Space Weather Prediction Research and Services for China Manned Space Mission

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Outline

I. General information of Space Environment Prediction Center (SEPC)
II. Services for China Manned space missions
III. Researches on Space Weather
I. SEPC – Foundation

- To support China manned space missions, SEPC was established in 1993 in NSSC, CAS;
- Set up its space environment operational system and forecasting team in 1998.
- Started to issue space environment prediction all over the world in 1998 via internet.

- 7days/week, 365days/year

http://www.sepc.ac.cn
SEPC is one of the four sub-centers of Regional Warning Center-China (RWC-China, ISES).

- **SAPC** (Solar Activity Prediction Center)
- **NAO/CAS** (National Astronomical Observatories)
- **SEPC** (Space Environment Prediction Center)
- **CSSAR/CAS** (Center for Space Science and Applied Research)
- **IDPC** (Ionospheric Disturbance Prediction Center)
- **RPRI** (Radio-Wave Propagation Research Institute)
- **GSPC** (Geomagnetic Storm Prediction Center)
- **GGI/CAS** (Geology and Geophysics Institute)
I. SEPC – Organization

- SE forecast group
- SE forecast research group
- SE model research group
- SE effects research group
- SE operation system developing group
- Space debris group

- 16 forecasters come from different groups
Outline

I. General information of Space Environment Prediction Center (SEPC)

II. Services for China Manned space missions

III. Researches on Space Weather
As a subsystem of space application system in China manned space engineering, SEPC has supplied space weather service in each step of China Manned Space Engineering.
Missions during Solar Cycles

- Nov. 20, 1999  Shenzhou Ⅰ
- Jan. 10, 2002  Shenzhou Ⅱ
- Mar. 25, 2002  Shenzhou Ⅲ
- Dec. 30, 2002  Shenzhou Ⅳ
- Oct. 15, 2003  Shenzhou Ⅴ
  The first manned spacecraft
- Oct. 12, 2005  Shenzhou Ⅵ
  Multi-person and multi-day
- Sep. 25, 2008  Shenzhou Ⅶ
  SVA
  Space-related scientific tests
- Sep. 29, 2011  Tiangong Ⅰ
- Nov. 1, 2011  Shenzhou Ⅷ
  Rendezvous and docking
- June 16, 2012  Shenzhou Ⅸ
  Maned rendezvous and docking
Service for China manned missions

Process of Space Weather Forecast Service

Design Period
Before Launch
In-Orbit experiment
Long-term experiment period

Space environment parameter
(long term forecast, ssn and radio flux)
SEE numeric evaluation (single event effects, radiation damage effects)

Background Analysis

Forecast for launch window
(solar activity, geomagnetic activity, space debris, atmospheric environment, radiation environment)

Mid-term Forecast
Short-term Forecast

Monitoring, forecast and warning
(solar eruption, solar proton, solar wind, geomagnetic storm, three times one day)

Nowcast
Forecast
Warning

Nowcast Forecast Warning

Monitoring, forecast and warning
(solar eruption, solar proton, solar wind, geomagnetic storm, once every day)
In 1999, in order to avoid Leonid burst, Shenzhou-1 postponed its launch time from Nov. 18 to Nov. 20 for 48 hours. This is the first time of changing launch plan due to space environment in China.

According to the observation, Meteoroid flux had declined to the safe level at the launch time.
Successfully avoided the severe space environment event—Solar Proton Event.
Geomagnetic field quiet period prediction for Shenzhou VII

The geomagnetic Ap index during SZ-7 launch, EVA and companion microsatellite experiment
2012 China dragon event

空间环境事件警报
发布时间：2012年1月24日10时00分（北京时）

事件名称：太阳质子事件，地磁暴

警报内容：

Space environment detectors on Tiangong I

• Energetic particle radiation detector
  – Proton
    2.5~5MeV
    5~10MeV
    10~18.5MeV
    18.5~40MeV
    40~80MeV
    80~150MeV
    >150MeV
  – Electron
    0.2~0.4MeV
    0.4~0.5 MeV
    0.5~0.6MeV
    0.6~0.8MeV
    0.8~1.0MeV
    1.0~1.2MeV
    1.2~1.5MeV
    >1.5MeV

• Orbital atmospheric environment detector
  – Density, composition
Solar proton event on March 7, 2012
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Model Research Review in SEPC

- Sunspot and solar F10.7 long-term and 27-day forecast
- Solar eruptive event forecast study

- A Three-Dimensional Asymmetric Magnetopause Model
- Prediction method study of relativistic electron flux at GEO orbit
- Regional TEC model
- Forecast model of ionospheric foF2
- Thermospheric density correction model
- Mid-term Ap index forecasting

- Solar wind velocity during low CME periods model research

- Magnetopause
- Ionosphere
- Thermosphere
- Geomagnetic field
• Mid-term Forecast

• Solar Cycle Forecast
Pch index and solar wind speed forecast
Three Dimensional Asymmetric Magnetopause Empirical Model (Lin et al. 2010, JGR)

◆ In comparison with previous magnetopause empirical models, this model reduces the standard deviation of prediction greatly.

◆ Parameterized by solar wind dynamic and magnetic pressures, IMF Bz, and the dipole tilt angle. It’s appropriate for the near-Earth magnetopause prediction under both normal and extreme solar wind conditions.

◆ Can describe the 3D magnetopause, including the asymmetries and the indentations near the cusps.

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<td>12.0%</td>
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GEO relativistic electron flux forecast model

regional TEC

Dst index forecast model
http://eng.sepc.ac.cn
Space environment alerts are issued for four categories: Relativistic Electron Enhancement (REE), Geomagnetic Storm (GMS), Solar proton event (SPE), and Solar x-ray flare (SXR). There are 3 types of Space Weather Alert Messages: alert, continuation alert, and summary. Alert messages are issued when an event threshold is crossed and contain information that is available at the time of issue. Continuation alert messages are issued when an event is proceeding in the next day. Summary messages are issued after the event ends, and contain additional information available at the time of issue. There are three-level alerts according to the eruption. The yellow color means minor storm, orange color means moderate storm, and red color means strong storm. If the color is green, it means quiet condition. From the web, we can see Space environment alerts 27-day cycle review and search history alerts.
Real-time Data
57 different countries have visited this site. 92 flags collected. View details »

New Unique Visitors
Yesterday: 69 ▲
30 day average: 57
Record: 230 on September 10, 2011
View history »

Flag Counter Views
Yesterday: 424 ▼
30 day average: 295
Record: 1,007 on June 25, 2012
View history »

This counter has been viewed 99,928 times by 21,232 unique users!

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Thanks for your attention!