Commission G Report

July 29, 2015

1. News

=== PANSY in full operation===

A full system PANSY radar operation with 520 kW peak-envelope transmitting power was successfully conducted at Syowa, Antarctica for continuous 40 days through April to May, 2015, for the observations of troposphere, stratosphere and mesosphere. (Yasunobu Ogawa, NIPR)

2. Meeting announcement/report

- 26th IUGG (International Union on Geodesy and Geophysics) General Assembly was held at Plague, Czech on June 22 – July 2, 2015. Detailed information is found in the following web-page. http://www.iugg2015prague.com/
- International Symposium on the Whole Atmosphere (ISWA) will be held at Ito Hall, The University of Tokyo, Tokyo, Japan, on 14-16 September 2016. Detailed information can be found in the following web-page. http://pansy.eps.s.u-tokyo.ac.jp/iswa/
- 14th International Symposium on Equatorial Aeronomy (ISEA) will be held at Bahir Dar University, Bahir Dar, Ethiopia on October 19-23, 2015. Detailed information can be found in the following web-page. http://www.bdu.edu.et/isea14/
- Internataional Reference Ionosphere (IRI) 2015 Workshop will be held on November 9-13, 2015. Also there is Capacity Building Event on November 2-6, 2015. Both events are held at King Mongkut's Institute of Technology Ladkrabang (KMITL), Bangkok, Thailand. Abstract submission is open until the end of July. Detailed information can be found in the following web-page. http://www.iri2015.kmitl.ac.th/

=== Commission-G meeting ===

- MU radar and Equatorial Atmosphere Radar Symposium 2015 will be held at Research Institute for Sustainable Humanosphere, Kyoto University on September 10-11, 2015.

3. Research Report

3.1. Report from National Institute for Polar Research (NIPR)
(Yasunobu Ogawa, NIPR)

=== Recent papers===

Ishida, T., Y. Ogawa, A. Kadokura, K. Hosokawa, and Y. Otsuka, Direct observations of blob deformation during a substorm, *Ann. Geophys.*, **33**, 525-530, doi:10.5194/angeo-33-525-2015, May 2015.

Ionospheric blobs are localized plasma density enhancements, which are mainly produced by the transportation process of plasma. To understand the deformation process of a blob, observations of plasma parameters with good spatial-temporal resolution are desirable. Thus, we conducted the European Incoherent Scatter radar observations with high-speed meridional scans (60-80S) during October and December 2013, and observed the temporal evolution of a blob during a substorm on 4 December 2013. This paper is the first report of direct observations of blob deformation during a substorm. The blob deformation arose from an enhanced plasma flow shear during the substorm expansion phase, and then the blob split into two smaller-scale blobs, whose scale sizes were more than ~100 km in latitude. Our analysis indicates that the Kelvin-Helmholtz instability and dissociative recombination could have deformed the blob structure.

Taguchi, S., K. Hosokawa and Y. Ogawa, Investigating the particle precipitation of a moving cusp aurora using simultaneous observations from the ground and space, *Progress in Earth and Planetary Science*, **2**:11, doi:10.1186/s40645-015-0044-7, 2015.

Using observations of a moving cusp aurora from a high-sensitivity all-sky imager at Longyearbyen, Svalbard, and in situ observations of the precipitating particles from a spacecraft that flew over the aurora, we examined the particle precipitation features in the early and final stages of the moving cusp aurora. We focused on two auroral structures created near noon, separated by approximately 3 min, during a southwestward interplanetary magnetic field (IMF) condition on 17 December 2012. The second auroral structure occurred when the IMF turned further southward. Immediately after the appearance of the latter structure, the two auroral structures were adjacently situated, and the DMSP F18 spacecraft passed through these regions.

Hosokawa, K. and Y. Ogawa, Ionospheric variation during pulsating aurora, J. Geophys. Res., doi:10.1002/2015JA021401, in press, 2015.

Data from the European Incoherent SCATter (EISCAT) UHF/VHF radars in Tromso (69.60N, 19.20E), Norway were statistically analyzed to reveal how the occurrence of pulsating aurora (PsA) modifies the electron density profile in the ionosphere. By checking 5 winter seasons (2007-2012) observations of all-sky aurora cameras of National Institute of Polar Research (NIPR) in Tromso, we have extracted 21 cases of PsA. The results can be summarized as follows: (1) hmE is lower (the energy of precipitation electrons is higher) during the periods of PsA than that in the surrounding interval, (2) When NmE is higher (flux of PsA electrons is larger), hmE tends to be lower (precipitation is harder), (3) hmE is lower and NmE is larger in the later magnetic local time, (4) When the AE index during the preceding substorm is larger, hmE is lower and NmE is larger.

Takahashi, T., S. Nozawa, T. T. Tsuda, Y. Ogawa, N. Saito, T. Hidemori, T. D. Kawahara, C. Hall, H. Fujiwara, N. Matuura, A. Brekke, M. Tsutsumi, S. Wada, T. Kawabata, S. Oyama, and R. Fujii, A case study on generation mechanisms of a sporadic sodium layer above Tromso (69.6N) during a night of high auroral activity, *Ann. Geophys.*, in press, 2015.

McCrea, I. W., A. Aikio, L. Alfonsi, E. Belova, S. Buchert, M. Clilverd, N. Engler, B. Gustavsson, C. Heinselman, J. Kero, M. Kosch, H. Lamy, T. Leyser, Y. Ogawa, K. Oksavik, A. Pellinen-Wannberg, F. Pitout, M. Rapp, I. Stanislawska, and J. Vierninen, The science case for the EISCAT_3D radar, *Progress in Earth and Planetary Science*, PEPS-D-14-00016R1, in press, 2015.

3.2. Report from Solat-Terrestrial Environmental Laboratory, Nagoya University
(Satonori Nozawa, Nagoya University)

=== Recent papers===

Shiokawa, K., Y. Otsuka, K. J. Lynn, P. Wilkinson and T. Tsugawa, Airglow-imaging observation of plasma bubble disappearance at geomagnetically conjugate points, *Earth Planets Space*, **67**:43, dio:10.1186/s40623-015-0202-6, 2015.

The first observation of the disappearance of a plasma bubble over geomagnetically conjugate points was reported using airglow imagers at Darwin, Australia (magnetic latitude: 22N) and Sata, Japan (21N) on 8 August 2002. It is suggested that the polarization electric field associated with equatorward neutral wind during a traveling atmospheric disturbance drives plasma drift across the magnetic field line to cause the observed bubble disappearance.

Ohya, H., K. Shiokawa, and Y. Miyoshi (2015), Daytime tweek atmospherics, *J. Geophys. Res. Space Physics*, **120**, 654–665, doi:10.1002/2014JA020375.

The first observation of daytime tweek atmospherics was reported based on measurements at Moshiri (44.37N, 142.27E) and Kagoshima (31.48N, 130.72E), Japan, during nonsolar eclipse days for 5 months in 1980-1994. The daytime tweeks had clear frequency dispersion with an average duration of 12 ms, which was shorter than that in the nighttime (~50m/s). The average occurrences of the daytime tweeks at Moshiri and Kagoshima were 0.6 and 0.1 tweeks per minute during 10:00-15:00 LT, respectively. Daytime tweeks up to the second-order mode were visible.

Fukushima, D., K. Shiokawa, Y. Otsuka, M. Nishioka, M. Kubota, T. Tsugawa, T. Nagatsuma, S. Komonjinda, and C. Y. Yatini, Geomagnetically conjugate observation of plasma bubbles and thermospheric neutral winds at low latitudes, *J. Geophys. Res. Space Phys.*, **120**, 2222–2231, doi:10.1002/2014JA020398, 2015.

The first was reported on simultaneous observations of zonal drift of plasma bubbles and the thermospheric neutral winds at geomagnetically conjugate points in both hemispheres at Kototabang, Indonesia (geomagnetic latitude (MLAT): 10.0S), and Chiang Mai, Thailand (MLAT: 8.9N) at 13-20 UT on 5 April 2011. The observed plasma bubble drift velocity was compared with the velocity calculated from the observed neutral winds and the model conductivity, to investigate the F region dynamo contribution to the bubble drift velocity. The estimated drift velocities were 60-90% of the observed velocities of the plasma bubbles, suggesting that most of the plasma bubble velocity can be explained by the F region dynamo effect.

Miyoshi, Y., S. Oyama, S. Saito, H. Fujiwara, R. Kataoka, Y. Ebihara, C. Kletzing, G. Reeves, O. Santolik, M. Cliverd, C. Rodger, E. Turunen, and F. Tsuchiya, Energetic electron precipitation associated with pulsating aurora: EISCAT and Van Allen Probes observations, *J. Geophys. Res. Space Phys.*, **120**, 2754–2766, doi:10.1002/2014JA020690, 2015.

The paper reports that sub-relativistic electrons precipitate into the atmosphere during the pulsating aurora. The EISCAT measurement indicated the significant ionization at the mesosphere associated with the pulsating aurora. The ground network observations for riometer and VLF radio waves confirmed that energetic electron precipitations occurred at wide area. A simulation study using the Van Allen Probes satellite data confirmed that the whistler mode chorus waves can cause wide energy electron precipitations associated with the pulsating aurora, which has been proposed by Miyoshi et al. [2010].

Abadi, Prayitno, Yuichi Otsuka, and Takuya Tsugawa (2015), Effects of Pre-reversal Enhancement of ExB drift on the Latitudinal Extension of Plasma Bubble in Southeast Asia, *Earth, Planets and Space*, **67**:74, doi:10. 1186/s40623-015-0246-7.

We investigated the effects of the F region bottomside altitude (h'F) maximum upward ExB drift velocity, duration of pre-reversal enhancement and the integral of upward ExB drift on the latitudinal extension of equatorial plasma bubbles in the Southeast Asian sector using the observations recorded by three GPS receivers and two ionosondes. The GPS receivers are installed at Kototabang (0.2S, 100.3E; MLAT 9.9S), Pontianak (0.02S, 109.3E; MLAT 9.8S) and Bandung (6.9S, 107.6E; MLAT 16.7S) in Indonesia. The ionosondes are installed at magnetically equatorial stations, Chumphon (10.7N, 99.4E; MLAT 0.86N) in Thailand and Bac Lieu (9.3N, 105.7E; MLAT 0.62N) in Vietnam. We analysed those observations acquired in the equinoctial months (March, April, September and October) in 2010-2012, when the solar activity index F10.7 was in the range from 75 to 150. Assuming that plasma bubbles are the major source of scintillations, the latitudinal extension of the bubbles was determined according to the S4 index. We have found that the peak of h'F, maximum upward ExB drift and the integral of upward ExB drift during the pre-reversal enhancement period are positively correlated with the maximum latitude extension of plasma bubbles, but that duration of pre-reversal enhancement does not show correlation.

3.3. Report from National Institute for Information and Communications Technology (NICT)
(Minoru Kubota, NICT)

=== Recent papers===

Maruyama, T., J. Uemoto, M. Ishii, T. Tsugawa, P. Supnithi, and T. Komolmis (2014), Low-latitude ionospheric height variation as observed by meridional ionosonde chain: Formation of ionospheric ceiling over the magnetic equator, *J. Geophys. Res. Space Physics*, **119**, 10,595–10,607, doi:10.1002/2014JA020215.

A multipoint ionosonde observation campaign was conducted along the magnetic meridional plane in Southeast Asia to study ionosphere-thermosphere coupling. One station was near the magnetic equator and two of the other stations were at off-equatorial latitudes (approximately 10 deg magnetic latitude). The daytime ionospheric peak height (hmF2) was analyzed for each season during the solar minimum years, 2006-2007 and 2009. The peak height increased for approximately 3 h after sunrise at the magnetic equator and off-equatorial latitudes, as expected from the daytime upward ExB drift. The apparent upward drift at the magnetic equator ceased before noon, while the drift at the off-equatorial latitudes continued upward and the layer height exceeded the equatorial height around noon. The noontime limited layer peak height at the magnetic equator, which was termed the ionospheric ceiling, did not depend on the season, while the maximum peak height at the off-equatorial latitudes largely varied with each season. Numerical modeling using the SAMI2 code was conducted and the features of the ionospheric ceiling were reproduced quite well. The dynamical parameters provided by the SAMI2 modeling runs showed that the ionospheric ceiling is formed by the field-aligned plasma diffusion, which is a part of the fountain effect.

Yokoyama, T., H. Shinagawa, and H. Jin, Nonlinear growth, bifurcation and pinching of equatorial plasma bubble simulated by three-dimensional high-resolution bubble model, *J. Geophys. Res. Space Physics*, **119**, 10,474-10,482, doi:10.1002/2014JA020708, 2014.

A new three-dimensional high-resolution numerical model to study equatorial plasma bubble (EPB) has been developed. The High-Resolution Bubble (HIRB) model is developed in a magnetic dipole coordinate system for the equatorial and low-latitude ionosphere with a spatial resolution of as fine as 1 km. Adopting a higher-order numerical scheme than those used in the existing models, the HIRB model is capable of reproducing the bifurcation, pinching, and turbulent structures of EPB. From a seeding perturbation resembling large-scale wave structure (LSWS), EPB grows nonlinearly from the crest of LSWS upwelling, bifurcates at the top of EPB, then becomes turbulent at the topside of the F region.

M Buhari, S., M. Abdullah, A. Hasbi, Y. Otsuka, T. Yokoyama, M. Nishioka, and T. Tsugawa, Continuous generation and two-dimensional structure of equatorial plasma bubbles observed by high-density GPS receivers in Southeast Asia, *J. Geophys. Res. Space Physics*, **119**, 10,569-10,580, doi:10.1002/2014JA020433, 2014.

High-density GPS receivers located in Southeast Asia (SEA) were utilized to study the two-dimensional structure of ionospheric plasma irregularities in the equatorial region. The longitudinal and latitudinal variations of tens of kilometer-scale irregularities associated with equatorial plasma bubbles (EPBs) were investigated using two-dimensional maps of the rate of total electron content change index (ROTI) from 127 GPS receivers with an average spacing of about 50-100 km. The longitudinal variations of the two-dimensional maps of GPS ROTI measurement on 5 April 2011 revealed that 16 striations of EPBs were generated continuously around the passage of the solar terminator. The separation distance between the subsequent onset locations varied from 100 to 550 km with 10 min intervals. The lifetimes of the EPBs observed by GPS ROTI measurement were between 50 min and over 7 h.

Wongcharoen, P., P. Kenpankho, P. Supnithi, M. Ishii, T. Tsugawa (2015), Comparison of E layer critical frequency over the Thai station Chumphon with IRI, *Adv. Space Res.*, **55**, 2131-2138, doi:10.1016/j.asr.2015.01.031.

In this research, as a part of working towards improving the IRI over magnetic equatorial region, the critical frequency of E layer in the ionosphere (foE) derived from the ionogram at Chumphon station (10.72 deg N, 99.37 deg E), Thailand, during 2005-2008 is analyzed. The Chumphon station is located in the magnetic equatorial region at the magnetic latitude of 3.22 deg N. The seasonal variation of the foE measurements is compared to the IRI foE predictions with the optional input in the sunspot number (Rz12) and the solar radio noise flux (F10.7).

Klinngam, S., P. Supnithi, S. Rungraengwajiake, T. Tsugawa, M. Ishii, and T. Maruyama (2015), The occurrence of equatorial spread-F at conjugate stations in Southeast Asia, *Adv. Space Res.*, **55**, 2139-2147.

In this study, the probability of equatorial spread-F (ESF) occurrence at the conjugate stations in Southeast Asia: Chiangmai station (CMU), Thailand, and Kototabang station (KTB), Indonesia, and near the magnetic equator, Chumphon station (CPN), Thailand, is presented. We analyze the ionogram data recorded by the Frequency Modulated Continuous Wave (FM/CW) ionosondes for the periods of minimum solar activity from September 2008 to April 2009 and in the equinoctial months (March and April) from 2006 to 2013. The spread-F signatures are manually categorized into three types: the frequency spread-F (FSF), the range spread-F (RSF) and the mixed spread-F (MSF) and the monthly average percentage of the occurrence of each ESF type is presented. The results show that the percentage of RSF occurrence at CPN, which is located around the magnetic equator, is higher than at other stations and the RSF mostly occurs during the equinoctial months.

3.4. Report from Research Institute for Sustainable Humanosphere, Kyoto University (RISH)
(Mamoru Yamamoto, Kyoto University)

=== Recent papers===

Watthanasangmechai, K., M. Yamamoto, A. Saito, T. Maruyama, T. Yokoyama, M. Nishioka, and M. Ishii, Temporal change of EIA asymmetry revealed by a beacon receiver network in Southeast Asia, *Earth Planets Space*, **67**:75, doi:10.1186/s40623-015-0252-9, 2015.

To reveal the temporal change of the equatorial ionization anomaly (EIA) asymmetry, a multipoint satellite-ground beacon experiment was conducted along the meridional plane of the Thailand-Indonesia sector. The observation includes one station near the magnetic equator and four stations at off-equator latitudes. This is the first EIA asymmetry study with high spatial resolution using GNU Radio Beacon Receiver (GRBR) observations in Southeast Asia. GRBR-total electron contents (TECs) from 97 polar-orbit satellite passes in March 2012 were analyzed in this study. Successive passes captured rapid evolution of EIA asymmetry, especially during geomagnetic disturbances. Instead, high background TEC associated with an intense electric field empowers the neutral wind to produce severe asymmetry of the EIA. Such rapid evolution of EIA asymmetry was not seen during nighttime, when meridional wind mainly controlled the asymmetric structures.

S. Tulasi Ram, K. K. Ajith, M. Yamamoto, Y. Otsuka, T. Yokoyama, K. Niranjan, and S. Gurubaran, Fresh and evolutionary-type plasma bubbles triggered by overshielding electric fields near sunrise terminator, *J. Geophys. Res. Space Phys.*, **120**, doi:10.1002/2015JA021427, in press, 2015.

The evolution of fresh and intense equatorial plasma bubbles (EPBs) near sunrise terminator which further sustained for > 90 minutes of post-sunrise period was observed by Equatorial Atmosphere Radar (EAR) at Kototabang during a minor geomagnetic storm period. These EPBs were initially observed around 250-350km altitudes, growing upward under eastward polarization electric fields and fully depleted along the flux tube. The background low-latitude F-layer dynamics that lead to the development of these dawn-time EPBs have been investigated from two ionosondes at magnetically conjugate low-latitude locations.

Tong Gan, Masayuki Yamamoto, Hashiguchi Hiroyuki, Hajime Okamoto, and Mamoru Yamamoto, Spectral parameters estimation in precipitation for 50-MHz band atmospheric radars, *Radio Science*, **50**, doi:10.1002/2014RS005643, in press, 2015.

50-MHz band Atmospheric Radars (ARs) can detect clear air echoes and hydrometeor echoes simultaneously. However, in order to calculate spectral parameters (i.e., echo power, Doppler velocity, and spectrum width) of the clear air echo accurately, the clear air echo must be separated from the hydrometeor echo well. In this study, we propose methods (top method and two-echo method) for calculating the spectral parameters in precipitation region. The top method is used when raindrops or solid hydrometeors with small echo intensities exist. The top method sets an echo cut level by using the peak intensity of a clear air echo. The echo cut level is used for separating clear air echoes from hydrometeor echoes. The results demonstrate that the top method and two-echo method are useful for reducing the errors of spectral parameters.