Observations of medium scale traveling ionospheric disturbances (MSTIDs) using the ground-based GNSS networks around Taiwan

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Using a network of ground-based GNSS receivers, medium-scale travelling ionospheric disturbances (MSTIDs) at the low-latitude equatorial ionization anomaly region is studied during 2013-2015. An algorithm using two-dimensional fast Fourier transform is developed to automatically identify the appearance of MSTIDs. Results show that the northward propagation of MSTID is predominated in daytime hours during April-July and in nighttime during March-August. On the other hand, southward MSTIDs are dominated in January-February and November-December in both daytime and nighttime. The statistical analysis of northward and southward propagations of MSTIDs at low-latitude reported here will be useful to understand its underlying physics.

Keywords: ionosphere, GNSS observations, Medium scale travel ionospheric disturbances

Traveling Ionospheric Disturbance Triggered by Tsunami of the 11 March 2011 Tohoku Earthquake

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An earthquake of magnitude 9.0 occurred near the east coast of Honshu (Tohoku area) generates a serve tsunami and disturbed the total electron content (TEC) within the ionosphere, which is called the tsunami-traveling ionospheric disturbances (TTIDs). Measurements of ground-based GPS receivers in Japan and Hawaii are employed to study TTIDs in the Pacific Ocean area. It is found that the TTID periods are of about 10-20 minutes. In the Japan region, the TTIDs initially lags tsunami wave by about 9.6 minutes, which is comparable to the estimated upward propagating time of acoustic gravity waves in the atmosphere, while in the Hawaii region, the TTID leads the underneath tsunami waves by about 1 hour, which might result from the oblique propagation of traveling atmospheric disturbances induced by tsunami waves.

Keywords: ionosphere, tsunami, GPS, TEC

Afternoon/sunset enhancement of the total electron content caused by solar eclipses

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Enhancement of the total electron content (TEC) during the afternoon/sunset period, which is considered being caused by the 24 Oct 1995 solar eclipse, has been observed and discussed by previous literature (Liu et al., Adv. Space Res., 1999; Tsai and Liu, J. Geophys. Res., 1999). During the 21 May 2012 annular solar eclipse, TEC profiles were employed to investigate the ionospheric solar eclipse effects, and the afternoon/sunset enhancement has again been observed a few hours later this eclipse event, occurring more than 16 years after the previous reported event. To find out the enhancement is an occasional or frequent phenomena, we investigated 12 total/annular solar eclipse during 2001 - 2016, in which the maximum obscuration belts passed over equatorial region, by using global ionosphere maps (GIM) data provided by Center for Orbit Determination in Europe (CODE). The enhancement has been observed in the majority of selected eclipses. A detail statistics of the occurrence in different condition and the possible mechanism of the afternoon/sunset enhancement is discussed and concluded in the present study.

Keywords: solar eclipse, ionosphere, total electron content

A Study of Lightning Activities and Geomagnetic Storms during 1998-2014

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We apply z test statistically examining lightning activities 30 days before and after the geomagnetic storm onset during a 17-year period of 1998-2014. The lightning activities are observed by Lightning Imaging Sensor onboard TRMM (Tropical Rainfall Measuring Mission) satellite, while the storm onset is derived by the Dst index. It is found that lightning activities significantly reduce after the geomagnetic storm, and a greater storm can suppress lightning activities for a longer period. The results also show that that the suppression effect is more prominent in the northern hemisphere than that in the southern hemisphere. These implies the storm-generated electric field in the atmosphere and the continental (land) effect being essential.

Keywords: Geomagnetic Storms, Lightning, TRMM, LIS

Topside ionosphere as observed by the Science and Technology Satellite-1 (STSAT-1) of Korea

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The Science and Technology Satellite-1 (STSAT-1) of Korea monitored high-latitude ionosphere at a sun-synchronous (1040-2240 local time) circular (altitude~680 km) orbit. The satellite was launched in September 2003, and its scientific observations began approximately two months later. It carried two Langmuir Probes (LPs) measuring cold electron density and temperature, an ElectroStatic Analyzer (ESA) sensitive to auroral electrons of <20 keV, and two Solid-State Telescopes counting radiation belt electrons in the energy range between ~100 keV and 400 keV. Operations of those payloads were normally restricted to northern high-latitudes, but occasionally extended to equatorial regions such that the low-latitude ionosphere can be monitored. In this presentation we show representative examples of the STSAT-1 observations at various regions and discuss how the data set can be exploited.

Keywords: high-latitude ionosphere, topside ionosphere, magnetosphere-ionosphere coupling

An observing system simulation experiment for FORMOSAT-5/AIP probing topside ionospheric plasma irregularities by using DEMETER/IAP

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In this paper, the ion density probed by IAP (Instrument d' Analyse du Plasma) on board the DEMETER (Detection of Electro-Magnetic Emissions Transmitted from Earthquake Regions) satellite is used to find whether the science payload of advanced ionospheric probe (AIP) on board FORMOSAT-5 can be employed to observe space weather of ionospheric plasma irregularities. It is found that the low-latitude irregularities within ±15° dip latitudes of the DEMETER/IAP ion density are nighttime phenomena, and become prominent in South America–Central Africa sector almost all the year round, especially during May-August. The high-latitude irregularities of the DEMETER/IAP ion density appear around ±65° dip latitude worldwide in both daytime and nighttime, and become very intense in the winter and equinox month/hemisphere. Results of DEMETER/IAP show that FORMOSAT-5/AIP can be used to monitor space weather of ionospheric daytime/nighttime plasma irregularities in not only the low- but also high-latitude ionosphere.

Keywords: FORMOSAT-5/AIP, DEMETER/IAP, ionospheric plasma irregularity

Development of regional ionospheric map and ionospheric prediction over Southeast Asia

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Dates back to 2003, National Institute of Information and Communications Technology (NICT) initiated the ionospheric observation network in Southeast Asia, a so-called Southeast Asia low-latitude ionospheric network (SEALION). Since then, ionospheric data has been collected and researched for a decade for research purpose. Nowadays, ionospheric data users increase. One of the reasons is that ionospheric data will become a must use dataset for air transportation business in the near future. Even though NICT has much data, the data itself is not friendly to non-scientist users. Moreover, there is no effective tool for ionospheric prediction in Southeast Asia yet. Recently we have developed a regional ionospheric map, and a regional ionospheric prediction based on artificial neural network (ANN). This paper introduces progress, success, and problem in the development.

Keywords: Ionospheric map, SEALION, Artificial neural network (ANN)

Global and Regional Ionosphere Mapping Based on GNSS Tracking Networks

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In the recent years, ionosphere weather becomes critical in high accuracy positioning, navigation and communication applications. An automated total electron content (TEC) processing system for real-time monitoring the ionospheric weather is needed in the modern communities. Based on our experience in construction of global TEC maps named Taiwan Ionosphere Group for Education and Research (TIGER) Global Ionosphere Map (TGIM) from ground- and space-based GPS networks, we also build up another data processing system, so-called regional ionosphere maps (RIM), using Kalman filter from the ground-based GNSS network in Taiwan area. The RIM system will generate hourly maps from GPS, GLONASS, Galileo and other satellite systems in real time with temporal resolution of 20 minutes, spatial resolution of 0.5˚ ×0.5˚ in latitude and longitude. The results not only provide higher-resolution parameters of ionospheric weather for positioning and navigation, but also for scientific communities, for example, on the study of seismo-ionospheric phenomena.

Keywords: Total electron content, Regional ionosphere map, GNSS

Assimilation of Radio Occultation data into NCAR/TIE-GCM model to study the influence of the interplanetary magnetic field on the ionosphere during the storm time

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We will construct a data assimilation model with the Thermosphere-Ionosphere Electrodynamics General Circulation Model (TIE-GCM) for the space weather in ionosphere during the magnetic storm time by assimilating the FORMOSAT-3 occultation total electron contents (OTEC). The TIE-GCM was developed by NCAR/HAO is a self-consistently electrodynamics coupled thermosphere and ionosphere model subjected by a few parameters with the lower and upper boundary conditions to describe the dynamics of the ionosphere and the thermosphere. The measured occultation total electron contents (OTEC) along the light path from GPS to LEO satellites could be assimilated with the TIE-GCM as a realistic model for the space weather in the ionosphere. We simulate the ionosphere in storm time in the day Sep. 09, 2011 with the assimilated data with 3 hours per cycle. During the geomagnetic storm time, we assimilated each three hours FORMOSAT-3 OTEC data with TIE-GCM to optimize the interplanetary magnetic field parameters used in the model that optimized the initial state of the model at the later time. Starting with the initial state at the initial time, we assimilate OTEC data forward one hour to the model to estimate the optimized interplanetary magnetic field parameters within this period. We make a three hours forward model run with the optimized parameters and the initial state to monitor the ionosphere. The results could be compared with the observation data in the ionosphere and the optimized interplanetary magnetic field parameters used in TIE-GCM will be compared with the values in the geophysical indices database (GPI).

Keywords: ionosphere

