Commission G Report

December 28, 2015

1. News

=== JAXA planetary exploration spacecraft AKATSUKI sent into the Venus' orbit ===

JAXA planetary exploration spacecraft AKATSUKI was successfully inserted into the Venus' orbit by the thrust ejection operation on December 7, 2015. After checking condition of the on-board instruments, scientific observations will start in April 2016 on the regular basis.

2. Meeting announcement/report

- MU radar /Equatorial Atmosphere Radar Symposium was held at RISH, Kyoto University on September 10-11, 2015. This is the annual meeting for the cooperative use of the facilities. Commission G of Japanese URSI started co-sponsor this symposium.
- 14th International Symposium on Equatorial Aeronomy (ISEA) was successfully held at Bahir Dar University, Bahir Dar, Ethiopia on October 19-23, 2015. http://www.bdu.edu.et/isea14/
- Internataional Reference Ionosphere (IRI) 2015 Workshop was held at King Mongkut's Institute of Technology Ladkrabang (KMITL), Bangkok, Thailand on November 9-13, 2015. There was Capacity Building Event during the period. http://www.iri2015.kmitl.ac.th/
- Special issue from the International CAWSES-II Symposium (2013 at Nagoya University) was completed in the open journal "Earth, Planets and Space (EPS)". Total 38 papers were published. http://www.earth-planets-space.com/series/ICS
- JpGU Meeting 2016 will be held at Makuhari, Chiba on May 22-26, 2016. There are Commission G-related sessions in the meeting. Abstract submission will be during January 7 until February 18, 2016. http://www.jpgu.org/meeting_2016/
- 2016 Beacon Scintillation Symposium is held at Trieste, Italy on June 27 – July 1, 2016. This meeting is co-sponsored by URSI Commission G. Abstract submission is open until January 15, 2016. http://t-ict4d.ictp.it/beacon2016
- 41st COSPAR Scientific Assembly will be held at Istanbul, Turkey on July 30 – August 7, 2016. Abstract submission is open until February 12, 2016. http://cospar2016.tubitak.gov.tr
- AOGS 13th Annual Meeting will be held at Beijing, China on July 31 – August 5, 2016. Abstract submission is open until February 19, 2016. http://www.asiaoceania.org/aogs2016/

3. Research Report

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

(Yasunobu Ogawa, NIPR)

=== Recent papers ===

(PANSY related papers)

Nishiyama, T., K. Sato, T. Nakamura, M. Tsutsumi, T. Sato, M. Kohma, K. Nishimura, Y. Tomikawa, M. Ejiri, and T. Tsuda Height and time characteristics of seasonal and diurnal variations in

PMWE based on 1-year observations by the PANSY radar (69.0°S, 39.6°E), Geophys. Res. Lett., 42, 2100-2108, doi:10.1002/2015GL063349, 2015.

We report height and time variations in polar mesosphere winter echoes (PMWE) based on the Program of the Antarctic Syowa mesosphere-stratosphere-troposphere/incoherent scatter (PANSY) radar observations. PMWE were identified for 110 days from March to September 2013. PMWE occurrence frequency increased abruptly in May when two solar proton events occurred. PMWE were also observed even during periods without any solar proton events, suggesting that a possible cause of the PMWE is ionization by energetic electron precipitations. The monthly mean PMWE characteristics showed that occurrence of PMWE were mainly restricted to sunlit time. This fact indicates that electrons detached from negatively charged particles play an important role. While PMWE below 72 km in altitude completely disappeared before sunset, it was detected above that altitude for a few hours even after sunset. This height dependence in the altitude range of 60-80 km can be explained qualitatively by empirical effective recombination rates.

Tomikawa, Y., M. Nomoto, H. Miura, M. Tsutsumi, K. Nishimura, T. Nakamura, H. Yamagishi, T. Yamanouchi, T. Sato, and K. Sato, Vertical Wind Disturbances during a strong wind event observed by the PANSY radar at Syowa Station, Antarctica, Mon. Wea. Rev., 143, 1804-1821, doi:10.1175/MWR-D-14-00289.1, 2015.

Characteristically strong vertical wind disturbances (VWDs) with magnitudes larger than 1 m/s were observed in the Antarctic troposphere using a new mesosphere-stratosphere-troposphere (MST) radar called the Program of the Antarctic Syowa MST/incoherent scatter (IS) Radar (PANSY) during 15-19 June 2012 at Syowa Station (69.0°S, 39.6°E). In the same period, two synoptic-scale cyclones approached Syowa Station and caused a strong wind event (SWE) at the surface. The VWDs observed during the SWE at Syowa Station had a nearly standing (i.e., no phase tilt with height) phase structure up to the tropopause and a power spectrum proportional to the -5/3 power of frequency. On the other hand, the observed VWDs were not associated with systematic horizontal momentum fluxes. Meteorological fields around Syowa Station during the SWE were successfully simulated using the Nonhydrostatic Icosahedral Atmospheric Model (NICAM). A strong VWD was also simulated at the model grid of 70.0°S, 40.0°E in NICAM, which had a standing phase structure similar to the observed ones. An analysis based on the Froude number showed that the simulated VWD was likely due to a hydraulic jump leeward of the coastal mountain ridge. The Scorer parameter analysis indicated that the observed VWDs at Syowa Station during 16-17 June 2012 were likely due to the hydraulic jump similar to that in NICAM. On the other hand, a possibility of lee waves was also suggested for the VWD observed on 18 June 2012.

Shibuya, R., K. Sato, Y. Tomikawa, M. Tsutsumi, and T. Sato, A study of multiple tropopause structures caused by inertia-gravity waves in the Antarctic, J. Atmos. Sci., 72, 2109-2130, doi:10.1175/JAS-D-14-0228.1, 2015.

Multiple tropopauses (MTs) defined by the World Meteorological Organization are frequently detected from autumn to spring at Syowa Station (69.0°S, 39.6°E). The dynamical mechanism of MT events was examined by observations of the first mesosphere-stratosphere-troposphere (MST) radar in the Antarctic, the Program of the Antarctic Syowa MST/Incoherent Scatter (IS) Radar (PANSY), and of radiosondes on 8-11 April 2013.

The MT structure above the first tropopause is composed of strong temperature fluctuations. By a detailed analysis of observed three-dimensional wind and temperature fluctuation components, it is shown that the phase and amplitude relations between these components are consistent with the theoretical characteristics of linear inertia-gravity waves (IGWs). Numerical simulations were performed by using a nonhydrostatic model. The simulated MT structures and IGW parameters agree well with the observation. In the analysis using the numerical simulation data, it is seen that IGWs were generated around 65°S, 15°E and around 70°S, 15°E, propagated eastward, and reached the region above Syowa Station when the MT event was observed. These IGWs were likely radiated spontaneously from the upper-tropospheric flow around 65°S, 15°E and were forced by strong southerly surface winds over steep topography (70°S, 15°E). The MT occurrence is attributable to strong IGWs and the low mean static stability in the polar winter lower stratosphere. It is also shown that nonorographic gravity waves associated with the tropopause folding event contribute to 40% of the momentum fluxes, as shown by a gravity wave-resolving general circulation model in the lower stratosphere around 65°S. This result indicates that they are one of the key components for solving the cold-bias problem found in most climate models.

(EISCAT related papers)

Tsuda, T. T., S. Nozawa, T. D. Kawahara, T. Kawabata, N. Saito, S. Wada, C. M. Hall, M. Tsutsumi, Y. Ogawa, S. Oyama, T. Takahashi, M. K. Ejiri,T. Nishiyama, T. Nakamura, and A. Brekke, A sporadic sodium layer event detected with five-directional lidar and simultaneous wind, electron density, and electric field observation at Tromso, Norway, Geophys. Res. Lett., doi:10.1002/2015GL066411, November, 2015

A sporadic sodium layer (SSL) was detected with five-directional lidar observation on 15 December 2012 at Tromso, Norway. We have derived the horizontal velocity of the SSL front from the SSL onset times at the five positions and compared it with the background wind velocity from the collocated meteor radar and European Incoherent Scatter (EISCAT) radar. As a result, both velocities were fairly consistent. The increase rate in the height-integrated sodium density around the SSL onset was 3-6 ×10^10 m^2 s^1, which was comparable to relatively large cases in the previous studies. However, the EISCAT-observed electric field was too small to induce such a rapid sodium atom production. In addition, the amounts of the sodium atom increases at the five positions were mostly same. Thus, there were no clear signatures for the sodium atom production. These results strongly indicate that the observed SSL was just advected by the background wind.

Taguchi, S., K. Hosokawa, Y. Ogawa, Three-dimensional imaging of the plasma parameters of a moving cusp aurora, Journal of Atmospheric and Solar-Terrestrial Physics, DOI:10.1016/j.jastp.2015.08.012, October, 2015.

During a period of negative IMF BZ on 13 January 2013, an all-sky imager at Longyearbyen, Svalbard observed a mesoscale aurora moving towards the east-northeast in the cusp, passing through the field of view of the EISCAT Svalbard Radar (ESR) elevation scan. The elevation scans that were being performed at that time have a horizontal coverage of approximately 300 km, at an altitude of 300 km. The plasma data obtained from the elevation scans and the 630-nm aurora emission data from the all-sky imager have shown that ion temperature enhanced 50-60 s earlier than electron density, and that the maximum auroral intensity in the ESR's field of view occurred about 40 s after the electron density enhancement. On the basis of these results we have constructed three-dimensional images of elevated ion temperatures and enhanced electron density associated with the mesoscale moving cusp aurora. The three-dimensional image shows that the enhancement of the ion temperature is prominent in the horizontal area of ~160 km×~80 km below an altitude of ~300 km, and that this volume forms on the forward side of the enhanced electron density region. We interpret these configurations as being a result of a mesoscale twin-cell convection, which is embedded in the background flow such that the symmetrical axis of the twin-cell is inclined from the background flow direction by several tens of degrees. Our method for visualizing three-dimensional features such as these could be an effective approach to understanding the mesoscale dynamics of the cusp, which is usually located in latitudes that are difficult for the currently-operated radars that permit three-dimensional, simultaneous measurements to investigate.

3.2. Report from Institute for Space-Earth Environmental Research (ISEE), Nagoya University
(Satonori Nozawa, Nagoya University)

NOTE: Solar-Terrestrial Environment Laboratory (STEL) was reorganized to Institute for Space-Earth Environmental Research (ISEE) on October 1, 2015.

=== Recent paper ===

Martinez-Calderon, C., K. Shiokawa, Y. Miyoshi, M. Ozaki, I. Schofield, and M. Connors (2015), Statistical study of ELF/VLF emissions at subauroral latitudes in Athabasca, Canada, J. Geophys. Res. Space Physics, 120, doi:10.1002/2015JA021347.

We present the first statistical analysis of ELF/VLF emissions observed on the ground at subauroral latitudes that includes their features, occurrences, and association with solar wind and geomagnetic variations. Using a 100 kHz sampling loop antenna located in Athabasca, Canada (54.60°N, 246.36°E, L = 4.3), we monitored these emissions, including chorus, quasiperiodic emissions, and hiss, from November 2012 to October 2013. We found a maximum occurrence rate in the morning sector (06-07 MLT, magnetic local time) and a minimum in the night sector (~18 to 02 MLT), in agreement with previous satellite measurements in the inner magnetosphere. We also found correlation between the ongoing substorm and storm activity and the increase of occurrence rates. The observed waves usually had a central frequency ~1-3 kHz lower than the half-gyrofrequency at the conjugate equatorial plane, indicating a wave source at higher latitudes. A superposed epoch analysis showed that the starting time of the ELF/VLF emissions is preceded by a rise in AE both on short (hours) and long (days) terms. Solar wind speed also started slowly rising ~1.5 days before, while density and dynamic pressure decreased shortly afterward. This may signify that high-speed solar wind conditions also contribute to the generation of ELF/VLF emissions detected at subauroral latitudes.

=== Observation report ===

Institute for Space-Earth Environmental Research (ISEE), Nagoya University report the first statistical analysis of ELF/VLF emissions based on 1-year 100kHz continuous observations at Athabasca, Canada (L = 4.3), in collaboration with Athabasca University and Kanazawa University. Characteristics of the ELF/VLF emissions, such as chorus, hiss, and QP emissions, and their dependence on local time, geomagnetic activity, and solar wind parameters are clarified.

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

=== Recent papers===

Yokoyama, T., H. Jin, and H. Shinagawa, West wall structuring of equatorial plasma bubbles simulated by three-dimensional HIRB model, J. Geophys. Res. Space Physics, 120, 8810-8816, doi:10.1002/2015JA021799, 2015.

Plasma density depletions in the equatorial ionosphere, or so-called equatorial plasma bubbles (EPBs), are generated in the postsunset period and tend to have a very complex spatial structure. Especially, the east-west asymmetry of EPBs has been reported by various observations. Using a high-resolution bubble (HIRB) model, which is a newly developed three-dimensional numerical model for the equatorial ionosphere, small-scale structuring at the west wall of large-scale F layer upwelling is clearly reproduced for the first time. It is not an eastward neutral wind but a vertical shear of zonal plasma drift velocity at the bottomside of the F region that plays an important role in accelerating the instability growth at the west wall and generating the east-west asymmetry of EPBs.

Park, J., H. Luhr, M. Nishioka, and Y.-S. Kwak, Plasma density undulations correlated with thermospheric neutral mass density in the daytime low-latitude to midlatitude topside ionosphere, J. Geophys. Res. Space Physics, 120, 6669-6678, doi: 10.1002/2015JA021525, 2015.

Plasma density undulations in the dayside low-latitude/midlatitude ionospheric F region were often attributed to thermospheric gravity waves (TGWs). However, the relationship between the former and the latter has been at best indirectly evidenced. In this study we investigate daytime fluctuations in neutral mass density () and plasma density (n(e)) measured onboard CHAMP from 2001 to 2010. A significant amount of daytime fluctuations in n(e) is strongly correlated with in situ fluctuations of , which we term TGW-related n(e) fluctuations. The TGW-related n(e) fluctuations are (1) stronger in the winter hemisphere than in the summer hemisphere and (2) strongest in the South American sector during June solstice months. These climatological features are in general agreement with those of TGWs reported previously, especially at midlatitudes. On the other hand, the relative amplitude of TGW-related n(e) fluctuations does not depend strongly on solar activity.

3.4. Report from Kyushu University
(Huixin Liu, Kyushu University)

=== Recent papers===

Guo, J., J. Forbes, F. Wei, X. Feng, Huixin Liu, W. Wan, Z. Yang, and C. Liu, B. Amery, Y. Deng, Observations of a large-scale gravity wave propagating over an extremely large horizontal distance in the thermosphere, Geophys. Res. Lett., 42, 6560-6565, doi:10.1002/2015GL065671, 2015.

In this paper we report the detection of a large-scale gravity wave propagating over an extremely large horizontal distance in the thermosphere on 28 July 2006. Specifically, after being launched at the northern auroral region on the dayside, this wave propagated equatorward with phase speeds on the order of ~720 m/s and finally almost traveled around the Earth once horizontally in the thermosphere prior to dissipation. The time taken to dissipate is about 15.5 h. It is the farthest-traveling large-scale gravity wave currently tracked by satellite measurements, made possible by a sudden injection of energy in an unusually clean propagation environment. This experiment of opportunity serves as an important step in furthering our theoretical understanding of gravity wave propagation and dissipation in the thermosphere.

Chang, L., Huixin Liu, Y. Miyoshi, C. Chen, F. Chang, C. Lin, J. Liu, Y. Sun, Structure and origins of the Weddell Sea Anomaly from tidal and planetary wave signatures in FORMOSAT-3/COSMIC obsevations and GAIA GCM simulations, J. Geophys. Res., 120, 1325-1340, doi:10.1002/2014JA020752, 2015.

The Weddell Sea Anomaly (WSA) is a recurrent feature of the austral summer midlatitude ionosphere where electron densities are observed to maximize during the local nighttime. In this study, tidal decomposition is applied to FORMOSAT-3 (Formosa Satellite)/Constellation Observing System for Meteorology, Ionosphere, and Climate (COSMIC) total electron content (TEC) and electron density observations between 2007 and 2012 to quantify the components dominating local time and spatial variation in the WSA region. Our results present some of the first three-dimensional spaceborne analyses of the WSA from a tidal perspective over multiple years. We find that the features of the WSA can be reconstructed as the result of superposition between the dominant diurnal standing (D0), eastward wave number 1 (DE1), westward wave number 2 (DW2), and stationary planetary wave 1 (SPW1) components in TECs, producing the characteristic midnight WSA peak. The D0, DE1, DW2, and SPW1 components are found to be an interannually recurring feature of the southern midlatitude to high-latitude ionosphere during the summer, manifesting as enhancements in electron density around 300 km altitude of the summer middle to high magnetic latitudes. The phases of the aforementioned nonmigrating diurnal signatures in electron density in this region are near evanescent, suggesting in situ generation, rather than upward propagation from below. However, the SPW1 signature shows some signs of an eastward tilt with altitude, suggesting possible downward propagation. The relation of these components to possible generation via in situ photoionization or plasma transport along magnetic field lines is also discussed using results from the Ground-to-topside model of Atmosphere and Ionosphere for Aeronomy (GAIA) general circulation model (GCM), connecting the tidal interpretation of the WSA to previously examined generation mechanisms.

Ryu, K., K. Oyama, L. Bankov, C. Chen, M. Devi, Huixin Liu, J. Liu, Precursory enhancement of EIA in the morning sector: contribution from Mid-latitude large earthquake in the north-east Asian region, Adv. in Space. Res., in print, doi:10.1016/j.asr.2015.08.030, 2015.

To investigate whether the link between seismic activity and EIA (equatorial ionization anomaly) enhancement is valid for mid-latitude seismic activity, DEMETER observations around seven large earthquakes in the northeast Asian region were fully analyzed (M P 6:8). In addition, statistical analysis was performed for 35 large earthquakes (M P 6:0) that occurred during the DEMETER observation period. The results suggest that mid-latitude earthquakes do contribute to EIA enhancement, represented as normalized equatorial N e , and that ionospheric change precedes seismic events, as has been reported in previous studies. According to statistical studies, the normalized equatorial density enhancement is sensitive and proportional to both the magnitude and the hypocenter depth of an earthquake. The mechanisms that can explain the contribution of mid-latitude seismic activity to EIA variation are briefly discussed based on current explanations of the geochemical and ionospheric processes involved in lithosphere–ionosphere interaction.

Hamid, N. S. A., Huixin Liu, T. Uozumi, et al., Longitudinal and Solar Activity Dependence of Equatorial Electrojet At Southeast Asian Sector, Earth. Planets and Space, accepted, 2015.

Guo, J., F. Wei, X. Feng, Huixin Liu, W. Wan, Z. Yang, J. Yao, and C. Liu, Alfven waves as a solar-interplanetary driver of the thermospheric disturbances, Scientific Reports, doi:10.1038/srep-15-25868A, accepted, 2015.