-0.9	> 300 @ 100 % albedo	0.25 km
0.470 $\mu$ m	0.445-0.495	> 300 @ 100 % albedo	0.5 km
0.545 $\mu$ m	0.52-0.57	> 300 @ 100 % albedo	0.5 km
0.645 $\mu$ m	0.62-0.67	> 300 @ 100 % albedo	0.5 km
1.378 $\mu$ m	1.371-1.386	> 300 @ 100 % albedo	0.5 km
1.61 $\mu$ m	1.58-1.64	> 300 @ 100 % albedo	0.5 km
11.4 $\mu$ m	10.3-12.5	0.2 K @ 300 K	2.0 km

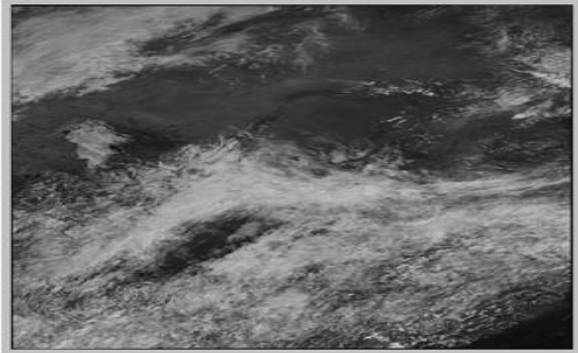




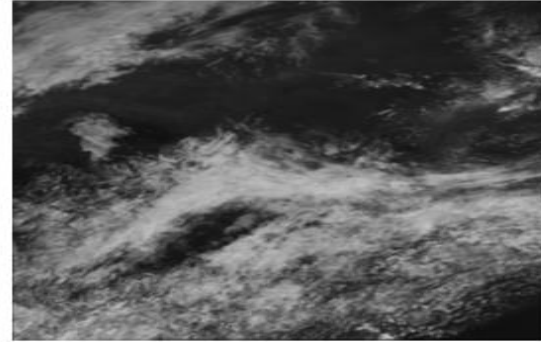


### 3)FY-4B post launching test progress

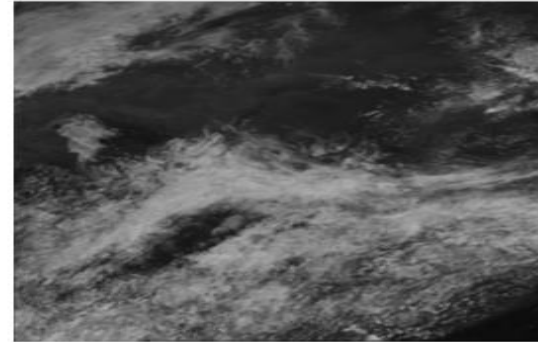
#### Geosynchronous High-speed Imager (GHI)



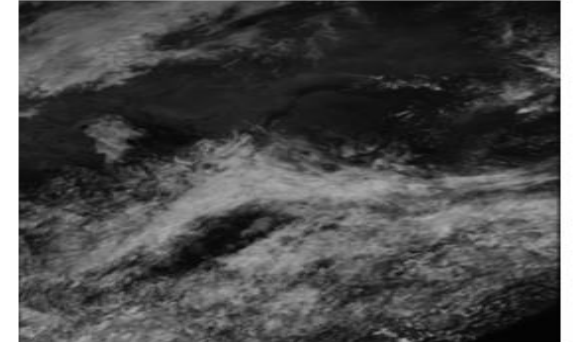
Band1



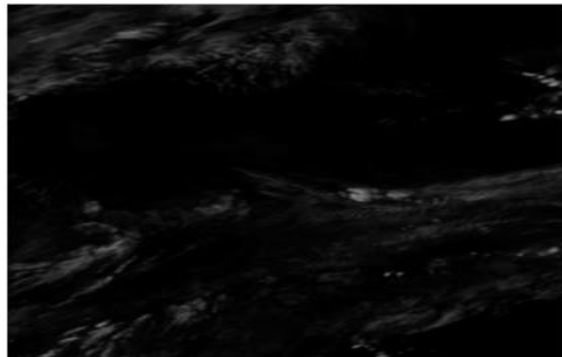
Band2



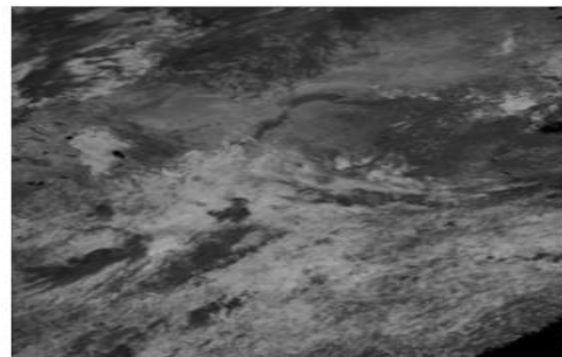
Band3



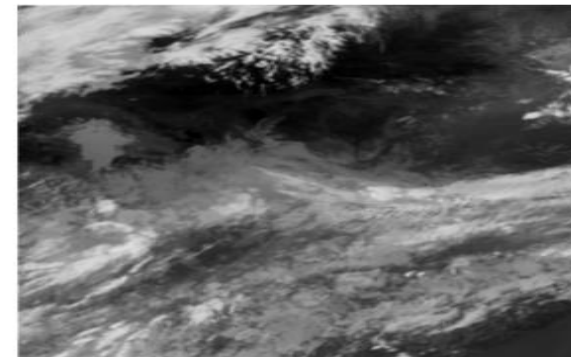
Band4



Band5



Band6

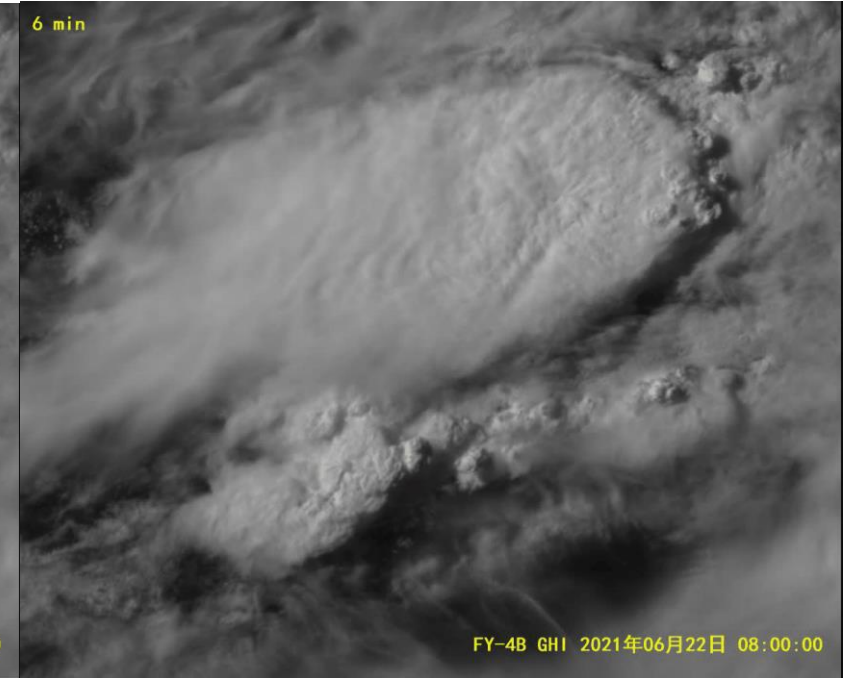
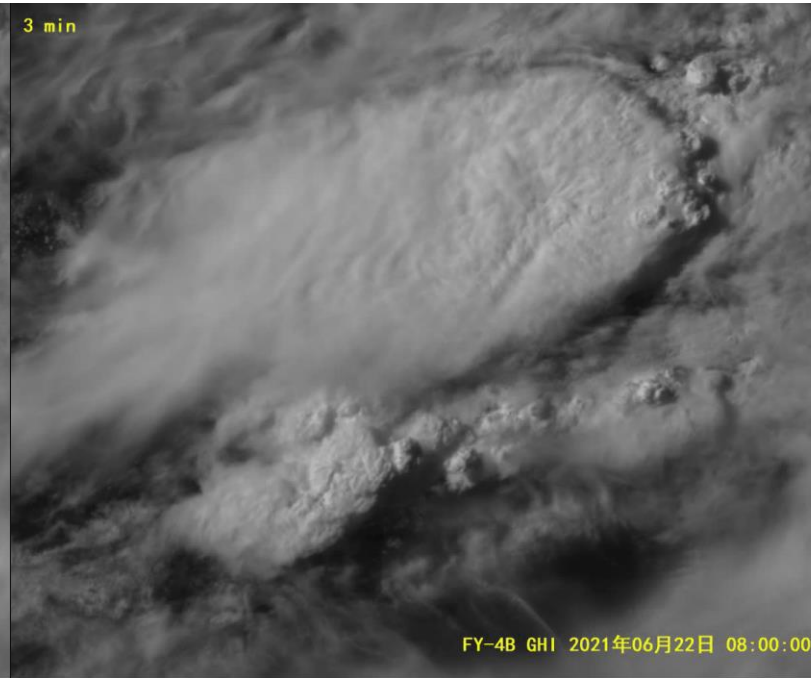
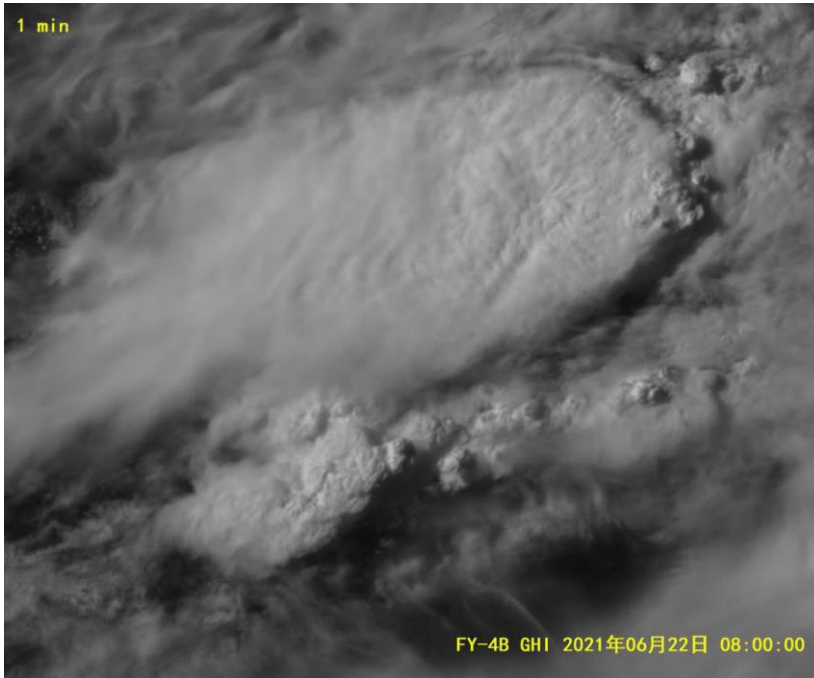


Band7



### 3)FY-4B post launching test progress

#### Geosynchronous High-speed Imager (GHI)



1min

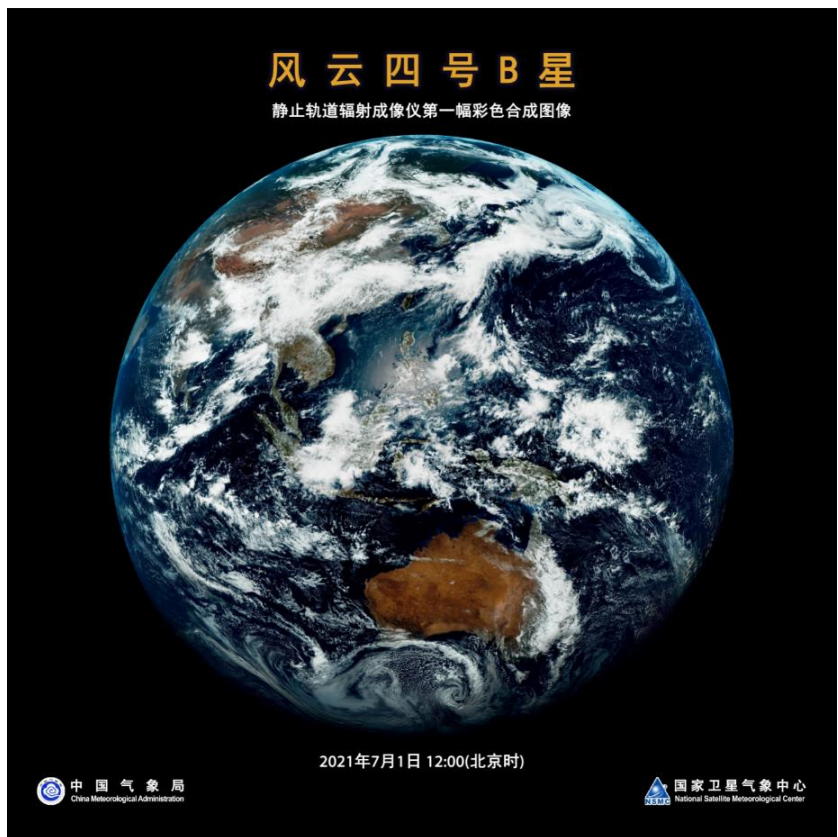
3min

6min

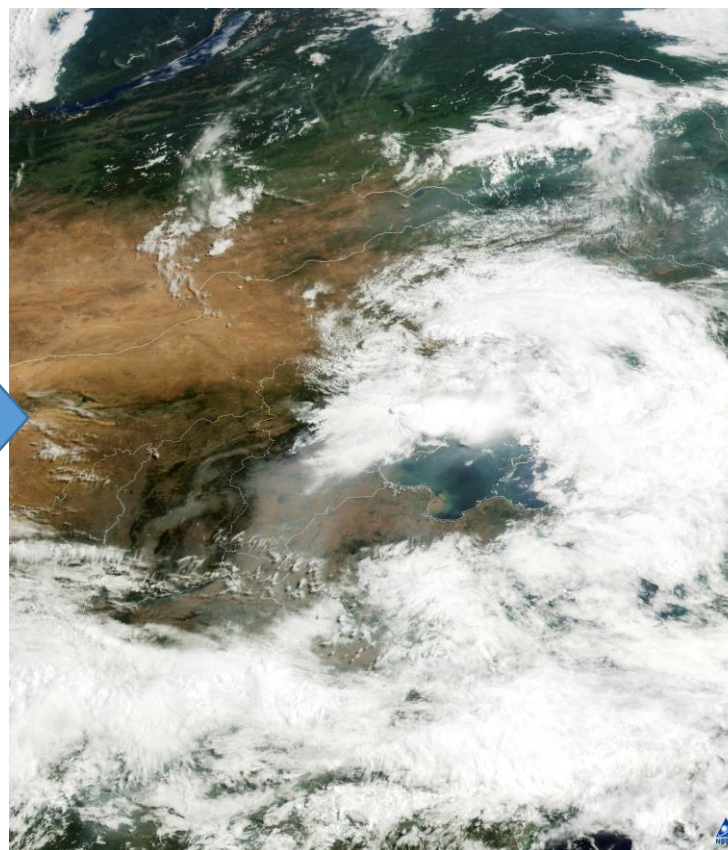


### 3)FY-4B post launching test progress

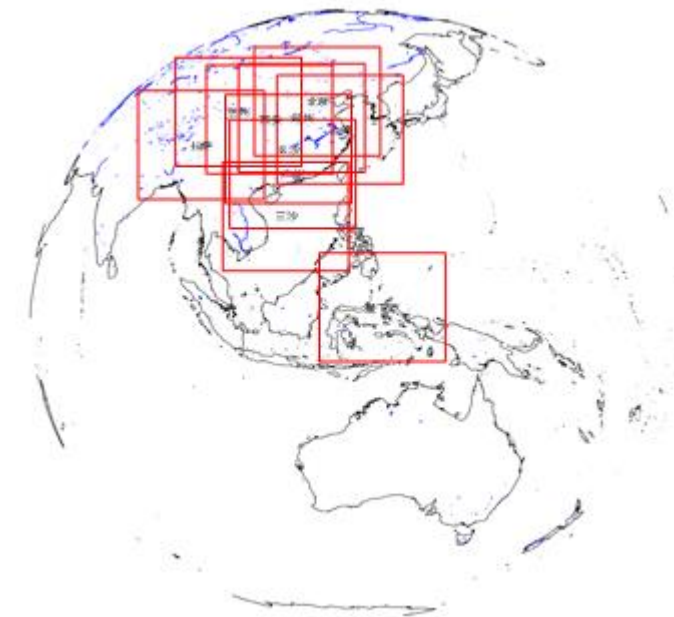
#### Geosynchronous High-speed Imager (GHI)



AGRI 5 min /1Km/China Natural Color



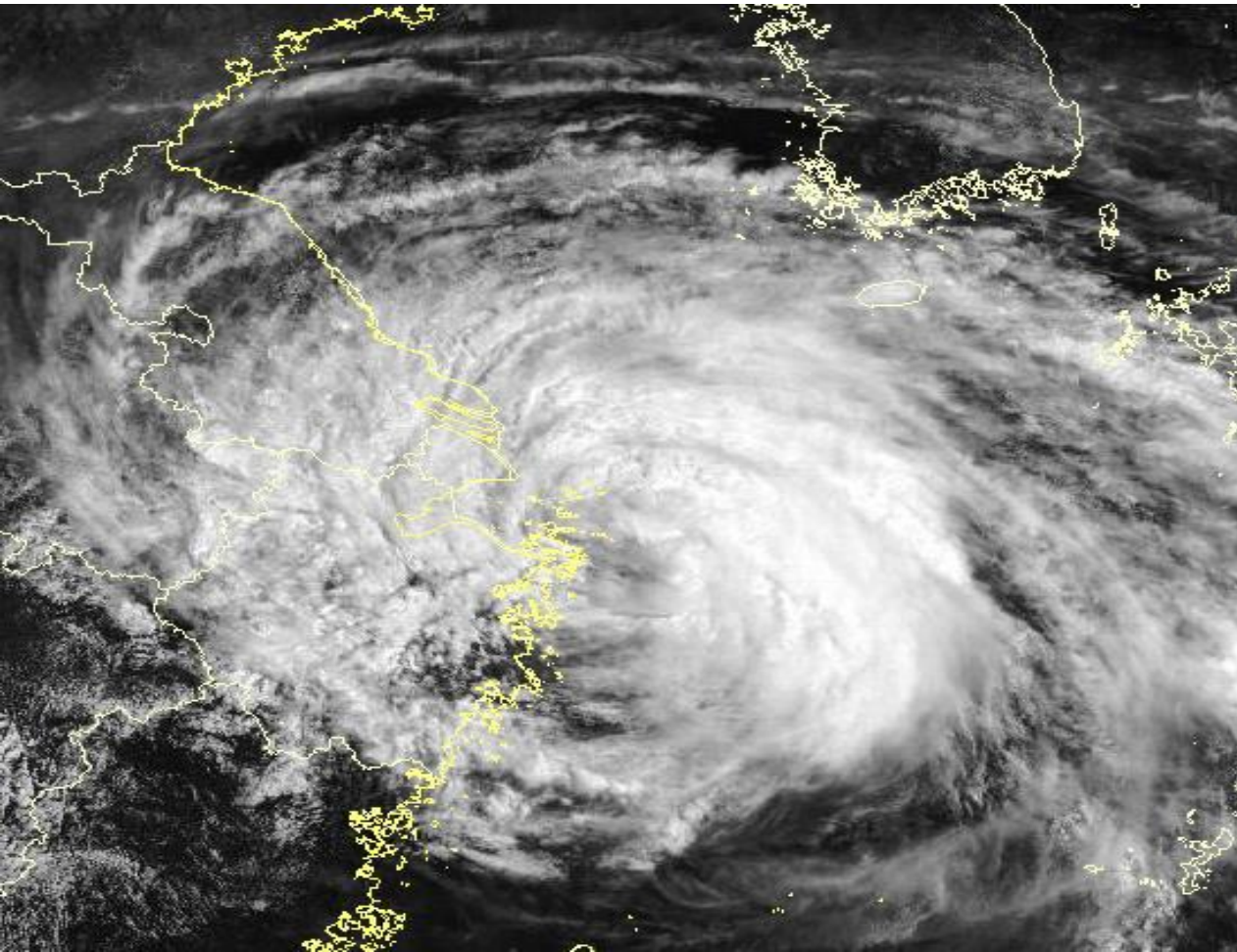
GHI 1min /0.25Km/True Color





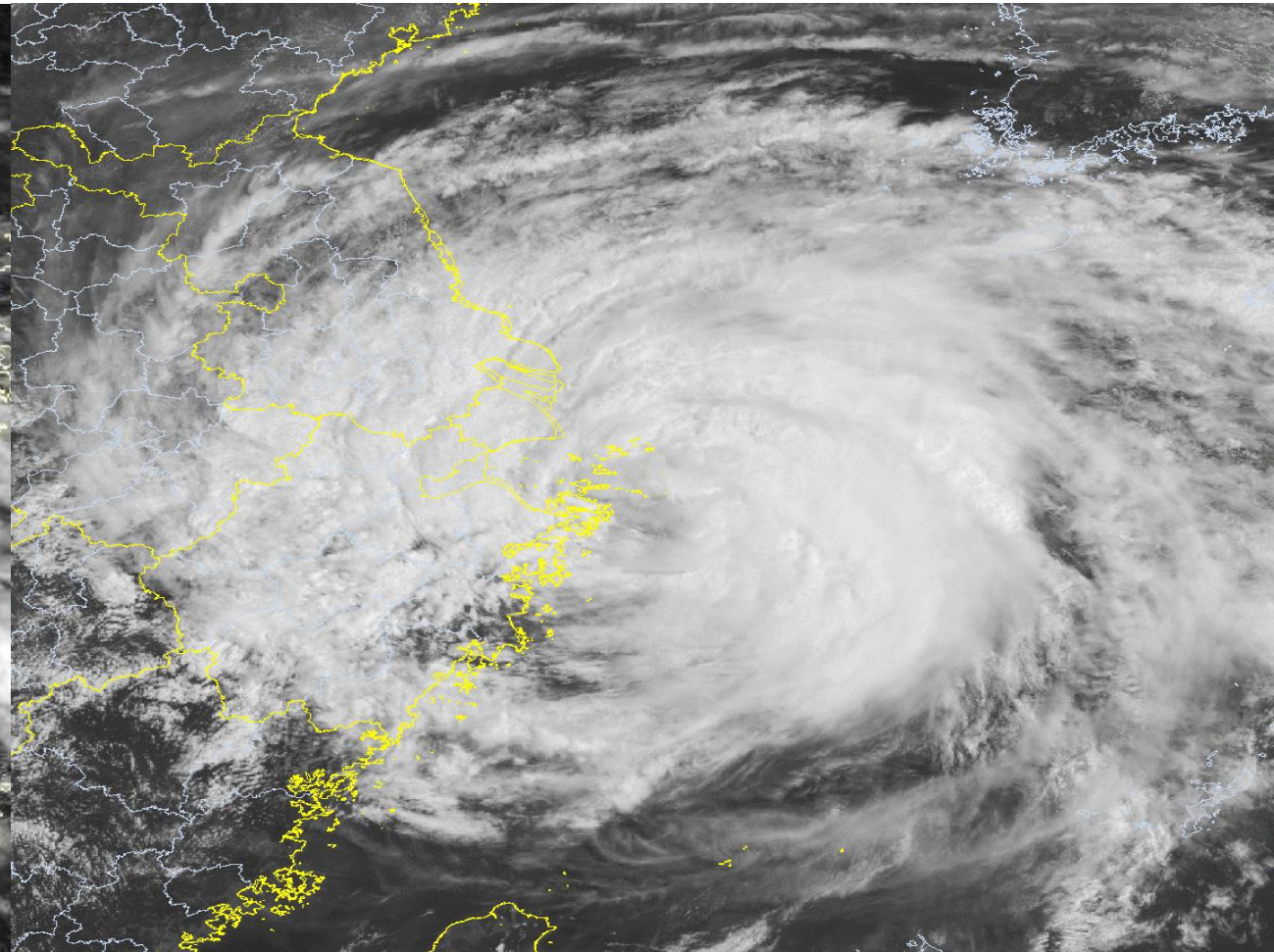
## Best practice for CMA FY-4 constellation

FY-4A/B AGRI: 5min interval-» large area observation



## Jul 25, 2021 Typhoon In-Fa case

FY-4B GHI: 1min interval-» 2KX2K regional observation

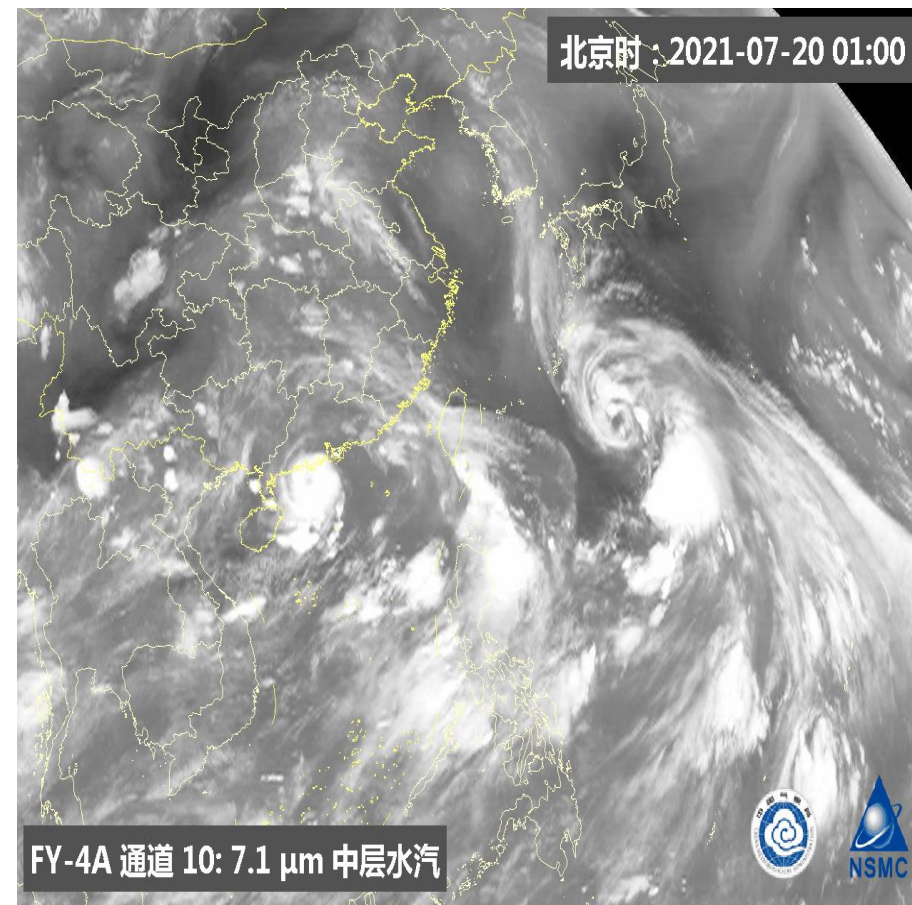
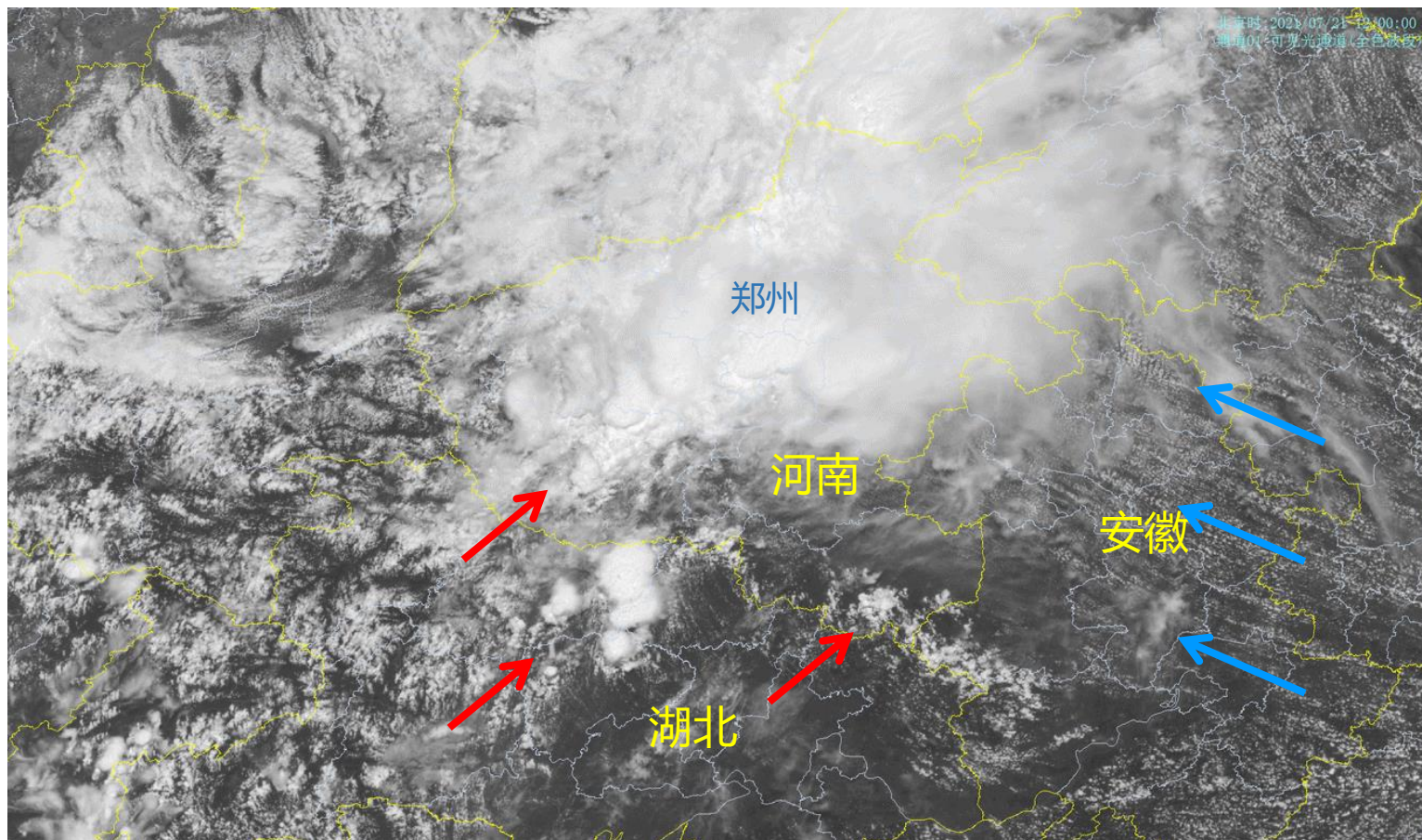




### 3)FY-4B post launching test progress

Geosynchronous High-speed Imager (GHI)

Jul 21,2021 Henan China

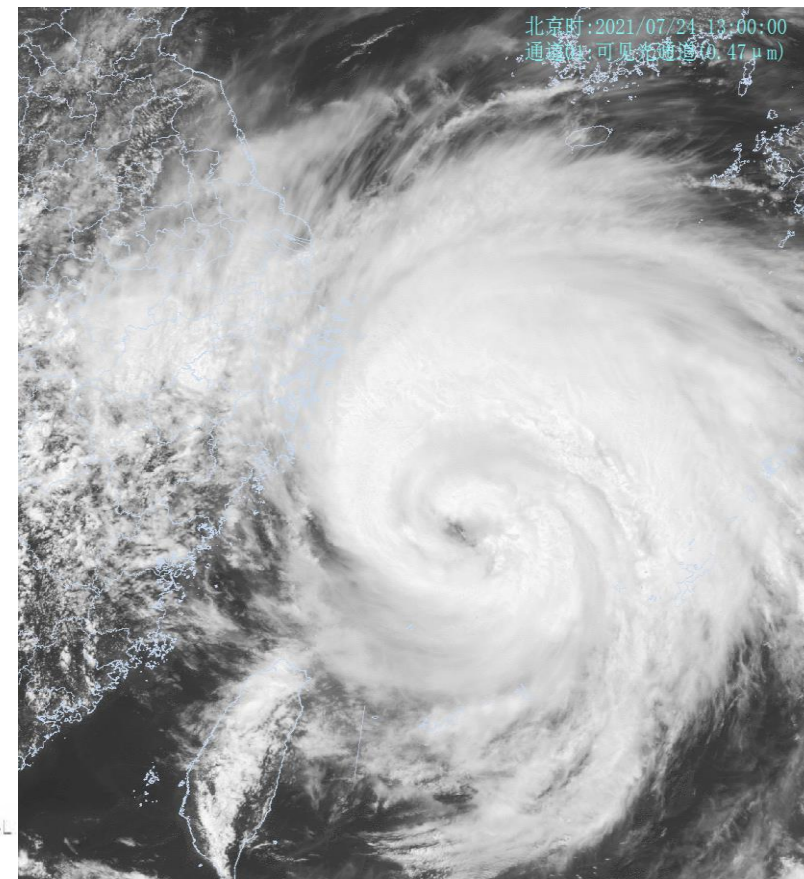
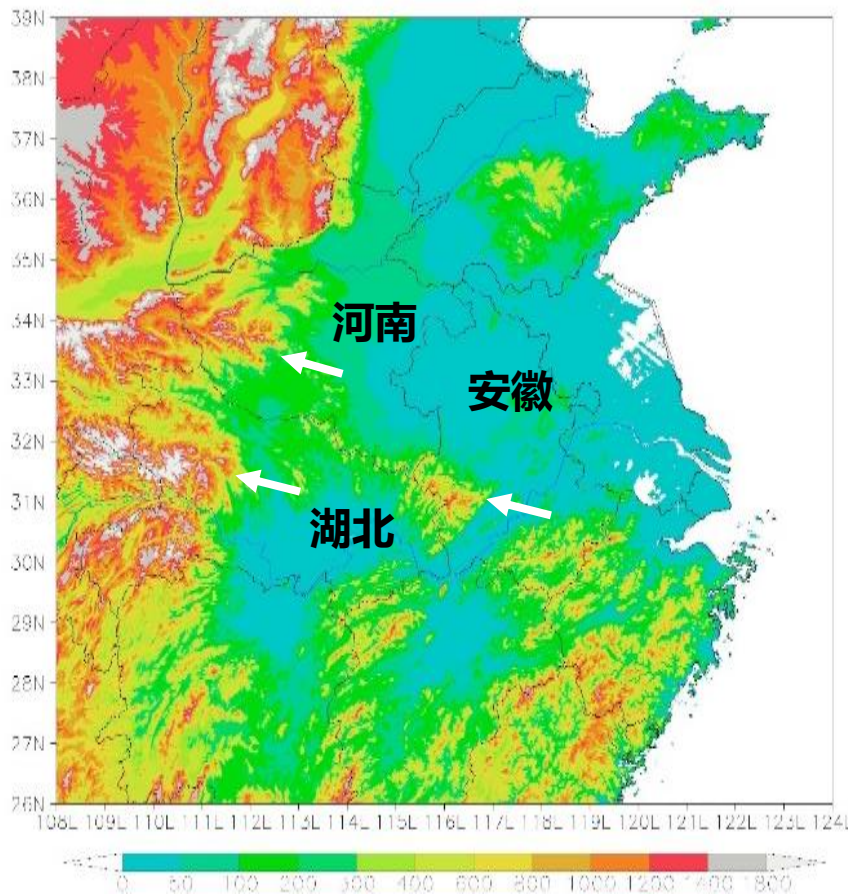
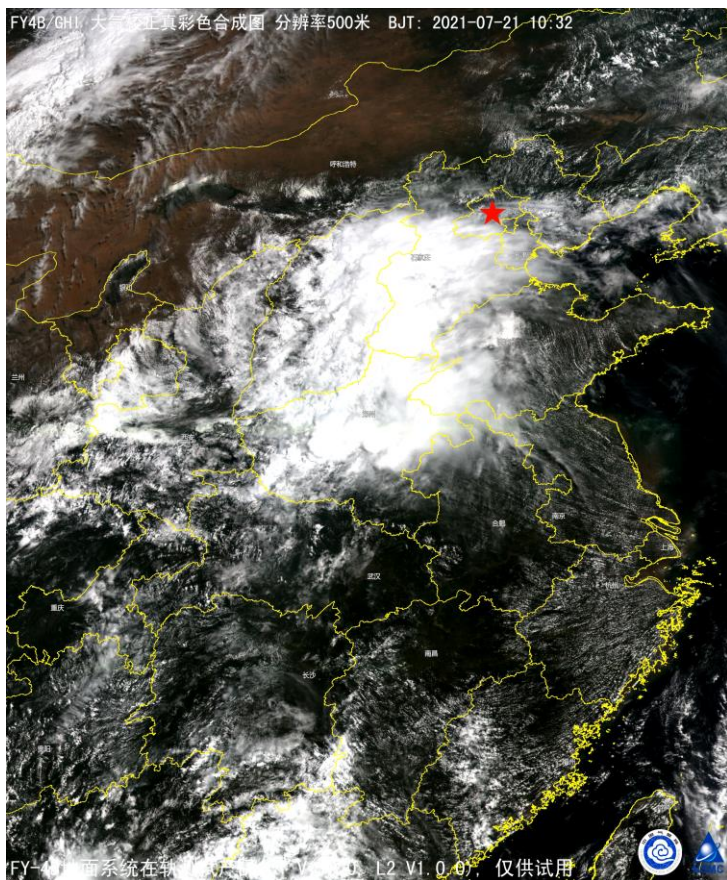




### 3)FY-4B post launching test progress

#### Geosynchronous High-speed Imager (GHI)

Jul 21, 2021 Henan China

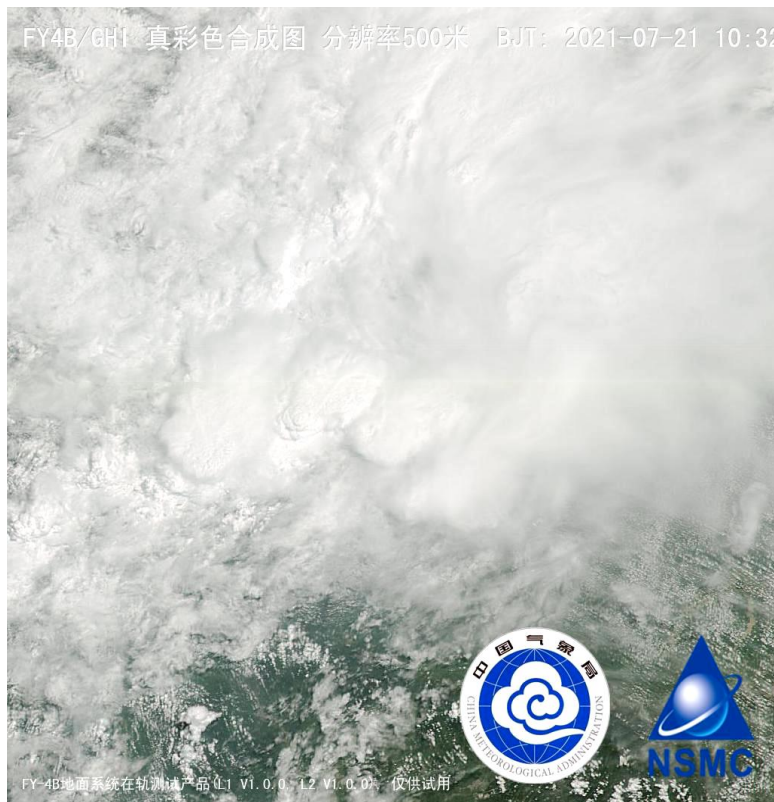




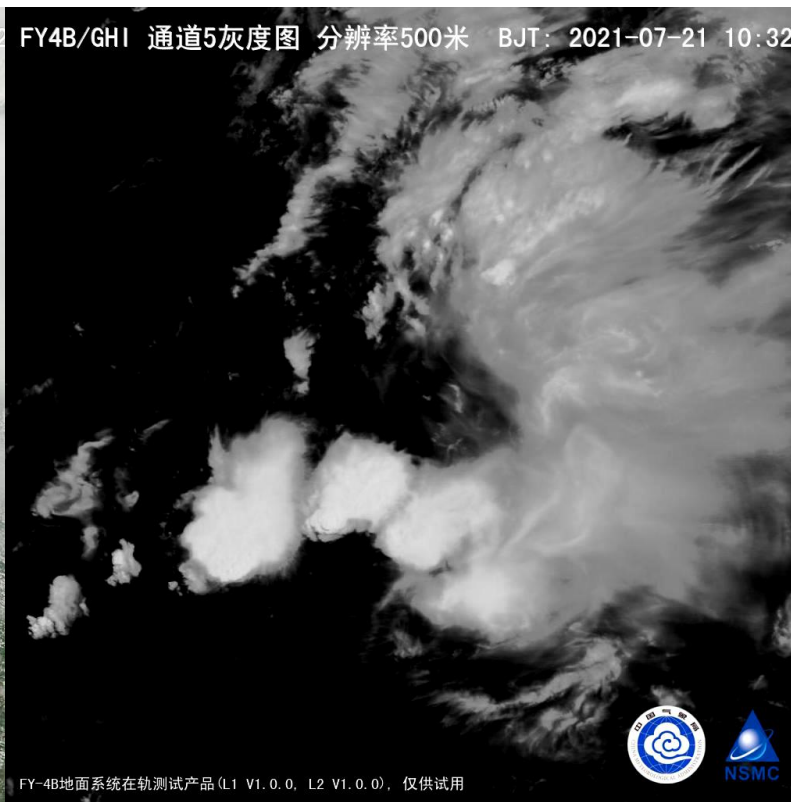
### 3)FY-4B post launching test progress

#### Geosynchronous High-speed Imager (GHI)

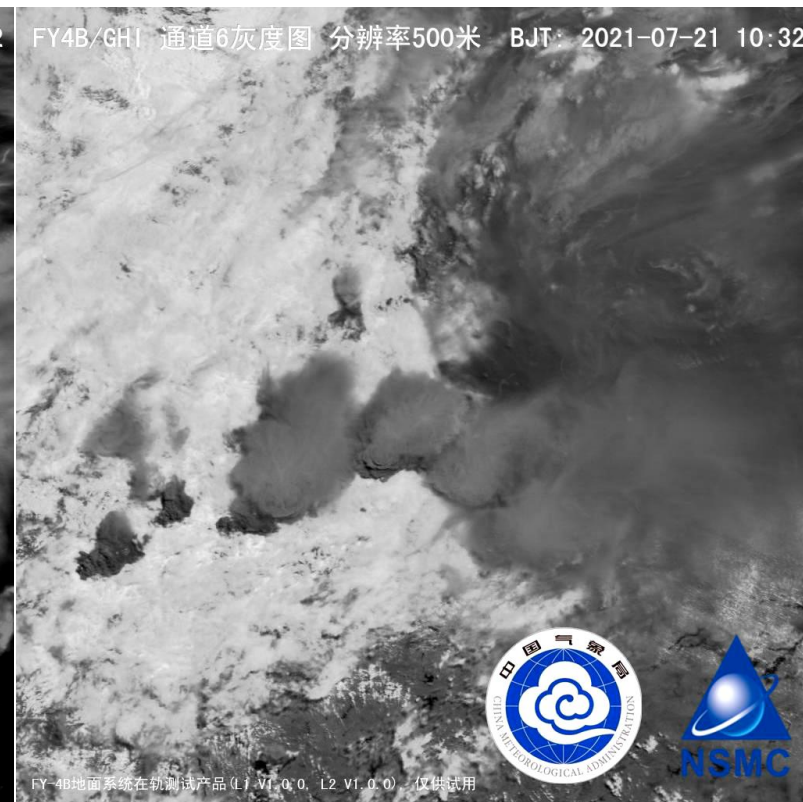
Jul 21, 2021 Henan China



True Color



Ch-5 cirrus channel



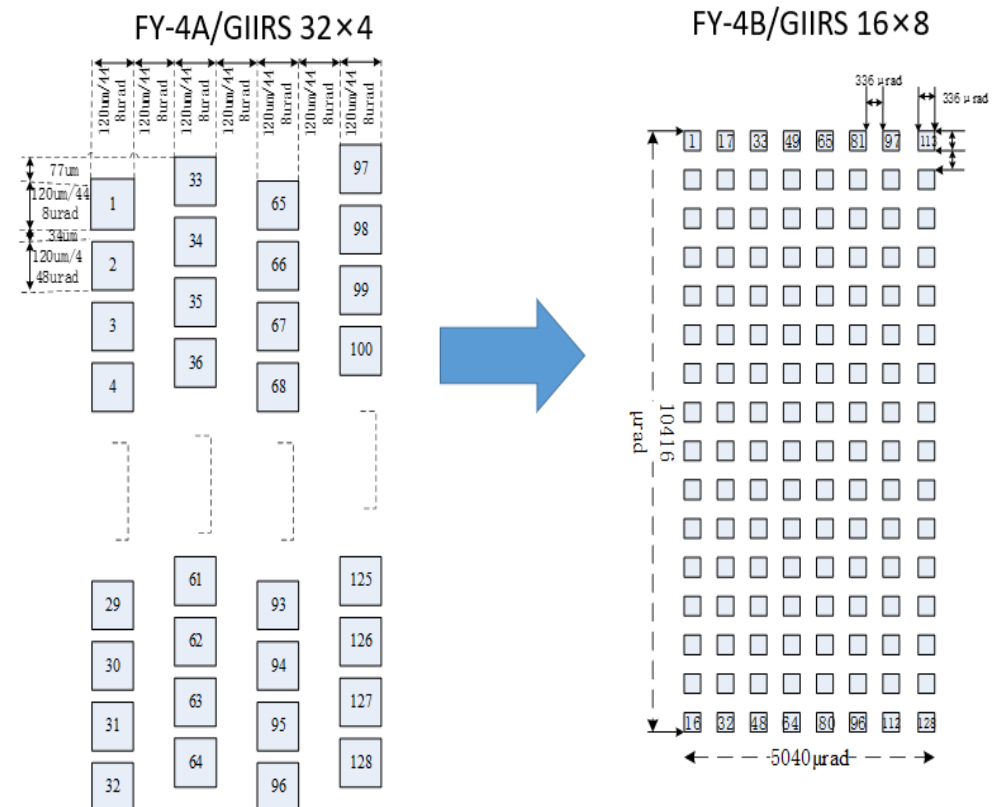
Ch-6 ice/water cloud



### 3)FY-4B post launching test progress

#### Geostationary Interferometric Infrared Sounder (GIIRS)

	FY-4A/GIIRS	FY-4B/GIIRS
Spectral Range	LWIR:700cm <sup>-1</sup> -1130cm <sup>-1</sup> S/MIR:1650cm <sup>-1</sup> -2250cm <sup>-1</sup>	LWIR: <b>680cm<sup>-1</sup></b> -1130cm <sup>-1</sup> S/MIR:1650cm <sup>-1</sup> -2250cm <sup>-1</sup>
Spectral resolution	0.625cm <sup>-1</sup>	0.625cm <sup>-1</sup>
Temporal Resolution	35min (1000*1000) 67min (5000*5000)	45min (5000*5000)

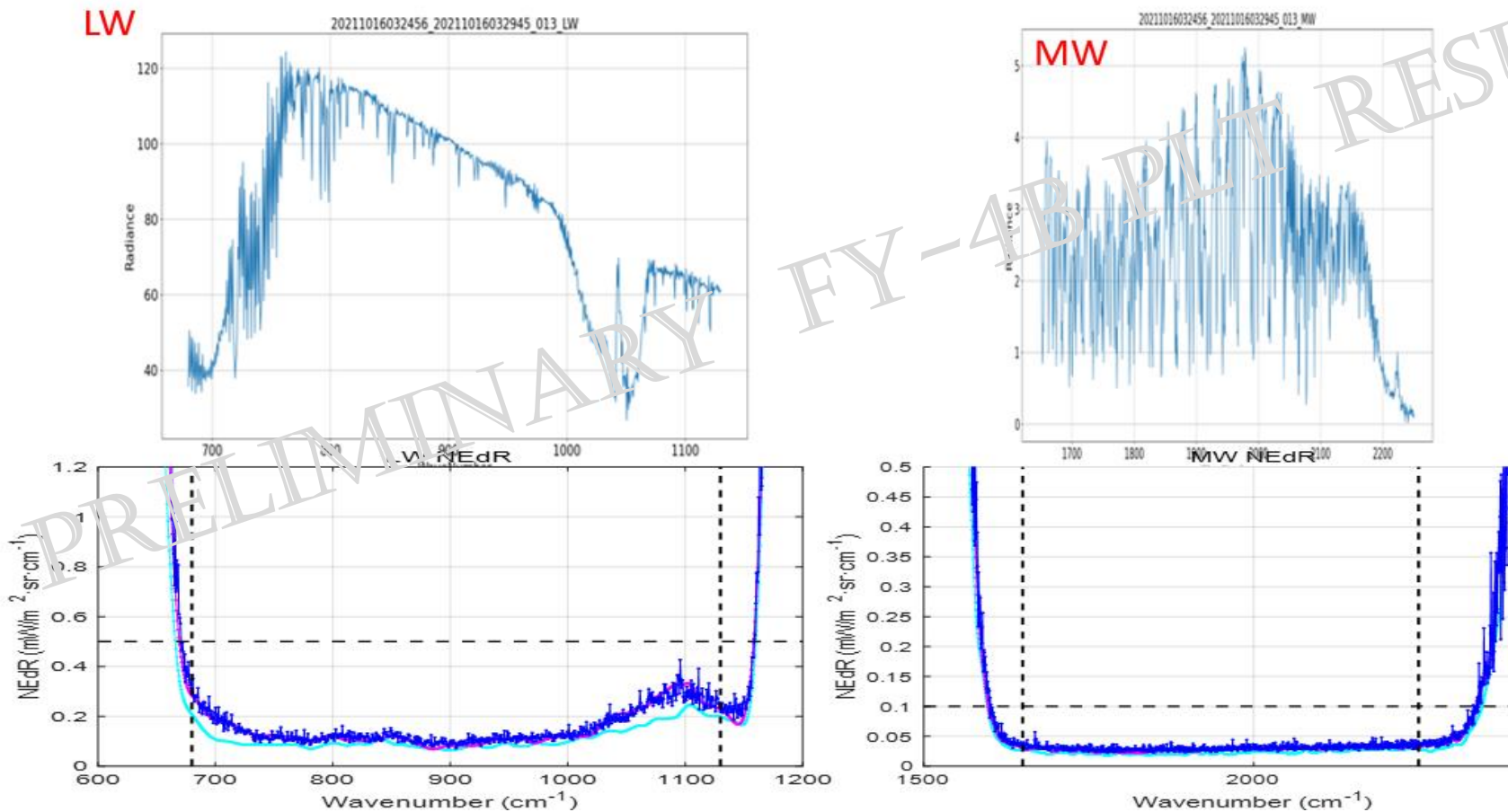






### 3)FY-4B post launching test progress

#### Geostationary Interferometric Infrared Sounder (GIIRS)

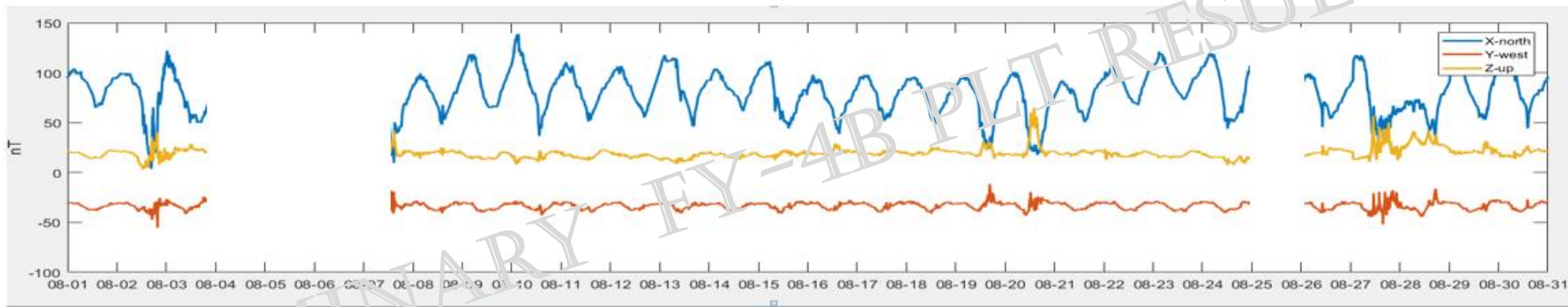




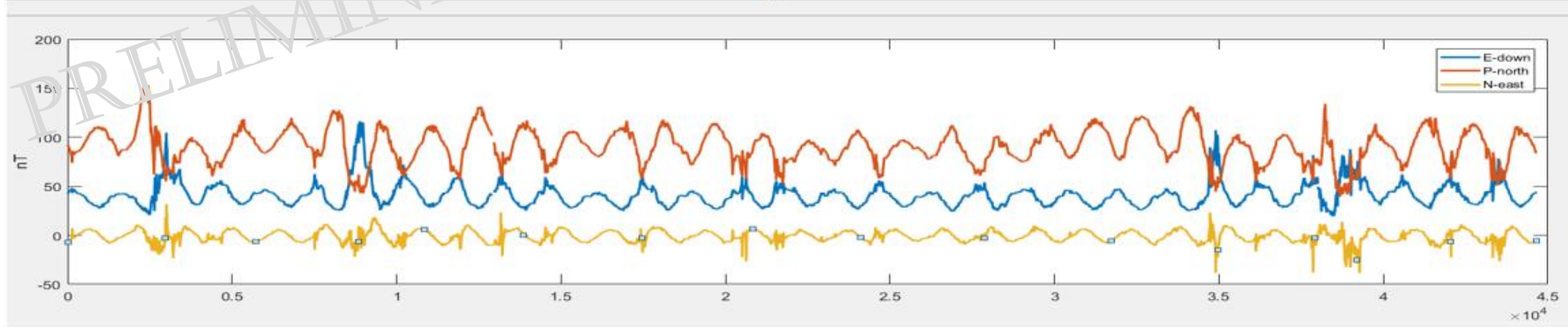
### 3)FY-4B post launching test progress

#### Space Environment Package(SEP)

#### Flux Gate Magnetometer (FGM)



FY-4B

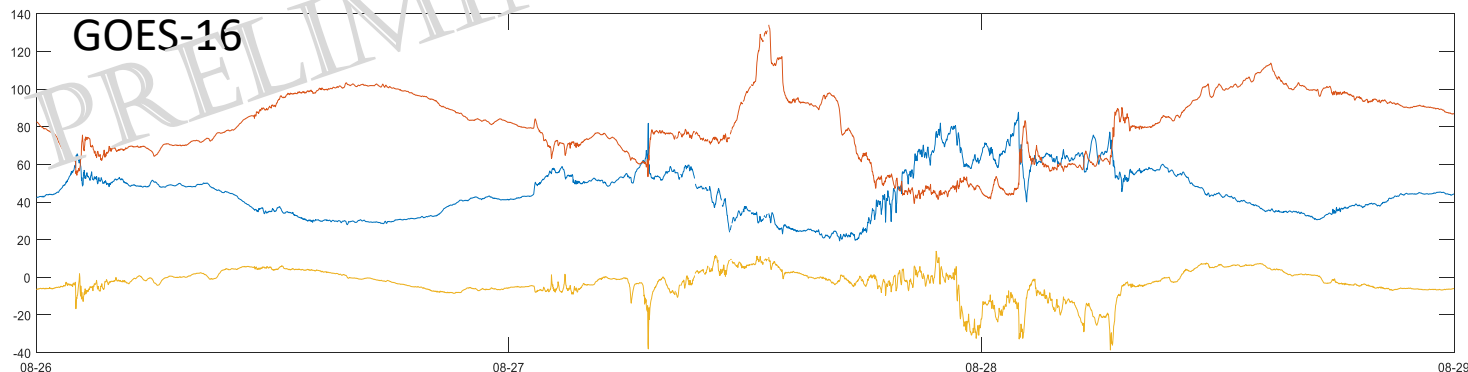
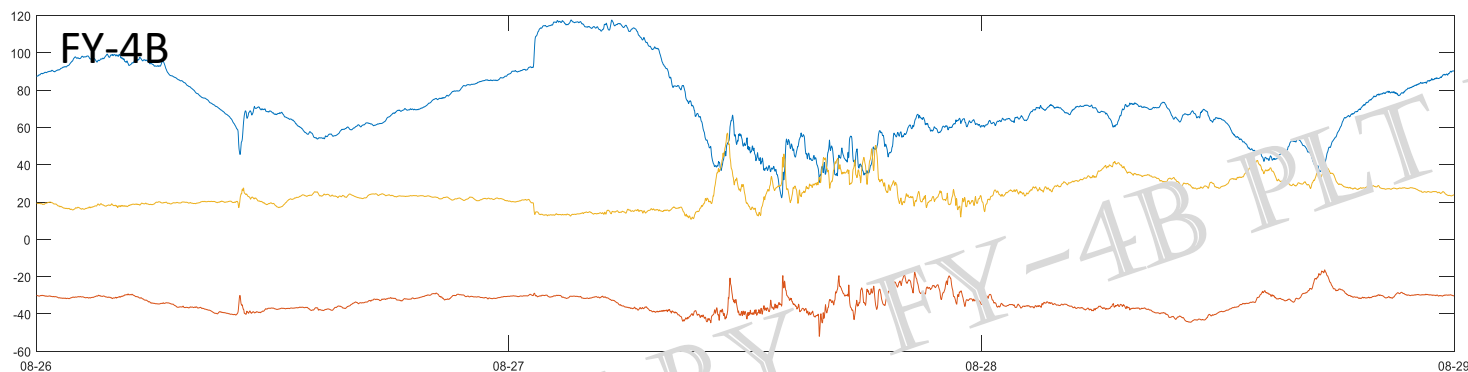


GOES-16

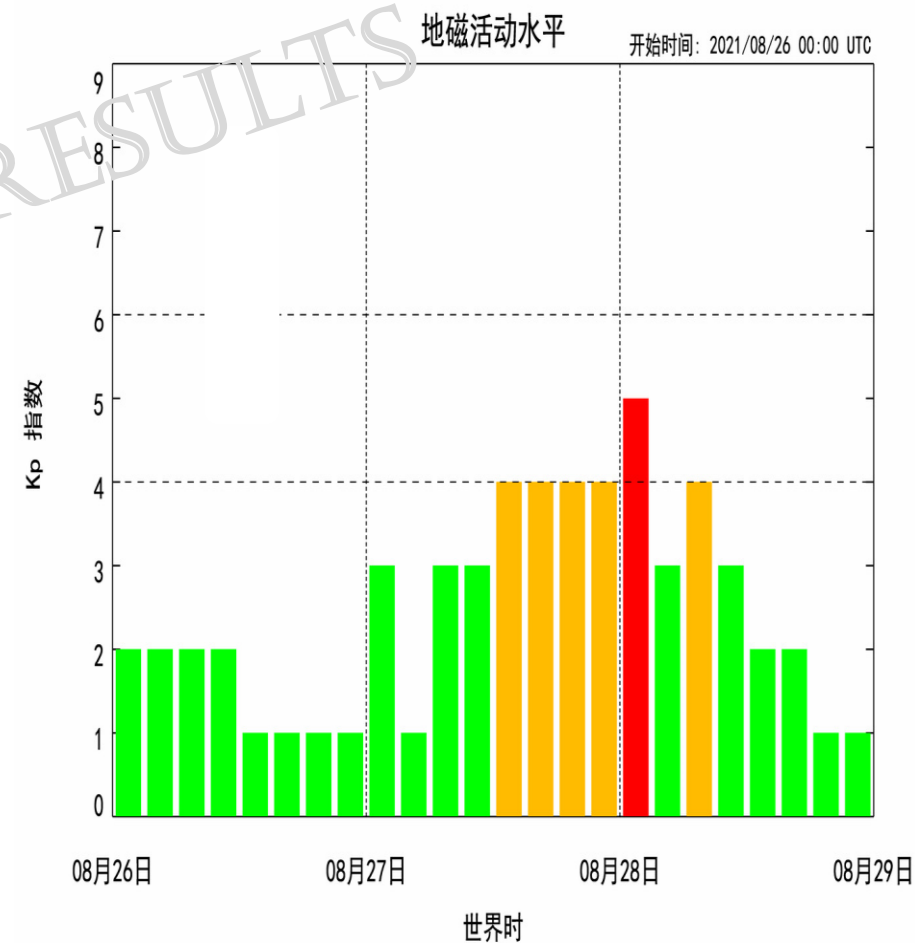


### 3)FY-4B post launching test progress

Space Environment Package(SEP)  
Flux Gate Magnetometer (FGM)



Aug 27-28.2021 geomagnetic storm: Kp=5





## 5) Future works

## FY-4B will be operation in Q2 2022

# 风云卫星布局 2025

## 静止卫星

### FY-4B [光学]

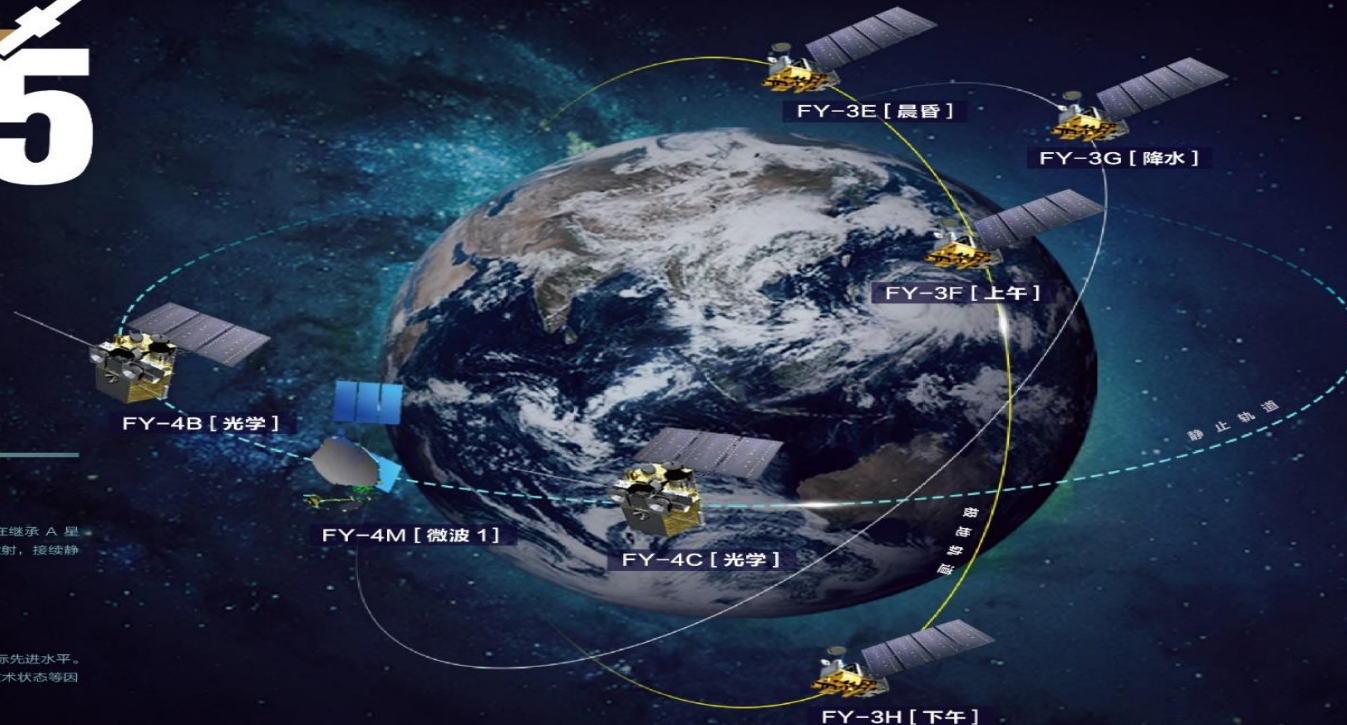
FY-4B 是我国新一代静止气象卫星的首发业务星，它在继承 A 星的基础上性能进一步提升。FY-4B 星计划于 2021 年发射，接续静止气象卫星的业务。

### FY-4C [光学]

FY-4C 星在前两颗星的基础上性能要全面达到和超过国际先进水平。FY-4C 星计划于 2022 年发射，定点位置将视当时的技术状态等因素来确定。

### FY-4M [微波 1]

风云四号微波卫星 FY-4M 星在静止轨道上对大气温度和湿度进行微波探测，50GHz 以上空间分辨率优于 50km。



## 极轨卫星

### FY-3E [晨昏]

FY-3E 星是晨昏轨道卫星，交点地方时为 5:30，计划于 2021 年发射。FY-3E 星侧重数值天气预报的应用目标，对天气会商、热带气旋和其它极端气象灾害预警、气候监测、空气质量监测、太阳和空间天气观测具有独特优势。

### FY-3F [上午]

FY-3F 星是上午轨道卫星，交点地方时为 10:00，计划于 2022 年发射。它在确保极轨气象卫星全球成像和大气垂直探测观测业务的基础上，侧重地球表面成像观测，主要应用于天气预报、生态、环境、灾害监测业务及研究。

### FY-3G [降水]

FY-3G 星为倾斜轨道卫星，主要用于降水测量，计划于 2022 年发射。FY-3G 星主要用于灾害性天气系统强降水监测，提供全球中低纬度地区降水三维结构信息，对提高降水气象预报准确率提供支持。

### FY-3H [下午]

FY-3H 星是下午轨道卫星，交点地方时为 14:00，计划于 2023 年发射。FY-3H 星侧重大气成份定量探测和气候变化监测，探测数据可用于天气预报、大气化学和气候变化监测业务及研究等方面。



## 5) Future works

# 风云卫星布局 2035

### 静止卫星

#### FY-4D [光学]

FY-4D 是风云四号 03 批的首发业务星，它在继承 C 星的基础上进一步提升性能。FY-4D 星计划于 2027 年发射，接续静止气象卫星业务。

#### FY-4E [光学]

FY-4E 是我国新一代静止气象卫星的业务星，计划于 2029 年发射，定点位置将视当时的技术状态等因素确定。

#### FY-4F [光学]

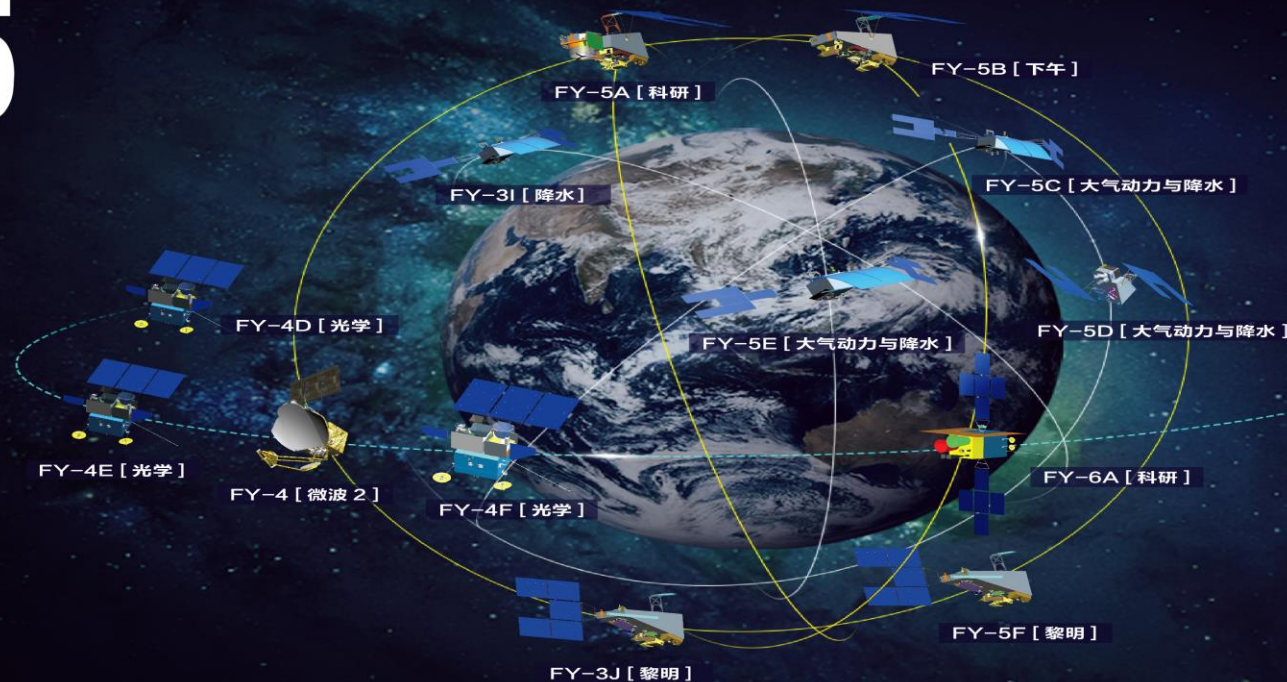
FY-4F 星计划于 2030 年发射，设计寿命 8 年，从而保证“组网观测、在轨备份”的业务格局，确保业务稳定运行至 2034 年。

#### FY-4 [微波 2]

FY-4 (微波 2) 星是风云四号微波星的首发业务星，计划于 2029 年发射，设计寿命 8 年，其主要载荷为静止轨道微波成像仪，最高空间分辨率优于 20 公里，满足对中小尺度天气系统探测频次优于 2 分钟。

#### FY-6A [科研]

FY-6A 是我国第三代静止轨道气象卫星首发科研试验星，以光学成像和主被动微波探测结合实现对大气温湿、降水、冰云、大气成分等的高精度探测，计划于 2035 年前发射，完成对风云四号卫星的升级换代。



### 极轨卫星

#### FY-3I [降水]

FY-3I (降水) 为确保业务连续，根据《国家民用空间基础设施中长期发展规划 (2015-2025 年)》的相关内容，研制风云三号 04 批极轨气象卫星，FY-3I 和 FY-3J。FY-3I 为降水星，设计寿命 8 年，计划于 2027 年发射。

#### FY-3J [黎明]

FY-3J 为黎明星，将接替 FY-3E，完成晨昏轨道卫星的业务接续。降交点地方时为 5:30，计划于 2028 年发射，设计寿命 8 年。

#### FY-5A [科研]

FY-5A (科研) 是我国第三代极轨气象卫星的首发科研试验星，上午轨道卫星，计划 2028 年发射，采用新型大卫星平台，平台性能和稳定性大幅提高，设计寿命 10 年，实现对风云三号卫星的升级换代。

#### FY-5B [下午]

FY-5B (下午) 星是下午轨道卫星，降交点地方时为 14:00，计划 2030 年发射。它是我国第三代极轨气象卫星的下午轨道首发业务星，数据主要用于全球数值天气预报、生态环境和灾害监测的业务及研究等方面。

#### FY-5C/D/E [大气动力与降水]

FY-5C/D/E (大气动力与降水) 星座采用倾斜轨道或伴星方式，形成大气动力与降水测量星座；专注中国区域和全球三维风场、降水测量，主要用于数值天气预报、强降水等灾害性天气及其次生灾害的应急监测。3 颗卫星组网编队飞行。

#### FY-5F [黎明]

FY-5F (黎明) 星是风云五号系列晨昏轨道卫星的首发星，降交点地方时为 5:30，计划 2035 年发射。以大气温湿廓线及近洋面风场探测为主，主要服务数值天气预报，与上、下午轨道卫星形成互补，满足精细全球数值天气预报的需求。



شكرا

Merci

ありがとう

terima kasih

obrigado

谢谢

Gracias

спасибо

Thank you

감사합니다