Space weather service and collaborations in NAOC

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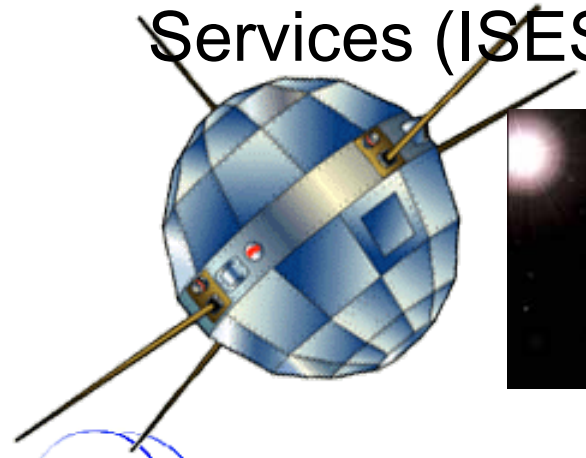
Outline

1. History
2. Solar observations
3. Solar activities forecasting services
4. Perspective

1. History

Solar activity prediction center of RWC-China has long-term domestic and oversea collaborations in solar observations and forecasting serves.

- Begin in 1969
  - short wave communication
  - space missions
- Services for Chinese first satellite mission in1970
- Member of International Space Environment Services (ISES) in 1990



Regional Warning Center of China (RWC-China)

- Setup in 1991
- Four sub-centers
  - **Solar Activity Prediction Center (SAPC) at NAOC (headquarters of RWC-China)**
  - Space Environment Prediction Center (SEPC)
  - Ionospheric Disturbance Prediction Center (IDPC)
  - Geomagnetic Storm Prediction Center (GSPC)
- RWC-China's tasks:
  (1) Data collection
  (2) User services
  (3) Information exchange with other RWCs

http://www.ises-spaceweather.org/

The International Space Environment Service (ISES) is a permanent service of the Federations of Astronomical and Geophysical Data Analysis Services (FAGS) under the support of the International Union of Radio Science (URSI) in association with the International Astronomical Union (IAU) and the International Union of Geodesy and Geophysics (IUGG).

2. Solar observations

Domestic solar observation sites

Observations at NAOC

Huairou Solar Observing Station (Huairou Reservoir, Beijing)

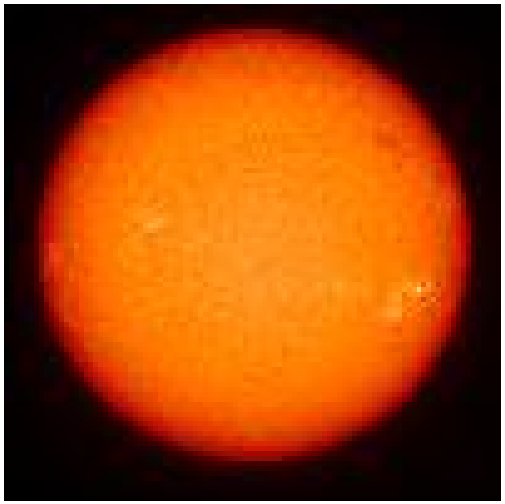
Solar Tower and Solar Telescope (Fuxian Lake, Yunnan)

China Solar Radio Heliograph (Mingantu, Inner Mongolia)

Round-the-clock and high resolution full disk Hα images (collaborations among solar observatories)

1500 - 0000 UT

BBSO (USA)



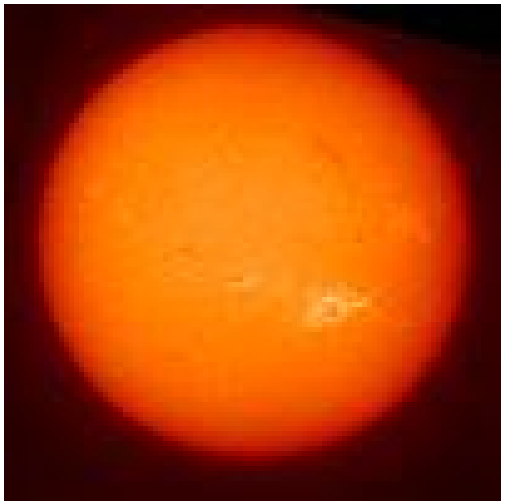
0600 - 1500UT

KSO (Austria),
CAO (Italy)

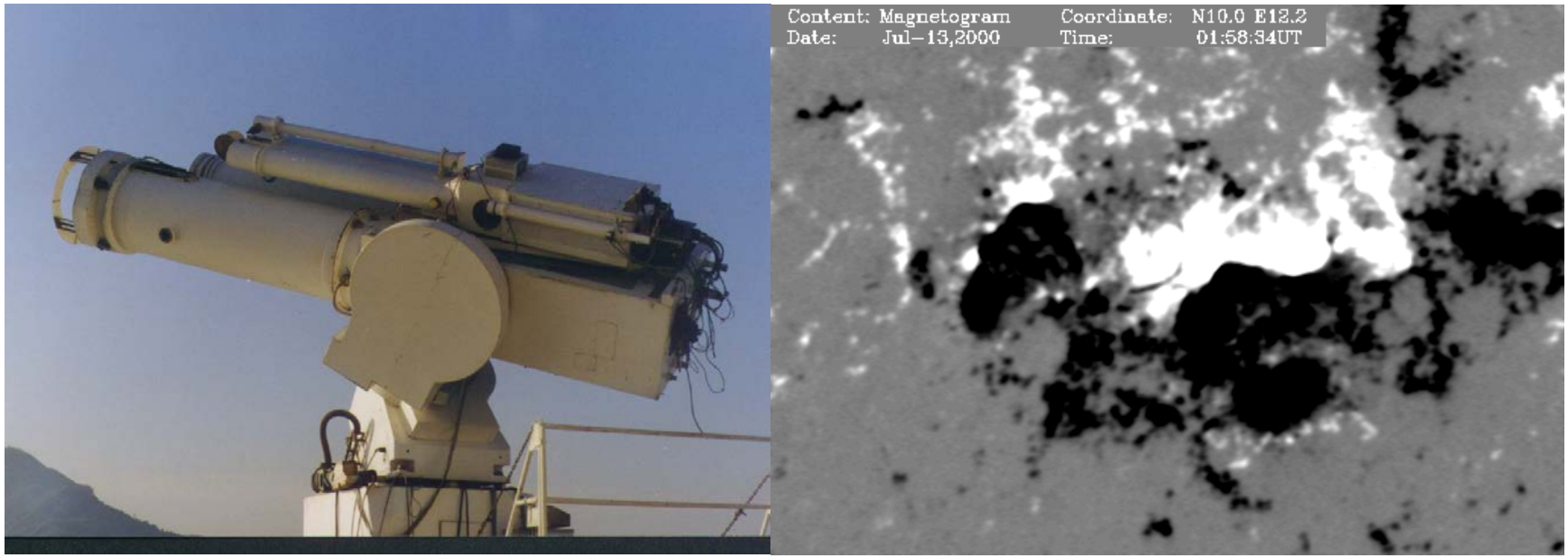
0100 - 0800 UT

YNAO, HSOS

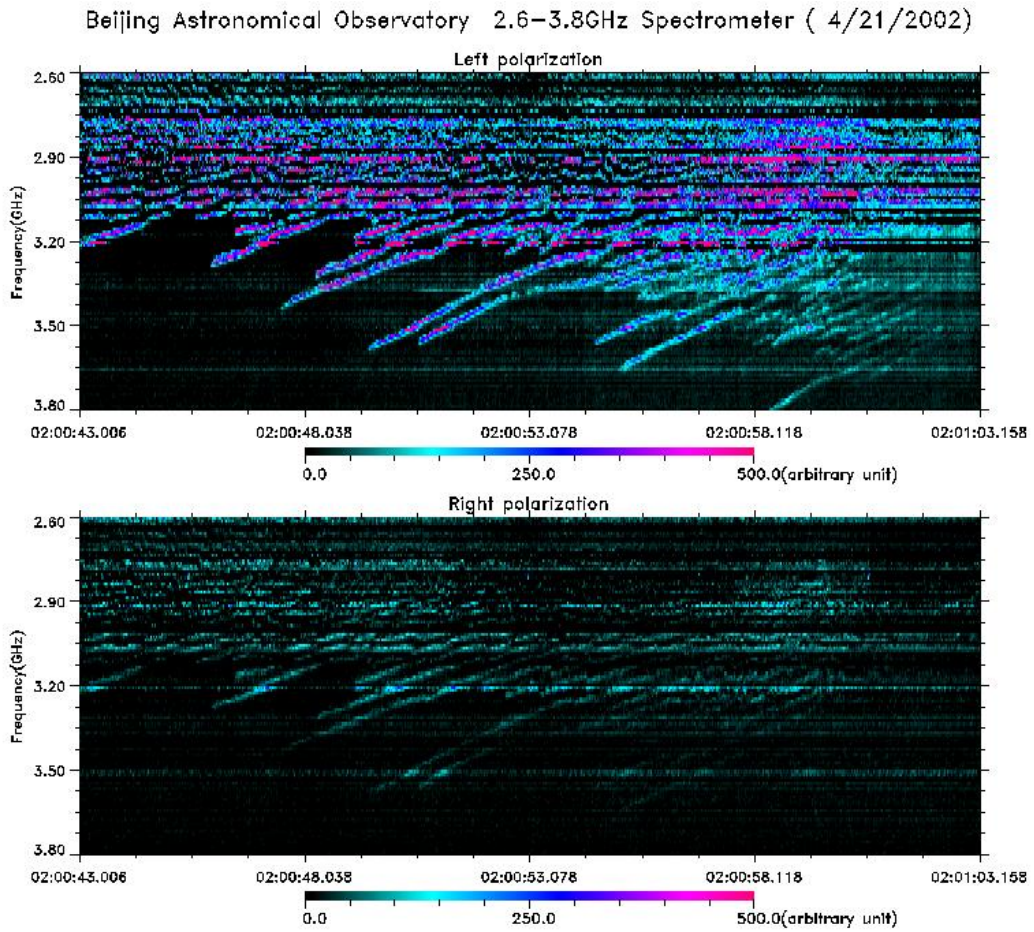
(China)



Solar Multi-Channel Telescope at Huairou, Beijing

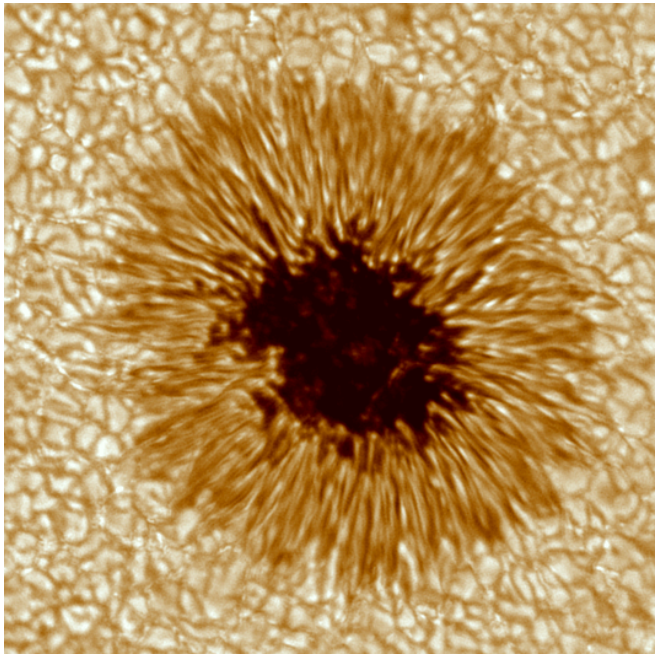


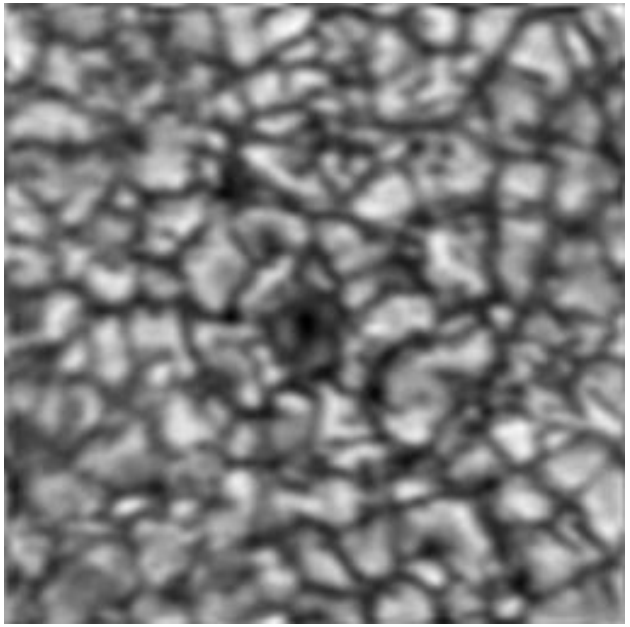
Solar Multi-Channel Telescope and the observed magnetogram



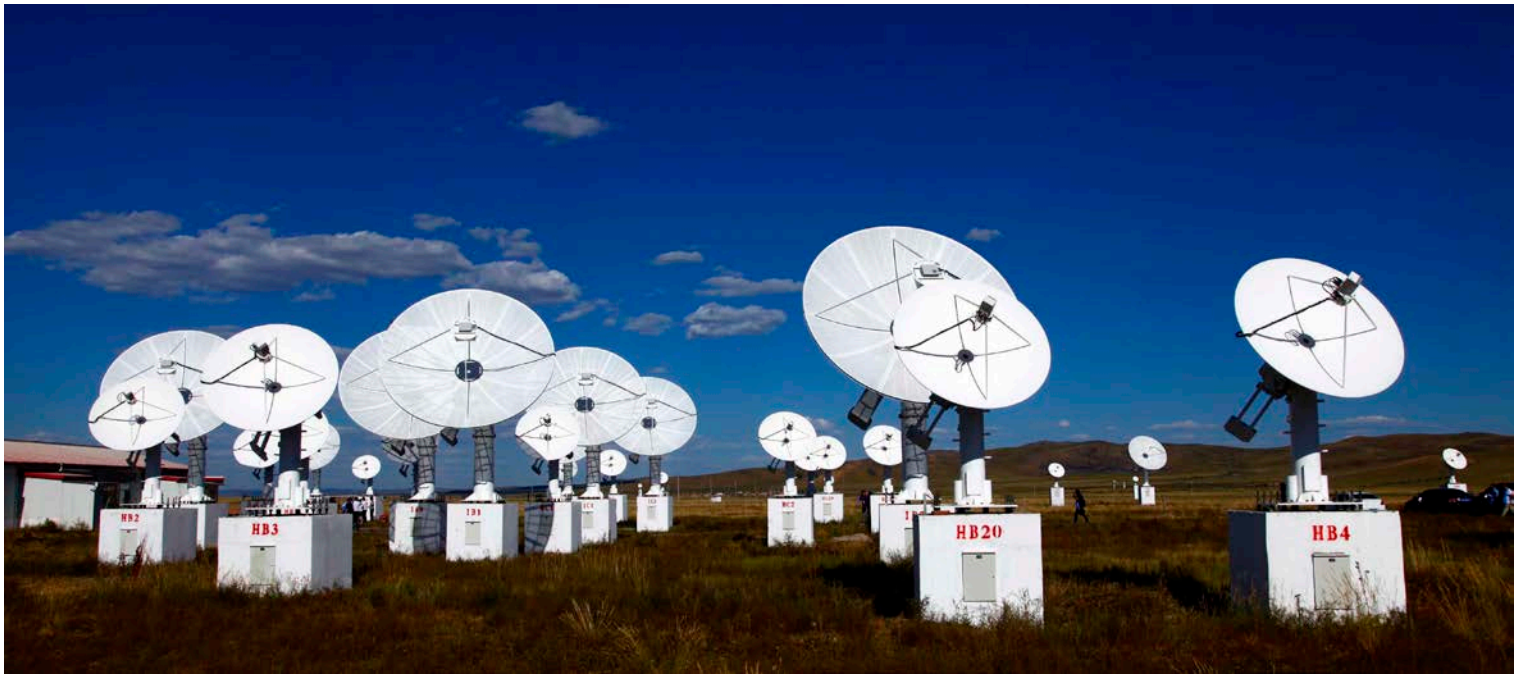
Data Observed by 0.7-7.6GHz broadband radio-spectrometers at Huairou, Beijing

Solar Tower at Huxian Lake

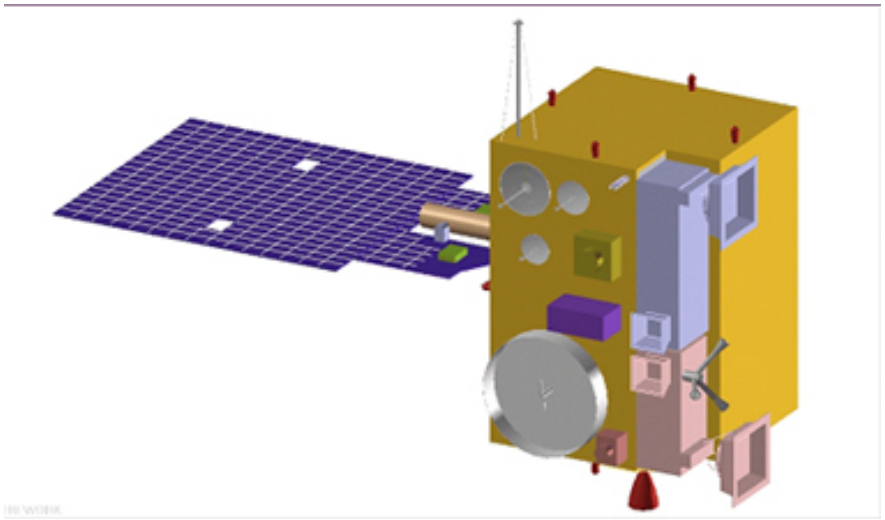




China Solar Radio Heliograph (Mingantu, Inner Mongolia)



Sharing observational data with other institutes



Solar flux and imaging observations from payloads on FY series and other satellites

Shidao solar observatory (Shandong)

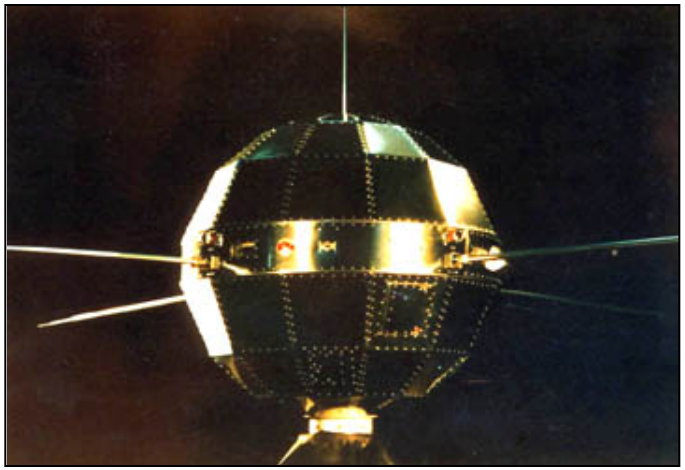
3. Solar activities forecasting services

Solar weather forecasting services at NAOC

- Short-term prediction (within 2 or 3 days)
  -- solar X-ray flare class within 2 days (none, C, M, X)
  -- solar proton event probability within 3 days
  -- solar 10.7cm radio flux daily values within 3 days
- Medium-term prediction (within 1 or 2 weeks)
  -- monthly mean sunspot number
  -- solar X-ray flare activity level
- Long-term prediction (in time scale of solar cycle)
  -- maximum value and phase of sunspot number

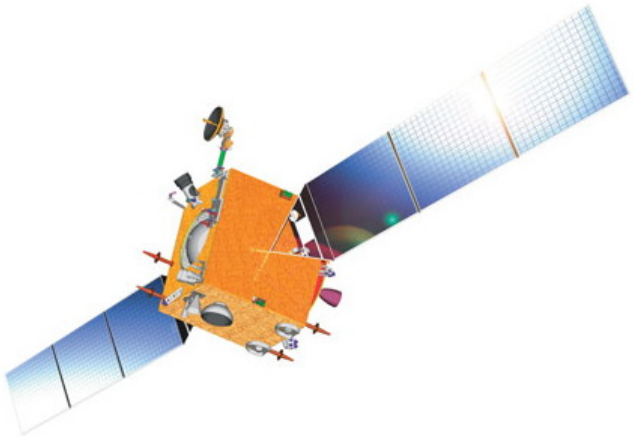
The daily solar activity forecasts are distributed both by web pages (http://rwcc.bao.ac.cn) and emails

Special services



Chinese first satellite mission (1970)

Shenzhou series of manned space flight



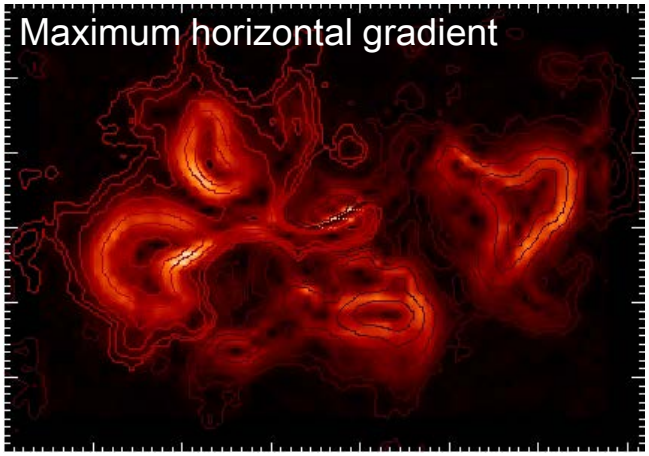
Chang’e series of moon exploration spacecraft

Researches on solar weather forecasting

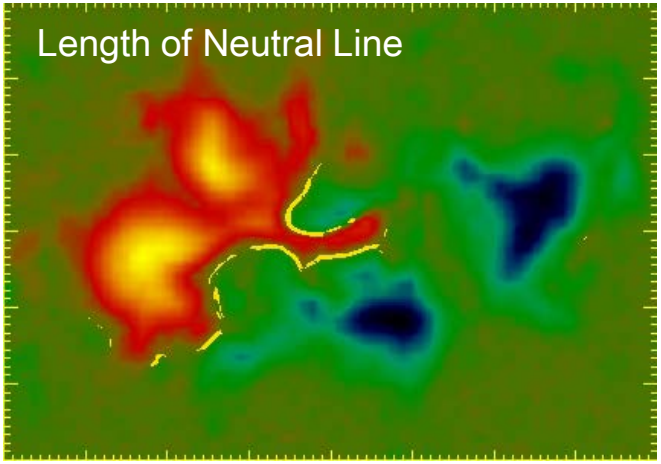
- Currently available prediction models:
  - -- solar flare short-term prediction models
  - -- solar proton event short-term prediction model
  - -- solar 10.7cm radio flux prediction model
  - -- solar active longitude prediction model
  - -- solar active level quantitative assessment model
  - -- solar 3-D coronal magnetic field NLFFF extrapolation model
- Forecasting models in development:
  - -- coronal mass ejection (CME) prediction model

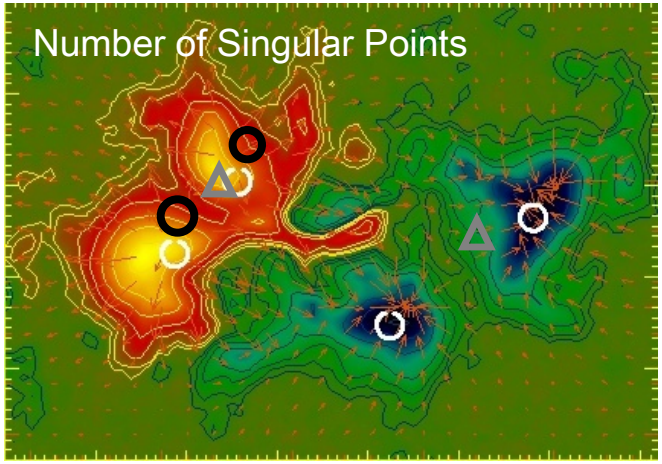
NAOC

New physical measures of magnetic field as input factor for the flare and proton event prediction models



Active Region
NOAA 9574
2001-08-11 UT





Physical measures reflect the complexities of the photospheric magnetic field

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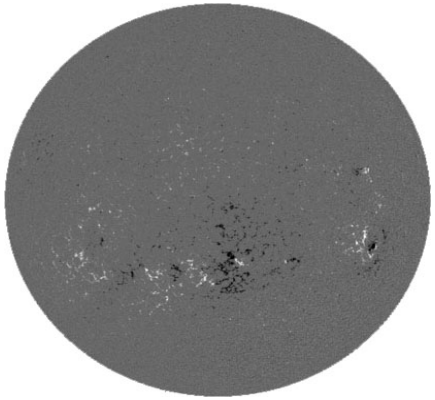
New artificial intelligence classifying algorithm for flare and proton events prediction models

Testing samples

Physical parameters

Magnetic complexity



Training samples

Physical parameters

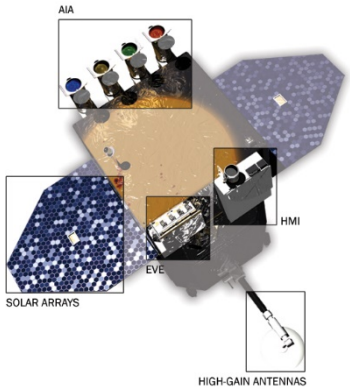
Magnetic complexity

Artificial intelligence

Training model

Test

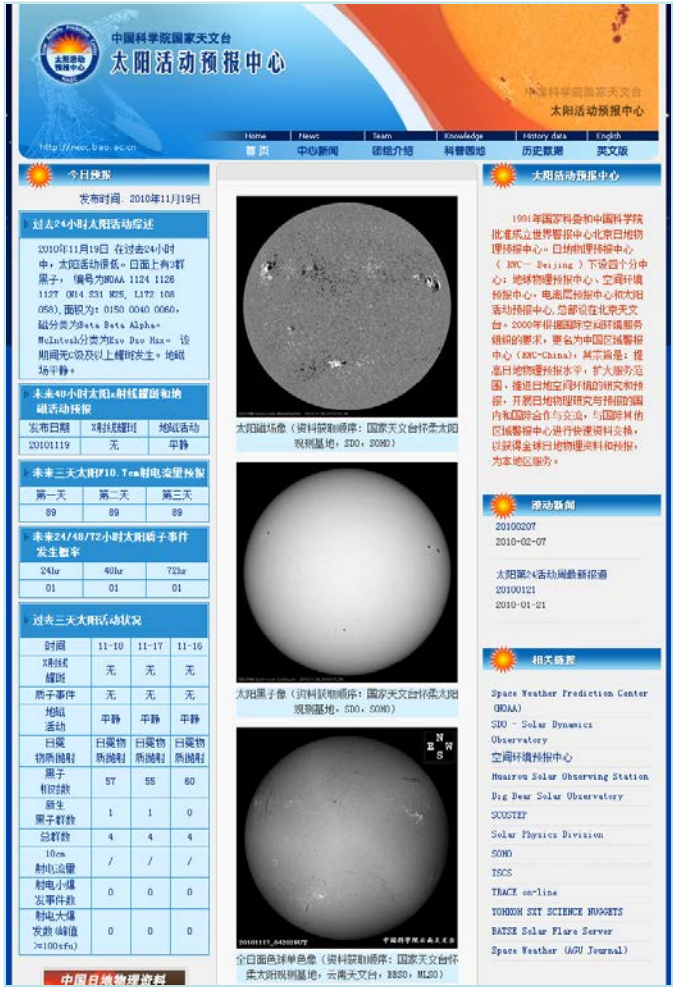
Results



Operational platforms for solar weather forecasting and distribution at NAOC

Operational Platform	Application time	Distribution media	Supporting computer system
First generation	2001 – 2006	Web page	Simple database system and data table; input observation data by hand; run prediction model by hand
Second generation	2006 – 2011	Web page; simple English language page	Simple database system; complex data table; grab observation data semi-automatically; prediction model can be controlled by platform
Third generation (being developed)	2011 -	Dynamic and Interactive web pages; Complete English language pages; **3-D computer simulation interface**	Dedicated database server; Mass storage devices; grab and extract observation data automatically; run prediction model automatically; 3-D virtual reality (VR) technique

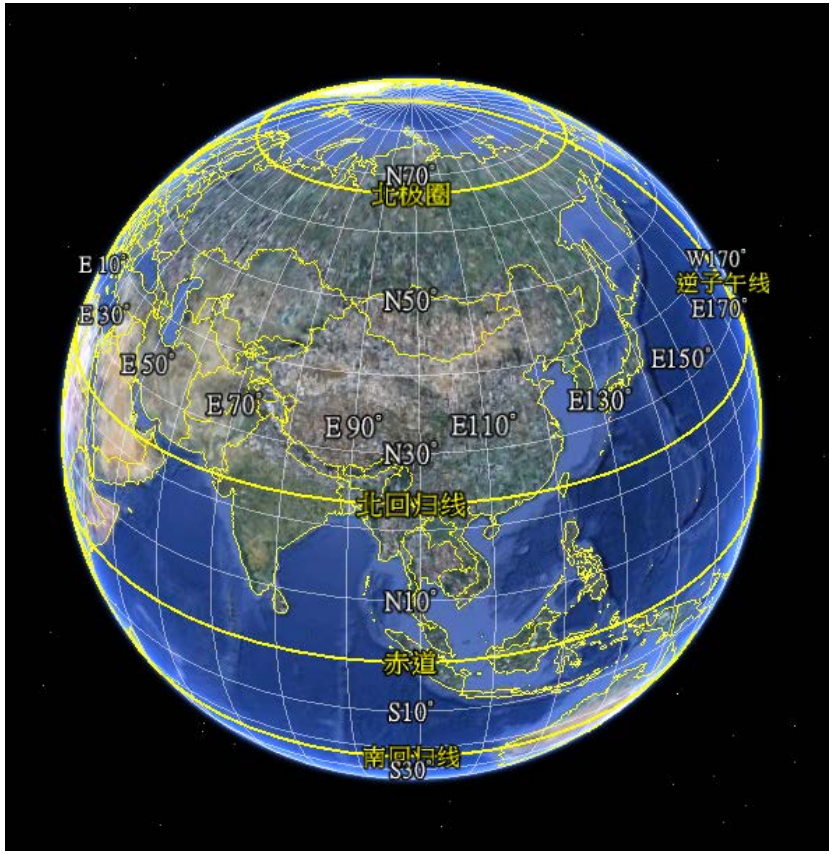
Web interface of the 2nd generation operational platforms (in Chinese language)



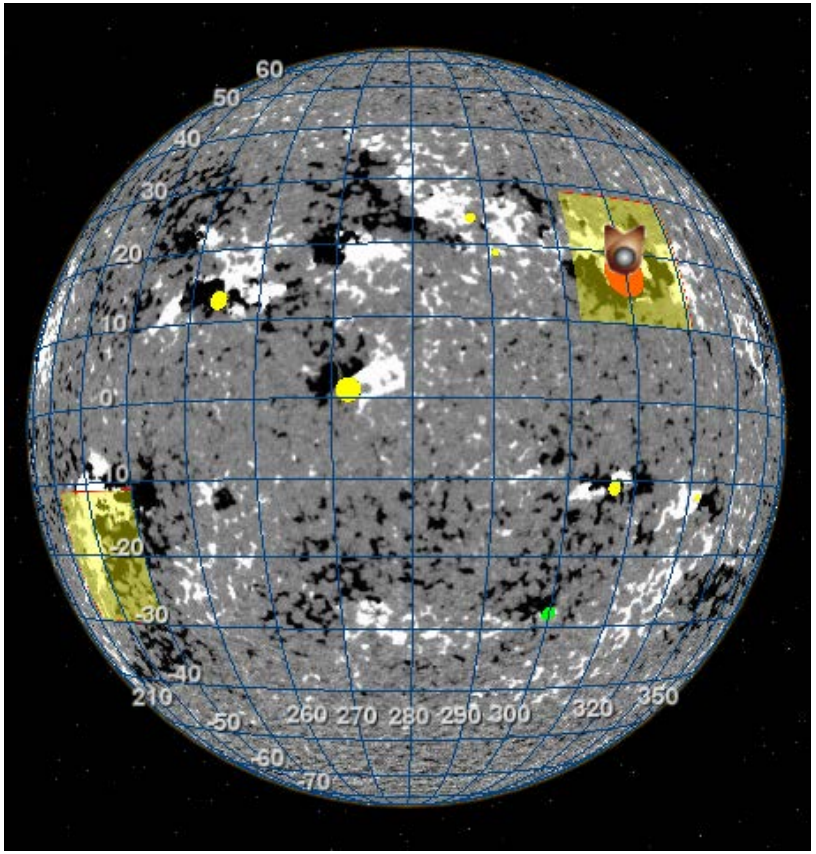
Home page: http://rwcc.bao.ac.cn

Admin Interface

3-D computer simulation – Virtual-Sun

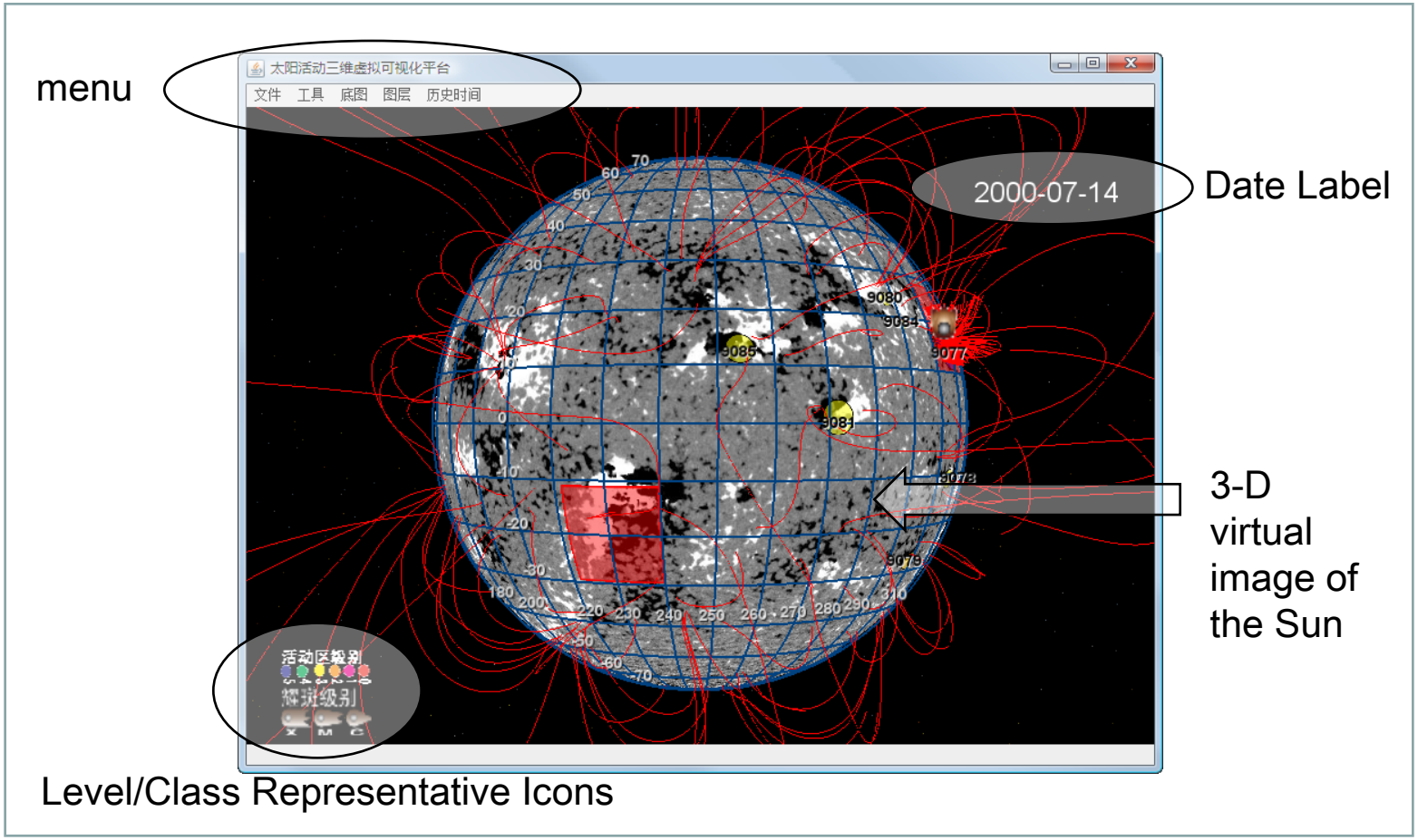


3-D Virtual Earth(Google Earth)



3-D Virtual Sun

Virtual-Sun Client interface

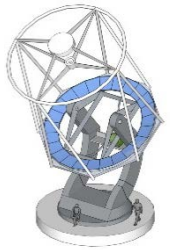


For online experience (1996-2009 historical data), please visit: http://159.226.170.65/virtual-sun/

4. Perspective

- Virtual-Sun
  - Monitoring real time solar activities
  - Running prediction models
  - Presenting forecasting results
- New observations (possible)
  - Deep-space solar observatory (DSO)
    1 meter solar telescope at L1

  - China Giant Solar Telescope (CGST)
    8 meter ring mirror solar telescope



A new generation operational solar weather monitoring and forecasting system is expected to be constructed in the near future at NAOC.

Thanks !