Commission G Report

April 10, 2015

1. Research Report

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

(Yasunobu Ogawa, NIPR)

=== Report from recent papers ===

(1) Pulsating auroras show quasi-periodic intensity modulations caused by the precipitation of energetic electrons of the order of tens of keV. It is expected theoretically that not only these electrons but also sub-relativistic/relativistic electrons precipitate simultaneously into the ionosphere owing to whistler-mode wave?particle interactions. The height-resolved electron density profile was observed with the European Incoherent Scatter (EISCAT) Tromso VHF radar on 17 November 2012. Electron density enhancements were clearly identified at altitudes >68 km in association with the pulsating aurora, suggesting precipitation of electrons with a broadband energy range from ~10 keV up to at least 200 keV. The riometer and network of subionospheric radio wave observations also showed the energetic electron precipitations during this period. During this period, the footprint of the Van Allen Probe-A satellite was very close to Tromso and the satellite observed rising tone emissions of the lower-band chorus (LBC) waves near the equatorial plane. Considering the observed LBC waves and electrons, we conducted a computer simulation of the wave?particle interactions. This showed simultaneous precipitation of electrons at both tens of keV and a few hundred keV, which is consistent with the energy spectrum estimated by the inversion method using the EISCAT observations. This result revealed that electrons with a wide energy range simultaneously precipitate into the ionosphere in association with the pulsating aurora, providing the evidence that pulsating auroras are caused by whistler chorus waves. We suggest that scattering by propagating whistler simultaneously causes both the precipitations of sub-relativistic electrons and the pulsating aurora.

(2) The solar zenith angle (SZA) dependence of the conductance is studied and a simple theoretical form for the Hall-to-Pedersen conductance ratio is developed, using the peak plasma production height. The European Incoherent Scatter (EISCAT) radar observations at Tromso (67 MLAT) on 30 March 2012 were used to calculate the conductance. The daytime electric conductance is associated with plasma created by solar extreme ultraviolet radiation incident on the neutral atmosphere of the Earth. However, it has been uncertain whether previous conductance models are consistent with the ideal Chapman theory for such plasma productions. We found that the SZA dependence of the conductance is consistent with the Chapman theory after simple modifications. The Pedersen conductance can be understood by approximating the plasma density height profile as being flat in the topside E region and by taking into account the upward gradient of atmospheric temperature. An additional consideration is necessary for the Hall conductance, which decreases with increasing SZA more rapidly than the Pedersen conductance. This rapid decrease is presumably caused by a thinning of the Hall conductivity layer from noon toward nighttime. We expressed this thinning in terms of the peak production height in the Chapman theory.

Reference

(1) Miyoshi, Y., S. Oyama, S. Saito, S. Kurita, H. Fujiwara, R. Kataoka, Y. Ebihara, C. Kletzing, G. Reeves, O. Santolik, M. Cliverd, C. J. Rodger, E. Turunen, and F. Tsuchiya, Energetic electron

precipitation associated with pulsating aurora: EISCAT and Van Allen Probe observations, J. Geophys. Res. Space Physics, in press, doi:10.1002/2014JA020690, 2015.

(2) Ieda, A., S. Oyama, H. Vanhamaki, R. Fujii, A. Nakamizo, O. Amm, T. Hori, M. Takeda, G. Ueno, A. Yoshikawa, R. J. Redmon, W. F. Denig, Y. Kamide, and N. Nishitani, Approximate forms of daytime ionospheric conductance, J. Geophys. Res. Space Physics, 119, pages 10397-10,415, doi:10.1002/2014JA020665, Jan. 2015.

1.2. Report from Solat-Terrestrial Environmental Laboratory, Nagoya University

(Satonori Nozawa, Nagoya University)

=== Report from recent papers ===

(1) Possible generation mechanisms of Pc1 pearl structures were investigated using multi-point induction magnetometers in Athabasca in Canada, Magadan in Russia, and Moshiri in Japan. Two Pc1 pulsations that were simultaneously observed at the three stations were selected. Based on polarization analysis, similarity of the pearl structures at differen stations, and model calculations, it is suggested that beating processes in the ionosphere could be one of the generation mechanisms of Pc1 pearl structures.

(2) The characteristics of nighttime medium-scale traveling ionospheric disturbance (MSTID) features observed over Yonaguni (24.5°N, 123.0°E; 19.3°N dip latitude), Japan are studied using all-sky imaging of OI 630.0 nm airglow emission. Detailed investigation suggests that the poleward propagating enhancement of airglow intensity, probably associated with themidnight pressure bulge, causes the MSTID features to disappear when they reach lower latitudes later in the night. When the MSTIDs reach lower latitudes well before midnight, they are found to be inhibited by the equatorial ionization anomaly crest region.

Reference

(1) Jun, C.-W., K. Shiokawa, M. Connors, I. Schofield, I. Poddelsky, and B. Shevtsov, Study of Pc1 pearl structures observed at multi-point ground stations in Russia, Japan and Canada, Earth Planets Space, 66, 140, doi:10.1186/s40623-014-0140-8, 2014.

(2) V. Lakshmi Narayanan, K. Shiokawa, Y. Otsuka, S. Saito, Airglow observations of nighttime medium-scale traveling ionospheric disturbances from Yonaguni: Statistical characteristics and low latitude limit, J. Geophys. Res., 119, doi: 10.1029/2014JA020368, 2014.

1.3. Report from Research Institute for Sustainable Humanosphere, Kyoto University (RISH)

(Mamoru Yamamoto, Kyoto University)

=== Report from recent papers ===

(1) The pulsed, beamwidth-limited atmospheric radar suffers from a finite resolution volume, making it difficult to resolve the small-scale irregularity structure of refractive index (or clear-air turbulence) in the scattering region. Multi-receiver and multi-frequency imaging techniques were thus proposed to improve the spatial resolution of the measurements in the finite resolution volume. The middle and upper atmosphere radar (MUR; 34.85° N, 136.10° N) possesses the capabilities of 5 frequencies, ranging from 46 MHz to 47 MHz, and up to 25 receivers to carry out the imaging techniques. In this paper, we exhibit the three-dimensional (3-D) radar imaging utilizing five frequencies and 19 receivers of the MUR. The Capon method was employed for the process of imaging, and examinations of a wavy layer and turbulent structures were made, in

which the spatial weighting effect on the imaging were mitigated beforehand. Information such as echo center and structure morphology in the resolution volume was then extracted. For example, the location distribution of echo centers could imply the traveling orientation of the wavy layer, which was correspondent with horizontal wind direction. Such information of wavy layer structure was more difficult to disclose without removal of the spatial weighting effect. This paper demonstrates an advanced application of 3-D radar imaging to some practical atmospheric phenomena.

(2) Using the fan sector backscatter maps of 47 MHz Equatorial Atmosphere Radar (EAR) at Kototabang (0.2°S geographic latitude, 100.3°E geographic longitude, and 10.4°S geomagnetic latitude), Indonesia, the spatial and temporal evolution of equatorial plasma bubbles (EPBs) were examined to classify the evolutionary-type EPBs from those which formed elsewhere and drifted into the field of view of radar. A total of 535 EPBs were observed during the low to moderate solar activity years 2010–2012, out of which about 210 (~39%) are of evolving type and the remaining 325 (~61%) are drifting-in EPBs. In general, both the evolving-type and drifting-in EPBs exhibit predominance during the postsunset hours of equinoxes and December solstices. Interestingly, a large number of EPBs were found to develop even a few minutes prior to the apex sunset during equinoxes. Further, the occurrence of evolving-type EPBs exhibits a clear secondary peak around midnight (2300–0100 LT), primarily, due to higher rate of occurrence during the postmidnight hours of June solstices. A significant number (~33%) of postmidnight EPBs generated during June solstices did not exhibited any clear zonal drift, while about 14% of EPBs drifted westward. Also, the westward drifting EPBs are confined only to June solstices. The responsible mechanisms for the genesis of fresh EPBs during postmidnight hours were discussed in light of equatorward meridional winds in the presence of weak westward electric fields.

References

(1) Chen, J. S., J. Furumoto, M. Yamamoto, Three-dimensional radar imaging of atmospheric layer and turbulence structures using multiple receivers and multiple frequencies Ann. Geophys., 32, 899-909, DOI:10.5194/angeo-32-899-2014, 2014.

(2) Ajith, K. K., S. T. Ram, M. Yamamoto, T. Yokoyama, V. S. Gowtam, Y. Otsuka, T. Tsugawa, and K. Niranjan, Explicit characteristics of evolutionary-type plasma bubbles observed from Equatorial Atmosphere Radar during the low to moderate solar activity years 2010-2012, J. Geophys. Res. Space Physics, 120 (2), 1371-1382, doi:10.1002/2014JA020878., 2015.

2. News

2.1. PANSY in full operation (Yasunobu Ogawa, NIPR)

Program of the Antarctic Syowa MST/IS radar (PANSY) introduced the first MST/IS radar in the Antarctic. The radar started research observation in 2012 with 1/4 of the full array system, and has collected almost continuous observational data in the troposphere, lower stratosphere and mesosphere for about three years. Although the full system operation has been postponed due to limited transportation in 2011/12 and 2012/13 seasons caused by a very thick sea-ice condition, full system observations have been successfully started in early 2015 with 520 kW transmitting power and 1045 array antennas.

2.2. MU Radar is awarded IEEE Milestone (Mamoru Yamamoto, RISH)

IEEE, an association dedicated to advancing innovation and technological excellence for the benefit of humanity, is the world's largest technical professional society. IEEE established the Milestones Program in 1983 to recognize the achievements of the Century of Giants who formed the profession and technologies represented by IEEE. Each milestone recognizes a significant technical achievement that occurred at least 25 years ago in an area of technology and having at least regional impact. In December 2014, IEEE decided to award Milestone to the MU (Middle and Upper atmosphere) radar as the first large-scale MST (Mesosphere, Stratosphere, and Troposphere) radar with a two-dimensional active phased array antenna system. The MU radar was established in 1984 by Kyoto University with collaboration of Mitsubishi Electric Corporation, and enabled continuous and flexible observation of the atmosphere, and has contributed to the progress of atmospheric science and radar engineering. Its dedication ceremony will be held on May 13, 2015 at Shirankaikan, Kyoto University.

3. Publication list

Publications were listed in each section of research report.