Japanese Operational Space Weather Activities - Current and Future -

T. Nagatsuma, S. Watari, H. Shinagawa, and K. T. Murata
Space Environment Group
National Institute of Information and Communications Technology
About NICT

• Location: Koganei, Tokyo + several branches in Japan
• Number of staff: ~800 including 300 of permanent researchers and 300 of Post Doc. (~20 staffs in space environment group)
• The Only national institute in Japan for Information Technology (basically research organization)
• The originality of our institute was in ionospheric observations for monitoring short wave propagations
• Our study fields expand not only narrow meaning of IT, but also wide areas.
Every afternoon, we make a daily forecast by the meeting.
WDC for Ionosphere

- Established on IGY year 1957
- Archiving mainly ionospheric vertical soundings of four Japanese and 141 worldwide stations.
- Items of ionospheric data
  - Ionospheric vertical soundings
  - Todside soundings
  - Oblique Incidence Soundings
  - Absorption
  - Ionospheric drifts and backscatter
  - Whistlers and VLF
  - Atmospheric Radio Noise
Broadcasting of SWx information on the Web, e-mail, etc.

Japanese Space Weather Information Center
http://swc.nict.go.jp/

http://www.nict.go.jp
New product for publicity and education - Weekly Space Weather News (trial version) -
Magnetometer & HF radar observations in Far East Siberia

South-East Asia low latitude Ionospheric Network (SEALION)

Ionosonde

Domestic Ionosonde Network & Hiraiso Solar Observatory

Hiraiso Solar Observatory

(Under National / International collaborations)
NICT Real-Time Space Weather Simulator

ACE Satellite (Solar Wind Data)

Magnetic Field data (MDI/SOHO)

The Sun and Solar Wind Model

The Earth

Super Computer

Antenna

Magnetosphere Model

Ionosphere and Thermosphere Model

Web Page
Space Weather User’s Forum (2009/12/21)

Topics:
- Tutorials from Space Environment Group
- Geomagnetic survey on the sea ground (JAMSTEC)
- SAR interferences due to plasma bubble (JAXA)
- Satellite charging (JAXA)
- Airplane navigation (MSAS:ENRI)
- Astronauts radiation effect (NIRS)
- Usage of space weather forecast by radio amateur (JARL)
- Solar power satellite and ionosphere (RISH)

Participants: more than 70
User / Customer’s needs

Major request

• Nowcast / Forecast of solar/geomagnetic activity.

• Nowcast / Forecast of space environment around GEO and LEO.

• Nowcast / Forecast of inosospheric scintillation and TEC map over Japan.

• Collecting practical needs of users / customers with educating space weather effect.

• Now we are building a close relationship with JAXA, and JMA, etc.
Questions?
Magnetometer & HF radar observations

RapidMAG

INTERMAGNET

King Salmon Radar
(SuperDARN)

NICT_MAG
Solar Radio / Optical Monitoring (Hiraiso)

Hα observation

Solar radio observation: HIRAS

Log-Peri. Antenna:
25-50MHz
10-meter Antenna:
50-500MHz
6-meter Antenna:
500-2500MHz
2-meter Antenna:
2800MHz

NiCT
Real-time beacon receiving  
(Solar and solar wind monitoring)

ACE
11-meter Antenna: S-band

STEREO
11-meter Antenna: X-band

a future possibility of beacon receiving: RBSP?
Domestic Ionospheric Networks

- Near real-time observations at four ionosondes in Japan (Wakkanai, Kokubunji, Yamagawa, Okinawa) and one ionosonde in Syowa Station, Antarctica.
- Observations routinely every 15 min (up to 1 min in special observations).
SEALION (South East Asia Low Latitude Ionospheric Network)

- Instruments: five FM-CW ionosondes, four GPS receivers, two GPS scintillation monitors, one magnetometer, and one all-sky imager.
- Collaborators: Kyoto univ., Nagoya univ. ENRI (Japan), VAST (Vietnam), CSSAR (China), KMITL, Chiang Mai Univ. (Thailand), LAPAN (Indonesia), San Carlos Univ. (Philippine)
High Frequency Trans-equatorial Propagation

- High-Frequency Trans-equatorial Propagation (HF-TEP) Experiments between Oarai, Japan and Shepparton, Australia.

- Oarai direction finder (ODF) consists of seven crossed-loop antennas 2 m in diameter that are located on a circle with a 60 m diameter.

[Maruyama and Kawamura, AG, 2006]
Computer simulation of the Sun and solar wind

Magnetic field (solar surface) data via SOHO/MDI

Publication on Web

Solar wind speed and magnetic fields
Computer simulation of Earth’s magnetosphere

Real-time observation data of solar wind via ACE satellite

Real-time data receiving at NICT (Koganei)

Visualization and database

Super computer (NEC SX-8R) @NICT (Koganei)

Publication on Web
Computer simulation of Ionosphere and Thermosphere

Simulation results from Magnetosphere simulation

Example 1

Example 2

Electron density

TEC map

Publication on Web
Example of Solar eclipse on 22th Jul, 2009

日食のしくみ

国立天文台 天文情報センター

日食時の超高層大気現象

太陽
紫外線/X線

電離圏
F層
E層
電子密度の減少
大気圏
大気の冷却

予測と観測結果の比較：電離圏全電子数の変動

Siミュレーションモデルで計算された日食時の電離圏の全電子数（TEC）の分布。青い部分が密度の高い部分。電離圏の上部（F層）では、電離圏が運動するので、皆既日食の場でTECが最低になるとは限らない。
BS放送の中断

2001年9月24日のX2.6/2Bフレアに伴ってACE衛星により観測された高エネルギー粒子

BSAT-2a衛星の姿勢制御に不具合が生じ、BSデジタル放送が一時中断した。

読売新聞2001年9月26日朝刊
In Japan, NICT (National Institute of Information and Communications Technology) has been in charge of space weather forecast services for more than 20 years. With help of geospace environment data exchanging among the international cooperation, NICT operates daily space weather forecast service every day to provide information on nowcasts and forecasts of solar flare, geomagnetic disturbances, solar proton event, and radio-wave propagation conditions in the ionosphere.

For prompt reporting of space weather information, we also conduct our original observation networks from the Sun to the upper atmosphere: Hiraiso solar observatory to monitor the solar activity (solar flare, solar radio burst, etc.), domestic ionosonde networks, magnetometer & HF radar observations in far-east Siberia and Alaska, and south-east Asia low-latitude ionospheric network (SEALION). ACE and STEREO real-time beacon data are received using our antennae facilities to monitor the solar and solar wind conditions in near real-time. These information and related products are provided via the internet.

We are also operating real-time computer simulations for solar and solar-wind, magnetosphere and ionosphere using a middle-class super-computer (NEC SX-8R). The three simulations are directly or indirectly connected each other based on real-time observation data to reproduce a virtual geospace on the super-computer.

In the present talk, we introduce our current and future plan of the operational space weather activities.
SEALION Research Targets

Zonal Plane

Large-Scale Wave Structure

GPS Scintillation

Plasma Bubble

GPS Satellite

Meridional Plane

Equatorial Anomaly

Traveling Ionospheric Disturbances

GPS Satellite

Magnetic Equator

Magnetic Field Line

Chumphon
[10.7°N, 99.4°E]

Bac Lieu
[9.3°N, 105.7°E]

Chiang Mai
[18.8°N, 98.9°E]

Chumphon
[10.7°N, 99.4°E]

Phuket
[8.09°N, 98.32°E]

Kototabang
[-0.20°N, 100.3°E]

West [8.09°N, 98.3°E]

East

North

South

NiCT
Space Weather Forecast Centers of
International Space Environment Service (ISES)

- Space Research Center
  (Warsaw, Poland)
- Lund Space Weather Center
  (Lund, Sweden)
- Royal Observatory of Belgium
  (Brussels, Belgium)
- Institute of Atmospheric Physics
  (Plague, Czech)
- Hydrometeorological Service
  (Moscow, Russia)
- Beijing Astronomical Observatory
  (Beijing China)
- Natural Resource Canada
  (Ottawa, Canada)
- NICT (Tokyo, Japan)
- NOAA/SWPC
  (Boulder, U.S.A.)
- INPE (Sao Jose dos Campos, Brazil)
- National Physical Laboratory
  (New Deli, India)
- Hermanus Geomagnetic Observatory
  (Hermanus, South Africa)
- IPS Radio and Space Services
  (Sydney, Australia)
Ground-based monitoring/observation for space weather
観測、シミュレーション、インフォマティクスの紹介
宇宙天気ニュース
障害の事例（ひまわり、B-sat）
User’s needs
Information of Ionosphere via Ionosonde

Ionosonde

Ionosonde Stations

- Wakkanai (~2009.2)
- Sarobetsu (~2009.3)
- Akita (~1993.1)
- Kokubunji (Tokyo) ~2001.8
- Okinawa/Ogimi (~2001.8)
- Yamagawa
- Okinawa
- Syowa (Antarctica)

http://wdc.nict.go.jp/IONO/
MAP of TEC (Total Electron Content) over Japan
Computer simulations
via super Computer
High Frequency Transequatorial Propagation

- High-Frequency Transequatorial Propagation (HF-TEP) Experiments between Oarai, Japan and Shepparton, Australia

- Oarai direction finder (ODF) consists of seven crossed-loop antennas 2 m in diameter that are located on a circle with a 60 m diameter.