# Introduction to International Space Weather Initiative (ISWI) and China's Participation (Meridian Project)

**Chi Wang**

National Space Science Center, CAS

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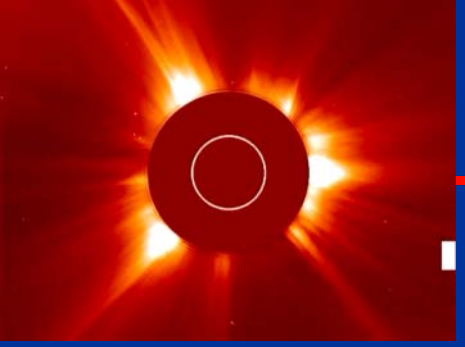
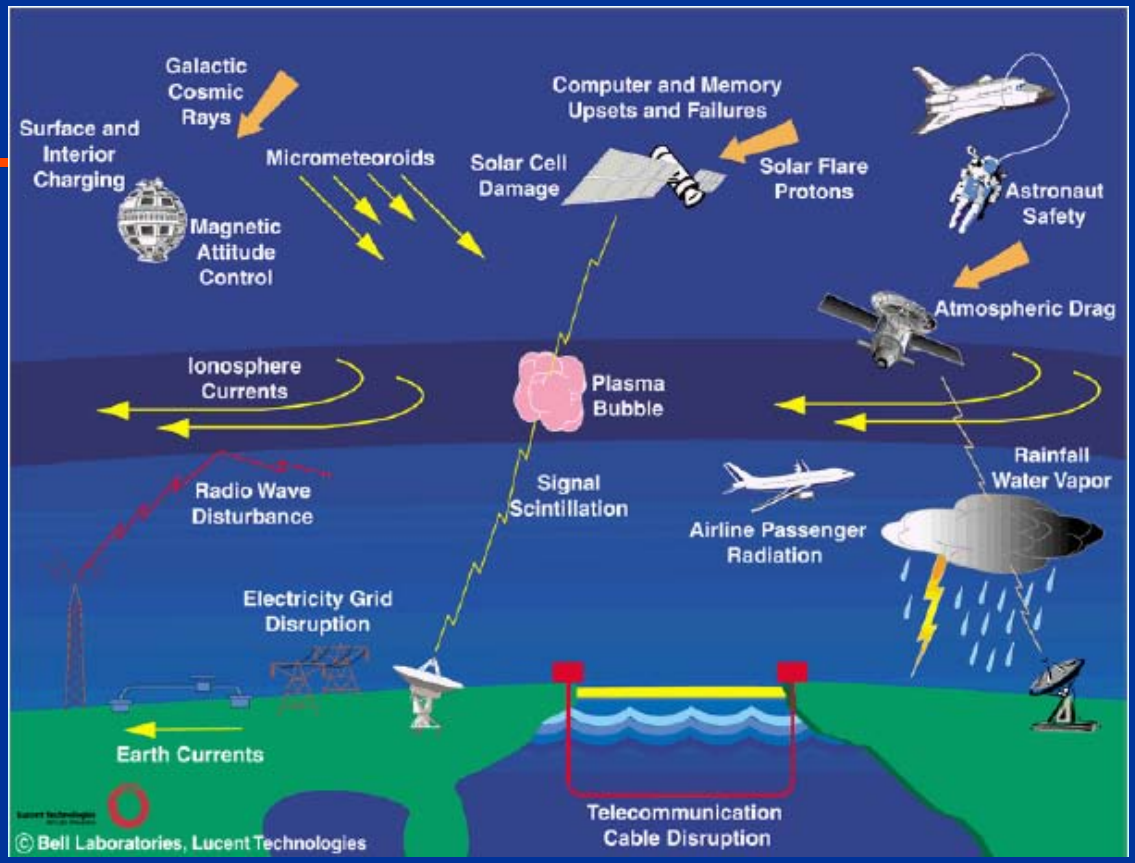
# Outline

- What is Space Weather?
- International Space Weather Initiative (ILWS)
- Chinese Meridian Project
- International Meridian Circle Project



# Space Weather




**refers to conditions on the Sun and in the solar wind, magnetosphere, ionosphere, and thermosphere that can influence the performance and reliability of space-borne and ground-based technological systems and endanger human life and health.**

***USA National Space Weather Program Strategic Plan (March 1995)***

# International Space Weather Initiative (ISWI)

- **UN Endorsement**
  - Opens new opportunities for collaboration in countries with little/no Space Physics by involving governments and Universities or National Labs
  - Encourages governmental response

# ISWI Objectives

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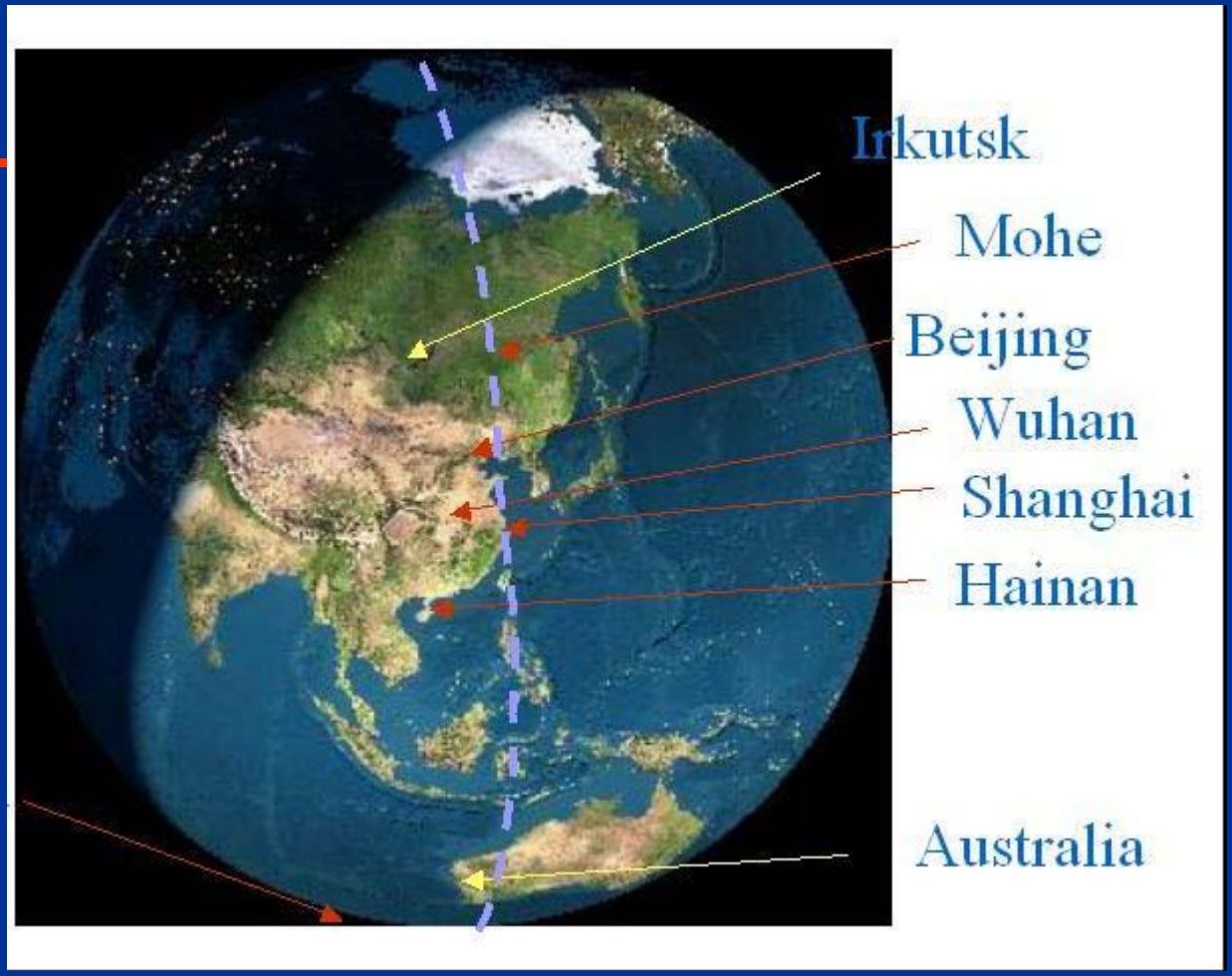
- Develop the scientific insight necessary to understand the science, and to reconstruct and forecast near-Earth space weather
  - Instrumentation and data analysis
    - Expand and continue deployment of new and existing instrument arrays
    - Expand data analysis effort for instrument arrays and existing data bases
  - Coordinate data products to provide input for physical modeling (Joint with other more extensive modeling efforts)
    - Input instrument array data into physical models of heliospheric processes
    - Develop data products that reconstruct past conditions in order to facilitate assessment of problems attributed to space weather effects
  - Coordinate data products to allow predictive relationships to be developed(Joint with Space Weather prediction organizations)
    - Develop data products to allow predictive relationships that enable the forecasting of Space Weather to be established
    - Develop data products that can easily be assimilated into real-time or near real-time predictive models

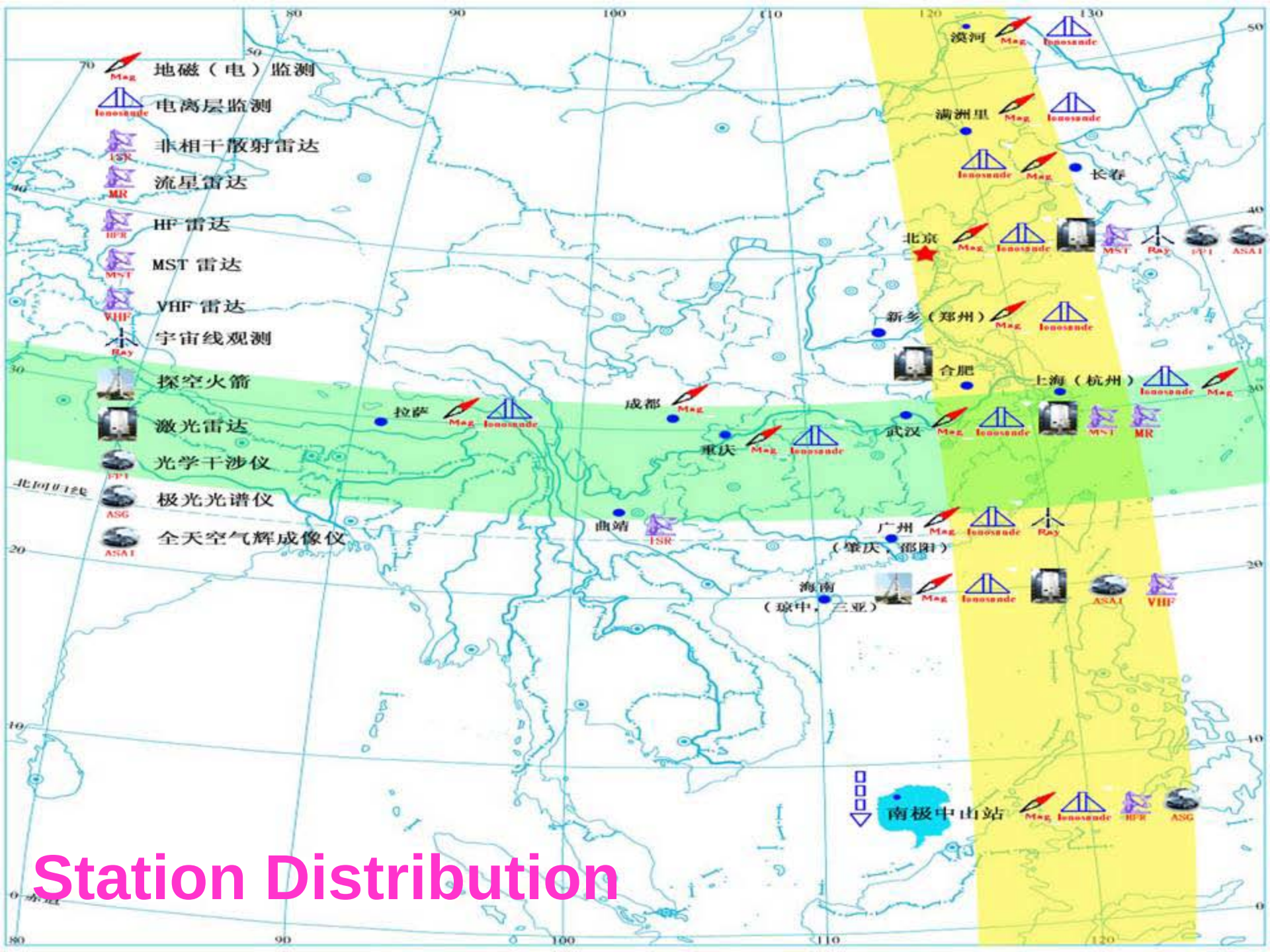
# ISWI Objectives

- Education
  - University and Graduate Schools
    - Encourage and support space science courses and curricula in Universities that provide instrument support
  - Public Outreach
    - Develop public outreach materials unique to the ISWI, and coordinate the distribution

# Meridian Project




It is a Chinese multi-station chain along 120ºE 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.


地磁（电）监测
电离层监测
非相干散射雷达
流星雷达
HF 雷达
MST 雷达
VHF 雷达
宇宙线观测
探空火箭
激光雷达
光学干涉仪
极光光谱仪
全天空气辉成像仪
漠河
满洲里
长春
北京
新乡（郑州）
合肥
上海（杭州）
拉萨
成都
重庆
武汉
曲靖
广州
（肇庆，邵阳）
海南
（琼中，三亚）
南极中山站
Station Distribution

| 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 | Qujing | 25.6N | 103.8E | Incoherent Scattering Radar |
| 14 | Chengdu | 31.0N | 103.7E | Geomagnetic, Ionospheric |
| 15 | Lhasa | 29.6N | 91.0E | Geomagnetic, Ionospheric |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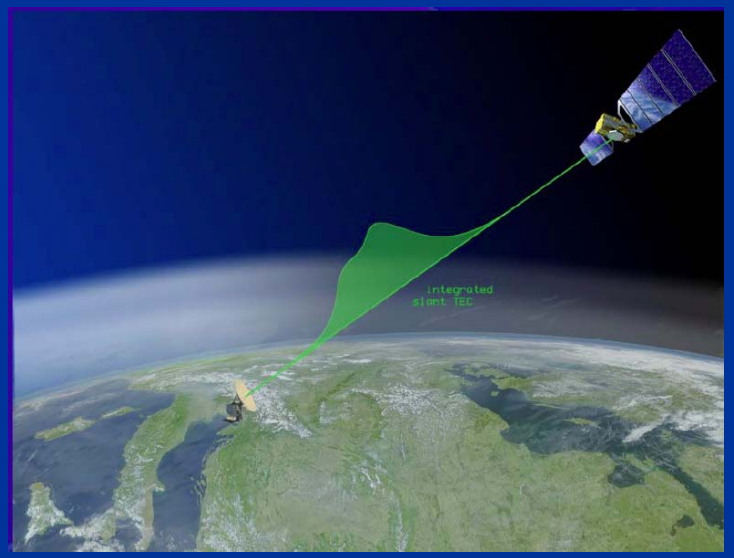
# Spatial Coverage

By

## The Meridian Project

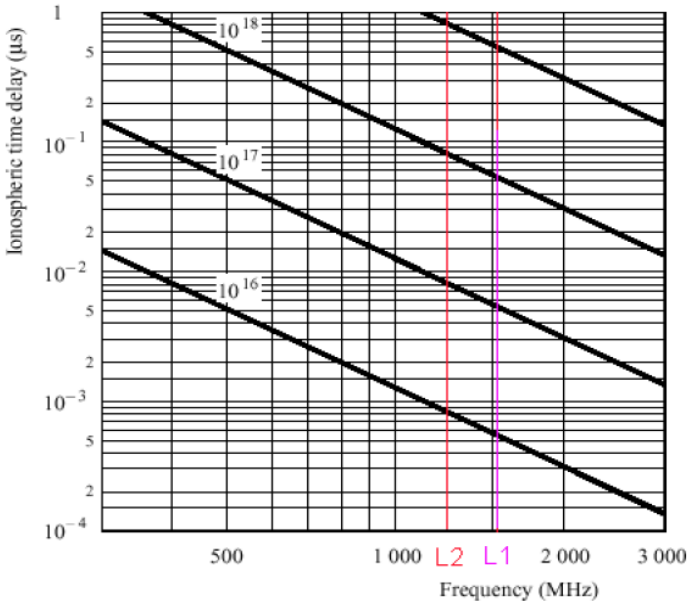
# Effect of Ionosphere: Signal Delay




**GNSS radio signals are slowed down as they propagate through the ionosphere, causing an increase in the propagation time of a signal when compared to the time of propagation through free space.**

**At present time, the signal delay is the main source of error to a satellite navigation system that operate at single frequency.**

**Without correction, this can lead to UERE of 50 m (User Equivalent Range Error for L1 if vTEC=120 TECu and Elevation angle = 12 deg using simple obliquity function).**



# Effect of Ionosphere: Scintillations

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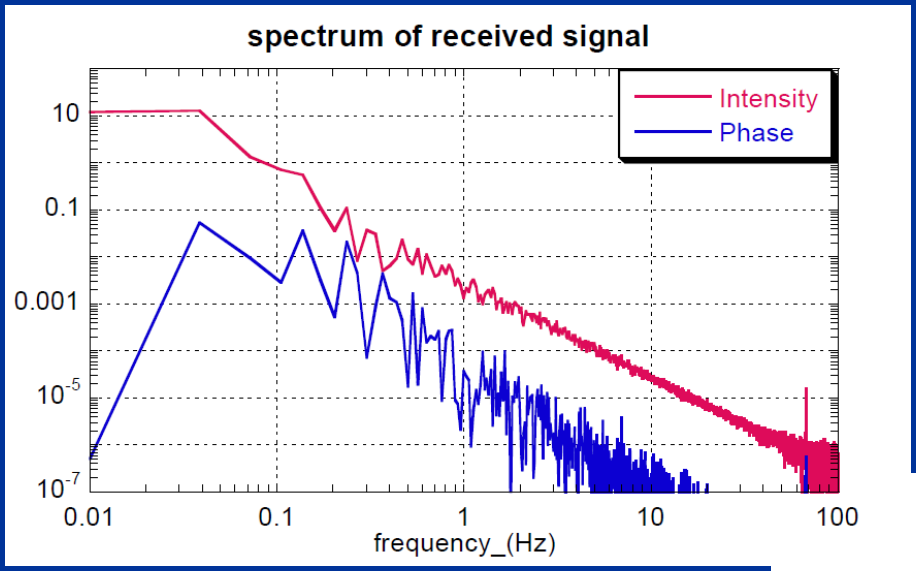
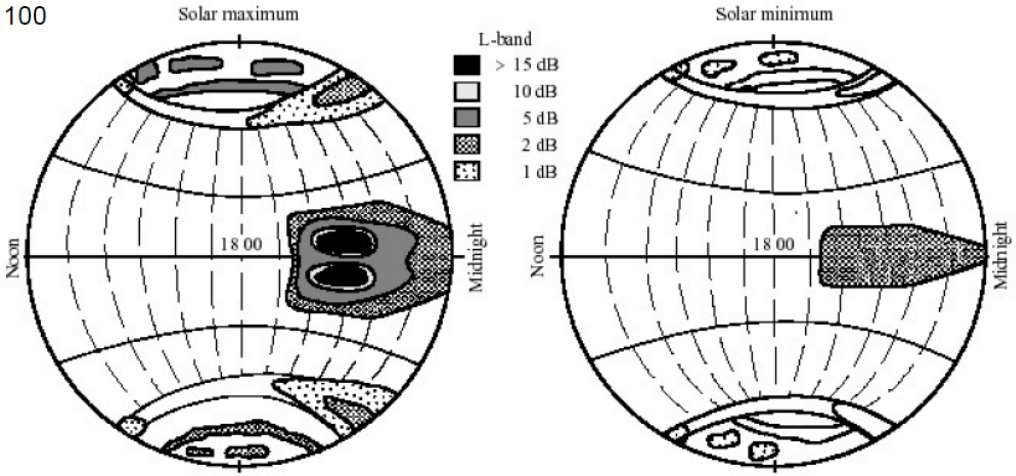



One of the most severe disruptions along a trans-ionospheric propagation path for Navigation signals is caused by ionospheric scintillations. Small-scale irregular structures are causing rapid variations in amplitude, phase and apparent direction of arrival.

There are two intense zones of scintillation, one at high latitudes and the other centred within ± 20° of the magnetic equator *[Basu]*




Scintillations are a threat to continuity and availability of navigation signals since they can cause cycle slips and loss-of-lock in the receivers

# CMP and GNSS

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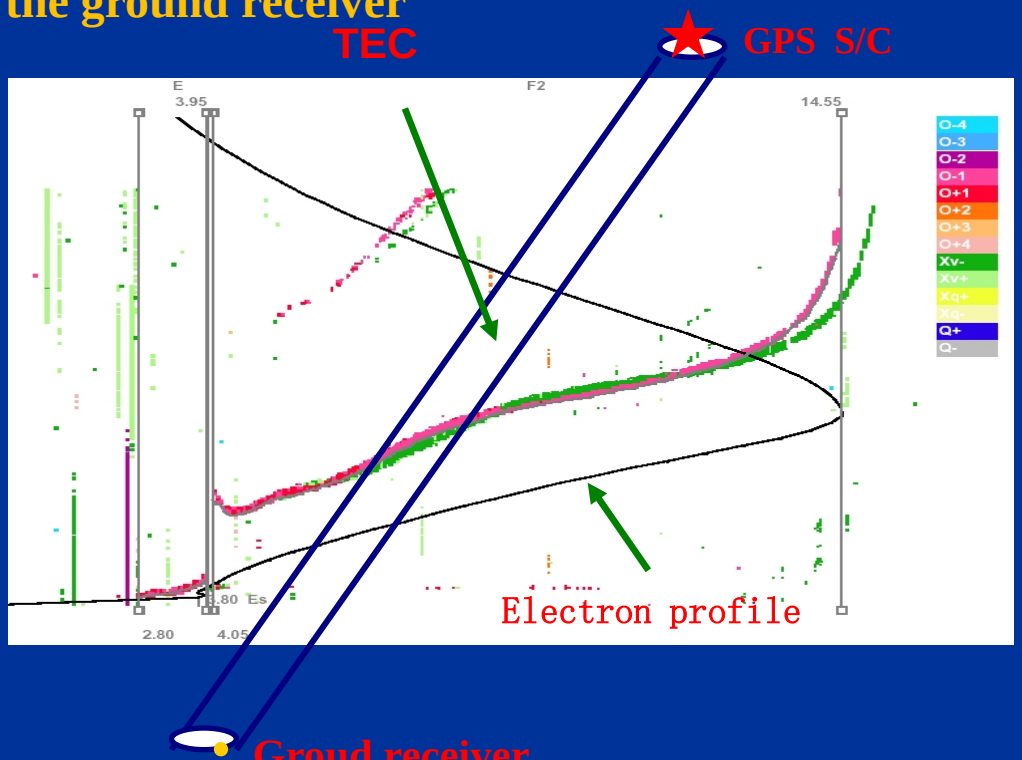
**As we know, Ionospheric Total Electron Content (TEC) is the total number of electrons in a cylinder (with a unit area bottom) connecting the GNSS satellite and the ground receiver**

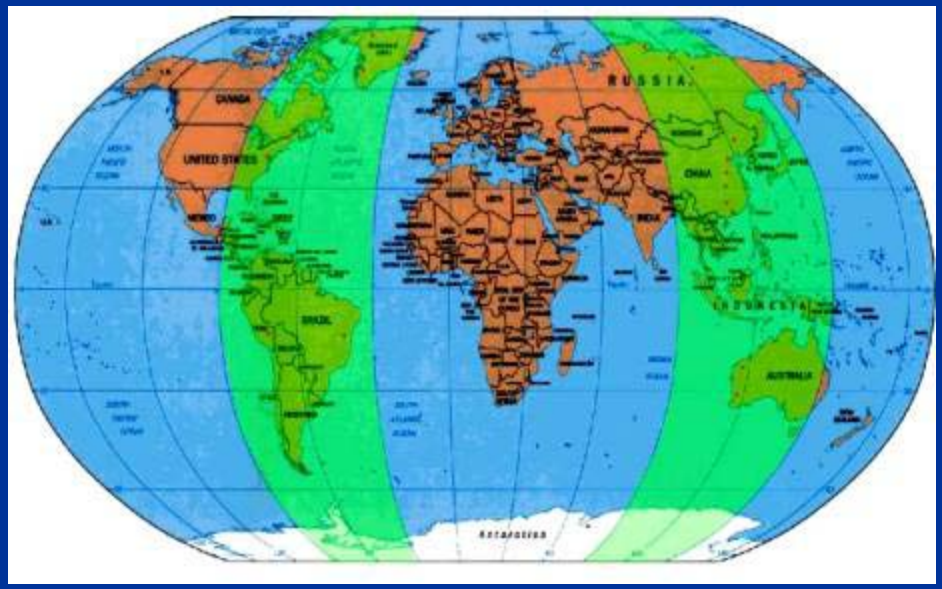



Ionospheric TEC and electron profile

- **TEC variation and disturbance often affect accuracy of the satellite positioning/navigation**
- **The ionospheric scintillation often makes signal disorder in the positioning/navigation**
- **In order to improve the accuracy, it is needed to establish a model to describe the TEC**
- **The ionospheric profile is also needed to improve the accuracy in the positioning / navigation**

- **In the Meridian Project， the TEC Monitor, Scintillation Monitor and Ionosonde can provide quantity of data to improve the accuracy of the positioning/navigation**

# International Collaboration




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

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