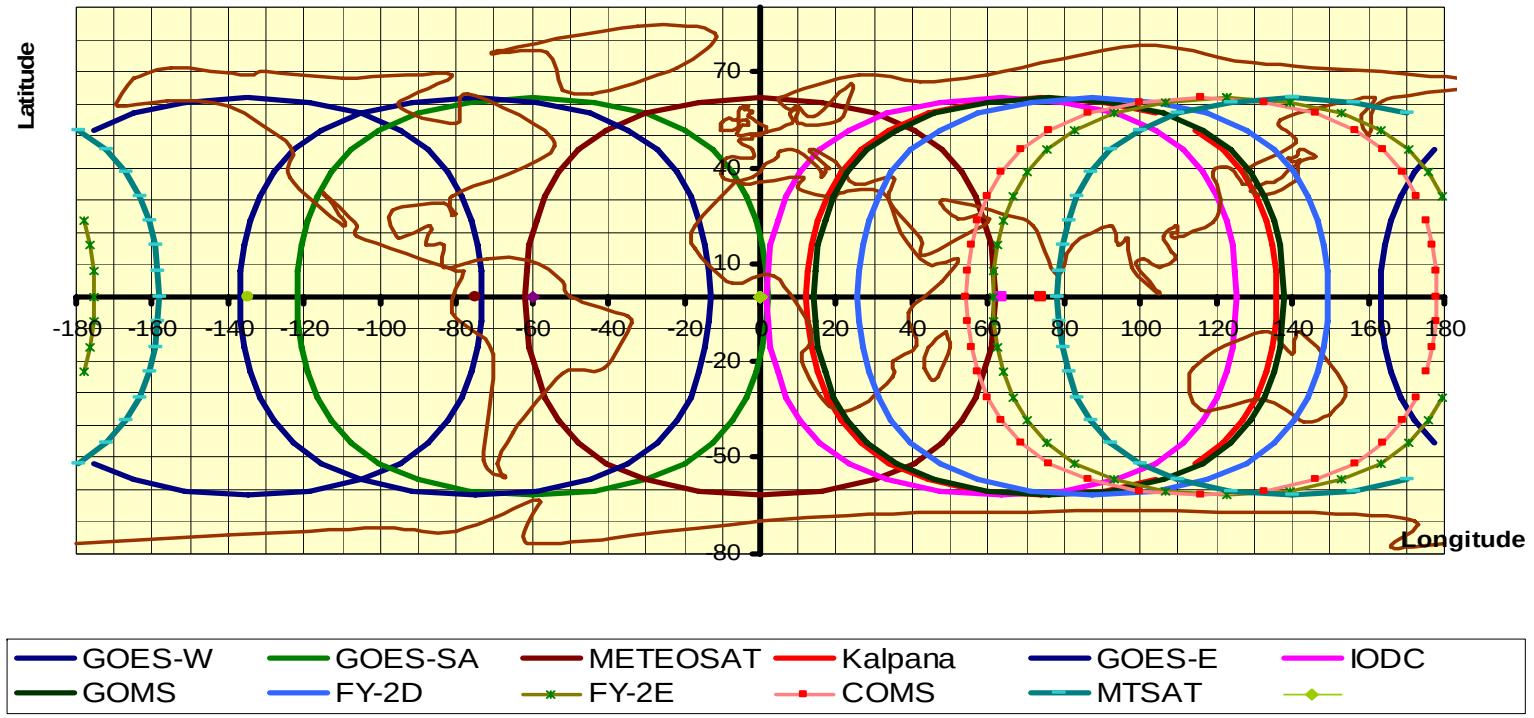
Vision to 2025

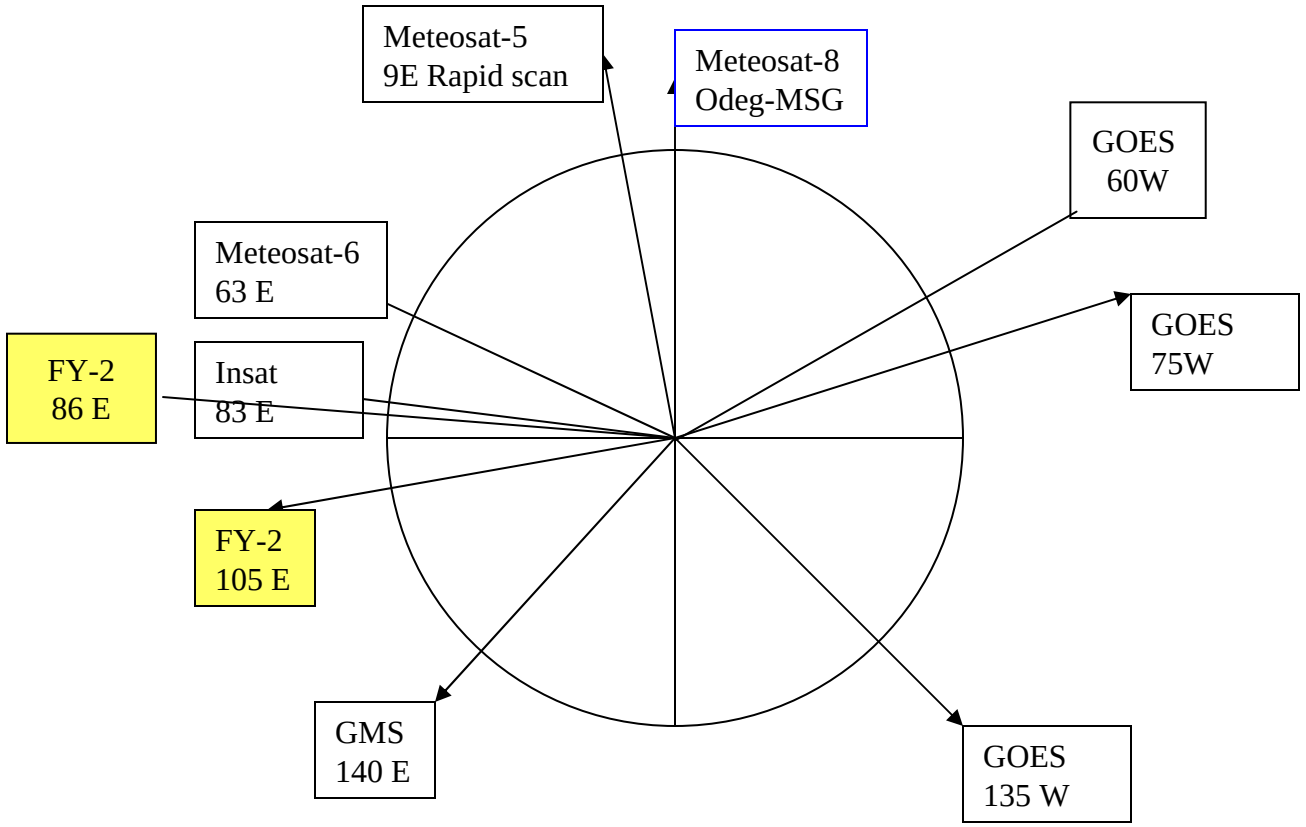
Observing capability	Expected outcome	WMO programme
At least 6 operational geostationary satellites:		
• With no more than 60° longitude difference between neighbouring locations	Optimize viewing angle with near-global coverage	WWW DRR WCP GCOS, WCRP
• All with IR/VIS multi-spectral imager	Weather and hazard monitoring (incl fires), SST, radiative fluxes	
• All with IR hyper-spectral sounder	Mesoscale permanent sounding, advanced AMV, contribution to chemistry	
Some with lightning detection	Severe warning lead time,	AMP/AEM, DRR, WWW

Optimization of Space-based observing systems

- GEO: scope of optimization
  - **6 operational GEO satellites**
  - **All with multispectral imager (IR/VIS)**
  - **Some with hyperspectral sounder (IR)**
  - **Quick-scan for regions where** severe weather conditions develop (e.g. cyclones, tornadoes, sounder storms)



Geostationary constellation and selected low earth orbiting satellites whose data are available today (7/2007)



NOAA-16 PM 17 AM

FY- 1D AM

METEOR-3M-N2 AM

Terra ConstellationAM

Aqua ConstellationPM

QuikSCAT AM

TRMM

ERS AM

Jason

COSMIC

Envisat AM

DMSP

SPOT AM

LANDSAT-7 AM

EO-1-AM

SAC-C

RESURS

IRS-P4

The current and future Chinese Geostationary Meteorological Satellite Systems

Wenjian ZHANG, Jun YANG

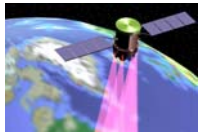
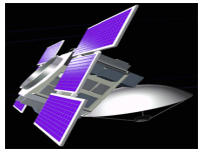
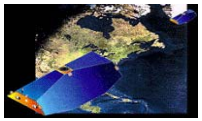
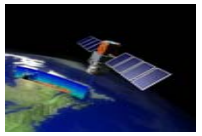
China Meteorological Administration (CMA)

Beijing 100081, P. R. China

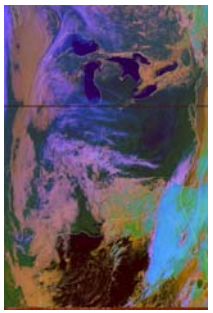
Chinese Missions to future GOS

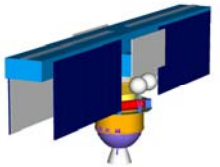
Current Era	Near Focus	Advanced Concepts

- FY1(leo)
- FY2 (geo)

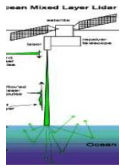





- FY3 (leo)
(VIRR,MODI
IRAS,MWAS
MWRI,TOM/OP)
- FY4 (geo)
(Imager, Sounder,
lightning sensor,
high res. CCD)





- Hyperspectral
- Conical MW
- New Initiatives



operational Missions

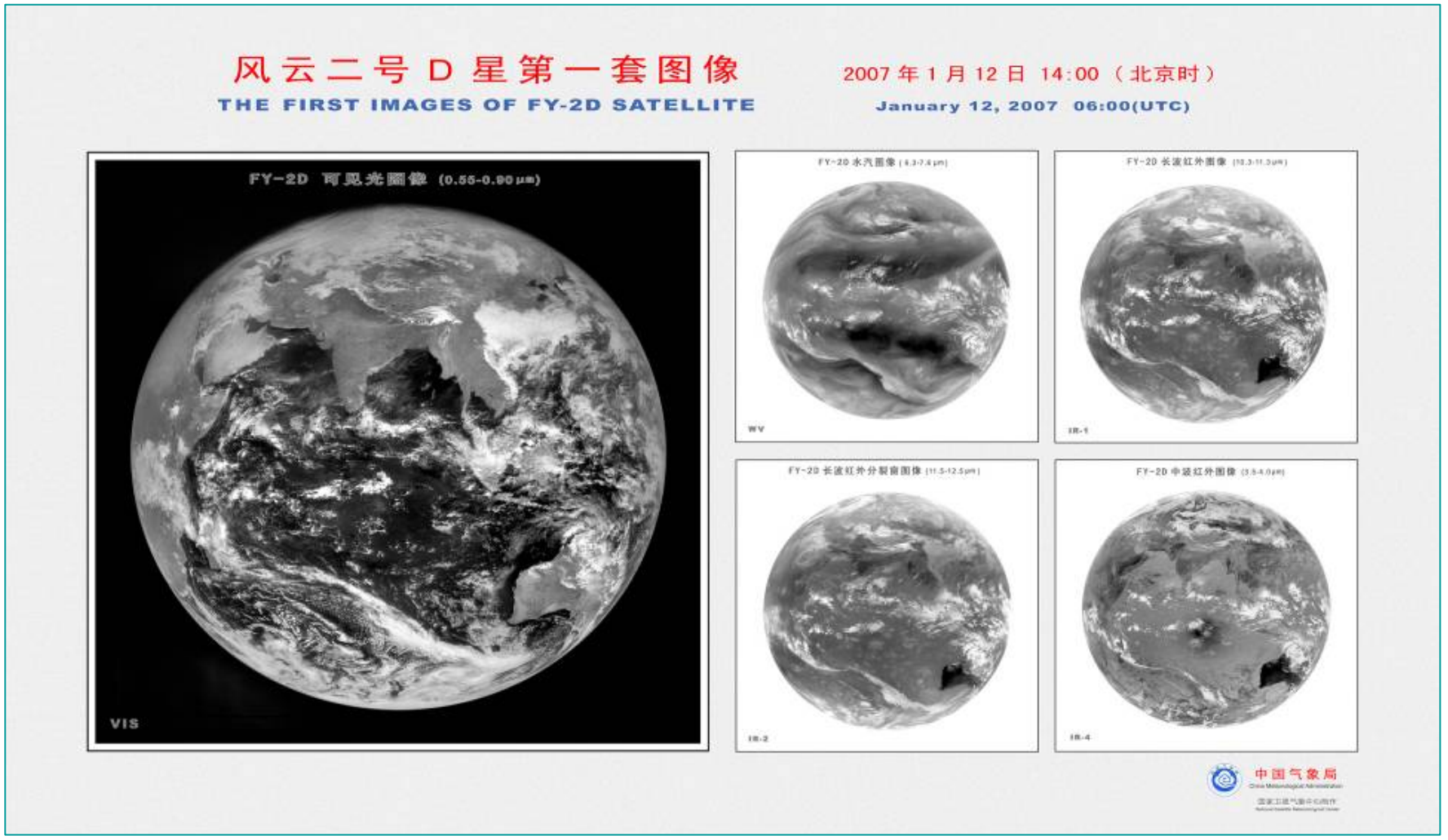
research Missions

FY-2 operational satellites

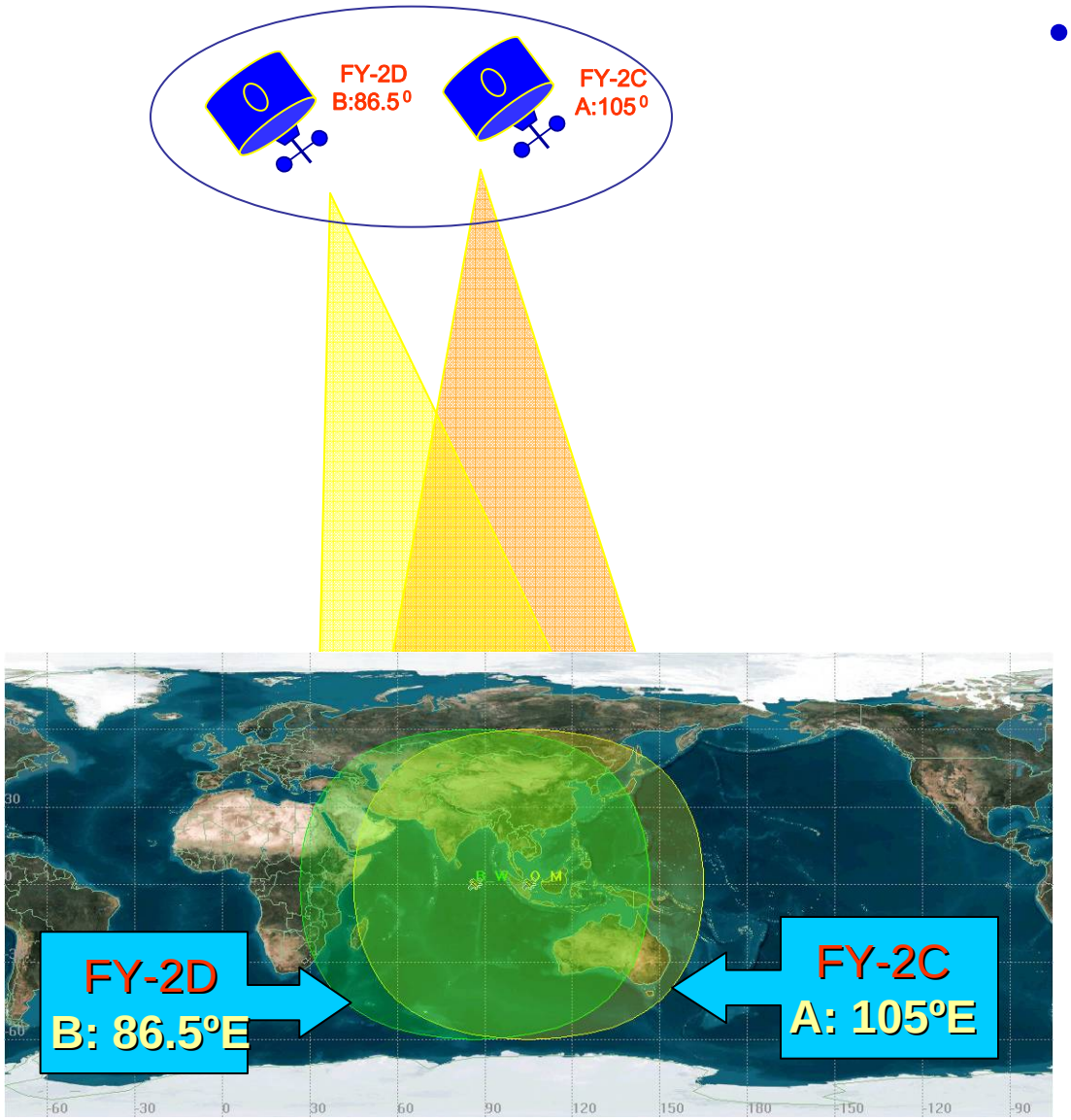
- FY-2 operational satellites are designed based upon the previous two experimental satellites, FY-2A&B, with the following improvements
  - **Five channel VISSR;**
  - **Improved NEDT for IR channels**
  - **Half-hourly observations during the main flooding season of China (June – August)**

	FY-2A/B	FY-2C/D/E	
Channels	Wavelength (μm) (quantization)	Channel	Wavelength (μm) (quantization)
1	0.5-1.05 (6 bits)	1	0.5-0.9 (6 bits)
2	6.3-7.6 (8 bits)	2	3.5-4.0 (10 bits)
3	10.5-12.5 (8 bits)	3	6.3-7.6 (8 bits)
		4	10.3-11.3 (10 bits)
		5	11.5-12.5 (10 bits)

Five channel FY-2D

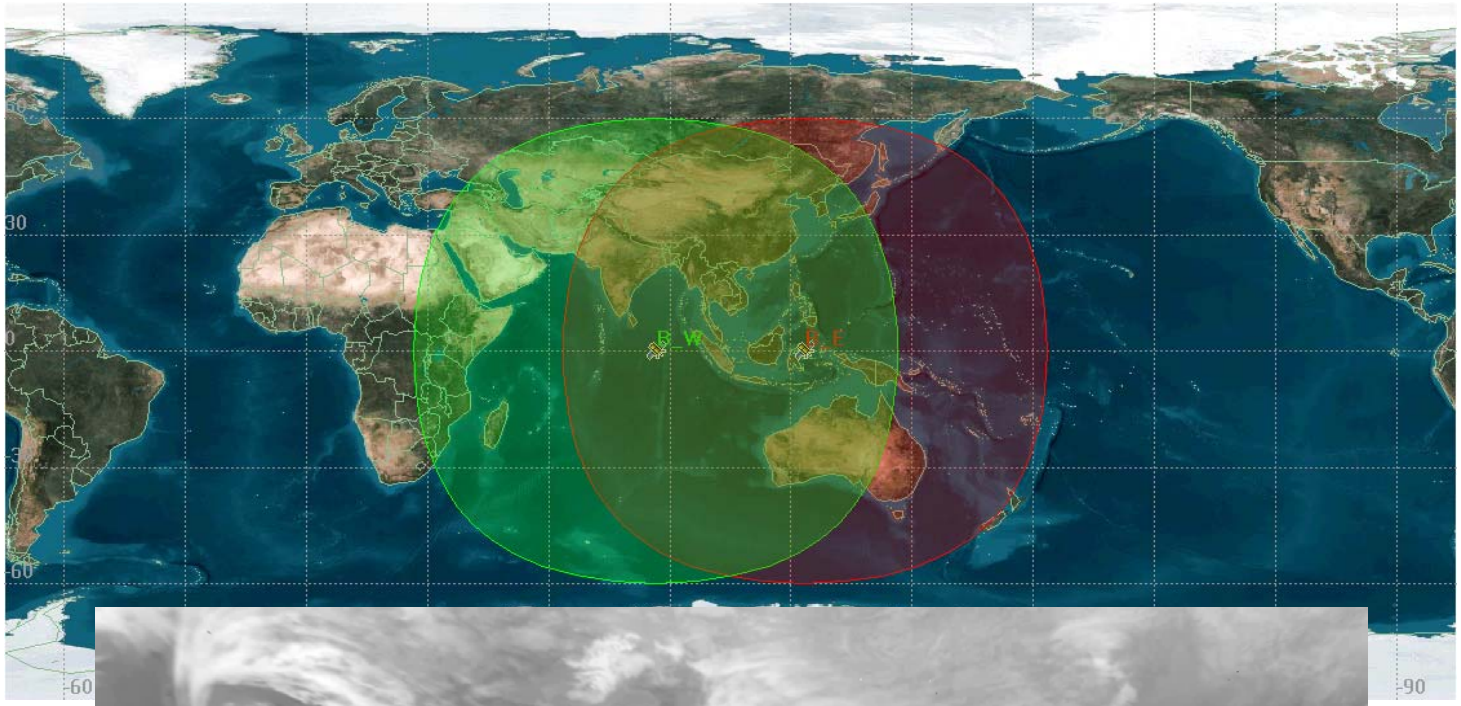


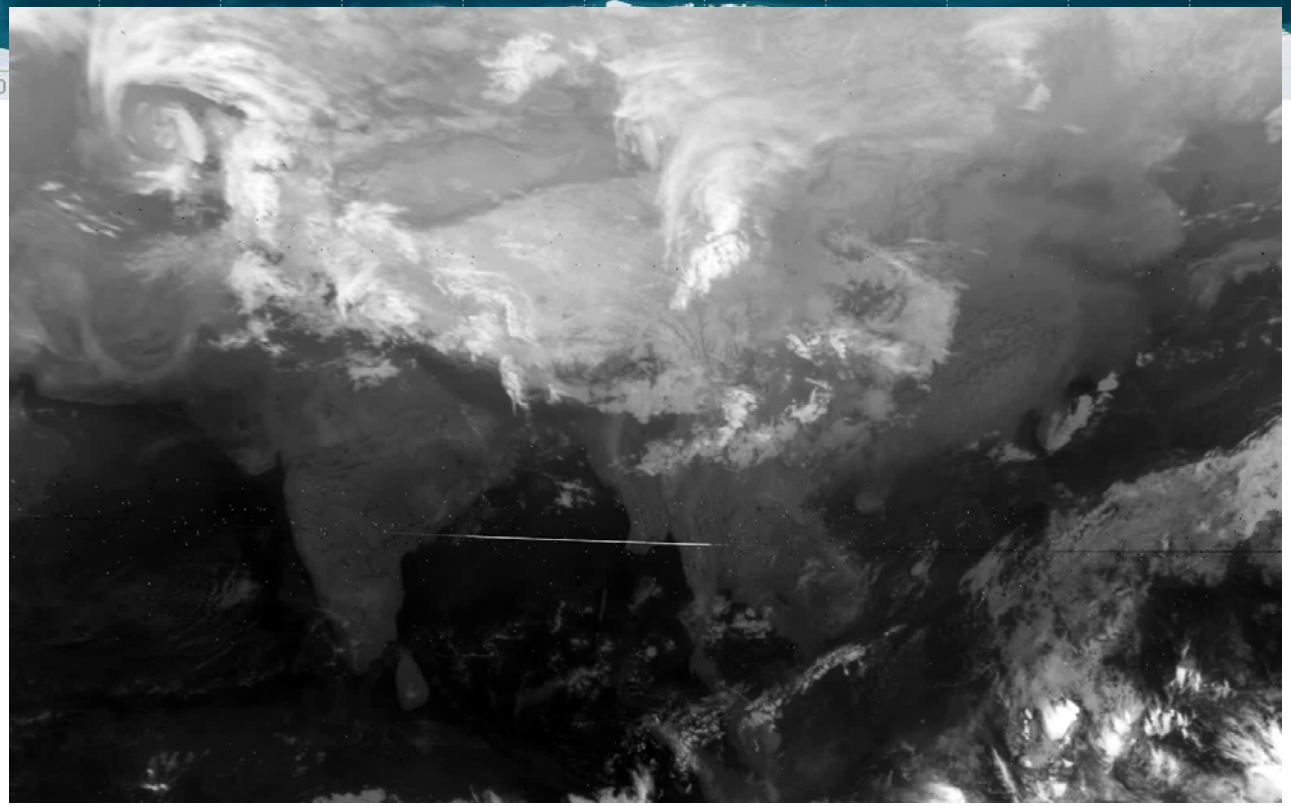
FY-2 Dual GEOSat operations



- **FY-2C、2D dual GEO observations**
  - Two FY GEO satellites take 96 images daily during the flooding season (July to August) ;
  - The movies every 15 minutes in the Northern hemisphere makes the frequent observations more powerful

Two FY-2 GEOSat Full coverage areas :
26.5° ~ 165°E
Two FY-2 GEOSat overlap coverage areas:
45°E ~ 146.5°E





- Two FY-2 Operational satellite configuration
- wider coverage
- frequent observations

FY-2 Ground segment

- A totally new ground segment is established and put into operation since FY-2C launch;
- More than 20 products for FY-2C have been developed, validated, and tested

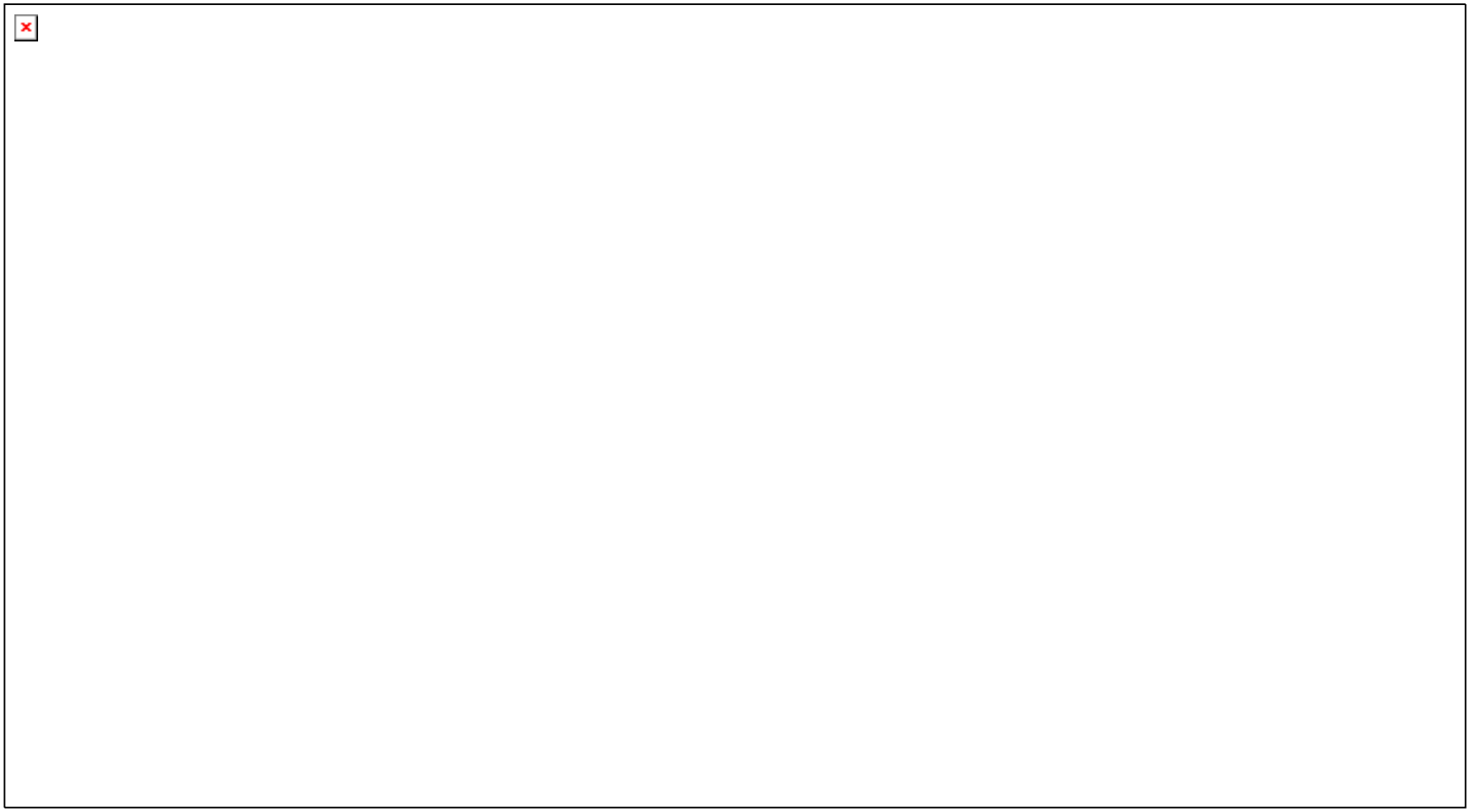
FY-2C major products

- Pre-processing and Image products
  - Accurate image registration and navigation
  - Channel data cross calibration with NOAA data
  - Sector images
  - Image maosic with MTSAT and Meteosat

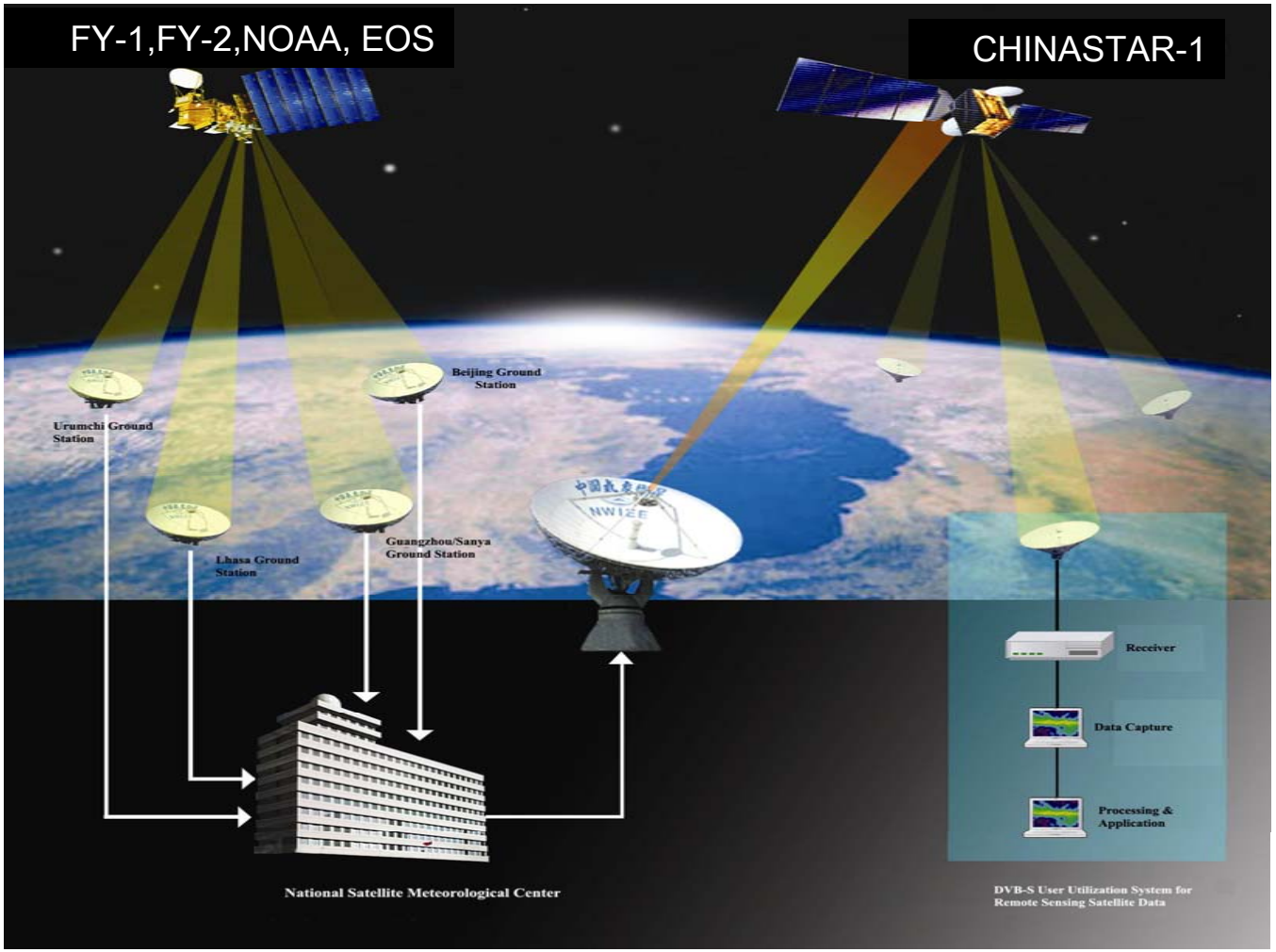
- **Quality products**
  - **Rainfall estimation**
  - **OLR** $_{\text{all IR}}$**, TBB** $_{\text{IR1}}$
  - **Cloud Motion Vector (CMV)**
  - **Cloud Amount**
  - **Total Precipitation water**
  - **Moisture profile (cloud products)**
  - **Cloud classification**
  - **Fog, Fire, Sea ice, Soil Wetness , snow cover**

Extensive satellite data broadcasting system

There are 2441 VSAT (Very Small Aperture Terminal) users, which can acquire near real time FY-2C data by retransmitting through communication satellite

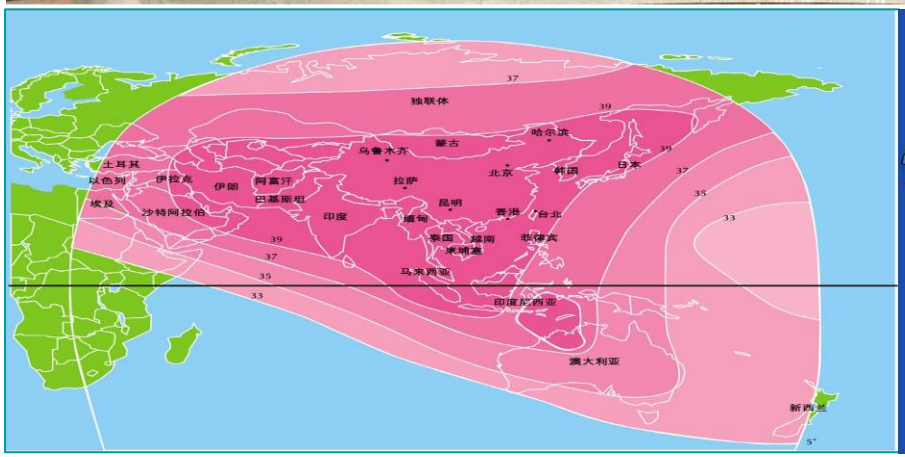


DVB-S based CMA FengYunCast System, which broadcasts GEO/LEO satellite data and products over China and A-P region



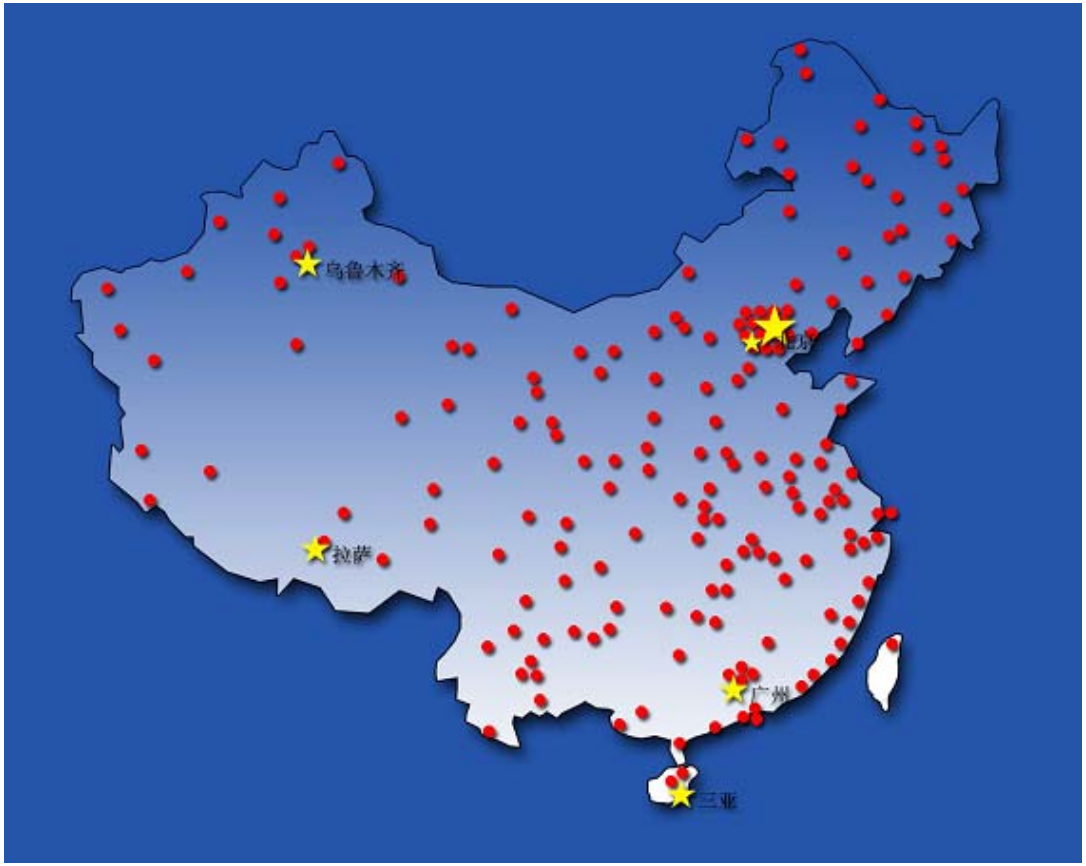
FENGYUNCast
upper: Donations to 11 countries
Lower left: Coverage in C Band

Lower right: reception stations in China,



Direct data reception stations of FY-2 in China

- Each Provincial meteorological Bureau of China (including Hong Kong, Macao)
- Ministry of water resources, Ministry of agriculture, Ministry of Forest, State Oceanic Administration, Air China, Ministry of Communication
- International Users (within data coverage countries, and global users)



Launch schedule for FY-2

- FY-2E: Nov. 2008
- FY-2F: Oct. 2010
- FY-2G: Oct. 2012

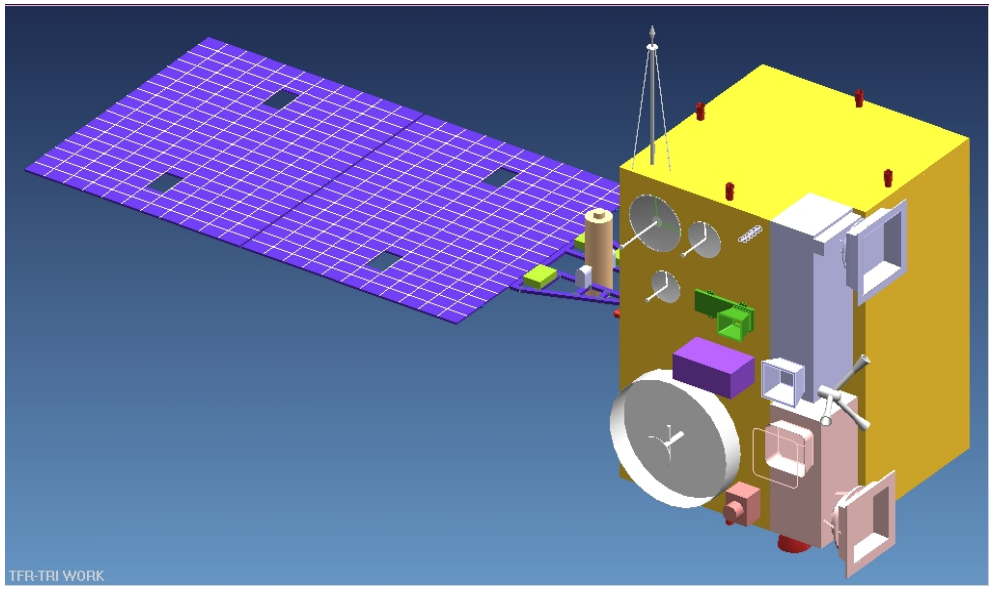
- With expectation of 5 year operational life span, two satellite configuration formed after FY-2D launch.
- FY-2 satellites located at 86.5E and 105°E
- Two FY-2 constellation will enhance the observation capability and, at the same time, meet the WMO contingency strategy requirements.

The Next Generation of Chinese Geo. Meteorological Satellites FY-4 Series

FY-4 develop and launch plan

- Development:
  - FY-4 Phase A : 2007-2008
  - FY-4 Phase B : 2009-2010
  - FY-4 Phase C : 2011-2012
- R&D / Operation
  - FY-4A/B : 2012-2014 (R&D)
  - FY-4C/D/E/F: 2016 beyond (Op.)

FY-4 Satellite Configurations



Main payload considerations

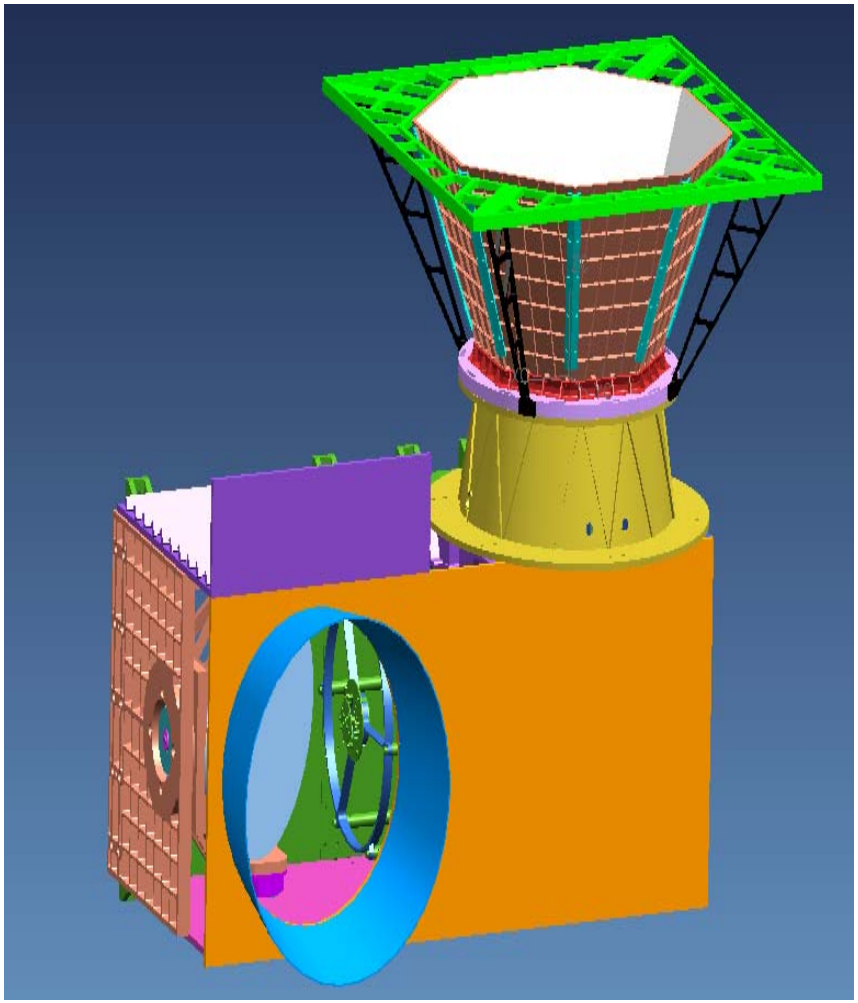
- ✓**Imaging Radiometer**
- ✓**CCD Imager (option)**
- ✓**Infrared Sounder**
- ✓**Lightning Maper**
- ✓**Solar X-ray Imager**
- ✓**Space Environment Monitor Suite**

Estimated weight :3200kg

Estimated power: 2000 W

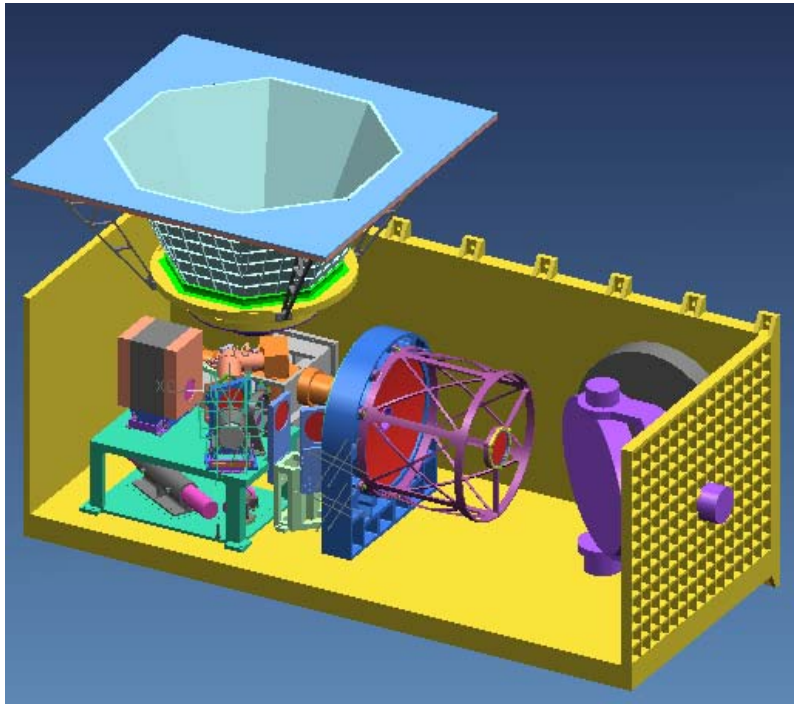
FY-4 Imaging Radiometer

- **Currently 12 channels, reference to MSG and GOES –R**
- **Imaging and radiometric channels combination**
- **Imaging channels with higher spatial resolution and frequent observation (China territory: 5 minutes)**
- **Radiometric channel: higher radiometric performance。**



FY-4 IR sounder

- **Fourier Transformation Infrared Interferometer**
- **856 channels in EDU**
- **Main observation area: Western Pacific and India Ocean.**
- **The Pre-phase A design and KEY Tech. study started since 2003**
- **The difficulties is foreseen, and international collaboration is highly encouraged**



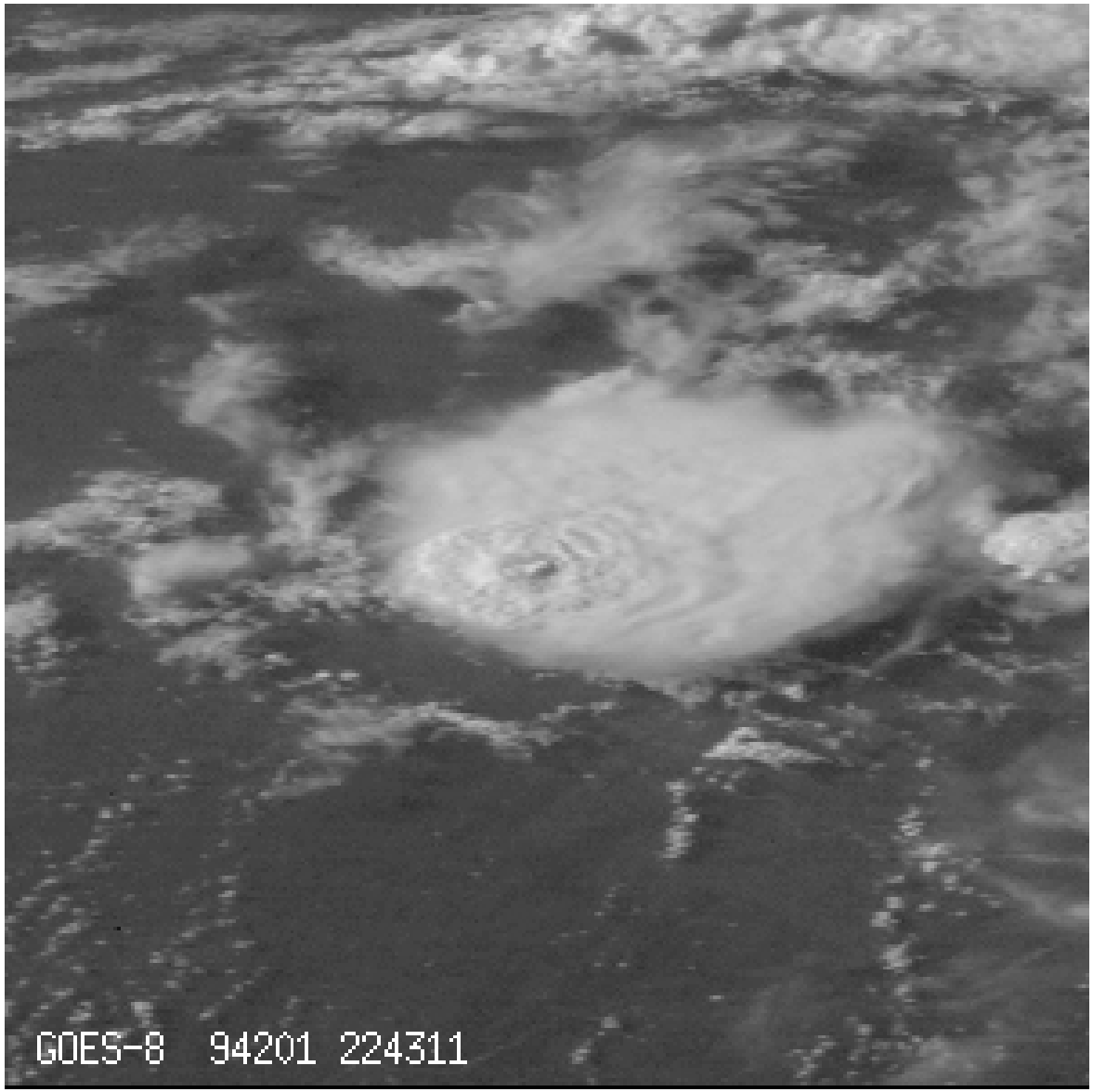
The development and evolution of deep convection

Unique in space and time

•To the right is the first ever one minute interval imagery taken by a geostationary satellite. It covers 6 minutes, and illustrates the dynamic nature of a strong (large hail) thunderstorm. The area covered is approximately 160 x 160 km.

•Imagine this at 10 sec. interval and 50-100 meter resolution

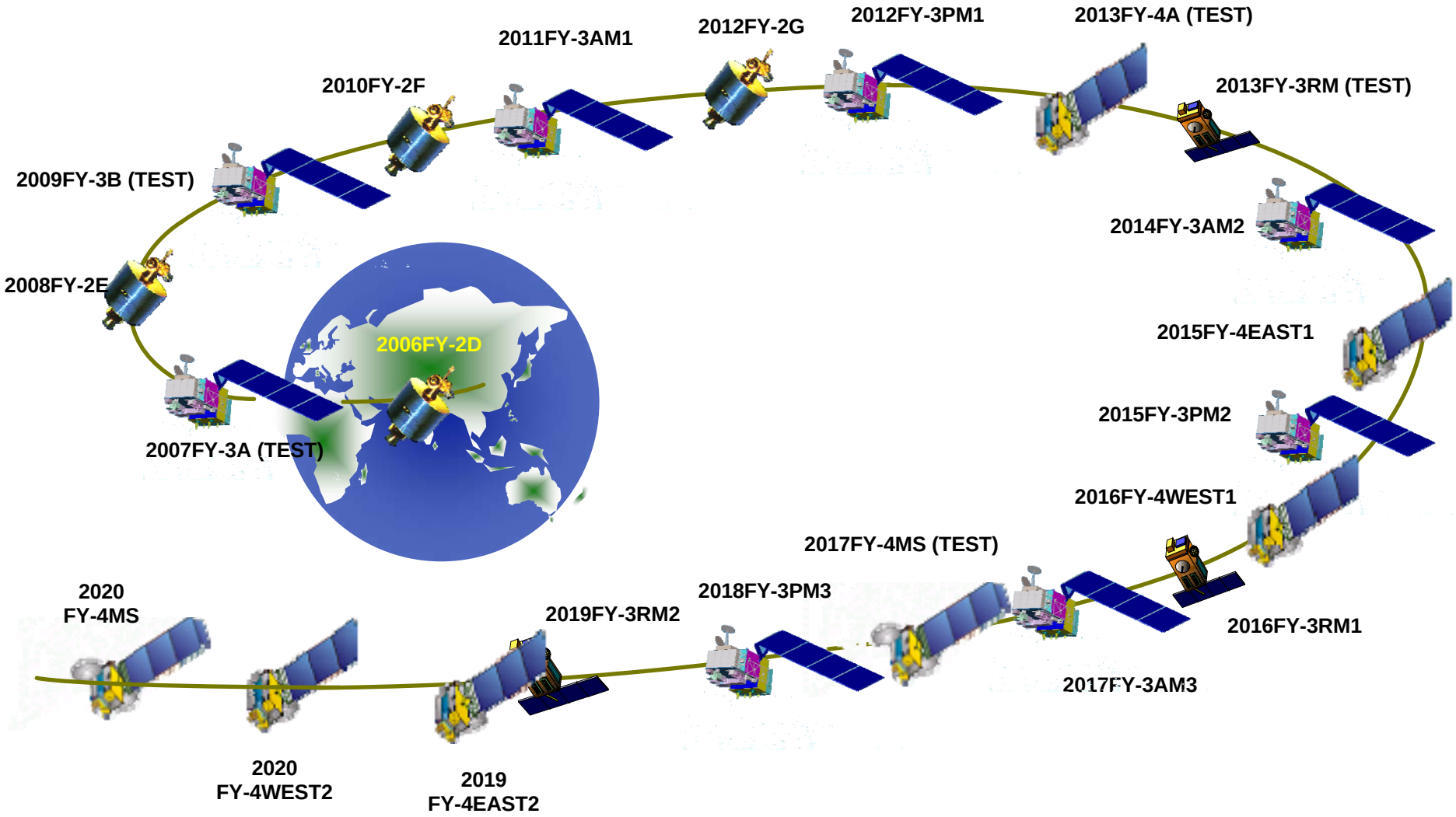
•**CCD –** Broadband visible at 500x500 km area with spatial resolution between 50 and 100 meters rapid refresh. Can extend dwell time for nighttime disaster monitoring (lights).



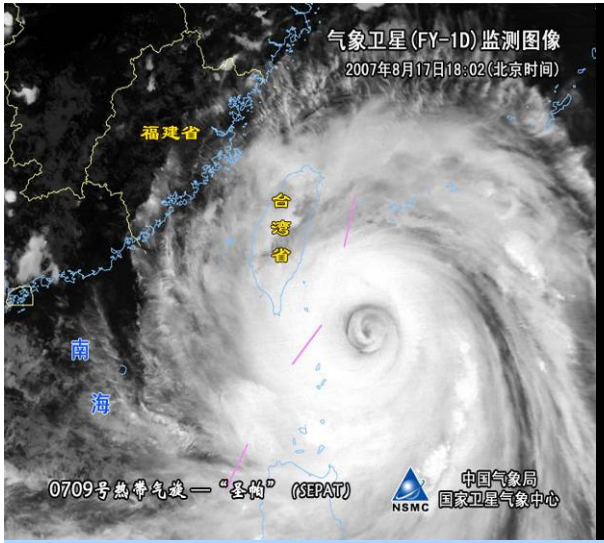
LaPlata Tornado Damage EO-1

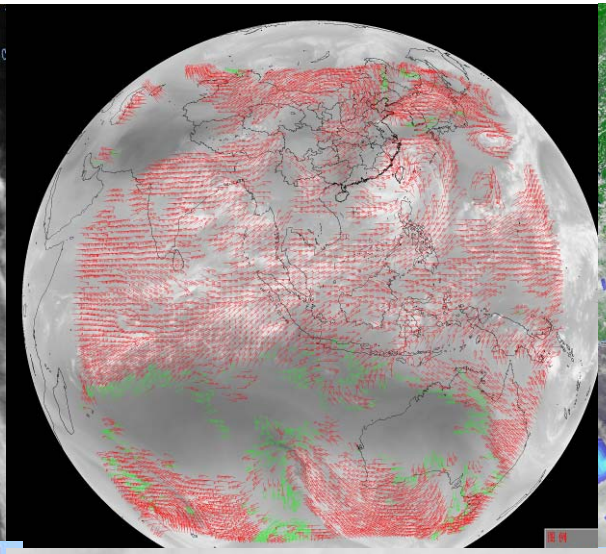
30 m original **Degraded to 60 m** **Degraded to 120 m**

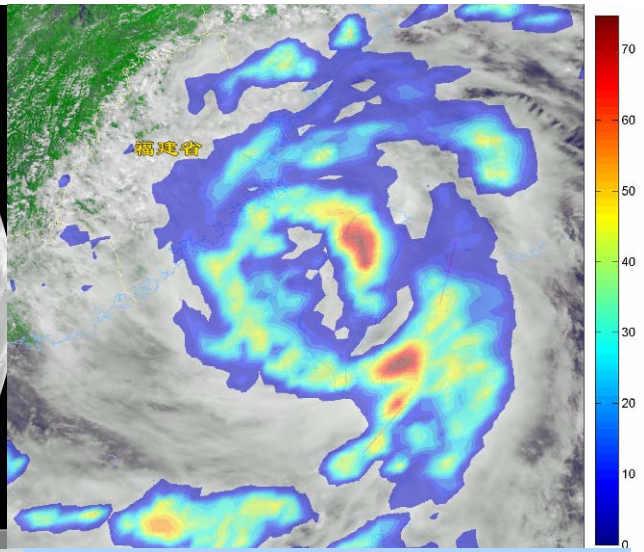
China Long-term Plan for meteorological satellite

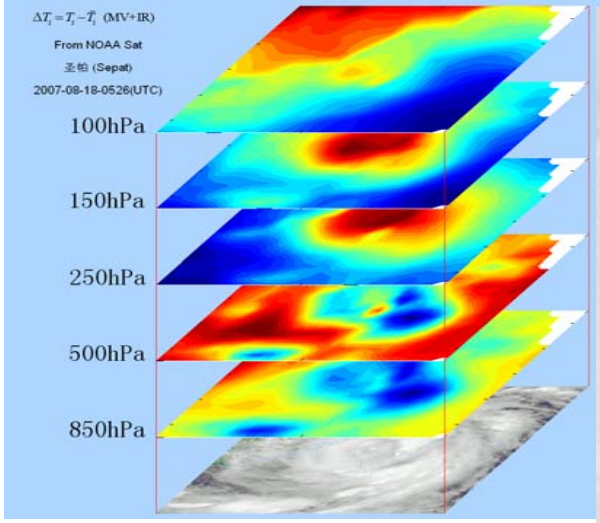


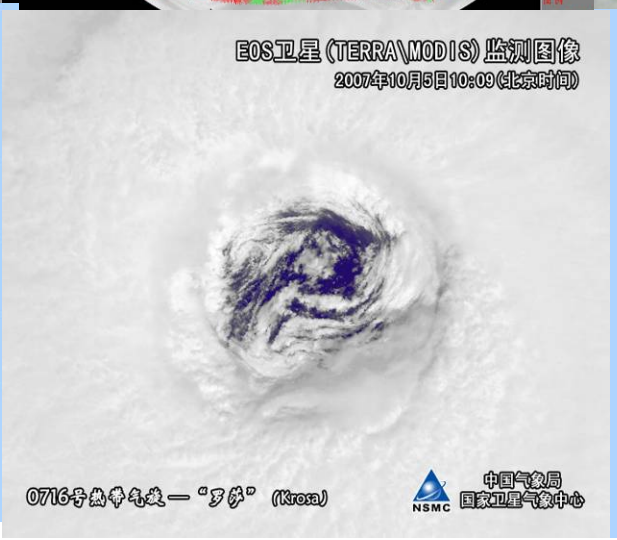
Various products developed for Typhoon monitoring

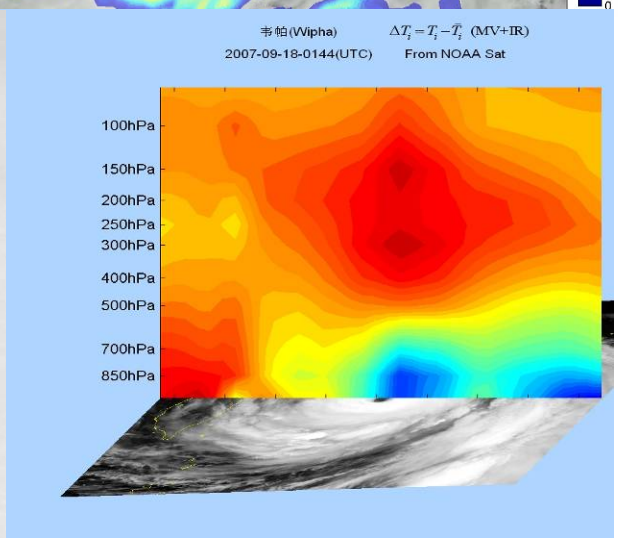




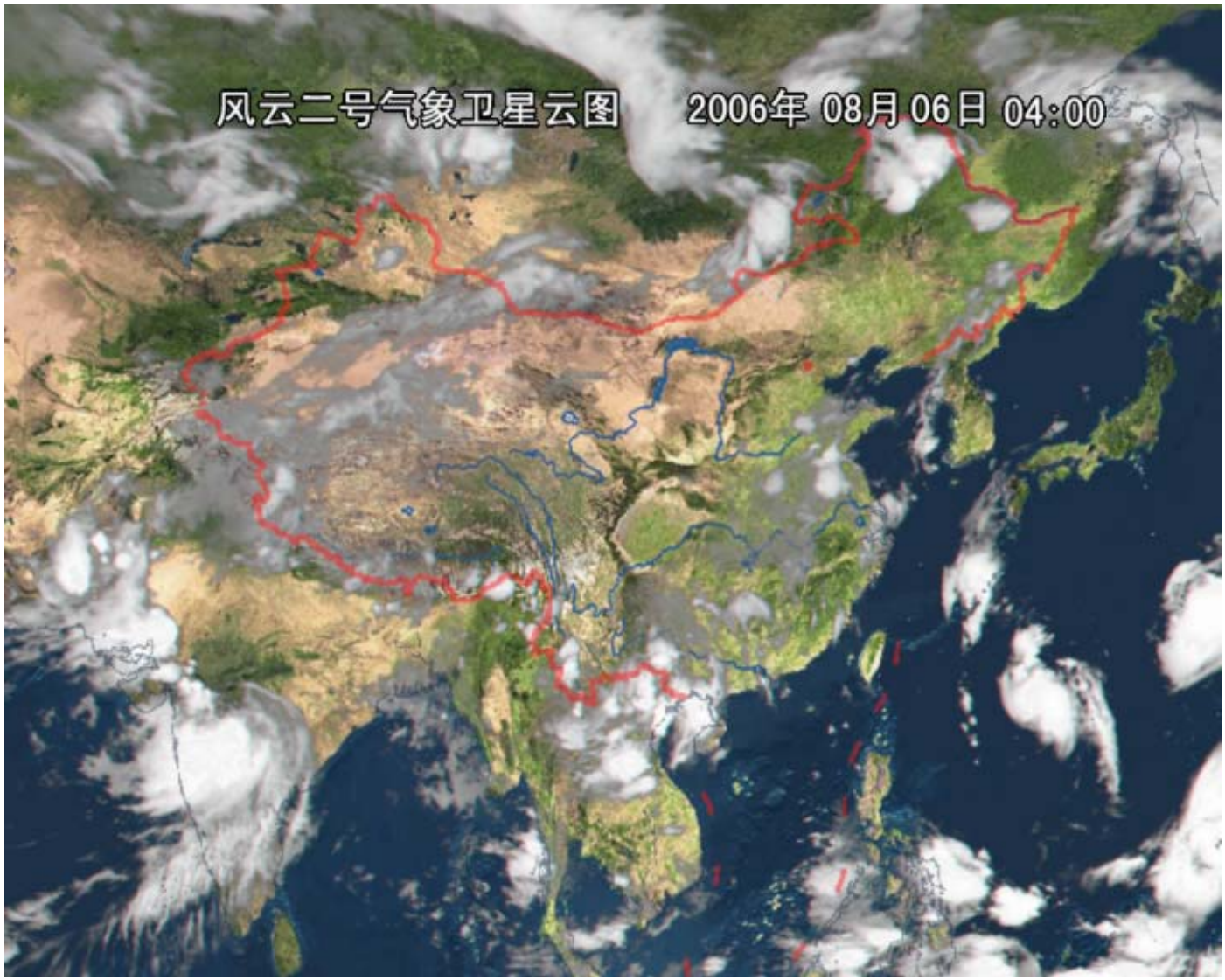


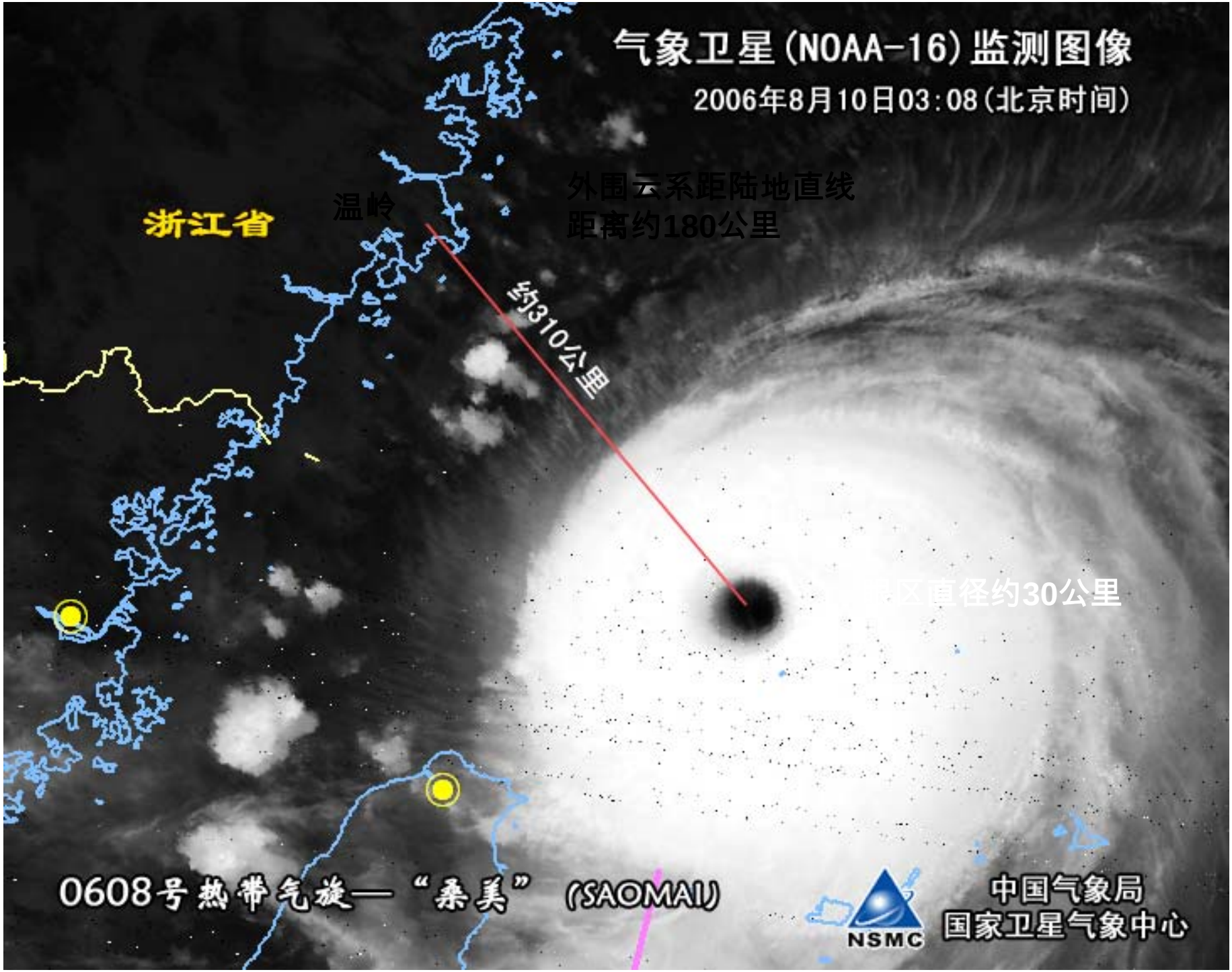


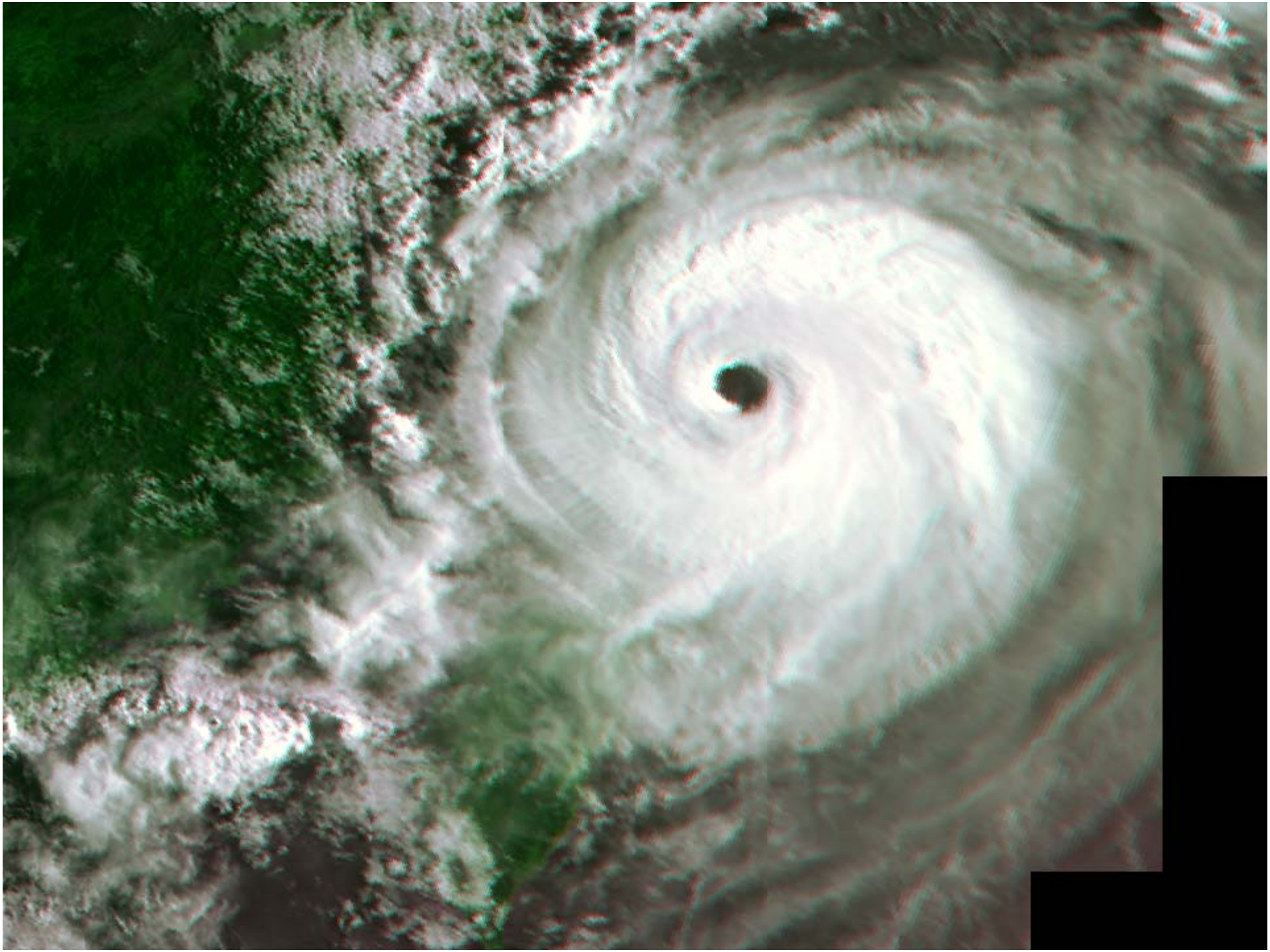


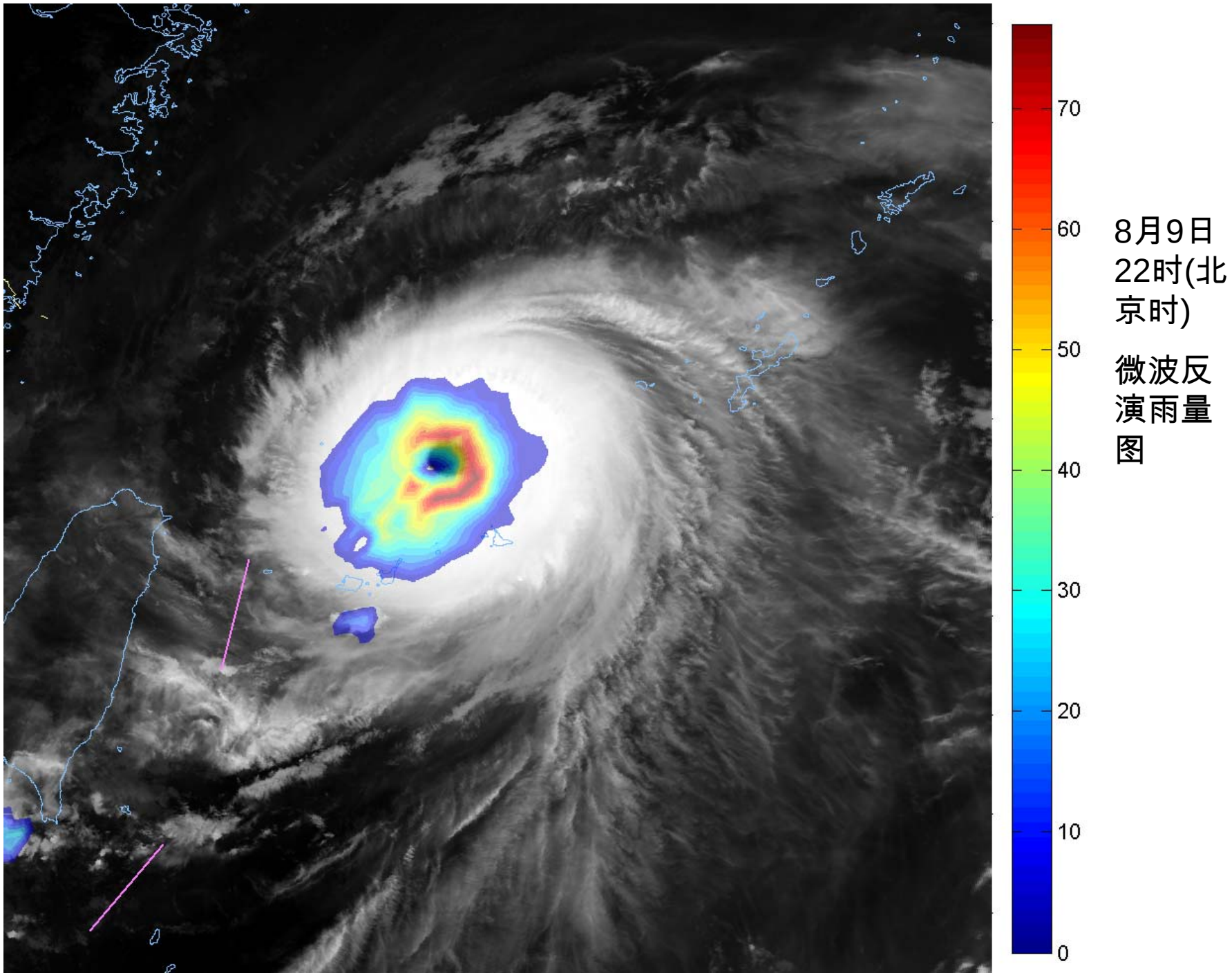


The Typhoon Saomi reached >60m/s Max wind speed



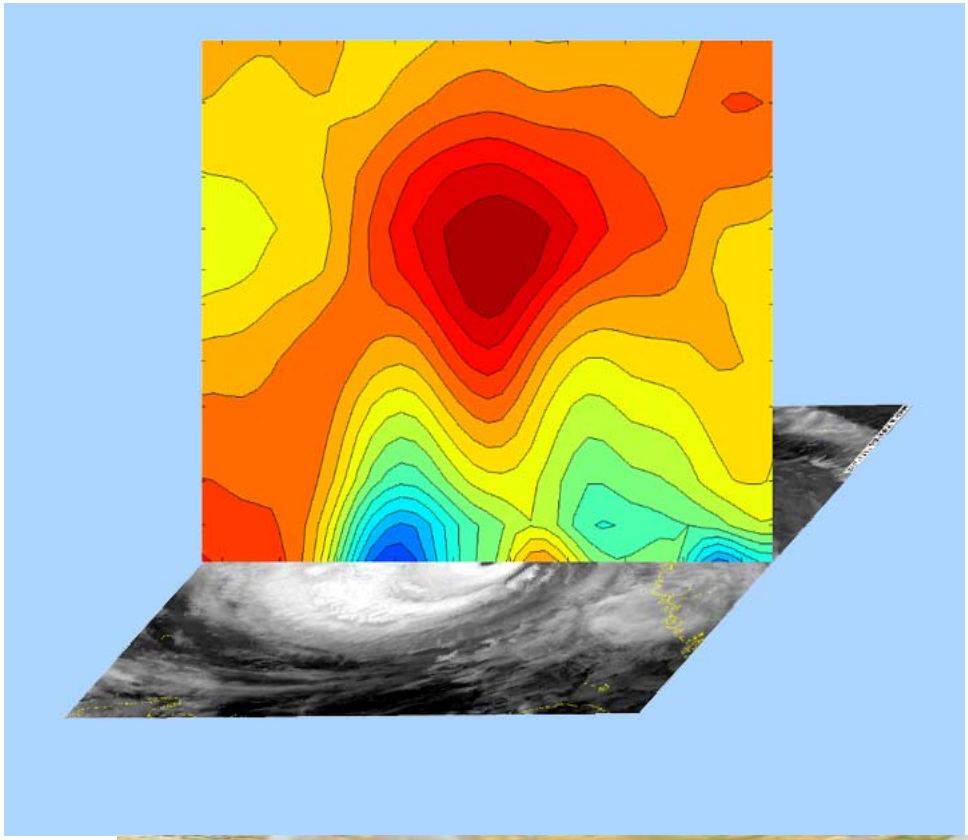

气象卫星(NOAA-16)监测图像
2006年8月10日03:08(北京时间)
浙江省
温岭
外围云系距陆地直线
距离约180公里
约310公里
眼区直径约30公里
0608号热带气旋—“桑美”(SAOMAI)
NSMC
中国气象局
国家卫星气象中心

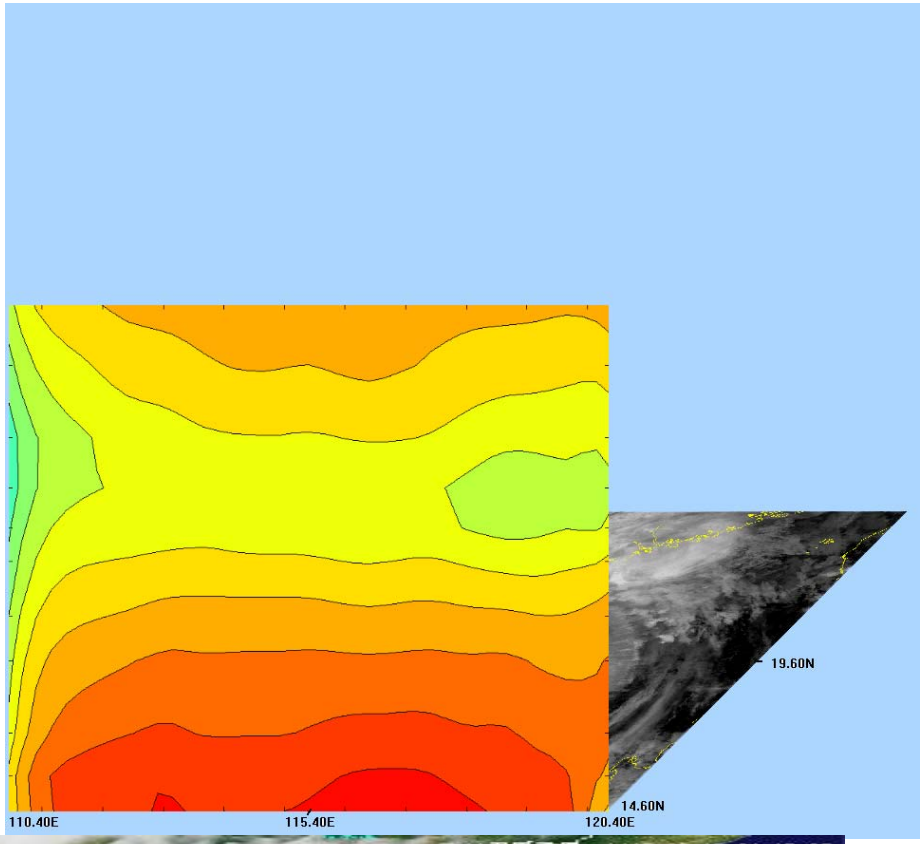


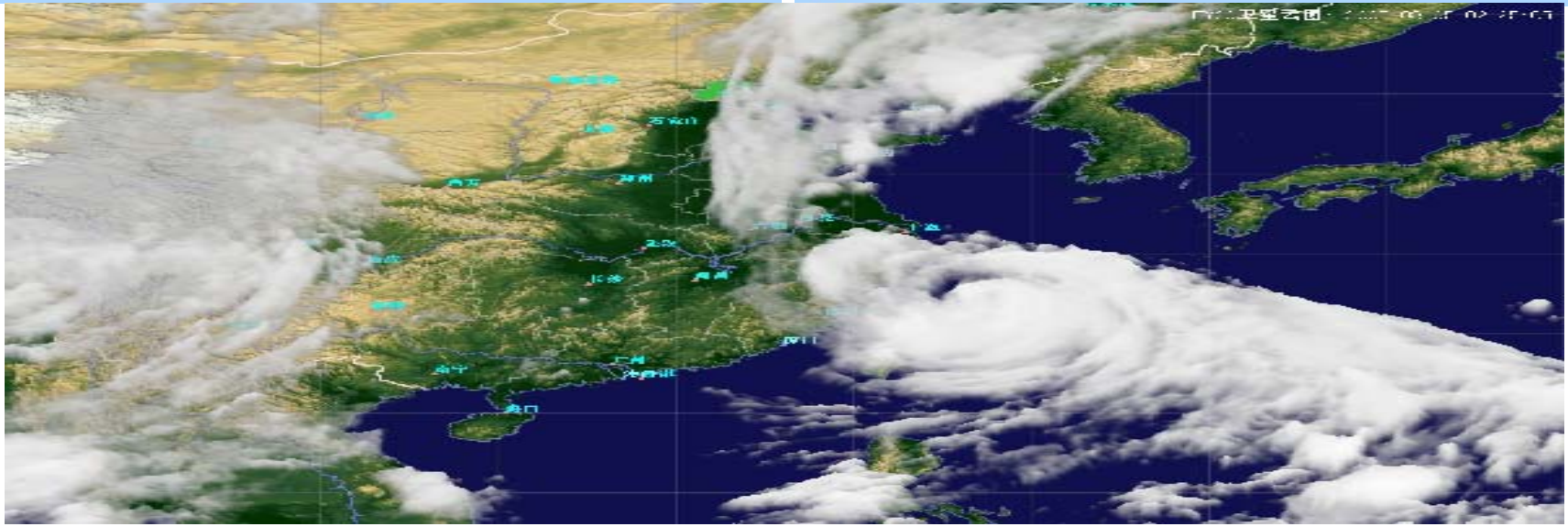


8月9日22时(北京时)

微波反演雨量图




19.60N
14.60N
110.40E
115.40E
120.40E



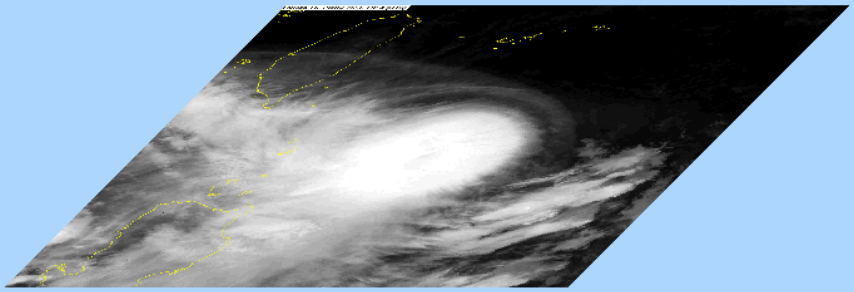
100hPa

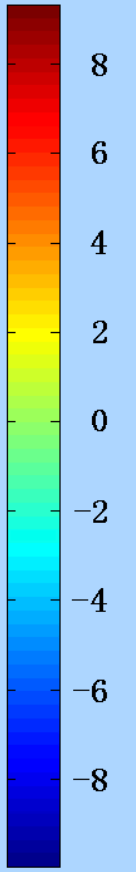
150hPa

250hPa

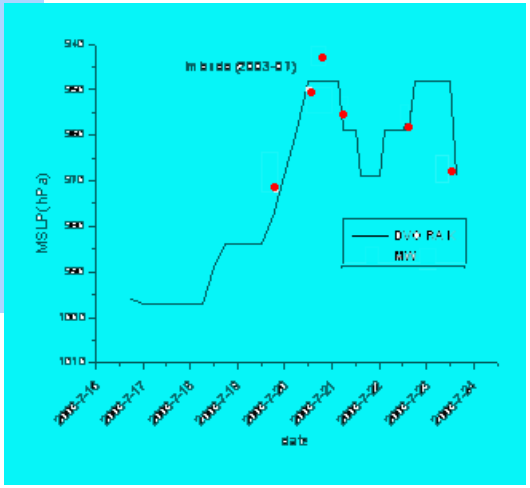
500hPa

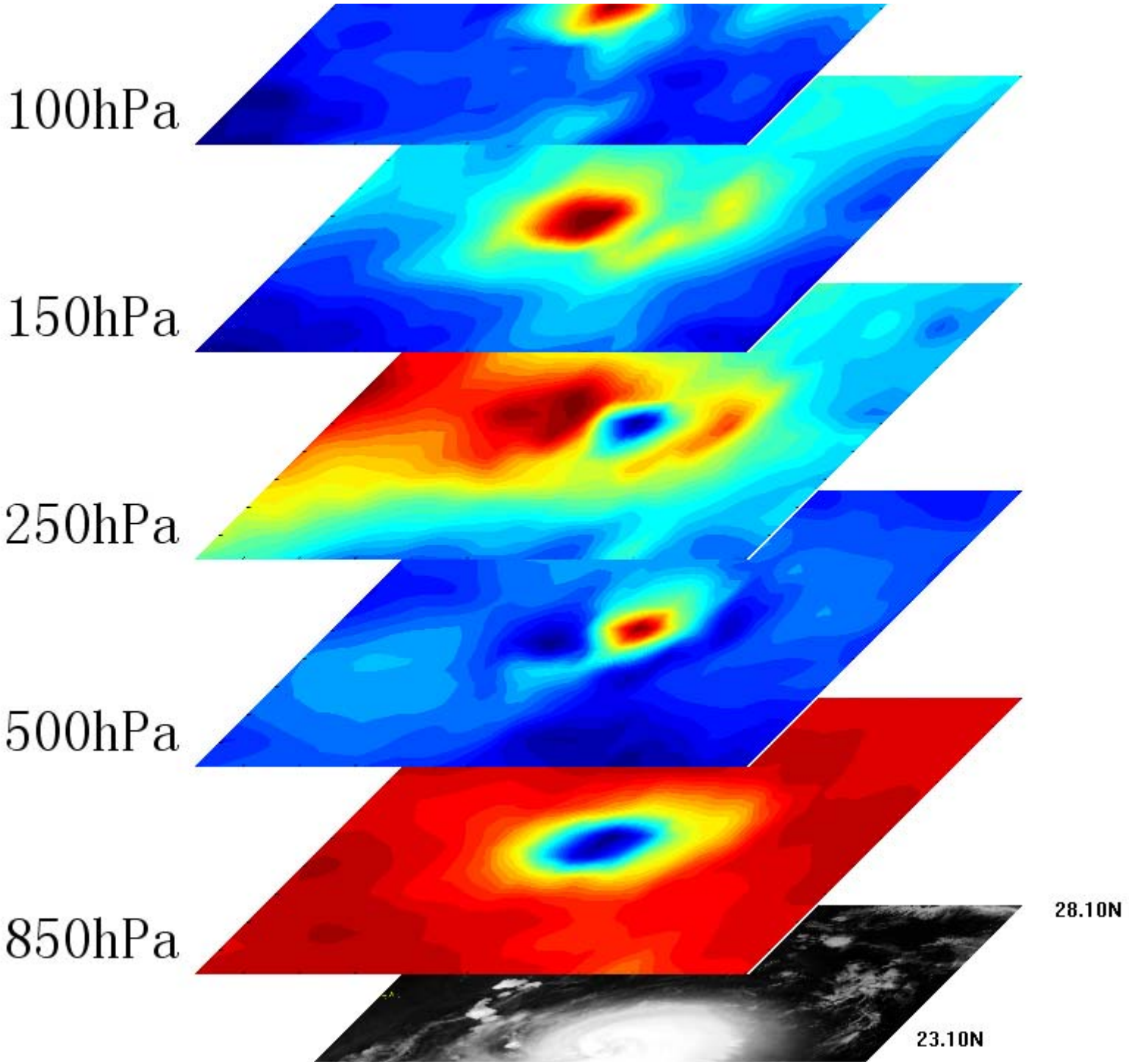
850hPa





单位:摄氏度

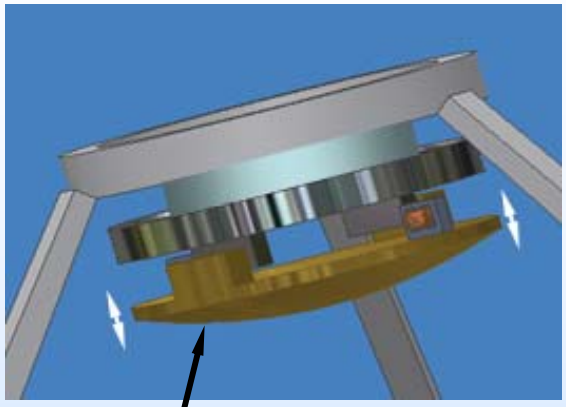



100hPa
150hPa
250hPa
500hPa
850hPa
28.10N
23.10N

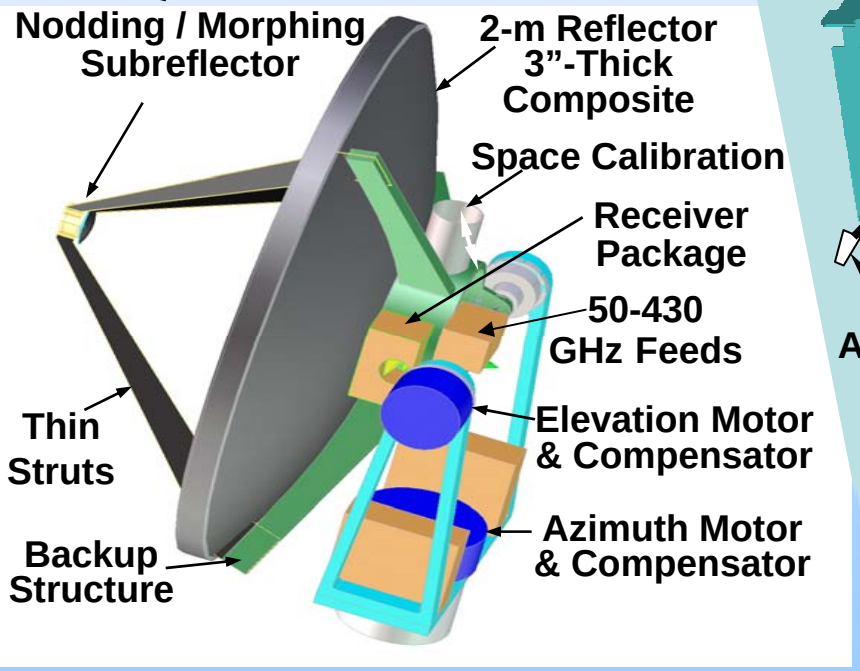
The future !!

GEO-Microwave

GeoMicrowave System Concepts

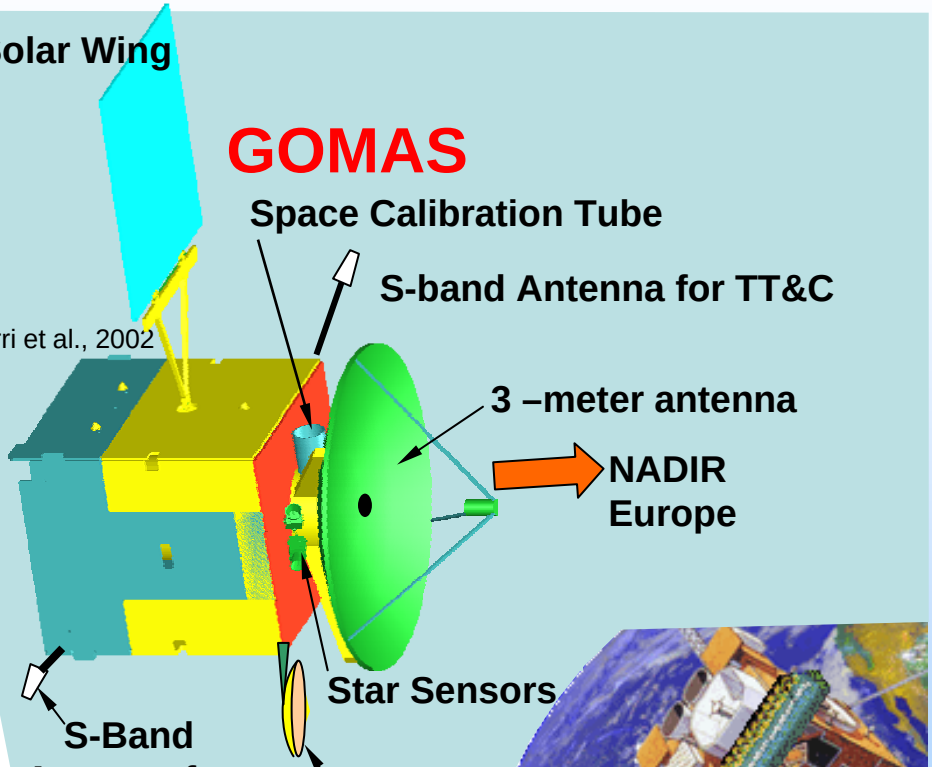


GEM

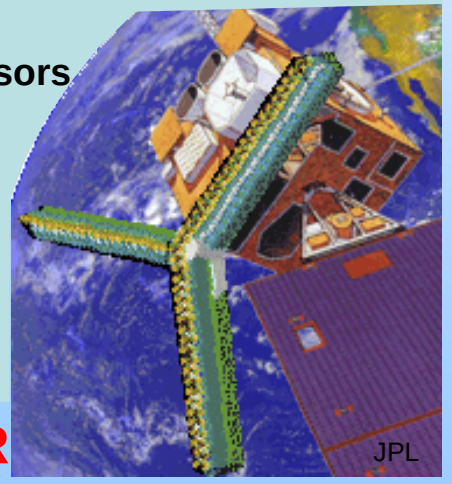


GOMAS

Bizzarri et al., 2002

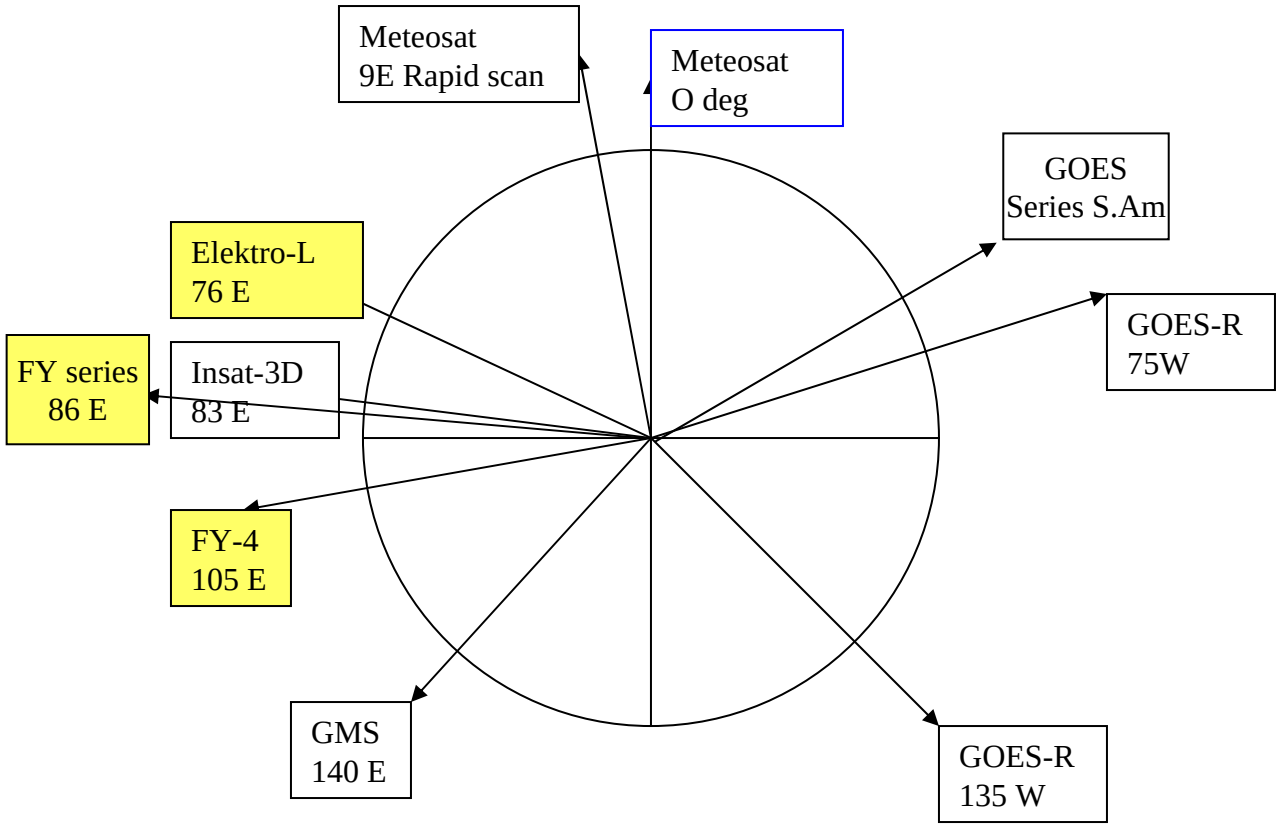


GeoSTAR



Sector	Future GEO satellites	Operator	Planned location	Planned launch	Other remarks
East Pacific (180°W-108°W) and West Atlantic (108°W-36°W)	GOES-O	USA/NOAA	135°W or 75°W	06/2008 (readiness)	-
	GOES-P	USA/NOAA	135°W or 75°W	2009	-
	GOES-R	USA/NOAA	135°W or 75°W	2014	ABI, GLM, SUV, EXIS, SEISS (Advanced Baseline Imager,Geostationary Lightning Mapper, Solar UV Imager, Extreme UV and X-ray Irradiance Sensors, Space Environment In-Situ Suite)
	MSG-3	EUMETSAT	0°	2011	-
	MSG-4	EUMETSAT	0°	2012	-
Indian Ocean (36°E-108°E)	Electro-L N1	Russia	76°E	End 2008	MSU-GS, HMS, DCS, GeoSAR
	Electro-L N2	Russia	76°E or 14.5°E (TBC)	2010	-
	Electro-L N3	Russia	76°E or 14.5°E (TBC)	2015	-
	INSAT-3D	India	TBD	mid-2008	Improved 6-channel Imager and 19-channel sounder
	FY-2F	China/CMA	86.5°E	2011	5-channel VISSR, LRIT
West Pacific (108°E-180°E)	FY-2E	China/CMA	123°E	2009	5-channel VISSR, LRIT
	FY-2G	China/CMA	123°E	2013	5-channel VISSR, LRIT
	COMS	Korea/KMA	128.2°E	mid-2009	5-channel HRIT/LRIT
	MTSAT follow-on	JAPAN	140°E	2015	-

Geostationary constellation and selected low earth orbiting satellites whose data are anticipated in 2010-15



METOP AM

NPOESS early AM & PM

FY- 3 AM/PM

METEOR-3M-N2 ?

NPP (PM)

ADM AM

GPM

GPS

DMSP

GOCE

SMOS AM

GCOM PM

CRYOSAT

RESURS

IRS

ALOS

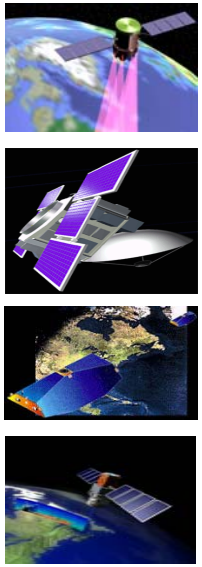
GoSAT

Russian Federation Missions to future GOS

Current Era	Near Focus	Advanced Concepts

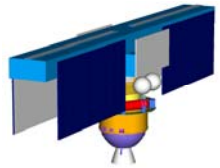
METEOR
OKEON

- RESURS

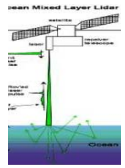


RESURS

ELECTRO-L



- Hyperspectral IR
- Synthetic Aperture Radar
- New Initiatives



Operational Missions

Research Missions

GOMS No. 2/Electro-L

- The satellite is planned to be launched in 2010 and will be placed into a geostationary orbit at 76°E.
- A second GOMS satellite is foreseen for 2012.
- The spacecraft will be three-axis stabilised
  - MSU-GS, a multi-zonal scanner with parameters close to those of the SEVIRI
  - Standard DCS equipment.
  - Relay data between weather centres
  - Receive and retransmit signals from Search and Rescue beacons of the COSPAS/SARSAT system.
  - Seven helio-geophysical sensors.

Molniya Orbit Possibility

- SRC Planeta and Lavochkin Association have developed proposals for the creation of future space systems for hydrometeorological monitoring of the Arctic region. The objectives of the Arctic system are similar to those of existing geostationary meteorological satellite systems, where the primary purpose is to provide information for the analysis and the forecast of weather in regional (Arctic regions) and on a global scale. Suggested design of the spacecraft Arctic-L offers capacity for mass and power supply to accommodate additional payloads, hence providing opportunities for international cooperation activities.

WORLD METEOROLOGICAL ORGANIZATION

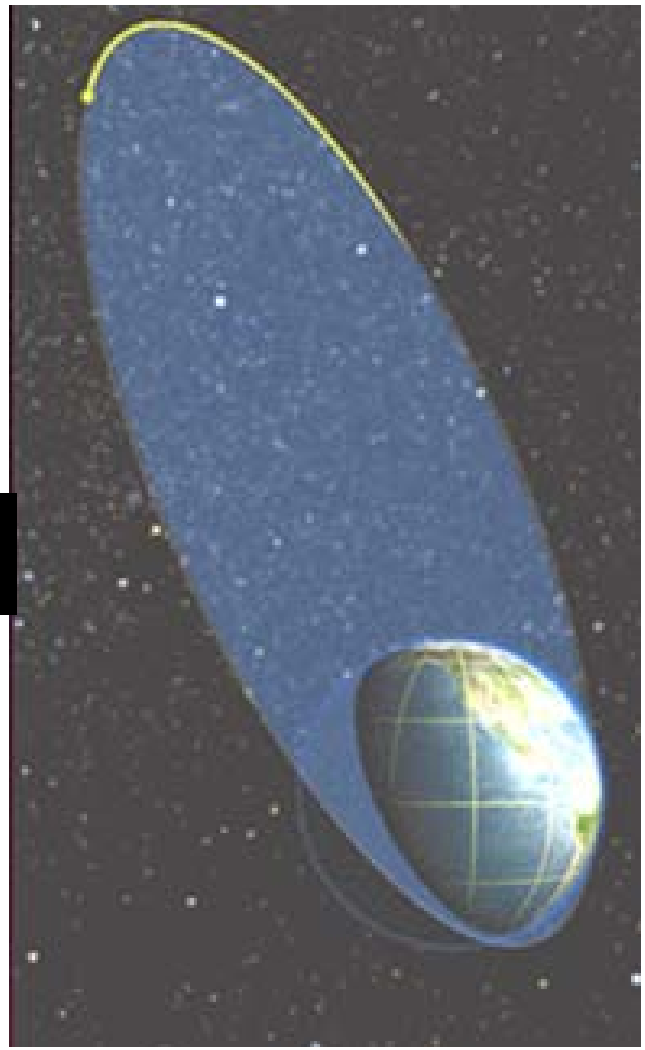
CONSULTATIVE MEETINGS ON HIGH-LEVEL POLICY
ON SATELLITE MATTERS

IGEOLAB FOR HIGHLY ELLIPTICAL ORBIT FOCUS GROUP

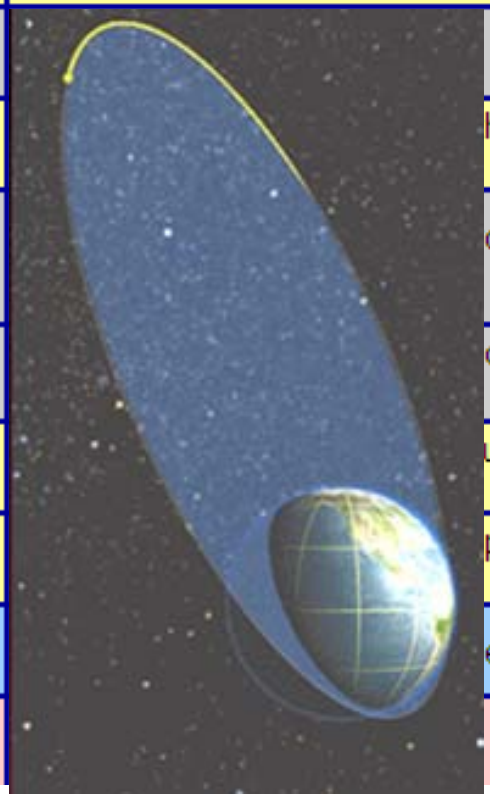
SECOND SESSION

GENEVA, 9-10 OCTOBER 2007

Molniya Orbit

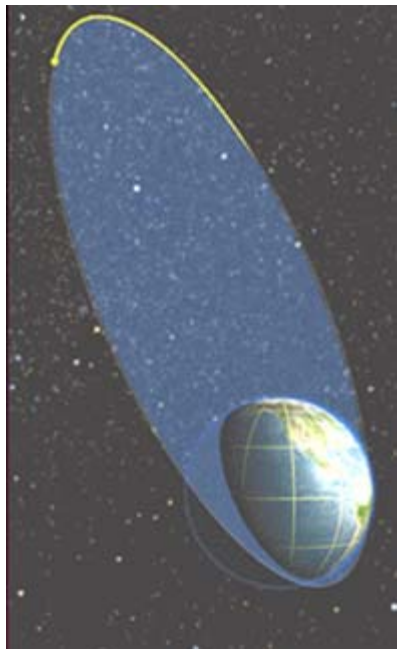


Date	Place	Host	Subject
15-16 January	New Orleans	WMO	Consultative Meetings on High-level Policy on Satellite Matters(CM-8)
21-24 January	New Orleans	AMS-NOAA	88th AMS and 5th GOES User Conference
19-21 February	Camp Springs	NOAA-WMO	Joint GRWG-3 and GDWG-2 (GSICS)
26-27 February	Geneva	WMO-CGMS	Task Force on Satellite Data Codes
Q1 (TBD)	Darmstadt	EUMETSAT-WMO-CGMS	R/SSC-CM Planning Meeting
March (TBD)	Canada	CSA - WMO	IGeoLab Highly Elliptical Orbits FG-3
21-25 April	Geneva	GCOS	
22 April (TBC)	Geneva	WMO-CGMS	h session)
5-6 May	Frascati	ESA/ESRIN, WMO	d session)
7-13 May	Angra dos Reis (Brazil)	ITWG	cientific
20-21 May(TBC)	Geneva	WMO	up (2nd)
21-22 May(TBC)	Geneva	WMO	p (2nd)
18-27 June	Geneva	WMO	ession)
August (TBC)	Brazil (TBC)	INPE, WMO	



Molniya Orbit Characteristics

- Highly Elliptical Orbit
  - apogee ~ 39,750 km, perigee ~ 600 km
  - Inclination ~ 60 deg, orbital period ~ 12 hrs
  - Good viewing about 8 hrs/orbit
  - Satellite moves low and fast over the southern hemisphere then slows as it moves across apogee in the northern hemisphere allowing for about 8 hours of good viewing per orbit



4:00 PM-5:30 PM, Wednesday, R02-R03

Session 4 Geostationary Satellites as a part of GEOSS

Cochairs: Eric Madsen, NESDIS, Silver Spring, MD; Jim Purdom, CIRA, Fort Collins, CO

4:00 PM	4.1	EUMETSAT's Geostationary Satellites as a part of GEOSS **Johannes Schmetz**, EUMETSAT, Darmstadt, Germany
4:15 PM	4.2A	Korea **Ae-Sook Suh**, Korea Meteorological Administration, Seoul, South Korea
4:30 PM	4.3	Plans for Japan's Satellite Program **Toru Hashimoto**, MSC/JMA, Tokyo, Japan
4:45 PM	4.4	Indian Meteorological Satellite Missions : Current and Planned **P.C. Joshi**, Indian Space Research Organisation, Ahmedabad, India
5:00 PM	4.5	China (Invited Speaker) **To be Determined**, TBD, N/a, TBD
5:15 PM		Russia (Invited Speaker)