

Chinese Meteorological Satellite and Calibration Activities



中国气象局中国遥感卫星辐射测量和定标重点开放实验室
Key Laboratory of Radiometric Calibration and Validation for Environmental Satellites, China Meteorological Administration

国家卫星气象中心卫星气象研究所
Institute of Satellite Meteorology, National Satellite Meteorological Center

Peng Zhang

E-mail : zhangp@nsmc.cma.gov.cn

Fax : 86-10-68409671

Topics

- 1. Short Introduction for National Satellite Meteorological Center (NSMC)**
- 2. Current Status of the Chinese Meteorological Satellite**
- 3. Data Services for the Chinese Meteorological Satellite**
- 4. Products Application for the Chinese Meteorological Satellite**
- 5. Earth-based reference sites in China for the Calibration**
- 6. Future Plan for the Chinese Meteorological Missions**

1. Short Introduction for NSMC

- To draft strategy and schedule for the future development of the Chinese meteorological satellites
- To construct the ground segment for Chinese meteorological satellites
- To maintain the on-orbit Chinese meteorological satellite in the operational way
- To fulfill the data archive, distribution and service for Chinese meteorological satellite
- To promote the scientific on the meteorological satellite and satellite meteorology
- To promote the satellite data application on the weather forecasting, climate change and weather disaster prevention
- To monitor and forecast space weather (New)

2. Current Status of the Chinese Meteorological Satellite



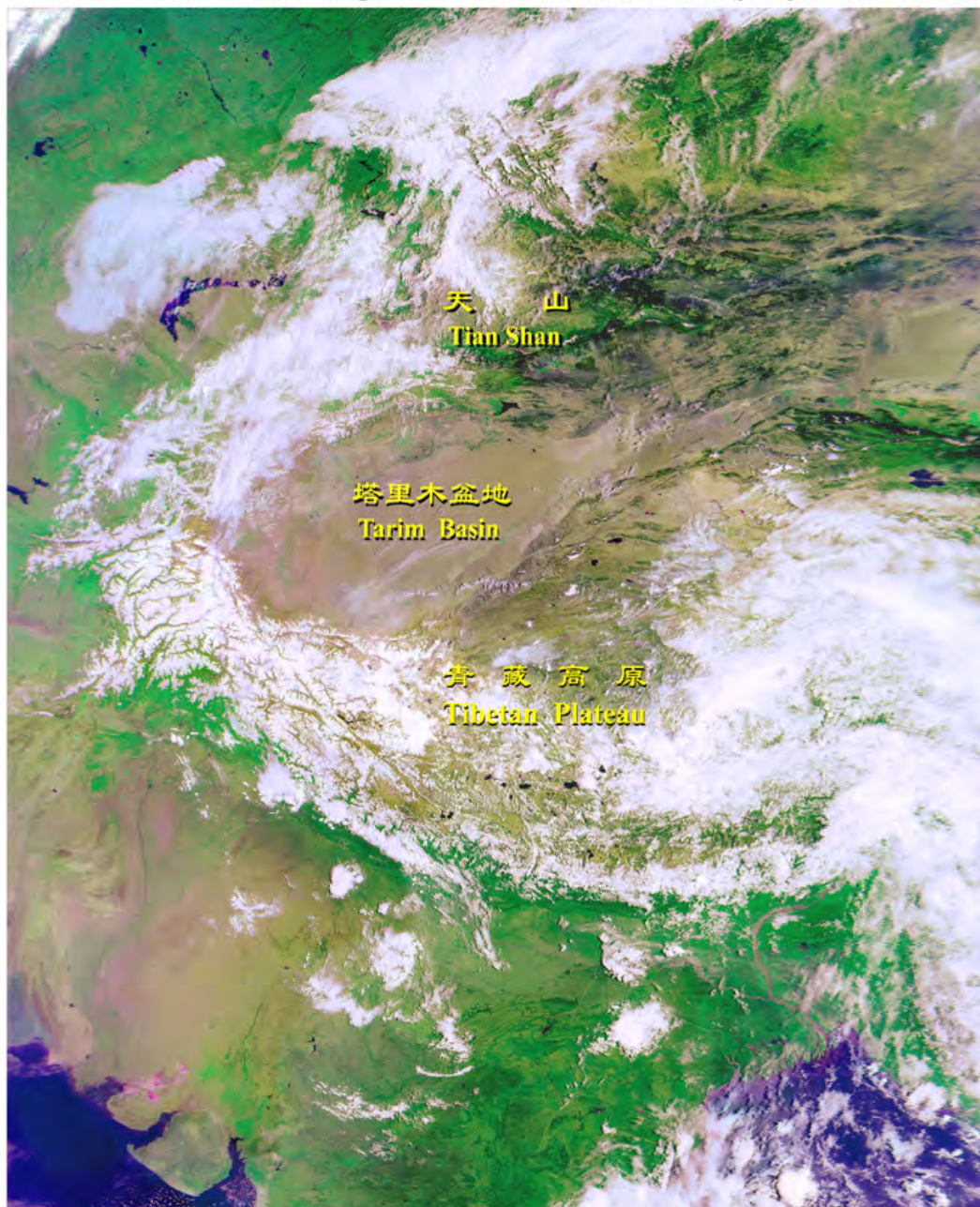
Since Jan. 1969, China began to develop his own meteorological Satellite

Leo	Launch Data		Geo	Launch Data
FY-1A	Sept. 7, 1988		FY-2A	Jun. 10, 1997
FY-1B	Sept. 3, 1990		FY-2B	Jun. 25, 2000
FY-1C	May 10, 1999		FY-2C	Oct. 18, 2004
FY-1D	May 15, 2002		FY-2D	Dec. 8, 2006

《风云一号》C星第一幅展宽云图

The First Stretched Cloud Image of FY-1C

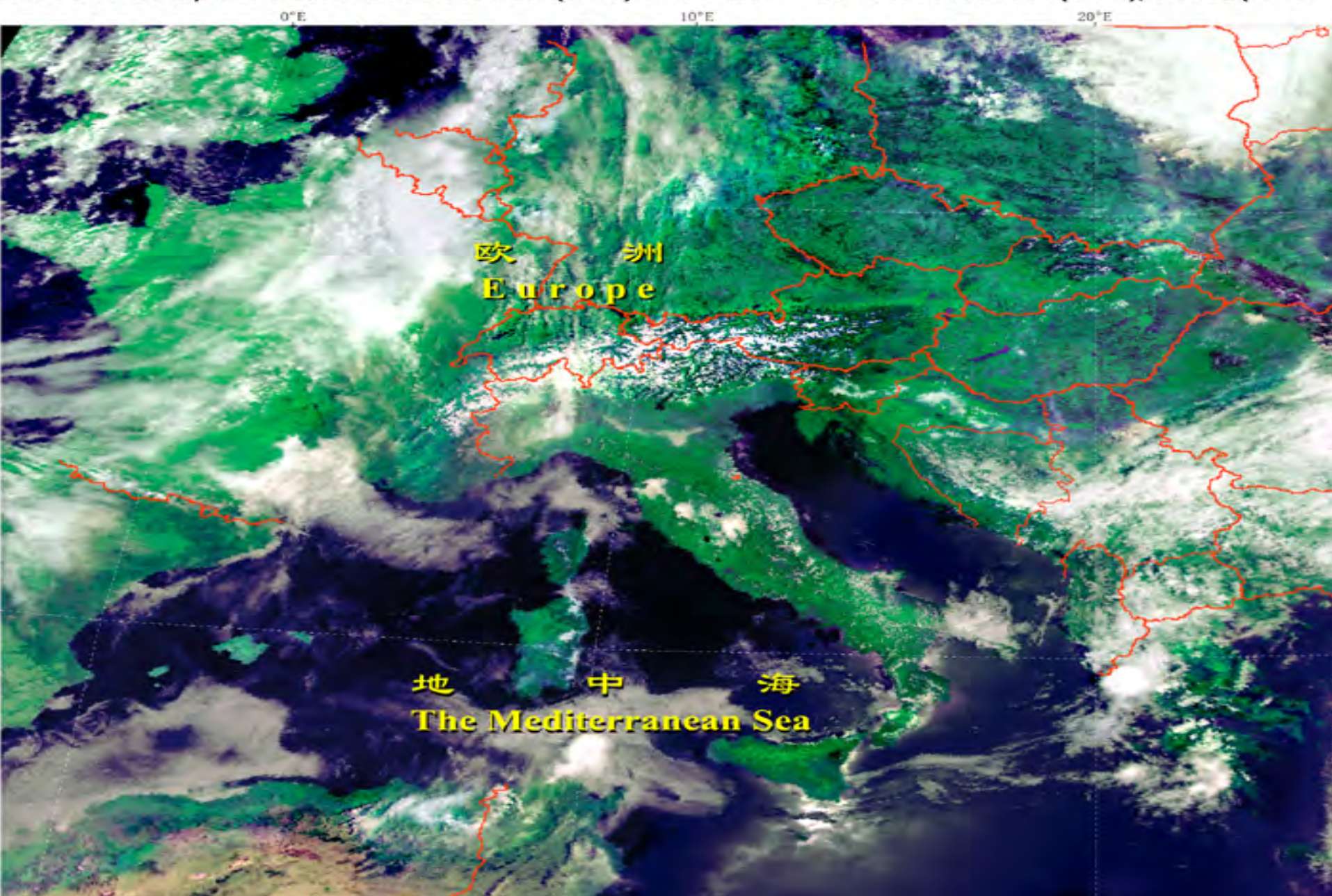
1999.5.10. 03:17(UTC) / 11:17 (北京时)





《风云一号》C星首次获取的延时云图

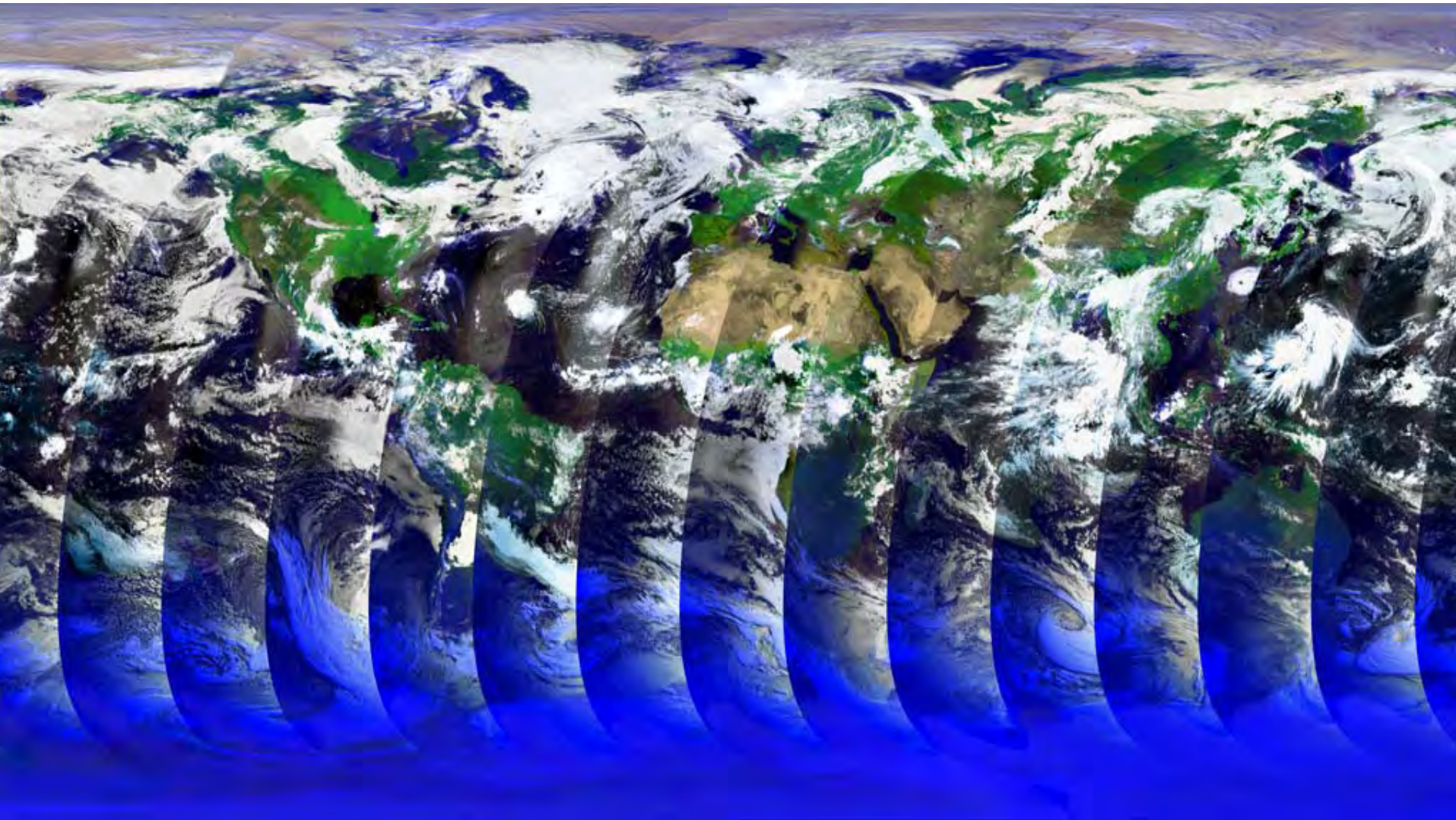
The First Delayed Picture Transmission (DPT) of FY-1C 1999.5.10.06:41(UTC)/14:41(北京时间)



**Composite
Imagery of
Antarctic
region by
FY-1C GDPT
Channel 1,2,3.**



Global Multi-Orbit Mosaic Image



风云二号 B 星第一幅可见光图像

FIRST VIS IMAGE OF FY-2B



2000 年 7 月 6 日 13:08-13:33 (北京时间)

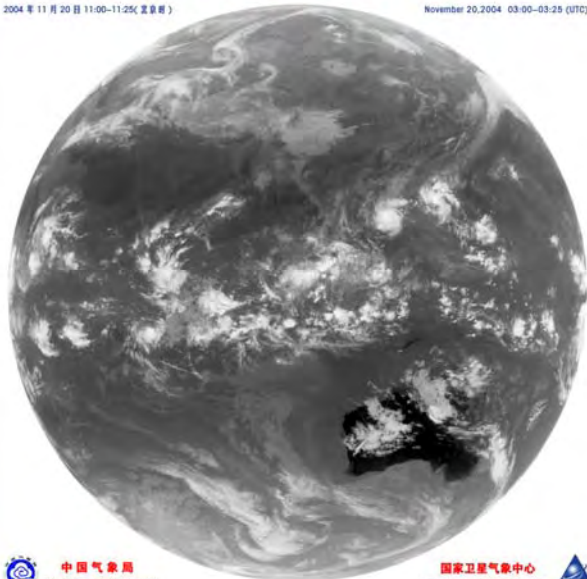
July 6, 2000 5:08-5:33 (UTC)



FY-2C 长波红外图像 (10.3-11.3 μm)

2004 年 11 月 20 日 11:00-11:25(北京时间)

November 20, 2004 03:00-03:25 (UTC)



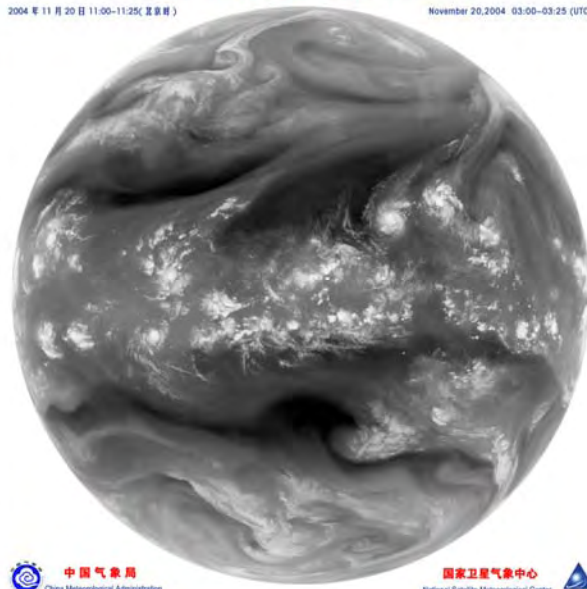
中国气象局
China Meteorological Administration

国家卫星气象中心
National Satellite Meteorological Center NSMC

FY-2C 水汽图像 (6.3-7.6 μm)

2004 年 11 月 20 日 11:00-11:25(北京时间)

November 20, 2004 03:00-03:25 (UTC)



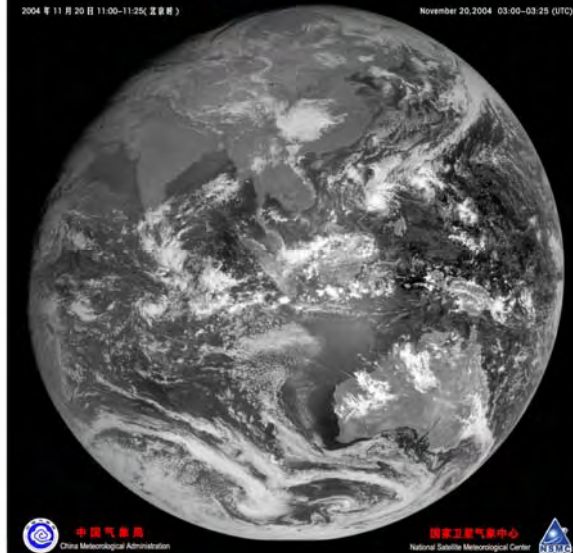
中国气象局
China Meteorological Administration

国家卫星气象中心
National Satellite Meteorological Center NSMC

FY-2C 可见光图像 (0.55-0.9 μm)

2004 年 11 月 20 日 11:00-11:25(北京时间)

November 20, 2004 03:00-03:25 (UTC)



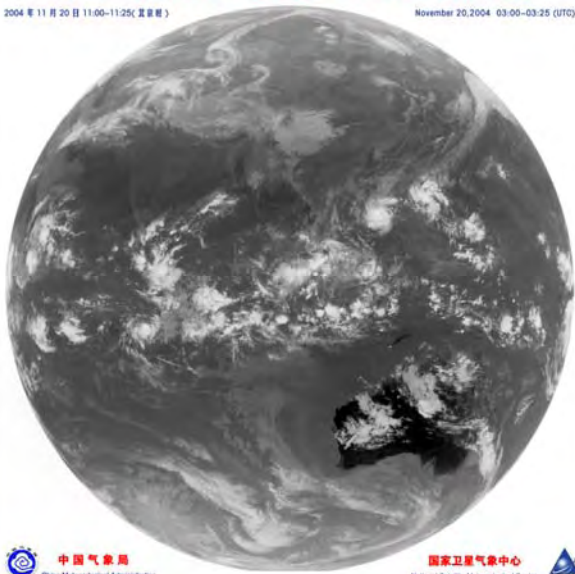
中国气象局
China Meteorological Administration

国家卫星气象中心
National Satellite Meteorological Center NSMC

FY-2C 长波红外分裂窗图像 (11.5-12.5 μm)

2004 年 11 月 20 日 11:00-11:25(北京时间)

November 20, 2004 03:00-03:25 (UTC)



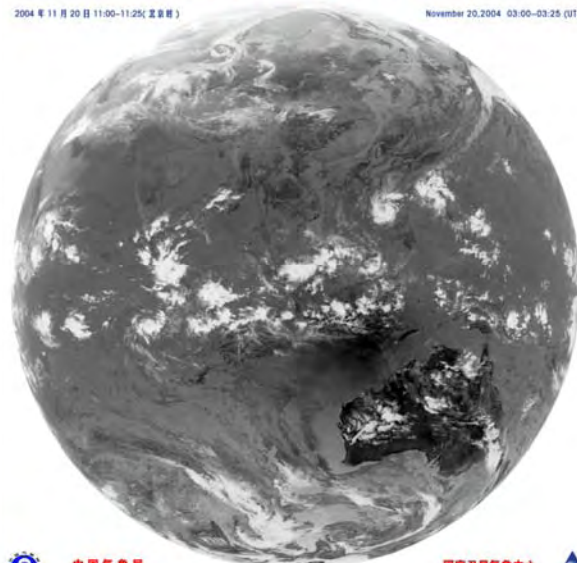
中国气象局
China Meteorological Administration

国家卫星气象中心
National Satellite Meteorological Center NSMC

FY-2C 中波红外图像 (3.5-4.0 μm)

2004 年 11 月 20 日 11:00-11:25(北京时间)

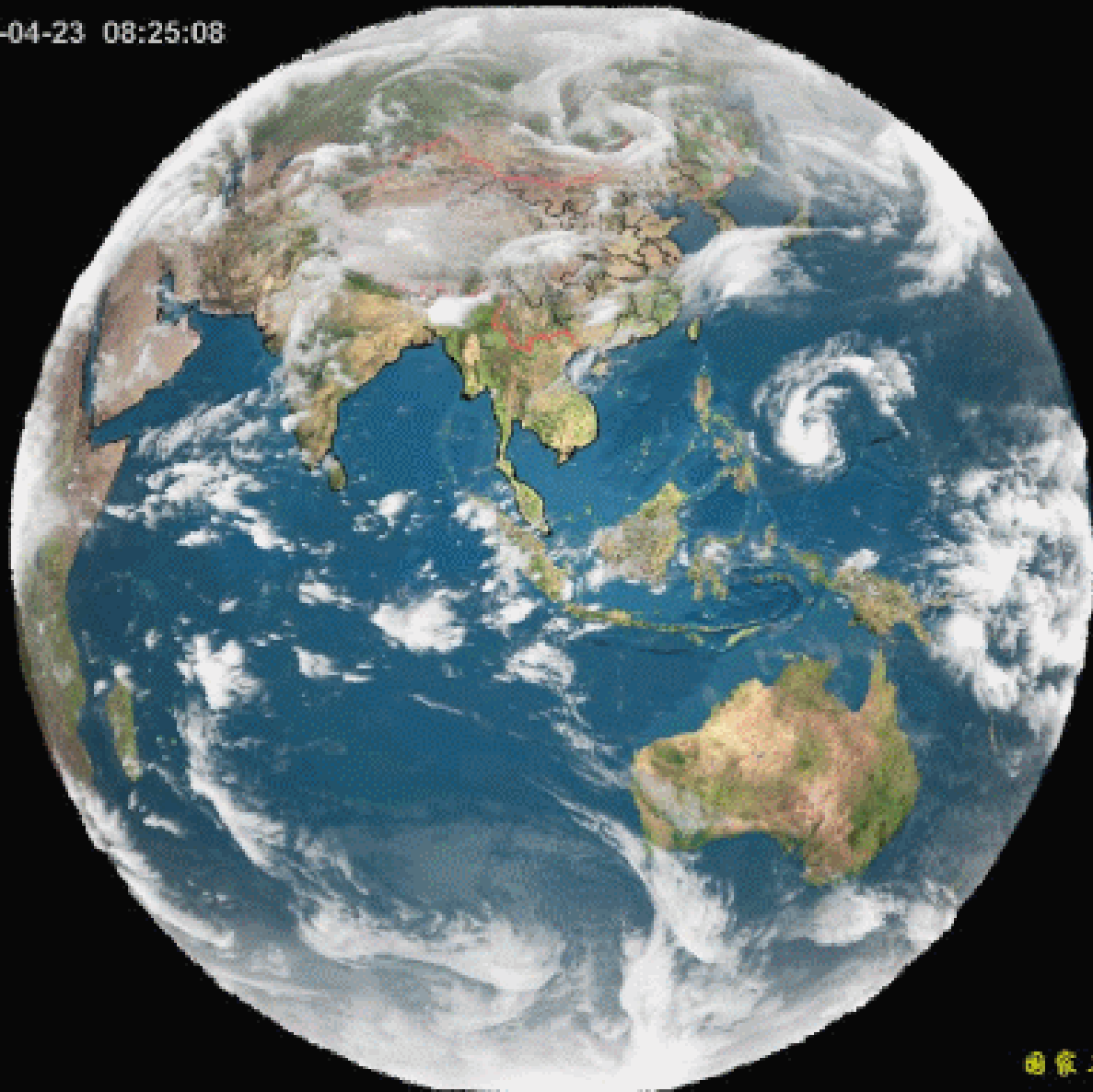
November 20, 2004 03:00-03:25 (UTC)



中国气象局
China Meteorological Administration

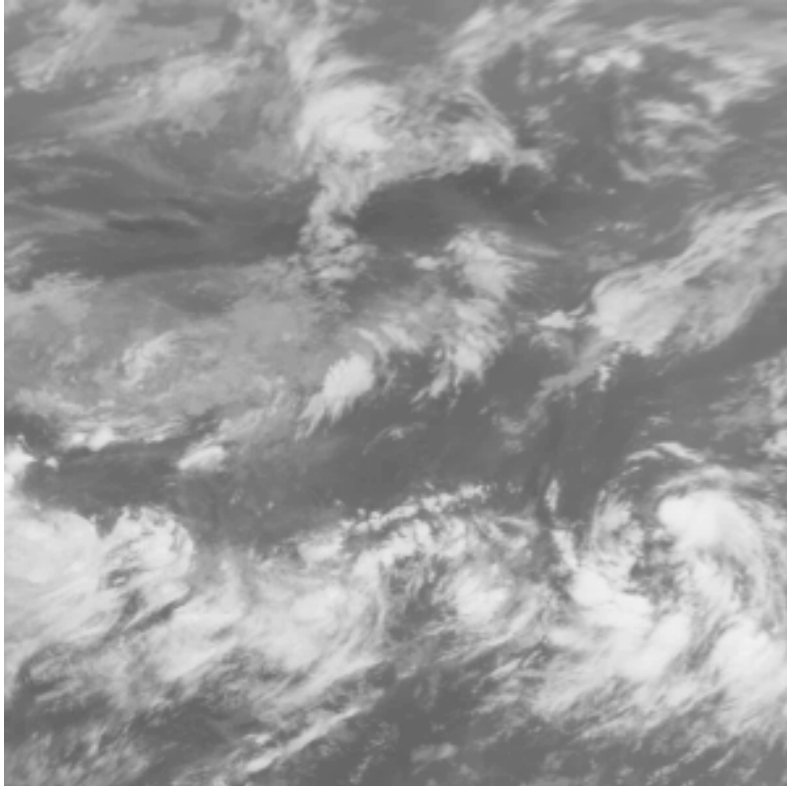
国家卫星气象中心
National Satellite Meteorological Center NSMC

FY2C 2005-04-23 08:25:08

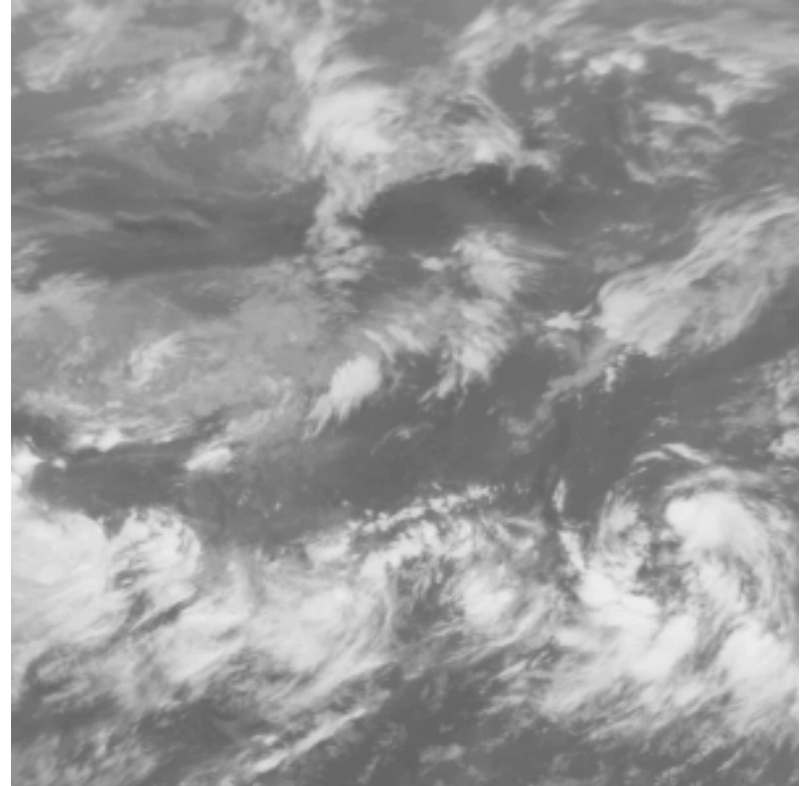


国家卫星气象中心

FY2C/D Animation



Before Processing



After Processing

Twist been processed
30 minutes to 15 minutes

3. Data Services for the Chinese Meteorological Satellite



Ground Segment for the Data acquisition



Data archive: History data over 20 years

Satellite	Data Format	Content/ Orbit	Period	Media	Total Content
FY-1C/1D	CHRPT	200MB	99.05-now	Tape	8 TB
	GDPT	300MB	99.05-now	Tape	10 TB
EOS-AM/PM	MODIS	1GB	00.12-now	CD	60 TB
NOAA (7-18)	HRPT	120MB	84.05-now	Tape	20 TB
GMS-4/5	S-VISSR	100MB	89.01-now	Tape	14 TB
FY-2A/B/C	S-VISSR	100MB	97.09-now	Tape	10 TB
METEOSAT-5	HRI	40MB	99.06-now	CD	1.5 TB
GMS-1/2/3	WEFAX	模拟图像	78.1-88.8	Film	- -
NOAA (4-7)	APT	模拟图像	72.1-85.6	Film	- -

Data archive: Current on operational

No.	Satellite	Data
Polar		
1	FY-1D	CHRPT、GDPT
3	EOS-AQUA/TERRA	MODIS
3	NOAA-12/16/17/18	HRPT
Geostationary		
4	FY-2C/D	S-VISSR
5	MTSAT	HiRiD
6	Meteosat-5	HRI

Products from FY2C/D



Name of Product	Coverage	Time/Day
Wind	50° N-50° S 55° E-155° E	4
SST	60° N-60° S 45° E-165° E	8
Upper Troposphere Humidity	60° N-60° S 45° E-165° E	8
ISCCP Data set	60° N-60° S 45° E-165° E	8
Precipitation Index	60° N-60° S 45° E-165° E	8
Precipitation Estimation	60° N-60° S 45° E-165° E	4
Cloud Classification	60° N-60° S 45° E-165° E	8
Cloud Amount	60° N-60° S 45° E-165° E	8
Humidity Profile from Cloud	50° N-50° S 55° E-155° E	8
Perceptible Water in Clear Sky Region	60° N-60° S 45° E-165° E	8
Outgoing Long wave Radiation	60° N-60° S 45° E-165° E	8
Solar Irradiance	60° N-60° S 45° E-165° E	1
Snow Cover	60° N-60° S 45° E-165° E	1
Sea Ice	60° N-60° S 45° E-165° E	1
Flood Monitoring	China	1
Soil Moisture	60° N-60° S 45° E-165° E	1
Fire Monitoring	China	24
Tropical Cyclone Position and Intensity	Western Pacific and India Ocean	24
Sand Storm Monitoring	China and Mongolia	8
Fog	China	24
TBB	60° N-60° S 45° E-165° E	8

Data Dissemination

- Satellite Directly Broadcast (400+ MDUS)
- GTS
 - ❑ Wind product
 - ❑ ATOVS
- Internet service (SDAC-satellite data achieve center)
 - ❑ More than 800 registered users;
 - ❑ 20TB/year
- DVB-S Service (110 users stations)

Satellite Data Dissemination: satellite.cma.gov.cn

中国卫星

遥感数据服务网

Secondary planet

[CONTACT US](#)
[SITEMAP](#)
[ENGLISH](#)

[我的信息](#) / [使用说明](#) / [特殊订购](#) / [应用展示](#) / [在线帮助](#) / [Q&A](#)

Home

User ID

Password

LOGIN

[登录 >](#)
[注册 >](#)

快捷菜单

[购物车](#)
[我的订单](#)
[云图动画](#)
[云图快视](#)

[帮助文档](#)
[资料下载](#)
[展示图库](#)
[使用规则](#)

相关链接

[中国气象局](#)
[国家卫星气象中心](#)
[国家气候中心](#)
[气象科学研究院](#)
[气象出版社](#)
[中国卫星遥感信息服务网](#)

搜索

EOS原始数据集

EOS原始数据集

EOS/MODIS 1B数据集

FY1/GDPT数据集

FY1/CHRP数据集

FY2/SWISSR数据集

GOES-9/GVAR数据集

NOAA/AVHRR数据集

卫星数值产品

SEARCH

系统介绍

中国遥感卫星数据服务网隶属于中国气象局和国家卫星气象中心，主要提供国内外气象和环境卫星（包括风云一号、风云二号、风云三号、风云四号、METEOSAT等）的实时、历史数据以及各类高级产品的在线检索和下载，同时按照用户需求提供相关数据定制服务。

卫星最新数据

卫星	数据起始时间	数据结束时间
FY2C	2005-06-26 06:00:00	2005-06-26 06:25:00
FY1D	2005-06-26 03:59:02	2005-06-26 04:08:02
TERRA	2005-06-26 04:30:03	2005-06-26 04:36:05
SEC	2005-06-26 06:30:00	2005-06-26 06:45:00

新闻

[风云二号02批气象卫星地面应用系统工程...](#) [2005/05/17]
[FY-2C第一项OLR卫星产品通过92...](#) [2005/04/26]
[关于风云二号C星实施姿态控制的通知](#) [2005/02/24]
[北京风云卫星气象科技公司招聘启示](#) [2005/01/04]
[关于风云二号C星实施姿态控制的通知](#) [2004/11/20]

快速搜索

FY-2C

SEARCH

EOS/MODIS

SEARCH

[云图动画](#) / [云图快视](#) / [帮助文档](#) / [资料下载](#) / [展示图库](#) / [使用规则](#) / [Q & A](#)



Products Dissemination: dear.cma.gov.cn

http://139.138.70.188/ - Microsoft Internet Explorer

文件(E) 编辑(E) 查看(V) 收藏(A) 工具(T) 帮助(H)

后退 前进 停止 刷新 主页 个人栏 搜索 收藏夹 历史 邮件 字体 打印 编辑 讨论 联系人

地址(0) http://139.138.70.188/ 转到 链接

卫星气象与环境监测

首页 应用产品 新品介绍 分析报告 卫星资料 技术文档 Virtual Laboratory 关于我们



Typhoon

国家卫星气象中心全年对西北太平洋和南海地区的热带气旋进行逐日监测，并向全球发送利用气象卫星资料对台风的定位报文。



Weather information

国家卫星气象中心每日对全国范围内的主要天气系统进行监测分析，并通过多种媒体发布分析信息。



Dust

国家卫星气象中心利用气象卫星对我国西北、华北、东北以及华东地区进行了沙尘天气监测。



Snow

每年10月至来年4月，国家卫星气象中心都要对内蒙古自治区，东北地区，新疆北部地区，青海、西藏、四川等高原地区进行积雪覆盖的监测和分析。



Forest Fire

国家卫星气象中心利用我国FY-1C等极轨气象卫星对全国重点地区的草场、林区进行了监测和日常服务，并逐步向全国范围扩展。



Flood

国家卫星气象中心利用我国FY-1C等极轨气象卫星对七大江河流域水管及其它一些地区的湖泊、水库、河流等水体进行了监测和日常服务。



国家卫星气象中心利用FY-1C资料生成植被长热监测图像。在



国家卫星气象中心利用气象卫星资料实时监测海冰的情况，并向有关

台风监测
天气监测
沙尘监测
火情监测
水情监测
植被监测
积雪监测
海冰监测

开始 http://139.138.70.1... 文档 1 - Microsoft... http://139.138.70.1... 未命名 - 画图 21:32

110 DVB-S reception station



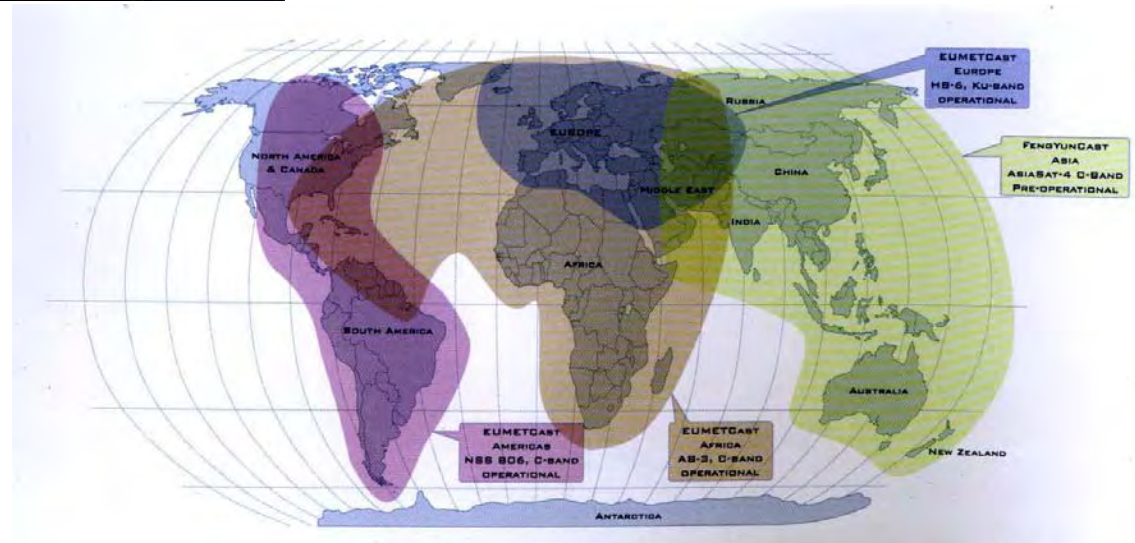
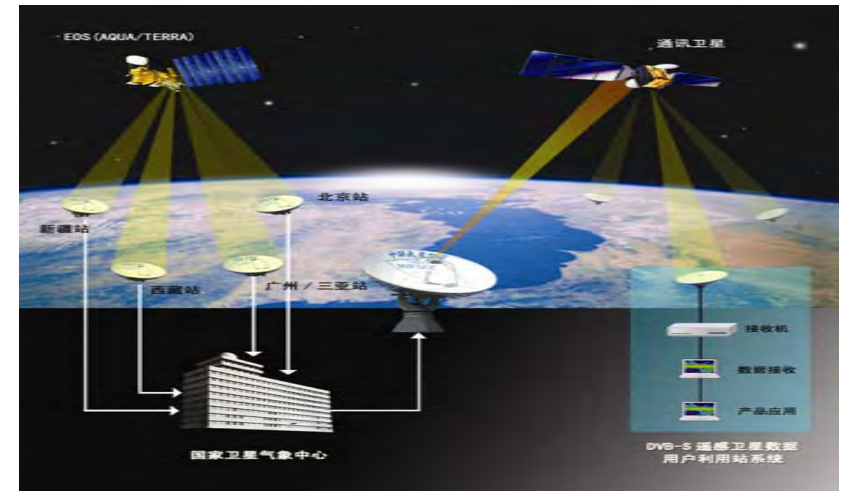
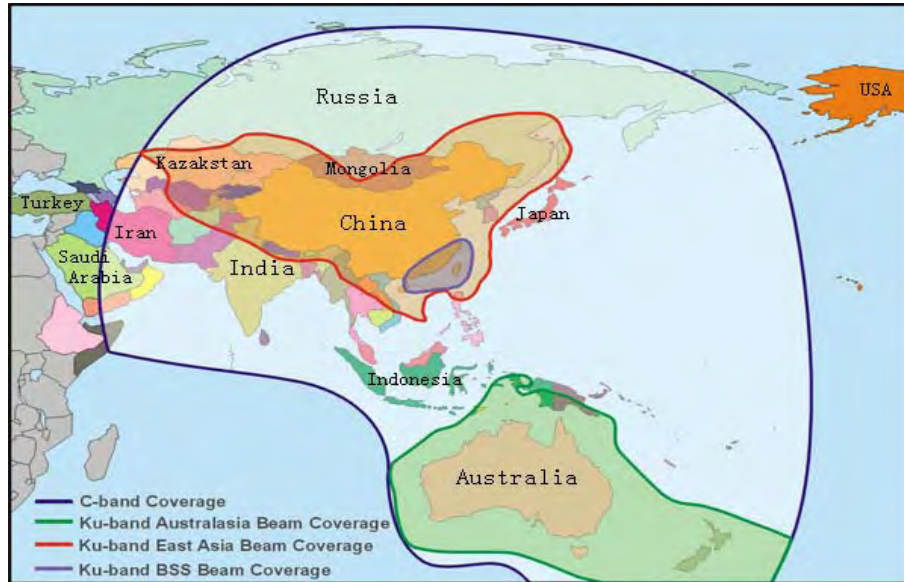
Bangladesh, Indonesia, Iran, Mongolia, Pakistan, Thailand
will be users this year.

EUMETCast reception



DVB-S (Ku Band to C band planned)

AsiaSat-4 at 122E



4. Products Application for the Chinese Meteorological Satellite



The Application in Weather Forecast

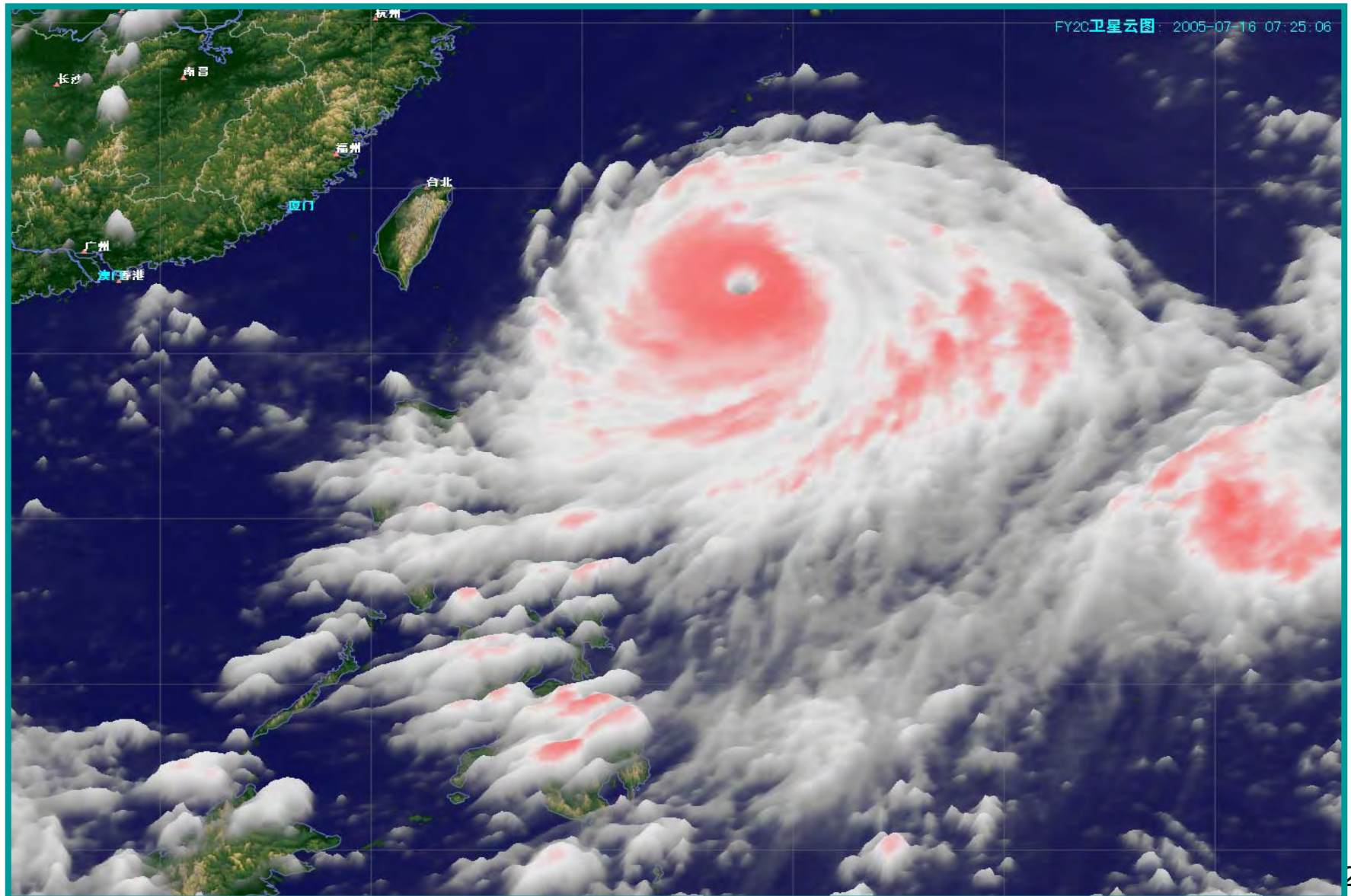
- (1) Synoptical analysis
- (2) Typhoon Guidance
- (3) Dust Storm Monitoring
- (4) Fog Monitoring
- (5) Precipitation Estimation
- (6) Cloud Classification
- (7) Satellite Data Assimulation into NWP

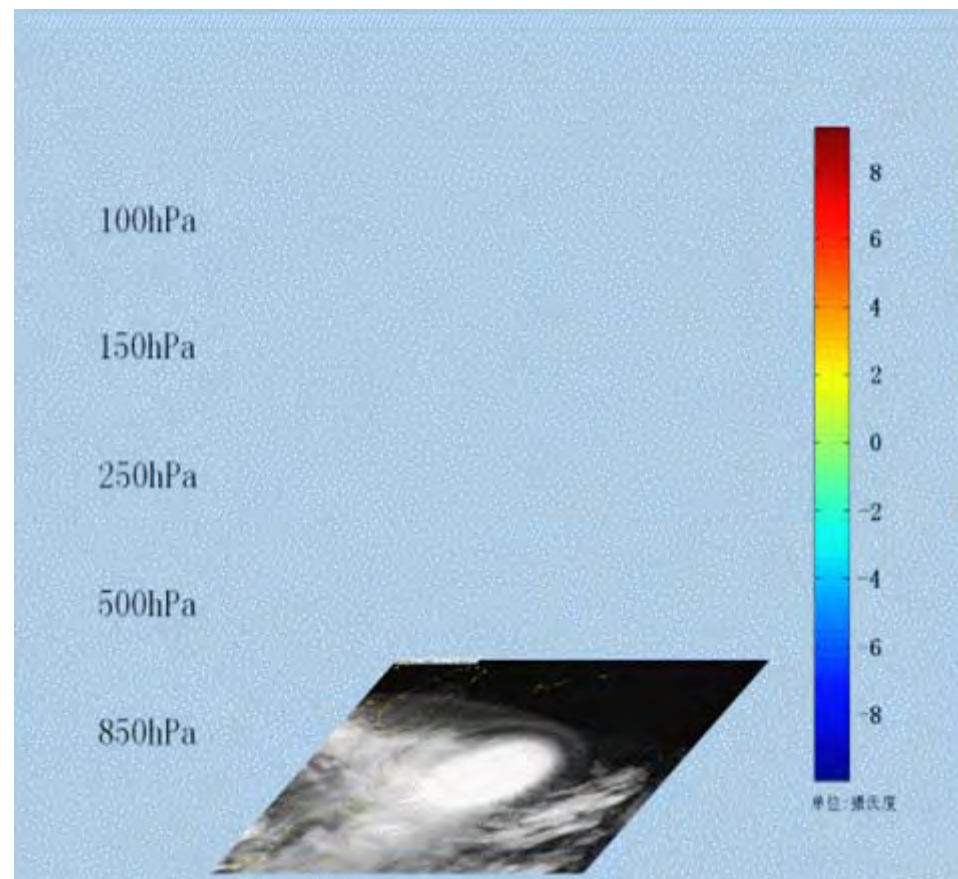
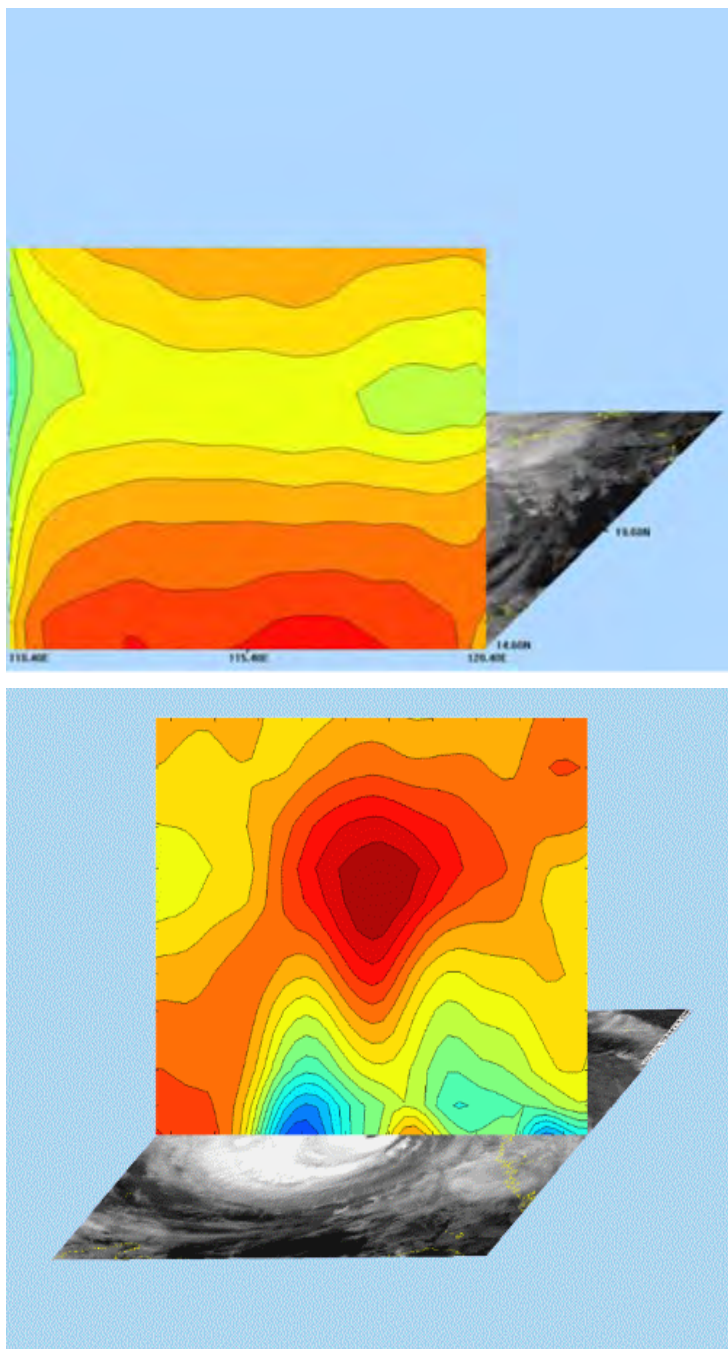


The Application in Disaster Reduction and Environment Monitoring

- (1) Drought
- (2) Vegetation Growth
- (3) Snow Cover
- (4) Flood
- (5) Forest and Grassland Fire
- (6) Sea Ice
- (7) Others

Typhoon Guidance





Temperature Profile

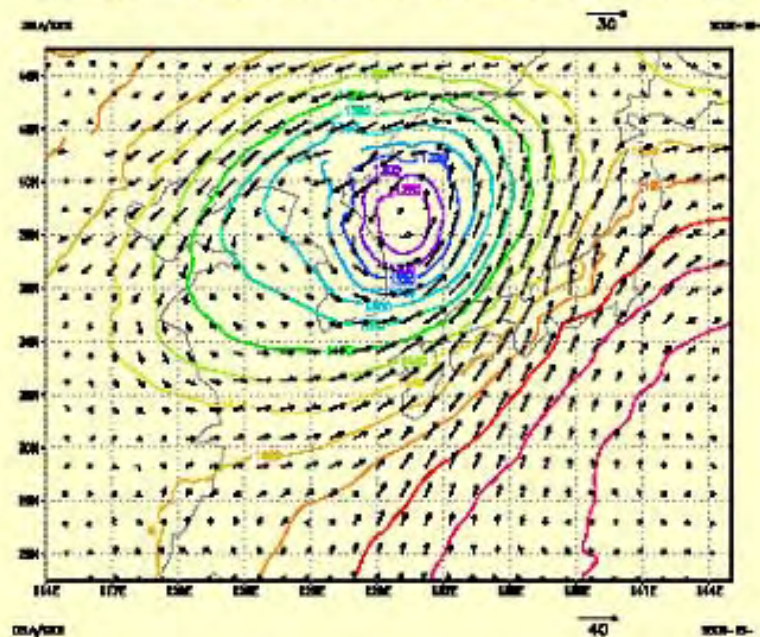
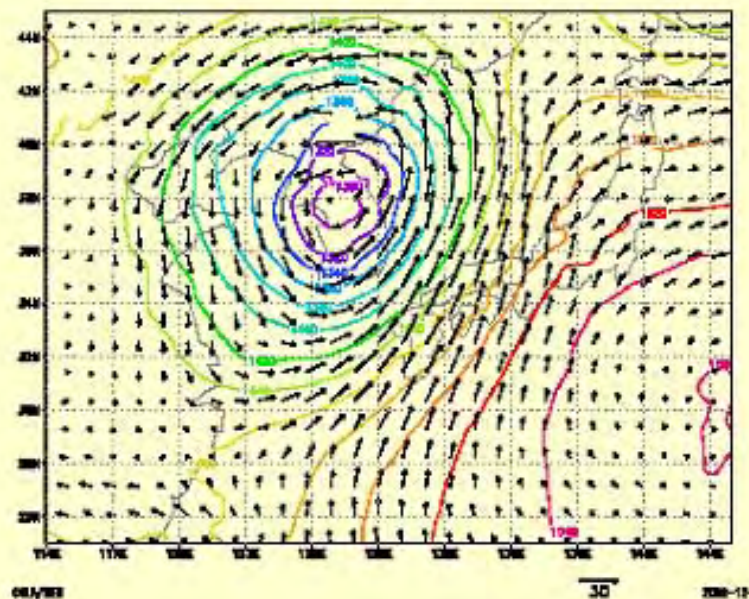
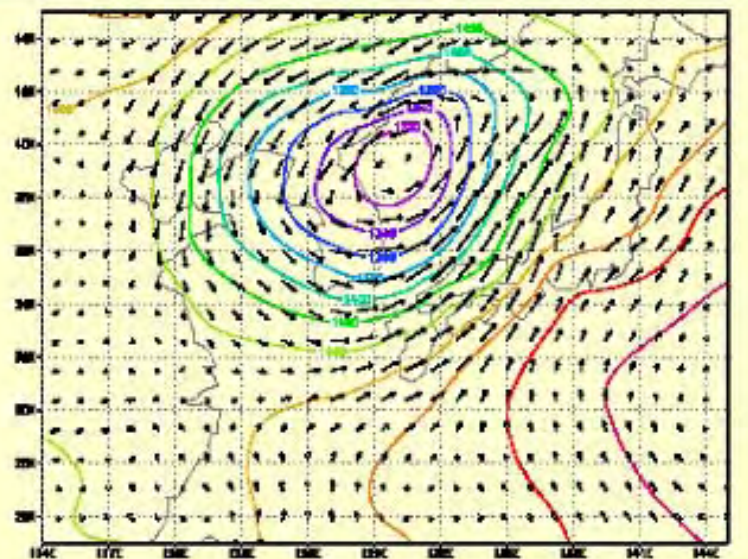


Comparison between Predictions

Right: July 6 12UTC 850 hPa H (analysis)

Below: 45h prediction (radiosondes only)

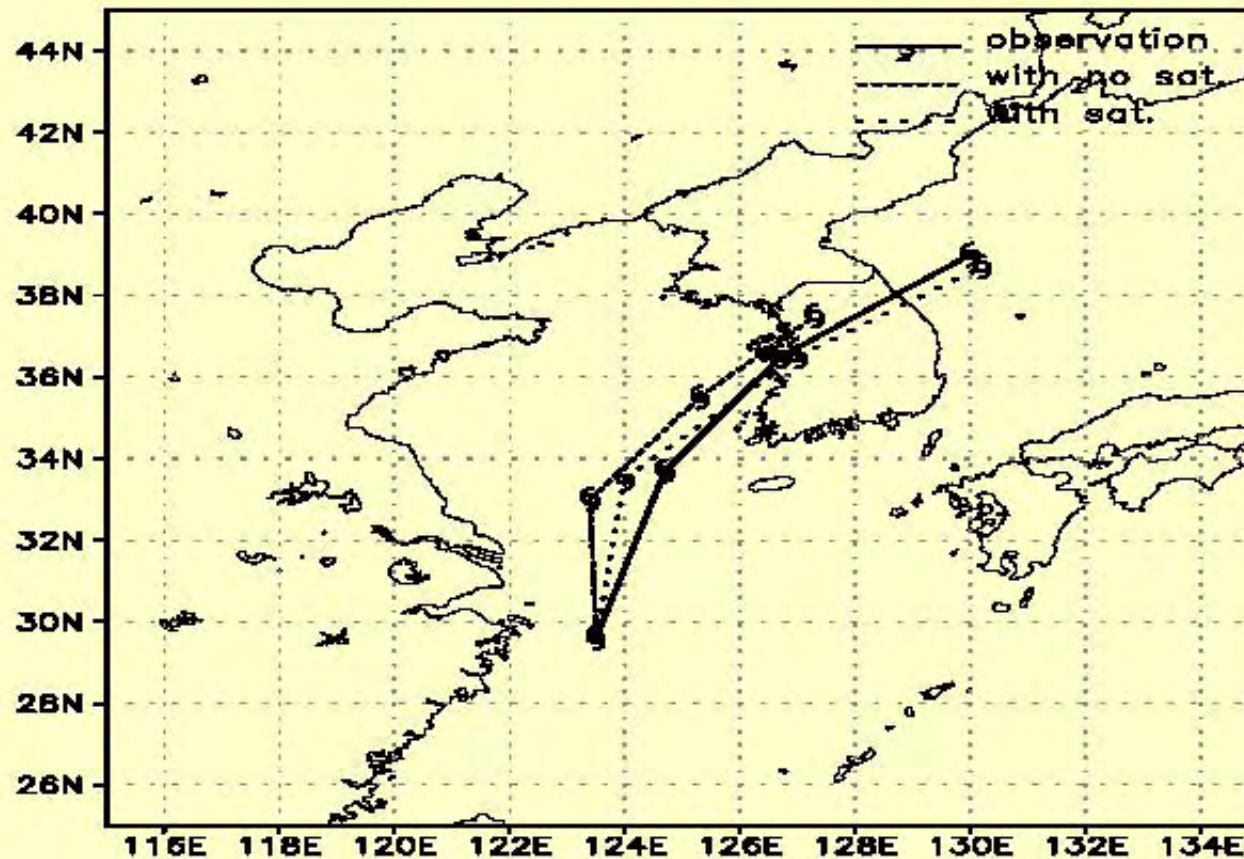
Right below: 45h prediction (radiosondes + satellite)





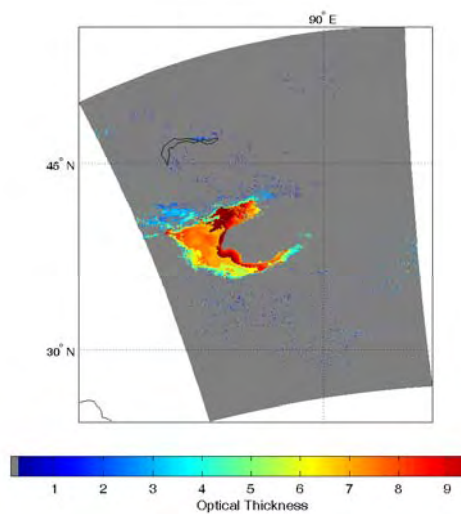
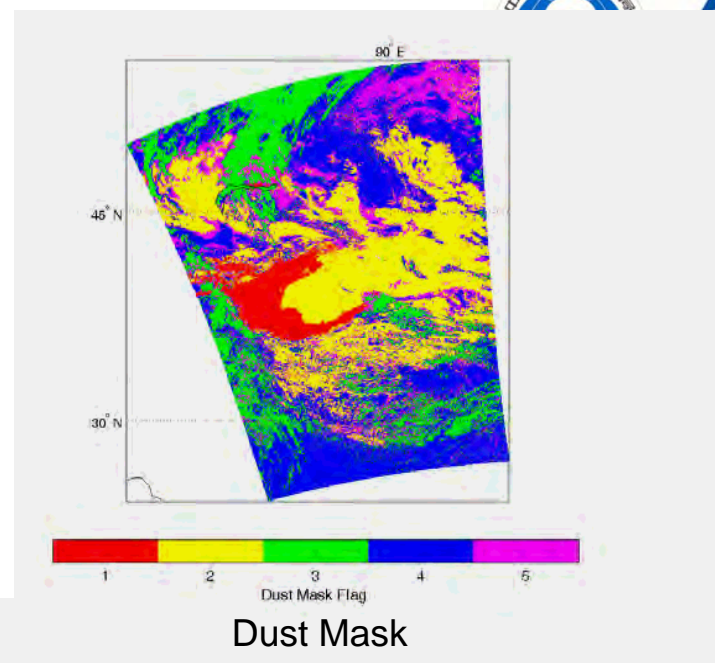
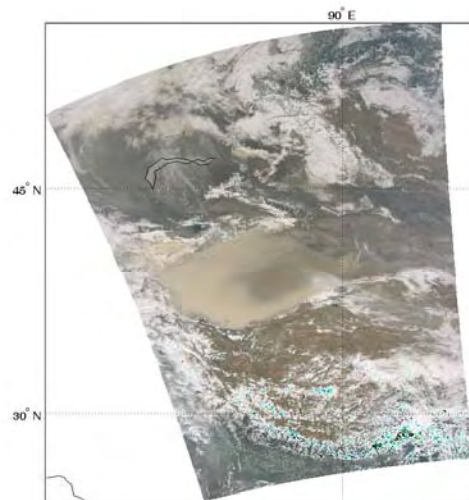
Impact on the track prediction

TYPHOON TRACK

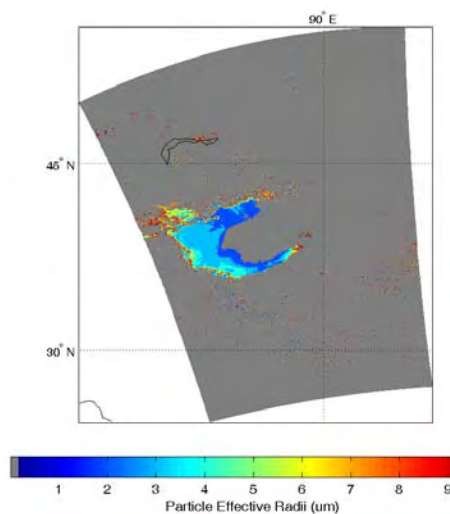


Starting from
15UTC July 4.
21,33,45 hours
forecasts of the
center's position
are shown

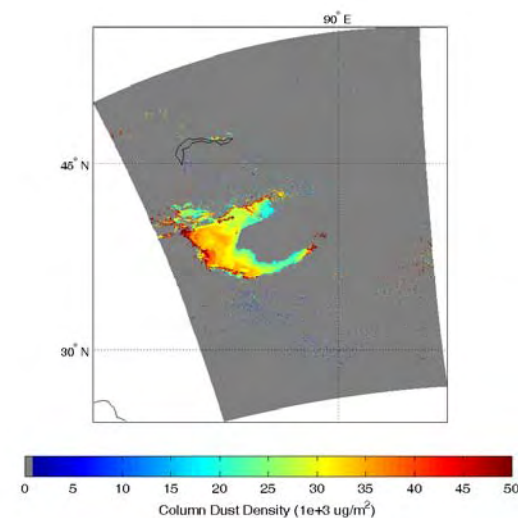
Dust Products



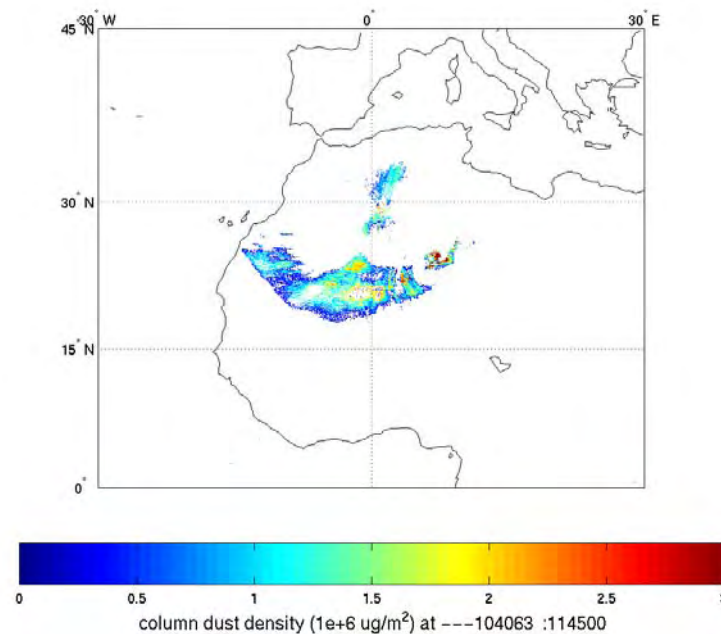
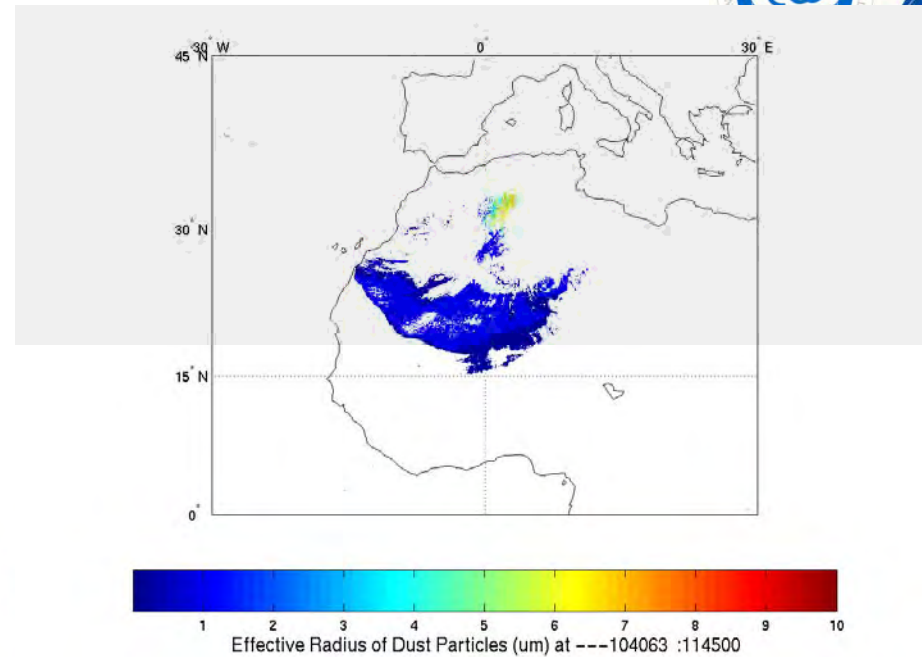
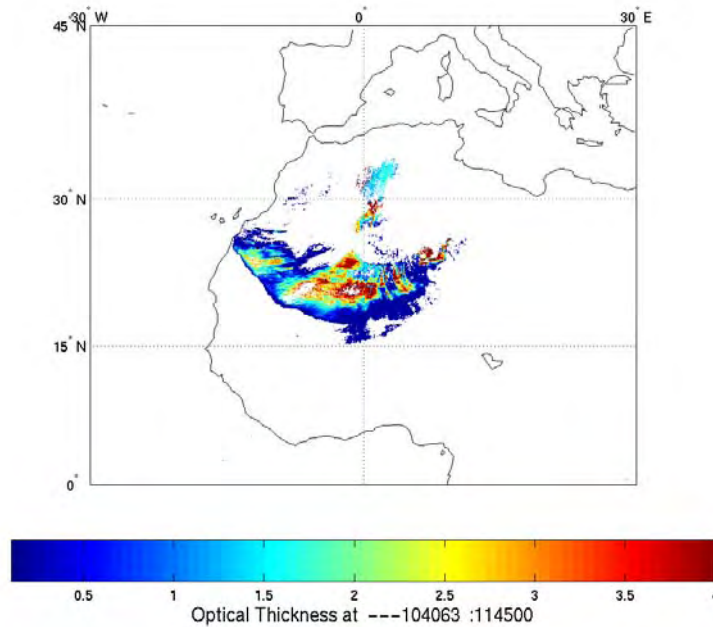
Dust AOD



Dust Particle Effective Radius

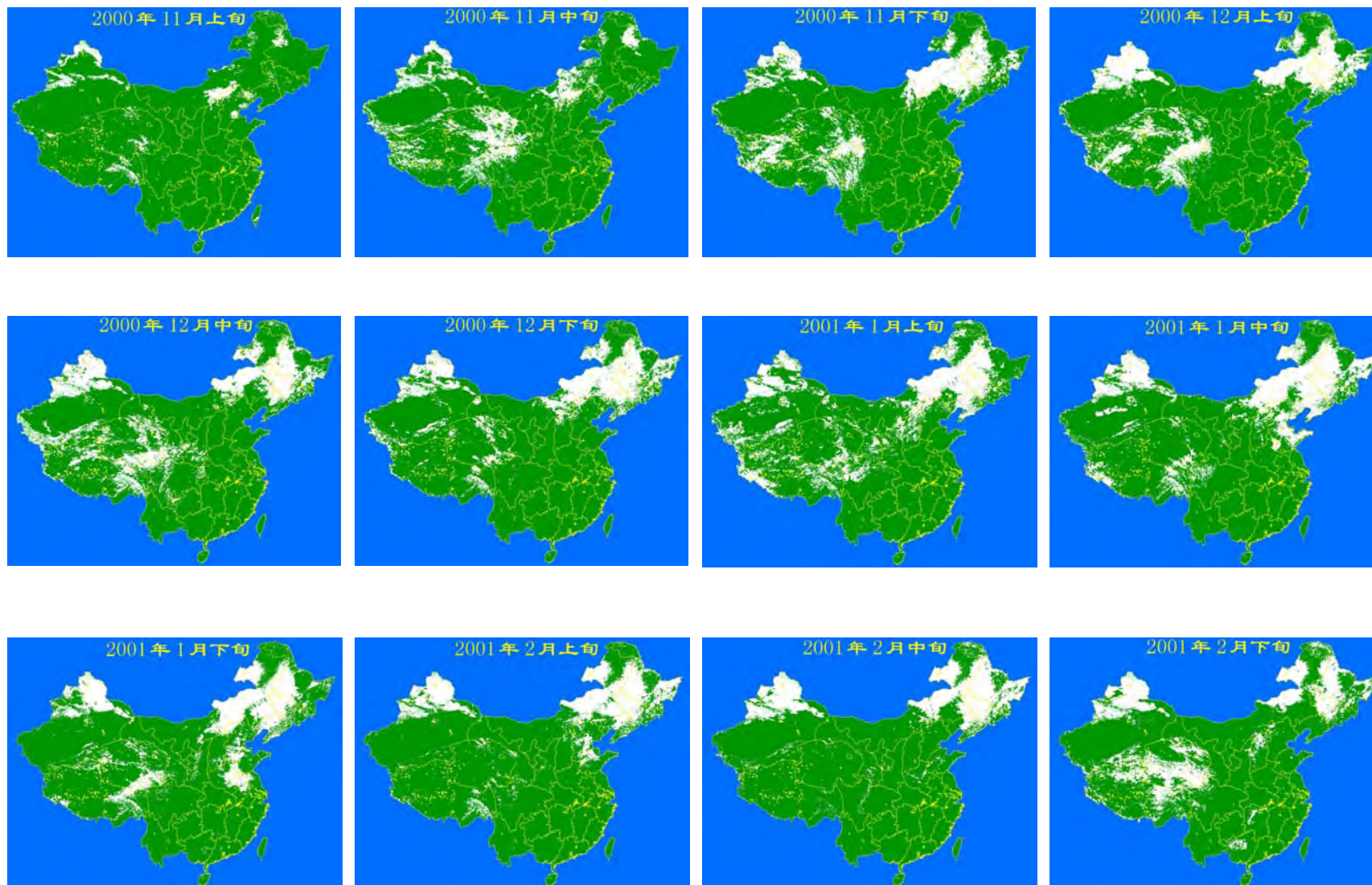


Dust Total Column Amount



Dust over Sahara

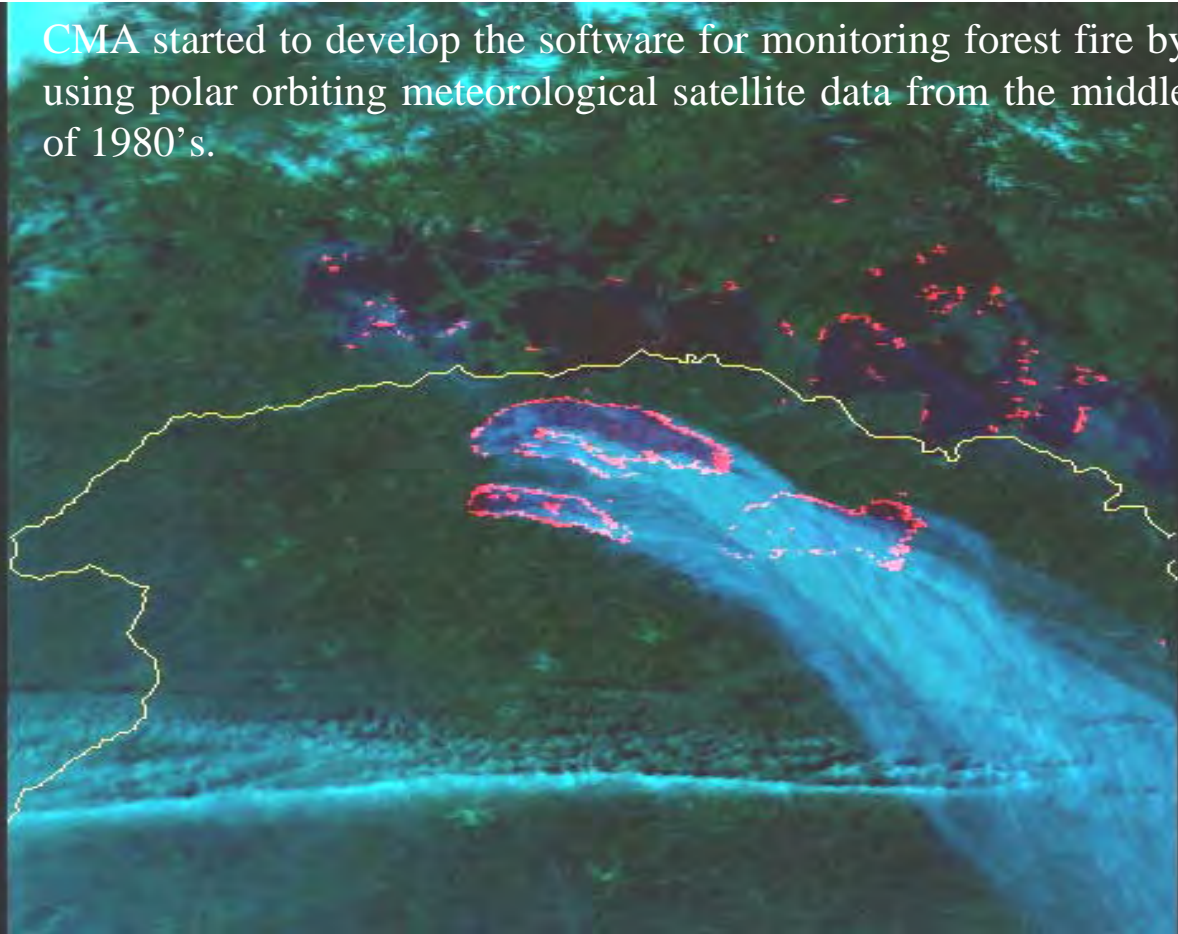
FY-1C Every 10-Day Snow Coverage



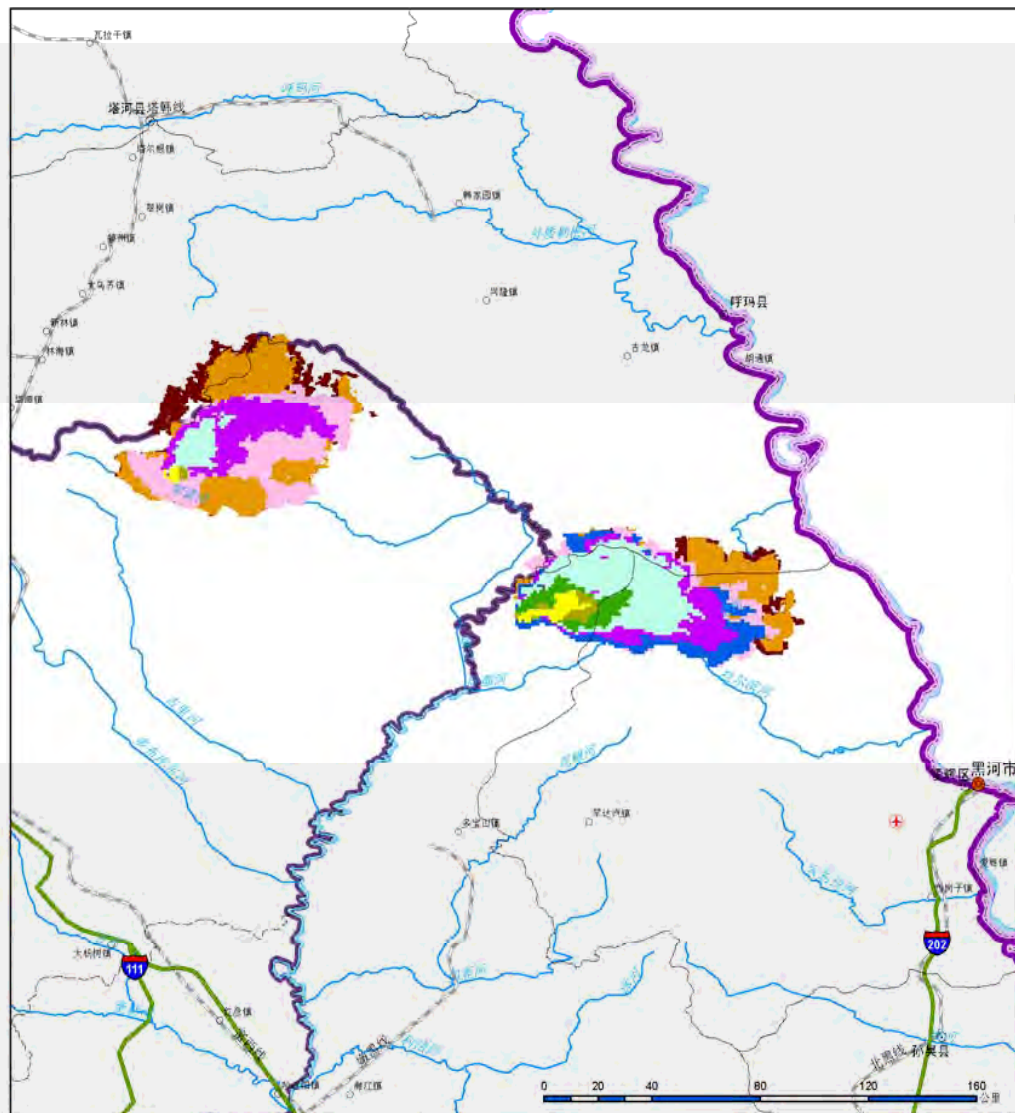
Forest and Grassland Fire Monitoring



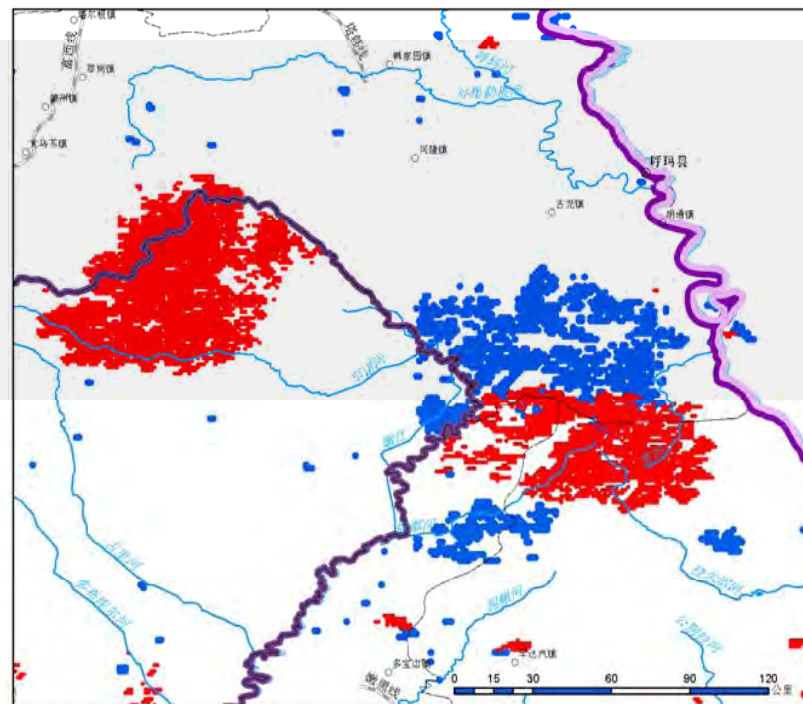
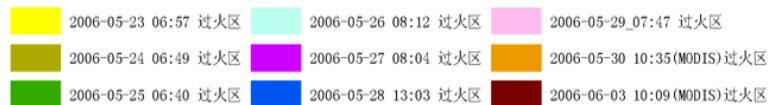
CMA started to develop the software for monitoring forest fire by using polar orbiting meteorological satellite data from the middle of 1980's.



2006年卫星遥感监测鄂伦春旗、黑河市过火区发展示意图



过火区逐日发展示意图



2005与2006年过火区对比示意图

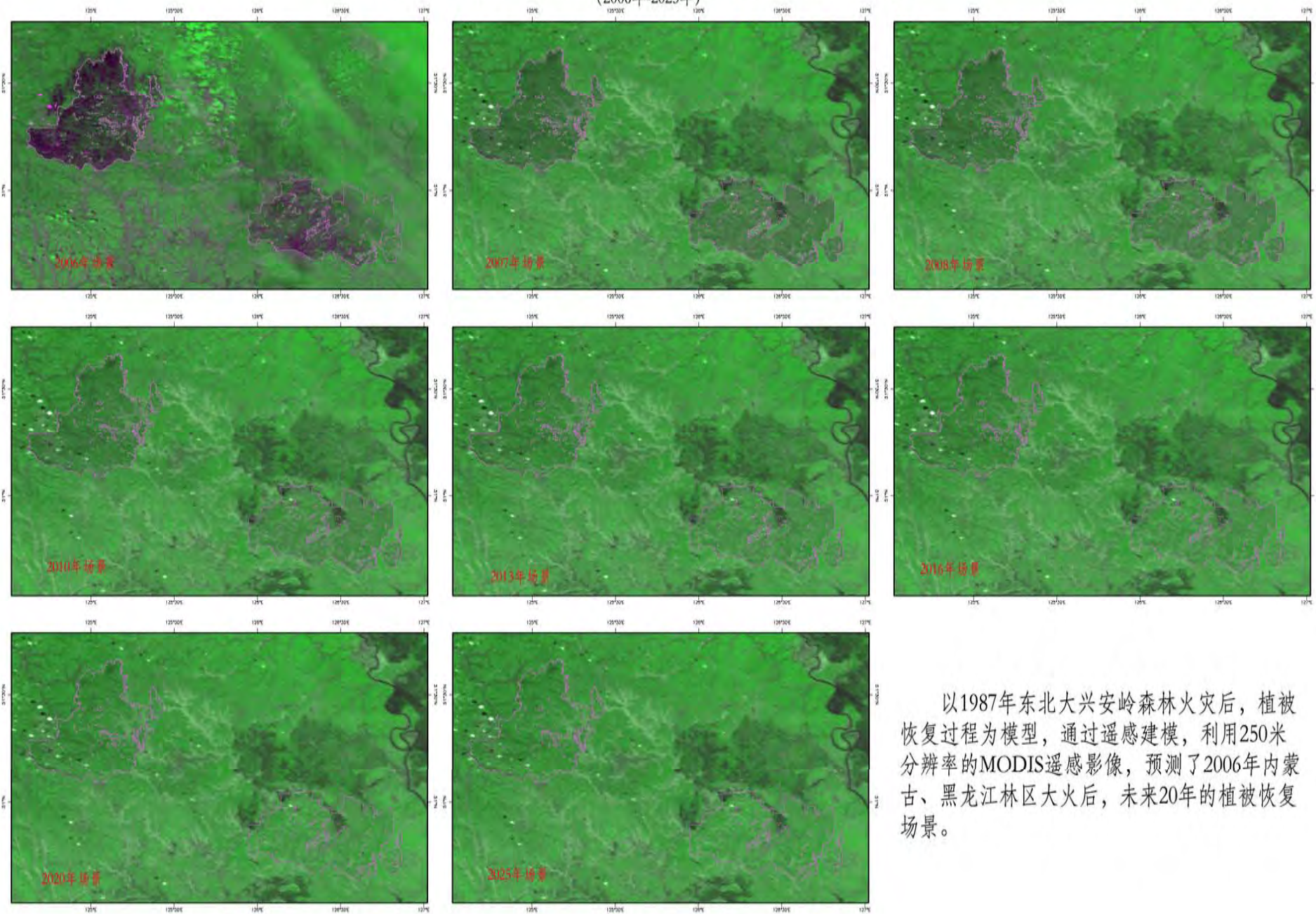
2006年逐像元 2005年逐像元

根据各火场过火区逐日发展示意图，各火场发展范围具有以下特点。

- 1、黑河市嫩江县火场持续向东蔓延，同时从25日向北蔓延至呼玛县境内，维持数日，未再深入发展。根据2005年和2006年卫星遥感火点分布分析，2005年10月呼玛县邻近黑河市嫩江县区域曾发生大范围火情，当地堆积可燃物已得到有效清除，因而今年火场蔓延至该地后，火灾蔓延条件降低，没有向北急剧发展。
- 2、鄂伦春旗火场主要向东和北方向蔓延，也曾向西部局部蔓延。根据2005年和2006年卫星遥感火点分布分析，鄂伦春旗火场周边地区2005年未发生火情，地面可燃物未得到清除，因而鄂伦春旗火场向呼玛县境内有较多的发展。
- 3、牙克石市火场前期向东蔓延，后又转向西北方向发展。



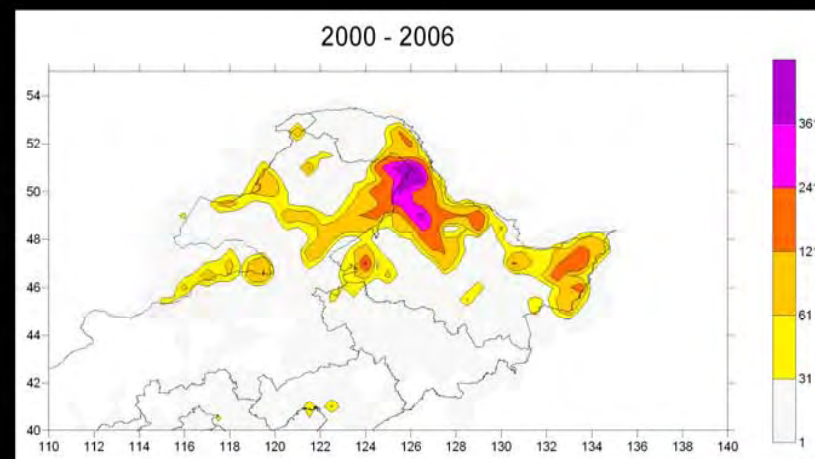
内蒙古、黑龙江过火区植被恢复场景预测遥感仿真 (2006年-2025年)



以1987年东北大兴安岭森林火灾后，植被恢复过程为模型，通过遥感建模，利用250米分辨率的MODIS遥感影像，预测了2006年内蒙古、黑龙江林区大火后，未来20年的植被恢复场景。

第五部分

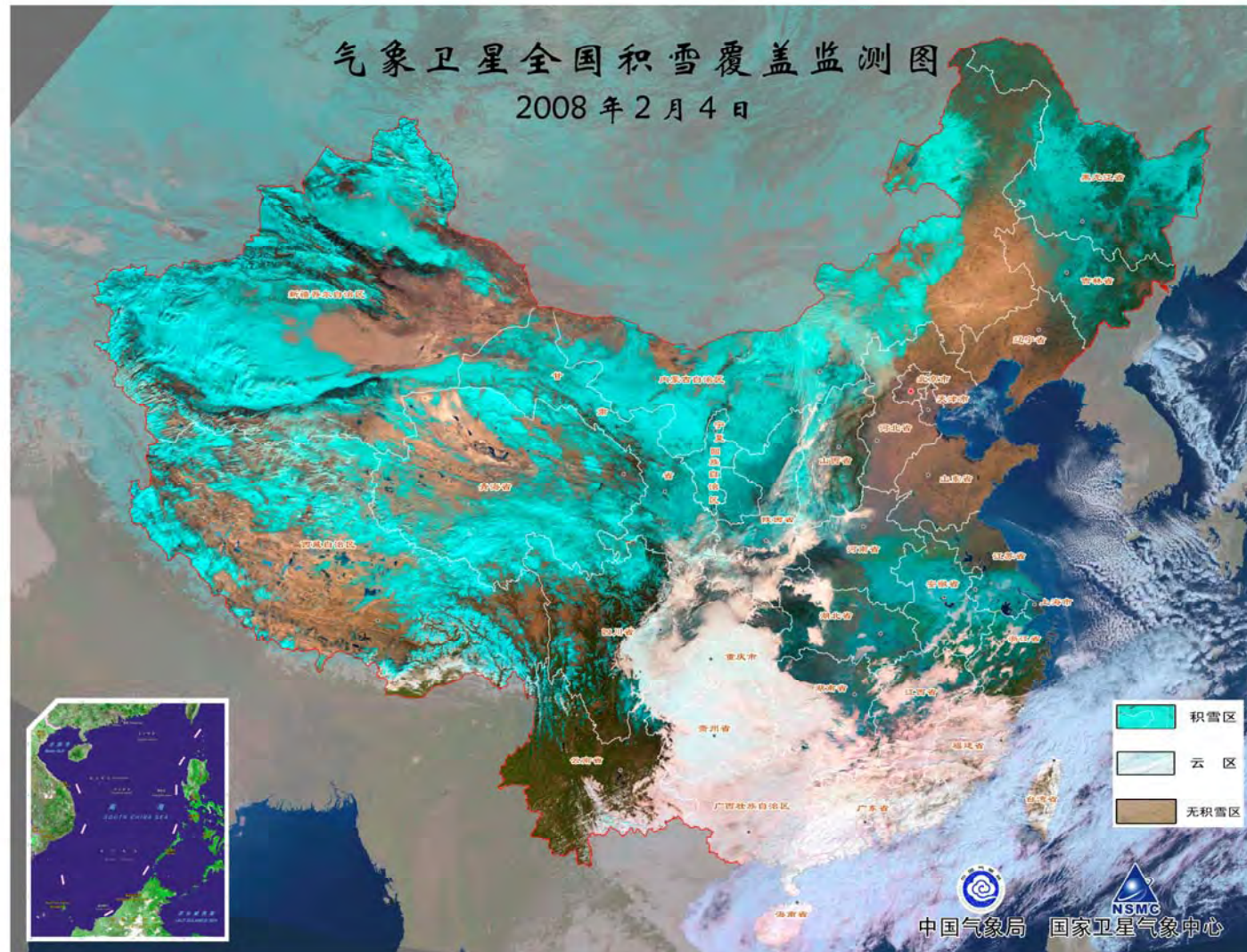
Fire Warning Index



东北地区卫星遥感火险指数图

利用 2000 年 1 月至 2006 年 5 月极轨气象卫星遥感监测得到的东北地区火点分布数据，以 0.5×0.5 度为空间尺度进行统计分析，可以得到每百平方公里每年火点发生的频次等值线分布图。经初步分析，火险高发区主要位于内蒙古自治区鄂伦春自治旗与黑龙江省呼玛县、嫩江县交界处至黑龙江省五大连池一线，黑龙江省杜尔伯特蒙古族自治县一带，佳木斯市、双鸭山市及鸡西市一带，以及内蒙古自治区东乌珠穆沁旗与蒙古国交界处，其中，内蒙古自治区鄂伦春自治旗与黑龙江省呼玛县、嫩江县交界处至黑龙江省五大连池一线为火点高发区（红色区域），平均百平方公里每年达到 6 次以上，是火灾预防的重点地区。

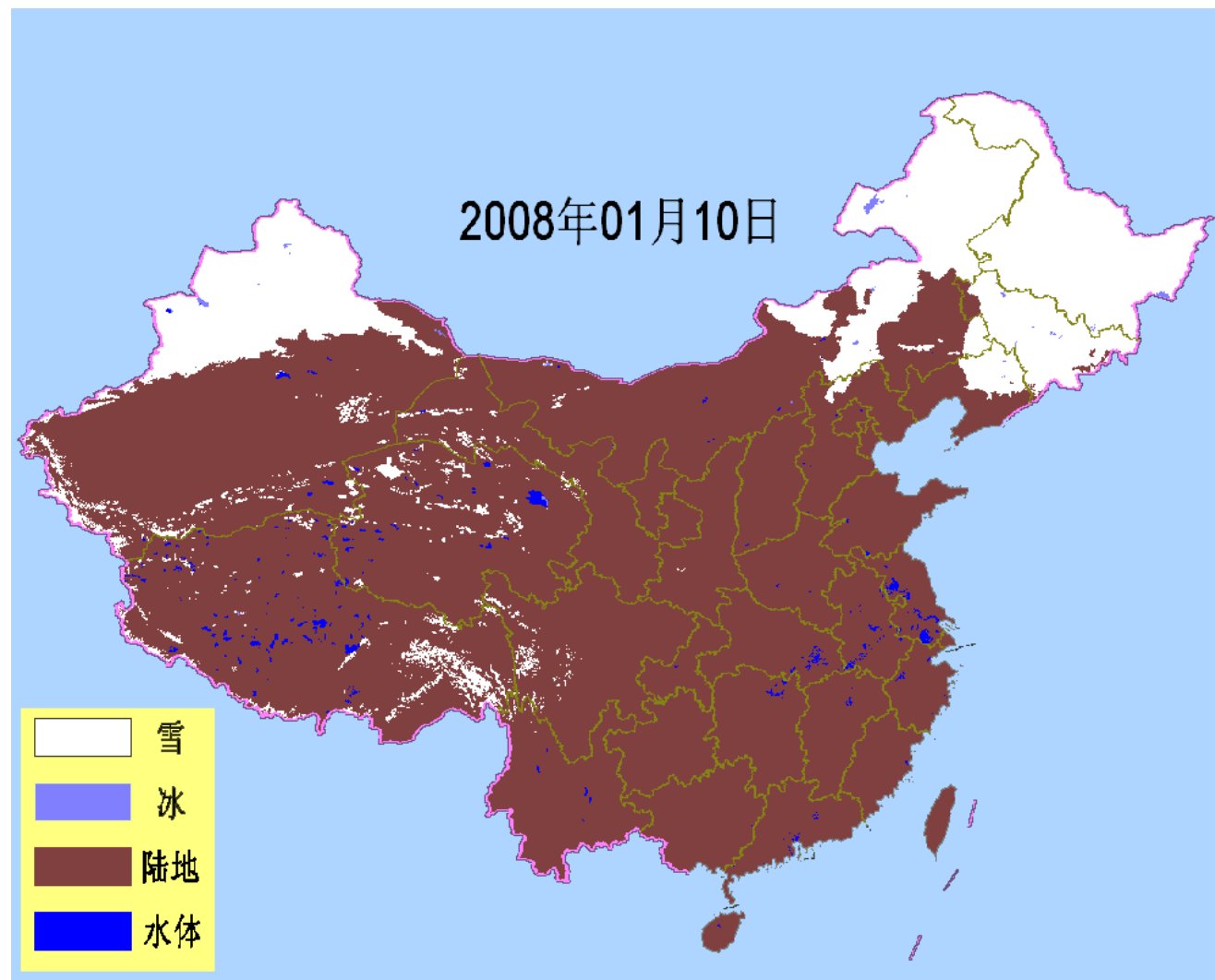
Monitoring Snow Cover during the freezing disaster



Snow, snow + rain mixed, super cooling rain

Snow Cover by combining Optical + Microwave

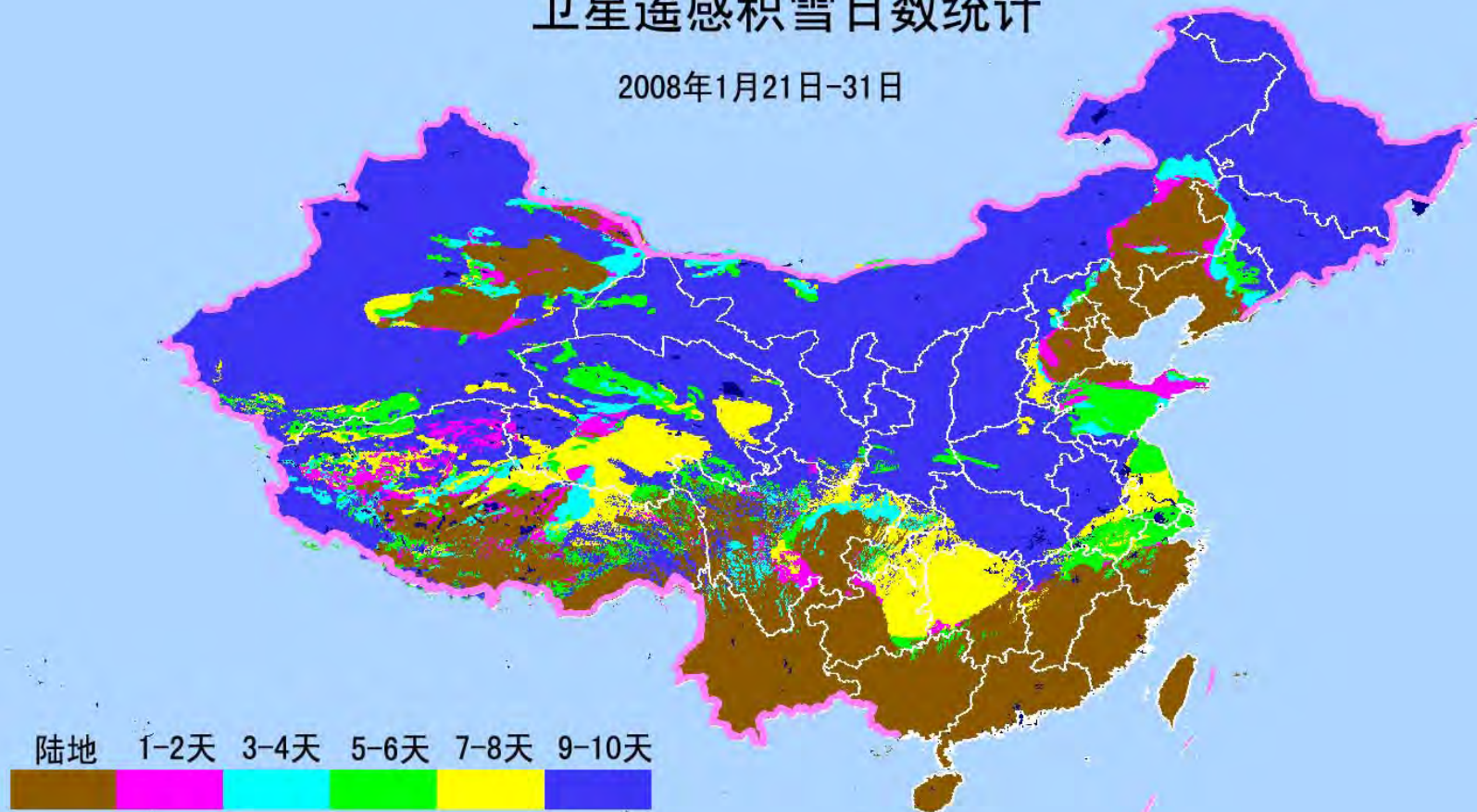
2008年1月10日-2月13日



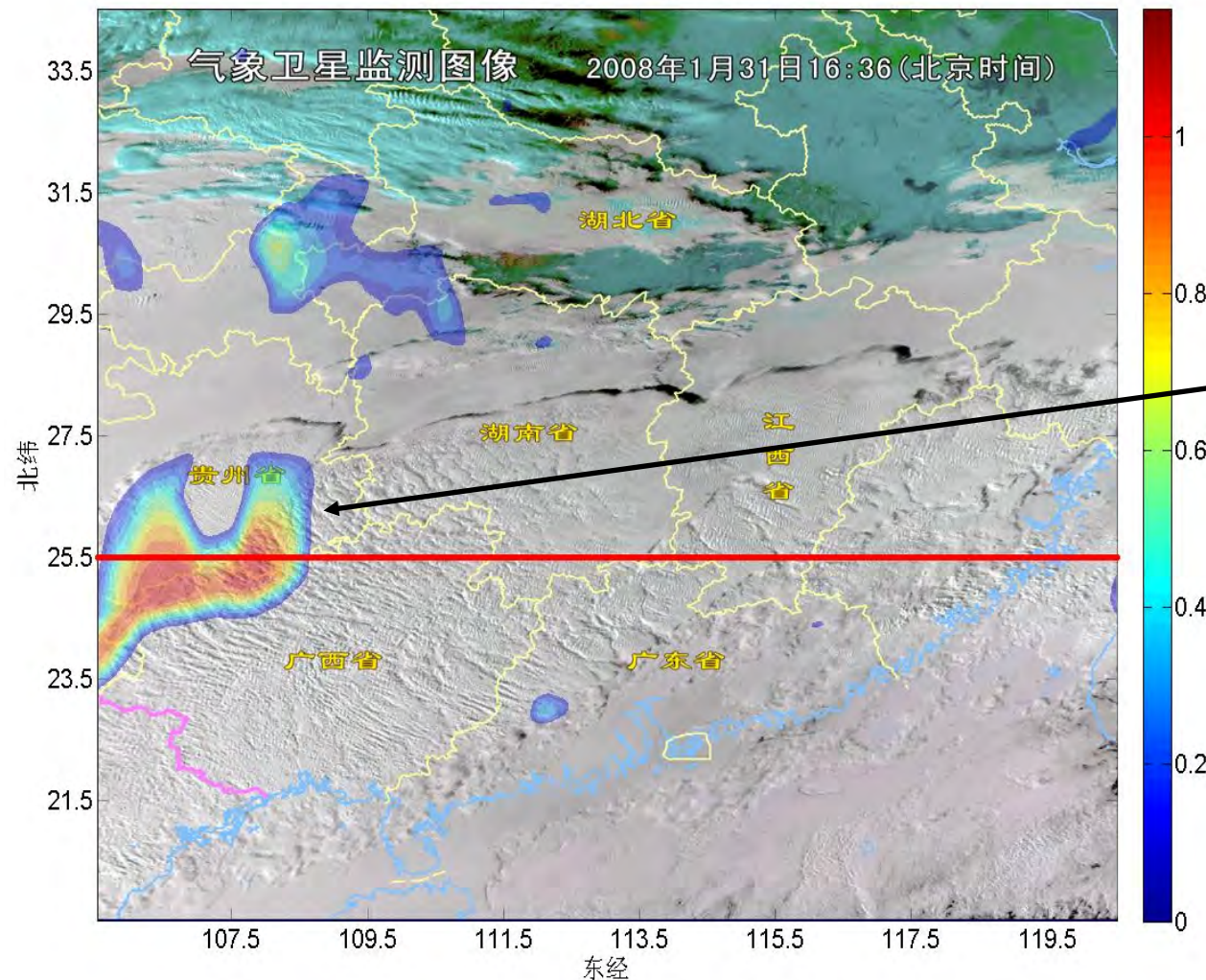
多源卫星遥感积雪覆盖监测图动画反映了1月中旬至2月中旬我国南方大范围降雪天气在南方等地造成积雪覆盖范围及动态发展变化。

卫星遥感积雪日数统计

2008年1月21日-31日



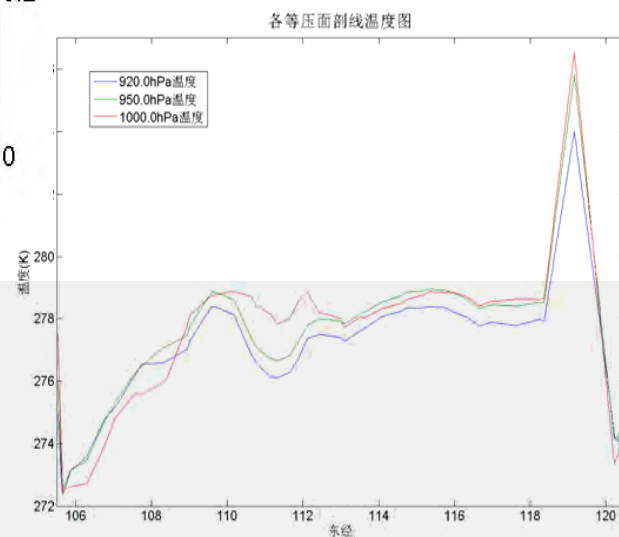
1月下旬卫星遥感积雪覆盖日数图中反映出，河南和湖北大部、安徽中北部、江苏和江西西北部等地区一直维持积雪覆盖，湖南中北部、贵州东部、江苏中部等地积雪覆盖约7-8天。

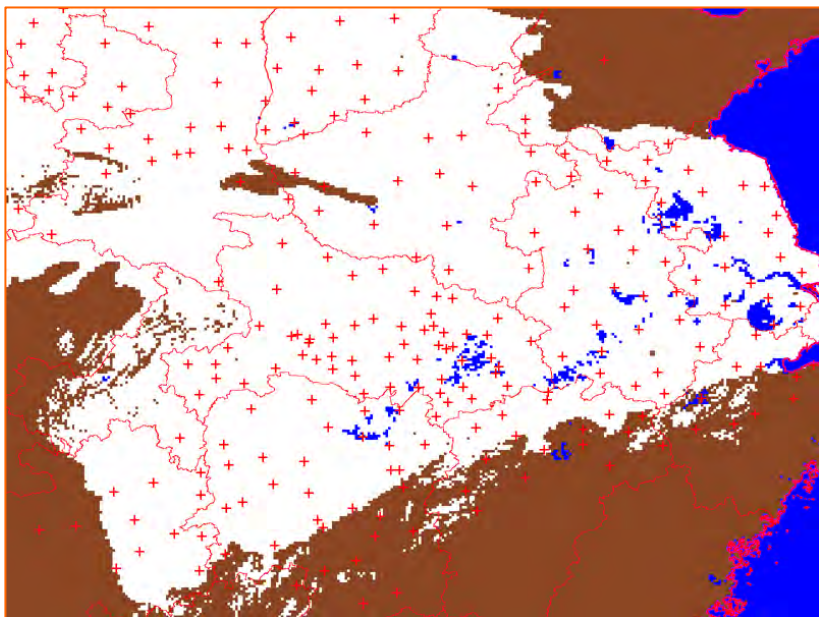


inversion layer

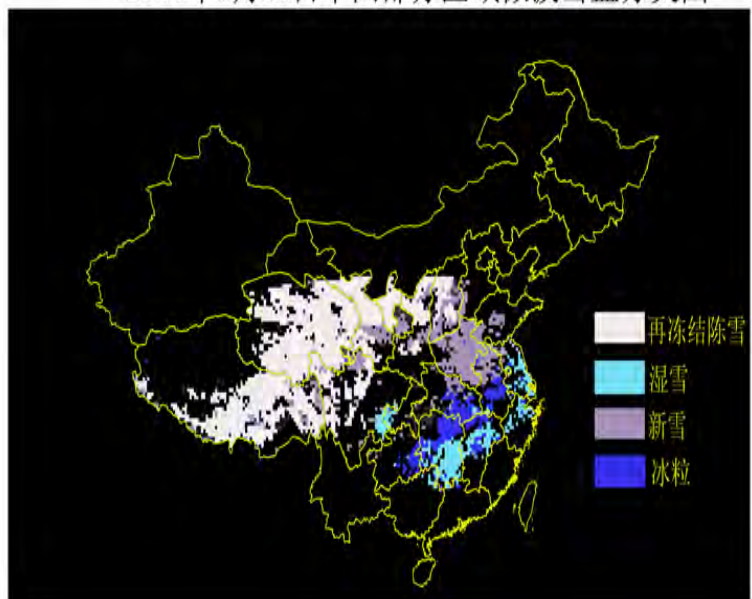
沿北纬线25.5°低
层气温分布曲线

2008年1月31日16:30卫星反演逆
温层与同时次云图平面叠加图



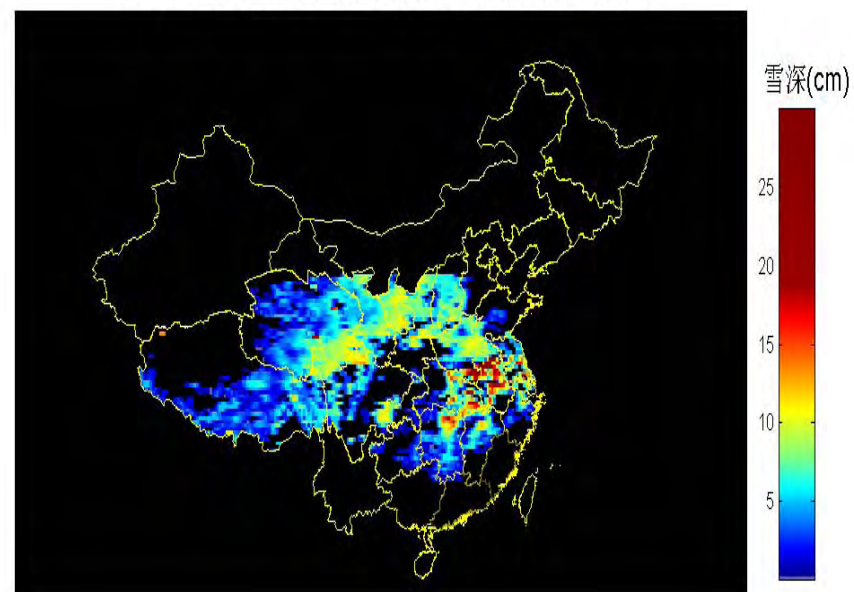


2008年1月28日中国部分区域微波雪盖分类图

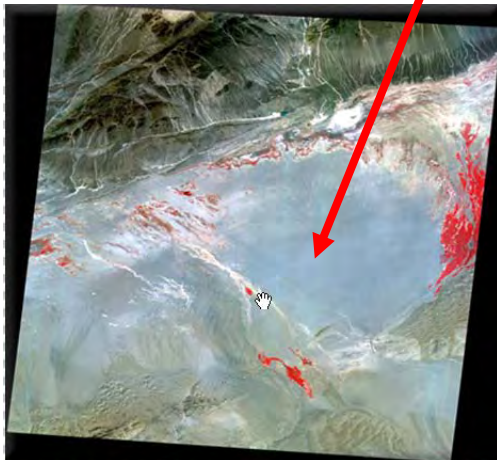


Products from NSIDC

2008年1月28日中国部分区域微波雪深监测图



5. Earth-based reference sites in China for the Calibration

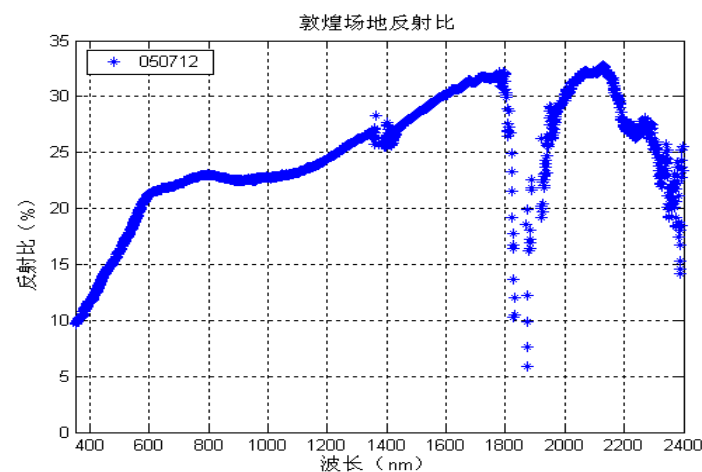
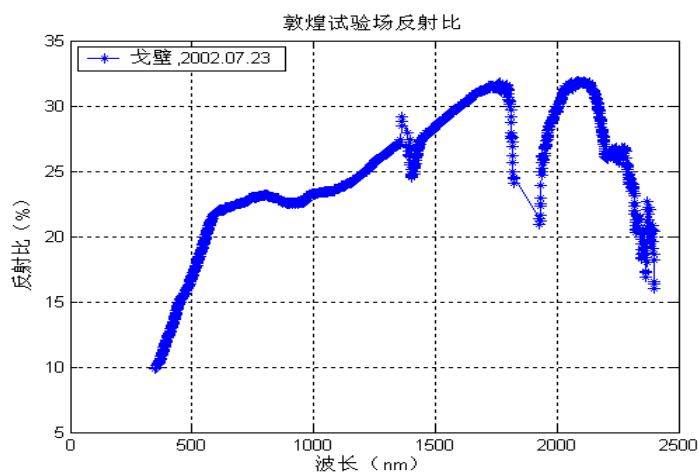
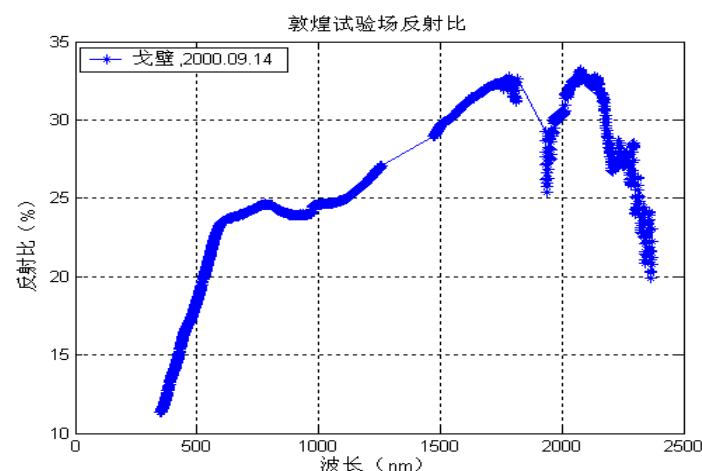
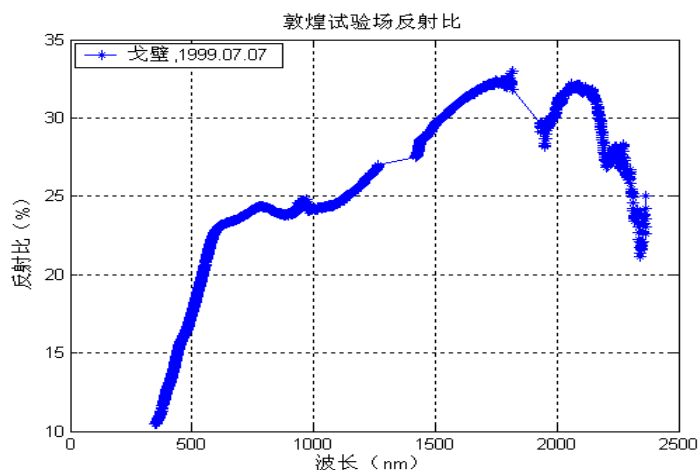


Four Earth-based reference sites in China

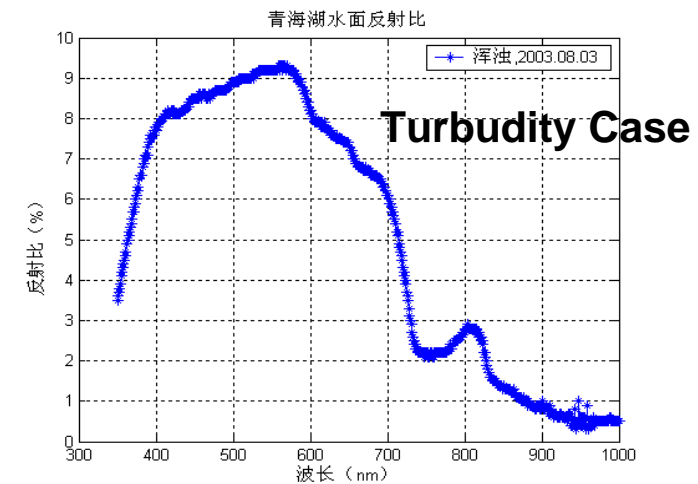
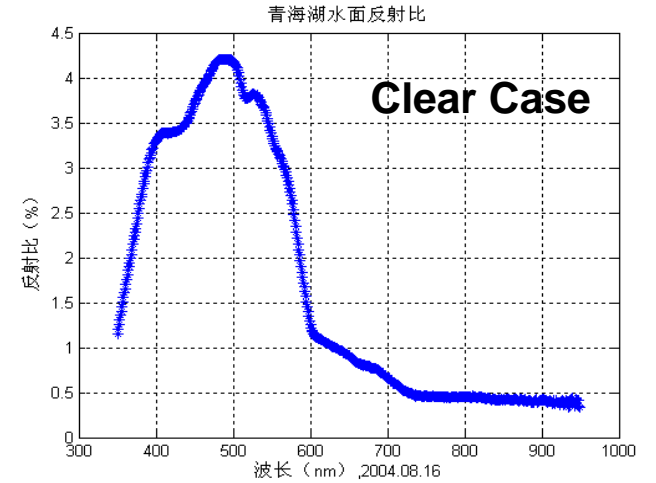
Site	Characteristic	Location	Purpose
Dunhuang	Gebi Desert, homogenous surface, dry atmosphere, and high visibility	40° 10' N, 94° 20' E Elevation: 1176 m	On-orbit calibration for VNIR band
Qinghai	Lake, Good Lambertian feature, dry atmosphere, and high visibility	36° 45' N, 100° 20' E Elevation: 3196 m	On-orbit calibration for TIR band
Beijing	Laboratory on the top of NSMC build	116.46° N, 39.92° E Elevation: 48 m	<ul style="list-style-type: none"> • Validation for the calculation from radiation transfer code with very high spectral resolution • Benchmark measurements
Lijiang	Local meteorological observation station, dry atmosphere, high visibility	100.25° N, 26.86° E Elevation: 2300 m	Pre-launch calibration for VNIR band of engineering and flight model

4 years of reflectivity in Dunhuang site

- show very good stability
- reflectivity define as the ratio of desert surface and reference board



Sight of Qinghai Lake



Depth of Lake: 20 m

Sight of Beijing Atmospheric Spectrum Observation Laboratory

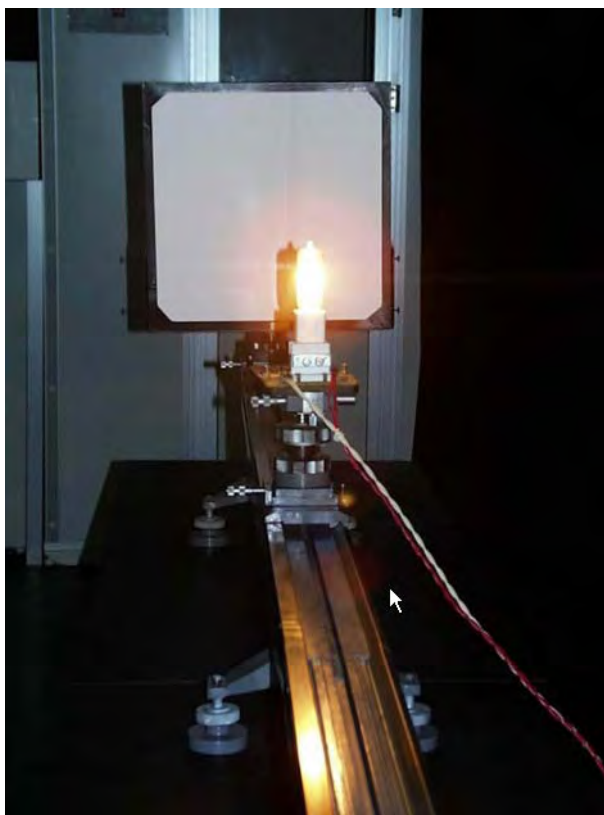
Ground-base measurement in very high spectral resolution with Bruker



大气观测实验室竣工图



Benchmark measurements in Beijing Atmospheric Spectrum Observation Laboratory

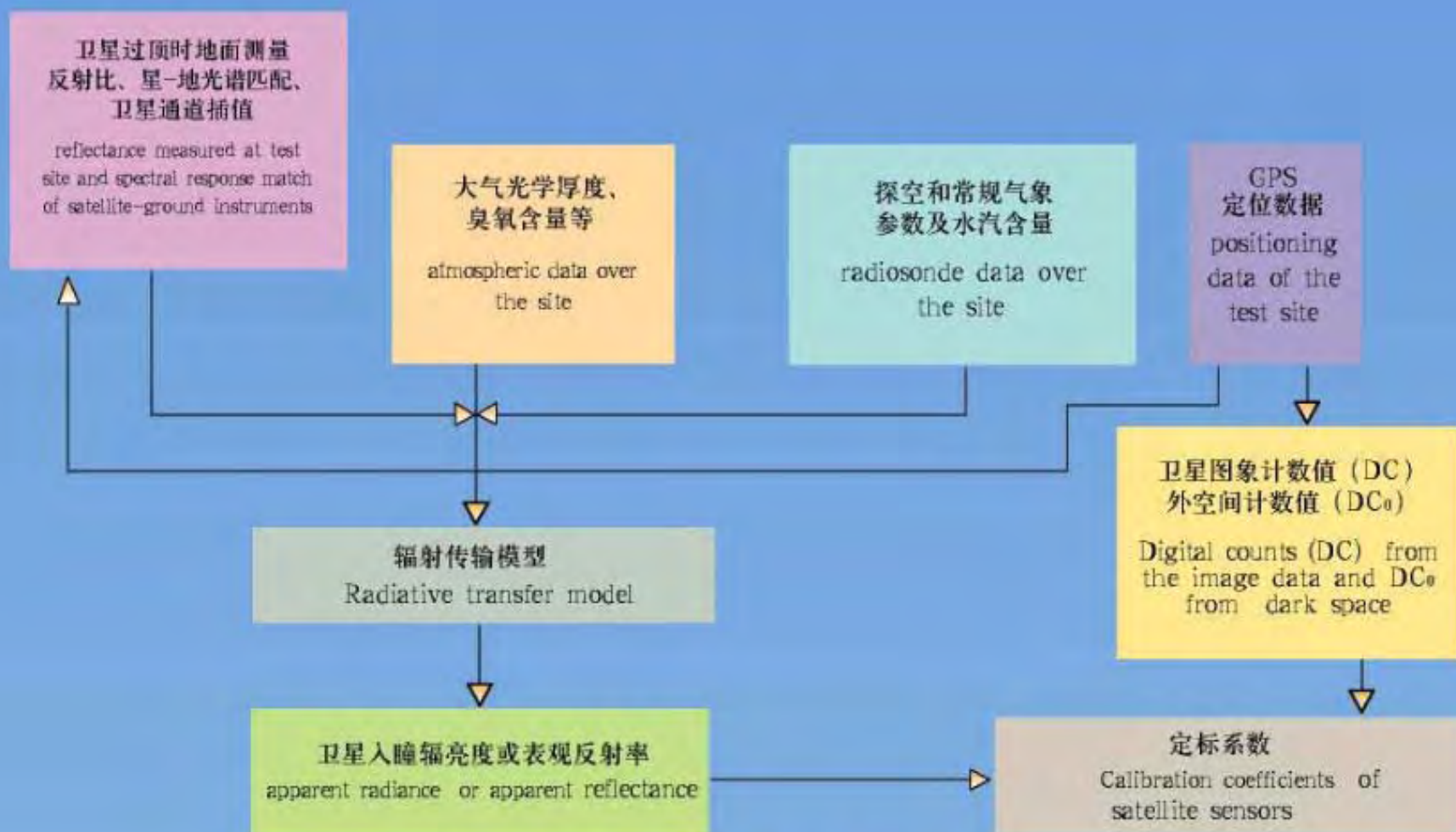


Reference Lamp

Integral Sphere

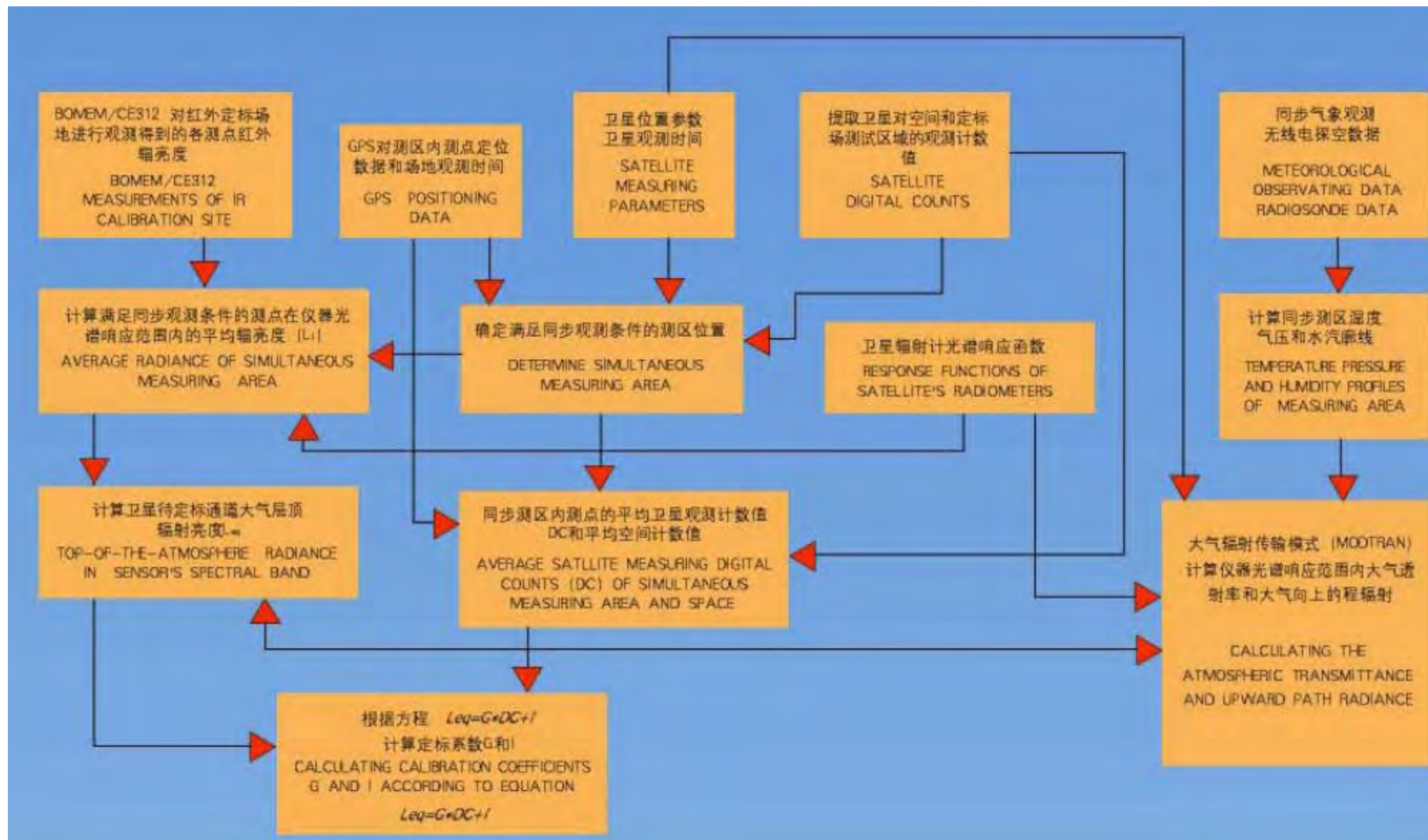


Reference Panel



可见 - 短波红外通道定标流程图
Reflectance-based calibration flow

Calibration flow for thermal channels



- DATE: 2007-7-24~2007-10-21
- PARTICIPANTS: National Satellite Meteorological Center (NSMC), National Satellite Ocean Application Service (NSOAS) ANHUI Institute of Optics and Fine Mechanics (AIOFM) Weather Bureau Of DUNHUANG, Atmosphere Detection Guarantee Center Of Qinghai Province etc.
- ITEMS: BRDF, Surface Reflectance, AOD, Meteorological Observation, SONDE



BRDF



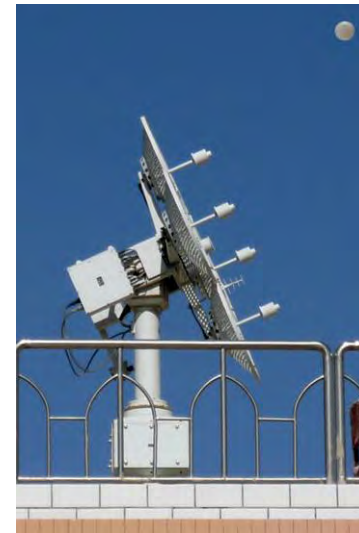
Surface Reflectance



AOD



Meteorological Observation



SONDE

List of the field campaign for recent years:

Field Campaign	Calibration Purpose	Campaign Site
1999	FY-1C, FY-2B	Dunhuang site
2000	FY-1C, CBERS-01	Dunhuang site and Qinhai Lake
2001	FY-1C, FY-2B	Qinhai Lake
2002	FY-1D/1C, FY-2B, HY-1, NOAA-17	Dunhuang site
2003	FY-1D/1C, FY-2B, HY-1	Qinhai Lake
2004	FY-1D, FY-2B, CBERS-02	Qinhai Lake
2005	FY-1D, FY-2C, MODIS	Dunhuang site and Qinhai Lake

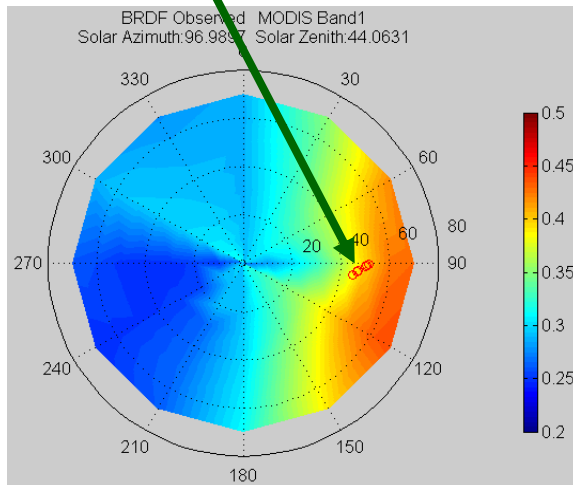
BRDF measurements of Gebi Desert

Goal: to reduce the BRDF impact on the reflectivity measurement

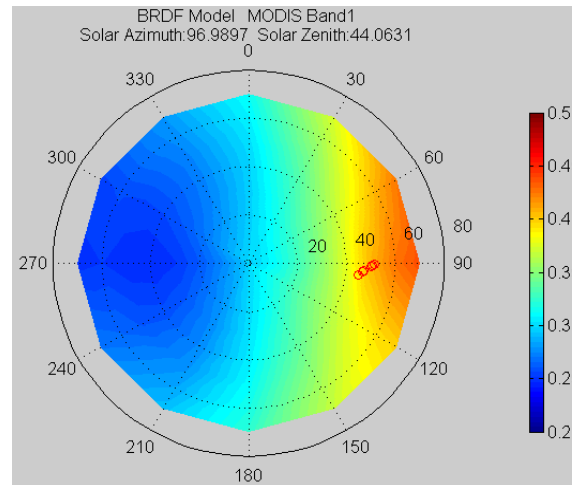
the sun's position within 50 minutes measurement time



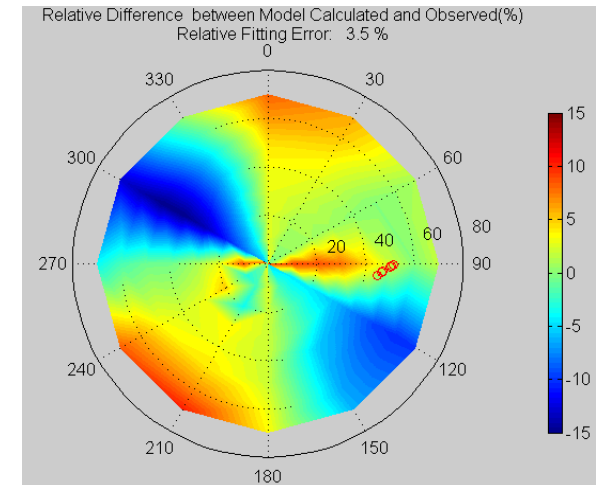
Dunhuang, 2002-07-23



Observation



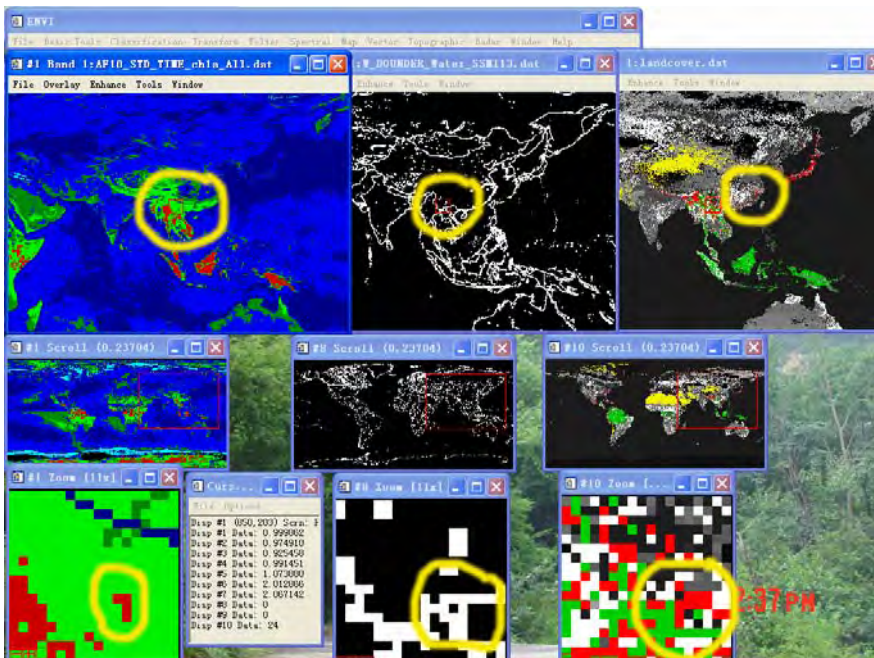
Roujean Model Simulation



Bias

Site selection for MW bands calibration

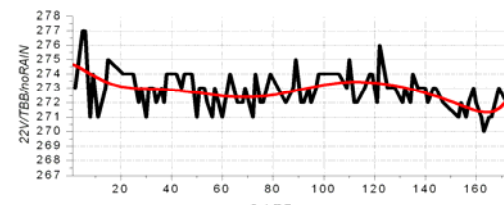
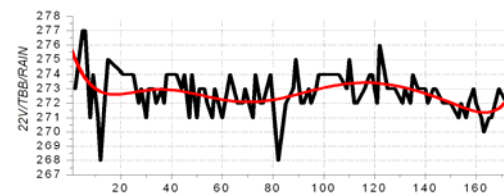
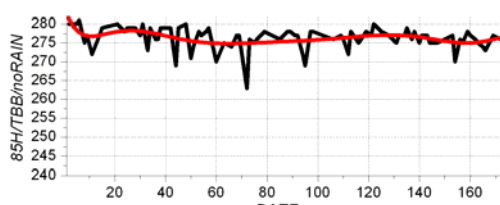
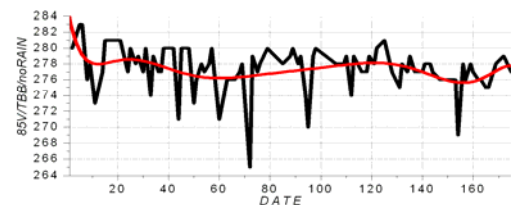
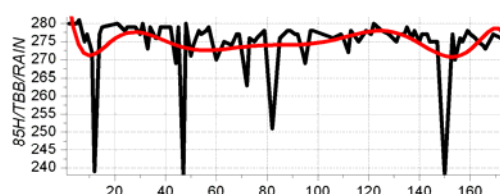
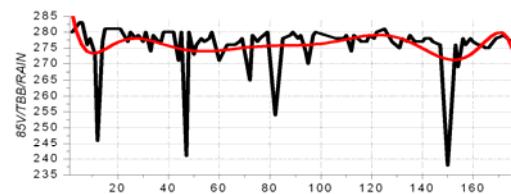
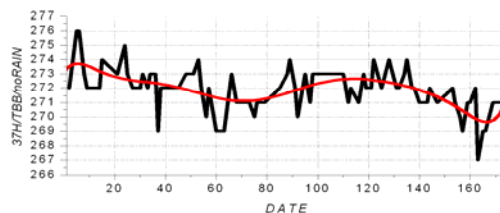
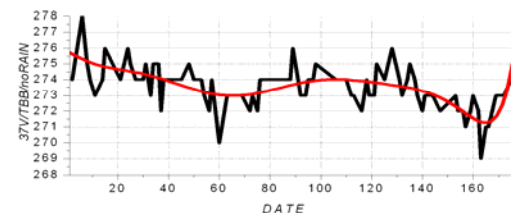
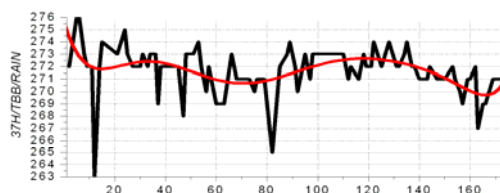
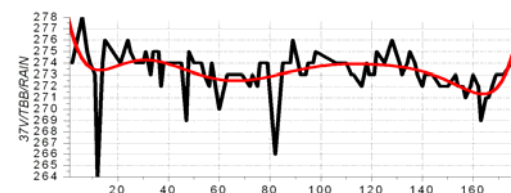
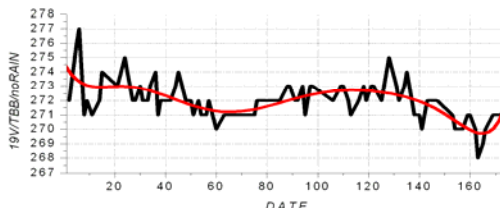
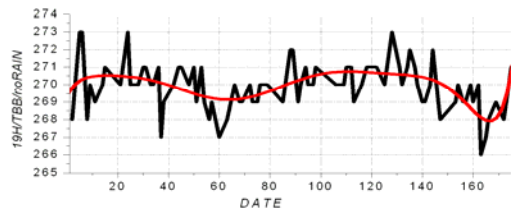
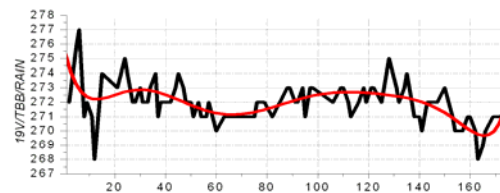
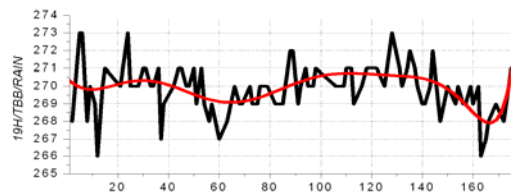
- The subtropical rain forest in the south area of Yunnan (location: longitude 100.5° E, latitude: 23.9° N)



Variance of SSM/I brightness temperature



The SSM/I brightness temperature time series from May to October (The south of Yunnan)



Field survey

- After analysing global microwave brightness stability, we went to the subtropical rain forest in the Yunnan.
- Then we do in-situ observation and analysis using radiative transfer model.
- Geography
 - Location: $23^{\circ} 55' 10''$ N-- $24^{\circ} 06' 15''$ N, $100^{\circ} 10' 15''$ E-- $100^{\circ} 20' 29''$ E;
 - Area: 268304Mu, 179km²;
 - the forest area: 154500Mu, 103km²;
 - the forest coverage ratio is 57.6%。

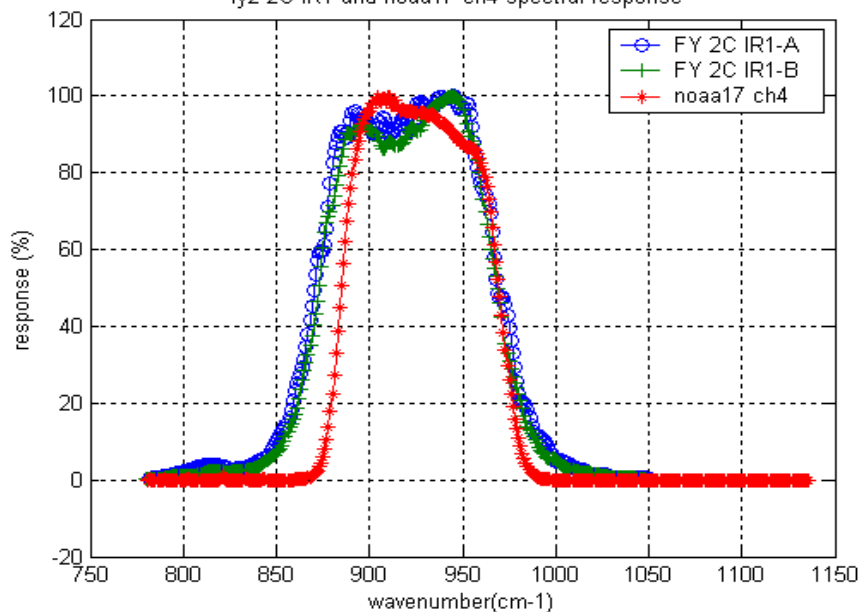
The
observation
situation



The
subtropical
rain forest
in Yunnan

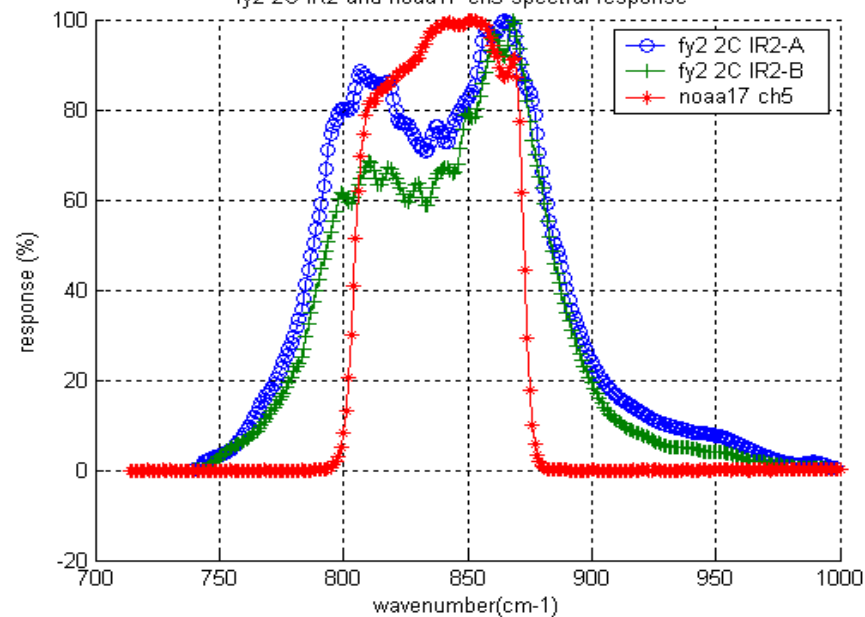


fy2 2C IR1 and noaa17 ch4 spectral response



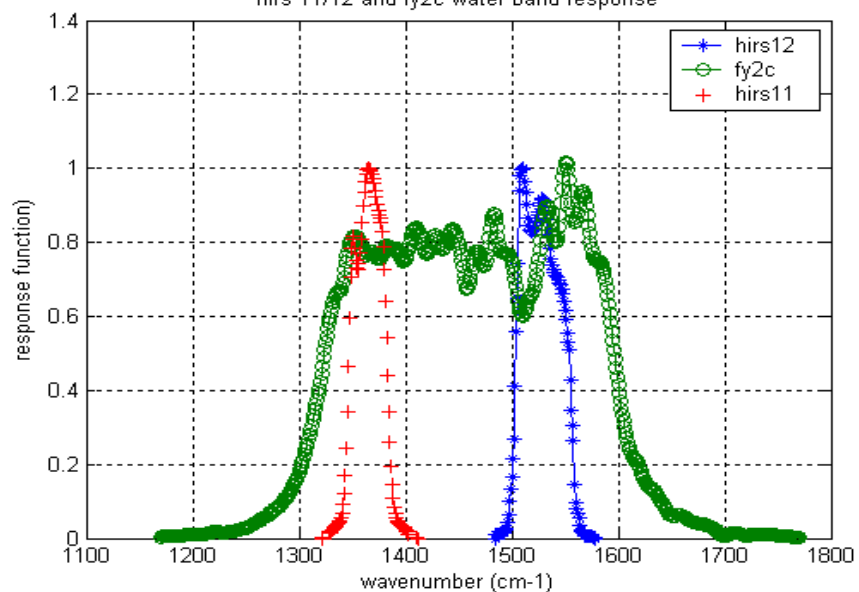
Schematic diagram of the response functions of ch4 and IR1 channel on board two satellites (NOAA-17 and FY-2C)

fy2 2C IR2 and noaa17 ch5 spectral response

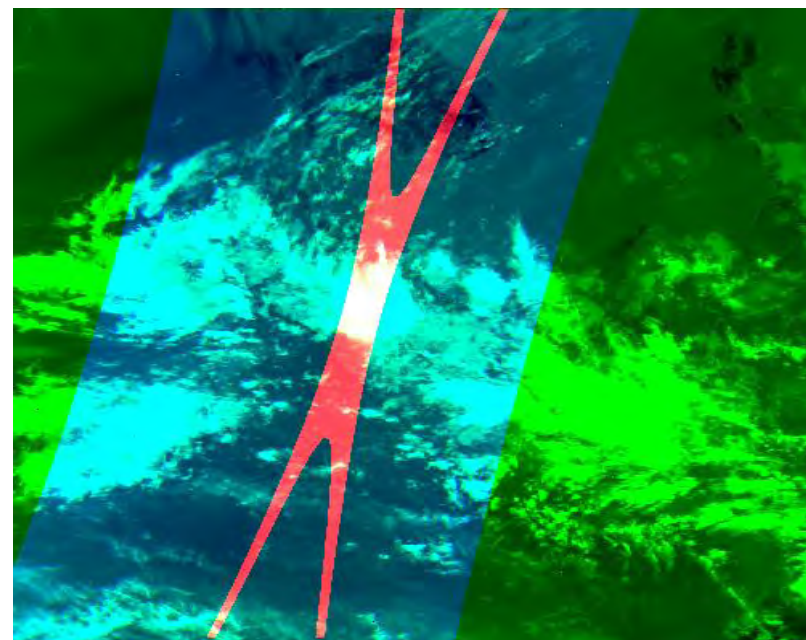


Schematic diagram of the response functions of ch5 and IR2 channel on board two satellites (NOAA-17 and FY-2C)

hirs 11/12 and fy2c water band response



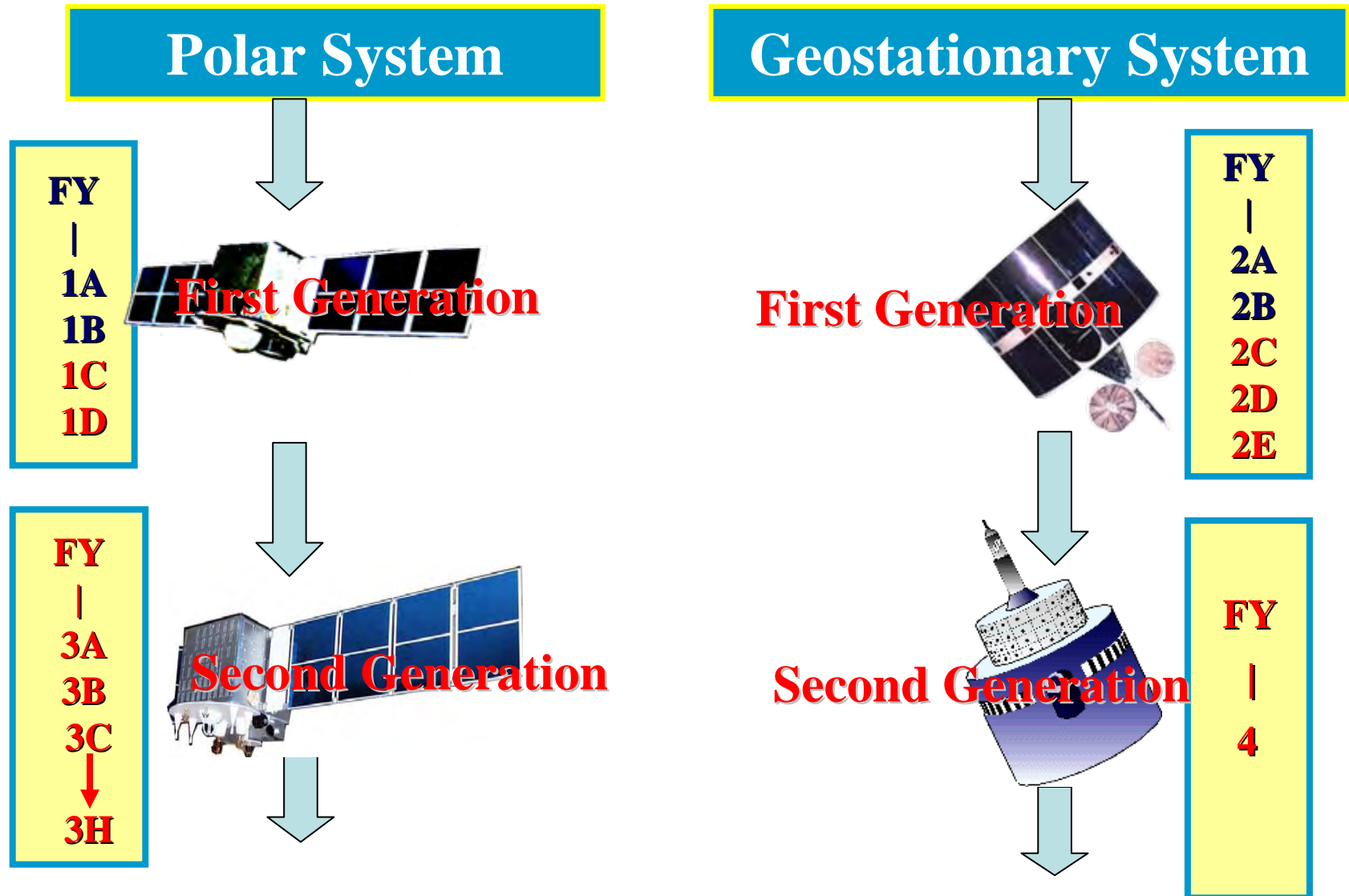
Schematic diagram of the response functions of WV channels on board two satellites (NOAA-17 HIRS/3 and FY-2C)



Sample zone (red area) for NOAA satellite passes the sub-point of FY-2C satellite

5. Future Plan for the Chinese Meteorological Missions

Chinese Meteorological Satellite: FengYun Series





Mission	88	89	90	91	92	93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15																																																													
FY1																																																																																										
	▲A				▲B								▲C				▲D																																																																									
FY2																																																																																										
											▲A										▲B										▲C										▲D										▲E																																							
FY3																																																																																										
																																									▲A										▲B										▲C																													
FY4																																																																																										
																																																			▲A																																							

Payloads onboard on FY-3A

<i>Abbreviation</i>	<i>Instrument Full Name</i>
VIRR	Visible and InfraRed Radiometer
IRAS	InfraRed Atmospheric Sounder
MWTS	MicroWave Temperature Sounder
MWHS	MicroWave Humidity Sounder
MERSI	MEdium Resolution Spectral Imager
SBUS	Solar Backscatter Ultraviolet Sounder
TOU	Total Ozone Unit
MWRI	Microwave Radiation Imager
SIM	Solar Irradiation Monitor
ERM	Earth Radiation Measurement
SEM	Space Environment Monitor

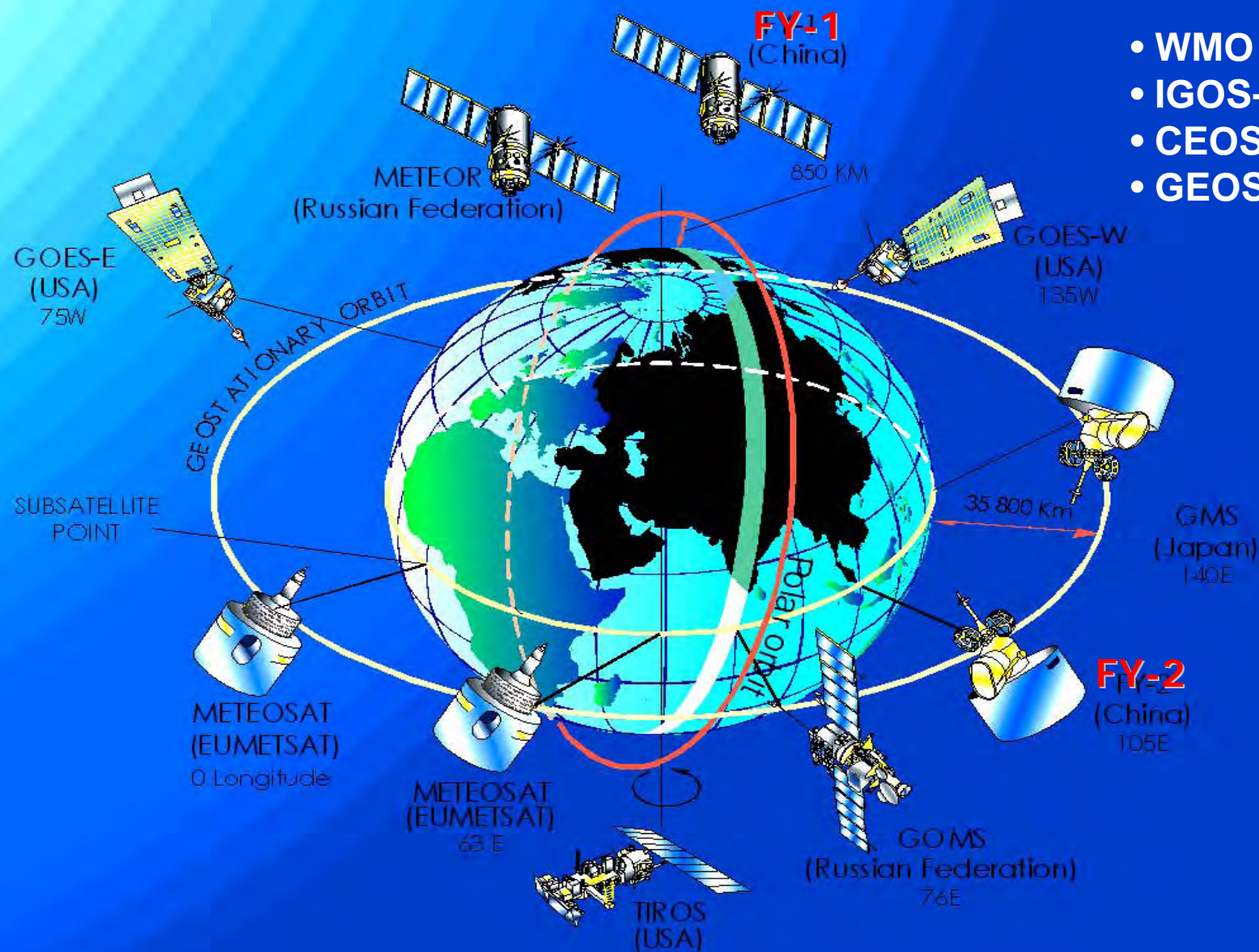
Basic Information for Each Instrument

Name of Instrument	Number of Channels	Spectral range	Field of Views /line	Spatial Resolution at Sub point (km)
VIRR	10	0.43 – 12.5 μ m	2048	1.1
IRAS	26	0.69 – 15.5 μ m	56	17
MWTS	4	50 – 57 GHz	15	50/75
MWHS	5	150 – 183 GHz	90	15
MERSI	20	0.41 – 12.5 μ m	2048/8192	1.1/250
SBUS	12	252 – 380 nm	240	70/10
TOU	6	309 – 361 nm	31	50
MWRI	6	10.65 – 150 GHz	240	15-70

Calibration Task for FY-3A

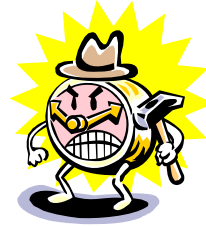
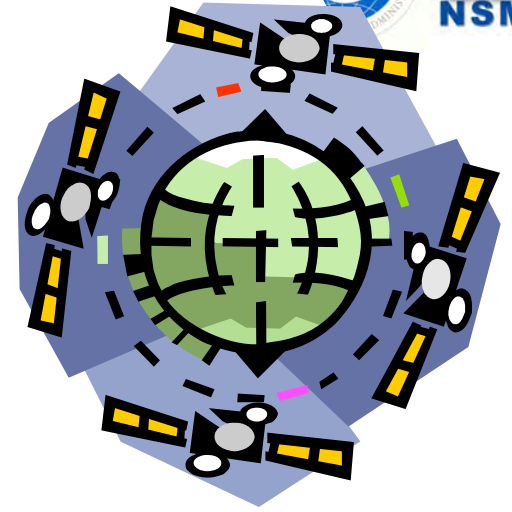
Instruments	Preflight Calibration & Characterization	On-board Calibration	In-flight Vicarious Calibration
VIRR	<ul style="list-style-type: none"> ✓ Solar-based VIS-NIR Cal. ✓ Integrating Sphere Cal. ✓ Lab thermal vacuum chamber TIR Cal. ✓ Spectral Response Function 	<ul style="list-style-type: none"> ✓ Black Body ✓ Space View 	<ul style="list-style-type: none"> ✓ CRCS sites Cal. ✓ Cross calibration: AVHRR, MODIS, ✓ Intra-Satellite Cross Calibration with VIRR
MERSI	<ul style="list-style-type: none"> ✓ Solar-based VIS-NIR Cal. ✓ Integrating Sphere Cal. ✓ Lab thermal vacuum chamber TIR Cal. ✓ Spectral Response Function ✓ Warm reflector ground calibration 	<ul style="list-style-type: none"> ✓ VIS/NIR Onboard calibrator ✓ Black Body ✓ Space View 	<ul style="list-style-type: none"> ✓ CRCS sites Cal. ✓ Cross calibration: MODIS, MERIS ✓ Intra-Satellite Cross Calibration with MERSI
MWRI	<ul style="list-style-type: none"> ✓ Antenna Test ✓ Emissivity test of microwave black body targets ✓ Lab thermal vacuum chamber Cal. 	<ul style="list-style-type: none"> ✓ Warmload BB ✓ Warm reflector ✓ Cold sky reflector 	<ul style="list-style-type: none"> ✓ Microwave Sites Cal. ✓ Cross Calibration: TMI, SSM/I, AMSR-E
IRAS	<ul style="list-style-type: none"> ✓ Vacuum Test ✓ Integrating Sphere Cal. 	<ul style="list-style-type: none"> ✓ Black Body ✓ Space View 	<ul style="list-style-type: none"> ✓ Cross Calibration: HIRS, AIRS, MODIS
MWTS	<ul style="list-style-type: none"> ✓ Antenna Test ✓ Emissivity test of microwave black body targets ✓ Lab thermal vacuum chamber Cal. 	<ul style="list-style-type: none"> ✓ Inter warm BB ✓ Space View 	<ul style="list-style-type: none"> ✓ Microwave Sites Cal. ✓ RAOB ✓ Cross calibration: AMSU-A, ATMS, SSMIS
MWHS	<ul style="list-style-type: none"> ✓ Antenna Test ✓ Emissivity test of microwave black body targets ✓ Lab thermal vacuum chamber Cal. 	<ul style="list-style-type: none"> ✓ Black Body ✓ Space View 	<ul style="list-style-type: none"> ✓ Microwave Sites Cal. ✓ RAOB ✓ Cross calibration: AMSU-B, HSB, MHS, SSMIS, ATMS
SBUS	<ul style="list-style-type: none"> ✓ Wavelength Cal. ✓ Radiometric Cal. ✓ Goniometric cal. ✓ Non-linearity cal. ✓ Interrange ratios cal. 	<ul style="list-style-type: none"> ✓ Solar irradiance ✓ Lamp 	<ul style="list-style-type: none"> ✓ Cross validation: SBUV/2 ✓ Ground measurement validation: WMO ground ozone measurements
TOU	<ul style="list-style-type: none"> ✓ Wavelength Cal. ✓ Radiometric Cal. ✓ Goniometric cal. ✓ Non-linearity cal. ✓ Interrange ratios cal. 	<ul style="list-style-type: none"> ✓ Solar irradiance ✓ Lamp 	<ul style="list-style-type: none"> ✓ Cross validation: OMI ✓ Ground measurement validation: WMO ground ozone measurements
ERB	<ul style="list-style-type: none"> ✓ Vacuum BB cal. ✓ Integrating Sphere Cal. 	<ul style="list-style-type: none"> ✓ Black Body ✓ Shortwave Lamp Source 	<ul style="list-style-type: none"> ✓ Cross calibration: CERES

FY Series will contribute to the global observation



- WMO GCOS
- IGOS-P
- CEOS
- GEOSS

..... *Stop Here*



*T
h
a
n
k
!*

