Model Development for the Next Generation Ionosphere and Plasmasphere Forecasting

*Tzu-Wei Fang[1], Naomi Maruyama[1], Tim Fuller-Rowell[1], Phil Richards[2], Mariangel Fedrizzi[1], Rashid Akmaev[3], Valery Yudin[1], Houjun Wang[1], Art Richmond[4]

1. University of Colorado Boulder, 2. George Mason University, 3. NOAA Space Weather Prediction Center, 4. NCAR High Altitude Observation

The Ionosphere-Plasmasphere-Electrodynamics (IPE) model is a new, time dependent, 3-D model of ionosphere and plasmasphere recently developed through collaboration between University of Colorado, George Mason University, NOAA Space Weather Prediction Center (SWPC), NOAA Global Systems Division (GSD), and NCAR High Altitude Observatory (HAO). It provides time dependent, global, three-dimensional plasma densities for nine ion species, electron and ion temperatures, and both parallel and perpendicular velocities of the ionosphere and plasmasphere. IPE is capable of producing the climatology of global total electron content (TEC) as well as the storm-time responses in the system, such as Storm Enhanced Density (SED). Driving the IPE with the Whole Atmosphere Model (WAM), an extended version of Global Forecast System (GFS), ionospheric change associated with large scale meteorological events (such as Sudden Stratospheric Warming) and day-to-day varying thermospheric tides can be captured. The WAM and IPE model are currently coupled through using the Earth System Modeling Framework (ESMF) and the one-way coupled WAM-IPE is scheduled to be in operation in NOAA SWPC in fall 2017. In this presentation, an overview of the WAM-IPE model development and its current status will be presented. Furthermore, the preliminary results from several research projects associated with the coupled WAM-IPE model will be discussed.

Keywords: Ionospheric forecast, ionosphere and thermosphere

The ionospheric pre-reversal enhancement electric field modeling by coupled thermosphere-ionosphere data assimilation system

*Chia-Hung Chen[1], Charles Lin[1], Tomoko Matsuo[2,3], Jann-Yenq Liu[4,5]

1. Department of Earth Sciences, National Cheng Kung University, 2. Cooperative Institute for Research in Environmental Sciences, University of Colorado Boulder, Boulder, Colorado, USA, 3. Space Weather Prediction Center, National Oceanic and Atmospheric Administration, Boulder, Colorado, USA, 4. Institute of Space Science, National Central University, Chung-Li, Taiwan, 5. Center for Space and Remote Sensing Research, National Central University, Chung-Li, Taiwan

We report that assimilating total electron content (TEC) into a coupled thermosphere-ionosphere model by using the ensemble Kalman filter (EnKF) results in improved specification and forecast of eastward pre-reversal enhancement (PRE) electric field (E-field). Through data assimilation, the ionospheric plasma density, thermospheric winds, temperature and compositions are adjusted simultaneously. The improvement of dusk-side PRE E-field calculation over the prior state is achieved primarily by intensification of eastward neutral wind. The improved E-field calculation promotes a stronger plasma fountain and deepens the equatorial trough. As a result, the horizontal gradients of Pedersen conductivity and eastward wind are increased due to greater zonal electron density gradient and smaller ion drag at dusk, respectively. Such modifications provide preferable conditions and obtain a strengthened PRE magnitude closer to the observation. The adjustment of PRE E-field is enabled through self-consistent thermosphere and ionosphere coupling processes captured in the model. This study suggests that the PRE E-field that is critical in driving the evening equatorial plasma instability could be better forecasted by assimilation of TECs in the 10 minutes cycling.

Keywords: ionospheric data assimilation model, pre-reversal enhancement, electric field

Recent activity and future plan of ionospheric observation in NICT

*Takuya Tsugawa[1], Michi Nishioka[1], Hisao Kato[1], Hiromitsu Ishibashi[1], Kornyanat Hozumi[1], Takumi Kondo[1], Takahiro Naoi[1], Takashi Maruyama[1], Mamoru Ishii[1]

1. National Institute of Information and Communications Technology

National Institute of Information and Communications Technology (NICT) has been observing ionosphere by ionosondes for over 70 years in Japan. At present, four ionosondes at Wakkanai(Sarobetsu), Kokubunji, Yamagawa, Okinawa(Ogimi) are automatically operated and controlled from Tokyo. We have been replacing the current 10C type ionosondes with Vertical Incidence Pulsed Ionospheric Radar 2 (VIPIR2) ionosondes which can separate the O-mode and X-mode ionospheric echoes automatically. In addition to ionosonde observations, we have developed two-dimensional total electron content (TEC) observation technique over Japan using the dense GNSS network, GEONET since mid-1990s. The TEC maps are now available on a realtime basis using streaming data of GEONET. We have developed ionospheric storm monitoring system based on the realtime observation data and a new ionospheric strom scale, I-scale, which is defined using the long-term ionospheric data in Japan.In addition to the ionospehric observations in Japan, we has developed the Southeast Asia low-latitude ionospheric network (SEALION) for the purpose of monitoring and researching severe ionospheric disturbances, such as plasma bubble. SEALION mainly consists of five FMCW ionosondes in four countries in Southeast Asia: Chiang Mai and Chumphon (Thailand), Kototabang (Indonesia), Bac Lieu (Vietnam) and Cebu (Philippines). We are now developing a new FMCW ionosonde system which is GNU Radio based software defined system. Observations of HF transequatorial propagation between Japan and Australia have also been used to research the generation and propagation characteristics of plasma bubbles. In this presentation, we will introduce recent activity and future plan of ionospheric observation in NICT.

Keywords: ionospehre, ionospheric storm, space weather, plasma bubble, ionosonde, GPS-TEC

Global Three-Dimensional Ionospheric Data Assimilation Model Using Ground-based GPS and Radio Occultation Total Electron Content

*CHIYEN LIN[1], Tomoko Matsuo[2], Jann-Yenq Liu[1], Charles Lin[3], Ho-Fang Tsai[3], Chao-Yan Chen[1]

1. Graduate Institute of Space Science, National Central University, TAIWAN, 2. Department of Aerospace Engineering Sciences, University of Colorado, Boulder, Colorado, USA, 3. Department of Earth Sciences, National Cheng Kung University, Tainan, Taiwan

In this study, an ionospheric data assimilation approach is presented based on the Gauss-Markov Kalman filter with IRI (International Reference Ionosphere) as the background model and designed to assimilate the total electron content (TEC) observed from ground-based GPS receivers and space-based radio occultation of FORMOSAT-3/COSMIC (F3/C) or FORMOSAT-7/COSMIC-2 (F7/C2). The Kalman filter consists of the forecast step according to Gauss-Markov process and the measurement update step. Observing System Simulation Experiments (OSSEs) show that the Gauss-Markov Kalman filter procedure can improve the accuracy of the data assimilation analysis over the procedure consisting of the measurement update step alone. Comparing to F3/C, the dense F7/C2 occultation observation further improves the model accuracy significantly. Validating the data assimilation results with GIMs (Global Ionosphere Maps), the vertical TECs from global ground-based GPS measurements, and the ionospheric F_2-peak height and electron density sounded by ionosondes are carried out. Both the OSSE results and the observation validations confirm that the developed data assimilation model can be used to reconstruct the three-dimensional electron density in the ionosphere satisfactorily.

Keywords: Space Weather, Data Assimilation, Radio Occultation

Global ionosphere map constructed by using total electron content from ground-based GNSS receiver and FORMOSAT-3/COSMIC GPS occultation experiment

*Yang-Yi Sun[1], Jann-Yenq Liu[2], Ho-Fang Tsai[3], Andrzej Krankowski[4]

1. Department of Earth and Planetary Science, Kyushu Univsersuty, 2. Graduate Institute of Space Science, National Central University, 3. Department of Earth Sciences, National Cheng Kung University, 4. Space Radio-Diagnostics Research Centre, University of Warmia and Mazury in Olsztyn

Effects of rapidly changing ionospheric weathers are critical in high accuracy positioning, navigation, and communication applications. A system used to construct the global total electron content (TEC) distribution for monitoring the ionospheric weather in near real time is needed in the modern society. Here we build the TEC map named Taiwan Ionosphere Group for Education and Research (TIGER) Global Ionospheric Map (GIM) from observations of ground-based GNSS receivers and space-based FORMOSAT-3/COSMIC (F3/C) GPS radio occultation observations using the spherical harmonic expansion and Kalman filter update formula. The TIGER GIM (TGIM) will be published in near real time of 4-hour delay with a spatial resolution of 2.5˚ in latitude and 5˚ in longitude and a high temporal resolution of every 5 min. The F3/C TEC results in an improvement on the GIM of about 15.5% especially over the ocean areas. The TGIM highly correlates with the GIMs published by other international organizations. Therefore, the routinely published TGIM in near real time is not only for the communication, positioning, and navigation applications, but also for monitoring and scientific study of ionospheric weathers, such as magnetic storms and seismo-ionospheric anomalies.

Keywords: Global Ionospheric Map, Total Electron Content, FORMOSAT-3/COSMIC, Ionospheric weather, GNSS

GAIA simulations of electric potential variations in the equatorial ionosphere after an intense solar flare

*Mitsuru Matsumura[1], Kazuo Shiokawa[1], Hiroyuki Shinagawa[2], Yuichi Otsuka[1], Hidekatsu Jin[2], Yasunobu Miyoshi[3], Hitoshi Fujiwara[4]

1. Institute for Space-Earth Environmental Research, Nagoya University, 2. National Institute of Information and Comunications Technology, 3. Kyushu University, 4. Seikei University

It has been known that intense solar EUV and X-ray radiation by flares increases the electron density in the dayside ionosphere. The density distribution depends on chemical factors such as the ionization rate determined by the solar zenith angle and the loss rate related to the density of molecular nitrogen and oxygen. In addition, recent satellite measurements and modeling studies have shown that flares vary the zonal electric field to further disturb the electron density. The mechanism of the electric field variations by flares is still unknown. One possible mechanism is the conductivity changes by the enhanced ionization. Another candidate is the neutral wind dynamo developed by solar heating. In order to understand how each candidate varies the zonal electric field, we implemented the Flare Irradiance Spectral Model (FISM) to the GAIA model, a coupled model of whole atmosphere-ionosphere system. We performed simulations for the X17 flare on October 28, 2003. We found that the ionization enhancement creates the strong positive electric potential in the pre-sunset sector. We also found that the heating enhancement creates the strong negative potential in the post-sunset sector. The both enhancements intensify the positive eastward electric field from the afternoon to the evening to sustain the TEC enhancement for more than three hours. The electric field variations were most significant at the sunset terminator, which could encourage the growth of plasma bubbles.

Keywords: equatorial ionosphere, solar flare, electrodynamics, modeling, GAIA

The July 2012 geomagnetic storm

*Libo Liu[1], Jiawei Kuai[1]

1. Institute of Geology and Geophysics, Chinese Academy of Sciences

Ionospheric storms represent an extreme state of the ionosphere, which are caused by geomagnetic storms, and the complicated ionospheric storm effects are always a research focus for the ionospheric community. The geomagnetic storm occurring on 14-17 July 2012 is an extremely rare event of space weather in solar cycle 24, characterized by a southward interplanetary geomagnetic field lasting for about 30 h below -10 nT.
In this talk, multiple instrumental observations including electron density from ionosondes, total electron content (TEC) from Global Positioning System (GPS), Jason-2, and Gravity Recovery and Climate Experiment (GRACE), and the topside ion concentration observed by the Defense Meteorological Satellite Program (DMSP) spacecraft are used to comprehensively present the regional differences of the ionospheric response to this event. In the Asian-Australian sector, an intensive negative storm is detected near longitude ~120°E on July 16, and in the topside ionosphere the negative phase is mainly existed in the equatorial region. The topside and bottomside TEC contribute equally to the depletion in TEC, and the disturbed electric fields make a reasonable contribution. On July 15, the positive storm effects are stronger in the Eastside than in the Westside. The topside TEC make a major contribution to the enhancement in TEC for the positive phases, showing the important role of the equatorward neutral winds. For the American sector, the EIA intensification is stronger in the Westside than in the Eastside and shows the strongest feature in the longitude ~110°W. The combined effects of the disturbed electric fields, composition disturbances and neutral winds cause the complex storm-time features. Both the topside ion concentrations and TEC reveal the remarkable hemispheric asymmetry, which is mainly resulted from the asymmetry in neutral winds and composition disturbances.
Acknowledgments
This research was supported by National Natural Science Foundation of China (41231065, 41321003).

Keywords: ionospheric storm, negativre storm, electric field

Occurrence climatology of *E*- and *F*-region field-aligned irregularities in the middle latitudes as observed by the Daejeon 40.8 MHz coherent scatter radar in South Korea

*Young-Sil Kwak[1,2], Tae-Yong Yang[3], Hyosub Kil[4], Jeaheung Park[1,2], Jong-Min Choi[1,5], Jaejin Lee[1,2]

1. Korea Astronomy and Space Science Institute, 2. Korea University of Science and Technology, 3. Korea Polar Research Institute, 4. The Johns Hopkins University Applied Physics Laboratory, 5. Chungnam National University

Electron density irregularities in the ionosphere interrupt the propagation of electromagnetic waves and are problematic for navigation and communication systems. For this practical importance, significant efforts have been made to establish information on the occurrence climatology of such irregularities, to understand the onset conditions of such irregularities, and to predict or avoid the impact of these irregularities on the society. While the irregularities occur in all latitudes, less attention has been paid to the irregularities in middle latitudes. This may be because the irregularities in middle latitudes are not as severe as those in other latitude regions. However, middle latitudes are also the place where various forms of irregularities occur. A new 40.8 MHz coherent scatter radar was built in Daejeon, South Korea (36.18º N, 127.14ºE, dip latitude: 26.7ºN) on 29 December 2009, and has since been monitoring the occurrence of field-aligned irregularities (FAIs) in the northern middle latitudes. We report on the occurrence climatology of the *E*- and *F*-region FAIs as observed by the Daejeon radar between 2010 and 2016. We examine the occurrence types of the irregularities and the dependence of the irregularities on geophysical conditions (local time, altitude, season, solar cycle, and magnetic activity). These results can be used as a tool for investigating the onset conditions of the middle-latitude irregularities.

Keywords: VHF coherent scatter radar, E- and F-region field-aligned irregularities, middle-latitude ionosphere

The FORMOSAT-3/COSMIC Global Scintillation Model

*Jann-Yenq Liu[1,2], Shih-Ping Chen[1], Yang-Yi Sun[3]

1. Graduate Institute of Space Science, National Central University, Taoyuan city, Taiwan, 2. Center for Space and Remote Sensing Research, National Central University, Taoyuan city, Taiwan, 3. Kyushu Univsersuty, Department of Earth and Planetary Science, Fukuoka, Japan

Humans heavily rely on Global Navigation Satellite System (GNSS) for applications of satellite communication, navigation, and positioning on the ground and/or aviation in the troposphere/stratosphere. However, ionospheric scintillations could severely impact on these applications. In this study, an empirical ionosphere scintillation model of the globe is constructed with S4-index data of FORMOSAT-3/COSMIC (F3/C) during 2007-2014 (hereafter F3CGS4 model). The model describes the S4-index as a function of diurnal variations in local time, seasonal variations in day of year, geographic variations in dip-latitude, and solar activities in EUV flux index PF10.7. The model well reproduces the F3/C S4-index observations, and yields good agreements with results of ground-based receiving satellite signals. These confirm that the constructed model can be used to forecast global L-band scintillations on the ground and in the near surface atmosphere.

Keywords: FORMOSAT-3/COSMIC, S4, Scintillation

Medium scale traveling ionospheric disturbances using FORMOSAT-2/ISUAL 630.0 nm airglow images

*P. K. Rajesh[1], J. Y. Liu[2], Charles Lin[1], A. B. Chen[3], R. R. Hsu[3], C. H. Chen[1], J. D. Huba[4]

1. Department of Earth Science, National Cheng Kung University, Taiwan, 2. Institute of Space Science, National Central University, Taiwan, 3. Department of Physics, National Cheng Kung University, Taiwan, 4. Plasma Physics Division, Naval Research Laboratory, Washington, D.C., USA

In this work characteristics of nighttime medium-scale travelling ionospheric disturbances (MSTID) are investigated using 630.0 nm limb images by Imager of Sprites and Upper Atmospheric Lightnings (ISUAL), onboard FORMOSAT-2 satellite. The limb integrated measurements, when projected to a horizontal plane, reveal bands of intensity perturbation with distinct southwest to northeast orientation in the southern hemisphere. Airglow simulations are carried out to confirm that such azimuthally oriented features are related to MSTID. Further statistical analysis shows more MSTID occurrence in solstices with peak in June-July months. The wavelengths of the observed perturbations were in the range 150-300 km. The wave fronts were oriented about 30˚-50˚ from the east-west plane, indicating that coupled Perkins and Es-layer instability might be important in the MSTID generation. The results demonstrate that spaced based airglow imaging is an effective method for global investigation of MSTID events that are appropriately aligned with the viewing geometry.

Keywords: MSTID, Ionospheirc disturbances, FORMOSAT-2/ISUAL, Space based airglow imaging

Mid-latitude sporadic-E detected by L-band InSAR and their dispersive and non-dispersive components inferred from split-spectrum technique

Takato Suzuki[2], *Masato Furuya[1], Jun Maeda[3], Kosuke Heki[1]

1. Department of Earth and Planetary Sciences, Hokkaido University, 2. Department of Natural History Sciences, Hokkaido University, 3. Hokkaido University Library

Sporadic E (Es) is known to generate unusual propagation of VHF waves over long distances, and is caused by a layer of ionization that irregularly appears within the E region of the ionosphere. However, the generation mechanism of Es remains unclear, because the conventional ionosonde observation of Es has limited spatial resolution. Maeda et al. (2016, GRL) succeeded in demonstrating mid-latitude Es signal over Japan two-dimensionally as an image, using interferometric synthetic aperture radar (InSAR) based on the L-band ALOS/PALSAR data. Although it is known to be a useful geodetic technique to measure ground and ice displacements, L-band InSAR can image the structure of Es with unprecedented spatial resolution when displacement signals are absent. Following Maeda et al. (2016), we aim to detect mid-latitude Es over Japan by InSAR based on the follow-on ALOS2/PALSAR2.
Because the SAR satellite has rather long recurrent intervals, 46 days for ALOS and 14 days for ALOS2, we need to search adequate SAR data sets that are very likely to detect Es signals. First, we chose the dates whose critical frequencies of Es (foEs) were more than 15MHz at ionosonde in Kokubunji, Wakkanai and Yamagawa in the morning and noon in 2016 from May to June; Es is known to be frequent in the local daytime of summer season. Secondly, we chose the ALOS-2/PALSAR-2 data sets whose observation area, dates and time matches the data above as closely as possible. Thirdly, we generated Global Navigation Satellite System –Total Electron Content (GNSS-TEC) map whose areas, dates and time are the same as the above and if Es appeared in the GNSS-TEC map, we do generate interferogram. As a result, we could detect the phase changes in the pair of February 17, 2016 (Master) and May 25, 2016 (Slave) along a track from Tottori to Okayama, western Japan. The location of the phase shift is close to the Es on the GNSS-TEC image. Therefore, we can consider the phase shift as the edge of Es.
Meanwhile, we also separated the Es signals into both dispersive and non-dispersive signals, using split-band InSAR technique; dispersive components are due to the free-electrons. We applied this technique to the results by both Maeda et al and the present study. As a result, it turns out that both the dispersive and non-dispersive signals indicated similar spatial patterns, suggesting that the non-dispersive signals were closely related to the dynamics of dispersive free-electrons. The non-dispersive signals may be attributable to positively charged ions associated with the generation of Es episods.

Keywords: ionosphere, Sporadic-E, InSAR

4D-var estimation of exhaust emissions by North Korean rockets

*Nicholas Ssessanga[1], Yong Ha Kim[1]

1. Chungnam National University (CNU)

In this paper, a four dimensional variation (4D-Var) data assimilation technique is used to characterize ionospheric holes created by North Korean ballistic missiles/rockets launched over South Korea. The ionospheric holes were assumed to be created due to a chain reaction between ions, electrons and neutral molecules (in this case H_2O and H_2) deposited in exhaust plumes. The neutral molecules dispersion model was developed based on advection-diffusion equation, and spherically symmetric diffusion assumed. Synthetic data (slant total electron content; STEC) that were generated using the exact GPS-receiver geometry over the South Korean region were utilized in validating the 4D-var technique. The reconstructed three dimensional structures nearly matched the original assumed ionospheric holes. Furthermore, applying the adjoint optimization technique to the observed STEC data we were able to estimate the amount of rocket emissions.

Keywords: 4D-var, Ionosphere, Rocket, Total Electron Content (TEC)

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

*Charles Lin[1], Chia-Hung Chen[1], Yu-Ting Chou[1], Jia-Ting Lin[1], P. K. Rajesh[1]

1. Department of Earth Science, National Cheng Kung University

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

*Lin Pei-Hsuan[1], Yu-Lin Tsai[2], Jann-Yenq Liu[1], Charles Lin[3], Chia-Hung Chen[3], Ho-Fang Tsai[3], Tso-Ren Wu[3]

1. Institute of Space Science, National Central University, Taoyuan, Taiwan., 2. Graduate Institute of Hydrological and Oceanic Sciences, National Central University, Taoyuan, Taiwan., 3. Department of Earth Science, National Cheng Kung University, Tainan, Taiwan.

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

*Shih-Sian Yang[1], Jann-Yenq Liu[1], Yang-Yi Sun[1,2]

1. Institute of Space Science, National Central University, Taiwan, 2. Department of Earth and Planetary Science, Kyushu University, Japan

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

*Yi-Wei Chang[1], Jann-Yenq Liu[1]

1. Institute of Space Science, National Central University, Taiwan (R.O.C)

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

Jaeheung PARK[1,3], *Young-Sil Kwak[1,3], Kyoung Wook Min[2], Jae-Jin Lee[1,3], Junga Hwang[1,3], Hee-Jun Kim[2]

1. Korea Astronomy and Space Science Institute, 2. Korea Advanced Institute of Science and Technology, 3. University of Science and Technology

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

Jann-Yenq Liu[1,2], *Yang-Yi Sun[1], Chi-Kuang Chao[1], Shih-Ping Chen[1], Michel Parrot[3]

1. Graduate Institute of Space Science, National Central University, Taoyuan, Taiwan, 2. Center for Space and Remote Sensing Research, National Central University, Taoyuan, Taiwan, 3. LPCE/CNRS, Orleans, France

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

*Kornyanat Hozumi[1], Noraset Wichaipanich[2], Takashi Maruyama[1], Takuya Tsugawa[1], Mamoru Ishii[1]

1. National Institute of Information and Communications Technology, 2. Faculty of Engineering, Rajamangala University of Technology Thanyaburi, No. 39, Moo 1, Rangsit-Nakhonnayok Road, Thanyaburi district,Pathum Thani 12110, Thailand

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

*Ho-Fang Tsai[1], Yang-Yi Sun[2], Jann-Yenq Liu[3], Min-Yang Chou[1]

1. Department of Earth Sciences, National Cheng Kung University, Taiwan, 2. Department of Earth and Planetary Sciences, Kyushu University, Japan, 3. Institute of Space Science, National Central University, Taiwan

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

*Ming-Quey Chen[1]

1. Graduate Institute of Space Science, National Central University

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

