Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

PEM32-P01 Room:Convention Hall Time:May 23 17:15-18:15

DC Electric field observation in the ionosphere by S-520-26 sounding rocket.

SUDA, Kousuke[1*], ISHISAKA, Keigo[1], ABE, Takumi[2], WATANABE, Shigeto[3]

[1]Toyama Prefectural University, [2]ISAS JAXA, [3]Hokkaidou University

Mesosphere and thermosphere at the altitude from 90km to 300km decide dynamics, temperature and structure of thermosphere. However, the observed data is insufficient. Because, a satellite cannot stay at the region long time. Air motion, density and temperature of vertical direction are physical basic parameter in order to understand the atmospheric structure and air temperature in the ionosphere. It is possible to investigate it only with the sounding rocket.

S-520-26 sounding rocket was launched at Uchinoura space center of JAXA on January 12 2012. It clarifies structure and plasma dynamics of mesosphere and thermosphere. This sounding rocket observes plasma motion, density, temperature and change of ionosphere F region at dawn, electric field and neutral atmospheric wind.

S-520-26 sounding rocket reached to an altitude of about 300 km 278 seconds after a launch, and observed DC electric field. This is aim. This observation method is called double probe method. That use pair of electric field antenna measurement. This research, observation of electric field is reported. And this data use to make clear plasma dynamics at F area.

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

PEM32-P02 Room:Convention Hall Time:May 23 17:15-18:15

Observation plan of electron density structure on lower ionosphere by S-310-40 sounding rocket

FUKAZAWA, Tatsuya[1*], ISHISAKA, Keigo[1], ASHIHARA, Yuki[2], ABE, Takumi[3]

[1]Toyama Pref. Univ., [2]Elec.Eng.Nara NCT., [3]ISAS/JAXA

In general, ionosphere has D layer (60~90km), E layer (90~140km), F1, F2 layer (140km~) at daytime. Each layer absorbs and reflects different wavelength wave. However D layer is disappearance at night. So, MF band wave which have been absorbed by D layer is reflected by E layer, and propagate in the distance. Therefore, at night we did a reception experiment by NHK Kumamoto 2nd broadcasting (873 kHz) which can be received at daytime at Uchinoura Space Center. As a result, in the winter night, we confirmed that the reception strength decreased during from 90 to 150 minutes after sunset. We observed the sporadic E layer in the ionosphere by Yamakawa MF radar (NICT) in Kagoshima. We did not found sporadic E layer. Therefore we guessed that there were occurred a high electron density on lower ionosphere. Thus, we did the S-310-40 sounding rocket plan for investigate on lower ionosphere When decrease the reception strength. After we checked phenomenon which could not be received the AM broadcasting, we launched S-310-40 sounding rocket at Uchinoura Space Center on 19 December 23:48(JST). We received radio waves are, 60 kHz (standard radio wave station), 405 kHz (Minami Daitou radio navigation beacons), 666 kHz (NHK Osaka 1st Broadcasting), and 873 kHz (NHK Kumamoto 2nd Broadcasting) by LF and MF radio band receiver. Moreover, at the same time we observed the electron density profile by the impedance probe and langmuir probe. We calculate density of magnetic field strength from result of S-310-40 sounding rocket plan, and use the Full wave method. So, we get electron density profile when abnormal propagation. We can separate right and left circularly polarization from each frequency's signal by frequency analyze. So, we can analyze the propagation characteristic. Therefore, we can guess the propagation characteristic and electron density on the lower ionosphere.

Keywords: sounding rocket, electron density

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

PEM32-P03 Room:Convention Hall Time:May 23 17:15-18:15

Electron density disturbances and plasma waves observed with S-310-40 and S-520-26 rockets

ENDO, Ken[1*], ONO, Takayuki[1], KUMAMOTO, Atsushi[1], SATO, Yuka[1], TERADA, Naoki[1], KATOH, Yuto[1]

[1]Tohoku University

From the end of 2011 to the beginning of 2012, two rocket campaigns were carried out at Uchinoura Space Center in Japan.

The first is the S-310-40 rocket experiment, whose rocket was launched at 23:48 on December 19, 2011. The purpose of the experiment was to understand the cause of the anomalous propagation of radio waves observed at Uchinoura sometimes in winter. We installed an impedance probe as one of instruments used in this experiment to measure the electron number density along the rocket's trajectory. The impedance probe detected UHR frequencies of the ionospheric plasma from 93 km to the apex 180km with a 125-msec time resolution. In addition, we successfully measured the phase of the impedance probe for the first time. Although we expected the existence of a high electron density layer in D-region or E-region of the ionosphere, the maximum electron density is about 5500/cc at most at altitudes between 100km to 105km. We also find that the electron density measurement was significantly affected by the rocket wake in the descending phase.

The second rocket experiment is 'WIND-II' (Wind measurement for Ionized and Neutral atmospheric Dynamics study -II) for the investigation of the momentum transfer between thermospheric neutral gas and ionospheric plasma. S-520-26 rocket was launched at 5:51 on January 12, 2012, just before the sunrise. In this experiment, lithium gas was released from the sounding rocket in the descending phase, and the resonantly scattered light was observed from three ground sites to measure some physical properties like the neutral wind velocity. We measured the electron number density and plasma waves along the rocket trajectory by an impedance probe and a plasma wave receiver in an altitude range of 90-298 km with a 250-msec time resolution to derive a vertical profile of background electron density in the ionosphere and to investigate the effects of the released lithium gas on the ionospheric plasma. The data from the impedance probe during both ascending and descending phase shows several electron density enhancements around altitudes of 90, 160 and 260 km, while the peak altitudes in the ascending phase were a few kilometers different from the descending phase. We also observed upper hybrid waves by the plasma wave receiver approximately above the altitudes of 240 km. Lithium gas had been supposed to release three times. However, the effects such as increases of electron density or decreases of the power of plasma waves were observed only about 10 sec and 30 sec after the expected time of the third release. On the event 10 sec after the third release, we couldn't detect the UHR frequencies probably due to the limit of the frequency range of the impedance probe. We also find effects of the rocket wake both on the electron density and the plasma wave measurements in the ascending phase as well as in the descending phase.

Moreover, it is striking that the impedance probe resonated at not only the UHR frequency but at other characteristic frequencies. For instance, in many cases of the measurements at an altitude of low electron number density, the impedance of the probe showed a local minimum value at the plasma frequency of the ambient plasma. Meanwhile, the local minimum values of the impedance appeared at twice the electron cyclotron frequency during the measurement in the relatively high electron density regions.

In this presentation, we show typical spectra obtained from the impedance probes as well as the results of the measurements by using the plasma wave receiver. We also discuss the electron density disturbances, the effects of the rocket wake or the lithium releases observed during the two rocket experiments.

Keywords: mid-latitude ionosphere, impedance probe, rocket experiment, electron density, plasma wave, chemical release

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

PEM32-P04 Room:Convention Hall Time:May 23 17:15-18:15

Laboratory experiment of sound propagation characteristics in rarefied atmosphere for developing PDI to be on-board

KIHARA, Daiki[1*], MORINAGA, Takatoshi[1], YAMAMOTO, Masa-yuki[1]

[1]Kochi University of Technology

Sound propagation characteristics in middle and upper atmosphere basically depend on atmospheric temperature and wind. Mainly, it can be derived by atmospheric models. But this measurement is comparatively difficult and previous experimental results are very limited. In 1960's, multiple bombs on-board a sounding rocket were used for measuring the sound propagation of explosions at multiple sites on ground in order to obtain temperature and wind profiles in middle and upper atmosphere. In 1990's, a measurement method by using MU-Rader with RASS(Radio Acoustic Sounding System), sending low-frequency sound from the ground. However, in-situ sound measurement in middle and upper atmosphere has never been carried out.

In-situ observation of an altitude profile of sound propagation characteristics quantitatively by using rocket borne sound transmitter and receivers will be carried out with sending low-frequency sound from a sound generator of RASS to be installed at Uchinoura launch site. The sound generated on ground will also be observed by the on-board microphones. In addition, audible sound and infrasound to be generated by rocket motor could be measured not only by infrasound sensors on ground but also by the on-board microphones. A plan to perform comparative verification between the in-situ measurement and the ground observation is scheduled in 2012.

The on-board instrument PDI (Propagation Diagnostics in upper atmosphere by Infrasonic/ Acoustic waves) consists of a speaker as sound source, one main microphone and two sub microphones as sound detectors, and a sound generator circuit. Those devices will be operated by sending 7 fixed-frequency sound waves between 10 Hz and 1 kHz into the surrounded atmosphere. And Observation of audible sound by rocket motor burning, operation sound of nose cone open and payload separation will also be carried out. The RASS speaker will generate high-power pulsating sound at about 100 Hz before the rocket launch from the ground so as to perform a trial measurement by the on-board microphones.

At present, as a laboratory experiment, by putting a main microphone and two sub microphones and a speaker in vacuum chambers at Kochi University of Technology and ISAS/JAXA, measurement of sound wave propagation characteristics in rarefied atmospheric environment has been performed 100 km altitude level (10^{-4} Pa). As a result, if was confirmed that received signal strength was decreased in rarefied condition. It is because the sound wave can propagate by vibrating molecules in the atmosphere and the decreasing signal strength is related on number of molecules in rarefied atmospheric environment.

Based on the result of the laboratory experiment, it was confirmed that the PDI to be on-board the S-310-41 sounding rocket will operated in middle and upper atmosphere.

Keywords: S-310-41, sound wave, sounding rocket, PDI

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

PEM32-P05 Room:Convention Hall Time:May 23 17:15-18:15

Continuous infrasound observation to monitor atmospheric phenomena related to activities of the Earth's crust

NAGAO, Hiromichi[1*], TOMIZAWA, Ichiro[2], IYEMORI, Toshihiko[3], KANAO, Masaki[4], TOKUNAGA, Terumasa[5], HIGUCHI, Tomoyuki[1]

[1]The Institute of Statistical Mathematics, [2]The University of Electro-Communications, [3]Graduate School of Science, Kyoto University, [4]National Institute of Polar Research, [5]Meiji University

Uncovering the dynamics of the multi-layered Earth, which consists of the solid Earth, the oceans, the atmosphere including the ionosphere, is likely to offer new insights in the Earth science. Recent improvements in the sensor technology and expanding geophysical observation networks enable us to detect observational evidence of physical interactions between any two successive layers. One of the typical phenomena related to the coupling between the solid Earth and the atmosphere is "seismoacoustic wave", which is an acoustic wave excited by a large earthquake. Nagao et al. (J. Geophys. Res., submitted) indicates, through data assimilation of the 2008 Iwate-Miyagi Nairiku Earthquake, that a joint analysis of seismograms and infrasound records could provide strong constraints on seismic mechanisms such as focal depth especially in the cases of shallow earthquakes. More infrasound observations would provide important information of activities of the Earth's crust although the number of infrasound observatories is insufficient at this moment.

In order to detect and clarify atmospheric phenomena related to activities of the Earth's crust, we have established an infrasound monitoring station at the Sugadaira Space Radio Observatory (36deg 31.389' N, 138deg 19.073' E) of the University of Electro-Communications. This station is located at appropriate distances from both the aftershock region of the 2011 Great East Japan Earthquake and the supposed area of the forthcoming Tokai-Tonankai-Nankai Earthquake. The joint observations of the atmosphere and the ionosphere could contribute to an establishment of tsunami early warning system, which detects precursive infrasound signals of tsunami.

Keywords: infrasound, seismoacoustic wave, Iwate-Miyagi Nairiku Earthquake, coupling between solid earth and atmosphere, ionosphere, tsunami

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

PEM32-P06 Room:Convention Hall Time:May 23 17:15-18:15

Characteristics of Total electron content variation after the M9.0 2011 off the Pacific coast of Tohoku earthquake

KAKINAMI, Yoshihiro[1*], WATANABE, Shigeto[2], KAMOGAWA, Masashi[3], MOGI, Toru[1], LIU, Jann-Yenq[4], Yang-Yi Sun[4]

[1]Institute of Seismology and Volcanology, Hokkaido University, [2]Department of Cosmoscience, Hokkaido University, [3]Department of Physics, Tokyo Gakugei University, [4]Institute of Space Science, National Central University

Sudden strong vertical displacement of Japan Trench by the M9.0 2011 off the Pacific coast of Tohoku earthquake (the Tohoku EQ) that occurred on 11 March 2011 triggered huge tsunami and the tsunami inflicted intolerable damage on Tohoku district, Japan. Acoustic and gravity waves excited by the tsunami propagated to thermosphere and disturbed ionosphere about 10 minutes after the mainshock, which are often observed after the large earthquakes. After the atmospheric waves arrive at the ionosphere and initial enhancement and depletion of plasma appeared, huge plasma depletion in the hundred kilometer scale occurred over the tsunami source area and lasted for a tens minimums. Simultaneously, various ionospheric disturbances were observed. In this paper, we investigate characteristics of ionospheric disturbances using Total Electron Content (TEC) calculated from the data of GPS network, GEONET (GPS Earth observation network system) which has more than 1000 GPS receivers. In order to investigate frequency of disturbances, we analyze TEC variation with Hilbert-Huang Transform (HHT) which can analyze data of non-stationary time series. Moreover, initial variations of TEC after arrival of the atmospheric waves at ionosphere are examined. Finally, interaction between atmosphere and ionosphere is discussed.

Keywords: the off the Pacific coast of Tohoku earthquake, ionospheric disturbance, tsunami, acoustic wave, gravity wave, total electron content

PEM32-P07 Room:Convention Hall Time:May 23 17:15-18:15

Ionospheric disturbances after the 2011 off the Pacific coast of Tohoku Earthquake studied with 1-Hz sampling GPS data

NISHIOKA, Michi[1], TSUGAWA, Takuya[1*], NAGATSUMA, Tsutomu[1], MURATA, Ken T.[1]

[1]National Institute of Information and Comunications Technology

Ionospheric disturbances after the 2011 off the Pacific coast of Tohoku Earthquake were studied in detail with 1-Hz sampling GPS-TEC data. The post-seismic ionospheric disturbances have been observed by GPS-TEC, HF Doppler Radar, and ionosondes. Tsugawa et al. [2011] analyzed 30-sec sampling TEC data and found concentric waves which propagated in the radial direction with a velocity of 100m/s - 3.5 km/s. The wave with the velocity of 3.5 km/s had a period of around five minutes. Ogawa et al. [2012] analyzed data of the HF Doppler radar in Hokkaido. They found an ionospheric disturbance which propagated with a velocity of 6.7 km/s. The period of the disturbance was about 2 minutes. Maruyama et al. [2011] investigated ionosonde data in Japan and suggested that the disturbance propagated around 7 km/s. The ionospheric disturbance with a large velocity (e.g., 6 - 7 km/s) has not found in GPS-TEC data. One of the reasons that the high-velocity disturbances with a short period was not detected by GPS-TEC data would be its sampling rate, that is, 30 second sampling. In this study, we utilized 1-Hz sampling TEC data in order to study the short-period disturbances. We used about 1200 stations data which are operated by the Geospatial Information Authority of Japan. We applied high-pass filters with a window of 2 - 10 minutes and detected short period waves. Comparing the data of HF Dopper radar and ionosonde, we found that the short period disturbance was not observed in the high-pass TEC data. This suggests that the fast waves could not propagated to the F-peak altitude because of its large damping rate. Only HF Doppler Radar and ionosonde, which observe bottom-side of F-layer could observe the short period waves.

Keywords: post-seismic ionospheric disturbance, total electron content, 1 second sampling, GEONET

PEM32-P08 Room:Convention Hall Time:May 23 17:15-18:15

Variations of total electron content in frequency domain accompanied by earthquakes

ABE, Keigo[1*], NAKATA, Hiroyuki[1], Toshiaki Takano[1], SAITO, Akinori[2]

[1]Graduate School of Engineering, Chiba University, [2]Department of Geophysics, Graduate School of Science, Kyoto University

Variations of total electron content (TEC) associated with earthquakes have been reported [e.g. Calias and Minster,1995; Afraimovich et al., 2001].The common feature of the variations of TEC is periodic variations with a period of several minutes which is caused by the atmospheric gravity waves. On the other hand, the spacial scales of these variations are not clear. Dense GPS network system, such as GPS Earth Observation Network System (GEONET), is very useful for studying the special scales of the variations. In the 2011 off the Pacific coast of Tohoku Earthquake occurred on 11 March 2011, TEC fluctuations spreading from the epicenter was observed using GPS-TEC data determined by GEONET.[Tsugawa et al., 2011]. This clear variation of TEC is rarely observed.

In this study,spacial scale of the TEC variation is examined by GPS-TEC data in frequency domain. For the earthquakes (M>6.5) occurred in the island and adjaceut area of Japan during 2000. Assuming that the height of the ionosphere is 350 km, ionosheric pierce points are determined. FFT is applied to 32 minutes of TEC data which obtained from GEONET receivers. In two events (the 2011 off the pacific coast of Tohoku earthquake (M8.4) occurred on 11 March 2011, the Tokachi-oki Earthquake in 2003(M8.0) occurred on September 2003), it is observed that the TEC variations whose range is 1.56 mHz˜9.38 mHz spread from the epicenters. The frequencies of these variations are consistent with the period of the atmospheric gravity waves or acoustic waves in the ionosphere . In the othe two events (the western Tottori prefecture earthquake in 2000(M7.3) occurred on 6 October 2000, the mid Niigata prefecture earthquake in 2004(M6.8) occurred on 23 October 2004), TEC variations in the high frequencies from 8.33 mHz to 9.38 mHz were observed in the vicinities of the epicenters. Since higher-frequency fluctuations enhance near the epicenter as compared to the fluctuations of the lower frequencies [Matsumura et al., 2011], results of this study is consistent with the numerical study.

Keywords: total electron content, ionosphere, earthquake, GPS, GEONET

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

PEM32-P09 Room:Convention Hall Time:May 23 17:15-18:15

TEC measurements using propagation delay difference of two-frequency signal of QZS

KINUGASA, Natsuki[1*], Takuto Shimizu[1], Tatsuhiro Muto[1], TAKAHASHI, Fujinobu[1]

[1]Yokohama National University

This study presents a method to calculate the ionospheric total electron content (TEC) using propagation delay difference of two-frequency signal of Quasi-Zenith Satellite.

Keywords: TEC, GPS, QZSS

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

PEM32-P10 Room:Convention Hall Time:May 23 17:15-18:15

Automated estimation of electron density profile in the ionosphere by the radio wave propagation characteristics

MIYAKE, Taketoshi[1*], SASAKI, Toru[1], ISHISAKA, Keigo[1], Toshimi Okada[1]

[1]Toyama Prefectural University

In the lower ionosphere, the approximate electron density profile can be estimated from the comparison between these observation results obtained by sounding rocket and propagation characteristics calculated with Full wave method. This estimation process, which is so-called ”wave absorption method”, has some problems. At first, we have no clear standard for comparing observation results and propagation characteristics calculated with Full wave method. In addition, we have to iterate many times correcting the electron density profile by handwork, calculating propagation characteristics with Full wave method and comparing observation results and calculated propagation characteristics. This iteration takes too long to estimate appropriate electron density profile. To reduce these problems, we developed an application to realize automated estimation of electron density profile by analyzing radio wave propagation characteristics.

At first, we decided the quantitive standard for comparing observation results and calculated propagation characteristics to realize this automated estimation application, Then, we analyzed variation effects of Full wave parameters and electron density profiles on calculated propagation characteristics, and developed the automated electron density estimation application. We succeed in estimating appropriate electron density profile automatically in very short time.

Keywords: ionosphere, plasma waves, electron density profile, Full wave method

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

PEM32-P11 Room:Convention Hall Time:May 23 17:15-18:15

Estimation of spatial structure of sporadic E layer with 2-dimensional FDTD simulations

KUROKAWA, Takahiro[1], MIYAKE, Taketoshi[1*], ISHISAKA, Keigo[1], Toshimi Okada[1]

[1]Toyama Prefectural University

We developed a 2-dimensional FDTD simulation code which can treat wave propagations in magnetized plasma. FDTD simulations can be performed with much less computer resources than those necessary for full particle simulations, in memories as well as cpu times. In thisd study, we performed FDTD simulations with different types of electron density profiles in the lower ionophere, uniform ionospheric layer model and oval shape electron cloud model, and then confirmed characteristics of MF wave propagations in the lower ionosphere. We especially study on effects of wave frequecies. According to sounding rocket experiments, we can only obtain altitude profile of wave intensity, especially magnetic field intensity. In this study, therefore, we are going to try to estimate spatial structure in the lower ionosphere by analyzing altitude profile of magnetic field intensities of waves with various frequecies.

Simulation results indicate that spatial structure in the lower ionosphere can be estimated by analyzing altitude profiles of different waves emitted from different wave sources with various frequencies. Effects of spatial structure in the lower ionosphere are shown especially on propagation characteristics of MF waves above the altitude of the spatial structure itself.For the future, we are going to perform simulations with more different models, for example, Es model of wave structure. And, we made comparison between the results of conducted rocket experiments in 2011 and the simulation results , vertified whether we can estimate the spatial structure of Sporadic E layer.

Keywords: Sporadic E layer, FDTD simulation, ionosphere, electron density profile, plasma wave propagation

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

PEM32-P12 Room:Convention Hall Time:May 23 17:15-18:15

Study on characteristics of relationship between Akebono satellite potential and electron density

MORINO, Naoki[1*], ISHISAKA, Keigo[1], KITAMURA, Naritoshi[2], SHINBORI, Atsuki[3], ONO, Takayuki[2], KUMAMOTO, Atsushi[4], NISHIMURA, Yukitoshi[5], MATSUOKA, Ayako[6]

[1]Toyama Pref. Univ., [2]Department of Geophysics, Graduate School of Science, Tohoku University, [3]Research Institute for Sustainable Humanosphere (RISH), Kyoto University, [4]Planetary Plasma and Atmospheric Research Center, Graduate School of Science, Tohoku University, [5]Department of Atmospheric and Oceanic Sciences University of California, Los Angeles, [6]Research Division for Space Plasma, Institute of Space and Astronautical Science, Japan Aerospace Ex

It has been investigated the relation between satellite potential and electron density in the magnetosphere and the field of the solar wind. There is good correlation between them. In ionosphere, plasmasphere and radiation area such as electron density is from 1/cc to 10^7/cc, however, it wasn't investigated using satellite potential. In this study shows characteristics of relationship between Akebono satellite potential and electron density. The way we get a satellite potential is measuring potential difference between a probe applied bias current and a satellite. During from 1 May, 1989 to 31 August, 1990 the probe had been applied bias current. In this term, the relation was investigated but the others which bias current wasn't applied isn't investigated. It is found out that sometimes the duration bias current isn't applied is correlated closely. We investigate plasma scalelength at surrounding a satellite in case correlation is closely between satellite potential and electron density as bias current was not applied The area which we can estimate the electron density from satellite current is expanded and we are able to obtain the electron density ever before.

Keywords: akebono, electron density, satellite potential

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

PEM32-P13 Room:Convention Hall Time:May 23 17:15-18:15

Geomagnetic conjugate observations of plasma bubbles and thermospheric neutral winds at equatorial latitudes

FUKUSHIMA, Daisuke[1*], SHIOKAWA, Kazuo[1], OTSUKA, Yuichi[1], NISHIOKA, Michi[2], KUBOTA, Minoru[2], TSUGAWA, Takuya[2], NAGATSUMA, Tsutomu[2]

[1]STELAB, Nagoya Univ., [2]NICT

Eastward-propagating plasma bubbles have been observed in 630-nm airglow images at equatorial latitudes. The eastward propagation of the plasma bubbles is a manifestation of plasma and neutral coupling in the equatorial thermosphere. The plasma bubbles show clear geomagnetic conjugacy [e.g. Otsuka et al., 2002]. However, the relation between drift velocity of the plasma bubbles and neutral wind velocity has not been investigated at geomagnetic conjugate points. In this study, geomagnetic conjugate observations of the plasma bubbles at low latitudes with thermospheric neutral winds were reported.

The plasma bubbles were observed at Kototabang (0.2S, 100.3E, geomagnetic latitude (MLAT): 10.0S), Indonesia and at Chiang Mai (18.8N, 98.9E, MLAT: 8.9N), Thailand, which are geomagnetic conjugate stations, on 5 April, 2011 from 13 to 22 UT (from 20 to 05 LT). These plasma bubbles were observed in 630-nm airglow images taken by using highly-sensitive all-sky airglow imagers at both stations. They propagated eastward with horizontal velocities of about 100-130 m/s. The eastward velocities of the observed plasma bubbles decreased with local time. Background thermospheric neutral winds were also observed at both stations by using two Fabry-Perot interferometers. The eastward wind velocities were about 70-130 m/s at Kototabang, and about 50-90 m/s at Chiang Mai. The drift velocities of plasma bubbles tend to be larger than the eastward neutral wind velocities. In the presentation, we discuss these results by considering the F-region dynamo effects and by comparing with HWM/IRI model data.

Keywords: plasma bubble, thermospheric wind, geomagnetic conjugate observation, airglow observation, F-region dynamo

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

PEM32-P14 Room:Convention Hall Time:May 23 17:15-18:15

Solar activity dependence of latitudinal variation of ionospheric fluctuations associated with equatorial plasma bubbles

MIGITA, Satoshi[1], NAKATA, Hiroyuki[1*], Toshiaki Takano[1], TSUGAWA, Takuya[2], NAGATSUMA, Tsutomu[2], SAITO, Akinori[3]

[1]Graduate School of Engineering, Chiba University, [2]National Institute of Information and Communications Technology, [3]Graduate School of Science, Kyoto University

It is well known that equatorial plasma bubbles (EPBs) are frequently observed in the magnetic equatorial region since EPBs generate in the magnetic equator. Rate of TEC change index, which is the standard deviation of temporal variations of total electron content (TEC), is used to detect EPBs because the enhancement of ROTI is dependent on the development of kilometer-scale disturbances. In the previous study, the authors studied the latitudinal dependence of ROTI associated with EPBs using GPS receivers of Southeast Asia Low-latitude Ionospheric Network (SEALION) installed by National Institute of Information and Communications Technology (NICT). Since EPBs extend along the magnetic field lines, the altitudes of an EPB is the highest in the magnetic equator. Then, it is expected that the the mean values of ROTI increase with latitude because the electron density in lower ionosphere is larger. As a result, however, the mean value of ROTI associated with EPBs is independent on latitude. One of the reasons for this independence is that the EPB occurred in the solar minimum period and the apex height is rather lower.

Recently, the solar activity becomes higher and EPBs are observed around Japan. In the present study, therefore, the latitudinal dependence of ROTI is studied using GPS data during the solar maximum period. It is shown that the mean value of ROTI increase with the latitude. In studying EPBs during the solar maximum period, GPS-TEC data determined by Japanese GPS Network, GEONET is also available. In addition, RINEX data in Shanghai, Manila, and Taipei are supplied by International GNSS Service (IGS) as for GPS station in the lower side of GEONET. The latitude dependence of ROTI determined by GEONET and IGS stations overlap each other at the geographic latitude of 20-30. This dependence is almost the same as that determined by SEALION stations. Therefore, the structures of EPBs are very similar in these longitudes.

Keywords: ionosphere, plasma bubble, GPS, TEC, ROTI

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

PEM32-P15 Room:Convention Hall Time:May 23 17:15-18:15

Structuring of polar cap patches: all-sky airglow observations in Longyearbyen, Svalbard

HOSOKAWA, Keisuke[1*], TAGUCHI, Satoshi[1], OGAWA, Yasunobu[2]

[1]Graduate School of Informatics and Engineering, University of Electro-Communications, [2]National Institute of Polar Research

A highly sensitive all-sky EMCCD airglow imager has been operative in Longyearbyen, Svalbard (78.1N, 15.5E) since October 2011. Primary target of this optical observation is "polar cap patches" which are defined as regions of plasma density enhancement drifting anti-sunward across the polar cap. Since the electron density within patches is often enhanced by a factor of 2?10 above a background level, airglow measurements at 630.0 nm wavelength are able to visualize their spatial structure in two-dimensional fashion. The imager in Longyearbyen obtains the 630.0 nm all-sky images with an exposure time of 4 sec, about an order of magnitude shorter than the conventional cooled CCD airglow imager. This could allow us to capture the small-scale plasma structuring process occurring in the vicinity of patches.

We present, as one of the first results from the imager, an event of polar cap patches drifting anti-sunward during the southward IMF conditions. On the night of December 21, 2011, between 1900 and 2300 UT, several polar cap patches were observed by the imager near midnight. The patches were much more elongated in the direction perpendicular to their motion. They passed through the zenith every about 7 min, which is comparable to the periodicity of the flux transfer event in the dayside equatorial magnetopause. This may imply that the patches during the current interval were generated in close association with transient reconnection on the dayside. In some images, small-scale undulations (~50 km scale) were identified along the trailing edge of the patches. This may be an indication that the structuring of patches is dominated by the gradient-drift instability because the trailing edge of patches is expected to be unstable for the gradient-drift waves in their linear stage.

Keywords: Polar cap patches, Plasma instability, Plasma convection, Airglow observations, Polar ionosphere

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

PEM32-P16 Room:Convention Hall Time:May 23 17:15-18:15

Comparative study of plasmaspheric filamental structures between EUV images by KAGUYA and TEC data by GPSComparative

HOZUMI, Yuta[1*], SAITO, Akinori[1], MURAKAMI, Go[2]

[1]Department of Geophysics, Graduate School of Science, Kyoto University, [2]Institute of Space and Astronautical Science, Japan Aerospace Exploration Agency Institute of Space

Total Electron density data derived by GPS is compared to two-dimensional images of the plasmasphere obtained by KAGUYA to clarify the formation mechanism of the plasmaspheric structures. He+ imaging of the Earth's plasmasphere have revealed several plasmaspheric density structures. The Extreme Ultraviolet Imager on the IMAGE satellite detected radial structures called ”finger”, and the Telescope of Extreme Ultraviolet onboard KAGUYA detected meridional structures called ”filament”. These structures are interpreted as isolated flux tube that is filled with denser plasma than neighboring tubes. The whole image of these structures, however, is still unknown since only EUV imaging have detected these. Considering very high mobility of plasma along the magnetic field line, these plasmaspheric tube enhancements are supposed to be connected to ionospheric structures. In this study, the ionospheric structure at the foot point of these flux tubes in the ionosphere is surveyed, using GPS-TEC data. Relation between the plasmasphere and the ionosphere, and the formation of the dense plasma isolated flux tube will be discussed in the presentation.

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

PEM32-P17 Room:Convention Hall Time:May 23 17:15-18:15

The observation of plasmapause using topside TEC data by LEO satellite

GOI, Yukari[1*], SAITO, Akinori[1]

[1]Kyoto University

The plasmasphere was observed using the TEC data which derived from the ground based GPS receivers and the GPS receivers on board the low earth orbit satellites.The plasmasphere react the geomagnetic activity directly. During geomagnetic disturbed time, the plasmasphere shrinks and the location of plasmapause move to lower latitude region immediately. IMAGE satellite revealed that the distribution of helium ion in the plasmasphere by EUV imager. CREES satellites observed that the plasmapause move to lower latitude region during geomagnetic disturbed time. In preceding study, the topside TEC data which derived from the low earth orbit satellites observed the plasmapause and the Storm Enhanced Density (SED). It is difficult to observe that the altitudinal structure of the plasmapause and the SED, because TEC data and images is the integrated to the electron density and the intensity. Our purpose is to reveal the altitudinal structure of the plasmapause and the SED. TEC data between LEO satellite and GPS satellite (LEO-TEC) is the integration value of the electron density in plasmasphere and topside ionosphere. The mid-latitude TEC enhancement was observed by TEC data which derived from GRACE satellites and COSMIC satellites. the amplitude of the mid-latitude TEC variation was compared using GRACE-TEC data and COSMIC-TEC data.

The mid-latitude variation was observed at 8:29UT on June 15, 2006. The TEC enhancement which observed by GRACE satellite appeared at 60N, 129E and the amplitude of that was about 1.8TECu. The TEC enhancement which observed by COSMIC appeared at 60N, 135E and the amplitude of that was about 1.5TECu. This result indicates that there was much contribution of the ionosphere in the mid-latitude TEC enhancement.

Keywords: plasmasphere, TEC, LEO satellite

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

PEM32-P18 Room:Convention Hall Time:May 23 17:15-18:15

Intercomparison of ionospheric observations obtained by 10C-type ionosonde and by FMCW-type ionosondes at Syowa station

NAGATSUMA, Tsutomu[1*], KITAUCHI, Hideaki[1], ISHIBASHI, Hiromitsu[1], Hisao KATO[1], KUBOTA, Minoru[1], MURATA, Ken T.[1]

[1]National Institute of Information and Communications Technology

Ionospheric routine observation at Syowa station, Antarctica has been operating more than fifty years. The dataset of ionospheric observation obtained at Syowa station is quite valuable for studying the long-term variations of ionosphere, and the relationship among the ionosphere, lower atmosphere, and solar activity. Currently we are operating single pulse type ionosonde (10C). To minimize the resources and effective operation for continuing our observation as regular survices, we will introduce new type of ionosonde (FMCW) in this eight-th plan of Antarctic research. We are operating FMCW-type ionosonde and 10C-type ionosonde simultaneously for comparison. This time, we try to compare the quality of both data by using manual-scaling ionospheric paramaters. We will show initial results of our comparison in our presentation

Keywords: Ionospheric observation, Single pulse method, FMCW method, Ionosonde, Antarctica

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

PEM32-P19 Room:Convention Hall Time:May 23 17:15-18:15

Relationship between global equivalent Sq current system and local geomagnetic Sq field

TAKEDA, Masahiko[1*]

[1]Data Analysis Center for Geomag. & Space Mag., Grad. School of Sci., Kyoto Univ.

Relationship between global equivalent current system and local geomagnetic Sq field in the Y (Sq(Y)) and Z (Sq(Z)) components was examined. It was found that Sq(Y) is more correlated with the global current system, probably because Sq(Z) is more sensitive to the local structure of the Earth's conductivity. More detailed relationship will be discussed in the presentation.

Keywords: geomagnetism, daily variation, global field, local field

PEM32-P20 Room:Convention Hall Time:May 23 17:15-18:15

Height estimation of ionospheric irregularities with amplitude scintillations of closely-spaced GEO

TANIYAMA, Hiroaki[1], TOMIZAWA, Ichiro[1*], NAKAMURA, MAHO[2]

[1]Center of Space Science and Radio Engineering, Univ. of Electro-Comm., [2]National Instituted of Information and Communication Technology

We have been developing the estimation method of ionospheric disturbance heights by using amplitude scintillations observed by two closely-spaced satellites[1]. The mehod depends on the comparison between the geometrical difference and on the Fresnel cutoff frequency of amplitude scintillations of 1.5GHz-band navigation signals transmitted from the two closely spaced geostationary satellites, ETS-VIII (146 deg E) and MTSAT-2 (145 deg E). The horizontal moving speeds required for the height estimation are provided by the three 60-m spaced antennas at Sugadaira Space Observatory, the University of Electro-Communications, in Nagano, by considering the patten shapes.

As the result of the analysis of the 10 scintillation events obtained in 2010, we have shown that the estimated disturbace heights are identified within about 50 km by the two processes. It is therefore concluded that the estimation of disturbce heights can be used for continuous observation of structures and movements of ionospheric disturbances.

Keywords: height of ionospheric irregularities, amplitude scintillation, closely-spaced geostationary satellite

PEM32-P21 Room:Convention Hall Time:May 23 17:15-18:15

Statistical analysis of mesospheric echoes observed by the SuperDARN Hokkaido radar

Taishi Tsuya[1], NISHITANI, Nozomu[1*], OGAWA, Tadahiko[2]

[1]Solar-Terrestrial Environment Laboratory, Nagoya University, [2]National Institute of Information and Communications Technology

Near-range (< 1000 km) echoes observed by the SuperDARN Hokkaido HF radar contain not only E-region echoes but also mesospheric / meteor echoes. We detect very near-range echoes observed especially in summer, which is likely to be mesospheric echoes. Mesospheric echoes are much observed at high latitudes and sometimes observed at mid-latitude in recent years. Mesospheric echoes in summer at high latitude are observed because temperature at the mesopause becomes very low (under 150 K) and radio waves are probably backscattered at mesopause by aerosols and cluster ions.

In this study, we determine criteria to select mesospheric echoes by reference to mesospheric echo events (Ogawa et al., Mid-latitude HF-radar Workshop, 2010), and perform statistical analysis of LT and seasonal dependences of mesospheric echoes observed by the SuperDARN Hokkaido radar. The results shows that echoes categorized as mesospheric echoes are observed preferably in summer and in daytime. This is consistent with the mesospheric echoes in high latitude reported by previous studies. More details of the statistical analysis and their physical interpretation will be presented.

Keywords: Hokkaido HF radar, SuperDARN, mesospheric echoes, mesopause temperature decrease, electron density

PEM32-P22 Room:Convention Hall Time:May 23 17:15-18:15

Multi-direction lidar system using a high power 589 nm coherent light in Tromso (1) System summary

KAWAHARA, Taku D.[1*], NOZAWA, Satonori[2], TSUDA, Takuo[2]

[1]Faculty of Eng., Shinshu University, [2]STEL, Nagoya University, [3]STEL, Nagoya University

We developed an all solid-state, water-free, high-power Na lidar for the measurements at EISCAT radar site in Tromso (69N), Norway. The lidar is capable of obtaining sodium density with the time resolution as good as 1 min. Using this capability, 3-dimensional observation is possible with a meaningful time resolution. The first step we are planning is 2-dimensional observation. Assuming 11 directions with 5 km horizontal distance at 100 km altitude covering 30 degree area including vertical direction, one 2-dimentional data can be obtained every 10 min which is good enough with discussing the atmospheric dynamics. We present the overview of this system and the test results of a prototype model.

Keywords: sodium lidar, MLT region, two dimensional observation, Tromso

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

PEM32-P23 Room:Convention Hall Time:May 23 17:15-18:15

Multi-direction lidar system using a high power 589 nm coherent light in Tromso (2) image processing

YOSHIMURA, Takashi[1*], KAWAHARA, Taku D.[1], NOZAWA, Satonori[2], TSUDA, Takuo[2]

[1]Faculty of Engineering, Shinshu University, [2]STEL, Nagoya University

We developed an all solid-state, water-free, high-power Na lidar for the measurements at EISCAT radar site in Tromso (69N), Norway. The lidar is capable of obtaining sodium density with the time resolution as good as 1 min. Using this capability, 3-dimensional observation is possible with a meaningful time resolution. In this system, we monitor the sky image including the laser line through the telescope using a CCD camera. We plan to build the system to find the laser line image automatically and correct the laser direction. In this talk, we report this data processing program and show some preliminary results.

Keywords: sodium lidar, high power laser, 3-dimensional obaservation, image processing

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

PEM32-P24 Room:Convention Hall Time:May 23 17:15-18:15

Simultaneous observation of sodium layer and lower ionosphere using sodium lidar and EISCAT radar

TSUDA, Takuo[1*], NOZAWA, Satonori[1], KAWAHARA, Taku D.[2], Tetsuya Kawabata[1], SAITO, Norihito[3], WADA, Satoshi[3], OYAMA, Shin-ichiro[1], SUZUKI, Shin[1], TAKAHASHI, Toru[1]

[1]STEL, Nagoya Univ., [2]Faculty of Engineering, Shinshu Univ., [3]ASI, RIKEN

In order to obtain better understanding on coupling process between neutral atmosphere and ionosphere in the polar region, we have conducted simultaneous observations of sodium layer and lower ionosphere using a sodium lidar (which was newly installed in early 2010) and EISCAT radar at Tromsoe, Norway (69.6 deg N, 19.2 deg E) since October 2010. In the presentation, we will report recent results of the simultaneous observations, in particular focusing on the following two issues. (1) It is considered that atmospheric gravity waves (AGWs) play an important role not only in the mesosphere but also in the thermosphere/ionosphere. However it is well unknown the AGW propagation process from the mesosphere to the thermosphere through the mesopause. Using sodium lidar data at 80-110 km and EISCAT radar data above 100 km, we investigate upward propagating AGWs in the sodium layer and traveling ionospheric disturbances (TIDs) in the lower ionosphere. (2) Relationship between auroral particle precipitations and sodium layer variations is a mysterious subject, although there are a few previous studies on this issue. For example, a previous study reported sodium density decrease during a geomagnetic active period, while another study pointed possibility of sodium density increase due to auroral particle precipitations. We investigate relationship between electron density (i.e. auroral particle precipitations) and sodium density variations based on the simultaneous observations by EISCAT radar and sodium lidar. Furthermore, we will discuss on relationship between auroral particle precipitations and neutral temperature variations.

Keywords: Sodium lidar, EISCAT radar, Polar region, Mesosphere, Lower thermosphere, Lower ionosphere

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

PEM32-P25 Room:Convention Hall Time:May 23 17:15-18:15

Detection of the mesospheric NOx enhancement due to solar proton event by the mm-wave spectrometer at Syowa Station

MIZUNO, Akira[1*], Yasuko Isono[1], NAGAHAMA, Tomoo[1], KUWAHARA, Toshihisa[1], Yasusuke Kojima[1], MAEZAWA, Hiroyuki[2], NAKAMURA, Takuji[3], EJIRI, Mitsumu[3], ARITA, Shin[4], Hirokazu Machiya[3], Satoshi Oichi[3], Natsumi Miura[3], TSUTSUMI, Masaki[3], YAMAGISHI, Hisao[3]

[1]STEL, Nagoya University, [2]Osaka Prefecture University, [3]NIPR, [4]Magnetic Observatory

Minor constituents in the middle atmosphere play important roles in the atmospheric structure, energy transfer, and photochemistry. Atmospheric composition of such minor constituents change due to the anthropogenic causes such as human industrial activities and the natural causes such as chemical reactions, solar UV, atmospheric circulation, volcanic eruption, and so on. Among such natural causes, the energetic particle precipitation (EPP) onto the middle atmosphere triggers the ion-molecular reactions resulting in the enhancement of NOx and HOx and depletion of ozone. Such effects are expected to increase for the next few years toward the solar maximum.

In order to detect such EPP effects on the atmospheric composition observationally, we installed a millimeter-wave spectroscopic radiometer at Syowa Station in the 52th Japan Antarctic Research Expedition (JARE52), and we started the steady observation in March 2011. In the winter season, we observe NO_2 and ozone, and NO and ozone are observed in the summer season because of the difference of the daylight hours.

On August 4, 2011, a solar proton event (SPE) with proton (>10MeV) flux of ~100 pfu occurred, but we could not detect significant NO_2 spectrum with an upper limit of 20mK (1-sigma) in antenna temperature. On January 23, 2012, we had a large SPE with proton flux of ~6,300 pfu, and we have detected NO emission line with an intensity of ~60 mK. The line width is ~ 1MHz, and it is interpreted that the spectral line corresponds to the enhancement of NO above ~ 60 km altitude. At present, we continue the follow up observation and make data reduction.

In our presentation, we will discuss the time variation of NO due to the SPE and relationship with the ozone that is also observed with the millimeter-wave spectrometer.

Keywords: atmospheric chemistry, mesosphere, stratosphere, energetic particle precipitation, solar proton event, remote sensing

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

PEM32-P26 Room:Convention Hall Time:May 23 17:15-18:15

An examination of passive radars as a new technique for the environmental observation

KAWAMURA, Seiji[1]*, SUGITANI, Shigeo[1], IWAI, Hironori[1], Hiroshi Hanado[1]

[1]National Institute of Information and Communications Technology

We, National Institute of Information and Communications Technology (NICT) examine a new observational technique called passive radar. In general, radars retrieve some information by transmitting radio waves and by receiving their scatted echoes. On the other hand, passive radars never transmit radio waves. It retrieve some information by receiving radio waves which are transmitted by others for the other purposes. Passive radars do not need new radio wave frequencies, and just consist of rather simple and low cost receivers because they do not transmit radio waves. We are going to observe rain fall, wind velocity, water vapor, ocean current, and so on
by this passive radar technique.

The development of passive radar technique is equal to that of receiving technique because they do not transmit radio waves. In these years we develop bistatic radar systems for weather radars and ocean radars. The development of bistatic radar system is also equal to that of receivers. The difference between bistatic and passive radars is whether or not we know the transmitted radio waves. Transmitted radio waves in the bistatic radar system are well-known, exclusive, and suitable for radar signal processing. But in passive radar system, in general, we may not know the transmitted radio waves well because they are transmitted by the others for the other purposes. The basic techniques for both bistatic and passive radars are mainly common, so we are able to consider the bistatic radar system as a kind of passive radar in the broad sense. We develop the receiving systems for both bistatic and passive radars using software radio
techniques.

In this presentation, we introduce a bistatic observation experiment for the ocean radar which is conducted in the last September in Yonaguni Island. In this experiments we succeeded retrieving ocean wave spectra using passive radar technique for the first time. Some other examinations for the passive radars are also introduced. Estimations of water vapor and rain fall mighty be possible using the radio waves for the terrestrial digital broadcasting by the passive radar technique.

Keywords: passive radar, bistatic, radar system

PEM32-P27 Room:Convention Hall Time:May 23 17:15-18:15

Development of turbulence detection and prediction techniques with next generation wind profiler radar for aviation safe

HASHIGUCHI, Hiroyuki[1*], YAMAMOTO, Mamoru[1], Kuniaki Higashi[1], KAWAMURA, Seiji[2], Ahoro Adachi[4], Yusuke Kajiwara[4], Kotaro Bessho[4], Masanobu Kurosu[5]

[1]Research Institute for Sustainable Humanosphere (RISH), Kyoto University, [2]National Institute of Information and Communications Technology (NICT), [3]Meteorological Research Institute (MRI), Japan Meteorological Agency (JMA), [4]Observation Division/Meteorological Research Institute (MRI), Japan Meteorological Agency (JMA), [5]Japan Airlines (JAL)

There are various meteorological phenomena which may cause serious trouble to aircraft operations. Especially, atmospheric turbulence (including wind shear) sometimes brings significant aircraft accidents because it is difficult to detect it by current operational meteorological observations. In 2000-2009, more than half of accidents in large aircrafts were brought by atmospheric turbulence. At present, PIlot weather REPort (PIREP) is a major method for observing atmospheric turbulence, but it is not suitable for monitoring atmospheric turbulence because it cannot continuously observe a specific area or altitude. Therefore, the development of a new observation instrument, which continuously covers wide altitude range, is needed. On the other hand, various forecast techniques for atmospheric turbulence have been developed based on PIREP data, so there is still room for improving its prediction accuracy.

The project supported by 'the Program for Promoting Fundamental Transport Technology Research of the Japan Railway Construction, Transport and Technology Agency (JRTT)' started in July 2011. In the present study, the prototype of the next generation 1.3-GHz wind profiler radar (WPR) that can be observed up to the cruising altitude of the aircraft is developed, and it aims at the establishment of the atmospheric turbulence detection technique by the remote sensing. In addition, the observational data with the WPR is used as verification data to improve the prediction accuracy of atmospheric turbulence. It aims to become the foundation of the aircraft accident prevention.

It is expected that the result achieved by the present study will be built into the WPR network of Japan Meteorological Agency (JMA) for the meteorological observations. In addition, it is expected to contribute to a safe service of the aircraft operation through the improvement of the prediction accuracy for atmospheric turbulence.

Acknowledgments: The present study was supported by the Program for Promoting Fundamental Transport Technology Research from the Japan Railway Construction, Transport and Technology Agency (JRTT).

Keywords: Wind Profiler, Turbulence, Aviation, Remote Sensing