2018 GSICS Data & Research Working Groups Annual Meeting

FY-4A satellite commissioning latest outcome

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NSMC

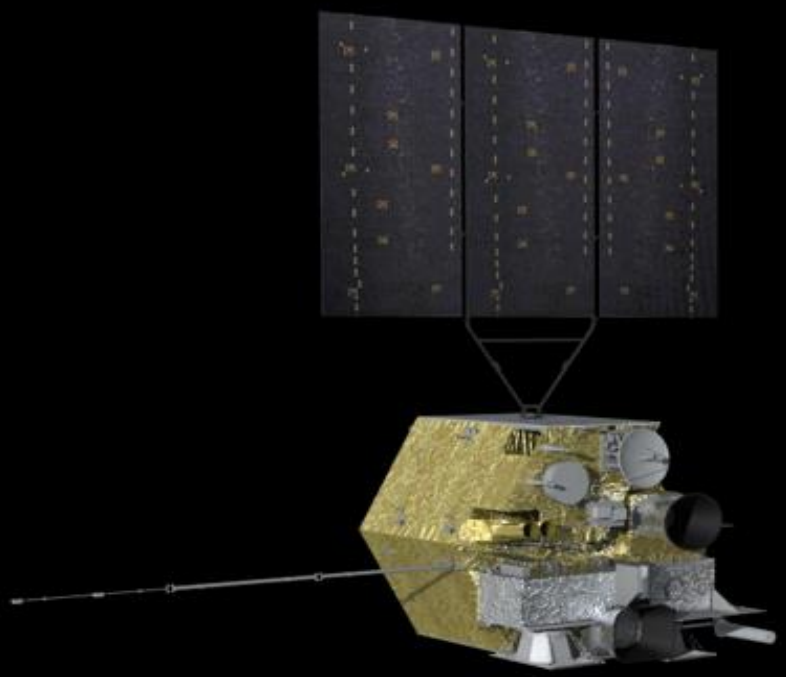
Outline

1. Background
2. Latest Outcome during Commissioning
3. Operational Readiness
4. Conclusion

In 11 December 2016, the 1st satellite of Fengyun-4 series was launched in Xichang successfully. Then, 6 days later (in 17 December 2016), it was positioned in 99.5°E of GEO orbit and renamed FY-4A.

FY-4A: New Era of GEO Satellite

together with GOES-R, MTG, Himawari-8/9.



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

Characteristics of Payloads (Specification & Main Usage)

Spectral Coverage	Spectral Band (μm)	Spatial Resolution (Km)	Sensitivity	Main Applications
VIS/NIR	0.45～0.49	1	S/N≥90 (ρ=100%)	Aerosol
	0.55～0.75	0.5～1	S/N≥200 (ρ=100%)	Fog, Clouds
	0.75～0.90	1	S/N≥5(ρ=1%)@0.5Km	Vegetation
	1.36～1.39	2		Cirrus
	1.58～1.64	2	S/N≥200 (ρ=100%)	Cloud,Snow
	2.10～2.35	2～4		Cirrus,Aerosol
Middle-wave IR	3.50～4.00	2	NEΔT≤0.7K(300K)	Fire
	3.50～4.00	4	NEΔT≤0.2K(300K)	Land surface
	5.80～6.70	4	NEΔT≤0.3K(260K)	WV
	6.90～7.30	4	NEΔT≤0.3K(260K)	WV
Long-wave Infrared	8.00～9.00	4	NEΔT≤0.2K(300K)	WV,Clouds
	10.3～11.3	4	NEΔT≤0.2K(300K)	SST
	11.5～12.5	4	NEΔT≤0.2K(300K)	SST
	13.2～13.8	4	NEΔT≤0.5K(300K)	Clouds,WV

AGRI

AGRI's Main Usage:

Acquire multiple band, high temporal resolution, high radiation accuracy images of Earth's surface, atmosphere and cloud

GIIRS's Main Usage:

Acquire atmospheric temperature and humidity profile structures under clear condition

LMI's Main Usage:

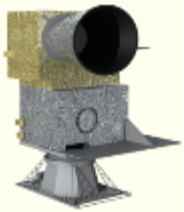
Acquire lightning distribution maps for a certain coverage

Spatial resolution	about 7.8Km 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
Quantization	12 bits
Measurement Error	10%

LMI

	Range	Resolution	Channels
Spectral Parameters (Normal mode)	LWIR: 700-1130 cm^{-1}	0.8	538
	S/MIR:1650-2250 cm^{-1}	1.6	375
	VIS : 0.55- 0.75 μm		
Spatial Resolution	LWIR/MWIR : 16 Km SSP		
	VIS : 2 Km SSP		
Operational Mode	China area 5000 × 5000 Km^2		
	Mesoscale area 1000 × 1000 Km^2		
Temporal Resolution	China area <1 hr		
	Mesoscale area <½ hr		
Sensitivity (mW/m^2srcm^2)	LWIR: 0.5-1.1 S/MIR: 0.1-0.14		
	VIS: S/N>200(ρ=100%)		
Calibration accuracy	1.5 K (3σ) radiation		
Calibration accuracy	10 ppm (3σ) spectrum		
Quantization Bits	13 bits		

GIIRS



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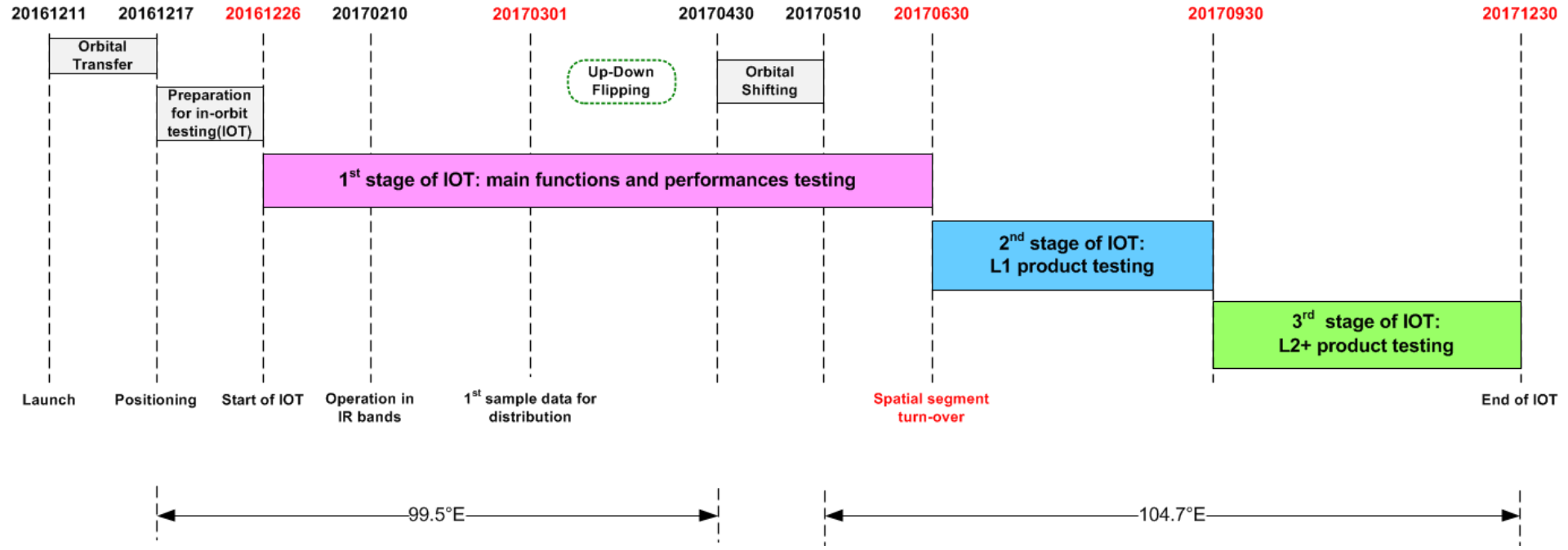
Schedule of in-orbit testing (IOT) for FY-4A



The whole IOT for FY-4A is composed of 3 stages:

1st stage ： 20161226-20170630， testing mainly for satellite function and performance， spatial segment of FY-4A is turned over to end users；

2nd stage：20170630-20170930， testing mainly for L1 products；

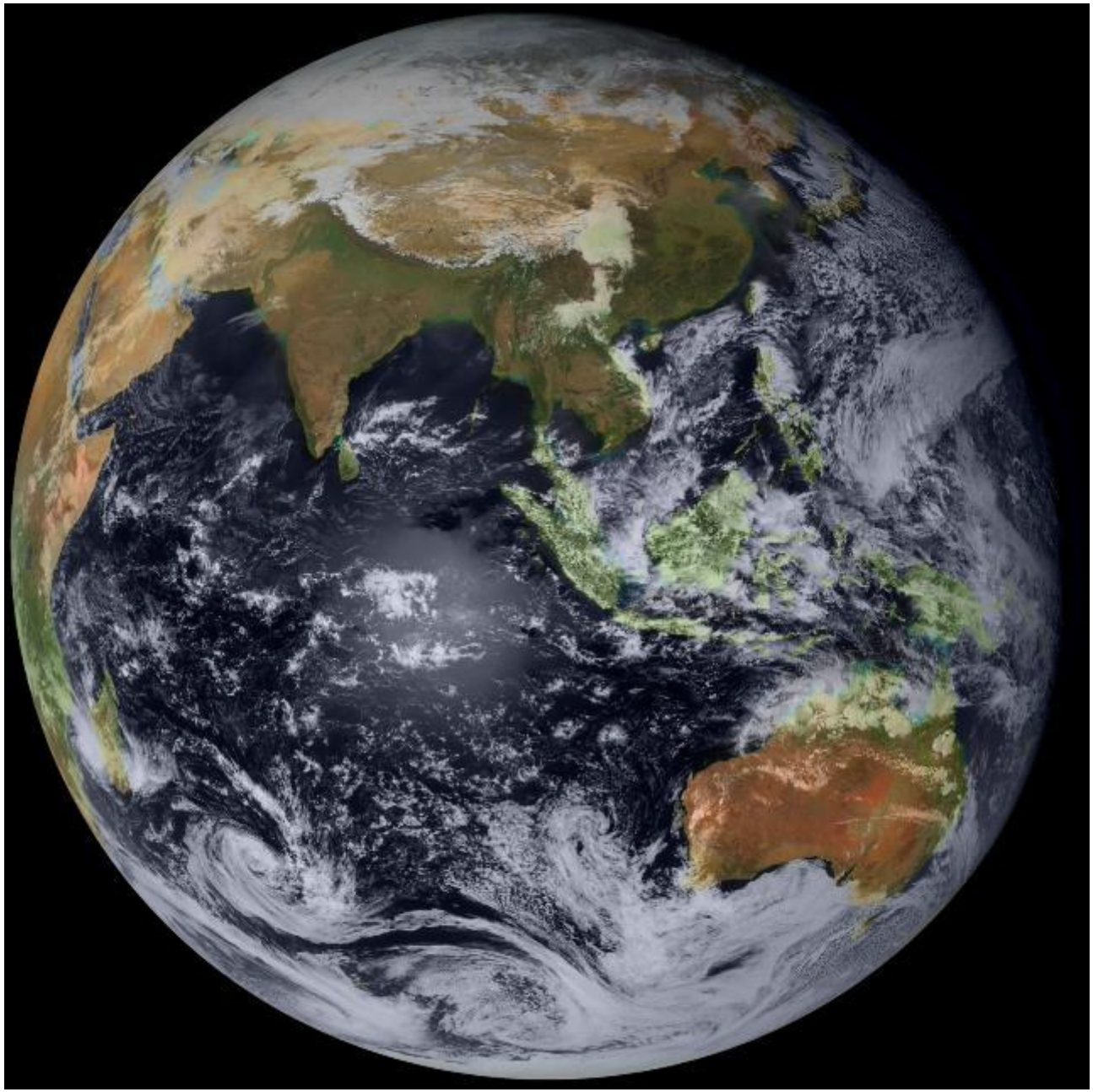
3rd stage： 20171001-20171230， testing mainly for L2+ products。

From Jan.1 to Mar.31 2018, a trial run for the whole space- and ground- systems of FY-4A is still undergoing to polish its performance gradually.

Main Results of 1st Stage of FY-4A IOT

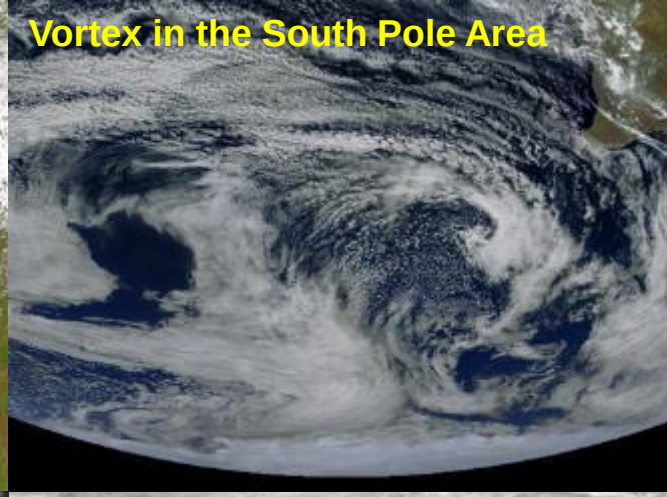
Testing Items	Results
1. Platform or Space Segment System	OK
2. Data transmission, Telemetry & Telecontrol, Data Acquisition System	OK
3. Combined Mission Management System Testing between Space and Ground Segments	OK
4. Ranging & Orbit Determination System	OK
5. Combined Image Navigation & Registration System Testing between Space and Ground segments	OK
6. Calibration & Validation System Testing	OK
7. Payload: AGRI	OK
8. Payload: GIIRS	OK
9. Payload: LMI	OK
10. Payload: SEP	OK

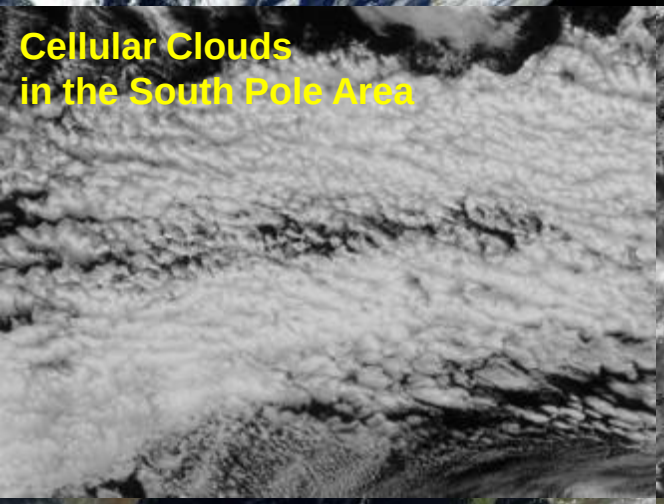
1st Chromatic Composition Image of AGRI

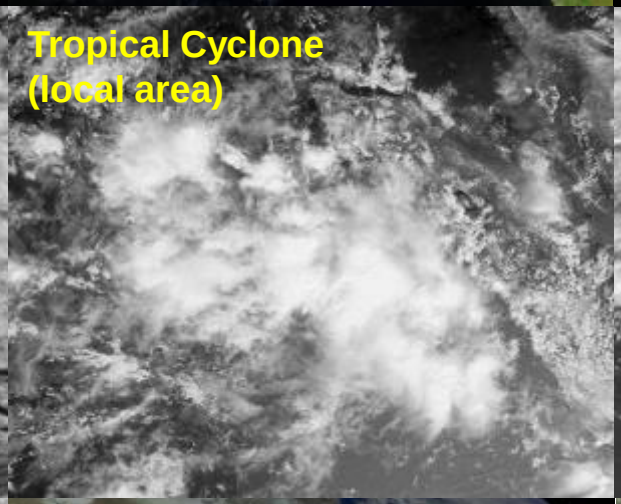



Cyclone in Australia

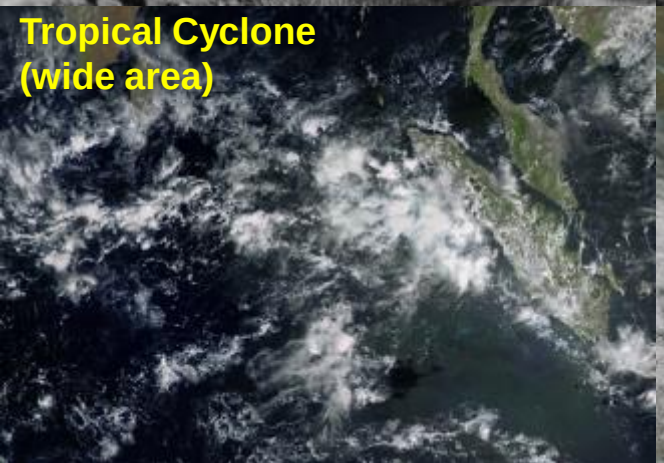

Haze in the Bay
of Bengal

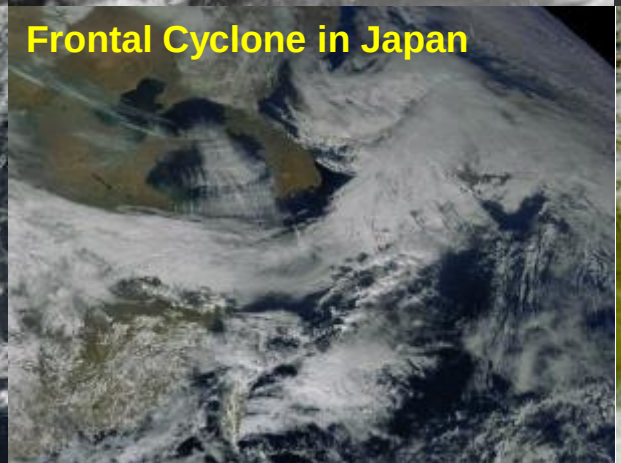

Vortex in the South Pole Area

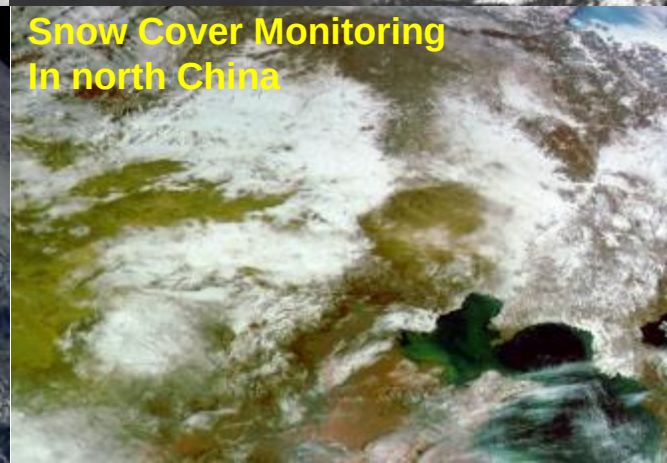

Cellular Clouds
in the South Pole Area


Tropical Cyclone
(local area)

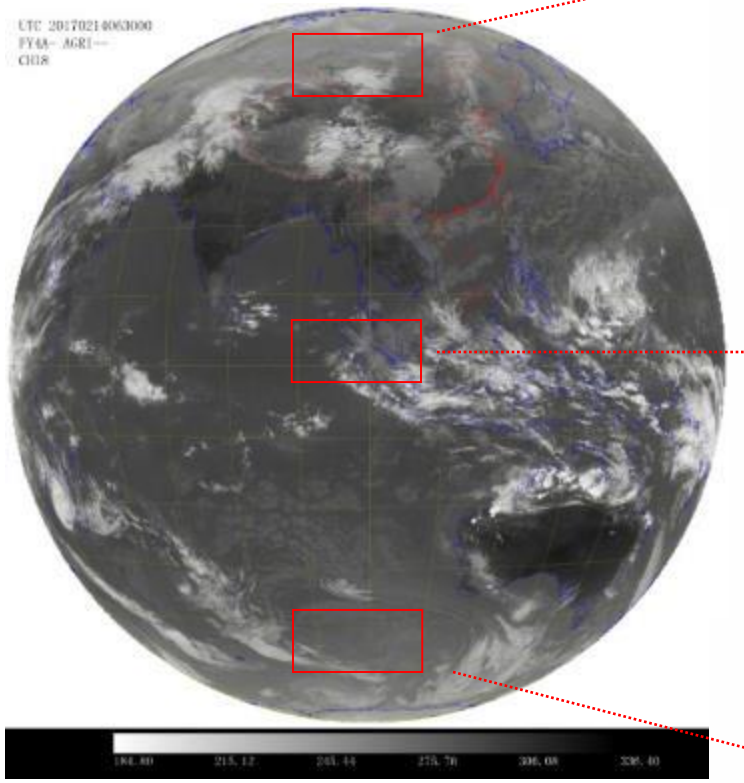

Tibet and its surrounding areas

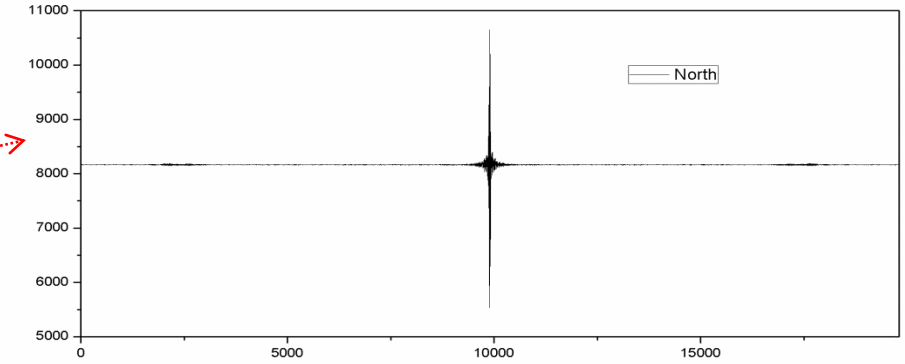

Tropical Cyclone
(wide area)

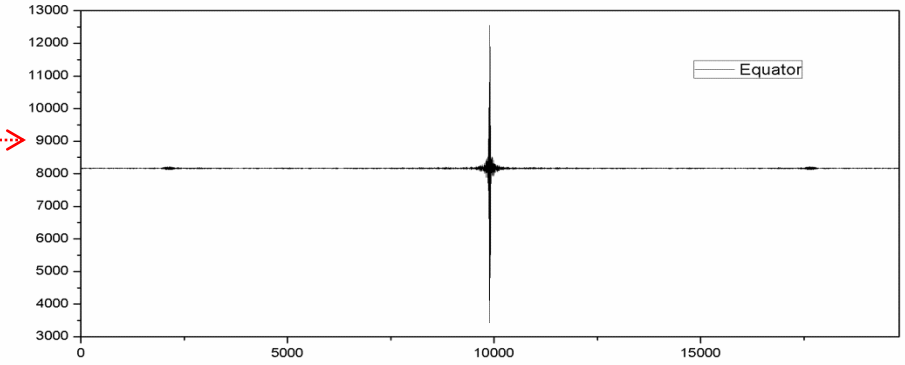

Frontal Cyclone in Japan

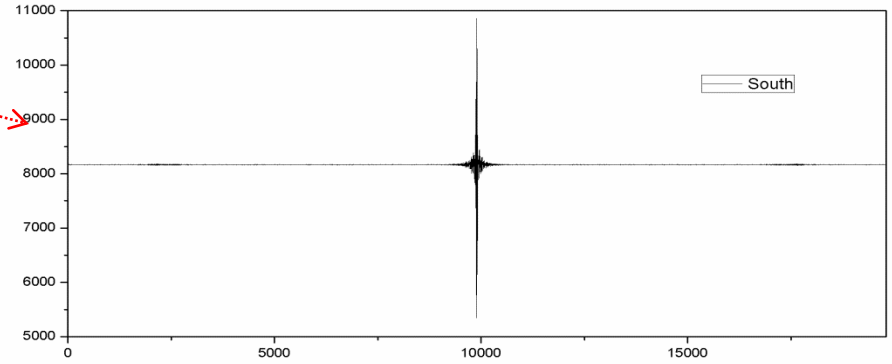

Snow Cover Monitoring
In north China

Initial measurements from GIIRS in IR spectrum：Interferogram

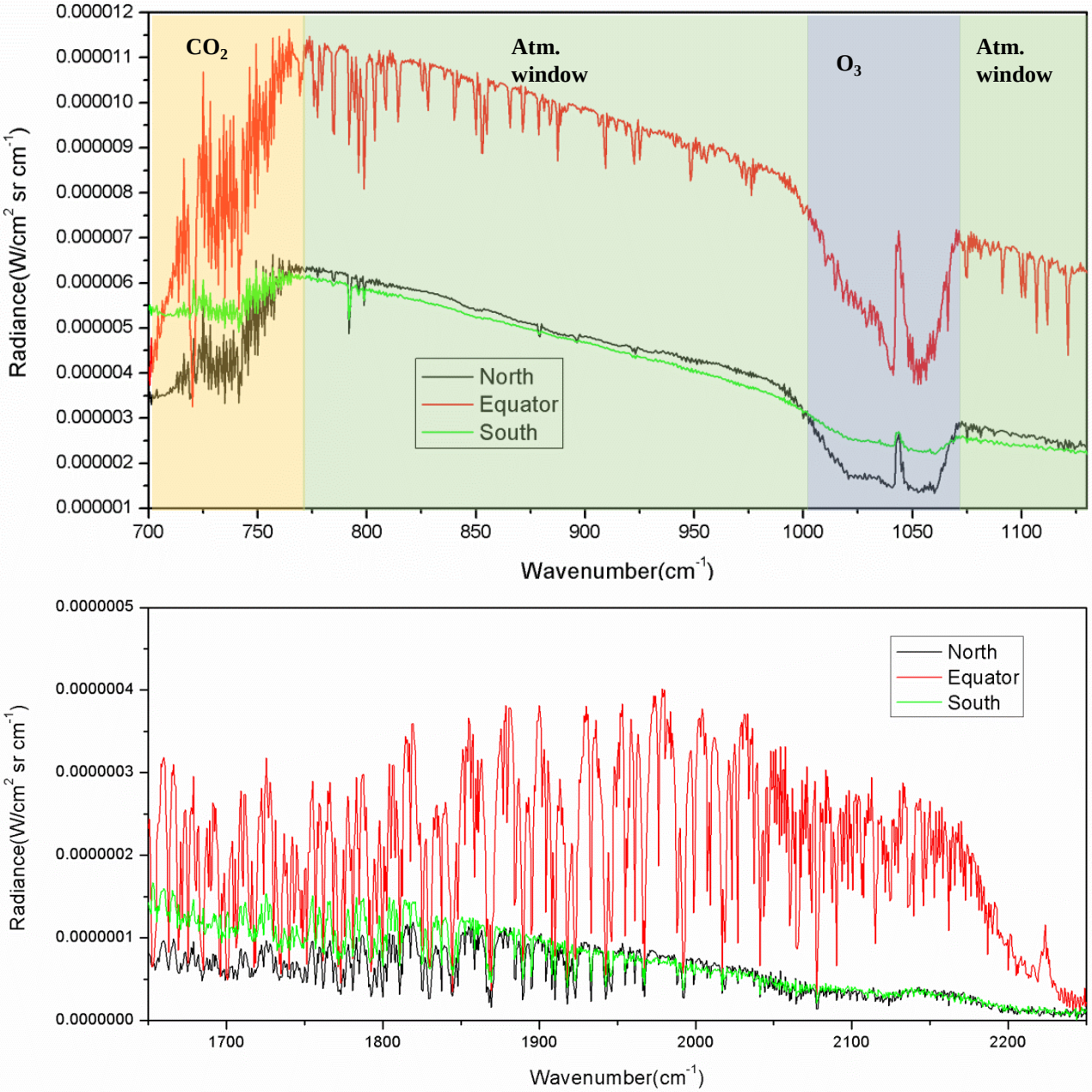




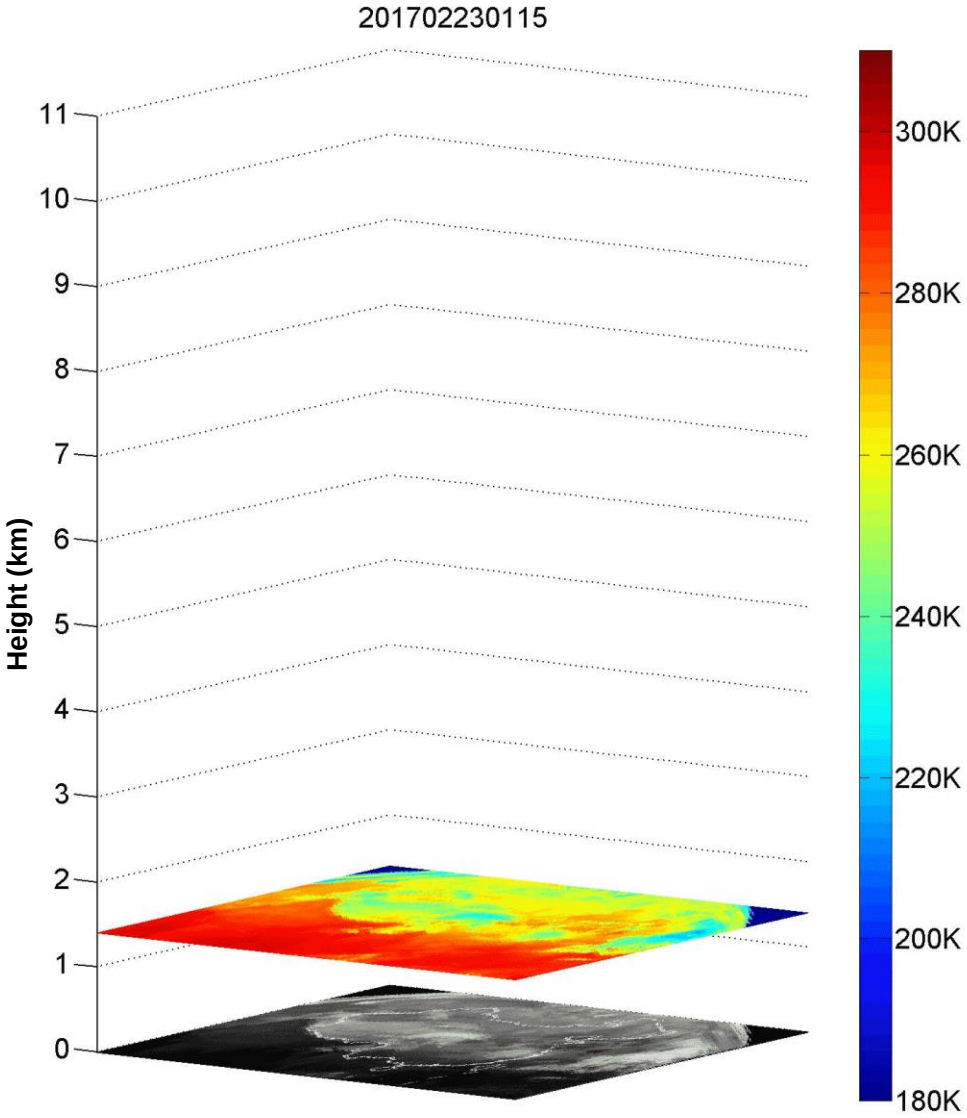




Initial measurements from GIIRS in IR spectrum：Spectrogram

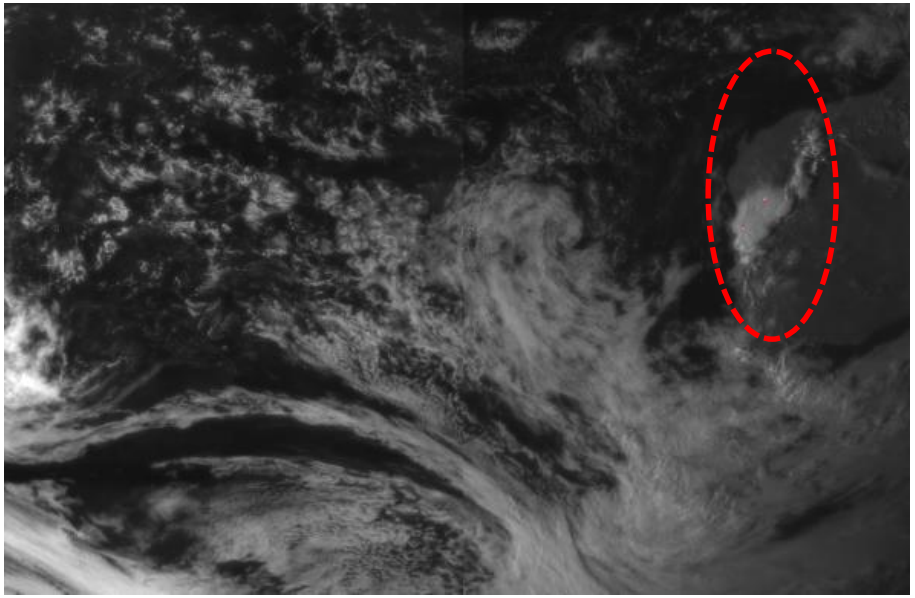


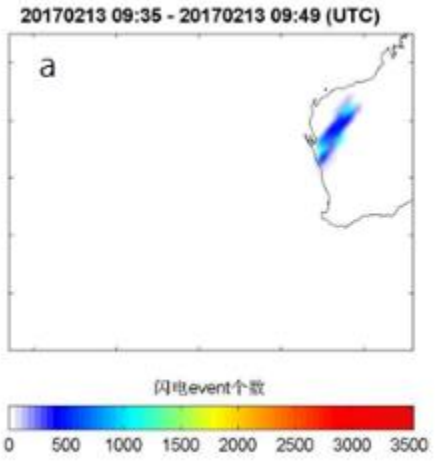
GIIRS：BT animation of different layers in troposphere for China area

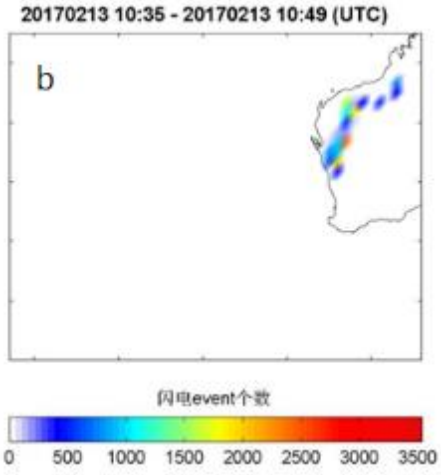


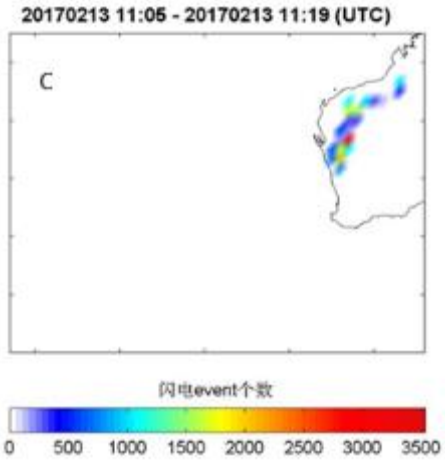
LMI：Dynamic Distribution of Lighting

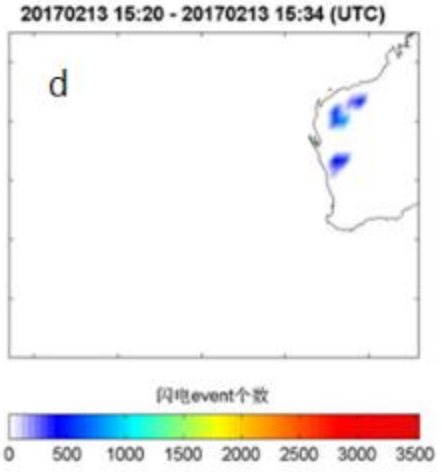
A typical thunderstorm occurred in West Australia during 13 February, 2017





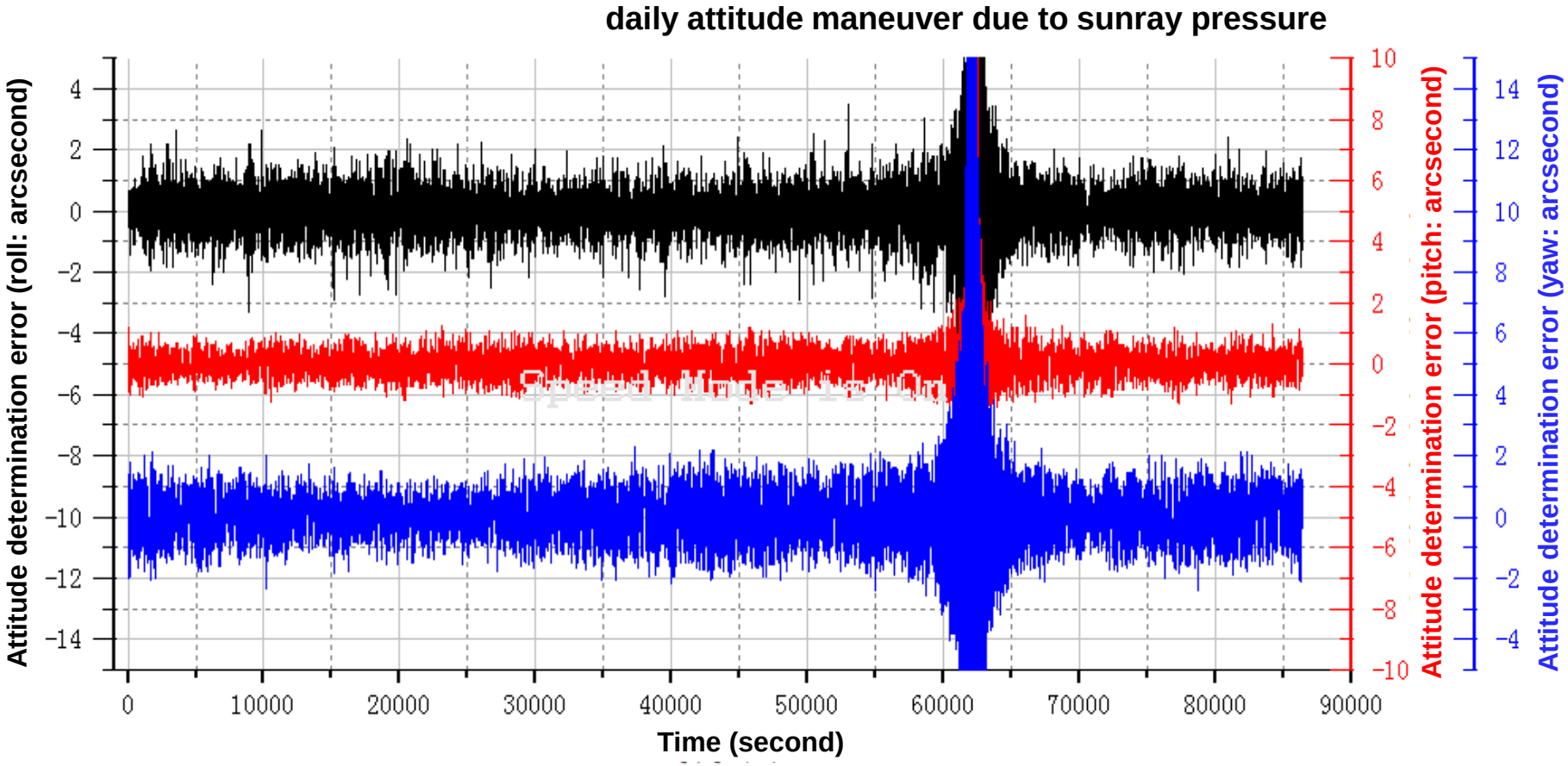






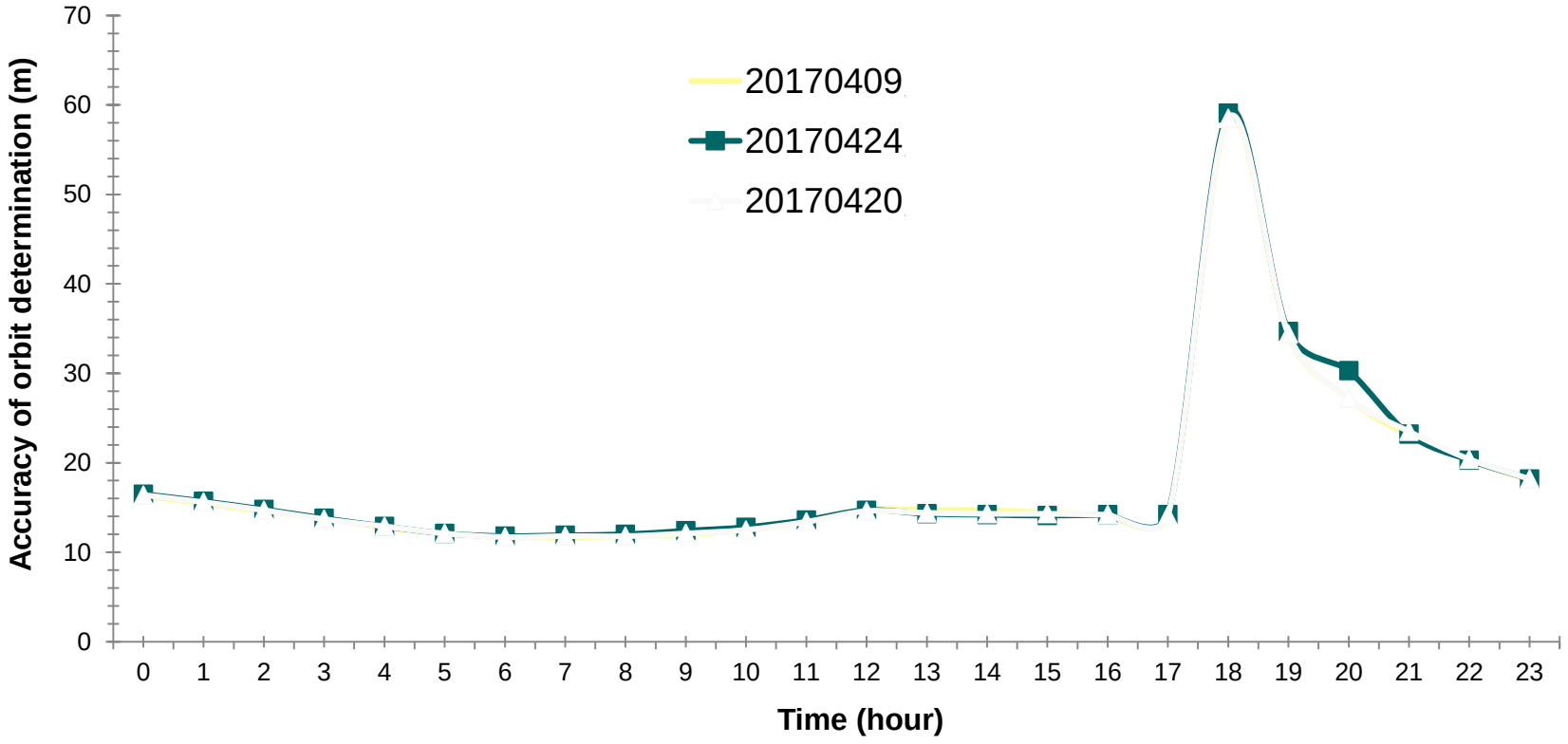
Typical IOT results： attitude determination error

	Specification	roll	pitch	yaw
Random error (arcsecond, 3σ)	3	2.5	1.0	2.0

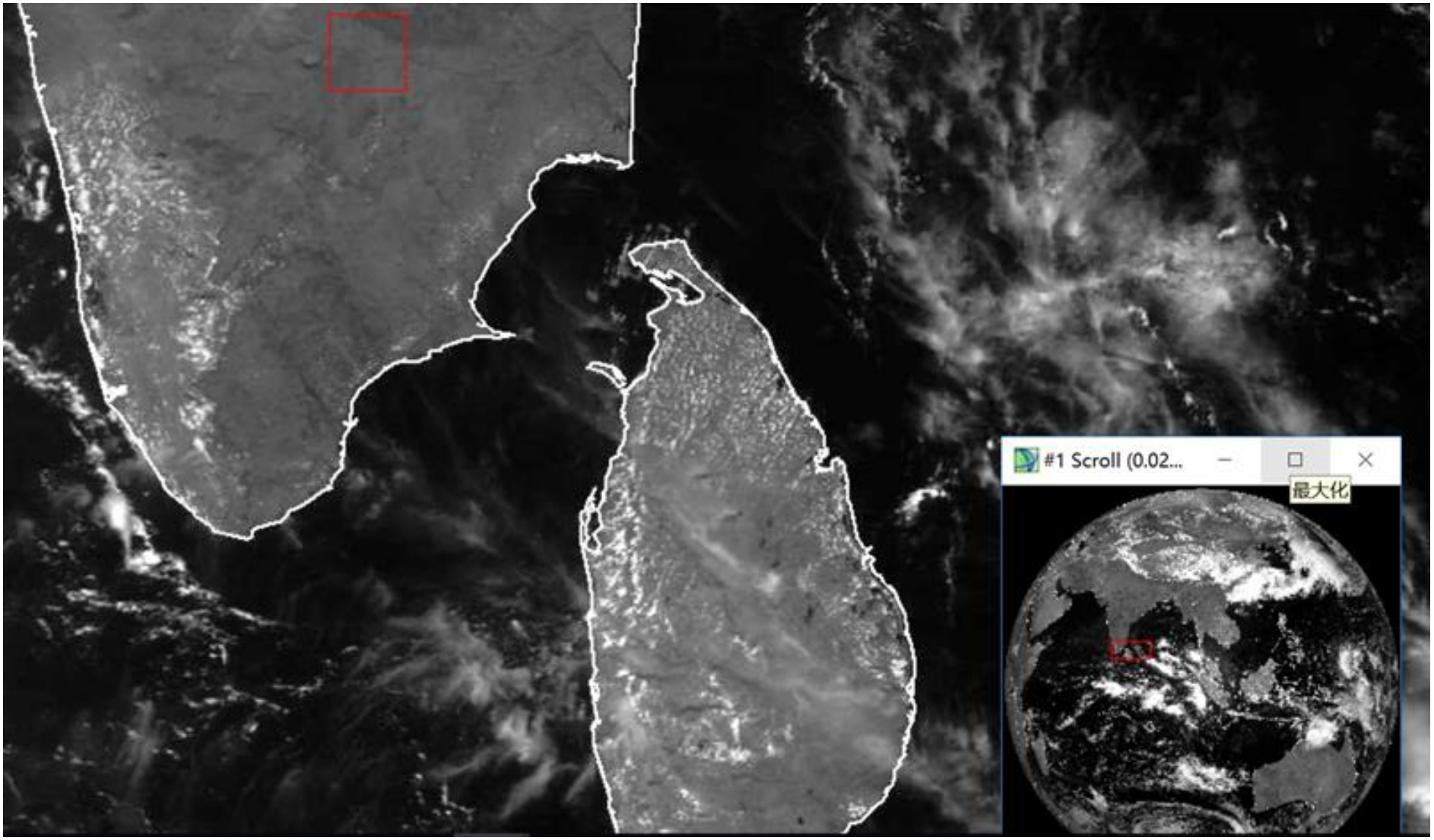


Typical IOT results：accuracy of orbit determination

Accuracy of orbit determination	specification	measurement
Long-segment of curve (6h): meter	20	16
Short-segment of curve (5m): meter	66	60



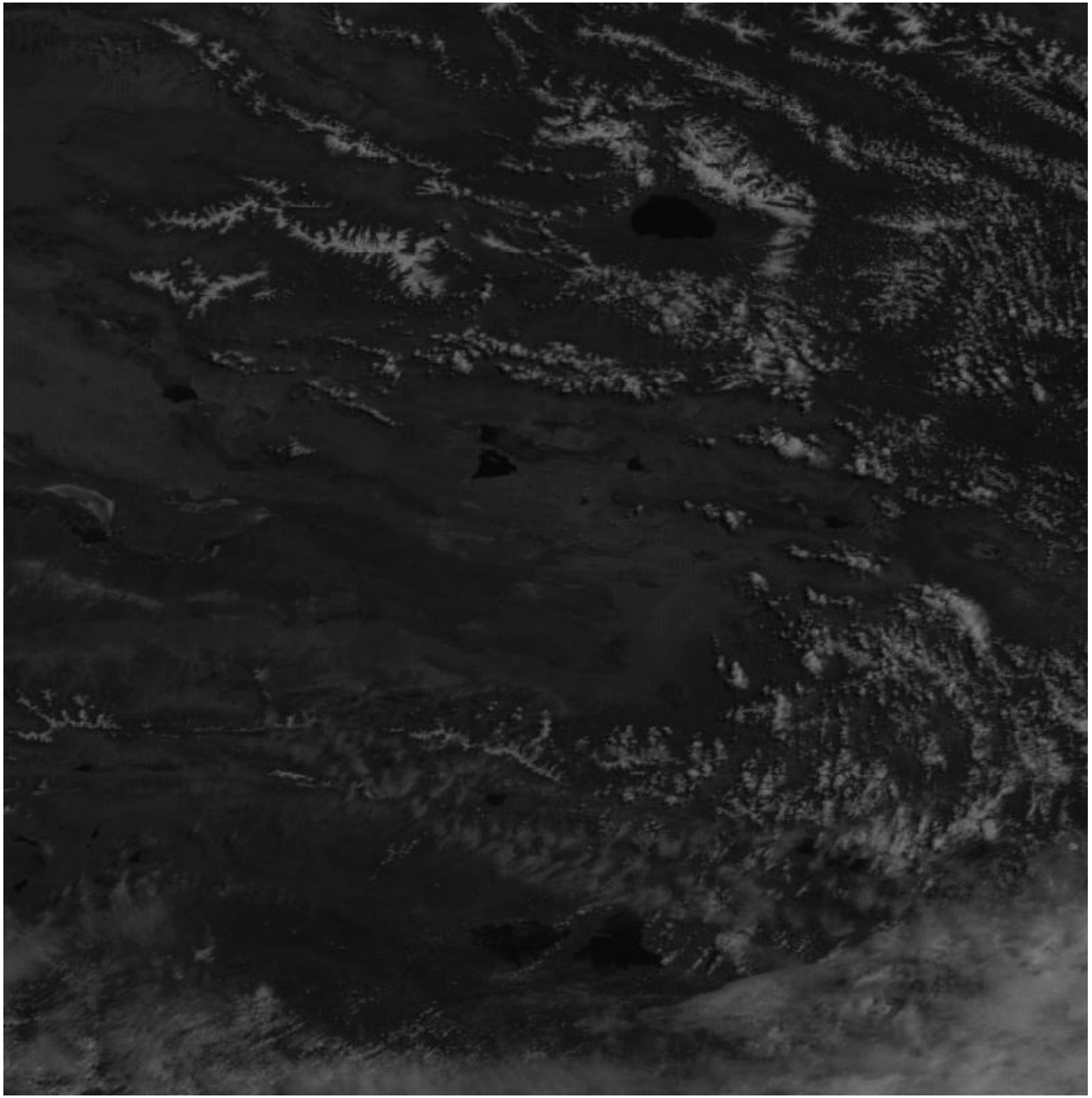
Typical IOT results：accuracy of AGRI INR (<1 IR pixel)

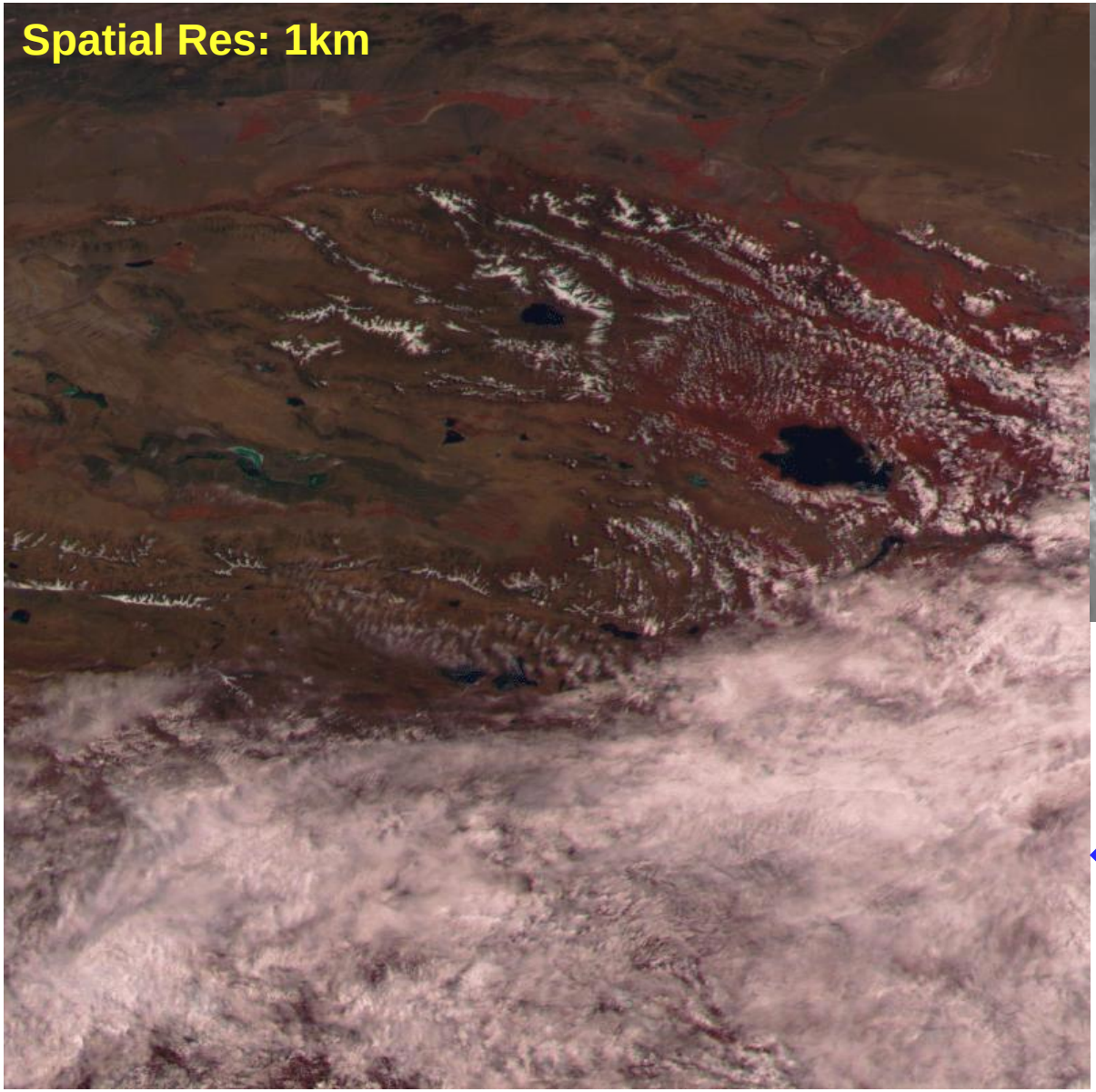


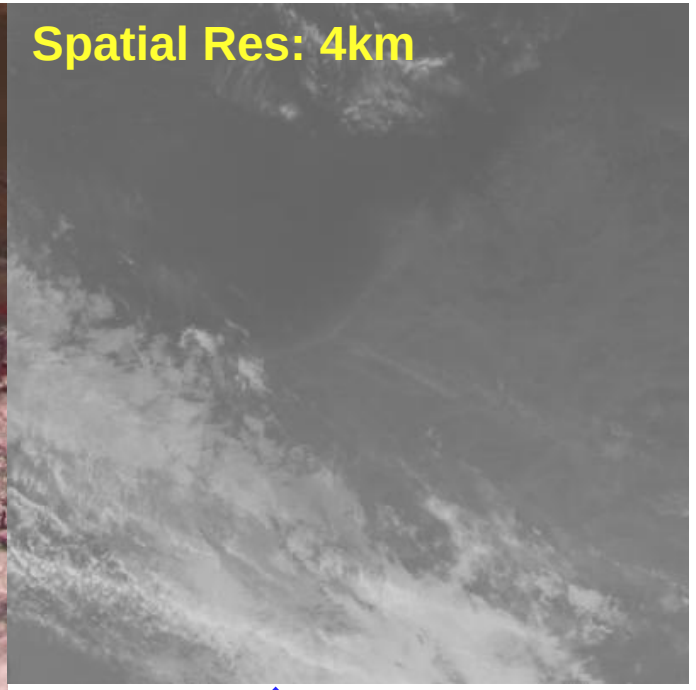
201704110500 UTC 0.75~0.90um 1km

Full Disc Animation (1km)

Animation of Local Area (0.5km)

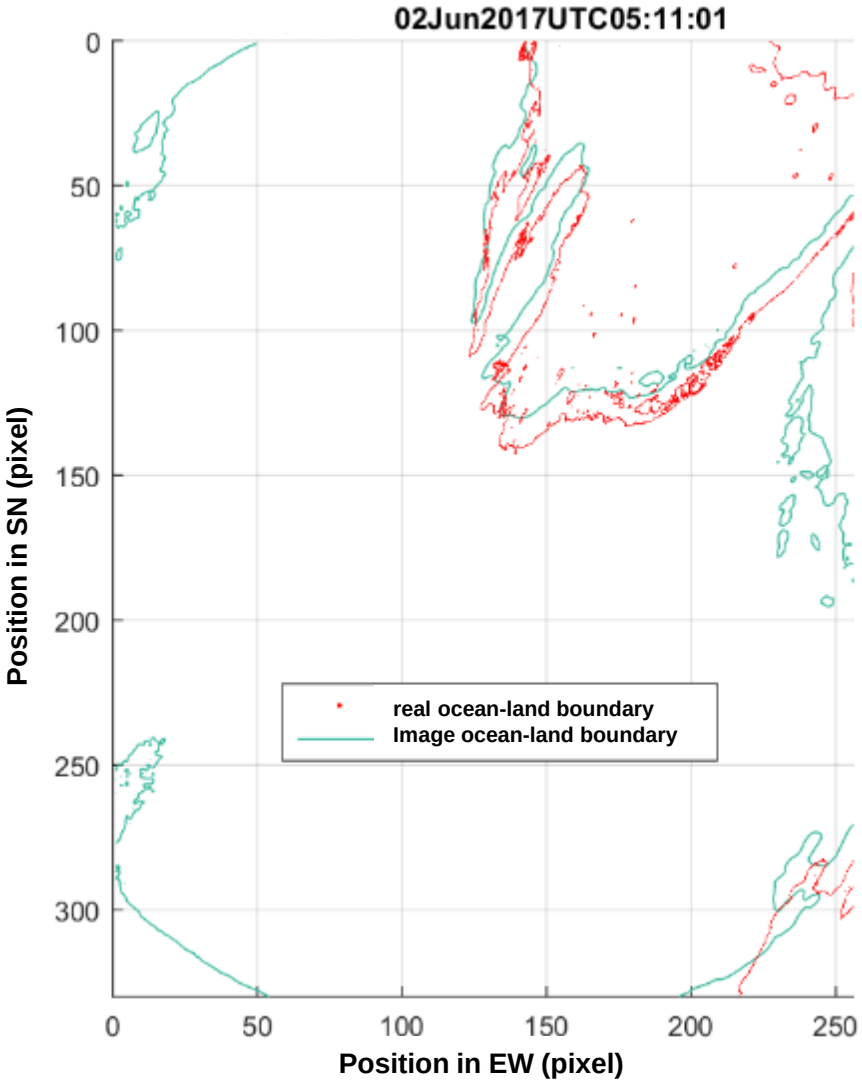




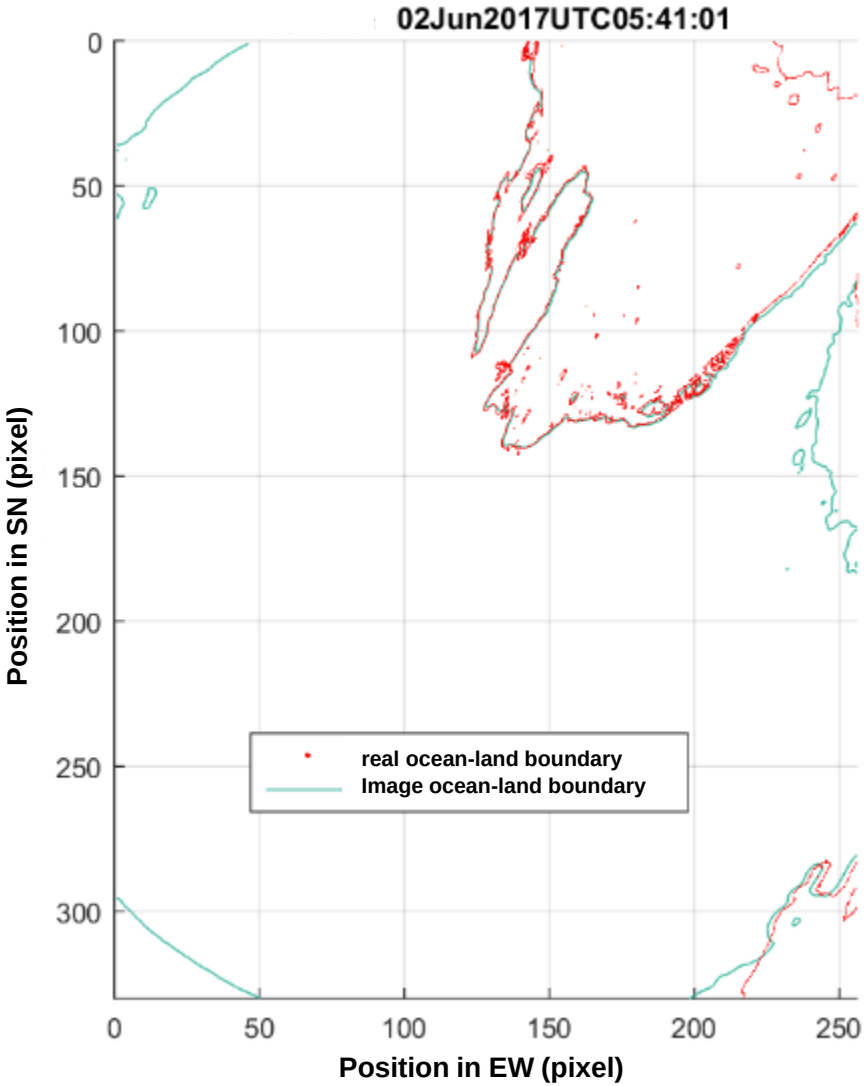


Animations of Local Area

Typical IOT results：accuracy of GIIRS INR (<1 IR pixel)

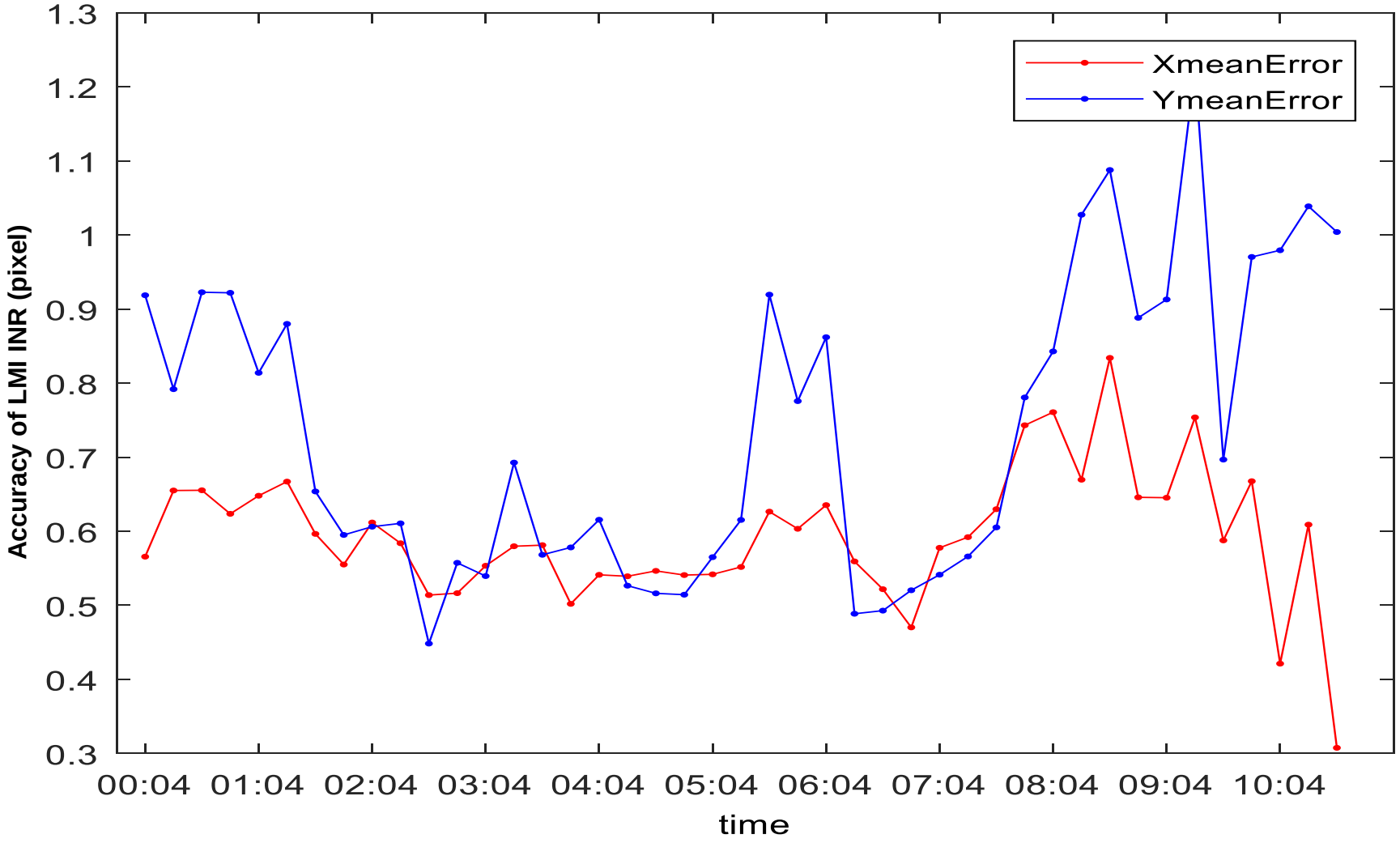


without thermal distortion compensation

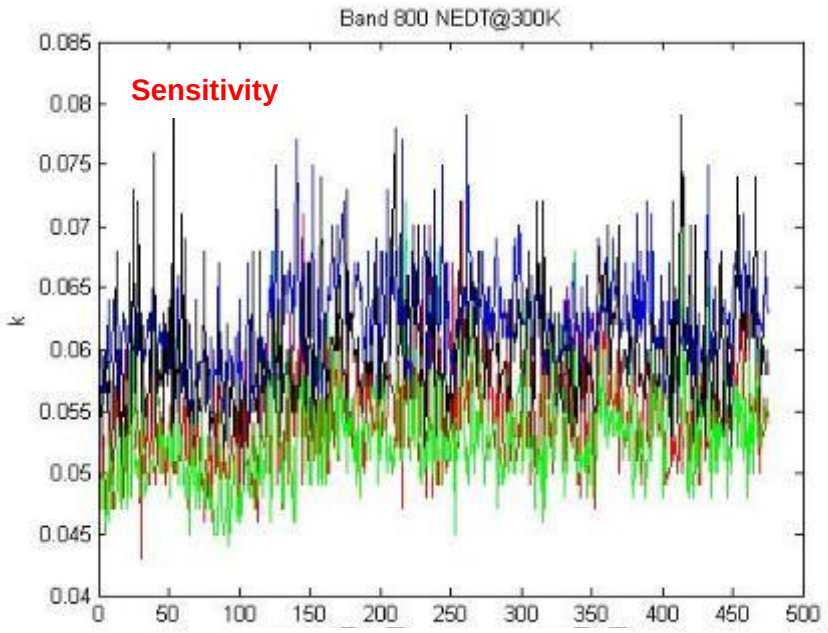


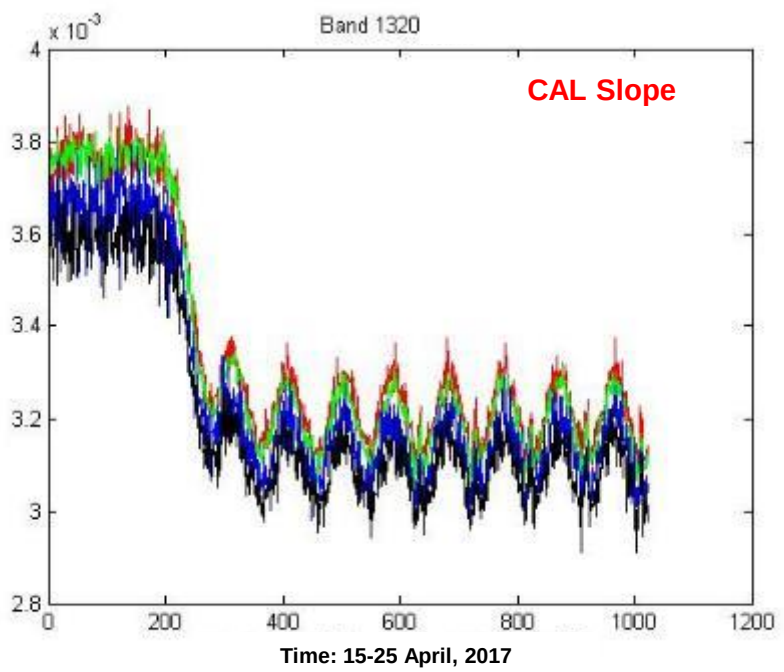
with thermal distortion compensation

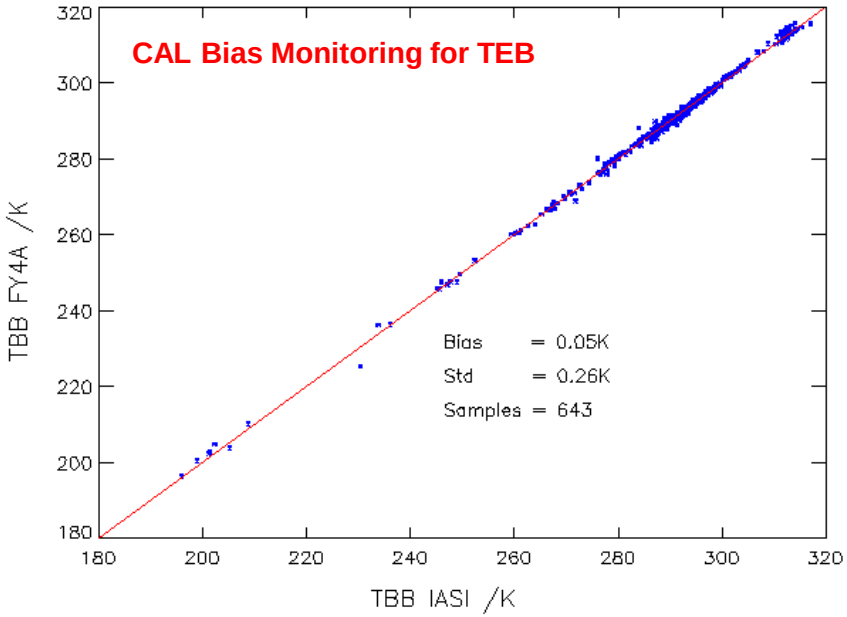
Typical IOT results：accuracy of LMI INR (<1 pixel) during Daytime

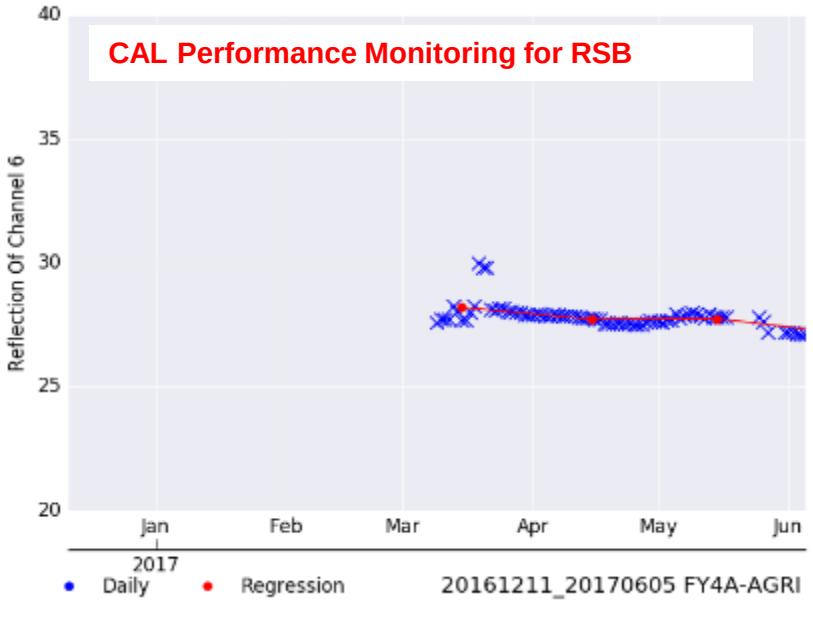


Typical IOT results： main performance monitoring for AGRI



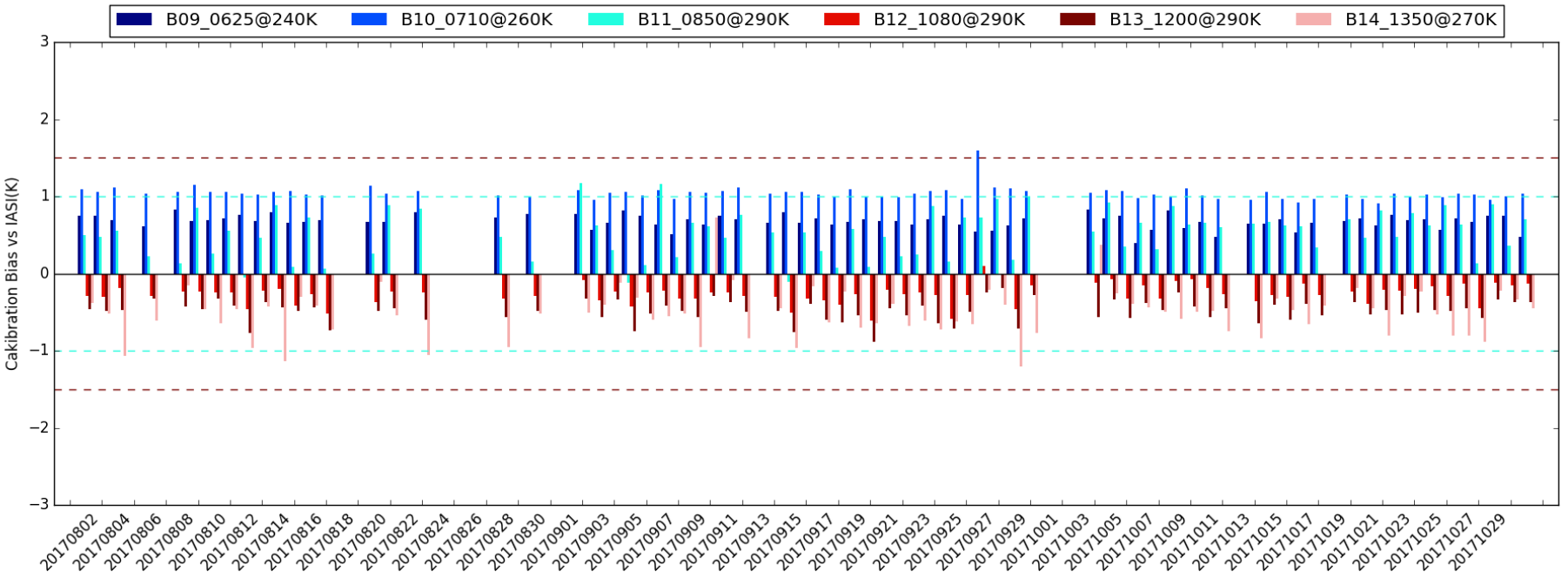






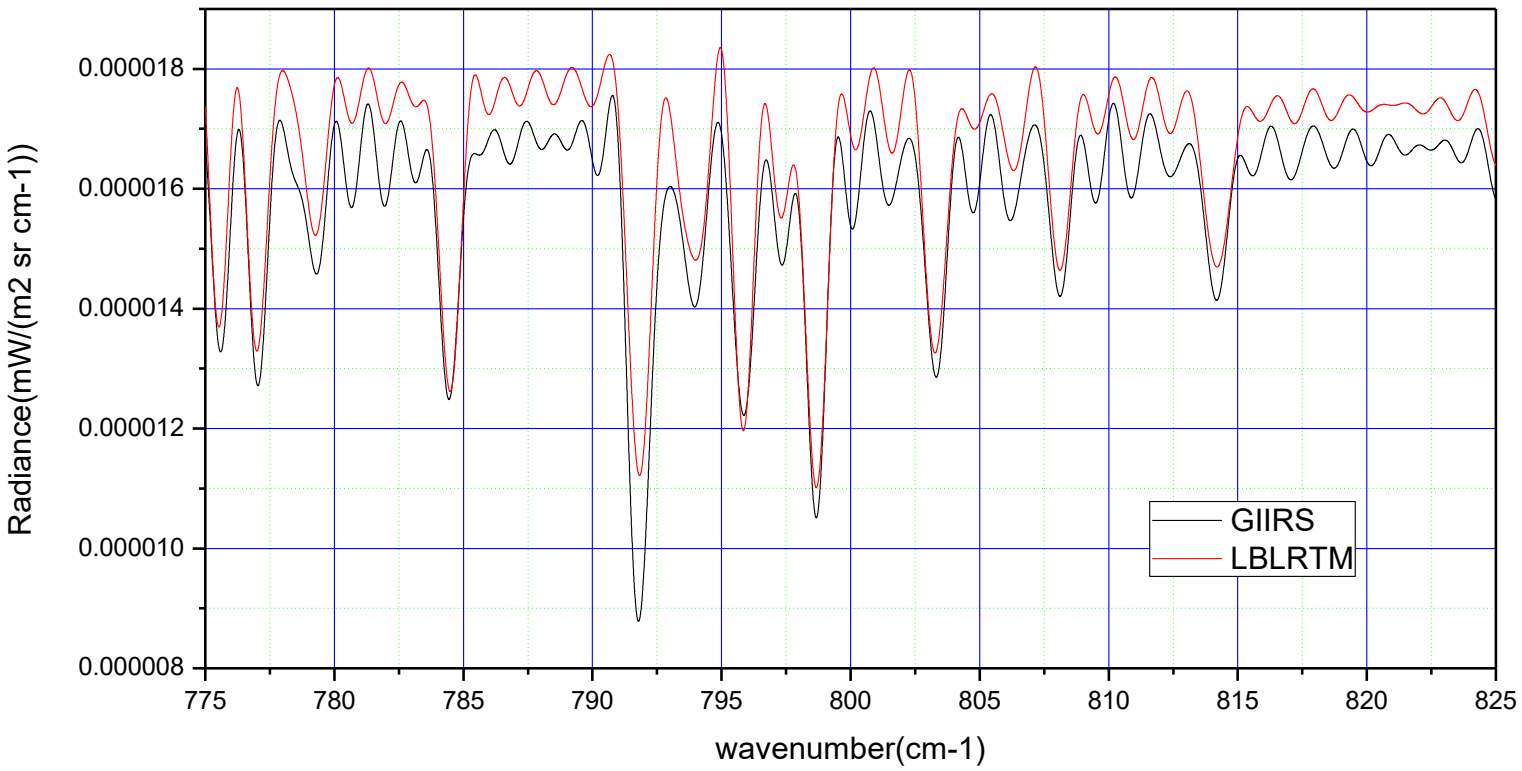
Typical IOT results：CAL bias monitoring for AGRI (IR)

Period: 20170801~20171031; Ref: METOP-A/IASI

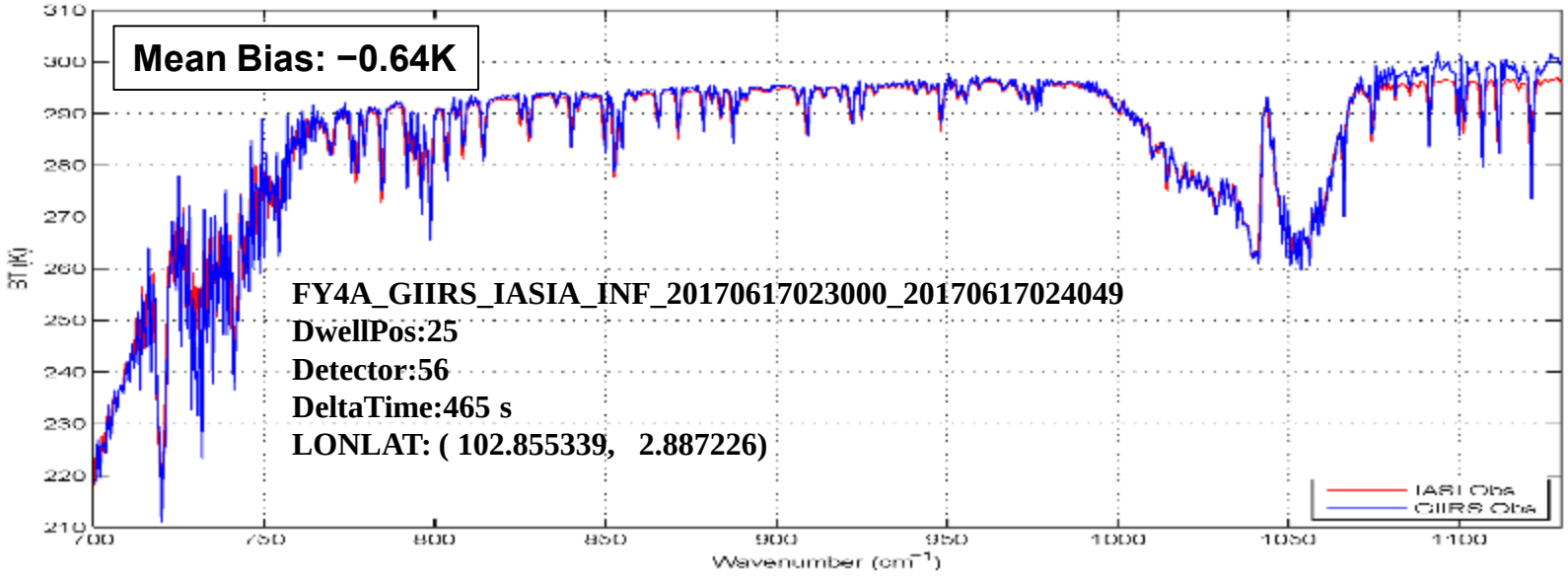


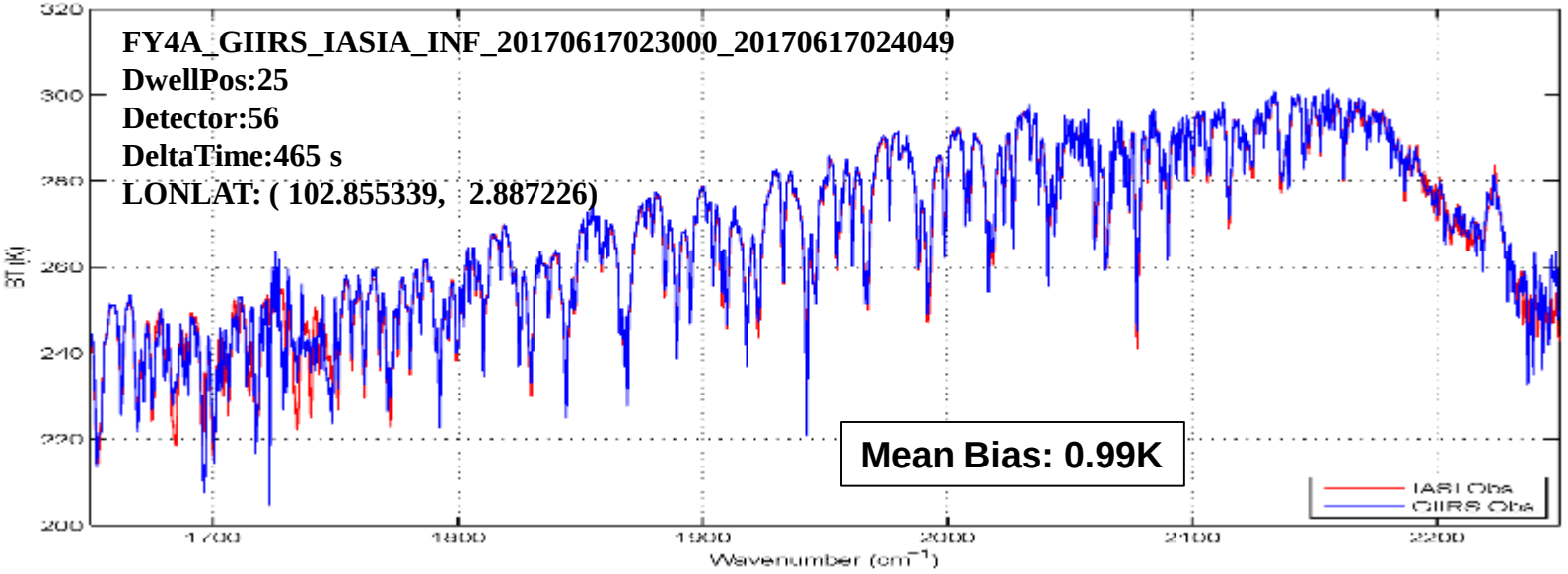
- **Full optical-path & aperture blackbody with a space-ground combined calibration method is adopted;**
- **Under the complex thermal environment of GEO orbit, the daily calibration biases for all TEBs are less than 1K;**
- **The daily calibration bias of 10.3μm band is perfect (<0.3K).**

Typical IOT results：Spectral CAL monitoring for GIIRS (< 8ppm)

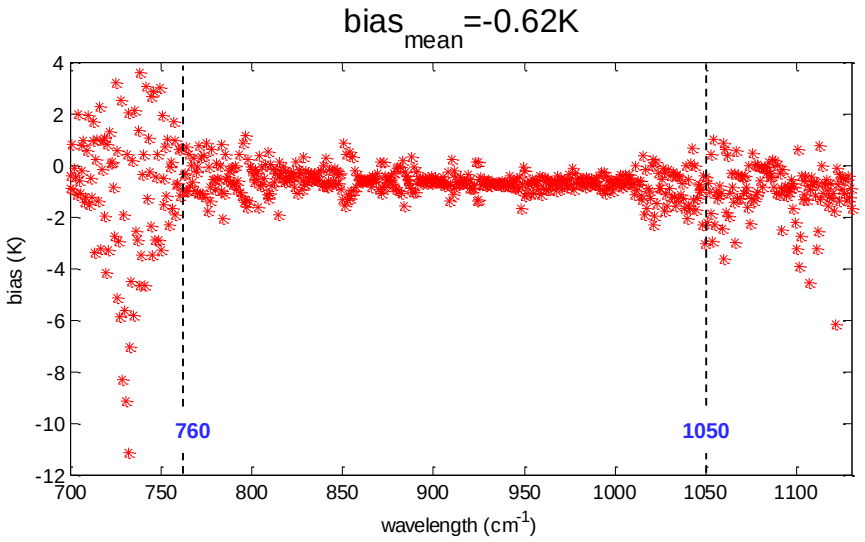


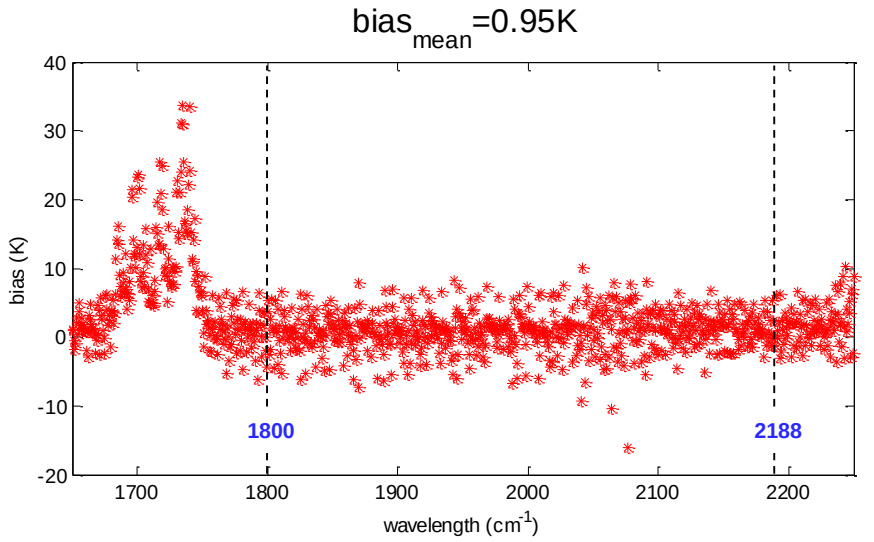
Typical IOT results (CASE)：Radiometric CAL bias monitoring for GIIRS

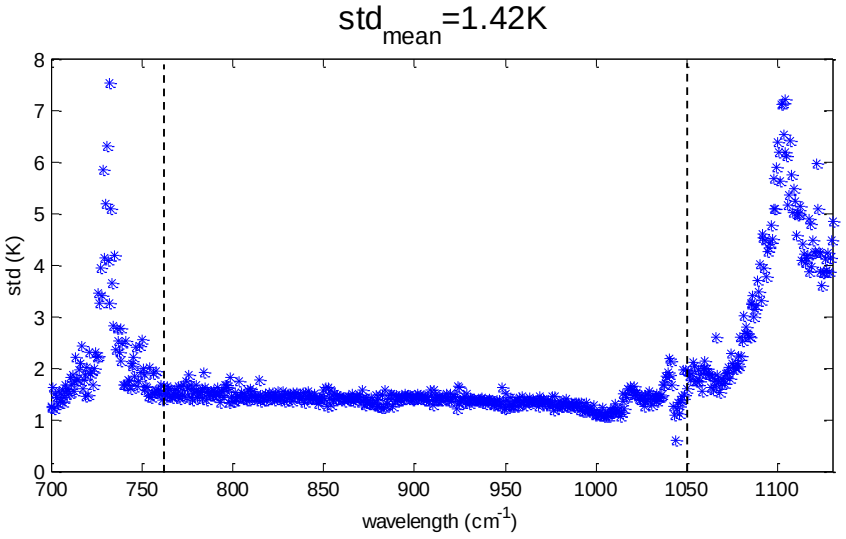


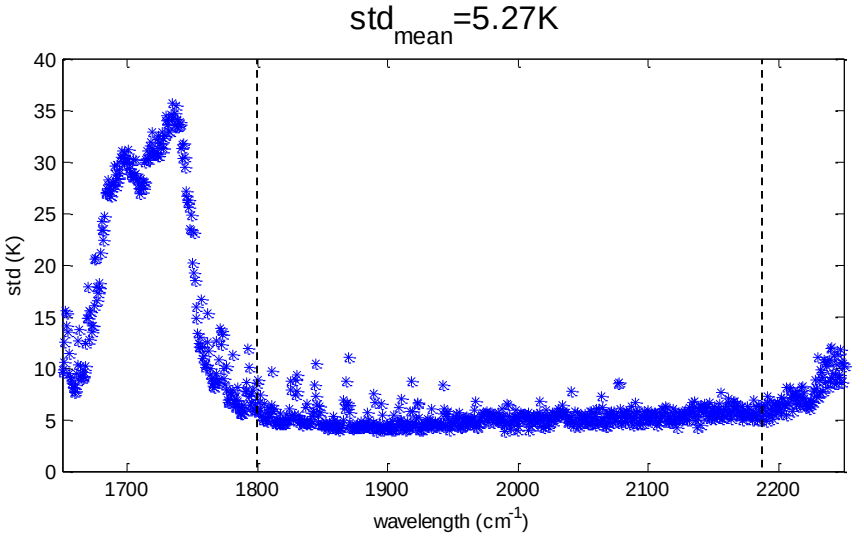


Typical IOT results (STA.): Radiometric CAL bias monitoring for GIIRS



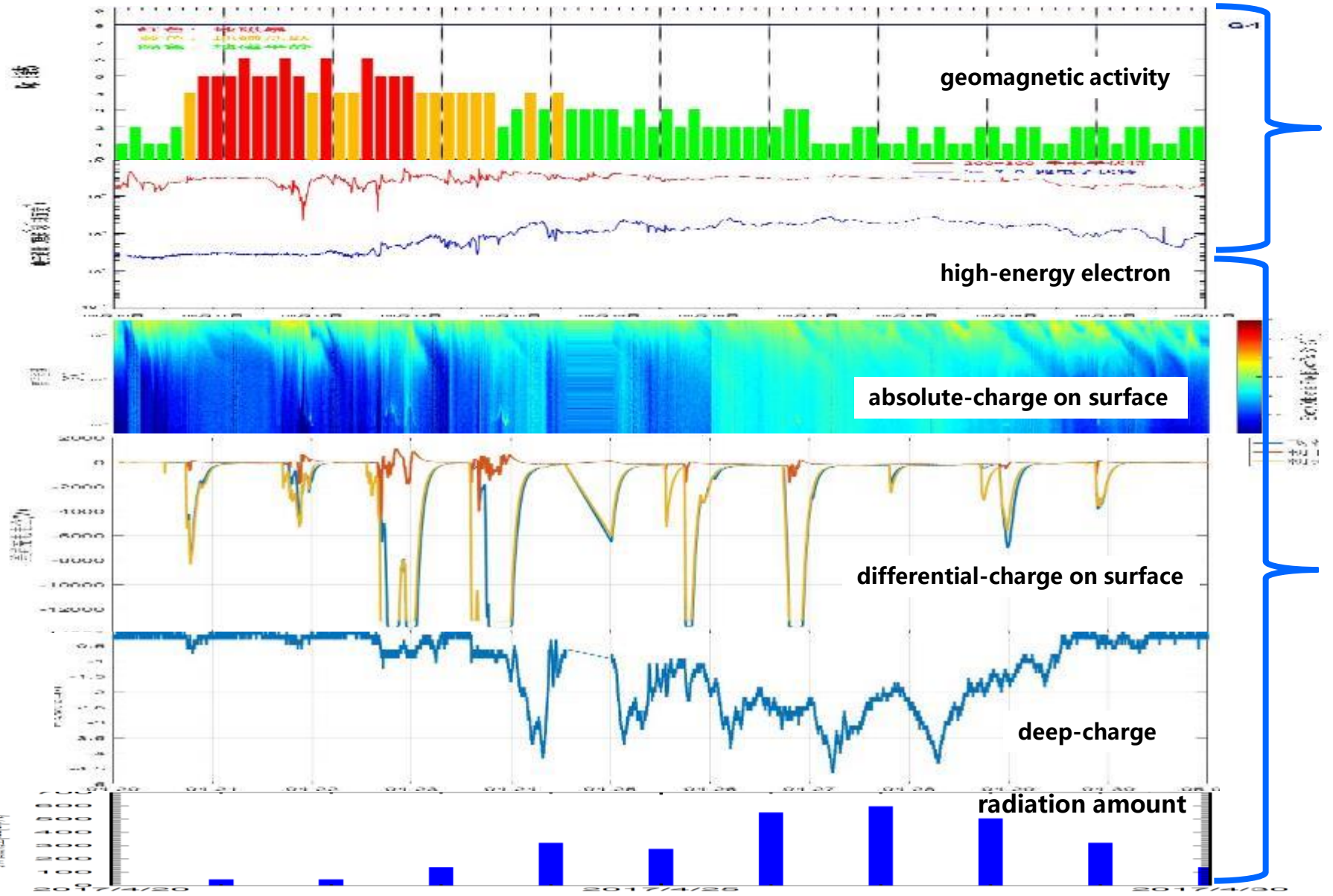






Period: 20170801~20171031; Ref: METOP-A/IASI; Samples: 110(LW)/108(MW)

Typical IOT results：In-orbit work performance monitoring for SEP

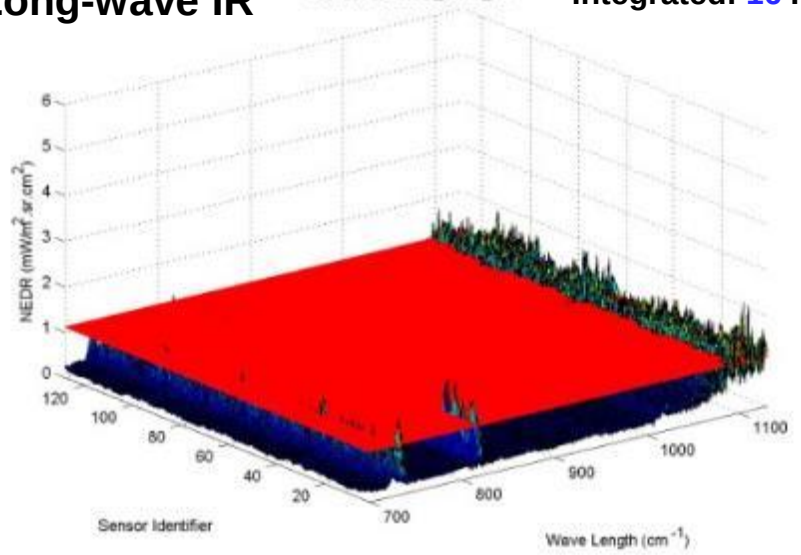


One big problem: sensitivity of GIIRS is worsen in partial spectrum since 8 March, 2017

Long-wave IR

20170527030550_0.625_16

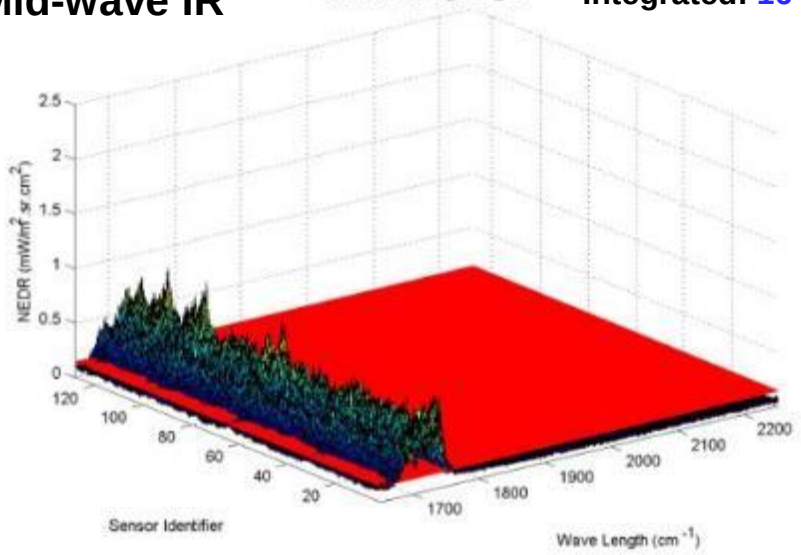
Integrated: 16 Fs



Mid-wave IR

20170527030550_0.625_16

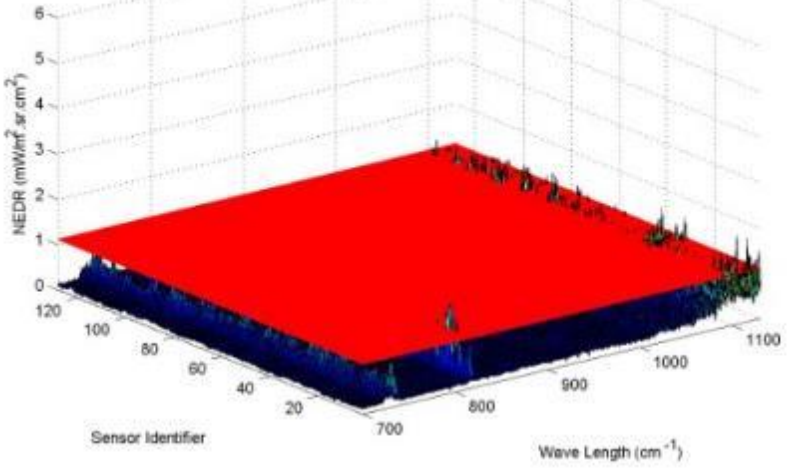
Integrated: 16 Fs



Long-wave IR

20170526060550_0.625_30

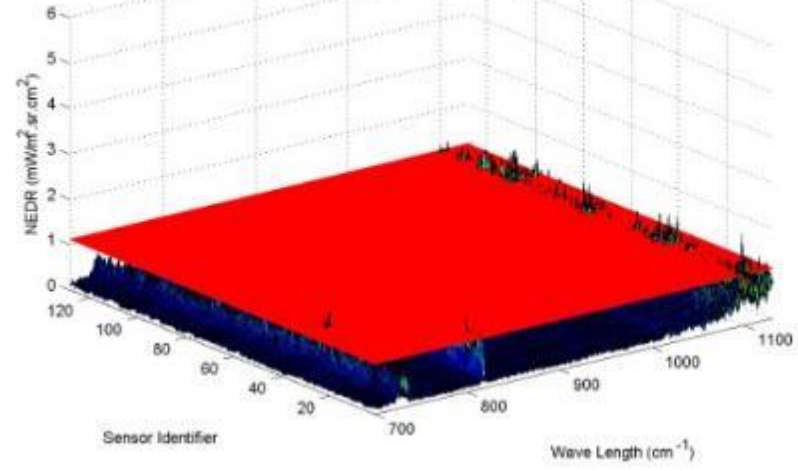
Integrated: 30 Fs



Mid-wave IR

20170527060550_0.625_30

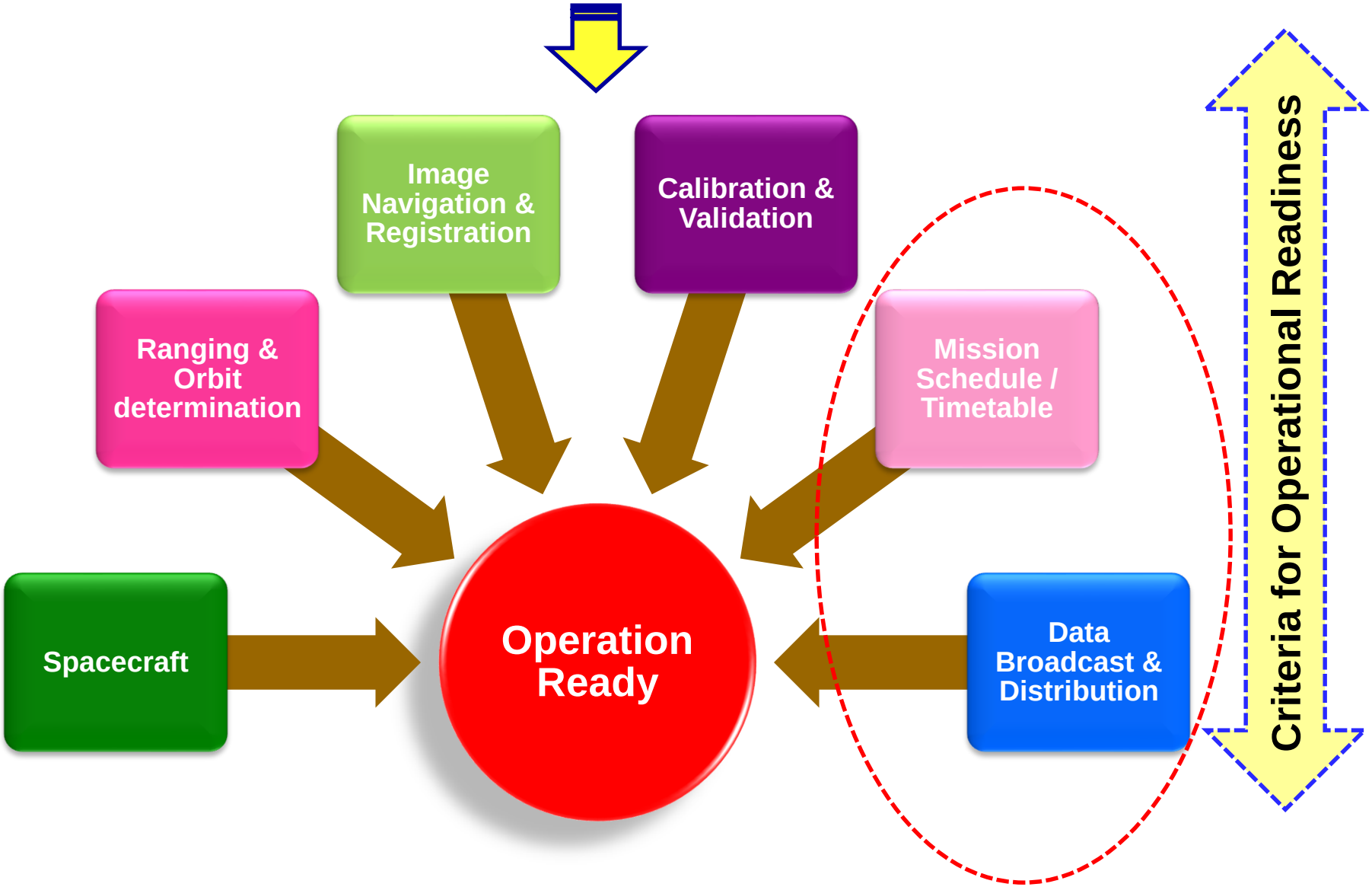
Integrated: 30 Fs



Outline

1. Background
2. Latest Outcome during Commissioning
3. Operational Readiness
4. Conclusion

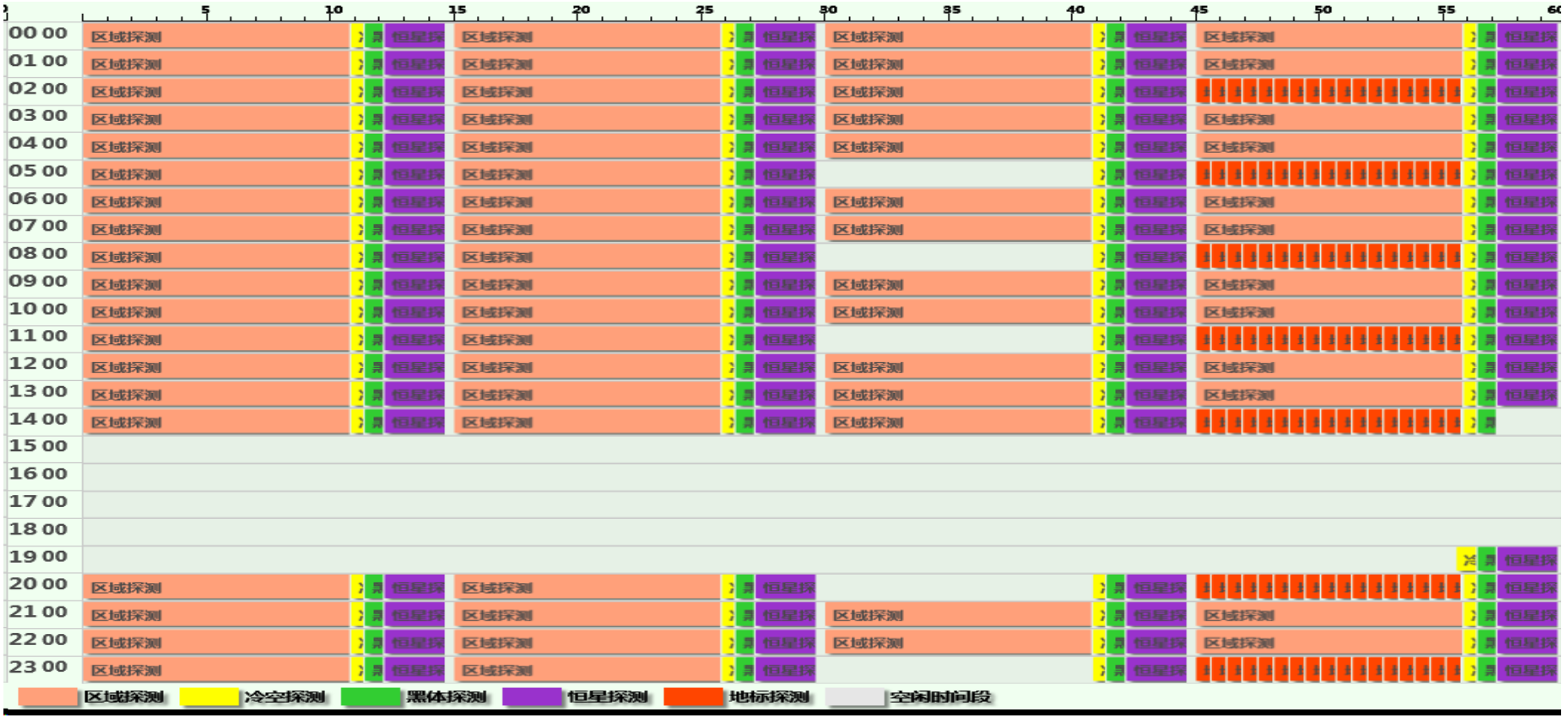
1st stage of in-orbit testing for FY-4A is completed



Mission Schedule: AGRI

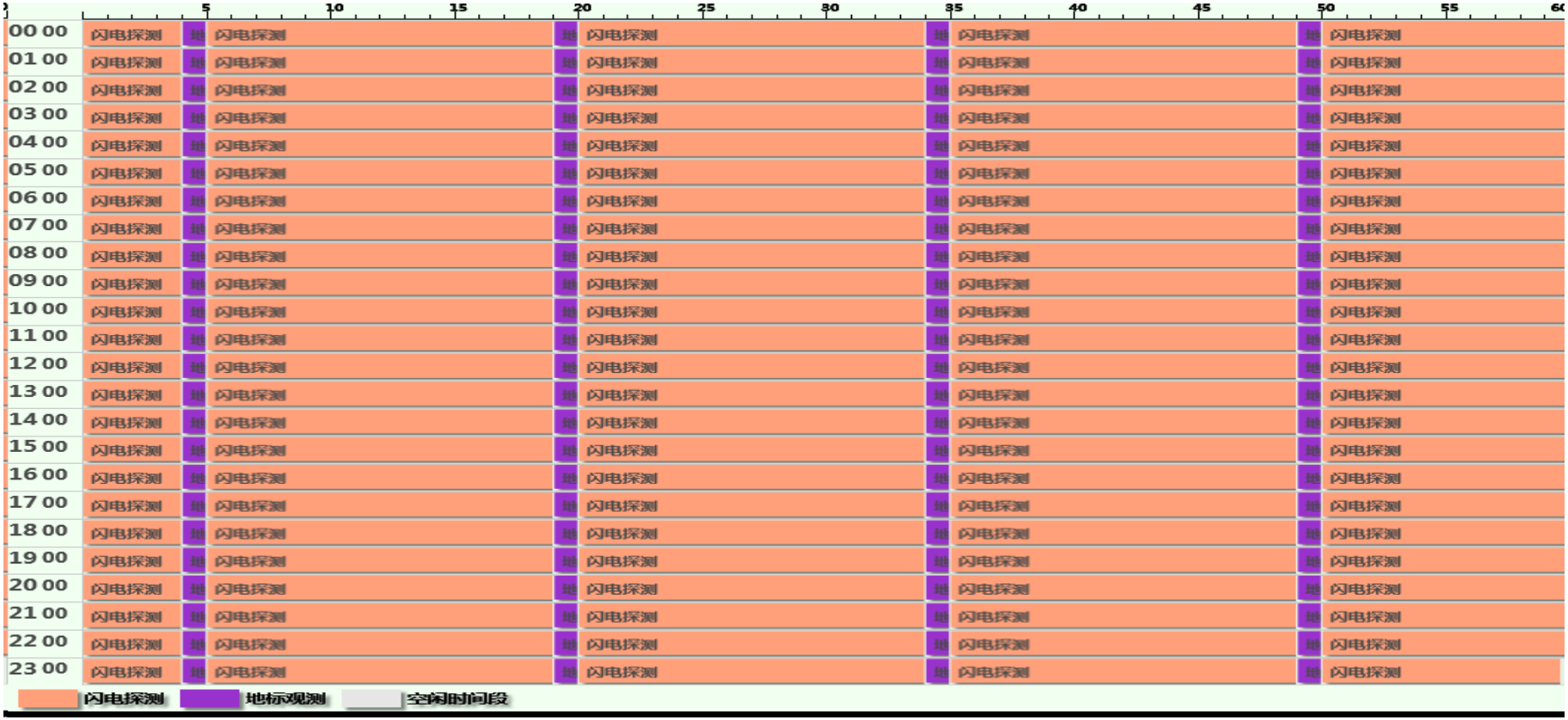
- Full disc observation can be finished within 15 min at one hour interval;
- Local area (China and its surrounding) observation is restricted within 5 min;
- A complete auxiliary observations (i.e. blackbody, space and star views) is performed every 15 min;
- Every 3 hours, a combination of 3 full-disc images is done to support AMV product generation;
- During 17-19 at local time, AGRI is suspended to ensure its safety.

Mission Schedule: GIIRS



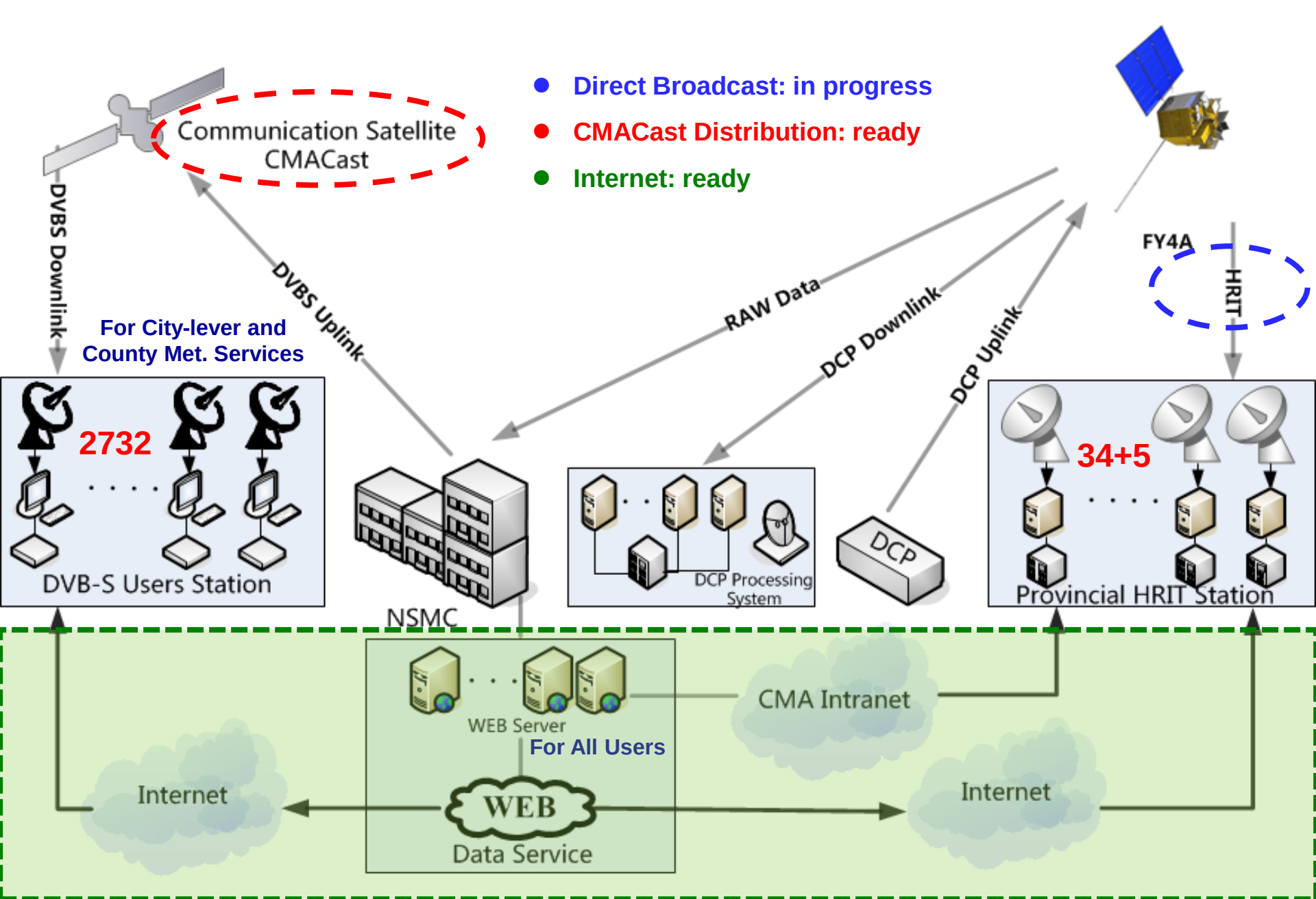
- Local area (China and its surrounding) observation is the main mode of GIIRS, and is divided into several 15-min fragments to fulfill (*Note*: totally about 2.5 hours);
- A complete auxiliary observations (i.e. blackbody, space and star views) is performed every 15 min;
- Every 3 hours, a group of landmark observations is done to support INR of GIIRS;
- During 15-19 at local time, GIIRS is suspended to ensure its safety.

Mission Schedule: LMI



- LMI observation is fixed on the local area (China and its surrounding);
- Every 15 min, a group of landmark observations is done to support INR LMI;
- LMI can continuously operate at all local;
- ……

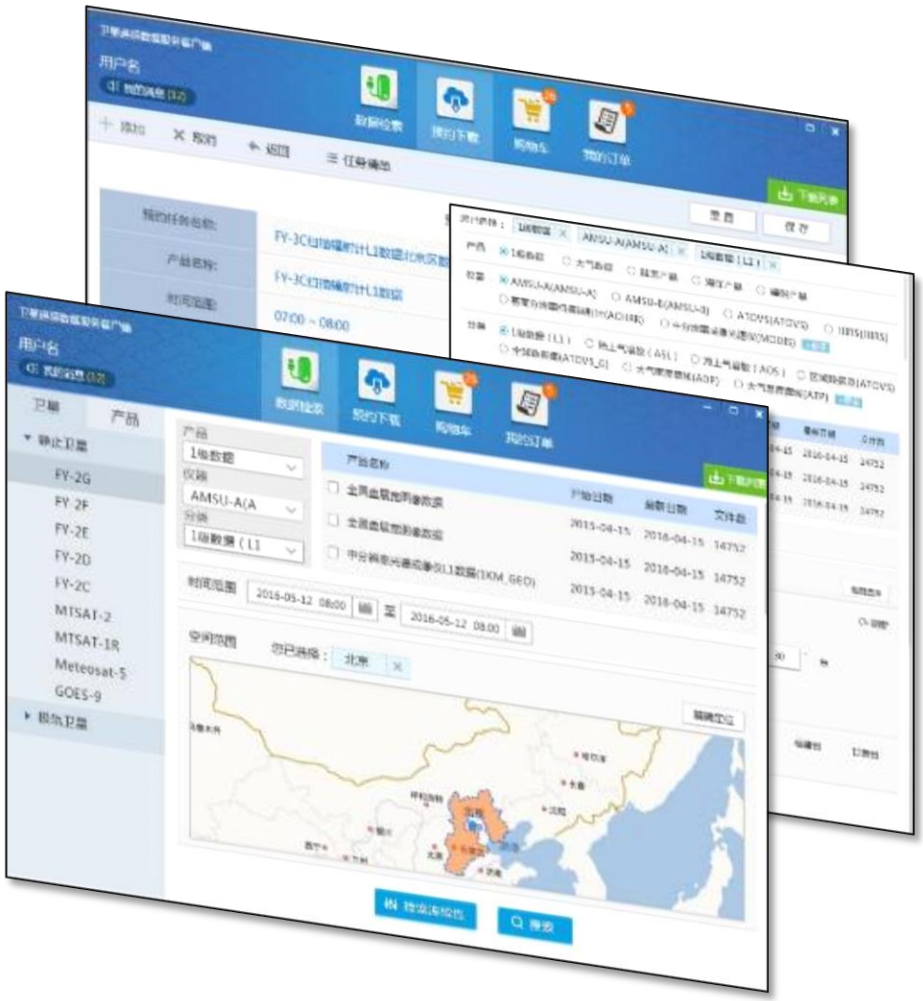
Data Broadcasting & Distribution

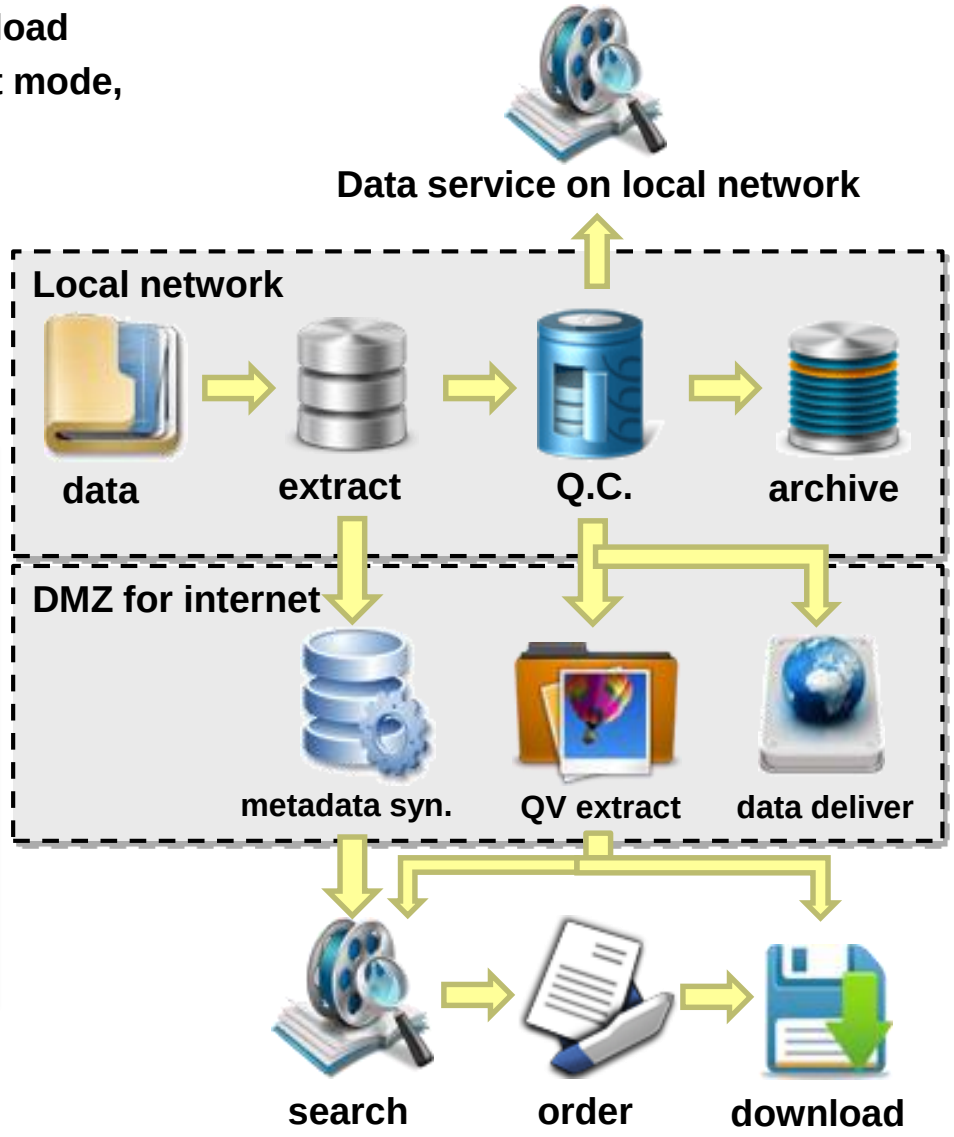


Customized Data Service via Internet

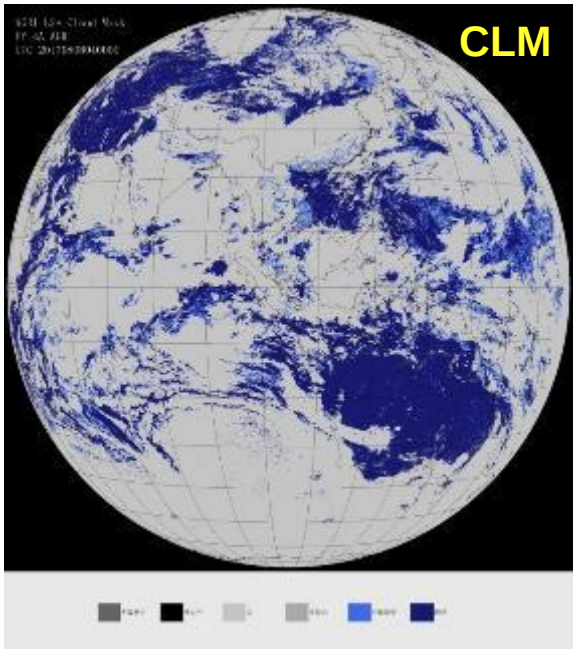
Terminal

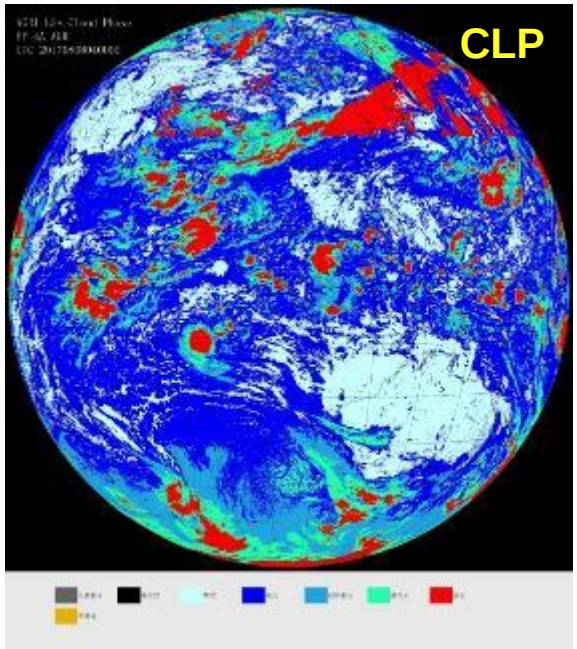
- ✓ identify on web, ordered & automatic download
- ✓ parallel download, resume from break point mode, P2P acceleration

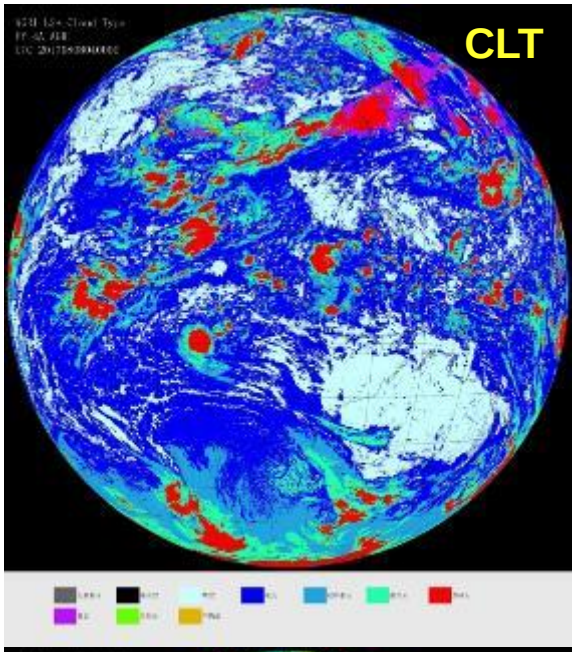


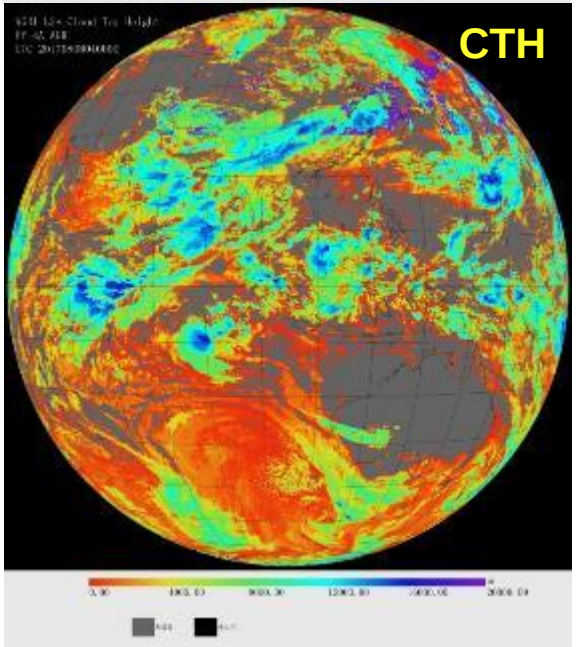


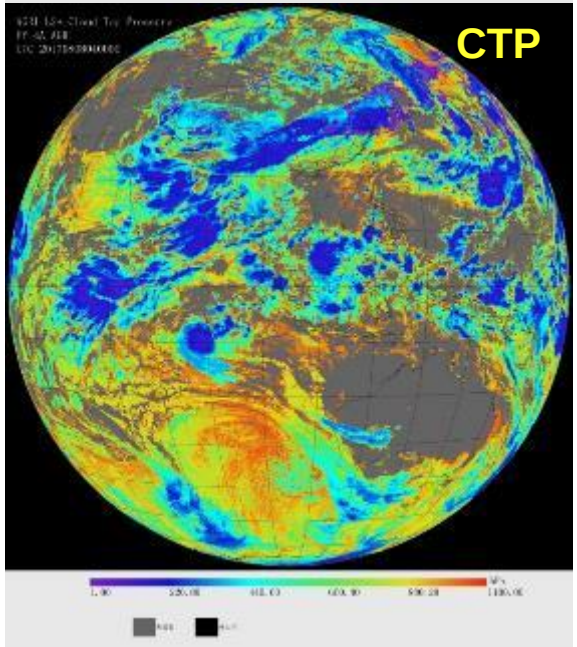
Main L2 Products of AGRI

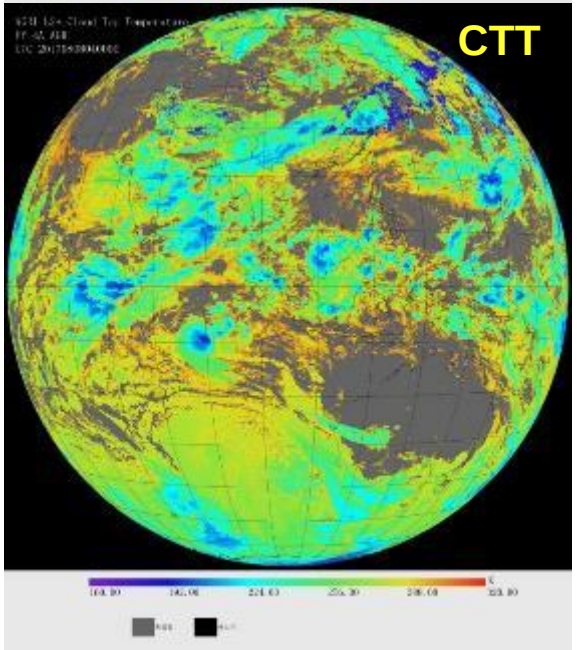






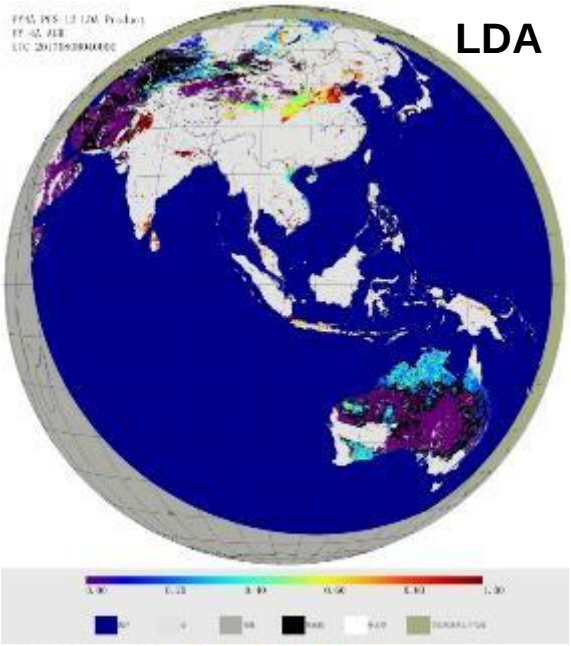




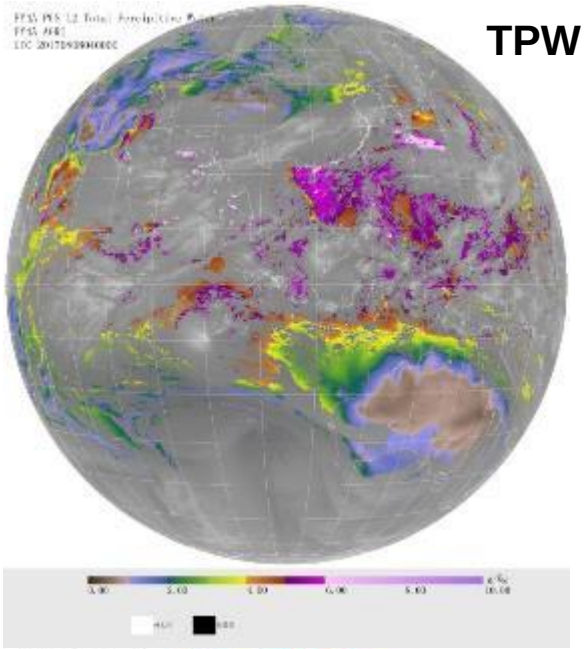


Main L2 Products of AGRI

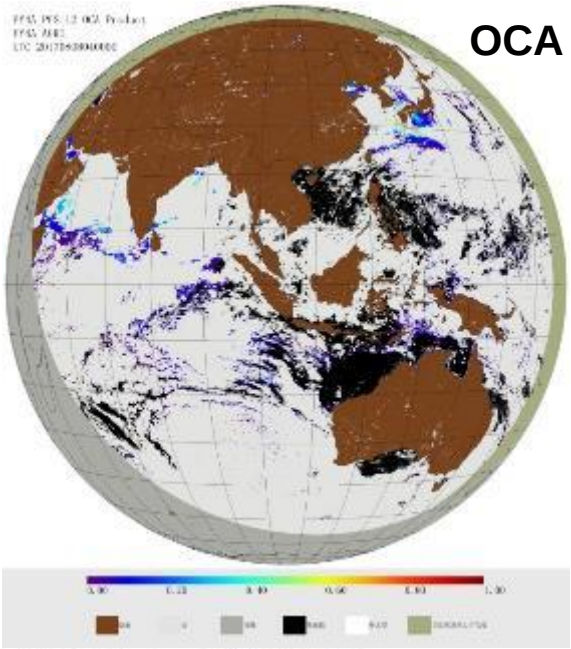
LDA



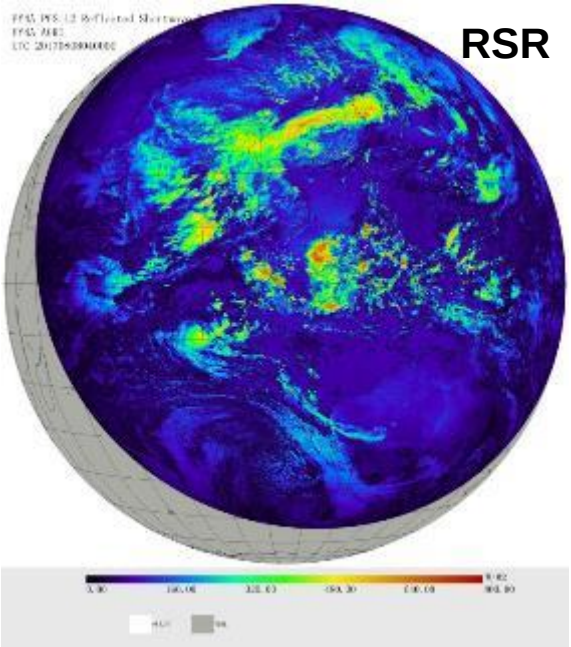
TPW



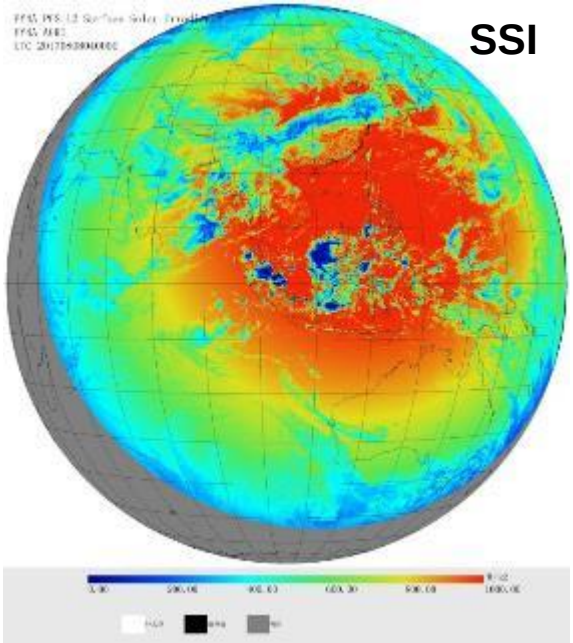
OCA



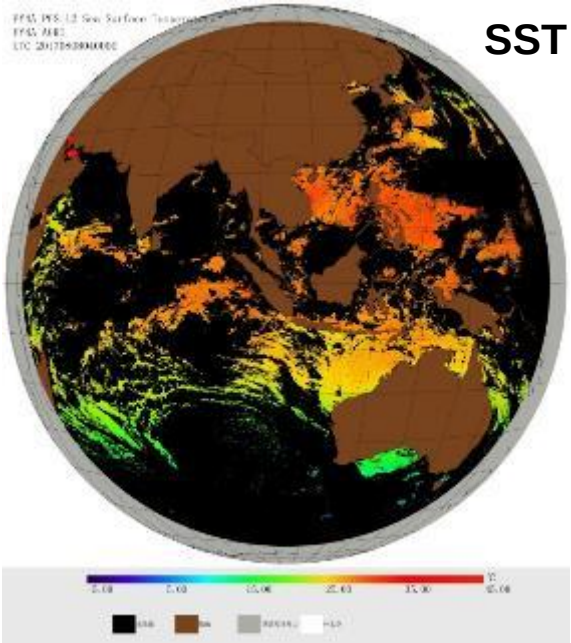
RSR



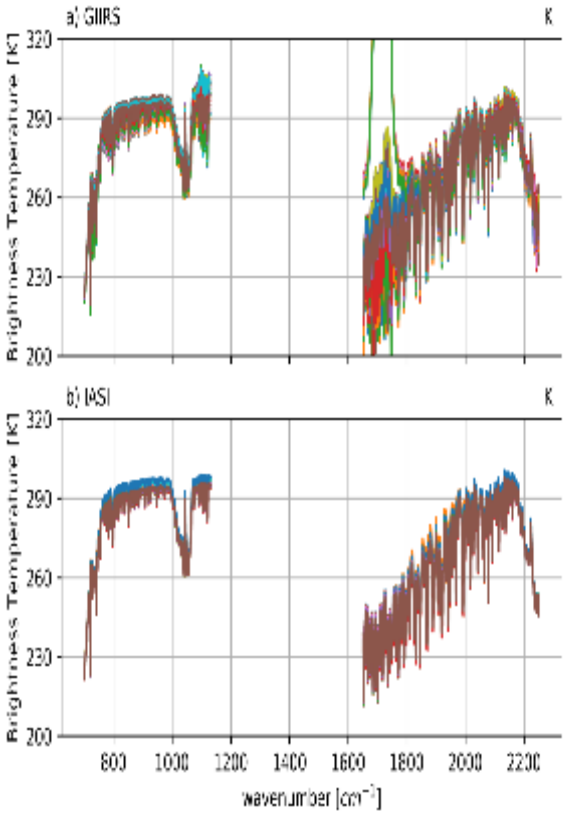
SSI

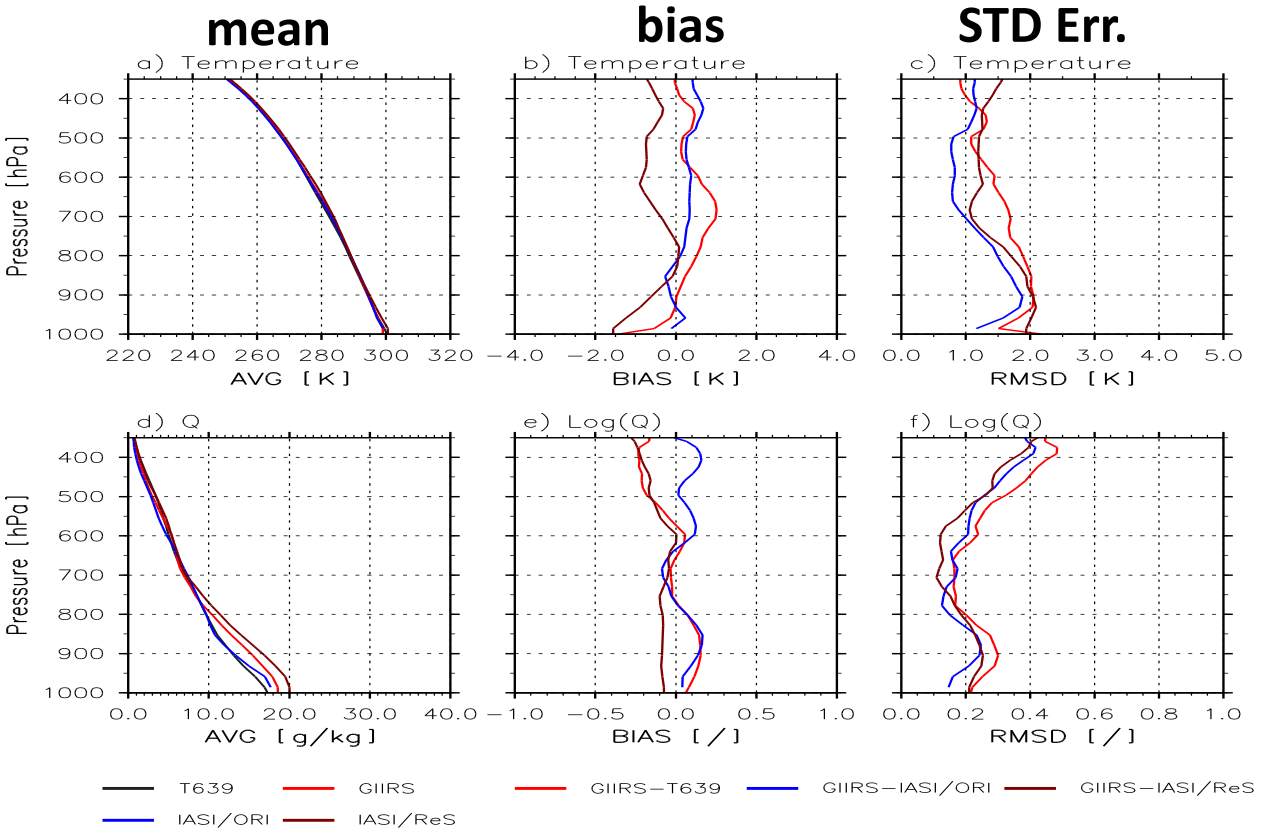


SST



Preliminary Temperature and Humidity Profiles from GIIRS



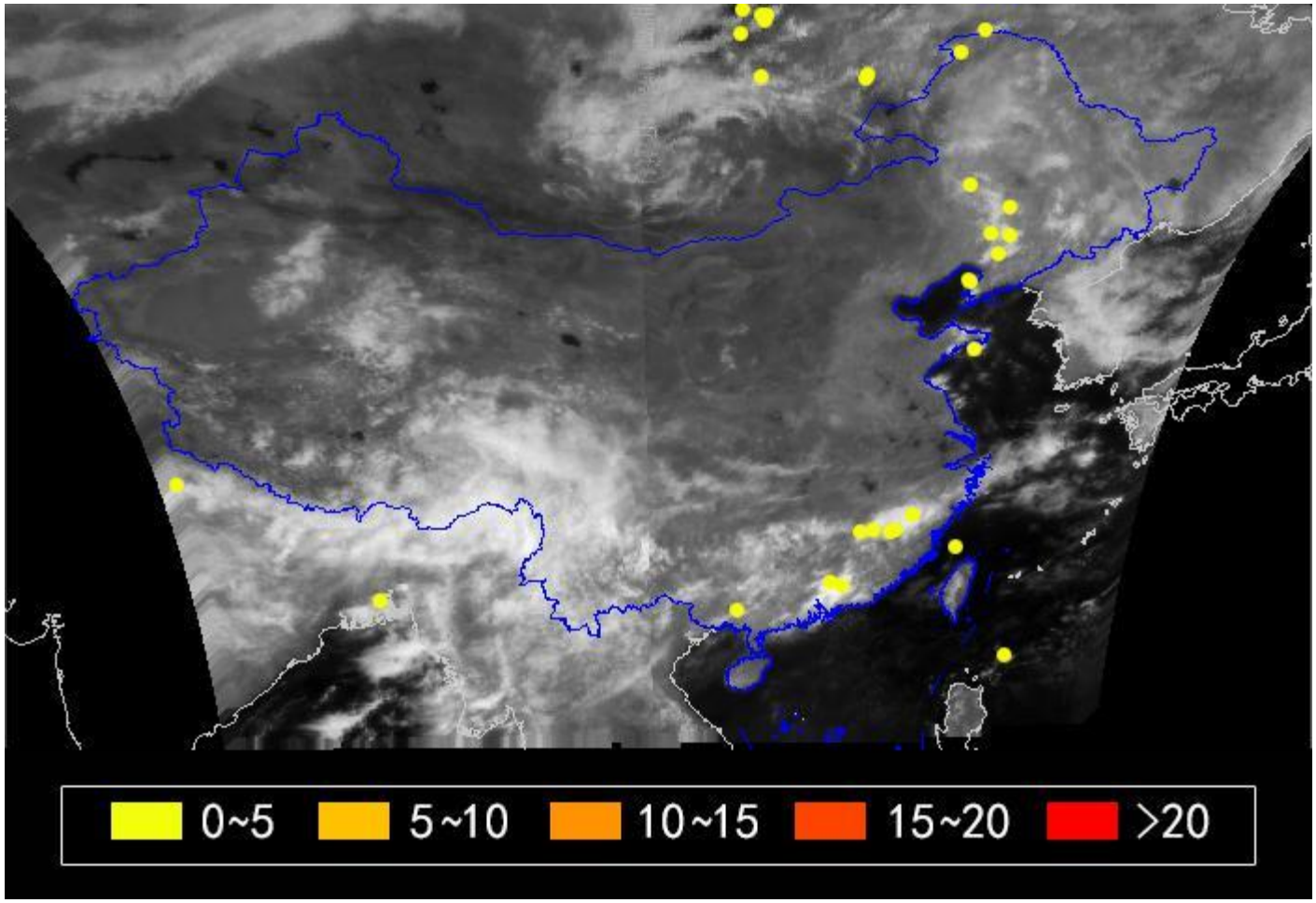


Merits: 1) Observation biases removed;

2) Observation channels optimized;

3) Physical and statistical methods are combined.

Main L2 Products of LMI



Validation for L2 products is undergoing

Outline

1. Background
2. Latest Outcome during Commissioning
3. Operational Readiness
4. Conclusion

- **New generation GEO meteorological satellite (FY-4) is commissioned and ready for real applications**
  - High temporal, spatial & radiometric accuracies imager is available;
  - High-spectral sounder is firstly onboard in GEO platform;
  - Multiple sensors can coordinate with each other stably;
  - Scheduled to provide operational service since April, 2018
- **Many detailed works need to be done further**
  - Hyperspectral soundings utilization in regional NWP model
  - Integrated applications with multiple-sensors in severe weather monitoring as well as short-term climate prediction
  - ……

Thanks for your attention

NSMC