

Chinese Ground-based Space Weather Monitoring Project (Meridian Project)



Dr. Chi Wang
Center for Space Science and Applied Research
Chinese Academy of Sciences

Feb. 10, 2011



Outline

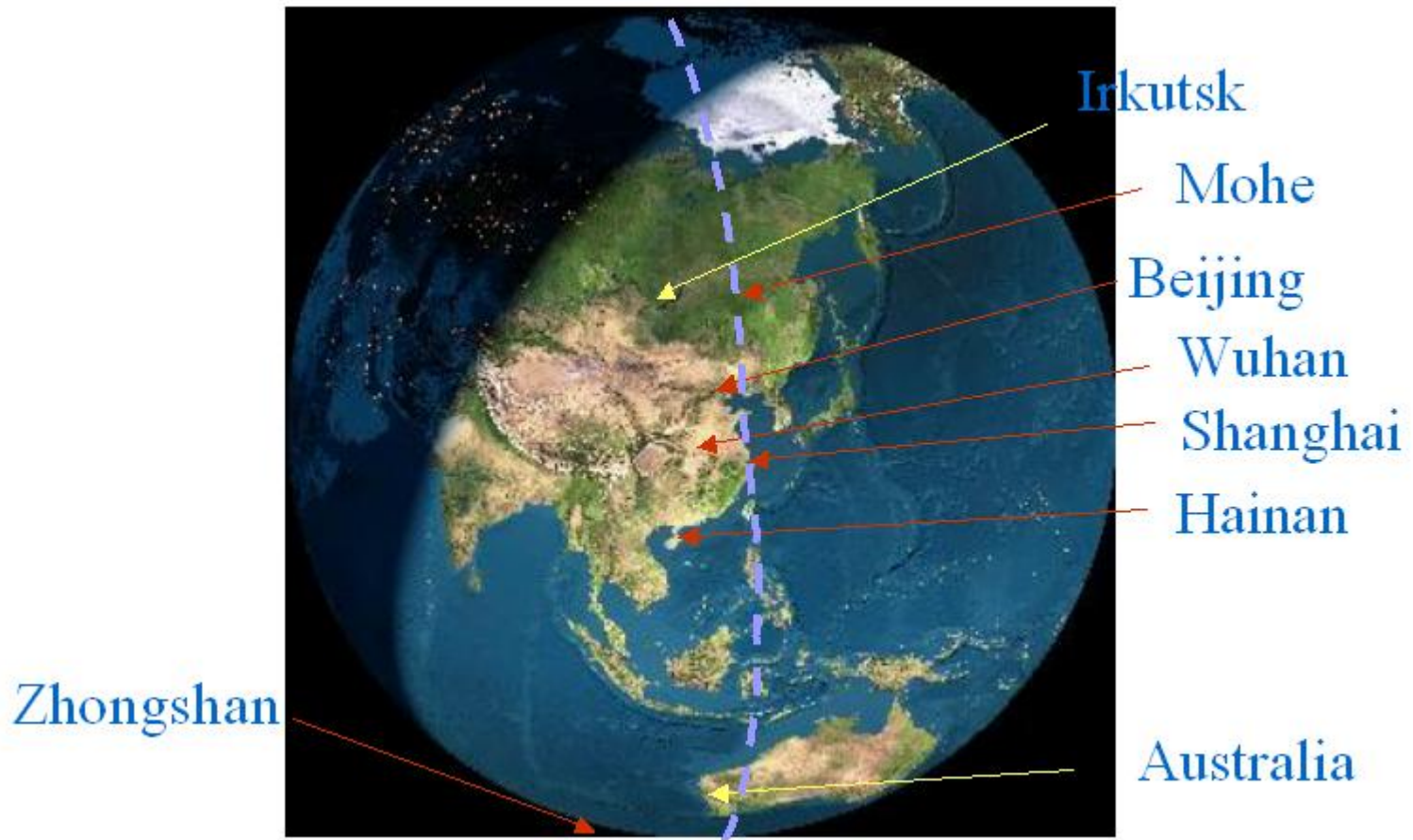
- Milestone
- Overview of the Meridian Project
- Structure of the Meridian Project
- International Collaboration



Milestone

- **2005.08** Meridian Project was officially approved by the China National Development and Reform Commission as a key scientific project.
- **2006.06** The feasibility study of the Meridian Project was evaluated and approved. The total budget is about 24 million US\$.
- **2008.01** Construction phase started
- **2011.01** Integrate and test phase started
- **2012.01** Official kick-off of operation





It is a Chinese multi-station chain along 120°E to monitor space environment, starting from Mohe, the most northern station in China, through Beijing, Wuhan, Guangzhou and extended to Chinese Zhongshan station in the Antarctic.



Scientific Principles



- ☑ Many basic physical processes occur along the meridian circle.
- ☑ With the rotation of the Earth, we can make global measurements of the space environment.

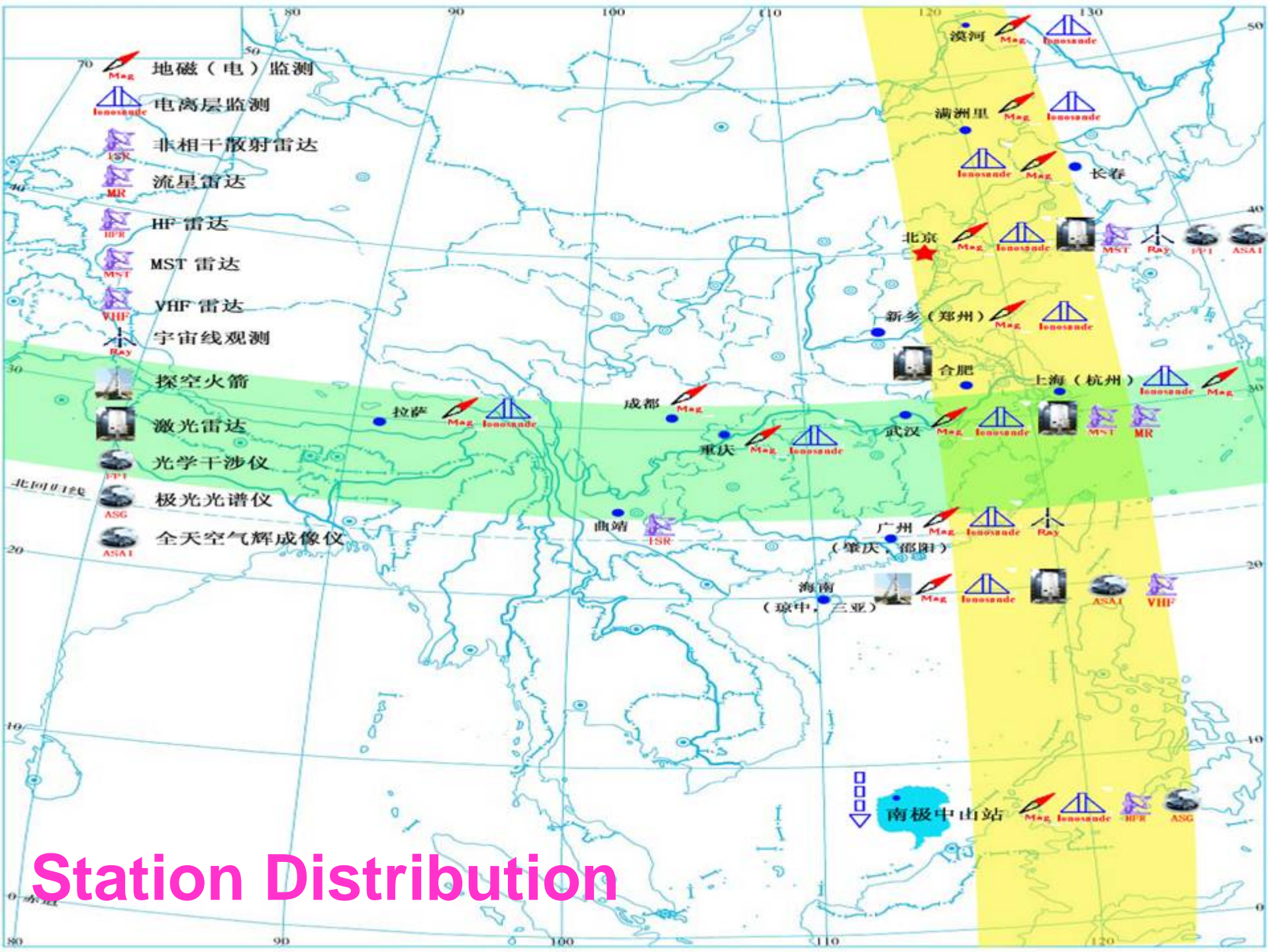


Observatories

15 Stations :

- ◆ 120° E Meridian Chain (10 stations): Mohe、Manzhouli、Changchun、Beijing、Xinxiang、Hefei、Wuhan、Guangzhou、Hainan、Zhongshan;
- ◆ 30° N Chain (5 stations): Shanghai (Hangzhou) 、Chongqing、Chengdu、Qijing、Laasa。
- ◆ Among them, Beijing、Wuhan、Hainan、Zhangsan are multi-tasking stations.





Station Distribution

Station	Lat.	Lon.	Instruments
Mohe	53.5N	122.4E	magnetometer, digisonde, TEC monitor/ionospheric scintillation monitor
Manzhouli	49.6N	117.4E	magnetometer, ionosonde
Changchun	44.0N	125.2E	magnetometer, ionosonde
Beijing	40.3N	116.2E	magnetometer, digisonde, lidar, all-sky imager, Fabry-Perot interferometer, mesosphere-stratosphere-thermosphere radar, interplanetary scintillation monitor, cosmic ray monitor, TEC monitor/ionospheric scintillation monitor, high frequency Doppler frequency shift Monitor
Xinxiang	34.6N	113.6E	magnetometer, ionosonde, TEC monitor/ionospheric scintillation monitor
Wuhan	30.5N	114.6E	magnetometer, digisonde, lidar, mesosphere-stratosphere-thermosphere radar, meteor radar, TEC monitor/ionospheric scintillation monitor, high frequency Doppler frequency shift monitor
Hefei	33.4N	116.5E	Lidar



Station	Lat.	Lon.	Instruments
Guangzhou	23.1N	113.3E	magnetometer, digisonde, lidar, mesosphere-stratosphere-thermosphere radar, meteor radar, TEC monitor/ ionospheric scintillation monitor, high frequency Doppler frequency shift monitor
Hainan	19.0N	109.8E	magnetometer, digisonde, TEC monitor/ionospheric scintillation monitor, Lidar, all-sky imager, very high frequency radar, sounding rockets, meteor radar
Zhangshan	69.4S	76.4E	magnetometer, digisonde, high-frequency coherent scatter radar, aurora spectrometer
Shanghai	31.1N	121.2E	magnetometer, TEC monitor
Chongqing	29.5N	106.5E	magnetometer, ionosonde
Qujing	25.6N	103.8E	Incoherent Scattering Radar
Chengdu	31.0N	103.7E	magnetometer, ionosonde
Lhasa	29.6N	91.0E	magnetometer, ionosonde



行星际

可见光
子射线
X射线

太阳风

IPS
观测
中子堆

磁层

500KM 电离层区

热层 F2 (80+)

F1

中间层 E (50-80) D

平流层 (15-50)

对流层 (0-15)

海平面



Spatial Coverage

By

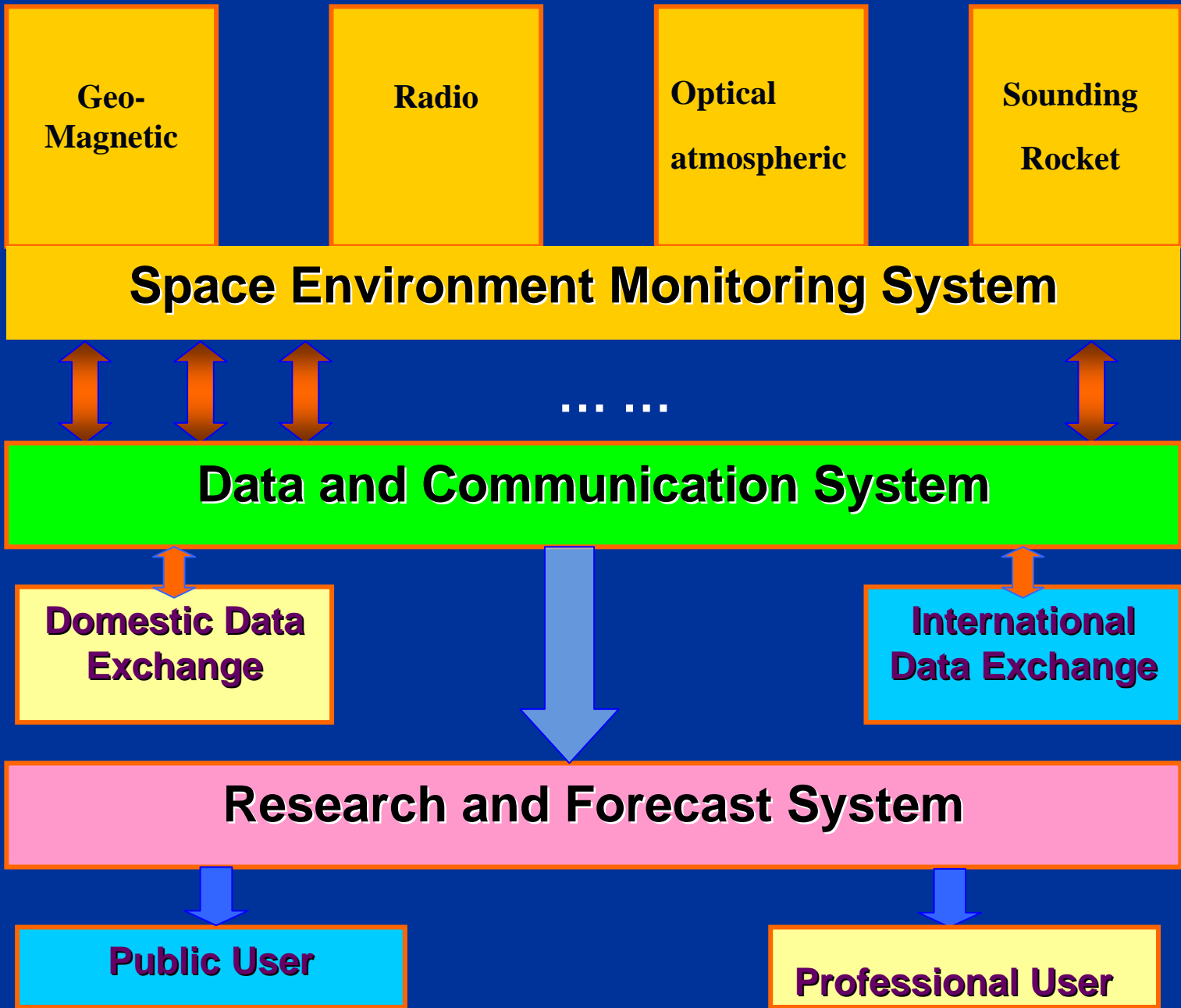
The Meridian Project

Parameters Observed

- ◆ **Earth Surface:** Geomagnetic field、 Geoelectronic field 、 Cosmic Rays;
- ◆ **Middle-Upper Atmosphere:** density、 temperature、 composition、 electric current;
- ◆ **Ionosphere:** density of electron and proton, temperature, irregular structures, electric current
- ◆ **Interplanetary Space:** solar wind plasma speed



FRAMEWORK

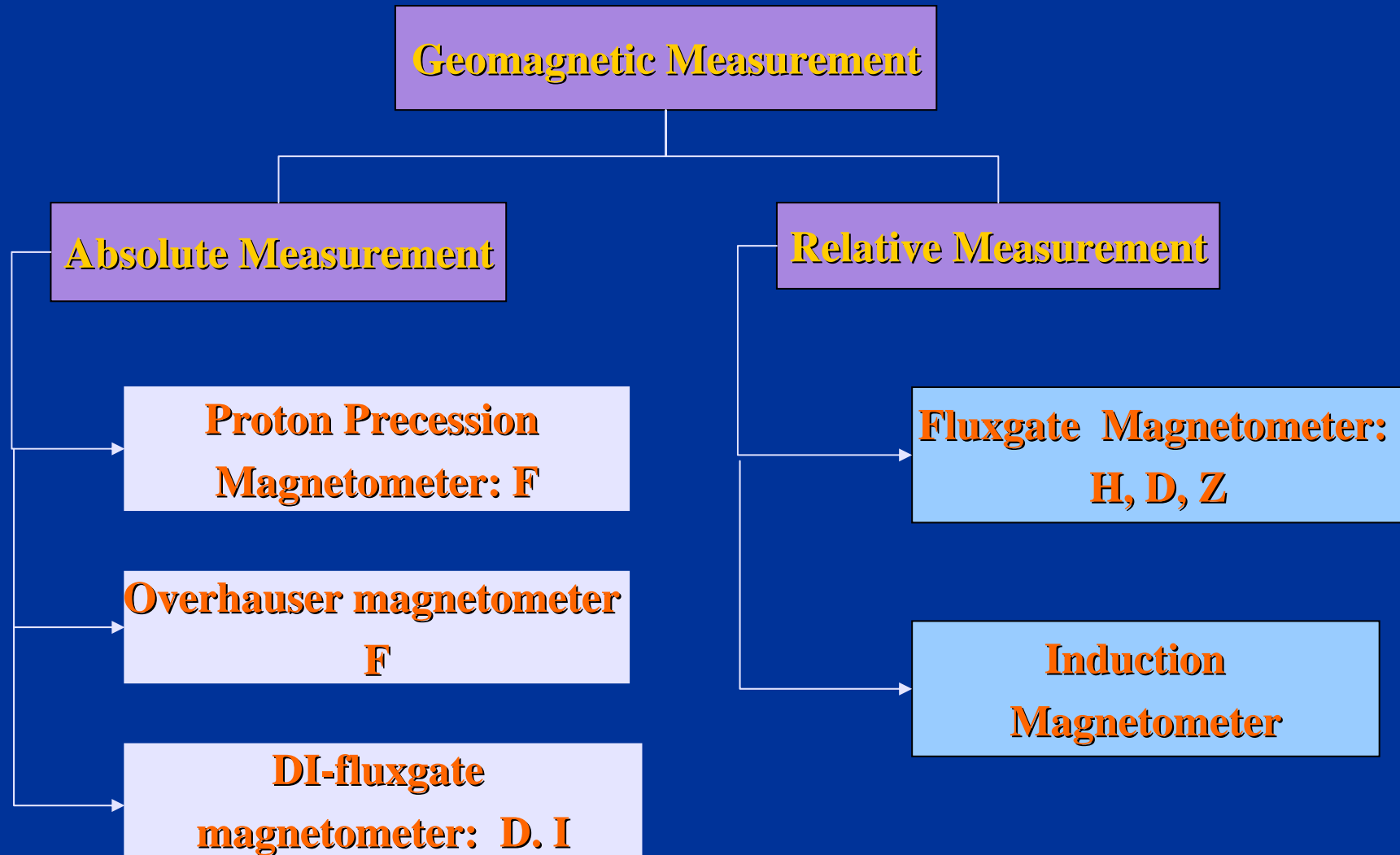


I. Geomagnetic Monitoring Subsystem

- To measure the variation of the geomagnetic (geoelectric) field
- To study the response of the geomagnetic (geoelectric) field to interplanetary disturbances



Instrument



Geomagnetic Instrument



ZD9A-11 地电场仪

地电场仪



Overhauser磁力仪



磁通门磁力仪



大气电场仪



感应式磁力仪



磁通门经纬仪

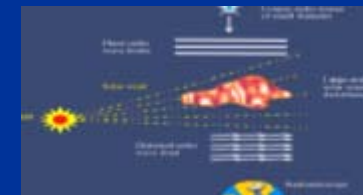


Geomagnetic Observatories



II. Radio Monitoring Subsystem

- To measure the physical parameters of the middle-upper atmosphere, ionosphere and the interplanetary space by use of remote sensing technique.



Four Parts



1. Incoherent Scattering Radar (ISR)

- ISR is located in Qujing, Yunnan Province (25.6° N, 103.8° E).
- To measure physical parameters of the middle-upper atmosphere and ionosphere from 70 up to 1000 km.
- ISR has a peak transmission power of ~ 2 MW.



ISR Radar

天线罩



操控室



进口发射机系统



发射机水冷系统



2. Radar Chain

Instrument	Detecting Content	Sites
MST Radar	Wind parameters of troposphere, stratosphere and mesosphere , ~50MHz	Beijing、 Wuhan
HF Coherent Scattering Radar (HF Radar)	To detect the motion of the ionospheric structure within a azimuth angle of 52° and 3000 km height by use of the scatter features of the ionospheric irregular structures	Zhongshan Station at South Pole
VHF Coherent Scatter Radar (VHF Radar)	To detect the irregular structure and drift (electrical field) in the ionospheric E lay, and to detect intensity and drift of the spread F, by measuring the intensity and Doppler Shift of the echo from the field aligned irregular bulk.	Hainan
Meteor Radar	To detect the wind field and diffusive coefficient of the atmosphere, the flux, position and velocity of the meteors between 70~110 km by tracing the meteors	Wuhan



MST Radar

北京
MST
雷达



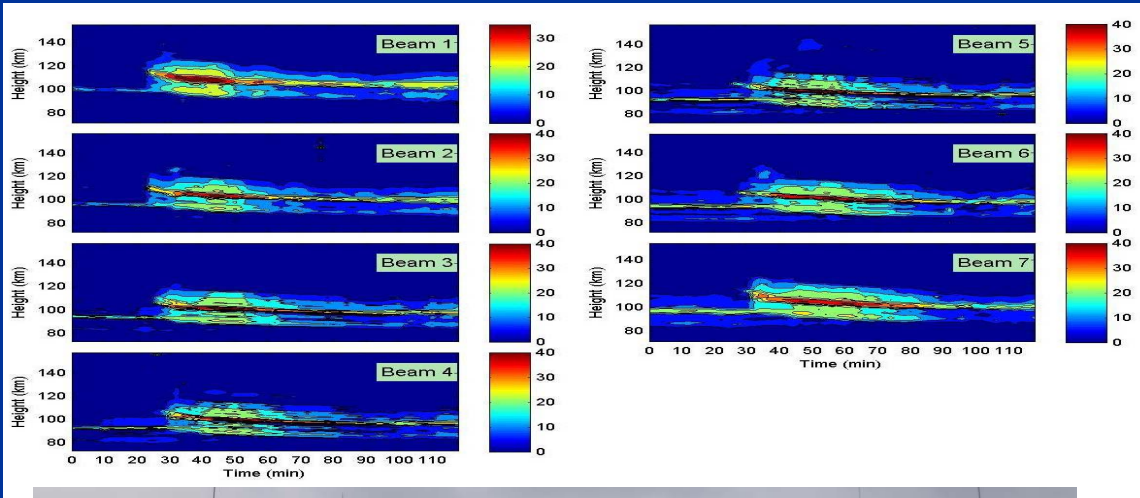
武汉
MST
雷达



HF Radar



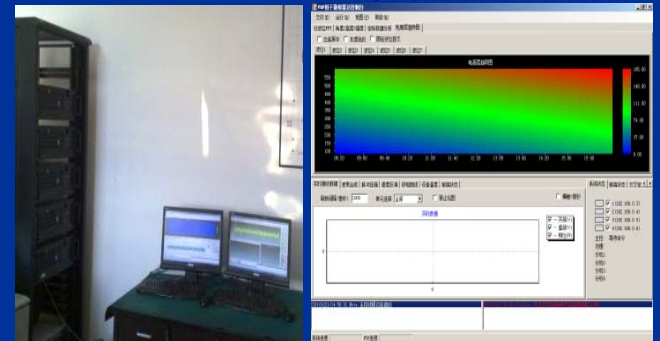
VHF Radar



前端数字单元实物



时钟同步设备



后端处理系统

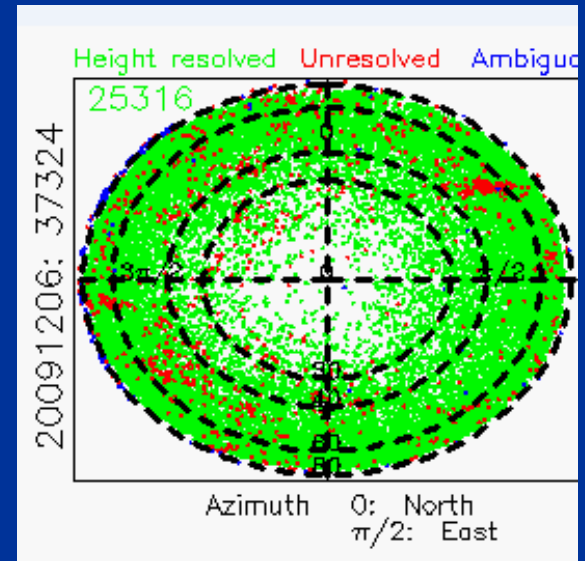
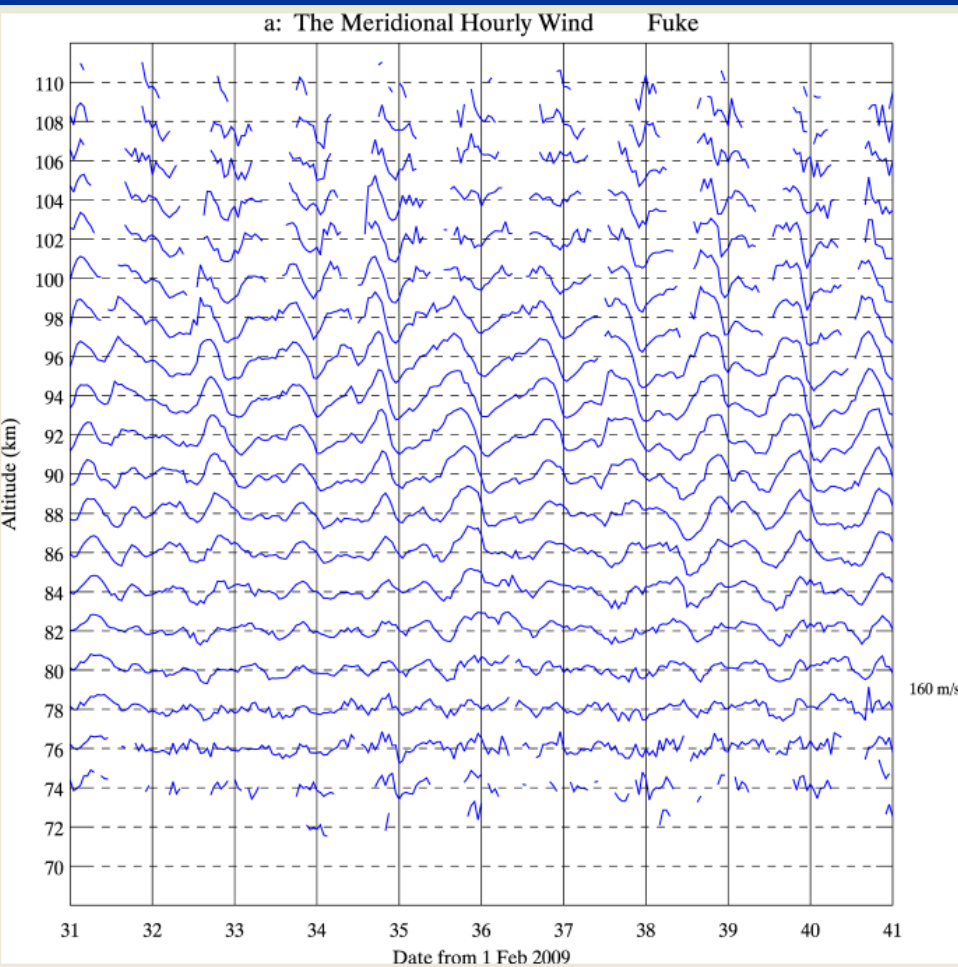




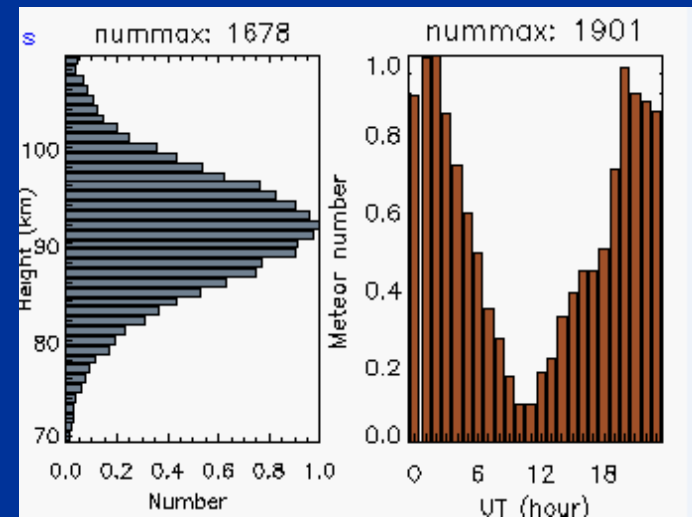
Meteor Radar



Meteor radar observation



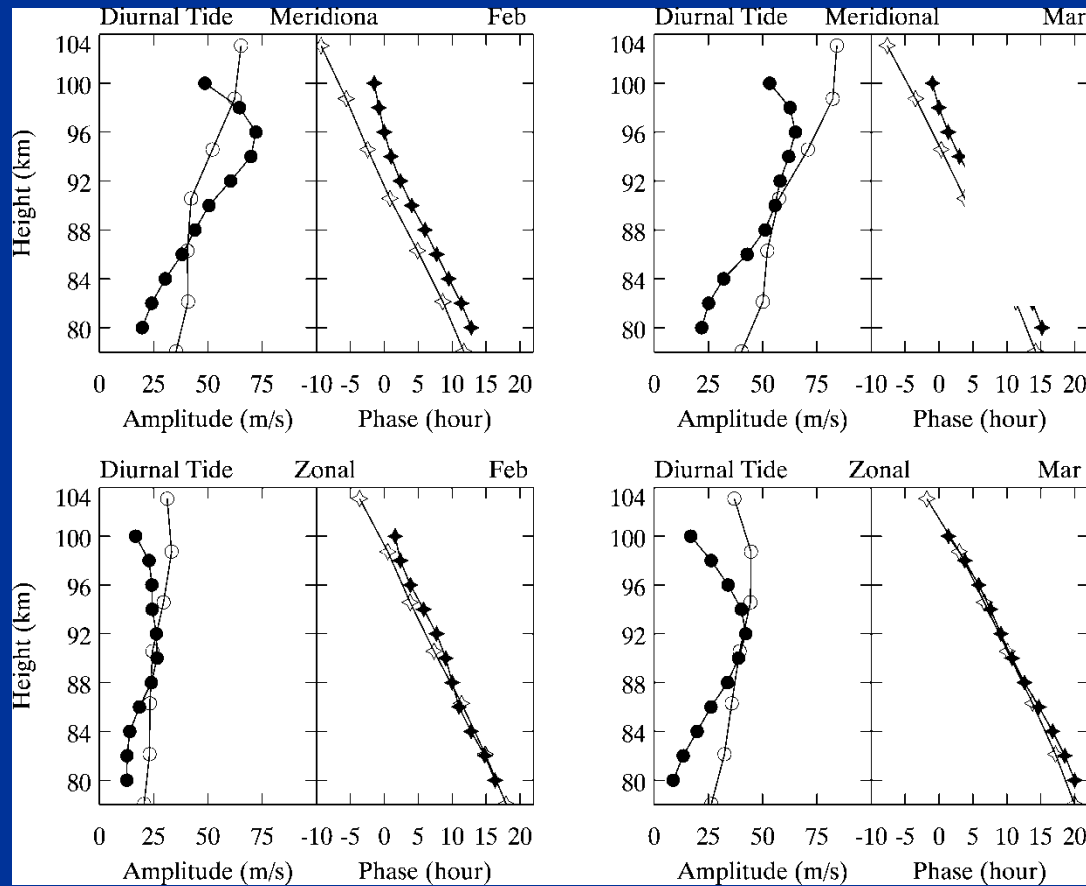
Observed meteors



Observed wind



Meteor radar observation: tidal winds



● ◆: Observation
○ ◇: GSWM02



3. Ionosode Chain

- **Digisonde**

Mohe (new) – Beijing (new) – Wuhan (upgrade)-Hainan (upgrade) – Zhangshan (upgrade)

- **Traditional Ionosonde**

Manzhouli – Changchun – Ghuanzhou – Chongqing - Lasha



Digi sonde



北京数字测高仪



海南数字测高仪



武汉数字测高仪



南极数字测高仪



漠河数字测高仪



4. Real time monitor chain of space environment

Instrument	Purpose	Site
Interplanetary Scintillation (IPS) Monitor	To monitor the interplanetary disturbance and obtain information about the solar wind velocity and plasma irregular structures	Beijing
Neutron Monitor	To detect the solar energetic particles and cosmic rays	Beijing, Guanzhou
Ionospheric TEC and Scintillation Monitors	To monitor the ionospheric TEC and scintillation in real time	Mohe, Beijing, Xinxiang, Wuhan, Hainan, Shanghai(Hangzhou)
HF Doppler Drift Monitor	To monitor multi-scale ionospheric disturbance propagation, by use of a long baseline system including a 3 HF Doppler antenna array in Beijing and a HF Doppler monitor in Wuhan	Beijing, Wuhan



IPS



50米天线



控制室



Neutron Monitor



北京宇宙线中子堆



广州宇宙线闪烁体望远镜



III. Optical-Atmospheric Monitoring Subsystem

- To measure the density, temperature, wind field, airglow and aurora spectrum by use of active and passive optical tools.



Station Distribution

■ Lidar Chain:

Beijing(new)-Wuhan(upgrade)-Hefei(new)-Hainan(new)

■ **Beijing:** All-sky Airglow Imager, FP-interferometer (new)

Hainan: All-sky Airglow Imager (new)

■ **Zhangshan:** Aurora Spectrometer (new)

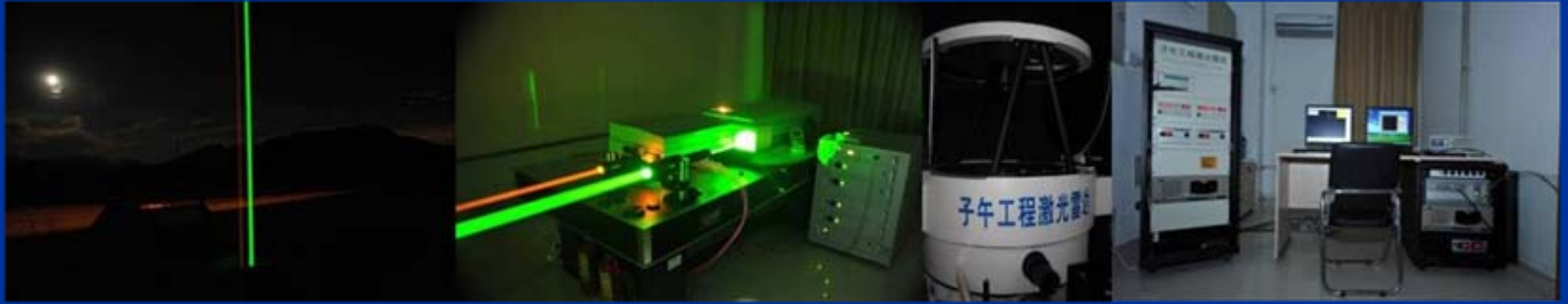


Instrument	Content	Sites
Lidar	Temperature and density profiles of the middle atmosphere	Beijing, Wuhan, Hefei, Hainan
Fabry-Perot Interferometer	Wind and temperature of atmosphere in the mesopause region and F2 layer	Beijing
All-sky Airglow Imager	The horizontal structure and transmitting feature of gravity waves in the mesopause region and the thermosphere	Beijing, Hainan
Aurora Spectrometer	Aurora spectrum, the atmospheric chemical species, the energetic spectrum of the energetic particles from the solar wind and the magnetosphere	Zhongshan Station in South Pole



Lidar

北京激光雷达

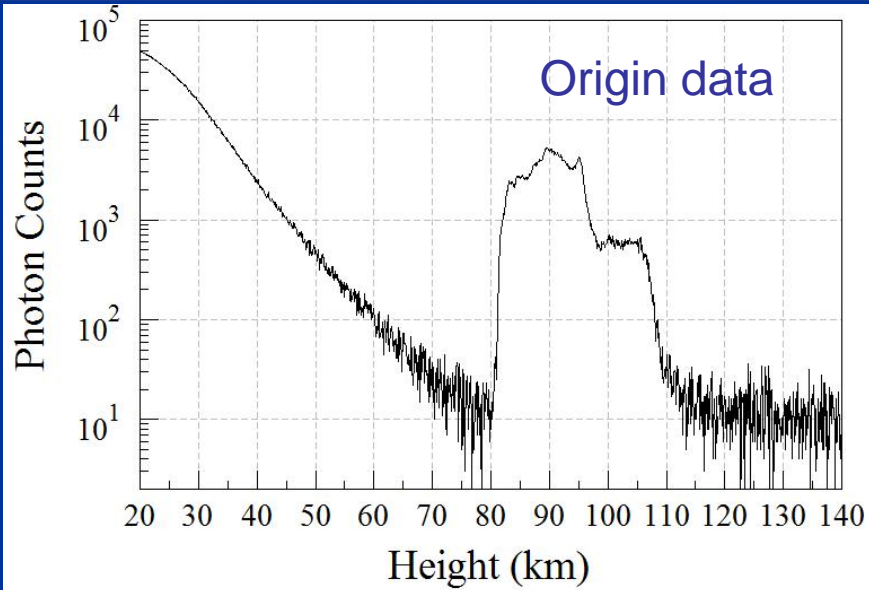


海南激光雷达

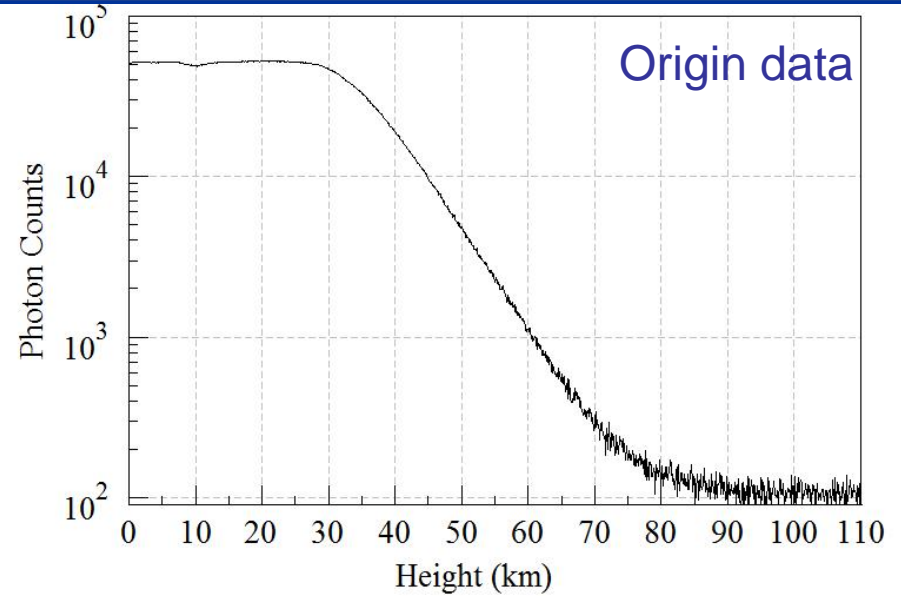


合肥激光雷达

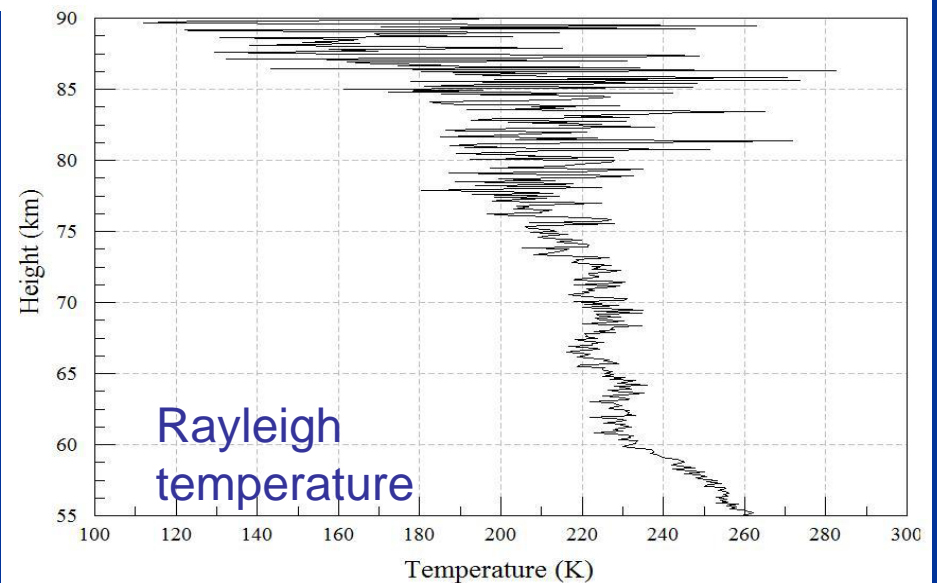
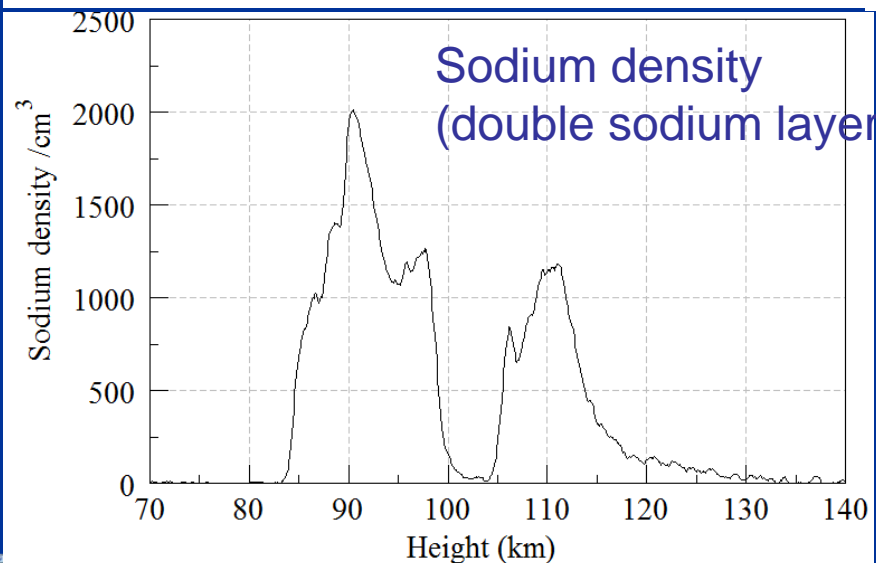




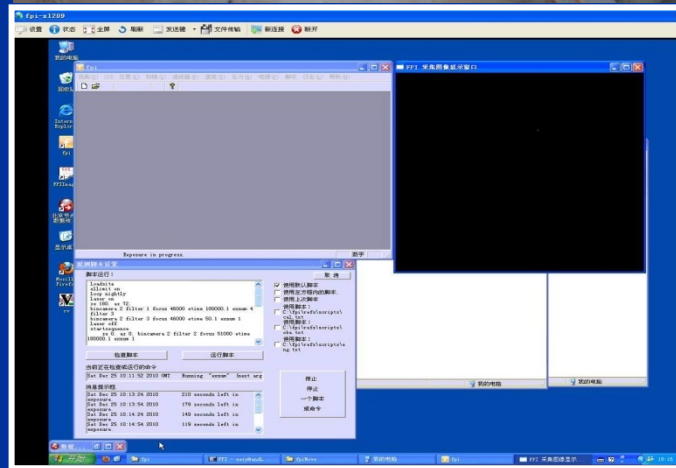
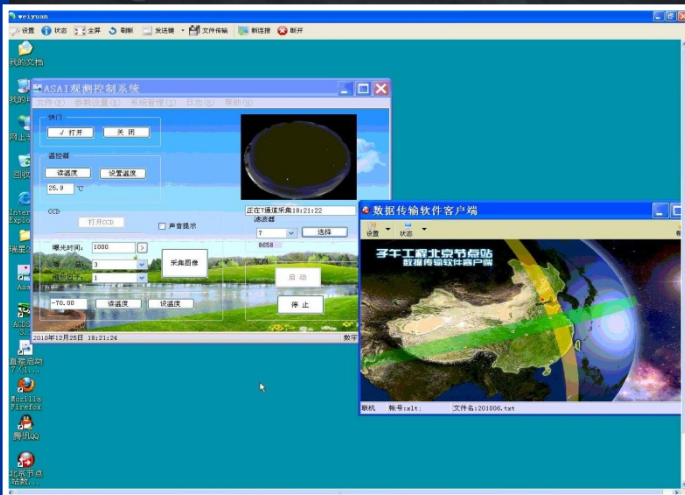
resolution: 166S and 0.96km



resolution: 20min and 0.96 km

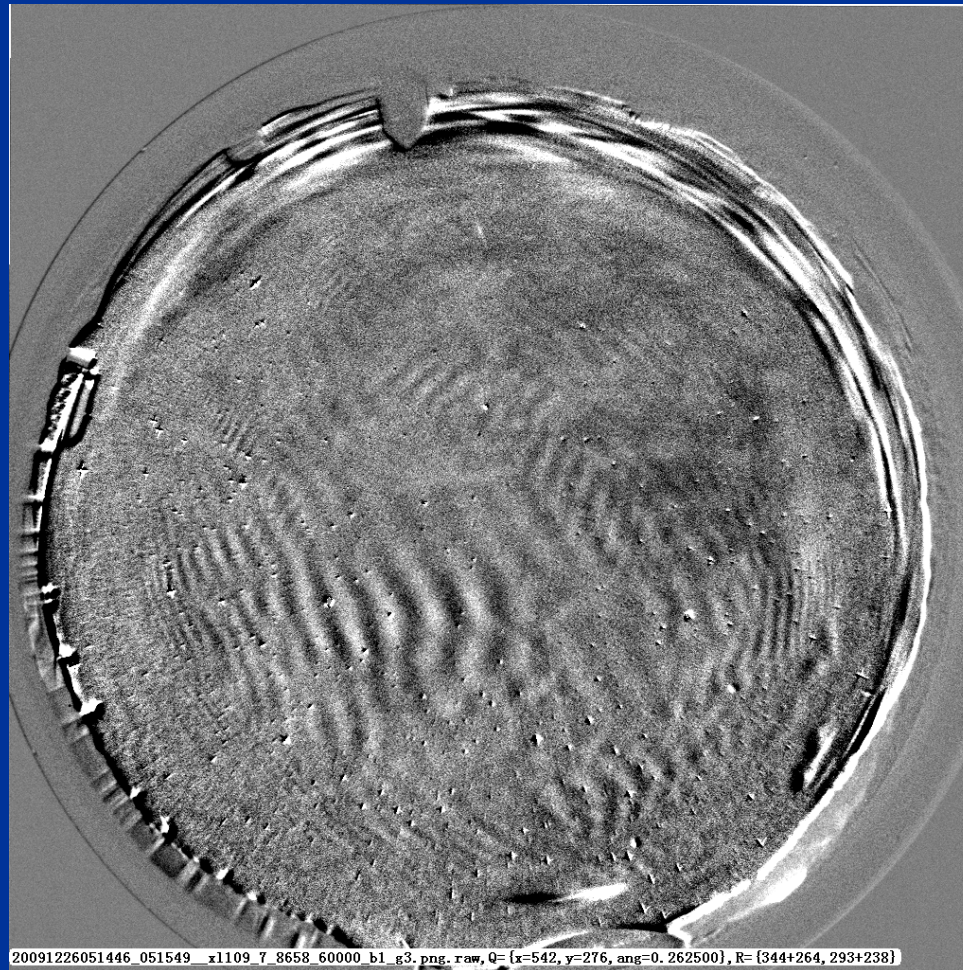


All-Sky Imager



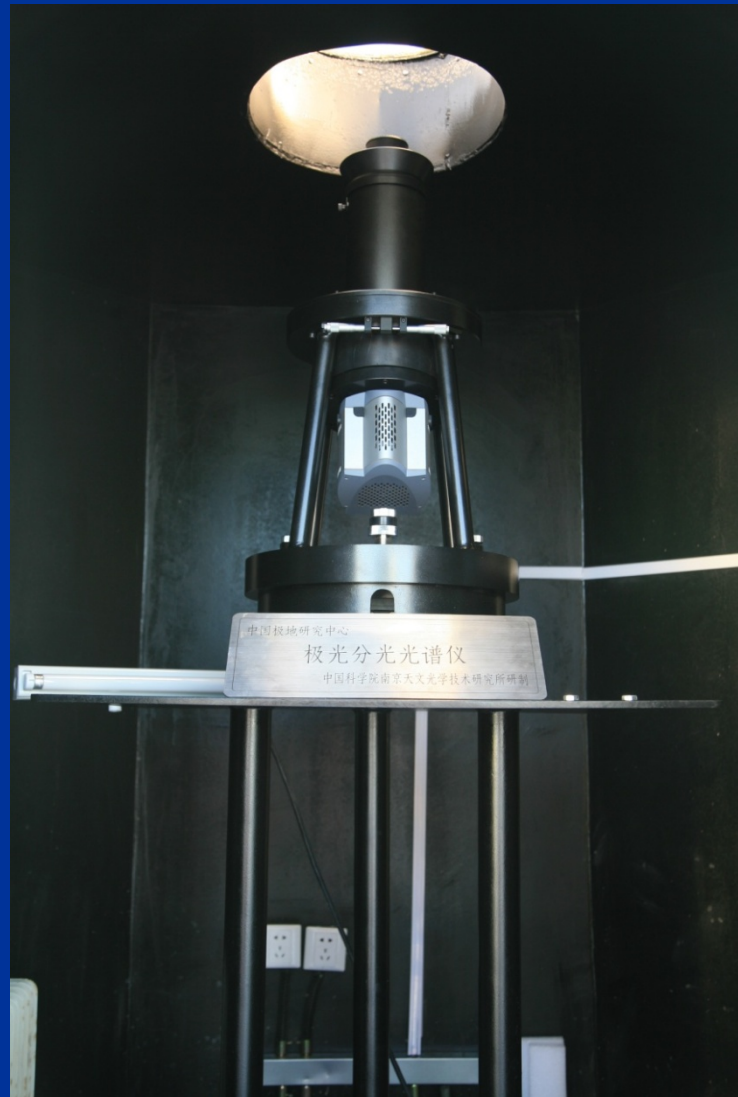
全天空气辉成像仪

光学干涉仪



A difference image between consecutive raw images of OH airglow at 05:14 LT and 05:15LT on Dec. 26, 2009. This image shows some gravity waves.

Aurora Spectrometer



南极中山站极光光谱仪

IV. Rocket Sounding Subsystem

- To make in-situ measurements of temperature, density, pressure, wind etc. in the height of 20~200 km.



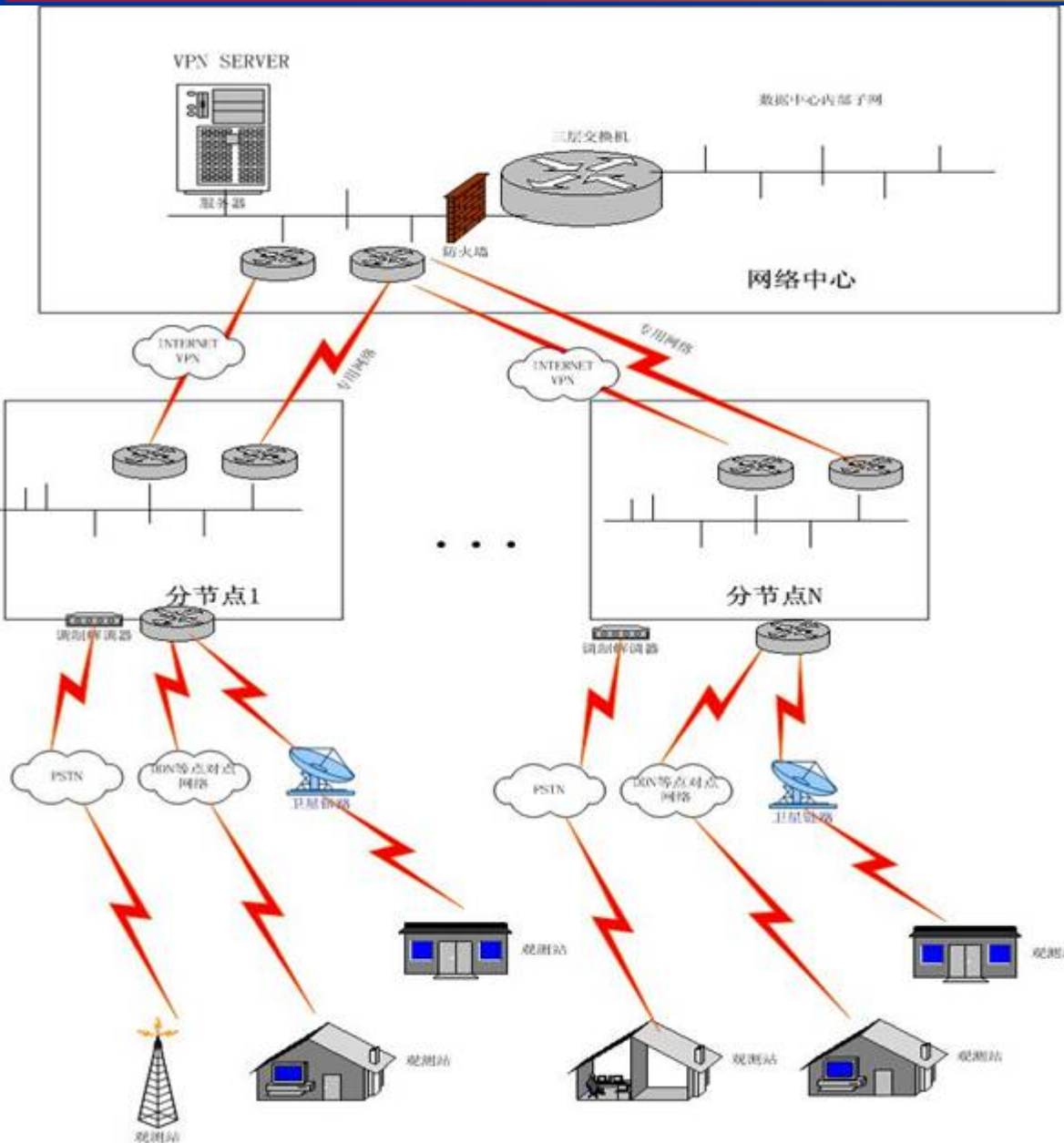
The first sounding rocket was successfully launched on June 3, 2010.



Data and Communication System

- Collect, transfer, process, store and distribute data
- International and domestic data exchange

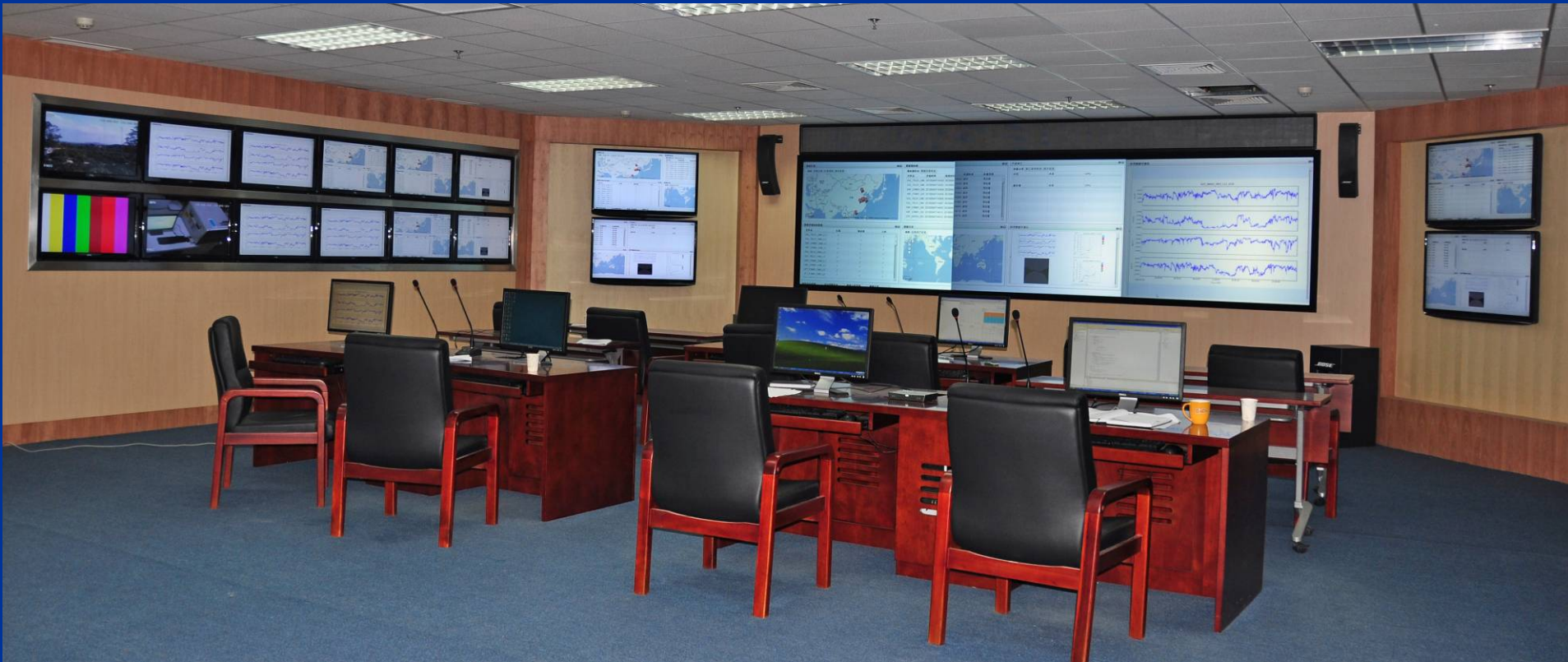




**Three-layer-
Structure:**

Station-Node-Center

Data Center



Data Center Storage Equipment



Research and Forecast System

- Coordinate observations, research and management
- Carry out research and model
- Jointly make space weather forecast
- Promote international collaboration



Science Operation Center

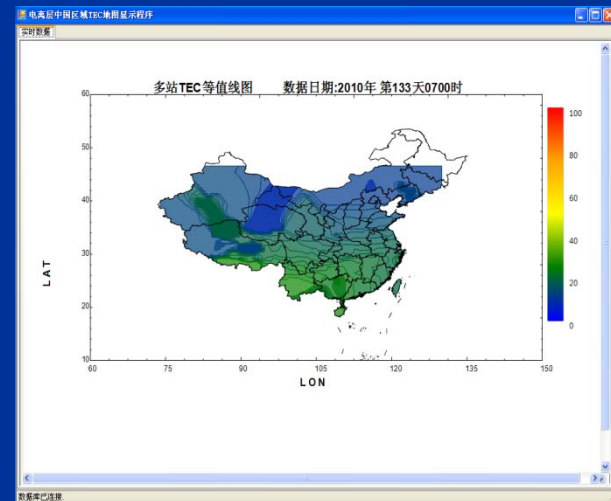
专用高性能计算平台



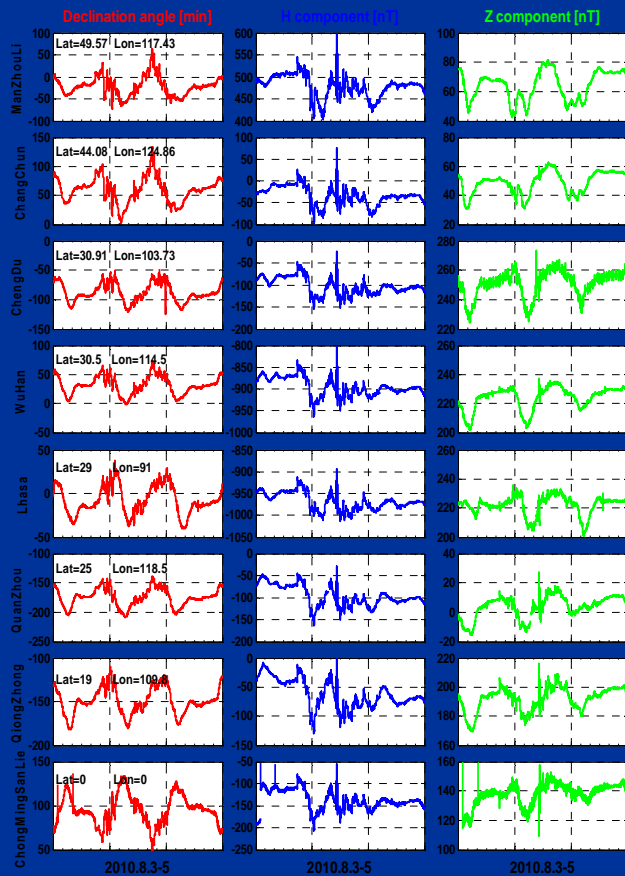
演示大厅



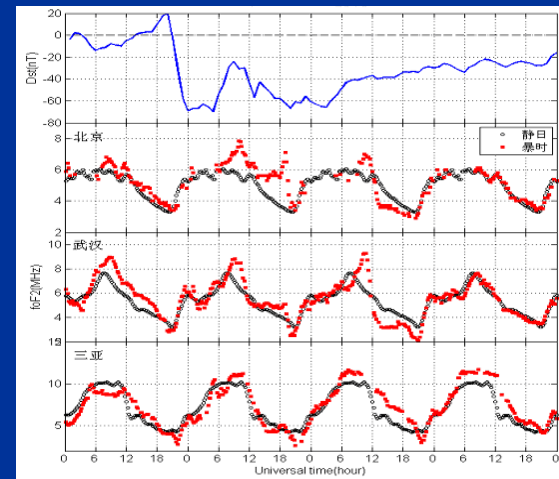
Space Weather Warning and Forecast Center



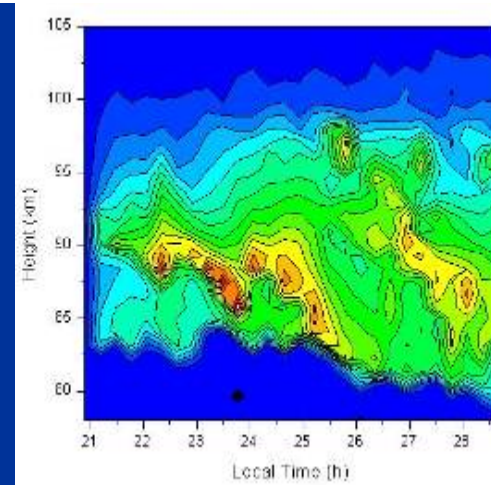
Observations of the geospace response of to the solar storm on Aug. 1 – 3, 2010



Geo
Magnetic
field



ionospheric



Na layer



Space Weather Journal Cover Article

(2010/08/19)



Editor's Comments:

What an ambitious,
broad-reaching, and
hard-hitting endeavor!



International Collaboration



The International Space Weather Meridian Circle Program (ISWMCP), proposal to connect 120°E and 60°W meridian chains of ground based monitors and enhance the ability of monitoring space environment worldwide.



What will ISWMCP do?

- **Coordinating observational campaigns;**
- **Making data available to the space weather community;**
- **Encouraging collaboration on scientific research and observations;**
- **Promoting education and public outreach on space science and technology.**



Summary

- Meridian Project is a ground-based network program to monitor space environment , which consists of a chain of ground-based observatories with multiple instruments.
- Meridian Project has officially been approved by Chinese government, and have been finished by 2011. The official operation will begin in 2012.
- International collaboration will make it possible to constitute the first complete environment monitoring chain around the globe.



Thank You!

Dr. Chi Wang

cw@spaceweather.ac.cn

