Commission G Report

August 6, 2014

1. Research Report

1.1. Report from National Institute of Communications and Information
(Takuya Tsugawa, NICT)

=== Report from recent papers ===

After the M9.0 Tohoku-oki earthquake in 2011, strong deformation of ionogram echo traces, forming multiple cusp signatures (MCS), were observed at three stations 790-1880 km from the epicenter. The vertical structure of the ionospheric disturbances was determined by true height analysis and compared with broadband seismograph records at stations close to the ionosondes. These ionospheric disturbances were caused by vertically propagating acoustic waves excited by the up/down ground motion of seismic waves. Numerical simulations have shown that acoustic waves with a period of 15-40 s and amplitude of order 1 mm/s at the ground level were sufficient to create MCSs. These acoustic wave parameters are consistent with the seismic records if the motion of the air mass on the ground level is assumed to be the same as the ground motion. The travel time diagram of the seismic records showed that the MCS ionogram first detected at each station was caused by P waves, while the others were caused by Rayleigh waves.

Reference

Maruyama, T., and H. Shinagawa (2014), Infrasonic sounds excited by seismic waves of the 2011Tohoku-oki earthquake as visualized in ionograms, J. Geophys. Res. Space Physics, 119, 4094?4108, doi:10.1002/2013JA019707.

1.2. Report from Solat-Terrestrial Environmental Laboratory, Nagoya University
(Kazuo Shiokawa, Nagoya University)

Solar-Terrestrial Environment Laboratory, Nagoya University has kept optical observations of the ionosphere and the thermosphere using the Optical Mesosphere Thermosphere Imagers at 13 stations in Japan, Canada, Russia, Thailand, Indoensia, Norway, Australia, and Hawaii. The nighttime medium-scale travelling ionospheric disturbance (MSTID) were statistically investigated using 630-nm airglow images obtained at subtropical site Yonaguni (24.5N, 22 1E), Japan in collaboration with the Electronic Navigation ResearchInstitute. The results show various characteristics of the equatorward boundary of the southwestward-moving MSTIDs at subtropical latitudes.

1.3. EISCAT Research Activities
(Satonori Nozawa, Nagoya University)

=== Report from recent papers ===

(1) High-latitude ionospheric variations at times near auroral substorms exhibit large temporal variations in both vertical and horizontal extents. Statistical analysis was made of data from the EISCAT UHF radar at Tromso, Norway, and International Monitor for Auroral Geomagnetic Effects magnetometer, particularly focusing on the height dependencies. Results show clear evidences of large electric field with corresponding frictional heating and Pedersen currents located just outside the front of the poleward expanding aurora. At the beginning of the substorm recovery phase, the ionospheric density had a large peak in the E region and a smaller peak in the F region.

(2) We examined the brightness of 630.0 nm airglow, I630, associated with polar cap patches observed during a magnetic storm that occurred on 22 January 2012. Brightness was measured using an all-sky imager (ASI) located at Longyearbyen, Svalbard. The observed I630 was compared with the F region electron density observed by the EISCAT Svalbard Radar (ESR). The I630 was positively correlated with the F2 layer peak electron density, NmF2, and inversely correlated with the altitude of the F2layer peak electron density, hmF2, as expected from the known relationship between these parameters. During the observation periods the measured brightness frequently exceeded the calculated I630; we infer that in most cases, low-energy particle precipitation is responsible for the extra brightness.

(3) A new solid-state sodium lidar installed at Ramfjordmoen, Tromso (69.6°N, 19.2°E), started observations of neutral temperature together with sodium density in the mesosphere-lower thermosphere (MLT) region on 1 October 2010. The new lidar provided temperature data with a time resolution of 10 min and with good quality between ?80 and ?105 km from October 2010 to March 2011. For the night of 5 October 2010, we succeeded in conducting simultaneous observations of the new lidar and the European Incoherent Scatter UHF radar with the tristatic Common Program 1 (CP-1) mode. Comparisons of neutral and ion temperatures showed a good agreement at 104 km between 0050 and 0230 UT on 6 October 2010 when the electric field strength was smaller, while significant deviations (up to ?25 K) are found at 107 km. We evaluated contributions of Joule heating and electron-ion heat exchange, but derived values seem to be underestimated.

Reference

(1) Oyama, S., Y. Miyoshi, K. Shiokawa, J. Kurihara, T. T. Tsuda, and B. J. Watkins, Height-dependent ionospheric variations in the vicinity of nightside poleward expanding aurora after substorm onset, *J. Geophys. Res.*, doi:10.1002/2013JA019704, 2014.
(2) Sakai, J., K. Hosokawa, S. Taguchi, Y. Ogawa, Storm-time enhancements of 630.0-nm airglow associated with polar cap patches, *J. Geophys. Res.*, doi:10.1029/2013JA019197, 2014.
(3) Nozawa, S., T. Kawahara, N. Saito, C. Hall, T. Tsuda, T. Kawabata, S. Wada, A. Brekke, T. Takahashi, H. Fujiwara, Y. Ogawa, and R. Fujii, Variations of the neutral temperature and sodium density between 80 and 107 km above Tromsoe during the winter of 2010-2011 by a new solid state sodium LIDAR, *J. Geophys. Res.*, doi:10.1029/2013JA019520, 2014.

2. Project progress

In March 2014, following research project was approved as one of 27 High-Priority Projects of the Master Plan 2014 of the Science Council of Japan. In July 2014, the project was further listed in the draft of Roadmap 2014 of Ministry of Education, Culture, Sports, Science and Technology (MEXT) as one of 10 new plans. We appreciate strong support from the URSI community.

<Project outline>

Title: Study of coupling processes in the solar-terrestrial system

Project Summary: Energy from the sun is divided into radiation and solar wind (high-speed particles), which are maximum at the equatorial and polar regions, respectively. We study the flow of the energy and materials in the whole atmosphere by establishing two large atmospheric radars at these singular points, and global observation network.

Scientific Significance: We elucidate energy and plasma flow from the Sun to the Earth, response of the Earth's atmosphere, ionosphere and magnetosphere to short/long period variability of the Sun, and coupling processes between these regions, which leads us quantitative understanding of the solar-terrestrial environment as a whole system.

Social Value: The development of the new radar has direct impact on radio science, informatics and electronics. Results from our studies will improve the forecast accuracy of severe weather and space weather. Our plan will serve national and international capacity building through field studies and international schools.

Period of the project: 2014 to 2024

Equipment of the project:

(1) Equatorial MU Radar
(2) EISCAT_3D Radar
(3) Global observation network

PI and Institutions:

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National Institute for Polar Research
Solar-Terrestrial Environment Laboratory, Nagoya University
International Center for Space Weather Science and Education, Kyushu University
IUGONET (Inter-university Upper atmosphere Global Observation NETwork) consortium

3. Publication list

Publications were listed in each section of research report.