Commission G Report

December 24, 2014

1. Research Report

1.1. Report from National Institute of Communications and Information (NICT)
(Minoru Kubota, NICT)

=== Report from recent papers ===

(1) A system to optimize the management of global space-weather observation networks has been developed by the National Institute of Information and Communications Technology (NICT). Named the WONM (Wide-area Observation Network Monitoring) system, it enables data acquisition, transfer, and storage through connection to the NICT Science Cloud, and has been supplied to observatories for supporting space-weather forecast and research. This system provides us with easier management of data collection than our previously employed systems by means of autonomous system recovery, periodical state monitoring, and dynamic warning procedures. Operation of the WONM system is introduced in this report.

(2) 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. On the other hand, the FSF occurrence at CMU and KTB, that are located in the northern and southern hemispheres, respectively, are higher than at CPN. The RSF occurrence typically has the peaks before midnight, while the maximum occurrence rate of FSF is after midnight. Furthermore, the RSF onsets normally precede the FSF onsets by about 1-2 h. As the solar activity levels go up, the percentages of RSF occurrence increase, but the percentages of FSF tends to decrease. In addition, we compare the statistics of observed RSF occurrence with the prediction of the IRI-2012 model. This work is important for an improvement of the IRI model in the prediction of the spread F occurrence probability in the low-latitude region.

Reference

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

=== Report from recent papers ===

The characteristics of nighttime medium-scale travelling ionospheric disturbance (MSTID) features observed over Yonaguni (24.5oN, 123.0oE; 19.3oN dip latitude), Japan are studied using all-sky imaging of OI 630.0 nm airglow emission. The uniqueness of these observations is that the area observed by the imager covers the transition region between low to middle latitudes in the ionosphere. Typical low latitude limit of mid-latitude type nighttime MSTIDs possessing phase front alignments along the northwest to the southeast occurs in this region. These MSTID features are rarely sighted at dip latitudes below 15o. We selected two year period for analysis in which one year corresponded to the solar minimum conditions and another year to the solar maximum conditions. The MSTIDs were observed to extend to farther lower latitudes during the solar minimum conditions than during the solar maximum periods. Their observed range of wavelengths, phase velocities, phase front alignment and propagation directions are similar to those observed at typical mid-latitude sites. However, on many occasions the phase fronts of the observed MSTIDs did not extend over the whole field of view of the imager indicating that some process inhibits their extension to further lower latitudes. Detailed investigation suggests that the poleward propagating enhancement of airglow intensity, probably associated with the midnight 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

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., in press, doi: 10.1029/2014JA020368, 2014.

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

=== Report from recent PANSY-related papers ===

(1) The PANSY radar is the first Mesosphere–Stratosphere–Troposphere/Incoherent Scatter (MST/IS) radar in the Antarctic region. It is a large VHF monostatic pulse Doppler radar operating at 47 MHz, consisting of an active phased array of 1045 Yagi antennas and an equivalent number of transmit‐receive (TR) modules with a total peak output power of 500 kW. The first stage of the radar was installed at Syowa Station (69° 00′ S, 39° 35′ E) in early 2011, and is currently operating with 228 antennas and modules. This paper reports the project's scientific objectives, technical descriptions, and the preliminary results of observations made to date. The radar is designed to clarify the role of atmospheric gravity waves at high latitudes in the momentum budget of the global circulation in the troposphere, stratosphere and mesosphere, and to explore the dynamical aspects of unique polar phenomena such as polar mesospheric clouds (PMC) and polar stratospheric clouds (PSC). The katabatic winds as a branch of Antarctic tropospheric circulation and as an important source of gravity waves are also of special interest. Moreover, strong and sporadic energy inputs from the magnetosphere by energetic particles and field-aligned currents can be quantitatively assessed by the broad height coverage of the radar which extends from the lower troposphere to the upper ionosphere. From engineering points of view, the radar had to overcome restrictions related to the severe environments of Antarctic research, such as very strong winds, limited power availability, short construction periods, and limited manpower

availability. We resolved these problems through the adoption of specially designed class-E amplifiers, light weight and tough antenna elements, and versatile antenna arrangements. Although the radar is currently operating with only about a quarter of its full designed system components, we have already obtained interesting results on the Antarctic troposphere, stratosphere and mesosphere, such as gravity waves, multiple tropopauses associated with a severe snow storm in the troposphere and stratosphere, and polar mesosphere summer echoes (PMSE).

(2) Strong meteor trail echoes are interferences in the wind velocity estimates made from mesosphere radar observations. Contaminated spectra are detected by their discontinuity and are removed at the risk of greater fluctuations of spectra, leading to a severe reduction of the signal-to-noise ratio (SNR) and inaccurate wind estimates for weak atmospheric echoes. This paper presents an adaptive signal processing technique for the suppression of spectral contaminations by meteor trail echoes. The method is based on the norm-constrained and directionally-constrained minimization of power (NC-DCMP), which balances the capability of canceling the clutter and the robustness of beam shaping, at the cost of a slight decrease in the SNR, which can be determined in advance. Simulation results show that with a 3 dB decrease of the SNR being allowed, the method improves the signal-to-interference ratio (SIR) by 15 dB, giving wind estimates that are about 8 m s −1 better in terms of root-mean-square error and providing four times as wide an observable range when compared with the results of the ordinary non-adaptive beamforming method. The results for an actual observation show that the improvement of both the SIR and the observable range are achieved as in the simulations, which implies that the method should provide the simulated accuracy for the estimation of wind velocity from actual observations.

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(1) Sato, K., M. Tsutsumi, T. Sato, T. Nakamura, A. Saito, Y. Tomikawa, K. Nishimura, M. Kohma, H. Yamagishi, and T. Yamanouchi, Program of the Antarctic Syowa MST/IS Radar (PANSY), J. Atmos. Solar-Terr. Phys., 118A, 2-15, 2014.

(2) Hashimoto, T., K. Nishimura, M. Tsutsumi, and T. Sato, Meteor Trail Echo Rejection in Atmospheric Phased Array Radars Using Adaptive Sidelobe Cancellation, J. Atmos. Oceanic Tech., in press, 2014.

=== Report from recent EISCAT-related papers ===

(1) Theoretical models and observations have suggested that the increasing greenhouse gas concentration in the troposphere causes the upper atmosphere to cool and contract. However, our understanding of the long-term trends in the upper atmosphere is still quite incomplete, due to a limited amount of available and well-calibrated data. The European Incoherent Scatter radar has gathered data in the polar ionosphere above Tromsø for over 33 years. Using this long-term data set, we have estimated the first significant trends of ion temperature at altitudes between 200 and 450 km. The estimated trends indicate a cooling of 10–15 K/decade near the F region peak (220–380 km altitude), whereas above 400 km the trend is nearly zero or even warming. The height profiles of the observed trends are close to those predicted by recent atmospheric general circulation models. Our results are the first quantitative confirmation of the simulations and of the qualitative expectations.

(2) Auroral patches in diffuse auroras are very common features in the postmidnight local time. However, the processes that produce auroral patches are not yet well understood. In this paper we present two examples of auroral fragmentation which is the process by which uniform aurora is broken into several fragments to form auroral patches. These examples were observed at Athabasca, Canada (geomagnetic latitude: 61.7°N), and Tromsø, Norway (67.1°N). Captured in

sequences of images, the auroral fragmentation occurs as finger-like structures developing latitudinally with horizontal-scale sizes of 40–100 km at ionospheric altitudes. The structures tend to develop in a north-south direction with speeds of 150–420 m/s without any shearing motion, suggesting that pressure-driven instability in the balance between the earthward magnetic-tension force and the tailward pressure gradient force in the magnetosphere is the main driving force of the auroral fragmentation. Therefore, these observations indicate that auroral fragmentation associated with pressure-driven instability is a process that creates auroral patches. The observed slow eastward drift of aurora during the auroral fragmentation suggests that fragmentation occurs in low-energy ambient plasma.

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1.4. Report from Graduate School of Science, Tohoku University
(Takeshi Sakanoi, Tohoku University)

=== Report from recent papers ===

(1) We present phase curves for Venus in the 1–2 μm wavelength region, acquired with IR1 and IR2 on board Akatsuki (February–March 2011). A substantial discrepancy with the previously-published curves was found in the small phase angle range (0–30°). Through analysis by radiative-transfer computation, it was found that the visibility of larger (~1 μm or larger) cloud particles was significantly higher than in the standard cloud model. Although the cause is unknown, this may be related to the recently reported increase in the abundance of SO2 in the upper atmosphere. It was also found that the cloud top is located at ~75 km and that 1-μm particles exist above the cloud, both of these results being consistent with recent studies based on the Venus Express observations in 2006–2008. Further monitoring, including photometry for phase curves, polarimetry for aerosol properties, spectroscopy for SO2 abundance, and cloud opacity measurements in the near-infrared windows, is required in order to understand the mechanism of this large-scale change.

(2) HISAKI (SPRINT-A) satellite is an earth-orbiting Extreme UltraViolet (EUV) spectroscopic mission and launched on 14 Sep. 2013 by the launch vehicle Epsilon-1. Extreme ultraviolet spectroscope (EXCEED) onboard the satellite will investigate plasma dynamics in Jupiter's inner magnetosphere and atmospheric escape from Venus and Mars. EUV spectroscopy is useful to measure electron density and temperature and ion composition in plasma environment. EXCEED also has an advantage to measure spatial distribution of plasmas around the planets. To measure radial plasma distribution in the Jovian inner magnetosphere and plasma emissions from ionosphere, exosphere and tail separately (for Venus and Mars), the pointing accuracy of the spectroscope should be smaller than spatial structures of interest (20 arc-seconds). For satellites in the low earth orbit (LEO), the pointing displacement is generally caused by change of alignment between the satellite bus module and the telescope due to the changing thermal inputs from the Sun and Earth. The HISAKI satellite is designed to compensate the displacement by tracking the target with using a Field-Of-View (FOV) guiding camera. Initial checkout of the attitude control for the EXCEED observation shows that pointing accuracy kept within 2 arc-seconds in a case of "track mode" which is used for Jupiter observation. For observations of Mercury, Venus, Mars, and Saturn, the entire disk will be guided inside slit to observe plasma around the planets. Since the FOV camera does not capture the disk in this case, the satellite uses a star tracker (STT) to

hold the attitude (“hold mode”). Pointing accuracy during this mode has been 20–25 arc-seconds. It has been confirmed that the attitude control works well as designed.

(3) The Sprint-A satellite with the EUV spectrometer (Extreme Ultraviolet Spectroscope for Exospheric Dynamics: EXCEED) was launched in September 2013 by the Epsilon rocket. Now it is orbiting around the Earth (954.05 km×1156.87 km orbit; the period is 104 minutes) and one has started a broad and varied observation program. With an effective area of more than 1 cm2 and well-calibrated sensitivity in space, the EUV spectrometer will produce spectral images (520–1480 Å) of the atmospheres/magnetospheres of several planets (Mercury, Venus, Mars, Jupiter, and Saturn) from the Earth’s orbit. At the first day of the observation, EUV emissions from the Io plasma torus (mainly sulfur ions) and aurora (H2 Lyman and Werner bands) of Jupiter have been identified. Continuous 3-month measurement for Io’s plasma torus and aurora is planned to witness the sporadic and sudden brightening events occurring on one or both regions. For Venus, the Fourth Positive (A1 Π-X1 Σ +) system of CO and some yet known emissions of the atmosphere were identified even though the exposure was short (8-min). Long-term exposure from April to June (for approximately 2 months) will visualize the Venusian ionosphere and tail in the EUV spectral range. Saturn and Mars are the next targets.

(4) Jupiter’s magnetosphere is a strong particle accelerator that contains ultrarelativistic electrons in its inner part. They are thought to be accelerated by whistler-mode waves excited by anisotropic hot electrons (>10 kiloelectron volts) injected from the outer magnetosphere. However, electron transportation in the inner magnetosphere is not well understood. By analyzing the extreme ultraviolet line emission from the inner magnetosphere, we show evidence for global inward transport of flux tubes containing hot plasma. High-spectral-resolution scanning observations of the Io plasma torus in the inner magnetosphere enable us to generate radial profiles of the hot electron fraction. It gradually decreases with decreasing radial distance, despite the short collisional time scale that should thermalize them rapidly. This indicates a fast and continuous resupply of hot electrons responsible for exciting the whistler-mode waves.

(5) We searched for hydrogen peroxide (H2O2) in the Martian atmosphere using data measured by the Planetary Fourier Spectrometer (PFS) onboard Mars Express during five martian years (MY27–31). It is well known that H2O2 plays a key role in the oxidizing capacity of the Martian atmosphere. However, only a few studies based on ground-based observations can be found in the literature. Here, we performed the first analysis of H2O2 using long-term measurements by a spacecraft-borne instrument. We used the ν4 band of H2O2 in the spectral range between 359 cm−1 and 382 cm−1 where strong features of H2O2 are present around 362 cm−1 and 379 cm−1. Since the features were expected to be very weak even at the strong band, sensitive data calibrations were performed and a large number of spectra were selected and averaged. We made three averaged spectra for different seasons over relatively low latitudes (50°S–50°N). We found features of H2O2 at 379 cm−1, whereas no clear features were detected at 362 cm−1 due to large amounts of uncertainty in the data. The derived mixing ratios of H2O2 were close to the detection limits: 16 ± 19 ppb at Ls = 0–120°, 35 ± 32 ppb at Ls = 120–240°, and 41 ± 28 ppb at Ls = 240–360°. The retrieved value showed the detection of H2O2 only for the third seasonal period, and the values in the other periods provided the upper limits. These long-term averaged abundances derived by the PFS generally agreed with the ones reported by ground-based observations. From our derived mixing ratio of H2O2, the lifetime of CH4 in the Martian atmosphere is estimated to be several decades in the shortest case. Our results and sporadic detections of CH4 suggest the presence of strong CH4 sinks not subject to atmospheric oxidation.

(6) We have investigated the cloud top structure of Venus by analyzing ground-based images taken at the mid-infrared wavelengths of 8.66 μm and 11.34 μm. Venus at a solar phase angle of ~90°, with

the morning terminator in view, was observed by the Cooled Mid-Infrared Camera and Spectrometer (COMICS), mounted on the 8.2-m Subaru Telescope, during the period October 25–29, 2007. The disk-averaged brightness temperatures for the observation period are ~230 K and ~238 K at 8.66 μm and 11.34 μm, respectively. The obtained images with good signal-to-noise ratio and with high spatial resolution (~200 km at the sub-observer point) provide several important findings. First, we present observational evidence, for the first time, of the possibility that the westward rotation of the polar features (the hot polar spots and the surrounding cold collars) is synchronized between the northern and southern hemispheres. Second, after high-pass filtering, the images reveal that streaks and mottled and patchy patterns are distributed over the entire disk, with typical amplitudes of ~0.5 K, and vary from day to day. The detected features, some of which are similar to those seen in past UV images, result from inhomogeneities of both the temperature and the cloud top altitude. Third, the equatorial center-to-limb variations of brightness temperatures have a systematic day–night asymmetry, except those on October 25, that the dayside brightness temperatures are higher than the nightside brightness temperatures by 0–4 K under the same viewing geometry. Such asymmetry would be caused by the propagation of the migrating semidiurnal tide. Finally, by applying the lapse rates deduced from previous studies, we demonstrate that the equatorial center-to-limb curves in the two spectral channels give access to two parameters: the cloud scale height H and the cloud top altitude zc. The acceptable models for data on October 25 are obtained at H = 2.4–4.3 km and zc = 66–69 km; this supports previous results determined from spacecraft observations.

(7) The propagation of compressional Pi 2 waves in the inner magnetosphere is investigated by analyzing the onset delay times between the ground and the geosynchronous altitude. We use the compressional component (northward) of magnetic data from low-latitude stations and the geosynchronous satellite ETS-VIII (GMLat. = -10.8°, GMLon. = 217.5°). The onset delays are determined by a cross-correlation analysis, and we analyzed the events with high waveform correlations (correlation coefficient greater than 0.75). Some of these high-correlation events have the properties of propagating waves; Pi 2 waveforms at the ground stations and the satellite were synchronized with each other when the data were shifted by onset delays. The results of the statistical analysis show that 87% of the Pi 2 onsets at a ground station (Kuju, GMLat. = 26.13°, GMLon. = 202.96°) were delayed from the Pi 2 onsets at ETS-VIII, and the average of the delay times was 29 sec. This clearly shows Pi 2 onsets (initial perturbations of Pi 2) propagated from the geosynchronous altitude to the low-latitude ground. The delay times tended to be larger around the midnight sector than around the dawn and dusk sectors. These results are consistent with two-dimensional propagation of fast waves estimated by the model of Uozumi et al. (J Geophys Res 114:A11207, 2009). The delay times are nearly identical to the travel time of fast waves from geosynchronous altitude to the low-latitude ground, and the local time variation of the delay shows the azimuthal propagation along the geosynchronous orbit. We conclude that the initial compressional perturbations of Pi 2 waves propagate radially and longitudinally as a fast wave in the inner magnetosphere.

(8) We report observations of very low frequency (VLF) and extremely low frequency (ELF) chorus waves taken during the ELF/VLF Campaign observation with High-resolution Aurora Imaging Network (VLF-CHAIN) of 17–25 February 2012 at subauroral latitudes at Athabasca (L=4.3), Canada. ELF/VLF waves were measured continuously with a sampling rate of 100 kHz to monitor daily variations in ELF/VLF emissions and derive their detailed structures. We found quasiperiodic (QP) emissions whose repetition period changes rapidly within a period of 1 h without corresponding magnetic pulsations. QP emissions showed positive correlation between amplitude and frequency sweep rate, similarly to rising-tone elements. We found an event of nearly simultaneous enhancements of QP emissions and Pc1/electromagnetic ion cyclotron wave

intensities, suggesting that the temperature anisotropy of electrons and ions developed simultaneously at the equatorial plane of the magnetosphere. We also found QP emissions whose intensity suddenly increased in association with storm sudden commencement without changing their frequency. Falling-tone ELF/VLF emissions were observed with their rate of frequency change varying from 0.7 to 0.05 kHz/s over 10 min. Bursty-patch emissions in the lower and upper frequency bands are often observed during magnetically disturbed periods. Clear systematic correlation between these various ELF/VLF emissions and cosmic noise absorption was not obtained throughout the campaign period. These observations indicate several previously unknown features of ELF/VLF emissions in subauroral latitudes and demonstrate the importance of continuous measurements for monitoring temporal variations in these emissions.

(9) We present a newly developed parameterization of radiative heating and cooling for Jupiter's upper troposphere and stratosphere (103 to View the MathML source) suitable for general circulation models. The scheme is based on the correlated k-distribution approach, and accounts for all the major radiative mechanisms in the jovian atmosphere: heating due to absorption of solar radiation by methane, cooling in the infrared by methane, acetylene, ethane, and collisionally-induced molecular hydrogen–hydrogen, and molecular hydrogen–helium transitions. The results with the scheme are compared with line-by-line calculations to demonstrate that the accuracy of the scheme is within 10%. The parameterization was applied to study the sensitivity of the heating/cooling rates due to variations of mixing ratios of hydrocarbon molecules. It was also used for calculating the radiative–convective equilibrium temperature, which is in agreement with observations in the equatorial region. In midlatitudes, the equilibrium temperature is approximately 10 K colder. Our results suggest that the radiative forcing in the upper stratosphere is much stronger than it was thought before. In particular, the characteristic radiative relaxation time decreases exponentially with height from View the MathML source near the tropopause to View the MathML source in the upper stratosphere.

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1.4. Report from the University of Electro-Communications
(Keisuke Hosokawa, The University of Electro-Communications)

=== Report from recent papers ===

This paper reports simultaneous observations of ionospheric scintillation during an auroral substorm that were made using an all-sky full-color digital single-lens reflex (DSLR) camera (ASC) and a Global Positioning System (GPS) ionospheric scintillation and total electron content monitor (GISTM) in Tromsø (69.60 N, 19.20 E), Norway. On the night of November 19, 2009, a small substorm occurred in northern Scandinavia. The ASC captured its temporal evolution from the beginning of the growth phase to the end of the recovery phase. The amplitude scintillation, as monitored by the S4 index from the GISTM, did not increase in any substorm phase. By contrast, phase scintillation, as measured by the σφ index, occurred when discrete auroral arcs appeared on the GPS signal path. In particular, the phase scintillation was significantly enhanced for a few minutes immediately after the onset of the expansion phase. During this period, bright and discrete auroral forms covered the entire sky, which implies that structured precipitation on the scale of a few kilometers to a few tens of kilometers dominated the electron density distribution in the E region. Such inhomogeneous ionization structures probably produced significant changes in the refractive index and eventually resulted in the enhancement of the phase scintillation.

Reference

Keisuke Hosokawa, Yuichi Otsuka, Yasunobu Ogawa and Takuya Tsugawa, Observations of GPS scintillation during an isolated auroral substorm, Progress in Earth and Planetary Science 2014 1:16.

1.5. Report from Electro Navigation Research Institute (ENRI)
(Susumu Saito, ENRI)

=== Report from recent papers ===

(1) We investigated low-latitude ionospheric scintillation in Indonesia using two GPS receivers installed at Bandung (107.6◦ E, 6.9◦ S; magnetic latitude 17.5◦ S) and Pontianak (109.3◦ E, 0.02◦ S; magnetic latitude 8.9◦ S). This study aimed to characterise climatological and directional ionospheric scintillation occurrences, which are useful not only for the physics of ionospheric

irregularities but also for practical use in GNSS (global navigation satellite system)- based navigation. We used the deployed instrument's amplitude scintillation (S4 index) data from 2009, 2010, and 2011; the yearly SSN (sunspot-smoothed numbers) were 3.1, 16.5, and 55.9, respectively. In summary, (1) scintillation occurrences in the post-sunset period (18:00–01:00 LT) during equinox months (plasma bubble season) at the two sites can be ascribed to the plasma bubble; (2) using directional anal- yses of the two sites, we found that the distribution of scintillation occurrences is generally concentrated between the two sites, indicating the average location of the EIA (equatorial ionization anomaly) crest; (3) scintillation occurrence enhancements for the two sites in field-aligned directions are herein reported for the first time by ground-based observation in a low-latitude region; (4) distribution of scintillation occurrences at Pontianak are concentrated in the southern sky, especially in the southwest direction, which is very likely associated with the plasma bubble tilted westward with increasing latitude; and (5) scintillation occurrence in the post-midnight period in the non-plasma-bubble season is the most intriguing variable occurring between the two sites (i.e. post-midnight scintillations are observed more at Bandung than Pontianak). Most of the post-midnight scintillations ob- served at Bandung are concentrated in the northern sky, with low elevation angles. This might be due to the amplitude of irregularities in certain directions, which may be effectively enhanced by background density enhancement by the EIA and because satellite–receiver paths are longer in the EIA crest region and in a field-aligned direction.

(2) The ionospheric delay gradient is an important parameter for the planning of ground-based augmentation system (GBAS) in a region. When it is beyond the limit, the integrity and safety for landing approach of CAT II/III may be com- promised. In order to maintain the availability and safety requirement of the sys- tem, the ionospheric threat models have been developed in several countries during the past few years. However, the ionospheric delay gradient associated with plasma bubble in low latitude region has not been studied well. In this work, we present some analytical results of ionospheric delay gradient based on three GPS monitoring stations near Suvarnabhumi airport in Thailand. The stations are located on the campus of King Mongkut's Institute of Technology Ladkrabang (13.7278°N, 100.7726°E), Stamford University (13.7356°N, 100.6612°E) and Suvarnabhumi airport (13.6945°N, 100.7608°E). The analyzed results on 1st September 2011 show that the ionospheric delay gradient varies from -95.23 to 107.7 mm/km during the occurrence of the plasma bubbles.

Reference

(1) P. Abadi, S. Saito, and W. Srigutomo, Low-latitude scintillation occurrences around the equatorial anomaly crest over Indonesia, Annales Geophysicae, 32, 7–17, 2014
(2) S. Rungraengwajiake, P. Supnithi, S. Saito, N. Siansawasdi, and A. Saekow, Study of ionospheric delay gradient based on GPS monitoring stations near Suvarnabhumi airport in Thailand, Air Traffic Management and Systems, 193-204, Springer, 2014.

1.6. Report from Department of Geophysics, Kyoto Univerisy
(Akinori Saito, Kyoto University)

=== Report from recent papers ===

Spaceborne imagers are able to observe the airglow structures with wide field of views regardless of the tropospheric condition that limits the observational time of the ground-based imagers. Concentric wave structures of the O2 airglow in 762 nm wavelength were observed over North America on 1 June 2013 from the International Space Station. This was the first observation in which the entire image of the structure was captured from space, and its spatial scale size was determined to be 1200 km radius

without assumptions. The apparent horizontal wavelength was 80 km, and the amplitude in the intensity was approximately 20% of the background intensity. The propagation velocity of the structure was derived as 125 ± 62 m/s and atmospheric gravity waves were estimated to be generated for 3.5 ± 1.7 h. Concentric structures observed in this event were interpreted to be generated by super cells that caused a tornado in its early phase.

Reference

Y. Akiya, A. Saito, T. Sakanoi, Y. Hozumi, A. Yamazaki, Y. Otsuka, M. Nishioka and T. Tsugawa, First spaceborne observation of the entire concentric airglow structure caused by tropospheric disturbance, Geophysical Research Letters, Volume 41, Issue 19, pages 6943–6948, 16 October 2014.

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

=== Report from recent papers ===

(1) Total electron content (TEC) is an important parameter for revealing latitudinal ionospheric structures, such as the equatorial ionization anomaly (EIA) in Southeast Asia. Understanding the EIA is beneficial for studying equatorial spread F. To reveal the structures, the absolute TEC as a function of latitude must be accurately determined. In early 2012, we expanded a GNU Radio Beacon Receiver (GRBR) network to provide latitudinal coverage in the Thailand-Indonesia sector. We employed the GRBR network to receive VHF and UHF signals from polar low-Earth-orbit satellites. The TEC offset is an unknown parameter in the absolute TEC estimation process. We propose a new technique based on the two-station method to estimate the offset for the latitudinal TEC estimation, and it works better than the original method for a sparse network. The TEC estimation system requires two iterations to minimize the root-mean-square error (RMSE). Once the RMSE reaches the global minimum, the absolute TECs are estimated simultaneously over five GRBR stations. GPS-TECs from local stations are used as the initial guess of the offset estimation. The height of the ionospheric pierce point is determined from the ionosonde hmF2. As a result, the latitudinal GRBR-TEC was successfully estimated from the polar orbit satellites. The two EIA humps were clearly captured by the GRBR-TEC. The result was well verified with the TEC reconstructed from the /NOFS density data and the ionosonde bottomside data. This is a significant step showing that the GRBR is a useful tool for the study of low-latitude ionospheric features.

(2) A GNU Radio Beacon Receiver (GRBR) system for total electron content (TEC) measurements using 150 and 400?MHz transmissions from Low-Earth Orbiting Satellites (LEOS) is fabricated in house and made operational at Ahmedabad (23.04°N, 72.54°E geographic, dip latitude 17°N) since May 2013. This system receives the 150 and 400?MHz transmissions from high-inclination LEOS. The first few days of observations are presented in this work to bring out the efficacy of an ensemble average method to convert the relative TECs to absolute TECs. This method is a modified version of the differential Doppler-based method proposed by de Mendonca (1962) and suitable even for ionospheric regions with large spatial gradients. Comparison of TECs derived from a collocated GPS receiver shows that the absolute TECs estimated by this method are reliable estimates over regions with large spatial gradient. This method is useful even when only one receiving station is available. The differences between these observations are discussed to bring out the importance of the spatial differences between the ionospheric pierce points of these satellites. A few examples of the latitudinal variation of TEC during different local times using GRBR measurements are also presented, which demonstrates the potential of radio beacon

measurements in capturing the large-scale plasma transport processes in the low-latitude ionosphere.

(3) Using numerical simulations, we investigated a method for calculating the spectral parameters from Doppler spectra collected by high-resolution wind profiler radars (WPRs). Because high-resolution WPRs collect a huge amount of Doppler spectra, calculations must be simple and fast. The proposed method has two steps. In the first step, the echo range (Recho), in which the Doppler spectrum point with peak intensity is contained and all the smoothed Doppler spectrum points have intensities that are greater than the noise intensity, was determined. For producing the smoothed Doppler spectrum, a running average with equal weight (RA) or multi-taper method (MTM) was used. In the second step, the spectral parameters were calculated using the Doppler spectrum points within Recho. By comparing the performance of the computation methods using RA and MTM, we concluded that the computation method using RA is more suitable because it has better estimation performance for small spectrum widths and the calculations are faster. Estimation error of the spectral parameters depends on the determination accuracy of the Doppler spectrum peak and Recho. Furthermore, for the case of a 512-point Doppler spectrum and 13-point RA, the estimation errors tend to be independent of the signal-to-noise ratio (SNR) when the peak level of the Doppler spectrum (pest) is ~8?dB or more greater than the noise intensity. For pest of < ~8?dB, the estimation errors are well correlated to pest and the SNR. Therefore, the number of incoherent integration times should be determined by considering the SNR and pest.

References

(1) Watthanasangmechai, K., M. Yamamoto, A. Saito, T. Tsugawa, T. Yokoyama, P. Supnithi, and C. Y. Yatini (2014), Latitudinal GRBR-TEC estimation in Southeast Asia region based on the two-station method, Radio Sci., 49, 910-920, doi:10.1002/2013RS005347.

(2) Thampi, S. V., M. S. Bagiya, D. Chakrabarty, Y. B. Acharya, and M. Yamamoto (2014), An ensemble average method to estimate absolute TEC using radio beacon-based differential phase measurements: Applicability to regions of large latitudinal gradients in plasma density, Radio Sci., 49, doi:10.1002/2014RS005372.

(3) Tong Gan, Masayuki K. Yamamoto, Hiroyuki Hashiguchi, Hajime Okamoto and Mamoru Yamamoto, Error estimation of spectral parameters for high-resolution wind and turbulence measurements by wind profiler radars, Radio Science, DOI: 10.1002/2013RS005369, in press, 2014.

2. Research meetings

International Workshop on Program of the Antarctic Syowa MST/IS Radar

Workshop date: March, 10-11, 2014.

Venue: Department of Earth and Planetary Science, Graduate School of Science, The University of Tokyo

Workshop program:
http://polaris.nipr.ac.jp/~tutumi/PANSYmeeting201403/pansy_workshop_program201403.html

3. Publication list

Publications were listed in each section of research report.