Ionospheric observations in Japan and Southeast Asia (June 2014 - March 2015)

Tatsuhiro Yokoyama, Michi Nishioka, and Hidekatsu Jin

Space Weather and Environment Informatics Laboratory
National Institute of Information and Communications Technology
Contact: iono@nict.go.jp
Ionosphere and Radio Propagation

- Sun
- X Ray
- EUV
- Visible light
- Global Navigation Satellite Systems (GPS/GNSS)
- Communication / Broadcasting Satellites
- Ionosphere
  - F region
  - E region
  - Es layer
  - Ionospheric storm
  - Radio absorption
  - Anomalous propagation
  - Propagation delay
  - Scintillation
- HF communication/broadcast
- FM/Community radios
- Satellite operation
- Positioning/Navigation
Ionospheric Observatories in Japan and Southeast Asia

- Ionosonde
- GPS Scintillation
- GPS TEC
- Magnetometer
- HF-TEP

Equatorial Atmosphere Radar (EAR)

Middle and Upper Atmosphere (MU) Radar

Syowa Station, Antarctica

Chiang Mai
Phu Thuy
Hainan
Chumphon
Bac Lieu
Phuket
Kototabang

Kotobuki
Oarai
Yamagawa
Okinawa
Wakkanai
Currently available GPS receivers for the measurement of total electron content (TEC)
Long-term variation of foF2 over Okinawa and Kokubunji at 12LT

http://wdc.nict.go.jp/IONO/index_E.html
Long-term variation over Kokubunji at all local time
Long-term variation of GPS scintillation at Indonesia

Courtesy of T. Ogawa
Recent activity of GPS ROTI in Southeast Asia

Nighttime ROTI - Daytime ROTI

 ROTI (TECU/min)

Day of Year

Nighttime ROTI - Daytime ROTI

 ROTI (TECU/min)

Day of Year

2014 2015

Courtesy of S. M Buhari; G2-5 on Friday session
Ionospheric Storm

**Positive Storm**
- F2-region plasma density enhancement
- Caused by disturbed electromagnetic force/thermospheric wind
- Frequently occurs at the initial phase of magnetospheric storms
- Positioning/navigation error

**Negative Storm**
- F2-region plasma density decrease
- Mainly caused by composition change in the thermosphere ([O]/[N2])
- Often continues for one to several days after positive storm
- HF communication outage
Wakkanai (45.16°N, 141.75°E)
Kokubunji (35.71°N, 139.49°E)
Yamagawa (31.20°N, 130.62°E)
Okinawa (26.68°N, 128.15°E)
TEC over Japan

8/26
Absolute TEC

8/27
Differential TEC
(5-day quiet period)

8/28
Positive storm

8/29
Absolute TEC

8/30
Differential TEC
Negative storm
6-9 January 2015
Wakkanai (45.16°N, 141.75°E)
Kokubunji (35.71°N, 139.49°E)

Kokubunji 2015/01/07 14:00:00 UT  
2015/01/07 23:00:00 LT
Yamagawa (31.20°N, 130.62°E)
Yamagawa (31.20°N, 130.62°E)
Okinawa (26.68°N, 128.15°E)
Okinawa (26.68°N, 128.15°E)
Ionosphere over Thailand on 7 January 2015

Chiang Mai (18.76°N, 98.93°E)  Chumphon (10.72°N, 99.37°E)

No Spread F
TEC over Japan

Absolute TEC

Differential TEC (5-day quiet period)

Positive storm at day and night

Latitude

Time (UT)
High-resolution TEC on 7 January 2015

Jan 07, 2015

TEC

Absolute TEC

Horizontal Distance [km]

Jan 07, 2015

TEC

60-min detrended TEC

Horizontal Distance [km]

Horizontal Distance [km]

Horizontal Distance [km]
High-resolution TEC on 7 January 2015

Jan 07, 2015
Absolute TEC at 2100 km

Jan 07, 2015
TEC

Geographic Latitude

Horizontal Distance [km]

Jan 07, 2015
Horizontal Distance [km]

UT

Absolute TEC [10^6 el/m²]

00:00 05:00 10:00 15:00 20:00

0 5 10 15 20 25 30
TEC over Japan on 7 January 2015

Absolute TEC

60-min detrended

5-min ROTI
TEC over Japan on 7 January 2015

Absolute TEC

60-min detrended

5-min ROTI
TEC over North America on 7 January 2015

Absolute TEC

60-min detrended

5-min ROTI
TEC over North America on 7 January 2015

10:00:00(UT) 01/07 2015

Absolute TEC

60-min detrended

5-min ROTI
TEC over Europe on 7 January 2015

00:00:00(UT) 01/07 2015

Absolute TEC

60-min detrended

5-min ROTI
TEC over Europe on 7 January 2015

12:00:00(UT) 01/07 2015

Absolute TEC

12:00:00(UT) 01/07 2015

60-min detrended

12:00:00(UT) 01/07 2015

5-min ROTI
Global TEC on 7 January 2015

Absolute TEC

60-min detrended

5-min ROTI
DRAWMING–TEC

(Dense Regional And Worldwide INternational GNSS–TEC observation)

The purpose of Dense Regional And Worldwide INternational GNSS–TEC observation (DRAWMING–TEC) project is to promote studies of ionospheric variations and their effect on GNSS among ionospheric researchers and GNSS researchers in the world. This project consists of (1) standardizing GNSS–TEC data, (2) developing dense TEC mapping technique, and (3) sharing the standardized TEC or GNSS data. If you have any questions or comments, please e-mail to iono@ml.nict.go.jp.

Quicklook

Global

Europe

Japan

N. America

Absolute TEC
Summary

- Peculiar ionospheric storm was observed on 7 January 2015.
  - Strong spread F over northern Japan
  - Unusually strong ROTI enhancement (like equatorial plasma bubbles)
  - Did not reach lower and equatorial latitudes
  - TEC enhancement in the nightside (Japan and US), and TEC decrease in the dayside (Europe) simultaneously (around the same UT)

→→→ Any suggestions for this event??

IONOGRAM
http://wdc.nict.go.jp/IONO/index_E.html

GPS-TEC
http://seg-web.nict.go.jp/GPS/DRAWING-TEC/