

Meridian Space Weather Monitoring Project (Meridian Project) and the International Collaboration

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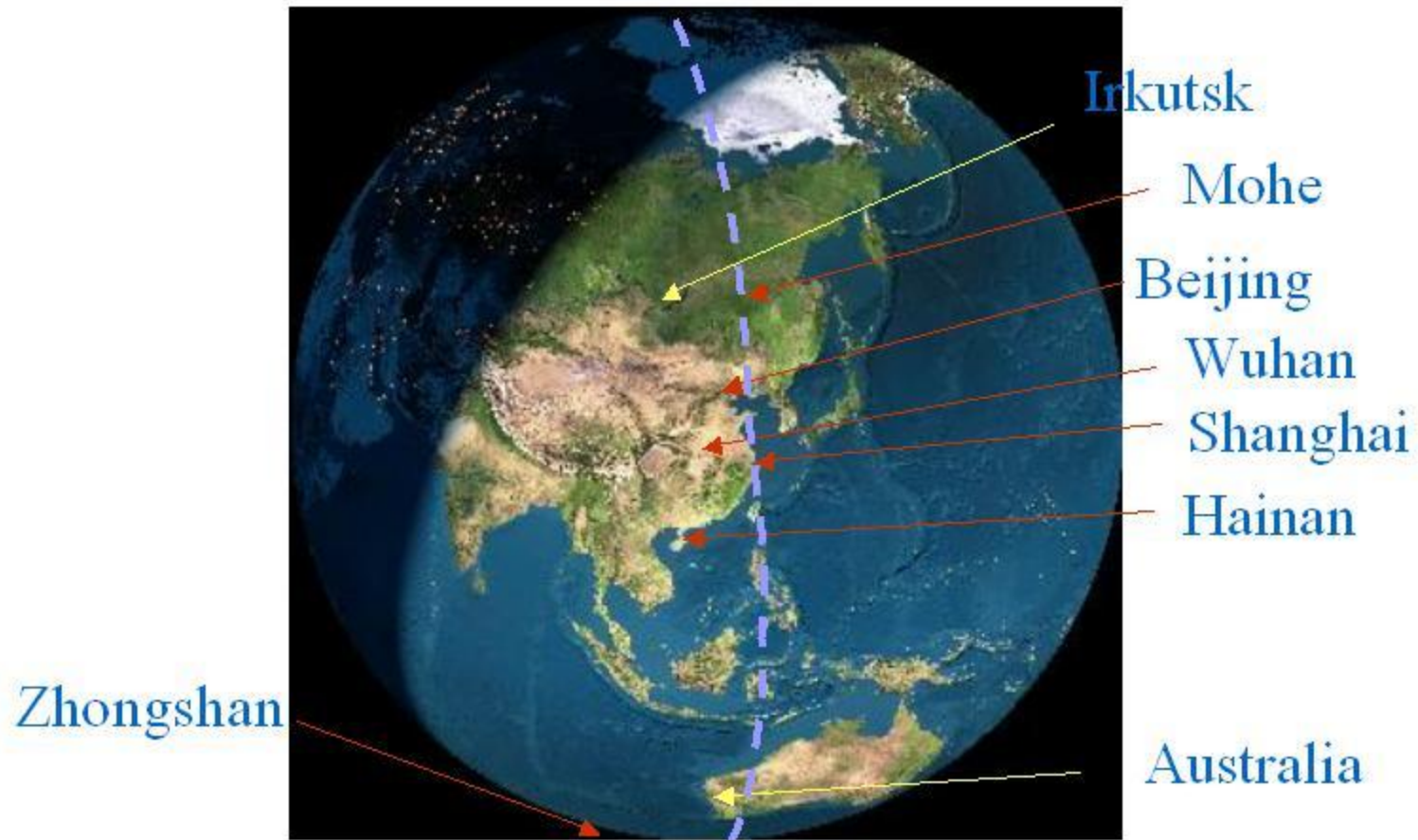


Outline

- **Overview of the Meridian Project (MP)**
 - **The Meridian Project Framework**
 - **Recent Development**

- **International Collaboration of MP**
 - **-Overview of IMCP**
 - **-Scientific goals**
 - **-Progress**





MP 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.

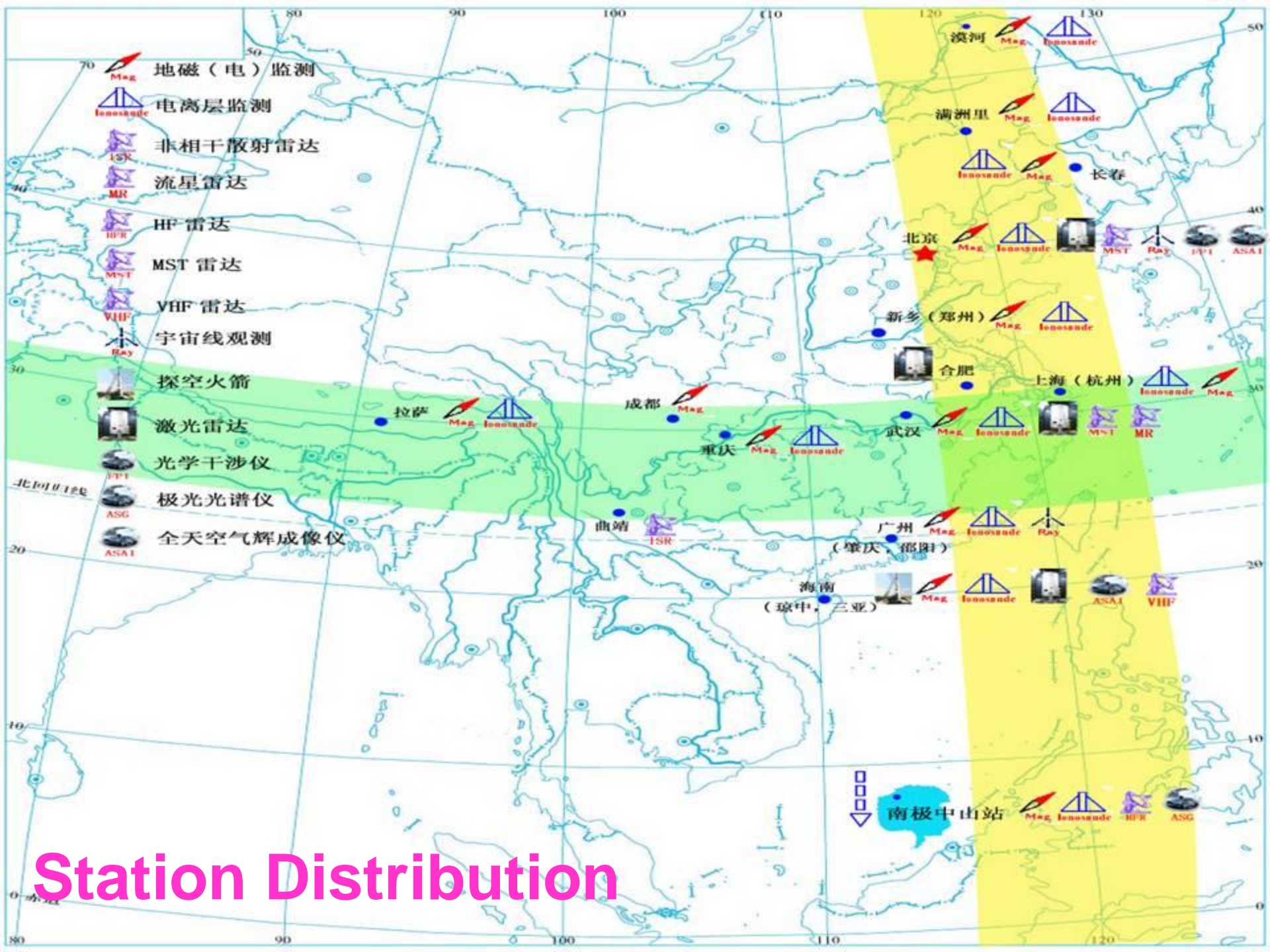


Scientific Principles



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





Station Distribution

Observatories

15 Stations Selected, No new station will be built :

(develop/purchase new instruments, upgrade existing equipment, get all stations connected, build central data base, organize research and application activities)

◆ **120°E Meridian Chain (10 stations) : Mohe, Manzhouli, Changchun, Beijing, Xinxiang, Hefei, Wuhan, Guanzhou, Hainan, Zhongshan ;**

◆ **30°N Chain (5 stations) : Shanghai (Hangzhou) , Chongqing, Chengdu, Qujing, Laasa.**

◆ **Among them, Beijing, Wuhan, Hainan, Zhongsan are multi-tasking stations.**



No	Station	Lat.	Lon.	Types of Observations
01	Mohe	53.5N	122.4E	Geomagnetic, Ionospheric
02	Manzhouli	49.6N	117.4E	Geomagnetic, Ionospheric
03	Changchun	44.0N	125.2E	Geomagnetic, Ionospheric
04	Beijing	40.3N	116.2E	Geomagnetic, Ionospheric, Lidar, MST Radar, IPS, Cosmic Rays , HF Doppler Array , All-sky Airglow Imager, F-P interferometer
05	Xinxiang	34.6N	113.6E	Geomagnetic, Ionospheric
06	Wuhan	30.5N	114.6E	Geomagnetic, Ionospheric, Lidar, MST Radar , HF Doppler Array , Meteor Radar ,
07	Hefei	33.4N	116.5E	Lidar
08	Guangzhou	23.1N	113.3E	Geomagnetic, Ionospheric, Cosmic Rays
09	Hainan	19.0N	109.8E	Geomagnetic, Ionospheric, Lidar, All-sky Airglow Imager , VHF Radar, Sounding Rocket
10	Zhangshan	69.4S	76.4E	Geomagnetic, Ionospheric , HF Radar , Aurora
11	Shanghai	31.1N	121.2E	Geomagnetic , Ionospheric
12	Chongqing	29.5N	106.5E	Geomagnetic, Ionospheric
13	Qijing	25.6N	103.8E	Incoherent Scattering Radar
14	Chengdu	31.0N	103.7E	Geomagnetic, Ionospheric
15	Lhasa	29.6N	91.0E	Geomagnetic, Ionospheric

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



行星际

可见光
宇宙线
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

非相干散射雷达

地磁仪

数字测高仪

光学干涉仪

激光雷达

火箭

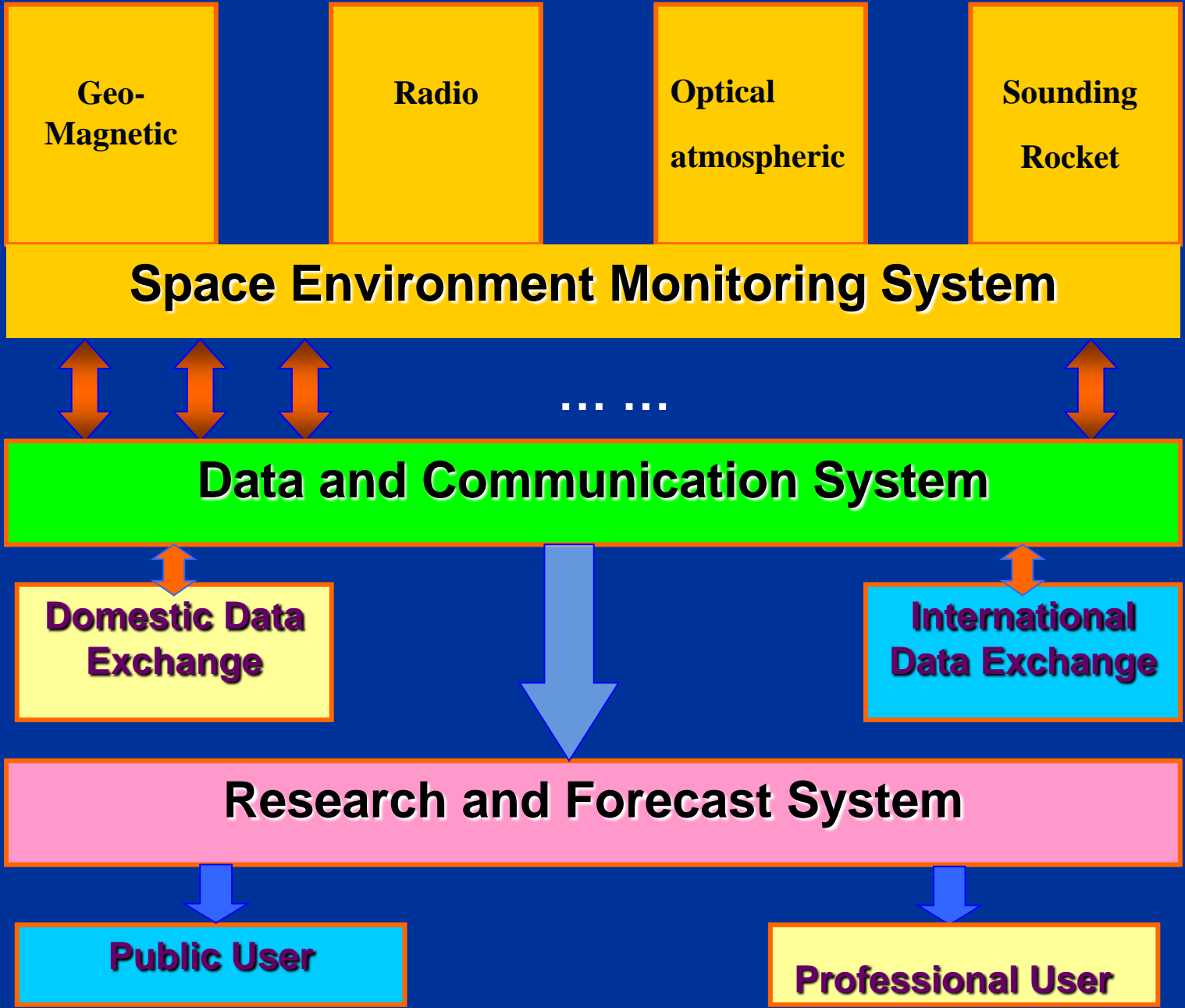
地磁仪
中子堆

Spatial Coverage

By

The Meridian Project

FRAMEWORK

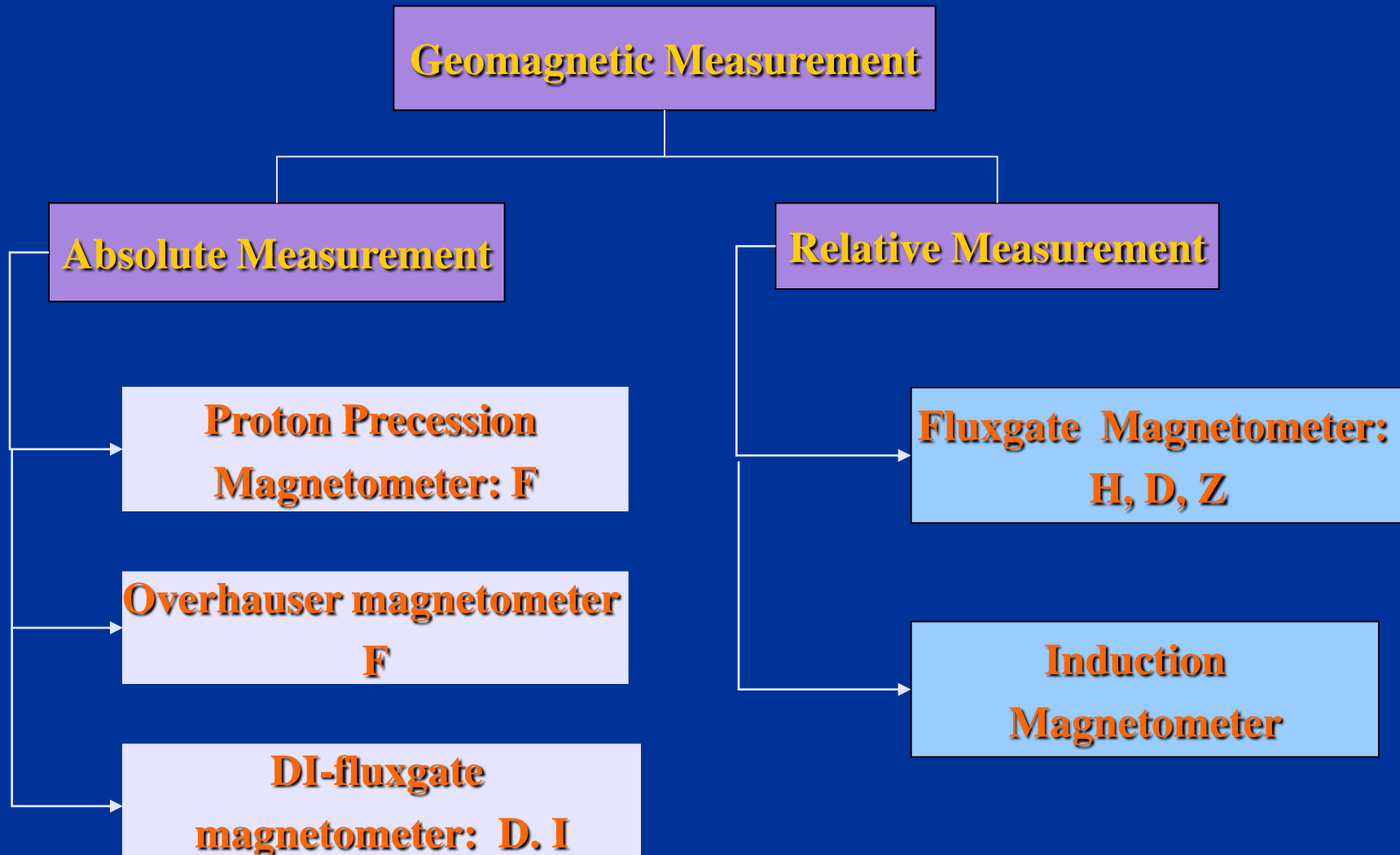


I. Geomagnetic Monitoring Subsystem

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



Instrument

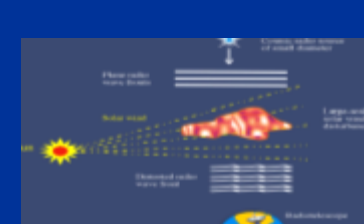


Geomagnetic Stations

No.	Station	Geomagnetic					Goelectric	
		DI	OVERHAUSE R	PPM	Fluxgate	Inductio n	Atmosp heric	Geoel ectric
1	Mohe	1	1	1	1	1	1	1
2	Manzhouli		1		1	1		
3	Zhangchun		1		1			
4	Beijing		1	1	1	1	1	1
5	Zhenzhou	1	1		1			
6	Wuhan		1		1	1	1	
7	Shaoyang		1		1			
8	Zhaojing	1			1			1
9	Qionzhou		1		1	1	1	
10	Sanya	1	1	1	1			
11	Zhongshan	1	1	1	1	1		
12	Hangzhou	1	1		1	1		1
13	Chendu		1		1	1		
14	Lasha		1		1	1		
Total		6	13	4	14	10	4	4

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)

- The most powerful equipment in MP
- 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 $\sim 3\text{MW}$.



2. Radar Chain

Instrument	Detecting Content	Sites
MST Radar	Wind parameters of troposphere, stratosphere and mesosphere	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 Mehe



3. Ionosode Chain

- **Digisonde (5)**

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

- **Traditional Ionosonde (4)**

Manzhouli – Changchun – Ghuanzhou – Chongqing - Lasha



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
Cosmic Ray Monitor	To detect the solar energetic particles and cosmic rays	Beijing, Guanzhou
GPS-TEC	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



III. Optical-Atmospheric Monitoring Subsystem

Instrument	Content	Sites
Lidar	Temperature , density, and wind profiles of the middle atmosphere sodium density	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



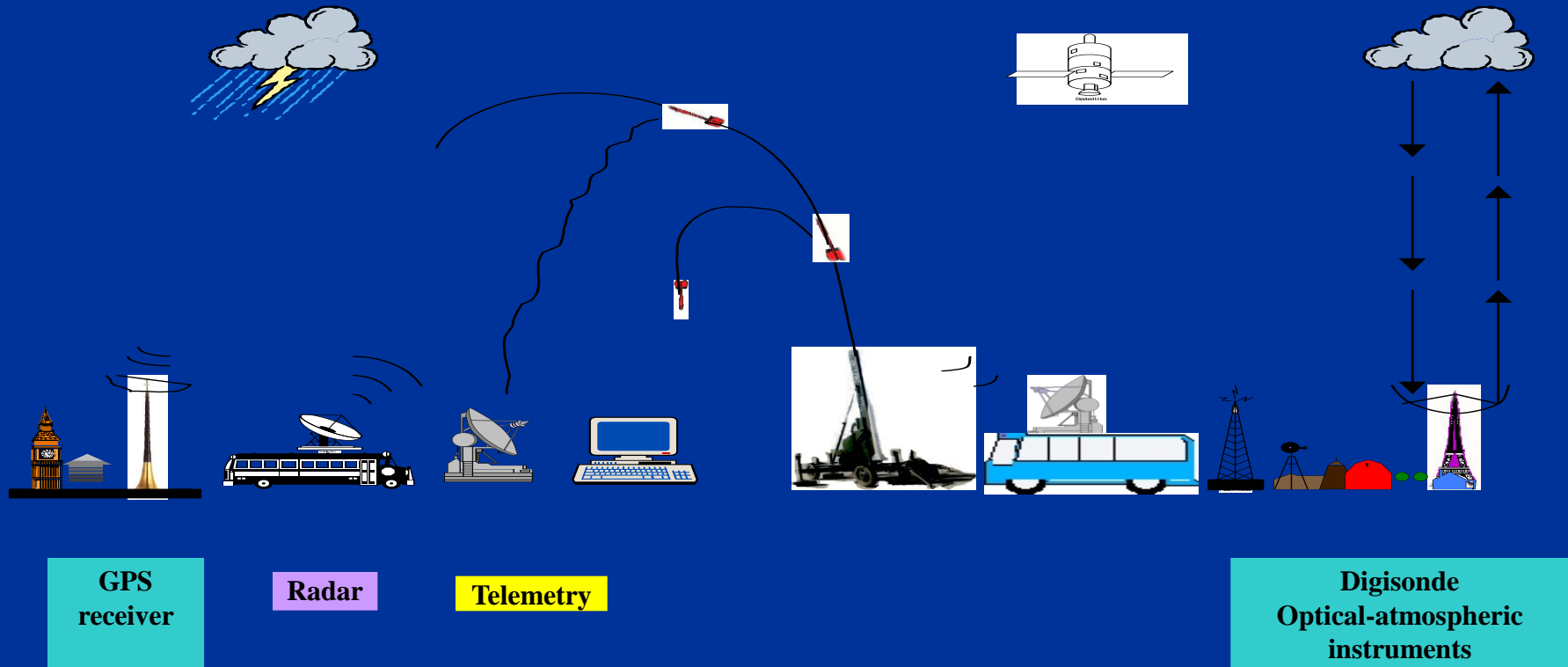
IV. Rocket Sounding Subsystem

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



Hainan Station: Low-latitude Multipurpose Station (20°N)

- Rocket Sounding Base
- 8 types of ground based equipments



Ground-Based Instruments in Hainan Station

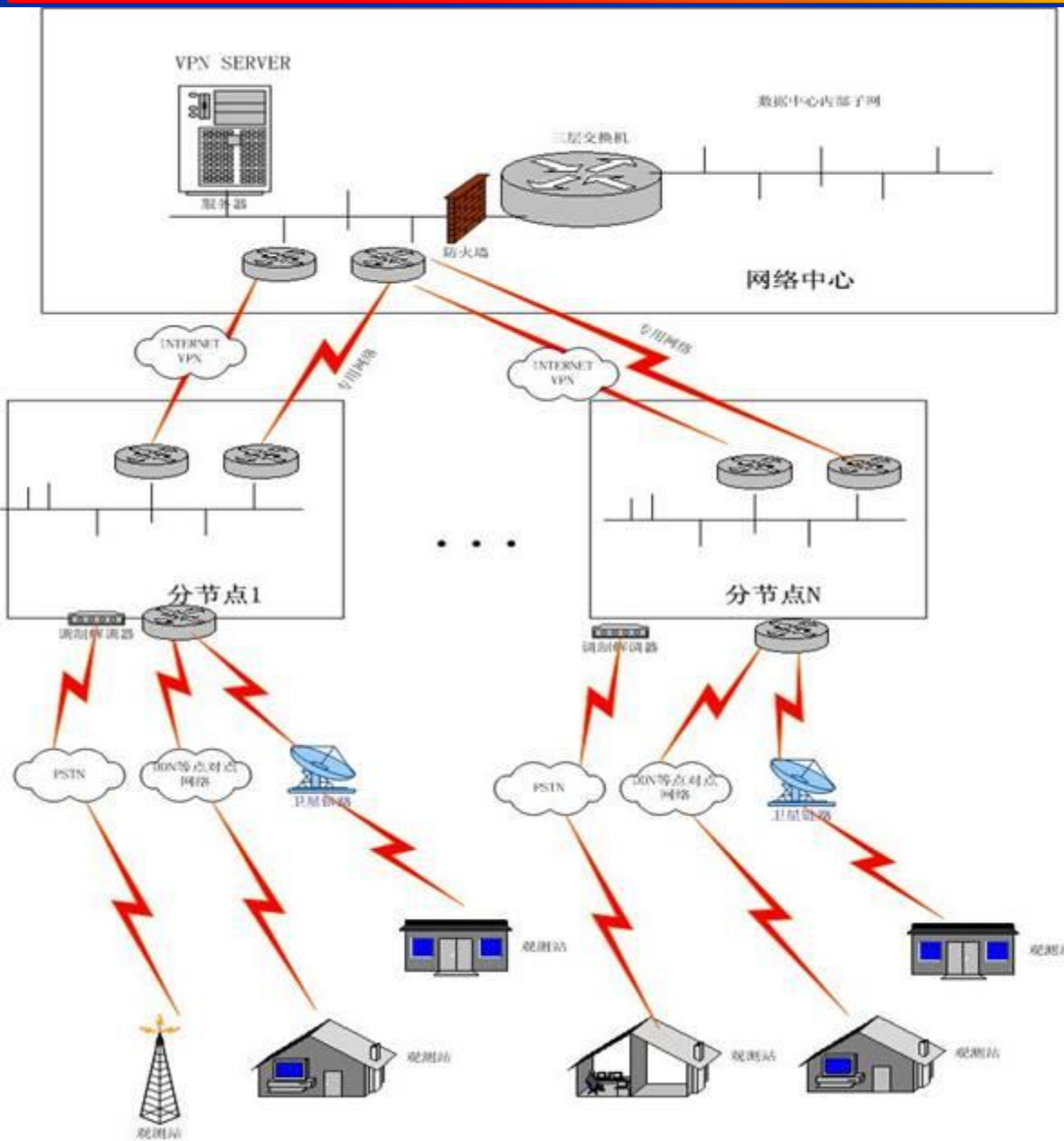
1. **DPS-4 digisode**
2. **GPS- TEC Monitor**
3. **Ionospheric Scintillation Monitors**
4. **Lidar**
5. **All-sky Airglow Imager**
6. **CHIMAG Fluxgate Magnetometer**
7. **Geoelectric Monitor**
8. **Meteor radar**



Data and Communication System

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





**Three-layer-
Structure:**

Station-Node-Center

Research and Forecast System

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



Recent Development



Research and Forecast
Center System has been
constructed.

Operation Center

High Performance
Computing Equipment



Recent Advances

Data Center



All the detection equipments have
bee developed

ISR Radar has been developed

Cover of
antenna



Control
room

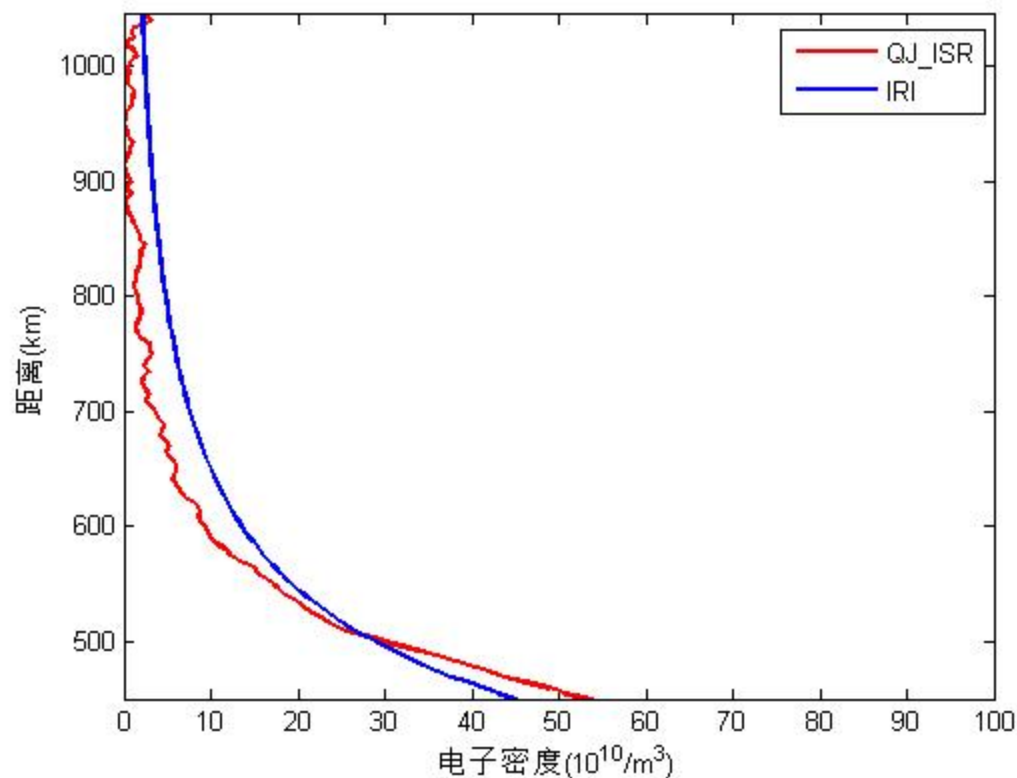
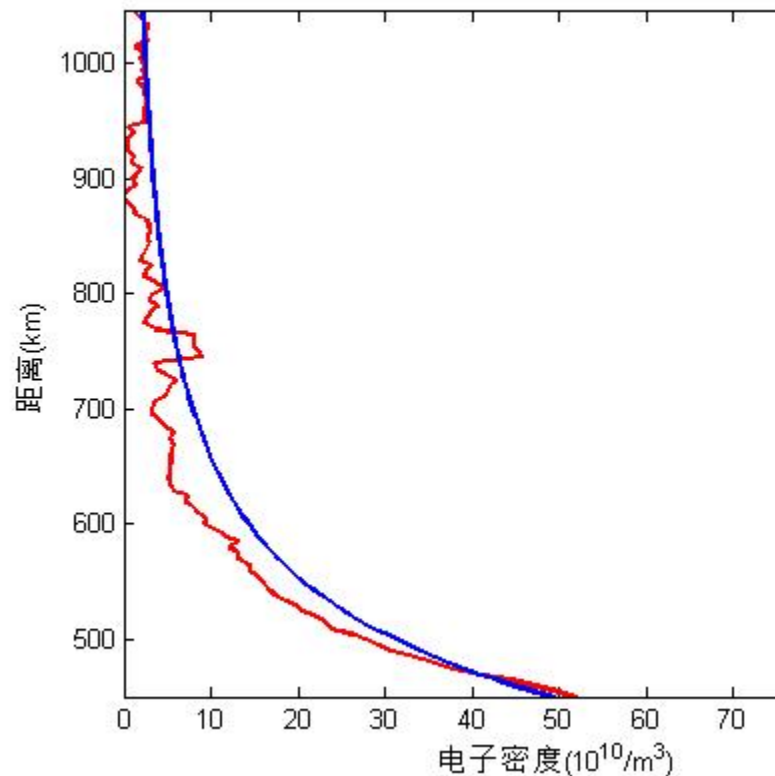


Cooling
system

Emitting
system



ISR Radar observed results



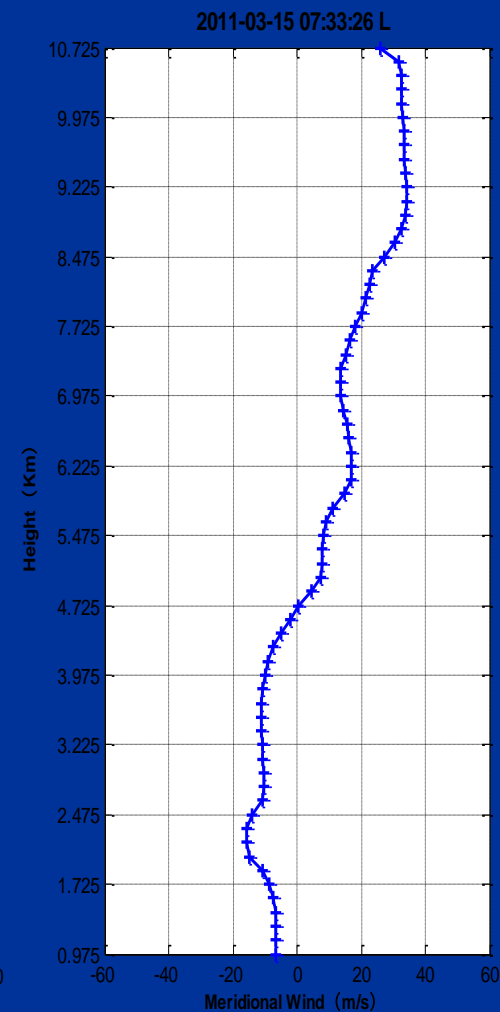
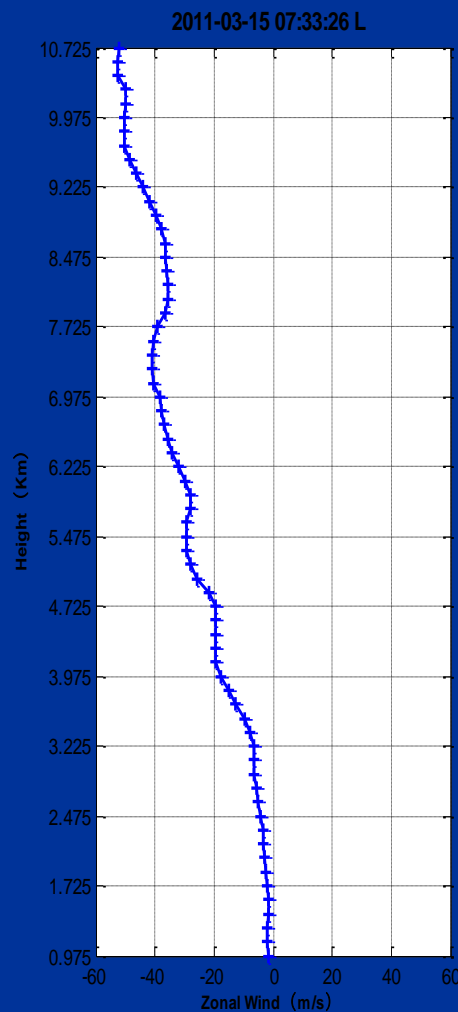
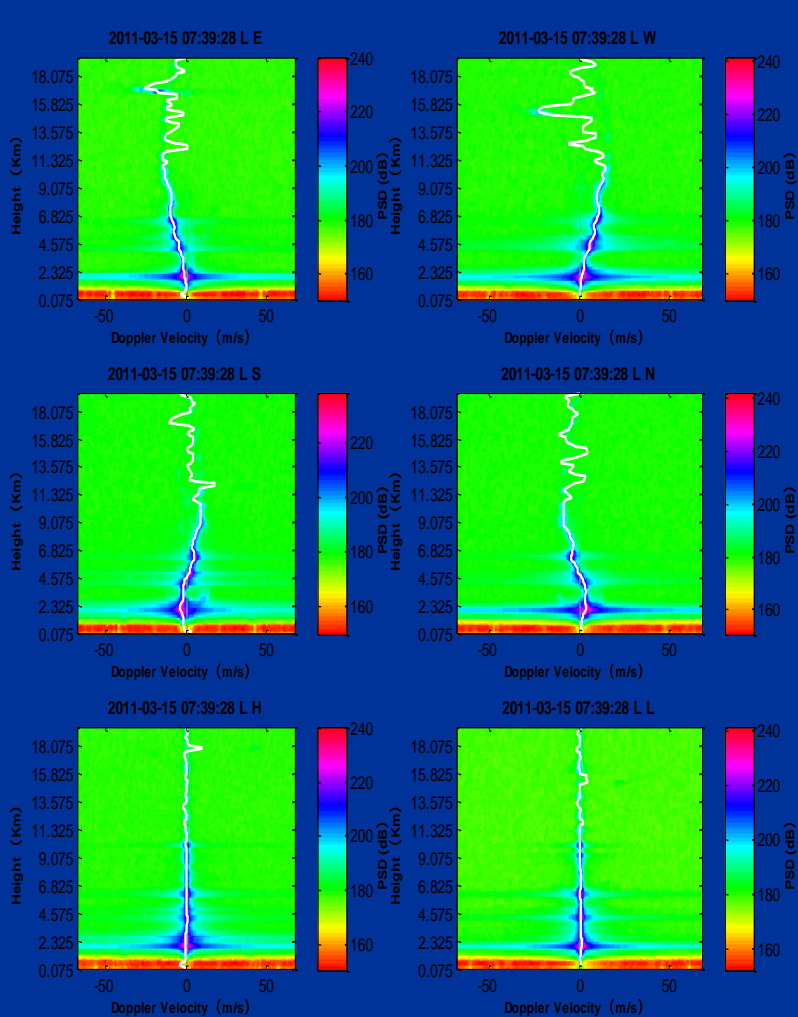
MST radar are also been developed

BJ
MST



WH
MS
T

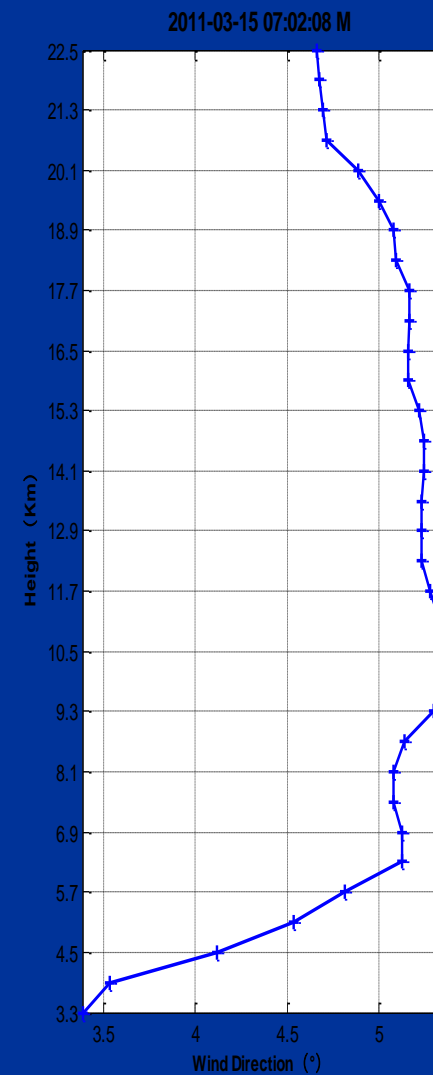
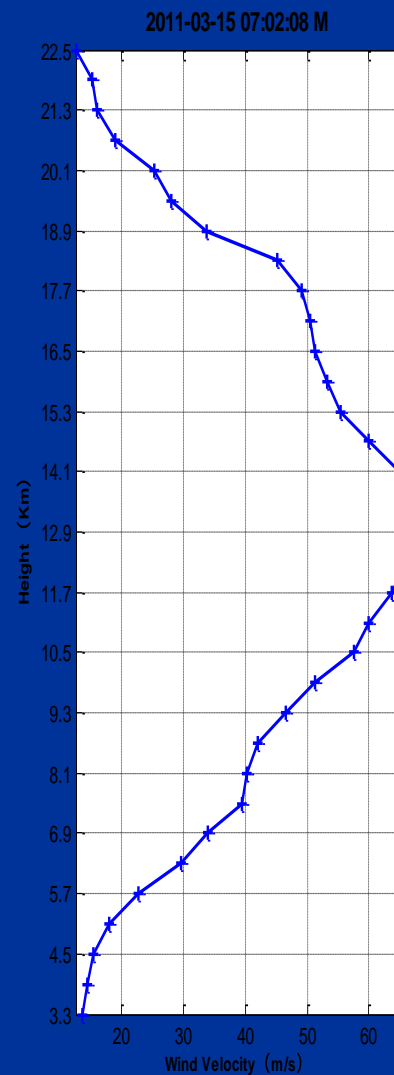
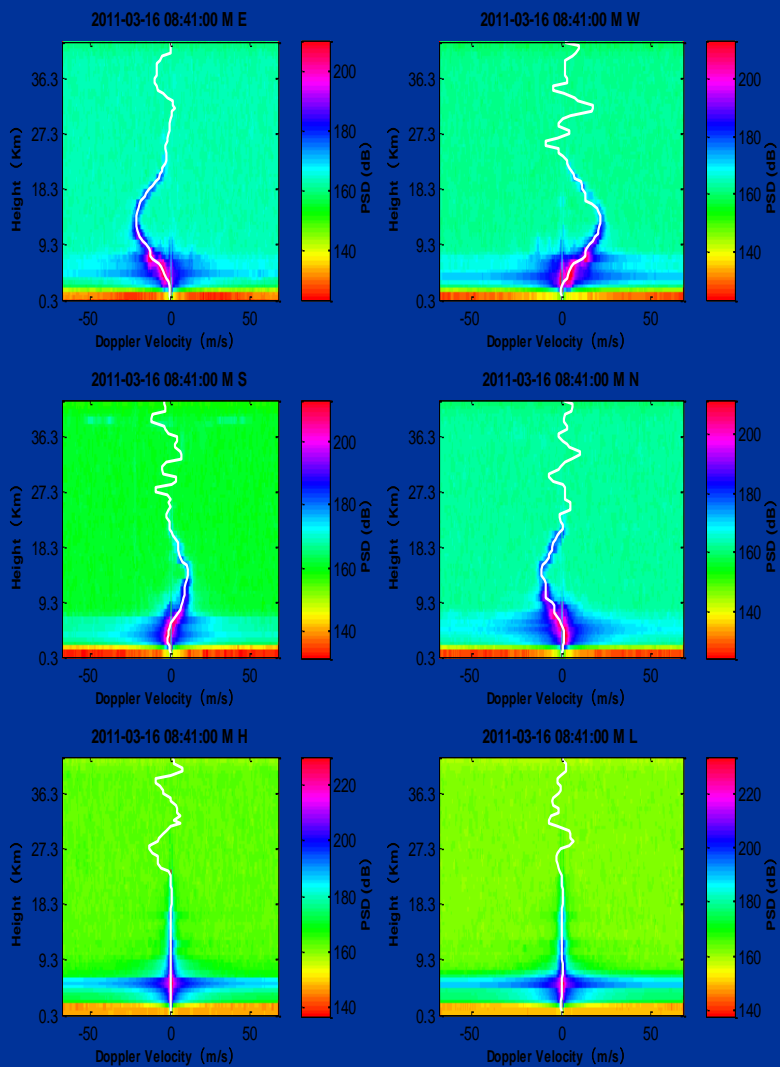




Power spectra

Winds in the lower atmosphere





MST雷达中模式回波功率谱图
Power spectra

Winds in the middle-lower atmosphere



HF radar in Antarctic

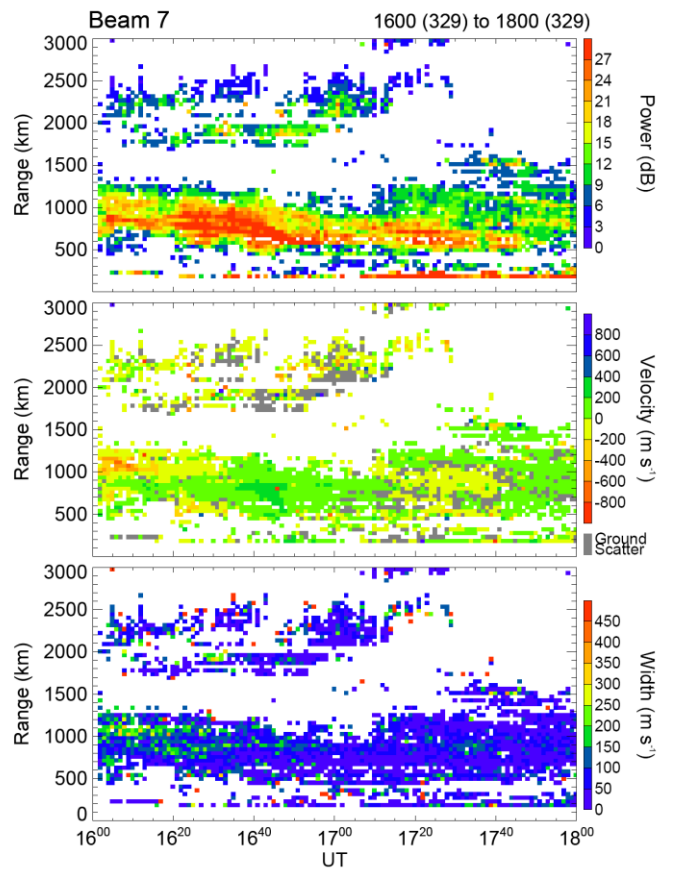


SUPERDARN PARAMETER PLOT

25 Nov 2010⁽³²⁹⁾

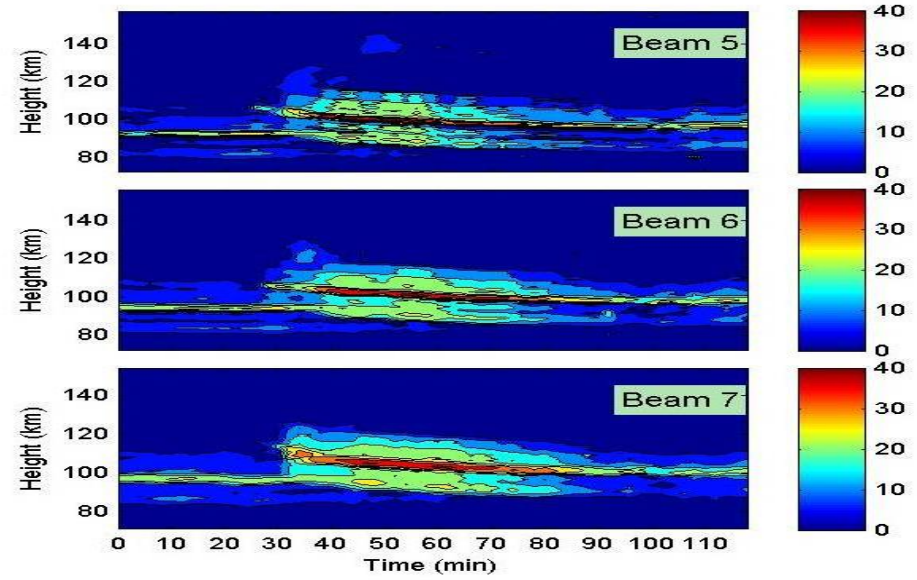
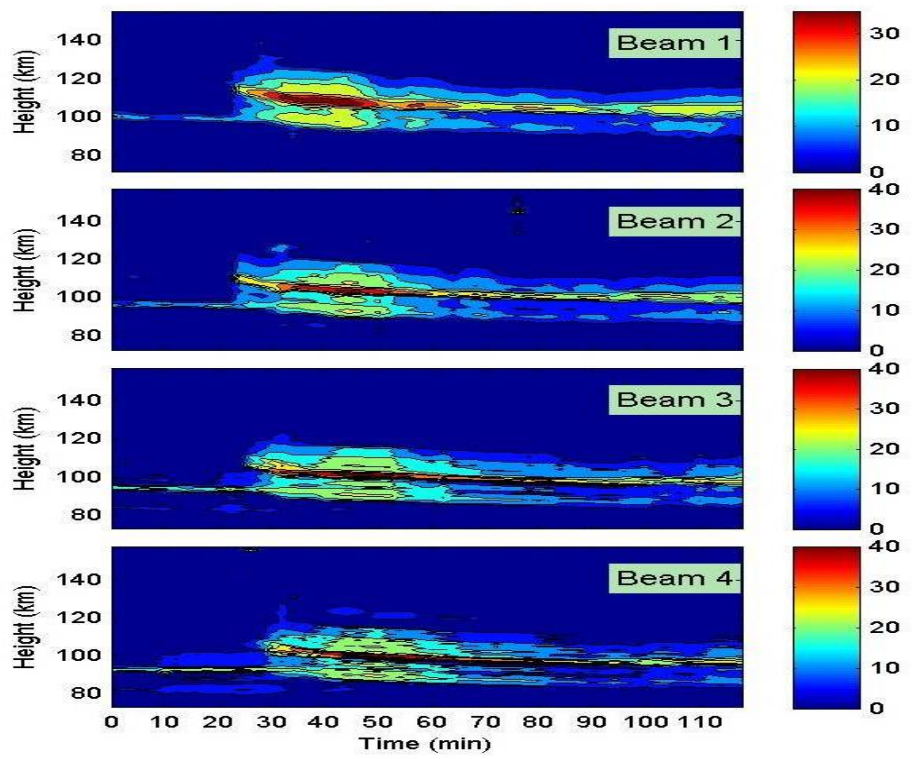
ZHONGSHAN

fast stereo normal (cw) scan mode (153)

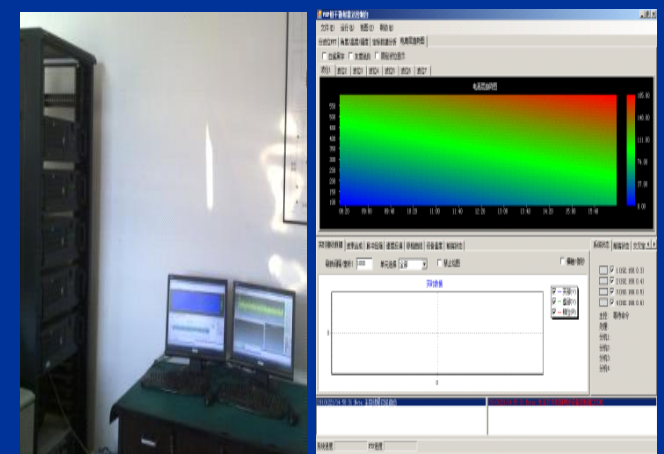


雷达回波强度、电离层对流速度和雷达速度谱展宽





VHF Radar



后端处理系统



Meteor Radar

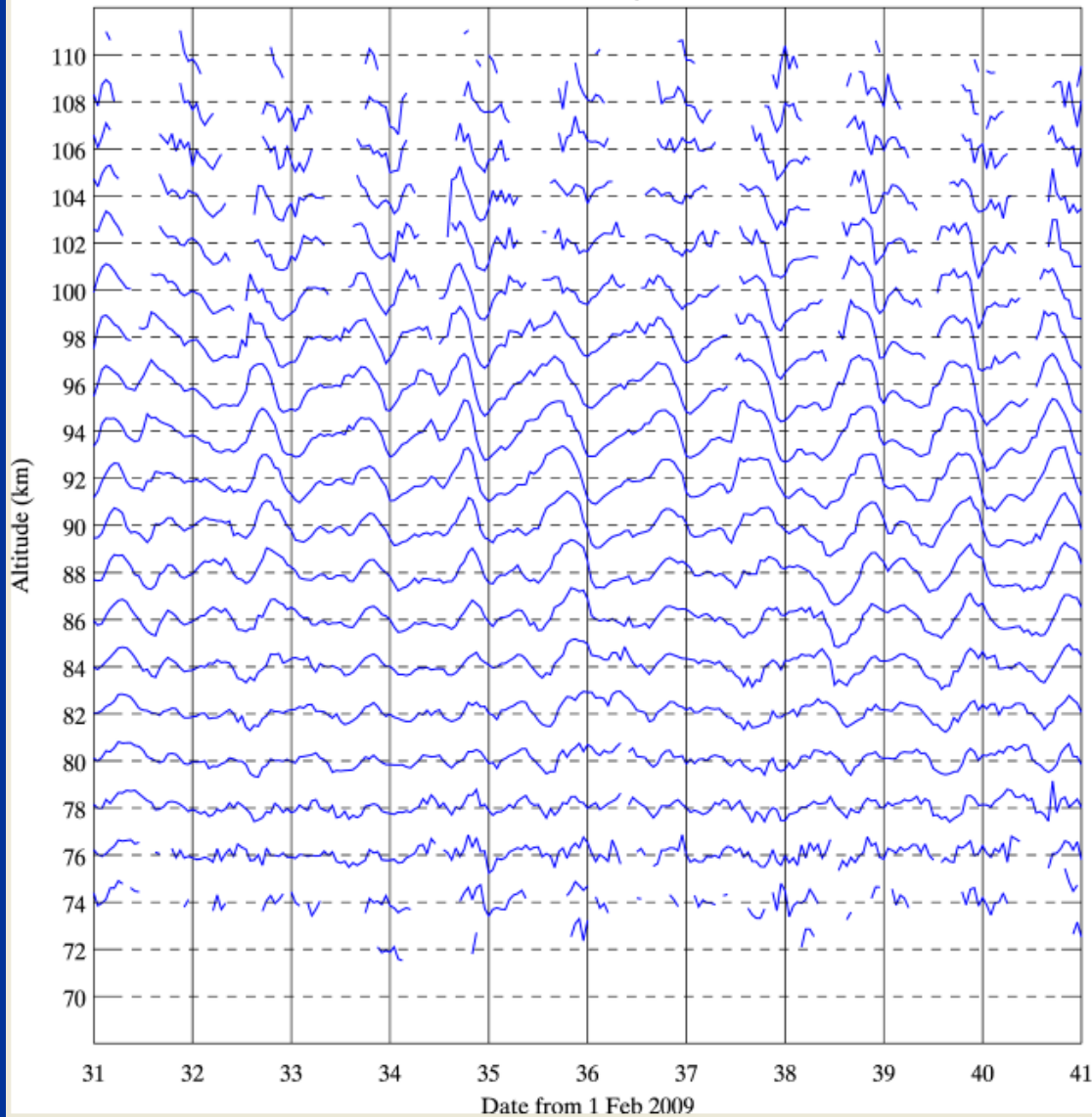


Meteor radar observations

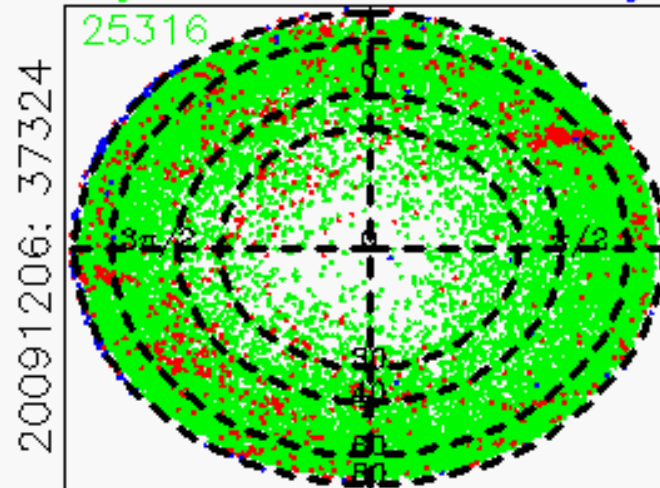


子午工程

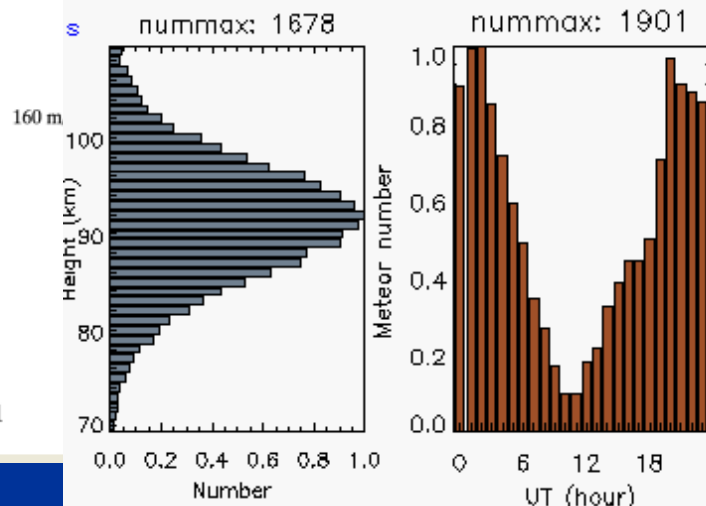
a: The Meridional Hourly Wind Fuke



Height resolved Unresolved Ambiguous



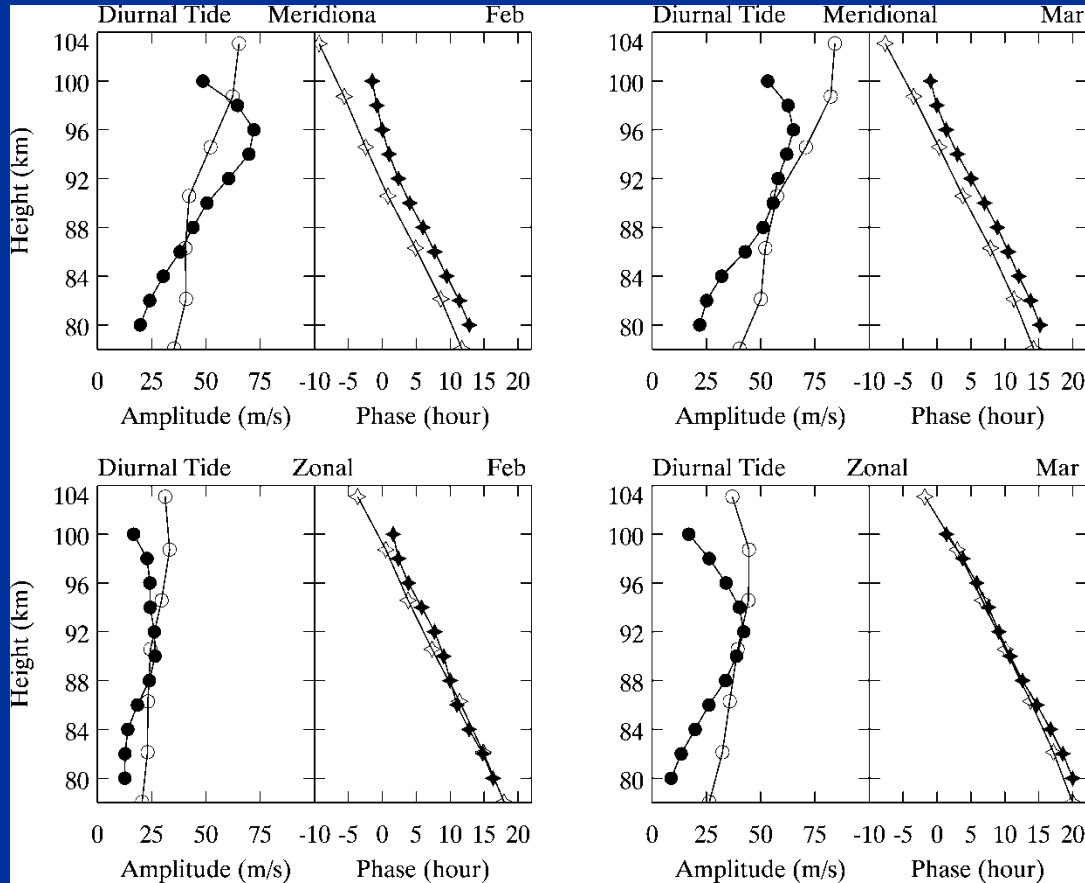
Observed meteors



Observed wind



Meteor radar observation: tidal winds



● ◆ : Observation
○ ◇ : GSWM02



Recent Advances



Cosmic Ray Detector has
been constructed



IPS



50米天线

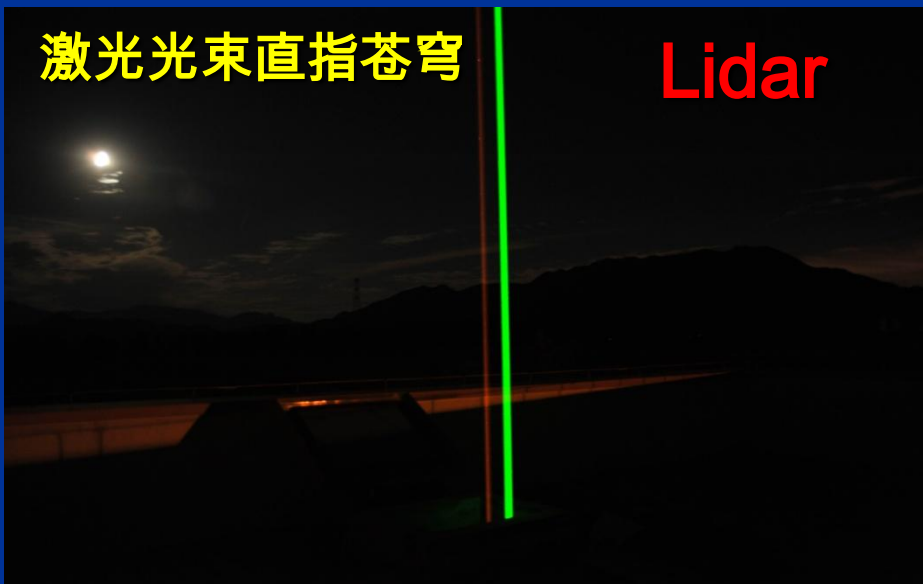


控制室

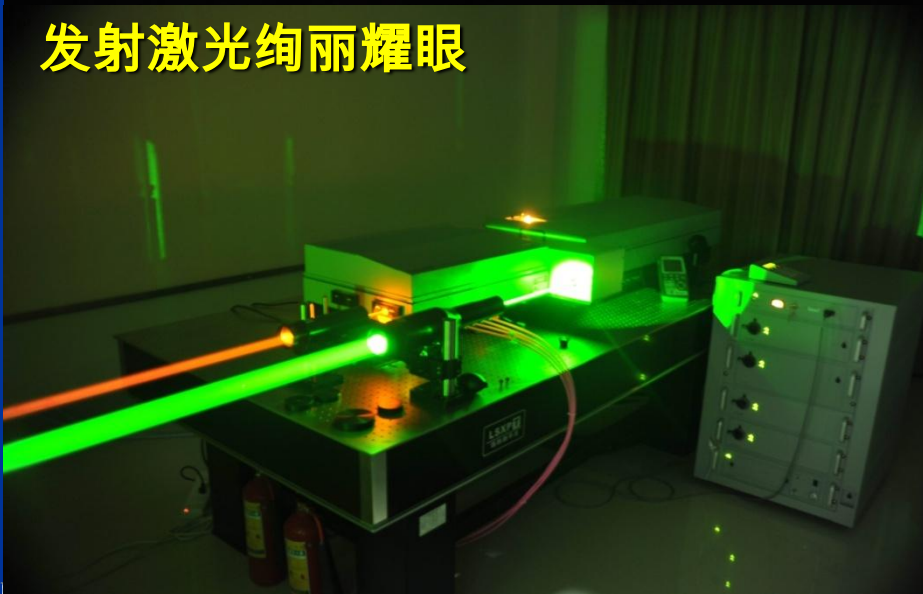


激光光束直指苍穹

Lidar



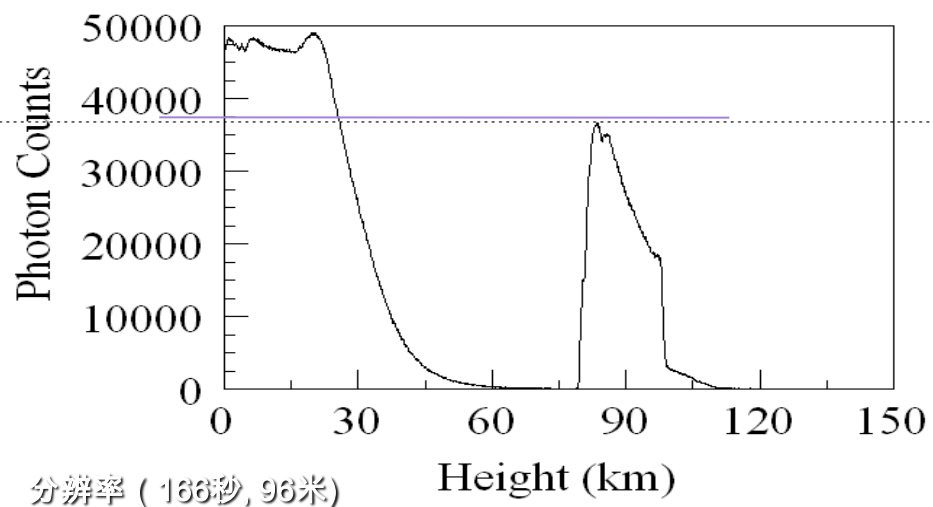
发射激光绚丽耀眼

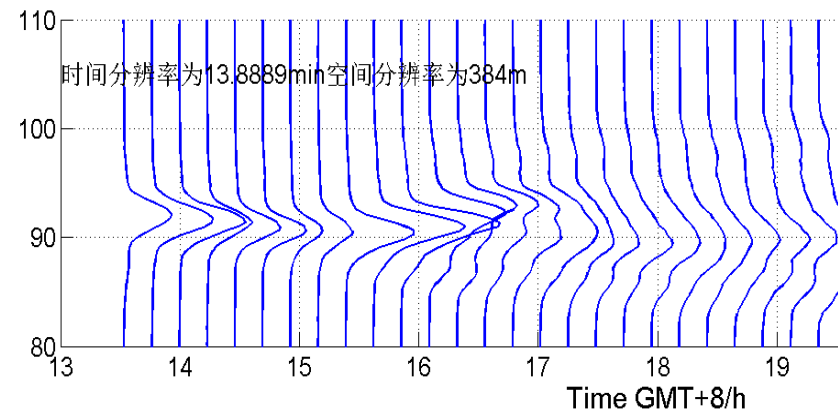


数据采集单元

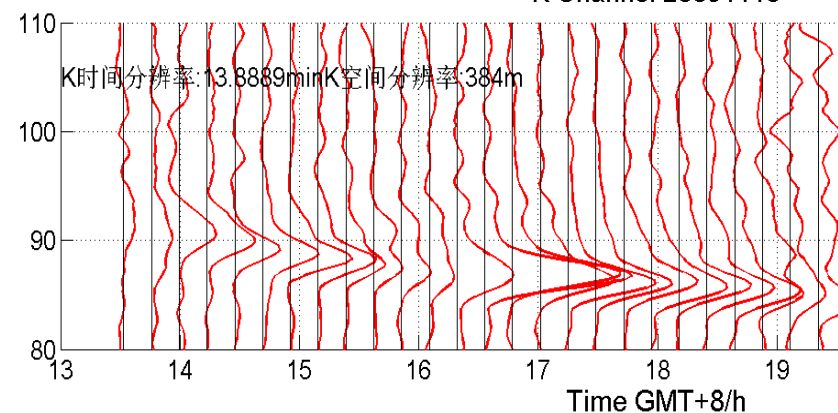


探测结果：Na回波光子数





K Channel 20091113



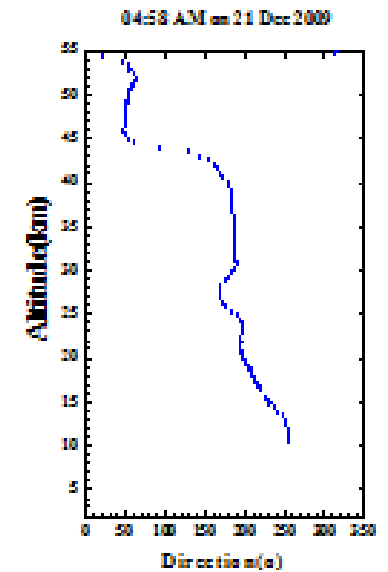
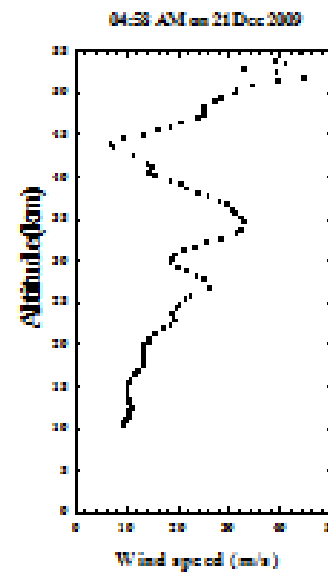
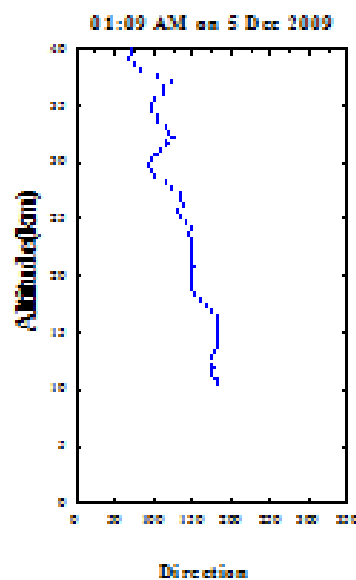
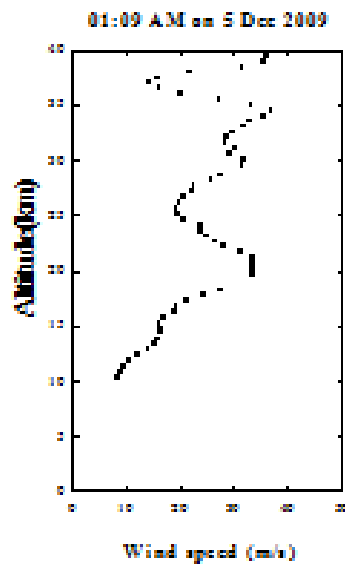
Simultaneously Observation of sodium layer and potassium layer



Recent Advances

Lidar

Initial Observations: Wind



Wind speed @ Hefei



All Sky imager



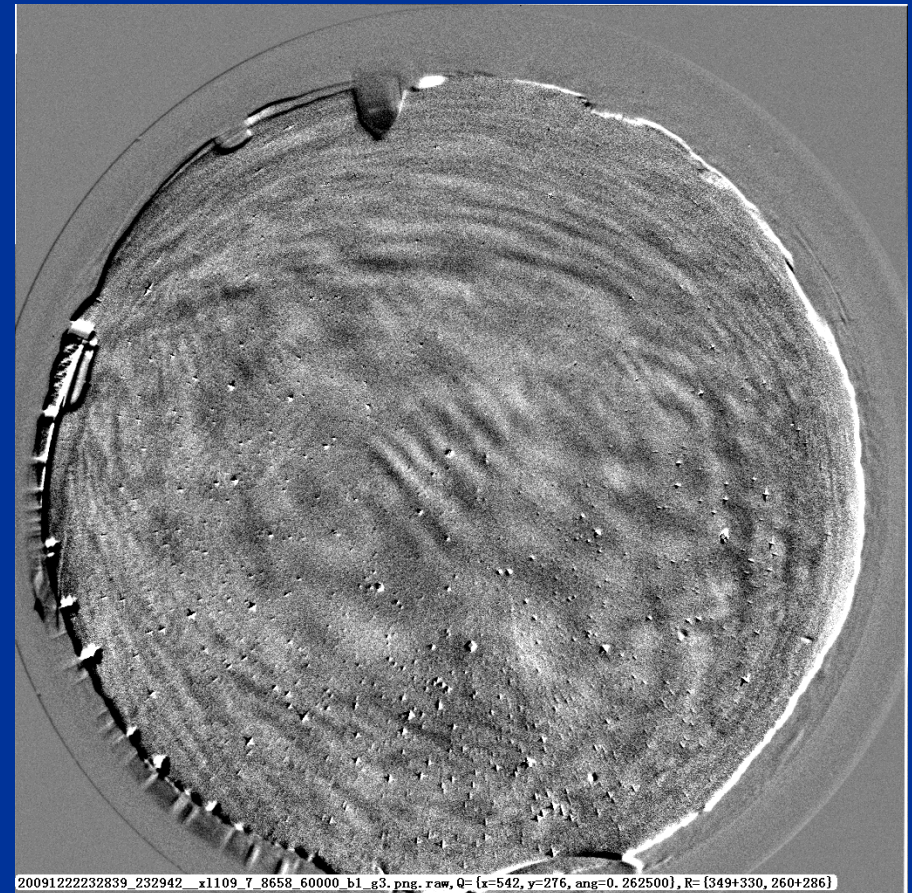
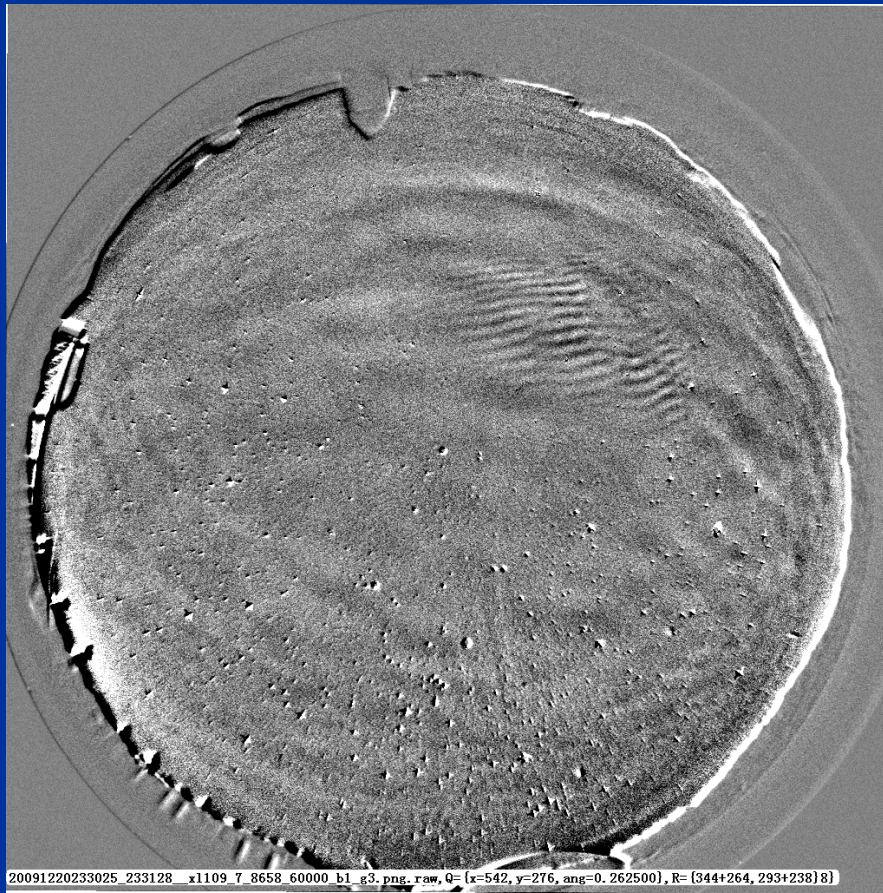
子午工程海南全天空气辉成像仪



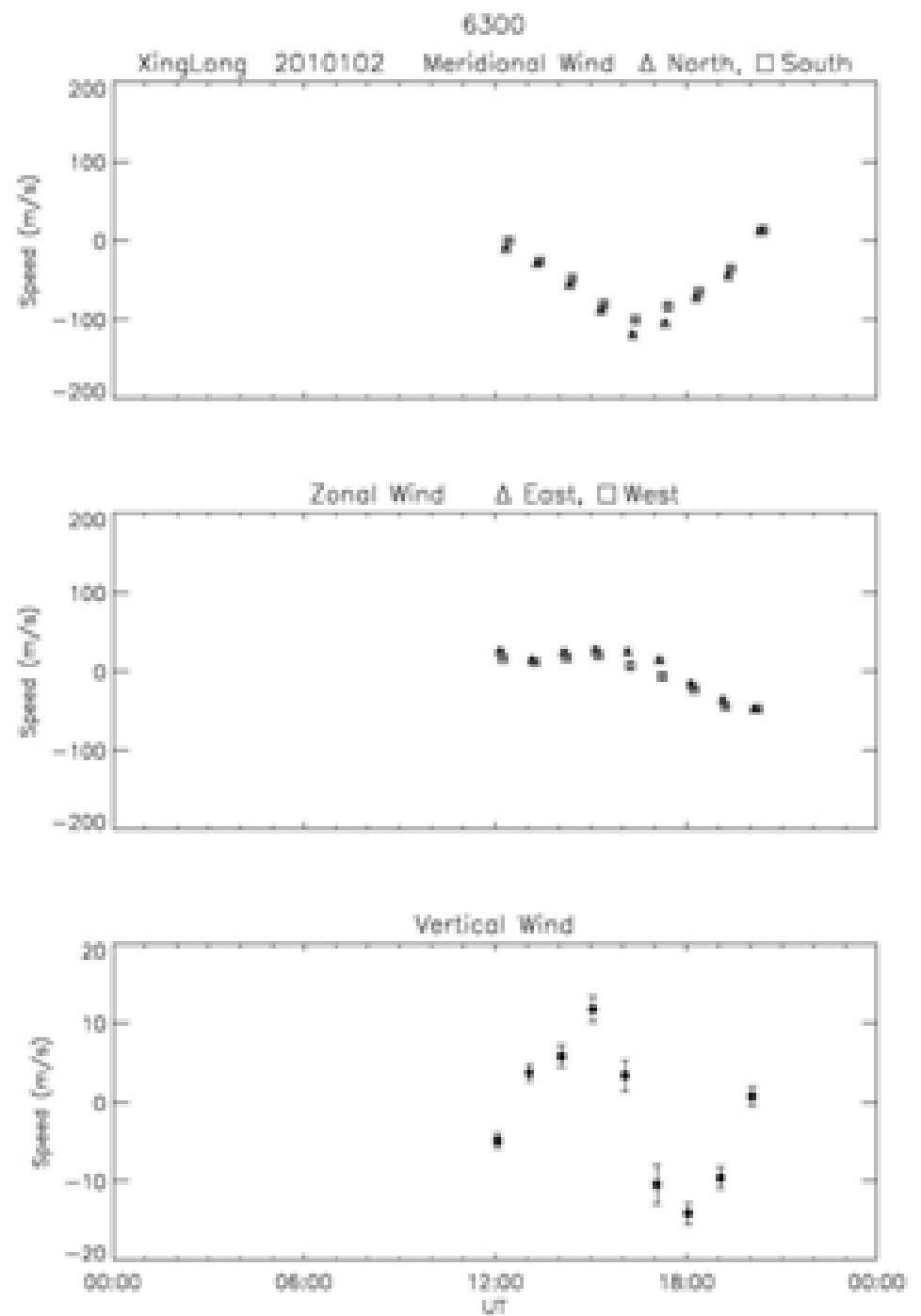
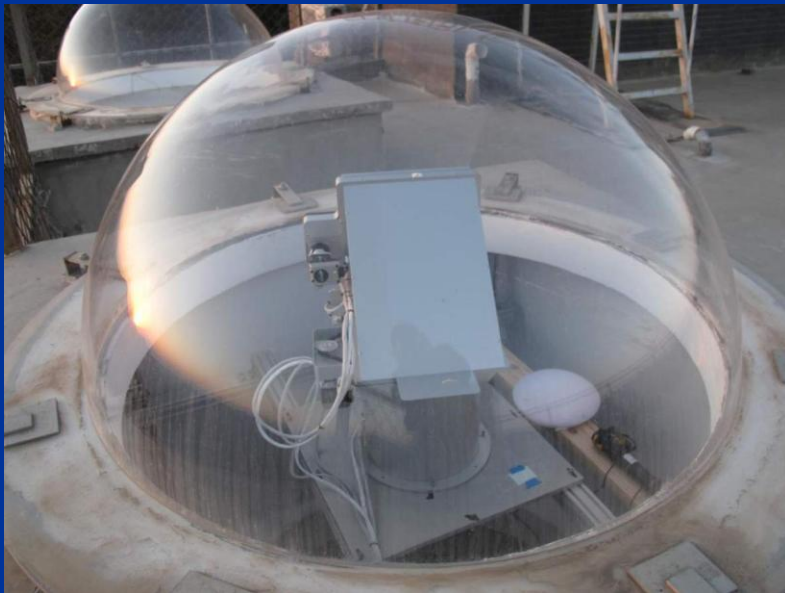
子午工程兴隆全天空气辉成像仪



1. ASAI ---- Observation Data



2. FPI ---- at Beijing



Sound Rocket Launching



The first observation of the space environment response to solar wind by Meridian Project (2010/08/03)

Magnetic data

ionosphere

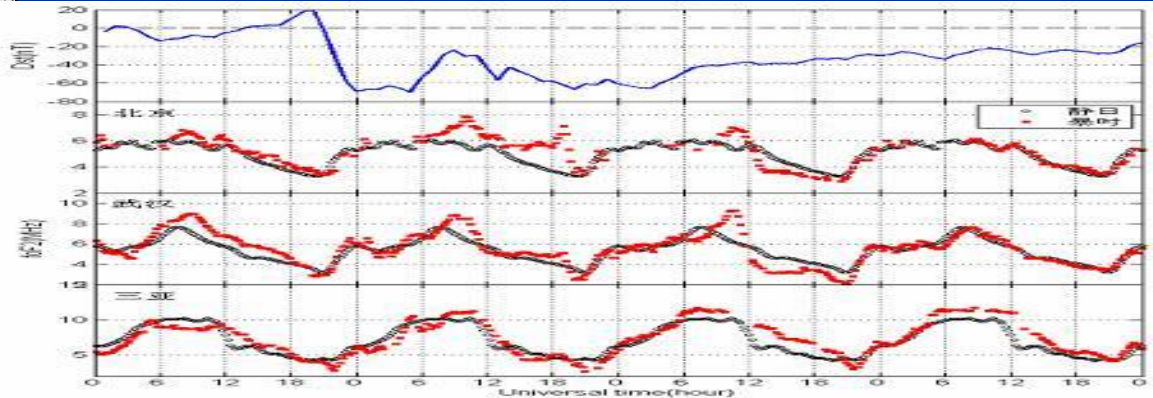
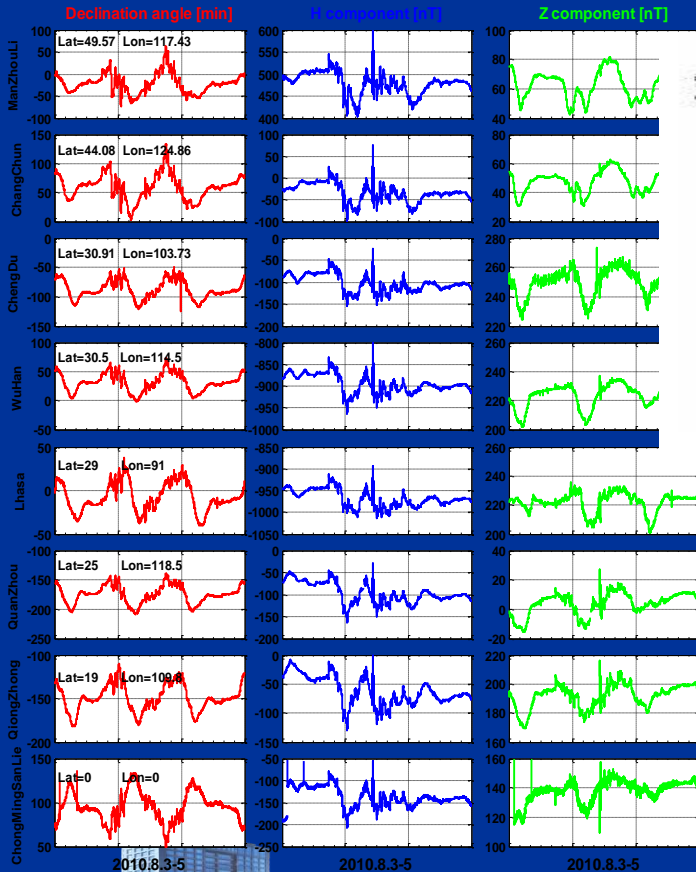
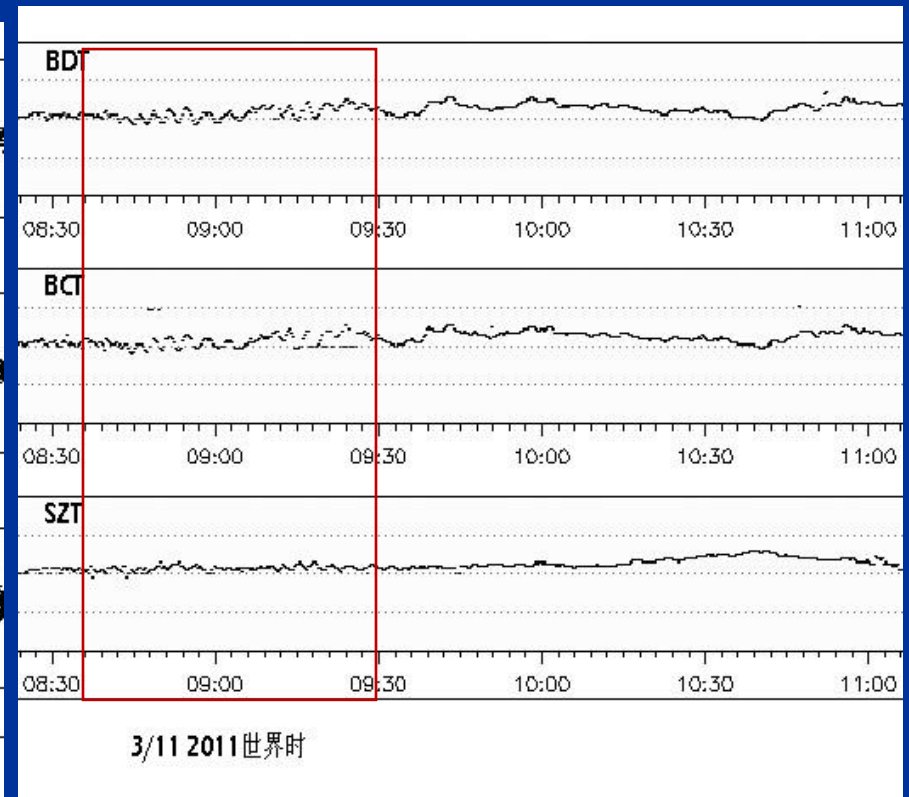
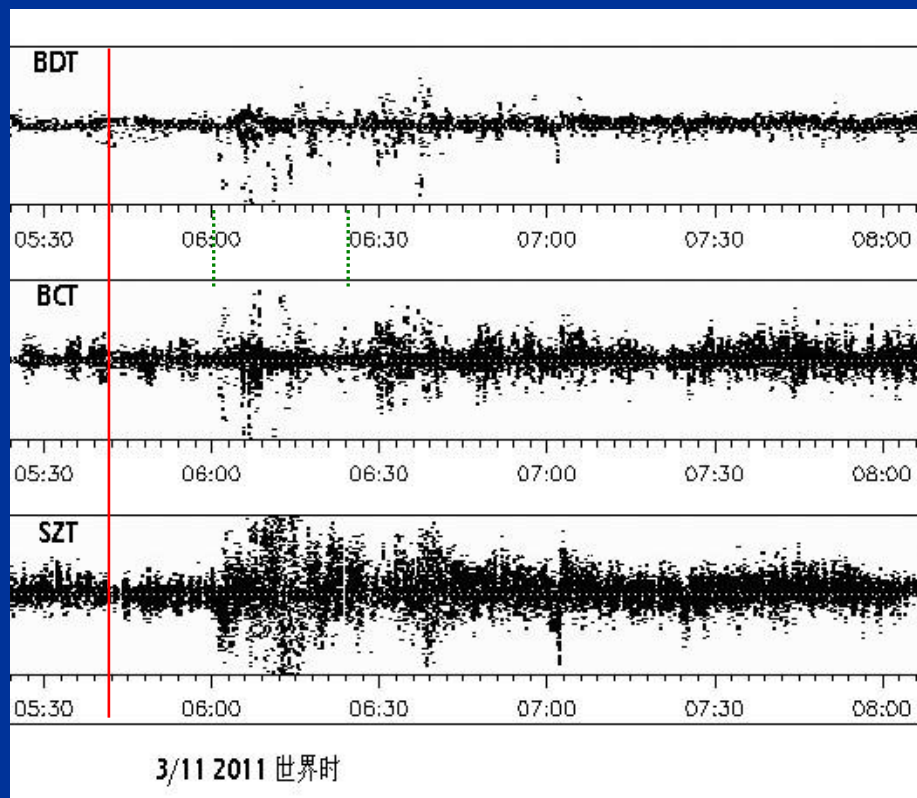


图4、8月3日至6日的Det指数和三个台站的电离层F2层峰值频率



Strong Ionospheric disturb observed by MP, after Mar.11, 2011 Earthquake in Japan



■ International Collaboration

– The International Space Weather Meridian Circle Program (IMCP)

① -Overview of IMCP

② -Scientific goals

③ -Progress

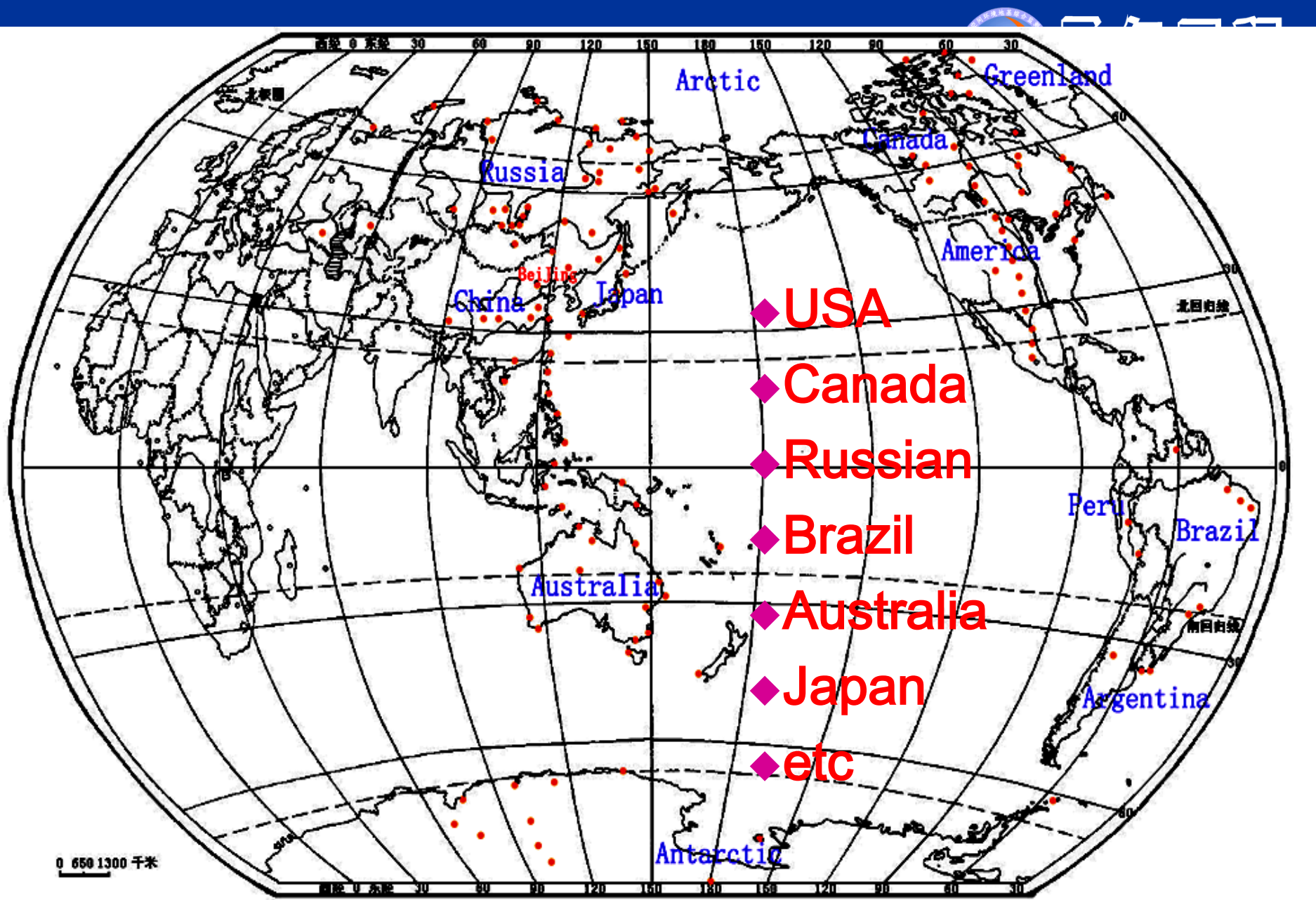


International Collaboration

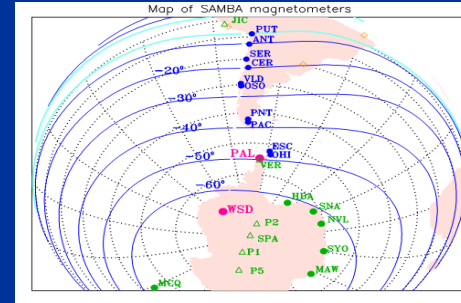
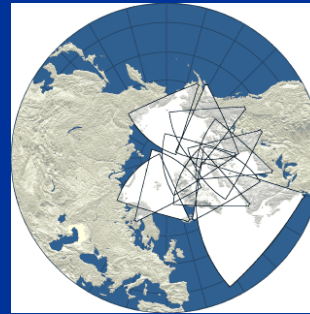


The **International Space Weather Meridian Circle Program (IMCP)**, proposal to connect 120°E and 60°W meridian chains of ground based monitors and enhance the ability of monitoring space environment worldwide.





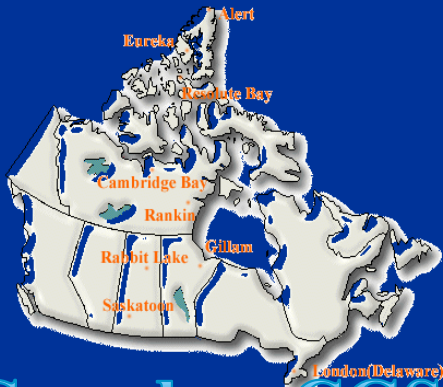
International ground-base observation system



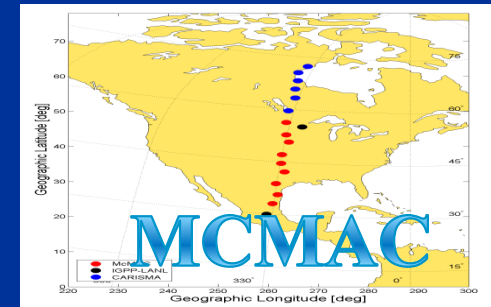
Russia-Yakutsk

Arctic-SuperDARN

America-SAMBA

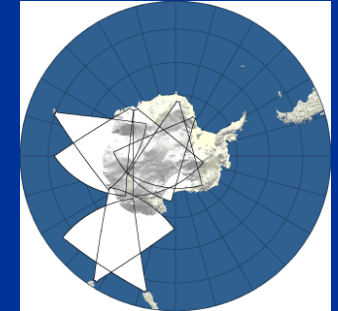
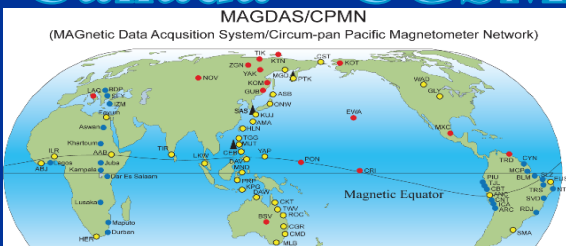


INPE Space Weather Project



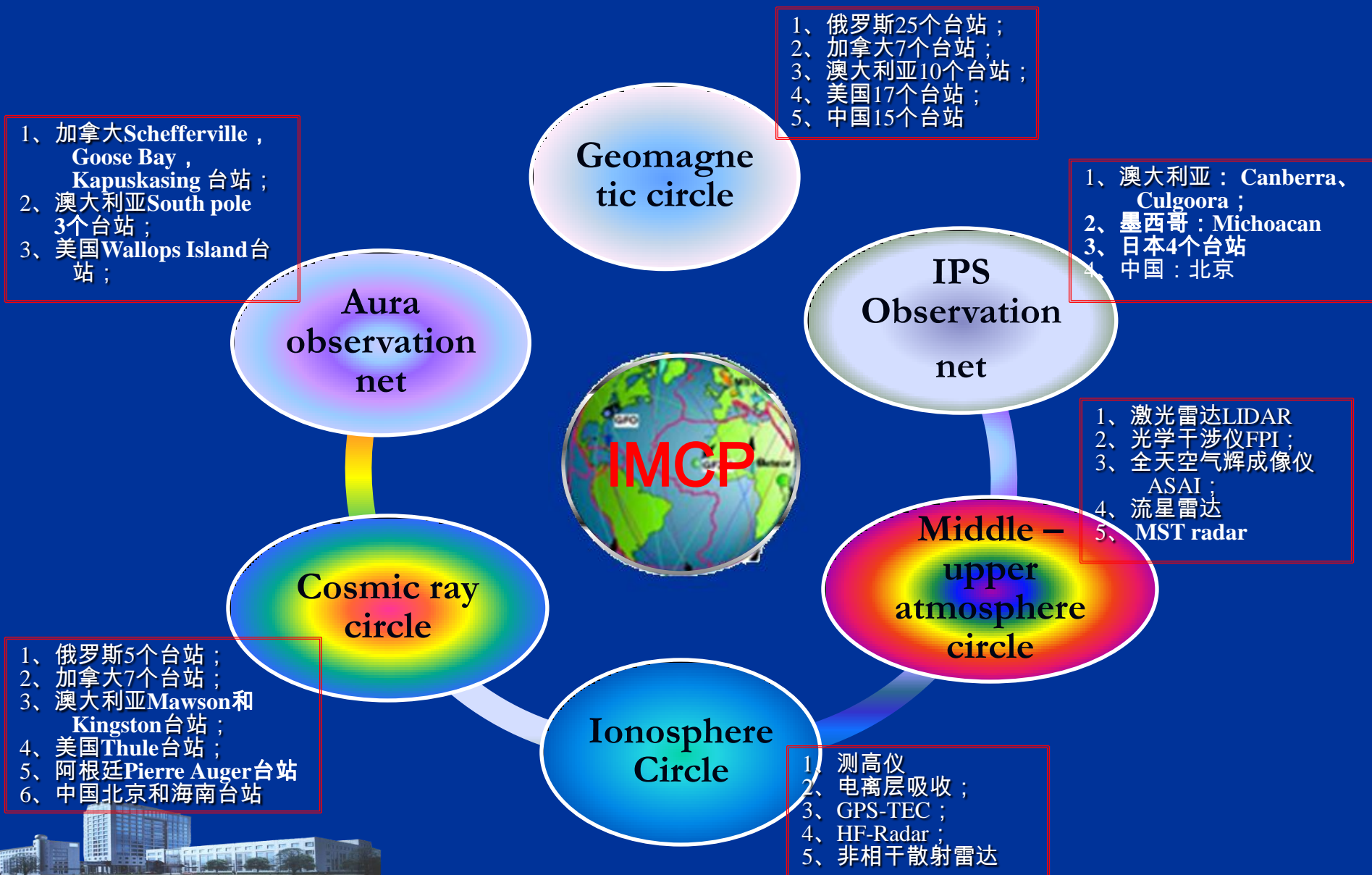
Antarctic-SuperDARN

Canada - CGSM



Japan-MAGDAS

Proposed Frame of IMCP



- 1. Use diverse instrumentation to observe physical parameters that pertain to the global space weather system, as well as its coupling to the Earth's atmosphere, with a special emphasis on the collection of data and information from all latitudes along a meridian circle**
- 2. Cooperate with appropriate space missions with a view toward characterizing the near-Earth space weather system as a coupled three-dimensional entity**
- 3. Understand the behavior of the geospace-atmosphere system under conditions of major magnetic storms and particle radiation**



- 4. Understand the coupling and feedbacks between geospace and the atmosphere in a global context**
- 5. Develop models and numerical capabilities to simulate and predict space weather in the geospace-atmosphere system covered by IMCP**
- 6. Produce space weather information and data products to improve related research in the participating countries and global community**
- 7. Use the collective resources of IMCP to promote awareness, public outreach, and education about space weather.**



An IMCP Scientific Committee are established to promote and coordinate cooperative activities, by engage in the following activities:

- Promote space weather monitoring and research through coordinated ground-based observations
- Support the International Space Weather Initiative (ISWI) and similar international programs
- Organize biennial IMCP scientific workshops
- Coordinate collaborative research activities within IMCP, as well as externally.



Cooperation agreements have been signed between Meridian Project and the above countries:

- Russian
- Canada
- Brazil
- Australia
- American(intend)
- Japan(intend)
- ...



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.
- International collaboration will make it possible to constitute the first complete environment monitoring chain around the globe.





Thank You!

