Global Space Weather Observational Network: Challenges and China’s Contribution

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2. Ground-based Projects
3. International Meridian Circle Plan (IMCP)

Missions and plans in the 5 years of near future
ESA-CAS joint mission

Space Weather Missions

Solar wind Magnetosphere Ionosphere Link Explorer (SMILE)

A New Mission to Image the Magnetosphere
Investigate the dynamic response of the Earth’s magnetosphere to the solar wind impact in a unique and global manner.

Full chain of events that drive Sun-Earth relationships: dayside reconnection / magnetospheric substorm cycle / CME-driven storms.
Space Weather Missions

Payloads

- Soft X-ray Imager (SXI)
- Ultra-Violet Imager (UVI)
- Light Ion Analyzer (LIA)
- MAGnetometer (MAG)
Space Weather Missions

Project Overview

- Elliptical Orbit: 5000km@perigee  19 Re@apogee
- Launch: 2023~24
- Lifetime: 3 years
Nov. 2016: Kick off

June 2017: Mission Consolidation Rev

Feb 2019: ESA-Mission Adoption

July 2019: PDR


May 2021: CDR

April 2023: Qualification and Flight Acceptance Rev

Nov 2023-April 2024: Launch

April 2023: Qualification and Flight Acceptance Rev

May 2021: CDR

July 2019: PDR

Feb 2019: ESA-Mission Adoption


June 2017: Mission Consolidation Rev

Nov. 2016: Kick off
Advanced Space-borne Solar Observatory (ASO-S)

### Scientific Objectives

- Simultaneously observe the full disc vector magnetic field, non-thermal images of hard X-rays, and initiation of CME
- Understand the causality between magnetic field and flares, magnetic field and CMEs, flares and CMEs
## Part 1: Space Weather Missions

### Payloads

<table>
<thead>
<tr>
<th>Payloads</th>
<th>Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full-disc vector MagnetoGraph (FMG)</td>
<td>Magnetic Field</td>
</tr>
<tr>
<td>Lyman-alpha Solar Telescope (LST)</td>
<td>CMEs</td>
</tr>
<tr>
<td>Hard X-ray Imager (HXI)</td>
<td>Solar Flares</td>
</tr>
</tbody>
</table>

![Diagram showing payloads](image)
Scientific Objectives

- Investigate the origin of the upflow ions and their acceleration mechanism
- Understand the impact of the outflows ions on magnetic storm development
- Characterize the ionosphere and thermosphere storm driven by magnetic storm
- Discover the key mechanism for the magnetosphere, ionosphere and thermosphere coupling
**Part 1**  
**Space Weather Missions**

### Satellite Specifications

<table>
<thead>
<tr>
<th>Spacecraft</th>
<th>ITA</th>
<th>ITB</th>
<th>MA</th>
<th>MB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inclination</td>
<td>90°</td>
<td>90°</td>
<td>90°</td>
<td>90°</td>
</tr>
<tr>
<td>Perigee</td>
<td>500km</td>
<td>500km</td>
<td>1Re</td>
<td>1Re</td>
</tr>
<tr>
<td>Apogee</td>
<td>1500km</td>
<td>1500km</td>
<td>7Re</td>
<td>7Re</td>
</tr>
</tbody>
</table>

- **4 satellites in elliptical orbits**
- **2 satellites (ITA and ITB)**  
  In thermosphere/ionosphere
- **2 satellites (MA and MB)**  
  In magnetosphere

### Payloads

- 4 satellites in elliptical orbits
- 2 satellites (ITA and ITB)
  In thermosphere/ionosphere
- 2 satellites (MA and MB)
  In magnetosphere
Part 1  Space Weather Related Mission

China Seismo Electromagnetic Satellite (CSES)

Scientific Objectives

• Investigate the structure and the dynamic of the topside ionosphere

• Understand the coupling mechanisms with the lower and higher plasma layers and the temporal variations of the geomagnetic field, in quiet and disturbed conditions

• Explore the correlations between the ionospheric variations and the occurrence of seismic events.

Launched on Feb. 2, 2018
# Orbit

<table>
<thead>
<tr>
<th>Style of orbit</th>
<th>Sun synchronous orbit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Altitude (km)</td>
<td>507</td>
</tr>
<tr>
<td>Inclination (deg)</td>
<td>97.4°</td>
</tr>
<tr>
<td>Period (min)</td>
<td>94.6</td>
</tr>
<tr>
<td>Local time of descending node</td>
<td>14:00pm</td>
</tr>
<tr>
<td>Revisiting period (day)</td>
<td>5</td>
</tr>
<tr>
<td>Institution</td>
<td>Payload</td>
</tr>
<tr>
<td>-------------</td>
<td>---------</td>
</tr>
<tr>
<td>Beijing Univ. of Aerospace and Astronauts</td>
<td>Search-Coil Magnetometer</td>
</tr>
<tr>
<td>National Space Science Center, CAS together with Austria Space Institute</td>
<td>High Precision Magnetometer</td>
</tr>
<tr>
<td>China Academy of Space Technology</td>
<td>Electric field detector</td>
</tr>
<tr>
<td>National Space Science Center, CAS</td>
<td>Plasma analyzer</td>
</tr>
<tr>
<td>National Space Science Center, CAS</td>
<td>Langmuir probe</td>
</tr>
<tr>
<td>China Academy of Space Technology</td>
<td>GNSS Occultation Receiver</td>
</tr>
<tr>
<td>Institute of Electrical Wave Propagation of China</td>
<td>Three frequency transmitter</td>
</tr>
<tr>
<td>Italian National Institute of Nuclear Physics; Institute of High Energy Physics, CAS</td>
<td>Energetic particle detector</td>
</tr>
</tbody>
</table>
Preliminary Results: Magnetic field distribution

CSES from April 23-28

SWARM from April 22-28

IGRF model
Preliminary Results: High Energetic Particles
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Part 2

Ground-based Projects

Chinese Meridian Project (I)

• Geomagnetic
• Optical-atoms
• Radio
• Rocket

Longitudes: 120°E
Latitudes: 30°N
15 Stations

Operation: 2012-now
Part 2  Ground-based Projects

Meridian Project II

1-Chain: Solar-interplanetary chain

3-Nets: Geomagnetic, Ionospheric, and Upper atmospheric nets

Longitudes: 120°E, 100°E
Latitudes: 30°N, 40°N

4-Focus:
• Polar
• North Part
• Hainan(South)
• Tibet Plateau

<table>
<thead>
<tr>
<th>Framework</th>
</tr>
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<tbody>
<tr>
<td><strong>1-Chain</strong></td>
</tr>
<tr>
<td>Solar –IP</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

**Space Environment Monitoring**

**Data and Communication**

**Prof. Users**

**Domestic**

**Science and Application**

**International**

**Operation**

**Forecast Support**

**Research Support**

**Applied Demonstration**

**Public Users**
Solar Radio Heliograph

Key Instruments

- Frequency: 30MHz－240MHz
- Freq. Resolution: 1 MHz
- No. of antenna: ~100
- Time Resolution: ~100ms
- Polarization: I, Q, U, V

- Frequency: 150MHz－450MHz
- Freq. Resolution: 2 MHz
- No. of antenna: 401
- Time Resolution: 0.1s
- Array Diameter: 1000m
IPS

**Key Instruments**

**InterPlanetary Scintillation**

- 3-station, 2-frequency
- Frequency: 327 and 654 MHz
- System Temperature: 120 K
- Sensitivity: 0.3 Jy
- Sample Rate: 10 ms
Digital Ionosonde

Key Instruments

- Frequency: 1 - 30 MHz
- Power: 300W (peak)
- Height resolution: 2.5, 5, 10 Km
- Sensitivity: 130 dBm

No. of Digisonde to be employed: 19
• Na-Lidar: 80-110 km, Temperature, Wind, and Density of Na-layer at 589.1 nm

• Enhanced-Lidar: 80-110km, Na, Fe, Ca, Ka, Diameter: 2m
Key Instruments

Helium Lidar

- Rayleigh: 30-90 km, T, N
- Na: 80-110 km, wind, T, Na-density
- He: 200-1000 km, He-density
- Diameter: 6 m
SuperDARN Radar

Key Instruments

HF radar array

- Phased-array Radar
- Frequency: between 8 and 20 MHz
- Power: 9.6 kW
- Height resolution: 15 – 45 km
Key Instruments

Incoherent Scatter Radar

- 3-Station ISR
- Frequency: 440 MHz
- Power: 4 MW (peak)
- Detection Range: 190 – 4000 km
Status

- Chinese Meridian Project II has been approved in Jan., 2018, with a total budget of 1.3B (RMB) or ~200 M (US$).

- The construction phase is expected to start by the end of 2018.
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Part 3

International Meridian Circle Plan (IMCP)

To connect 120°E and 60°W meridian chains of ground based monitors worldwide, in order to provide a global picture of unfolding space weather events.

IMCP will be one of the candidates for the Key International Projects/Plans initiated by MOST (Ministry of science and technology) in China.
International Meridian Circle Program (IMCP)

- Coordinating observational campaigns (Observation Platform)
- Data sharing and Exchange (Information Platform)
- Encouraging collaboration on scientific research and observations (Research Platform);
- Promoting education and public outreach, personnel exchange (Education Platform)
Summary

- Space weather has received significantly high-level attention in China, and China will be making great contributions to the global space weather observational network in the next 5 years.

- To understand the space weather need much more efforts where new missions are encouraged and international collaborations are very much demanded.