Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

PEM032-01 Room:103 Time:May 26 14:15-14:30

Detection of transient ELF emission caused by the extremely intense cosmic gamma-ray flare

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We report on the first clear detection of transient Extremely-Low-Frequency (ELF) signal caused by an extremely intense cosmic gamma-ray flare. On 2004 December 27, the brightest gamma-ray flare ever recorded was observed by numerous satellites. A transient ELF emission observed at Moshiri and Onagawa in Japan exactly coincided with the peak time of the flare, and its wide pulse width of ~40 ms disfavors the possibility of lightning origin. Furthermore, the two horizontal components of ELF magnetic field data recorded at Esrange in Sweden showed clear transient Schumann resonance waveforms. The source direction determined by the Lissajous method roughly corresponds to the subflare point. The chance probability that a sprite occurs within 30 ms of the peak flare time is ~0.025%, which again clearly excludes the sprite origin. Thus, a bright cosmic gamma-ray flare is a new source of transient ELF radio signals observed on the Earth.

Keywords: ionospheric disturbance, gamma-rays, ELF, Schumann resonance

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PEM032-02 Room:103 Time:May 26 14:30-14:45

Millimeter-wave spectroscopic observations from Syowa Station to study the effect of energetic particle precipitation on

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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 effect of ion-molecular reactions triggered by energetic particle precipitation (EPP) onto the middle atmosphere is expected to become conspicuous for the next few years as the solar activity increases toward the solar maximum. Such effects due to the EPP can be seen prominently in polar regions. Some examples of the EPP effects have been reported such as Ozone destruction in the mesosphere coincident with a strong solar proton event (e.g., Jackman et al, 2001) and NOx enhancement and Ozone reduction due to auroral electron and descending vortex air during the polar nights (e.g., Seppala et al. 2007). Most of those observations were carried out by satellite instruments, and the observing positions moves from hour to hour. Although satellite observations favorable to obtain 2-D/3-D images that are useful to identify the affected area, they may not be suitable to analyze the short-time variation of the vertical profiles of chemical compositions caused by a solar proton event whose typical time scale is only for a few days. On the other hand, continuous observations from a fixed ground position with a highly sensitive remote sensing system allow us to obtain fine sampling time-domain dataset and should be appropriate to elucidate the short-time variation. Thus we conceived of a plan to install a millimeter-wave spectroscopic radiometer at Syowa Station and to conduct a continuous monitoring to detect the composition change due to EPP.

However, in order to execute the plan, we had to reduce the electric power requirement of the radiometer system, since the supplying capacity of the power generator is limited and the current usage is close to the limit in Syowa Station. Finally, we newly developed a power-saving and portable spectroscopic radiometer system. Two researchers, Isono and I went to Syowa Station in the end of 2010 as members of the 52th Japanese Antarctic Research Expedition (JARE52) team in order to install the new radiometer system and to start steady observation. As of February 2011, the installation has not been completed, but we expect to obtain the spectral data of some minor constituents by the JPGU meeting. In my talk, I will present the aim of the project, specifications of the new radiometer system, and the initial observational results.

This research project is a part of the sub-project of the VIII-th term Prioritized Research Project of National Institute of Polar Research (NIPR) entitled "Global environmental change revealed by observations of the Antarctic middle and upper atmosphere" and the medium-term project of Solar-Terrestrial Environment Laboratory (STEL) of Nagoya University entitled "Research on magnetic storm and atmospheric change at the solar maximum".

Keywords: Mesosphere Stratosphere, Millimeter-wave spectroscopy, Remote sensing, Energetic particle precipitation

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PEM032-03 Room:103 Time:May 26 14:45-15:00

EISCAT_3D (Next-Generation IS Radar Project for Atmospheric and Geospace Science): Current status and roadmap

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The EISCAT Scientific Association (current member countries: China, Finland, Germany, Japan, Norway, Sweden and United Kingdom) is actively preparing for the construction of its next-generation radar, which will provide comprehensive 3D monitoring of the lower/middle/upper atmosphere and ionosphere. The EISCAT_3D radar will consist of multiple phased arrays, using the latest signal processing and beam-forming techniques to achieve ten times higher temporal and spatial resolution than the present radars. EISCAT_3D will be a volumetric radar, capable of imaging an extended spatial area with simultaneous full-vecter drift velocities, designed for continuous operation modes, short-baseline interferometric capabilities for sub-beamwidth imaging, real-time data access and extensive data archiving facilities. The highly modular and expandable design envisages a system with at least one circular active array comprising 16,000-32,000 antennas. This central site will also include outlying antennas for imaging applications. At least four smaller remote sites, comprising receiving arrays of some 8,000 antennas will be located between 50 and 150km from the central site.

A four-year EISCAT_3D Design Study started since May 2005 supported by EU to develop an outline design for a multi-static, phased-array radar system. In 2008, the European Strategy Forum on Research Infrastructures (ESFRI) selected EISCAT_3D for inclusion in its roadmap of large-scale European environment research infrastructures for the next 20-30 years. In 2010, the EISCAT_3D Preparatory Phase proposal has successfully passed the EU evaluation process, and a four-year program is due to start from this October. In this paper, we present the outline and the current situation of the EISCAT-3D project including the science plans in order to call for interests and to promote consortium among the domestic user communities.

Keywords: EISCAT, ionosphere, themosphere, next-generation

Japan Geoscience Union Meeting 2011
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PEM032-04 Room:103 Time:May 26 15:00-15:15

FPI-derived lower thermospheric wind at high latitude during DELTA-2 campaign for periods of geomagnetic disturbance

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Simultaneous observations were conducted with a Fabry-Perot interferometer (FPI) at a wavelength of 557.7 nm, an all-sky camera at a wavelength of 557.7 nm, the European Incoherent Scatter (EISCAT) UHF radar, and a rocket-borne chemical release method using trimethyl aluminum during the Dynamics and Energetics of the Lower Thermosphere in Aurora 2 (DELTA-2) campaign in January 2009 near Tromsoe, Norway. A notable advantage of this campaign was the intensive measurement of the thermosphere and ionosphere with various independent instruments, which provided thermospheric wind velocity, ionospheric density and temperature, electric field, and auroral intensity. Since these physical parameters were simultaneously obtained from a localized volume of the thermosphere and ionosphere, ambiguities caused by data interpolation under assumption of spatiotemporal homogeneity were minimized. This paper concentrated on the lower-thermospheric wind dynamics at the poleward side of a bright aurora associated with breakup at 00:23 UT on 26 January 2009. The FPI showed that the lower-thermospheric wind (in altitude range of 120-150 km) was accelerated upward and poleward by 17 m/s and 29 m/s, respectively, for 2.75 minutes. The Joule and particle heating rate and the Lorentz force were calculated from the EISCAT radar data then estimated the wind acceleration due to thermal expansion and momentum transfer by collisions. The comparison of the wind acceleration between the observed and the predicted suggested that the observed acceleration was larger than the predicted one by more than 1 order, although the data set minimized ambiguities induced by assumption of the spatiotemporal homogeneity. This paper proposed another energy dissipation process in association with fluctuating electric field at frequency of about 10 Hz. While there were no diagnostic tools during the DELTA-2 campaign for measuring the fluctuating electric field, predicted temperature enhancements were in sufficient level to explain the observed wind acceleration.

Keywords: aurora, airglow, optical instrument, ionosphere, thermosphere, high latitude

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PEM032-05 Room:103 Time:May 26 15:15-15:30

Study on latitudinal variation of the thermospheric mass density and zonal wind

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Recent observational studies have revealed that the latitudinal distributions of the mass density and zonal wind at low latitudes in the thermosphere are strongly influenced by the ionosphere. In particular, the mass density trough during daytime and the fast eastward jet during evening are located along the dip equator. However, physical mechanisms of these equatorial anomalies of the neutral atmosphere are not well known. In this study, using an atmosphere-ionsophere coupled model (GAIA), we investigate generation mechanism of the latitudinal distributions of the mass density and zonal wind at low latitudes. The GAIA solves the ionosphere-thermosphere interaction self-consistently, including the electrodynamics, so taht we can discuss the generation mechanism quantitatively. In order to investigate the generation mechanism of the mass density trough along the dip equator, the latitudinal distributions of the temperature and the atmospheric constituent, such as atmospheric oxygen, are studied in detail. As for the eastward jet formation, effects of the ion drag, pressure gradient force, advection term, Coriolis term on the momentum balance of the zonal wind are examined.

Keywords: thermospheric structure, numerical simulation, coupled model

Japan Geoscience Union Meeting 2011
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PEM032-06 Room:103 Time:May 26 15:30-15:45

Night time annual variation of longitudinal structure in the topside ionosphere observed by the DEMETER satellite

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Nigh time longitudinal structure of electron density (Ne) and temperature (Te) in the topside ionosphere are examined using data observed by the DEMTER satellite from 2006-2007 under geomagnetically quiet condition (Kp<3). Distribution of Ne show complex structure due to longitudinal structure excited by latent heat release in troposphere as well as middle latitude enhancement and the Weddel sea anomaly. On the other hand, Te does not show clear longitudinal structure. A spectrum analyses are performed with the DEMETER data around magnetic equator. Wavenumber 1 of Ne dominates other wavenumbers during May-July and December-January. Wavenumber 4 of Ne becomes dominant in March and August-October. Meanwhile, wavenumber 1 of Te is pronounced in all months except December. Wavenumber 4 of Te only becomes dominant in October. These features of Ne and Te are significantly different from those in the daytime. In this paper, mechanism of longitudinal structures of Ne and Te are discussed comparing daytime distributions.

Keywords: ionosphere, longitudinal structure, electron density, electron temperature, DEMETER, wave-4

Japan Geoscience Union Meeting 2011
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PEM032-07 Room:103 Time:May 26 15:45-16:00

The statistical study of the local time dependence of Mid-latitude TEC enhancement using TEC data

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The difference of the local time dependence of Total Electron Content (TEC) enhancement at mid-latitude was clarified by TEC data. TEC enhancement in topside ionosphere was detected with TEC data. TEC data between GRACE and GPS satellite is the integration value of the electron density in plasmasphere and topside ionosphere. The local time dependence of TEC enhancement at mid-latitude was studied from 2003 to 2006 statistically. Three type of local time dependence was founded. First type is the pre-dawn type. This type was observed during pre-dawn region from 01LT to 04LT and most of them are tend to be observed during geomagnetic quiet term. All the rest types are daytime type and evening type. In these type, TEC enhancement at mid-latitude were tend to occur during geomagnetic disturbed term. The difference of altitudinal region which occurred TEC-enhancement at mid-latitude between daytime type and pre-dawn type was researched during May, 2003. The difference of altitudinal region was researched by comparing GRACE-TEC and ground based GPS data during May, 2003. The main enhanced region of daytime type was detected above topside ionosphere. All TEC-enhancement in daytime was derived from SED. The main enhanced region of pre-dawn type was detected around topside ionosphere. These results indicate that the origin of TEC-enhancement is different between daytime and pre-dawn type.

Keywords: TEC data, total electron content, plasmasphere, low earth orbit satellite, mid latitude, ionosphere

Japan Geoscience Union Meeting 2011
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PEM032-08 Room:103 Time:May 26 16:00-16:15

Analysis of the vertical and horizontal structures of the airglow observed by the Reimei satellite

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The vertical structure and the horizontal structure of the O airglow and the OH airglow observed by the Reimei satellite were studied. Observations of the airglow by ground-based imagers are carried out for many times. There are observations of the airglow by WINDII/UARS in 1990s. There are few observations of the airglow emission by the artificial satellites in recent 10 years. The observational data of the O airglow (557.7-nm wavelength) and the OH airglow (670-nm wavelength) taken by the Multi-spectral Auroral Camera (MAC) on the Reimei satellite in the Earth limb direction are used in this study. The measured data of Reimei/MAC is integration value. Volume emission rate of airglow was derived from the observational data under the assumption of the uniformity of the volume emission rate in the emission layers. There was the difference of 10 km in altitude between the emission layer of the O airglow and that of the OH airglow. This difference is consistent with the results of the previous observations. Reimei/MAC observes the airglow emission in the region from 45° N to 15° N. The declination of the volume emission rate of these airglow emissions in the equatorial direction were found from the statistical studies of the observational data from March 2008 to December 2010. The latitudinal structures found in this study were different from that of the earlier studies and the calculations with the models. The volume emission rate of the airglow depends on the number density of the emission sources and the temperature. The number density of O and OH, which are the main sources of the airglow emission observed by Reimei/MAC, are thought to be affected by the atmospheric tide.

Keywords: airglow, the Reimei satellite, Multi-spectral Auroral Camera, volume emission rate

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PEM032-09 Room:103 Time:May 26 16:30-16:45

MSTID simultaneously observed with the SuperDARN Hokkaido radar and FORMOSAT: initial results

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We present some initial results from simultaneous observations of nighttime mid-latitude medium-scale traveling ionospheric disturbances (MSTID) observed with the Hokkaido SuperDARN HF radar and 630-nm airglow intensity observed with a limb imager of FORMOSAT-2/ISUAL. The radar observes two-dimensional MSTID structures propagating in the horizontal plane, while the limb imager does two-dimensional airglow structures in the vertical plane. The observations were made during the night on 20 and 21 December 2006 and 29 December 2008. Preliminary analyses of data from both instruments suggest that spatial MSTID structures observed with the radar are identified as airglow intensity enhancements observed with ISUAL, though the radar field-of-view is separated by a few hundred kilometers or more from the ISUAL observation areas.

Keywords: medium-scale traveling ionospheric disturbances, midlatitude ionosphere, HF radar, 630-nm airglow

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PEM032-10 Room:103 Time:May 26 16:45-17:00

Study of Medium-Scale Traveling Ionospheric Disturbances (MSTID) based on rocket/ground-based observation campaign

Mamoru Yamamoto[1*], Akinori Saito[2], Yuichi Otsuka[3], Tatsuhiro Yokoyama[4], Masa-yuki Yamamoto[5], Takumi Abe[6], Hiroto Habu[6], Shigeto Watanabe[7], R. F. Pfaff[4], Miguel F. Larsen[8]

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Medium-Scale Traveling Ionospheric Disturbances (MSTID) is enhanced in the summer nighttime of the mid-latitude ionosphere. The seeging mechanism of the MSTID is not only a simple reflection of atmospheric waves to the ionosphere, but includes complicated processes including the electromagnetic coupling of the F- and E-regions, and inter-hemisphere coupling of the ionosphere. A big observation campagin with sounding rocket(s) and ground-based instruments are planned for summer 2012. The key parameter of the observations is the neutral wind in the F- and E-regions. We present observation plan and current status of this research project.

Keywords: ionospheric waves, MSTID, MU radar, Sounding rocket, Neutral wind

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PEM032-11 Room:103 Time:May 26 17:00-17:15

Study of equatorial night-time MSTIDs using the data of airglow images, neutral winds, and ionospheric heights

Daisuke Fukushima[1*], Kazuo Shiokawa[1], Yuichi Otsuka[1]

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In our previous study, we observed night-time medium-scale traveling ionospheric disturbances (MSTIDs) at Kototabang (0.2S, 100.3E, geomagnetic latitude (MLAT): 10.6S), Indonesia during 7 years from October 2002 to October 2009. We took 630-nm night airglow images by using a highly-sensitive all-sky airglow imager. However we didn't compare these observations with thermospheric neutral winds which can be observed by Fabry-Perot interferometers (FPIs) and ionospheric heights which can be observed by ionosondes.

We analyzed two different events of MSTIDs observed at Kototabang, Indonesia after October 2009. One event is that north-eastward MSTID was observed from 15 to 16 UT and southwestward MSTID was observed from 16 to 17 UT on 11 September 2010. The other event is that quasi-periodic southward MSTIDs were observed from 16 to 18 UT on 10 December 2010. The former event seems to be waves generated from midnight temperature maximum (MTM). The latter event is similar to MSTIDs observed in our previous study because they were quasi-periodic waves moving southward. In the presentation, we discuss detailed characteristics of these two events by using the data of the thermospheric neutral winds observed by a FPI and the data of the ionospheric heights observed by an ionosonde.

Keywords: airglow, equatorial thermosphere, MSTID

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PEM032-12 Room:103 Time:May 26 17:15-17:30

VHF radar and ionosonde observations of post-midnight irregularities in Indonesia

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We have been operating a 30.8-MHz radar at Kototabang (0.2^{o}S, 100.3^{o}E; dip latitude 10.4^{o}S), Indonesia since February 2006 to perform continuous observations of the E- and F-region field-aligned irregularities (FAIs) over Indonesia. From the continuous observation of the F-region FAIs from 2006 to 2011, we find that FAIs frequently occur at post-midnight between May and August under low solar activity periods. This seasonal and local time dependence of the FAI occurrence is not consistent with those of plasma bubbles occurring under high solar activity period.

At Kototabang, an ionosonde has been operated. We have compared spread F occurrence with the FAI occurrence and found that most of the post-midnight FAIs coincide with spread F. Furthermore, we have analyzed ionosonde data at Pontianak (0.0^{o}S, 109.3^{o}E), Indonesia on May and August 2009. Pontianak is located approximately 1,000 km east of Kototabang at the almost same latitude of Kototabang. At both Kototababg and Pontianak, spread F frequently occurs at around midnight. From comparison of the spread F occurrence between Kototabang and Pontianak, we find that most of spread F occur simultaneously at both sites, although spread-F occurs more frequently at Pontianak than Kototabang. This result indicates that the post-midnight ionospheric irregularities may be generated simultaneously in a wide area extending more than 1,000 km in zonal direction.

Keywords: equatorial ionosphere, FAI, spread F, ionospheric irregularity, radar

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PEM032-13 Room:103 Time:May 26 17:30-17:45

Structure of the intense Es observed on June 9, 2008

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In the recent study we have revealed that the intense Es event (foEs>30MHz) observed on June 9, 2008 had the occurrence area of about 150km in the east-west direction and moved about 200km in north, by using the amplitude scintillation observations of the stationary satellite MTSAT-2 and the GPS satellites in corresponding to the wavefront structure deduced by the HF doppler observations. the analysis was performed by using the 24 amplitude scintillation events because they can be easily identified by the quasi-periodic shape, the duration of less-than 1 minute and the peak-to-peak amplitude of more than 6dB, even in fluctuating data, and because the TEC variation only shows a small noise-like fluctuation. In this study we have found out the relationship between the shape and timing of the TEC variation and the amplitude scintillation in the Es events. Thus we applied the method to identify TEC variations as a Es event, and obtained totally 20 events in the TEC data. Those events show the TEC increase of less than 0.7TECU and the same duration as the amplitude scintillation.

The quasi-periodic amplitude variation can be modeled by a diffraction pattern produced by a long and cylindrical Es with a Gaussian-shape in cross section [2]. We have obtained the full-width of 120m and the peak electron density of $3x10^{13}m^{-3}$ by using the observation parameters, f=1575.42MHz, v=55m/s and h=120km. the peak electron density may explain the intense foEs value of more than 30MHz observed at the NICT Kokubunji. Then the equivalent width can be calculated as 230m dividing the TEC enhancement of $7x10^{15}$m{-2} by the estimated peak electron density. We can, therefore, suppose a diffusive electron distribution around the main Gaussian distribution. It is concluded that the cross-section structure of the intense Es on June 9, 2008, is implimented by the peak electron density of $3x10^{13}m^{-3}$, the main width of 120m, and the diffusive attachment.

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Keywords: sporadic E (Es), structure of Es, amplitude scintillation, TEC

Japan Geoscience Union Meeting 2011
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PEM032-14 Room:103 Time:May 26 17:45-18:00

Daytime Es layer structures revealed by the MU radar ultra-multi-channel imaging during the partial solar eclipse

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During the partial solar eclipse that occurred on 22 July 2009 near Shigaraki, Japan, the MU radar observed quasi-periodic radar echoes from the E region. Ultra-multi-channel imaging of the radar echoes with multi-beam experiment revealed spatial structures of the daytime Es layer. This is a rare observation that shows daytime Es layer structure in detail. Short-lived ripple-like structures with a wavelength of about 10 km were observed, suggesting modulation by breaking atmospheric gravity waves. Polarization effect associated with sudden disappearance of the conducting E region on QP echo generation is further examined.

Keywords: ionosphere, sporadic E layer, MU radar, radar imaging, QP echo, solar eclipse

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PEM032-15 Room:103 Time:May 26 18:00-18:15

Lunar tide effects in the equatorial electrojet observed by MAGDAS/CPMN

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The occurrence of equatorial counter electrojet (CEJ) is a westward flow of currents in the ionospheric E-region. The occurrence of CEJ is believed to be related with the lunar tide during geomagnetic quiet days. We have analyzed ground magnetic field data obtained from MAGDAS/CPMN equatorial stations during 2007-2009, in order to study the lunar tide effects on the equatorial electrojet (EEJ). The magnetic H-component perturbation due to the lunar-tide ionospheric currents shows a semi-diurnal variation in the normal Sq. This variation is found to be synchronized with lunar phase at all equatorial stations. The amplitude of semi-diurnal variation is generically 25% as large as mean value of the EEJ, but sometimes is become larger than 10 times. The anomalous enhancement of the semi-diurnal variation is found to be related with sudden stratospheric warming (SSW) on 19-24 January 2009. When the CEJ occurs in the morning (or evening) sector, the EEJ tends to become larger in the evening (or morning) sector. Magnetic H-component variations at the equatorial stations can be used to examine the lunar effects in the equatorial electorojet, and to understand the lunar-tide ionosphere-atmosphere coupling.

Keywords: equatorial electrojet, equatorial counter electrojet, lunar tide, MAGDAS, magnetic equator, ground magnetic field

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PEM032-16 Room:103 Time:May 26 18:15-18:30

Ordinary existing magnetic micropulsations and their relation to small-scale magnetic fluctuations over the ionosphere

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Magnetic pulsations with period around 4 minutes have been observed on the ground in many occasions, for example, just after the earthquakes such as 2004 Great Sumatra Earthquake or strong volcanic eruptions such as 1991 Mt. Pinatubo eruption. These pulsations are supposed to be generated through the ionospheric dynamo caused by the vertical acoustic resonance between the ground and the ionosphere. Although the amplitude is small, similar phenomenon is generally observed when the lower atmosphere is disturbed by, for example, typhoons, inland earthquakes, etc. Recent observation suggests that they cause not only the ionospheric currents but also the field-aligned currents. We summarize these results, in particular, of geomagnetic observation and discuss the mechanism.

Keywords: magnetic pulsation, acoustic gravity wave, micro-barometric variation, ionospheric dynamo, field-aligned current, lower atmospheric disturvances

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Summary of observational results obtained with the new Tromso sodium LIDAR

Satonori Nozawa[1*], Takuya Kawahara[2], Takuo Tsuda[1], Tetsuya Kawabata[1], Norihito Saito[3], satoshi Wada[3], Toru Takahashi[1], Shin-ichiro Oyama[1], Hitoshi Fujiwara[4], Ryoichi Fujii[1]

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On October 1, 2010, the new sodium LIDAR installed at Ramjordmoen, Tromsoe (69.6N, 19.2E), where the EISCAT radars have been operated, started observations of neutral temperature in Mesosphere-Lower Thermosphere (MLT) region (80-110 km). The new LIDAR can provide temperature data with time resolution of 10 min - 20 min with good quality. This talk will give an overview of results obtained with the new sodium LIDAR over 6 months (October 2010 - March 2011). We have operated the sodium LIDAR as follows: about 1 month in October 2010, about 2 weeks in November 2010, about 2 weeks in January 2011. In total, we seceded in obtaining neutral temperature data for about 180 hrs. We plan to operate the LIDAR for about 2 weeks in February 2011, and about 2 weeks in March 2011. So far, major results are summarized as follows:

(1) Simultaneous observations with the EISCAT UHF radar. For 2 nights, October 5-6, 2010 and November 14, 2010, we succeeded in conducting simultaneous observations with the EISCAT UHF radar. During the period, the electric field values were relatively small. We have compared neutral temperature values observed by the LIDAR with the ion temperature values by the EISCAT UHF radar between 95 and 105 km. In general, it is found in fairly good agreement.

(2) Periodic variations of neutral temperature for about several hours. On October 29, 2010, we observed that the neutral temperature varied clearly with time between 80 and 105 km for about 9 hrs. We have derived the period to be about 4 hrs as well as the vertical wavelength to be about 10 km for this event. In addition, We have obtained the neutral temperature data with 12 hrs -15 hrs linterval for 4 nights on January 7, 8, 11, and 12, 2011. Clear temporal variations are identified in the datasets, thus we will derive tidal amplitudes and phase as well as shorter interval periodic variations.

(3) Sporadic sodium layer. On January 11, 2011, we observed a sporadic sodium layer event, which showed high sodium density (one order higher than usual density values) for about 3 hrs. We have analyzed MF radar data, meteor radar data, magnetometer data, aurora camera, and ionosonde data to investigate its cause.

We will present summary of observational results over the 2010 season, and also present our upgraded plan of the LIDAR system.

Keywords: polar region, neutral temperature, mesosphere, lower-thermosphere, sodium LIDAR, Tromsoe

Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

PEM032-18 Room:103 Time:May 27 08:45-09:00

Injection seeding technique for the new Na lidar system in Tromso

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We developed an all solid-state, water-free, high-power Na wind/temperature lidar for measurements at EISCAT radar site in Tromso (69N), Norway. The lidar has an absolute laser frequency monitoring system at 589 nm using Doppler-free saturated absorption technique with a heated Na cell. Fast and accurate laser frequency switch can be done with an acousto-optic frequency shifter. All these systems concerning laser frequency control are called as an injection seeding technique and vital for the temperature/wind observation. In the presentation, we discuss the results of the injection seeding experiments for the system validation.

Keywords: lidar, sodium, Nd:YAG laser, injection seeding

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PEM032-19 Room:103 Time:May 27 09:00-09:15

Sporadic sodium layer observed with the Tromso sodium lidar

Takuo Tsuda[1*], Satonori Nozawa[1], Takuya Kawahara[2], Tetsuya Kawabata[1], Norihito Saito[3], satoshi Wada[3], Shin-ichiro Oyama[1], Hitoshi Fujiwara[4], Yasunobu Ogawa[5], Shin Suzuki[1], Ryoichi Fujii[1], Tadahiko Ogawa[6], Nobuo Matuura[1]

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The mesospheric and lower thermospheric sodium layer, distributed at 80–110 km height, have been observed for more than 30 years by resonance scattering lidars. During these observations, researchers discovered the sudden formation of dense thin sodium layer superposed on the normal sodium layer. Such an enhanced layer is called a sporadic or sudden sodium layer (SSL). Typical feature of the SSL is a thin layer with a full-width at half maximum (FWHM) of 1–2 km lasting for a tens of minutes to several hours, and its peak sodium density is a few to tens times larger than that of the background sodium density. Several possible mechanisms have been discussed in previous studies. The hypotheses are, for example, direct meteoric input, energetic electron bombardment on meteoric smoke particles, and ion neutralization in the sporadic E layer. Most case studies trying to identify the generation mechanism of SSL seem to focus on only one of the proposed theories. To examine a couple of mechanisms at once, it is essentially valuable to accumulate many kinds of related observations, such as sodium lidar, meteor radar, MF radar, incoherent scatter radar, ionosonde, and auroral camera.

On 11 January 2011, a sporadic sodium layer was observed with a sodium lidar, which was newly installed in the European incoherent scatter (EISCAT) radar site at Tromsoe, Norway (69.6N, 19.2E). The SSL observation at the EISCAT radar site is quite suitable for the SSL study because several instruments are working there. In this study, we have investigated the generation mechanism of the observed SSL analyzing data of the sodium lidar, MF radar, meteor radar, auroral camera and so on. As the results, the observed SSL seems to have no connections with the auroral precipitations and the direct meteor inputs, but have a relationship with a sporadic E layer accompanied by a vertical wind shear. Furthermore, the SSL can provide observational data with higher signal-to-noise ratio. Such high quality data is useful for investigating fine structure of the sodium density. In order to investigate fine structure in the observed sporadic sodium layer, we have analyzed the lidar data with 5-sec time resolution and found (quasi) periodic oscillations in the peak height of the sodium density. The observed oscillations had periods of 5–14 min, and its height differences of peak-to-bottom were 288–1152 m. The height change rates were 1.0–3.6 m/s for upward and 1.1–4.8 m/s for downward. From these features, the observed structure seems to be parts of the atmospheric gravity waves and/or Kelvin-Helmholz billows. We have examined the background atmospheric condition of the sporadic sodium layer using the lidar temperature data as well as the MF radar wind data. Mostly, the estimated Brunt-Vaisala periods were 3–8 min (i.e., no convective instability) and the estimated Richardson numbers were larger than 0.25 (i.e., no wind shear instability). Based on these results, we have discussed the fine structure observed in the SSL.

Keywords: Sporadic sodium layer, Lidar, Polar region, Mesosphere, Lower thermosphere, Atmospheric gravity wave

Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

PEM032-20 Room:103 Time:May 27 09:15-09:30

Periodic variations for several hours of neutral temperature observed with the sodium LIDAR at Tromsoe

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We have been studying atmospheric dynamics of the polar Mesosphere and Lower Thermosphere (MLT) with EISCAT (European Incoherent SCATter) radar, MF radar, and meteor radar located at the EISCAT Tromsoe site (69.6 deg. N, 19.2 deg. E). For the further improvement of our knowledge regarding mesospheric/lower thermospheric dynamics at high latitudes, we installed a new sodium LIDAR at the same site. The new sodium LIDAR is available for obtaining height-resolved temperature as well as wind velocity in the upper mesosphere and lower thermosphere. The neutral temperature of the upper atmosphere is one of the important parameters to understand contributions of the atmospheric waves such as gravity and tidal waves to the MLT coupling process.

Since 1 October 2010, the sodium LIDAR observations have been conducted for about 8 weeks. In total, we succeeded in obtaining the temperature data for about 180 hours. One of the notable advantages of this LIDAR is high time resolution of 10-20 minutes, which enable us to study oscillations like gravity waves and tides in the upper mesosphere and the lower thermosphere. Of particular interest in the temperature variations is clear downward phase propagation appeared on 29 October 2010. The oscillation period is about 4-hours, and its vertical wavelength is about 10 km. The amplitude at 90 km is about 15 K. Several events with downward phase propagation are observed in January 2011.

The presentation will show the observational results of these oscillations. Comparisons with periodic variations of wind velocity observed with the MF radar will be also shown.

Keywords: sodium LIDAR, Atmospheric gravity wave, Tromsoe, Mesopause and Lower Thermosphere, EISCAT, variation of temperature

Japan Geoscience Union Meeting 2011
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PEM032-21 Room:103 Time:May 27 09:30-09:45

Initial results from a Rayleigh-Raman lidar at Syowa station

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The polar regions of the middle atmosphere are in the downward/upward stream of the meridional circulation in winter/summer, and shows a significant seasonal change in the upper region. However, observations over the Antarctic are very limited, and therefore profiling dynamical parameters such as temperature and wind, as well as minor constituents is very important there. The National Institute of Polar Research (NIPR) is carrying our a six year prioritized project of the Antarctic research observations since 2010. One of the sub-project is entitled “the global environmental change revealed through the Antarctic middle and upper atmosphere.” In this project, active remote sensings such as a large atmospheric radar (PANSY) and a lidar, as well as profiling of minor constituents by a millimeter wave spectrometer are being installed in Syowa, Antarctica. In this paper, an initial report of the Rayleigh Raman lidar observations which have been commenced by the 52th JARE (Japanese Antarctic Research Expeditions) in early 2011.

The lidar observes temperature and atmospheric density perturbation in the stratosphere and mesosphere, including PSC (Polar Stratospheric Clouds and PMC (Polar Mesospheric Clouds). Two Nd:YAG lasers of 355 nm (300mJ x 20Hz, 100mJ x 20Hz) and two telescopes (82 cm and 35 cm) are used. Elastic scatter and N2 vibrational Raman scatter (387nm) are detected in four channels using photon counting and A/D techniques. The system has installed and started operation in February this year. In the paper, initial results of temperature, clouds and atmospheric waves will be reported.

Keywords: Middle atmosphere, lidar, polar region, gravity waves

Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

PEM032-22 Room:103 Time:May 27 09:45-10:00

Latitude variation of tides and quasi-2 day waves three meteor radars in northern Norway

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A new meteor radar was installed at Bear Island (74.5 deg N, 19.0 deg E) in summer 2007 to investigate the mesospheric and lower thermospheric wind dynamics in the polar cap region. The meteor radar has been almost continuously operated since November 1, 2007, collecting abundant data set of 39 months (up to now) to investigate seasonal as well as year-to-year variations of mean winds, tides and quasi-two day waves (Q2DW). The meteor radar provides well height-resolved wind data typically in the height region between 80 km and 100 km with height resolution of about 3 km. In this study, the wind data are integrated into one-hour bin to reduce data perturbations for every month. Spectral analysis is employed using the hourly mean data to retrieve wave parameters of diurnal and semidiurnal tides. For Q2DW analysis, on the other hand, we use consecutive 8-day interval data. The major results are summarized as follows:

(1) Mean winds exhibit clear seasonal and year-to-year variations. The year-to-year variation is greater in winter than in summer. We think one of major causes is the influence of planetary waves. In particular, the effect of Sudden Stratospheric Warming (SSW) seems to be important. The SSW occurred in January and February 2009 and 2010.

(2) The amplitude of meridional component of diurnal tides shows clear difference between summer months (April to October) and winter months. It is almost constant between April and October. In winter months it is smaller, and is very small between 80 km and 90 km.

(3) The amplitude of semidiurnal tides grows with the altitude increasing, and it becomes 15-30m/s at 100 km except for October. In October over the 3 years, the semidiurnal tides have small amplitude between 90 km and 100 km.

(4) The amplitude of Q2DW is higher in winter and summer, and much lower at equinox. In winter, Q2DW activity can be found from 80 to 100 km, while in summer it is only limited above 90 km. There are, however, several events found in summer when the activity is high between 80 and 100 km.

Bear Island (74.5 deg N, 19.0 deg E) is located in the almost middle of two sites such as Longyearbyen (78.2 deg N, 16.0 deg E) and Tromsoe (69.6 deg N, 19.2 deg E). The longitude of the three stations is almost the same, so we here investigate latitudinal variations of tides and Q2DWs using data obtained at these 3 stations from November 2007 to January 2011. We will present the results, and also will present variations of wind velocities associated with SSW events.

Keywords: northern Norway, meteor radar, tidal wave, quasi two day wave, latitudinal variation

Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

PEM032-23 Room:103 Time:May 27 10:00-10:15

The 2009-2010 monthly MU radar observation programme for meteor head echoes

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Meteors, or colloquially shooting stars, are caused by particles from space that are heated up and shattered in the atmosphere. Different estimates of how much mass these meteoroids bring to our planet vary by several orders of magnitude. We conducted a systematic set of monthly meteor head echo observations from 2009 June to 2010 December (>500 h), except for 2009 August, with the Shigaraki Middle and Upper atmosphere (MU) radar in Japan (34.85 degree N, 136.10 degree E), resulting in more than 100 000 high-quality meteor detections. The ultimate purpose of our observation programme is to improve the estimate of the flux of extraterrestrial material into the Earth's atmosphere and to investigate the possible flux of extrasolar meteoroids entering the solar system and crossing Earth's orbit.

Using the interferometric ability of the MU radar we have developed analysis algorithms that give precise geocentric velocities and directions of the observed meteoroids - a few hundreds of metres per seconds and a fraction of a degree, respectively. About 3000 events from about ten thousand head echoes per 24 h observation have the above mentioned accuracy. The head echoes are detected in the height range of 73-127 km. The high number of detections allows us to map the seasonal variation of the sporadic meteor influx, as well as its characteristics in form of geocentric velocity and altitude distribution of the deposited material. The initial altitude distribution shows clear velocity dependence, higher velocity meteoroids ablating at higher altitude.

Our data set contains both shower and sporadic meteor detections. Sporadics are those meteoroids that cannot be directly ascribed to a parent body. Sporadics are the most numerous among our observed particles, and the main contributors to the mass influx into the Earth atmosphere. Shower meteors provide good opportunities to compare head echo observations, as well as our analysis methods, with results using other techniques as with photographic and video observation systems.

Keywords: meteor, meteoroid, HPLA radar, head echo

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PEM032-24 Room:103 Time:May 27 10:15-10:30

Gravity wave variability in the equatorial MLT region over Pameungpeuk, Indonesia (7.4ˆ[o]S, 107.4ˆ[o]E)

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[1]RISH, Kyoto University, Uji, Japan

We study short period gravity waves (20-120 min.) in the equatorial Mesosphere and Lower Thermosphere (MLT) observed by an MF radar at Pameungpeuk (7.4ˆ[o]S, 107.4ˆ[o]E). In particular, we study diurnal variation of short period gravity wave variance and its relation to convection in the troposphere. Overall, the gravity wave variance at 88 km enhances between 20 LT and 07 LT, with a peak around 3 LT. The enhancement is mainly observed during September-October and February-April. The convective activity persists from 14 - 24 LT with a peak activity around 18 LT and enhances between November-April. Time delay between the peak of convective activity and peak of GW enhancement is 1-15 hours. This agrees well with theoretical calculations and previous reports based on reverse ray tracing analysis. This study shows that, indeed, convection is the major source for gravity waves observed in the equatorial MLT region.

Keywords: MLT Dynamics, Gravity waves, MF Radar, Convection

Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

PEM032-P01 Room:Convention Hall Time:May 27 10:30-13:00

Stagnation of a polar cap patch and decay of the accompanying plasma irregularities

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We report an event in which a polar cap patch, as detected by an all-sky imager (ASI) at Resolute Bay, Canada, stopped its anti-sunward motion and wandered around within the field-of-view of the ASI for more than 1 h. During the wandering motion of the patch, a significant reduction of the cross-polar cap plasma convection was observed by the SuperDARN radars. 10-15 min before the stop of the patch, the IMF observed by the Geotail spacecraft showed a clear northward turning. Such a change in the IMF orientation could lead to the halt of the cross-polar cap convection and resultant stagnation of the patch.

When the patch stagnated, its luminosity decreased gradually, which allows us to investigate how the patch plasma decayed in a quantitative manner. The decay of the patch can be quantitatively explained by the loss through recombinations of O+ with ambient N2 and O2 molecules, if we assume the altitude of the optical patch to be around 295 km. The derived altitude of the patch around 295 km is much higher than the nominal value at 235 km obtained from the MSIS-E90/IRI2007 models. This is probably because the loss process was much faster in the lower-altitude part of the patch; thus, the peak altitude of the patch increased as it traveled across the polar cap due to rapid recombination at the bottomside of the F region.

During the interval of interest, one of the SuperDARN radars at Rankin Inlet, Canada observed a cluster of field-aligned irregularities (FAIs) in the region of enhanced 630.0 nm airglow associated with the patch. These patch-associated FAIs promptly decayed following the weakening of the optical patch, which was obviously due to a convolution effect of the decrease in the patch-associated density gradient and the reduction in the background convection caused by the northward turning of the IMF. However, the decay of the FAIs was much quicker than that of the optical patch. This suggests that the abrupt reduction of the convection probably played a more important role than the gradual decrease of the patch-associated density gradient in causing the prompt decay of the patch-associated FAIs. This indicates that the strength of the background electric field is very crucial in maintaining small-scale density structures in the polar cap.

Keywords: Polar Cap Patches, Polar Cap Ionosphere, Plasma Convection

Japan Geoscience Union Meeting 2011
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PEM032-P02 Room:Convention Hall Time:May 27 10:30-13:00

Observations of nighttime medium-scale travelling ionospheric disturbances by 630-nm airglow imagers near auroral zone

Kazuo Shiokawa[1*], Masato Mori[1], Shin-ichiro Oyama[1], Yuichi Otsuka[1], Satonori Nozawa[1], Martin Connors[2]

[1]STEL, Nagoya University, [2]Athabasca University

We study nighttime medium-scale travelling ionospheric disturbances (MSTIDs) observed in the 630-nm airglow imagers at Tromso (69.6N, 19.2E; magnetic latitude: 67.1N), Norway and at Athabasca (54.7N, 246.7E; magnetic latitude: 61.7N), Canada. This is the first study of high-latitude MSTIDs by all-sky imagers in the European and Canadian longitudinal sectors. For Tromso we analyzed airglow images for two winters from 9 January to 2 March 2009 and from 9 October 2009 to 3 March 2010. For Athabasca, we analyzed 2-year data from September 2005 to August 2007. At both stations, the MSTIDs were observed before the midnight with the occurrence rate of more than ~30 %. The average wavelengths, phase velocities, and periods of the observed MSTIDs were 100-400 km, 50-150m/s, and 30-60 min, respectively. We found that MSTIDs at Tromso tend to show eastward motion in addition to the typical southwestward motion. At Athabasca, we recognized a tendency that southwestward-moving MSTIDs occur frequently in winter. In summer, however we found characteristic northward-moving MSTIDs at Athabasca. At both stations, some MSTIDs showed characteristic change of their directions of propagation and wave front in association with auroral activity. We report an example of sudden motion of MSTIDs at substorm onset observed at 1730 UT on December 8, 2009 at Tromso. On the basis of these results, we discuss possible cause of generation and motion of high-latitude nighttime MSTIDs.

Keywords: medium-scale traveling ionospheric disturbance, airglow, auroral zone, ionosphere, thermosphere, substorm

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PEM032-P03 Room:Convention Hall Time:May 27 10:30-13:00

An observation plan of ionospheric scintillations by use of GPS signals received in Syowa Station, Antarctica

Hideaki Kitauchi[1*], Minoru Kubota[1], Takuya Tsugawa[1], Hiromitsu Ishibashi[1], Tsutomu Nagatsuma[1], Ken T. Murata[1]

[1]NICT

We begin observation of ionospheric scintillations, by the use of GPS (Global Positioning System) signals, in Syowa Station [69.00'19"S,39.34'52"E], East Ongle Island, Antarctica. In the 52nd Japanese Antarctic Research Expedition started from November 2010, two GPS receivers–one at the Ionospheric Observatory (site name SYO1) and the other the Administration Building (SYO2)–have been implemented (Fig. 1).

Part of the realtime data, not yet calibrated well, is available on the following web site:
http://wdc.nict.go.jp/IONO2/ANTARCTIC/SYOGS/SYO1/TEC/
http://wdc.nict.go.jp/IONO2/ANTARCTIC/SYOGS/SYO2/TEC/

図1. 南極昭和基地に設置したGPSシンチレーション観測システム配置図

Keywords: Syowa Station, Antarctica, ionospheric scintillations, GPS signals, observation plan

Japan Geoscience Union Meeting 2011
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PEM032-P04 Room:Convention Hall Time:May 27 10:30-13:00

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

Toru Sasaki[1*], Taketoshi Miyake[1], Keigo Ishisaka[1], Toshimi Okada[1]

[1]Toyama Prefectural University

SRP-5 sounding rocket was launched from Poker Flat Research Range, Fairbanks, Alaska at 14:17 LT on January 10, 2009. The primary science objective of SRP-5 Project is to measure the plasma density profile of the polar D region ionosphere above Poker Flat Research Range, which was carried out with using a plasma probe, radio receivers, and other sensors. The objective of TPU (Toyama Prefectural University) radio receiver is to investigate the electron density profile in the polar D region at daytime. The electron density profile in the lower ionospheric region is estimated from the absorption of three radio waves observed by SRP-5 sounding rocket.

We observed three different radio waves, CHENA (257 kHz), KFAR (660 kHz) and KCBF (820kHz), transmitted from navigation and broadcast stations near Fairbanks, Alaska. They were successfully observed from the altitude 0 to 98 km during the ascent flight. The receiver observed magnetic field intensities and waveforms down converted to about 100 Hz. During the rocket ascent, up to about 150 seconds, the intensities of these radio waves attenuate gradually with increasing time, until they reach the system noise level of the receiver at about 110 seconds. These attenuations are due to collisions between the electrons and the neutral molecules in the lower ionosphere. On the other hand, the spectra of three radio waves are obtained by FFT (Fast Fourier Transform) from the waveforms. These spectra branch into two after launch, since the frequencies of the polarized waves are affected by the rocket spin.

The approximate electron density profile can be estimated from the comparison between these observation results and propagation characteristics calculated with Full wave method. The estimated electron density profile suddenly increase then decrease at the altitudes between about 80 and 90 km. The magnetic intensity, calculated with Full wave method from this electron density profile, are almost the same as the experimental results. In addition, we are going to distinguish the right- and left-hand polarized waves from the spectra of observed three radio waves, and estimate more detailed electron density profile in the lower ionosphere below 65 km.

This estimation process 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 are going to develop a application to realize automated estimation of electron density profile by the radio wave propagation characteristics analysis.

Keywords: radio wave propagation characteristic, electron density profile, ionosphere, sounding rocket measurement

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PEM032-P05 Room:Convention Hall Time:May 27 10:30-13:00

The Ionospheric Nighttime Electron Density Enhancement by 3D Tomography Method around European Region

Chia Hung Chen[1*], Akinori Saito[1], Charles Lin[2], Jann-Yenq Liu[3]

[1]Kyoto University, Japan, [2]National Cheng Kung University, Taiwan, [3]National Central University, Taiwan

The nighttime electron density enhancement of the Earth's ionosphere is characterized by the greater electron density in the nighttime than that in the daytime. Recently, this anomaly feature has intensely been studied by using satellite observations and model simulations. Results show that there are three obvious nighttime electron density enhancement regions around South American, European, and Northeast Asian. The 3D tomography method, employs GPS data observed by an network of dual-frequency GPS receivers, is used in this study to study the three-dimensional structure of the nighttime electron density enhancement around European region, where covers a lot of GPS receivers. Furthermore, we compare with the tomography results and the SAMI2 (Sami2 is Another Model of the Ionosphere) model simulation results. The results will be shown in the poster.

Keywords: 3D tomography, nighttime electron density enhancement, GPS-TEC

Japan Geoscience Union Meeting 2011
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PEM032-P06 Room:Convention Hall Time:May 27 10:30-13:00

Observations of total electron content variations using GPS networks in Europe

Yuichi Otsuka[1*], Shinta Nakagawa[1], Kazuo Shiokawa[1], Takuya Tsugawa[2]

[1]Solar-Terrestrial Environment Laboratory, [2]NICT

Using GPS receiver networks in Europe, we have disclosed two-dimensional structure of Total Electron Content (TEC) over Europe and detected ionospheric troughs and Medium-Scale Traveling Ionospheric Disturbances (MSTIDs) on the TEC perturbation maps. In this study, the perturbation component of TEC is obtained by subtracting 1-hour running average from a time series of TEC along the GPS satellite and receiver. From statistical study of the GPS-TEC maps in 2008, we found that the ionospheric troughs were observed frequently between sunset and midnight on equinoxes. This result is consistent with previous studies. We also find that the observed MSTIDs can be categorized into two types. One type is daytime MSTIDs, which frequently occur in winter. Since most of the daytime MSTIDs propagate southeastward, we speculate that the daytime MSTIDs could be caused by atmospheric gravity waves in the thermosphere. Second type is nighttime MSTIDs, which also frequently occur in winter. Nighttime MSTIDs propagate southwestward. This propagation direction is consistent with the idea that polarization electric fields could play an important role in generating nighttime MSTIDs.

Keywords: GPS, TEC, ionosphere, ionospheric trough, TID

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PEM032-P07 Room:Convention Hall Time:May 27 10:30-13:00

Study of mid-latitude ionosphere convection during super quiet period with the SuperDARN Hokkaido radar

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Characteristics of the ionospheric convection in the mid-latitude and subauroral regions have been studied by various kinds of observation instrument and computer experiments in the last few decades. A presence of westward flow around midnight at mid-latitude has been extensively discussed. This kind of flow can be generated by so-called disturbance dynamo mechanisms working at mid-latitudes (Blanc et al., JGR, 1980). We tested the disturbance dynamo theory by using ionospheric echo data obtained by the SuperDARN Hokkaido radar for 4 years. The SuperDARN Hokkaido radar has been measuring line-of-sight velocities of ionospheric irregularities, which can be regarded as line-of-sight velocities of ionospheric convection. The radar can monitor ionospheric convection at mid-latitude (geomagnetic latitude: 40 to 60 degrees), which could not be monitored by using preexisting SuperDARN radars. In the previous study we found the presence of westward flows around midnight at about 40 to 55 degrees geomagnetic latitude, which intensified with increasing geomagnetic activity. On the other hand, Gonzales et al. (1978, JGR) showed that the ionospheric convection flow just before midnight becomes eastward when the geomagnetic activity level is very quiet (1-day sum of Kp index less than or equal to 14) using the Millstone Hill radar data. This tendency was not found from our previous study using SuperDARN Hokkaido radar.

Kumar et al. (2010, JGR) reported using the data from Digisonde drift measurements made at Bundoora (145.1 degrees E, 37.7 degrees S geographic, 49 degrees S magnetic), Australia, that the effects of major storms (minimum Dst $<$ -60nT) in the nighttime mid-latitude ionosphere were observed to last up to 50 hrs after storm onset. In order to understand the effects of the disturbance dynamo on the mid-latitude nighttime ionosphere, we reanalyzed the SuperDARN Hokkaido radar data using only the data under very quiet geomagnetic condition for preceding 48 hours. However, the tendency reported by Gonzalez et al. (1978) was not found even when geomagnetism index Kp was less than or equal to 0+ and the influence from previous geomagnetic storms has been removed. More detailed analysis result will be presented.

We are studding the of the character of mid-latitude ionosphere convection observed by radar that influenced by the Dst index defined storm, using Superposed Epoch Anaysis (SEA). A more detailed analytical result is scheduled to be reported in the lecture.

Keywords: SuperDARN, SuperDARN Hokkaido radar, mid-latitude ionosphere, disturbance dynamo, westward flow, Geomagnetic kp Indices

Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

PEM032-P08 Room:Convention Hall Time:May 27 10:30-13:00

Variation of Ne and Ni observed by DEMETER during 2009 total solar eclipse

Kaori Mochizuki[1*], Masashi Kamogawa[1], Yoshihiro Kakinami[2], Wang Xiaoni[3], Jean-Jacques Berthelier[3], Tatsuo Onishi[3]

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We investigate topside ionospheric dynamics of 2009 total solar eclipse in East Asia by using Ne/Te and Ni/Ti data of French satellite DEMETER, of which altitude is around 660 km. On July 22, 2009, one of DEMETER orbits crossed eclipse zone, and the distance closest to the total eclipse area was approximately 200km. Just after the total solar eclipse, Te decreased while Ne did not change. Before the maximum obscuration, Ne decreased and Te increased because production rate of plasma decreased under the F-region. Since strong fountain effect appeared up to +30 degree in latitude, the satellite measured the enhancement of Ne, while Te further decreased due to the eclipse. This feature differs from another eclipse case [Wang et al., JGR, 2010]. In the presentation, we discuss quantitatively ionospheric dynamics during the total solar eclipse.

Keywords: Total solar eclipse, Ion density, Electron density, Gravity wave

Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

PEM032-P09 Room:Convention Hall Time:May 27 10:30-13:00

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

Takahiro Kurokawa[1*], Taketoshi Miyake[1], Keigo Ishisaka[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 this 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.

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

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PEM032-P10 Room:Convention Hall Time:May 27 10:30-13:00

Study on the estimation of the electron density profile in the lower ionosphere with time domain Full wave analysis

Takahiro Futatsuya[1], Taketoshi Miyake[1*], Keigo Ishisaka[1], Yasuhiro Murayama[2], Seiji Kawamura[2]

[1]Toyama Prefectural University, [2]NICT

MF radar estimates the electron density pro?le in the lower ionospheric D and E regions at the altitude from 60km to 100km by using the partial re?ection information of MF radar transmission wave. Electrons of lower ionosphere are closely related to neutral dynamic meteorology and chemistry including such as hydrated ion and NOx in this region, therefore, it has a possibility to ?nd a new physical knowledge in the mesosphere and lower ionosphere. However, it is dif?cult to observe precise electron density pro?le in the lower ionosphere continuously with the present MF radar system.

In this study, we are going to simulate the observation process of the present MF radar system with using time domain Full wave method, and investigate the observation method to observe the precise electron density pro?le in the lower ionosphere. One of the methods to estimate the electron density profile by the present MF radar system is DAE. DAE is a technique to estimate the electron density pro?le from the differential amount between the left and the right polarized waves re?ected by the lower ionosphere. We have simulated the ovservation process of MF radar and examined the problem and improvement points with time domain Full wave analysis. We found some parameters used in DAE method are not appropriate. We can estimate more accurate electron density profile by using appropriate parameters in DAE method.

Keywords: electron density in the lower ionosphere, Full wave analysis, MF radar, DAE method

Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

PEM032-P11 Room:Convention Hall Time:May 27 10:30-13:00

Solar cycle variations of the tweek reflection height

Hiroyo Ohya[1*], Kazuo Shiokawa[2], Yoshizumi Miyoshi[2]

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The purpose of this study is to reveal solar-cycle variations of the tweek reflection height. Tweek atmospherics are reflected at a height where the equivalent electron densities are 20 - 30 cm^{-3}. Descent (rise) of the reflection height corresponds to increase (decrease) in electron density in the ionospheric D- and lower E-regions. It is known that electron density in the sub-ionosphere depends on solar activities, although nighttime lower ionosphere has not been sufficiently investigated yet. An advantage of using tweeks is to be able to monitor variations of electron density less than 10^2 cm^{-3} along long propagation paths (several thousands of kilometers). From cut-off frequency of the first order mode on dynamic spectrum, we can estimate the reflection height. We use tweek data obtained at Kagoshima (31.5N, 130.7E), Japan, on magnetically quiet days in 1976-2010; solar cycles 21,22, 23, and the rising phase of solar cycle 24. The average and standard deviation of the reflection height were 95.9 km and +/-3.1 km, respectively. The years when the tweek reflection height was lower than 93.0 km were 1976 (solar minimum), 1979 (solar maximum), 1985 (solar minimum), 1995-1997 (solar minimum), and 2002 (solar maximum). On the other hand, the years when the tweek reflection height was higher than 99.0 km were 1977-1978 (rising phase), 1987-1991 (rising phase to solar maximum), and 2006-2009 (solar minimum). The significant peaks of the periodgram were seen to be 13.3, 3.2, and 1.3 years. We have considered possible causes of this long-term variation of the reflection height: geocorona emission, galactic cosmic ray (GCR), particle precipitation from the inner radiation belt, and the neutral atmosphere. In the presentation, we discuss possible causes of this long-term variation of the reflection height.

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PEM032-P12 Room:Convention Hall Time:May 27 10:30-13:00

The dependence of latitude of period of small magnetic variation in the middle and lower latitude over the ionosphere fr

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As the result of the analysis of magnetic field observed by Oersted satellite to measure the Earth's magnetic field accurately at the low altitude(600 km - 900 km) from 1999 to 2002, the existence for nearly all the time of magnetic variation with period shorter than 30 seconds has been reported. We can, as to variation in the region between the middle and lower latitude, see the phenomenon a lot that the period becomes longer with the decrease of latitude. This phenomenon is also shown by magnetic field observed by CHAMP satellite to measure the Earth's magnetic field accurately at the low altitude(300 km - 450 km) from 2000. The calculation of power spectra with respect to period of this variation using the Maximum Entropy Method shows the above characteristic property. This property is reverse to that of geomagnetic pulsation that the period of it, in general, becomes shorter with the decrease of latitude, that is, this can be thought to be beyond description of the magnetic variation. It may, with the assumption that this phenomenon is of Nature, be attributed to the effect of the lower atmosphere. It follows from this theory that the wave arising in the lower atmosphere propagates to the upper to cause dynamo in the ionosphere, accompanied by the magnetic variation that is observed by both the satellites. Following this mechanism, the supposition that the spatial scale in the ionosphere is homogeneous, or, is dependent of the latitude will, because of the increase of the interval of latitude between lines of magnetic force with the increase of latitude, lead to the fact that the spatial scale should become bigger in the upper layer of the ionosphere where the satellite flied, that is, the period should become longer. This time we will, in comparison with Oersted data and CHAMP data, report the result of whether or not the above model is valid, with the dependence of the period of the observational small magnetic variation with respect to the region, the local time, the season respectively.

Keywords: ionosphere, small magnetic variation, CHAMP satellite, Oersted satellite

Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

PEM032-P13 Room:Convention Hall Time:May 27 10:30-13:00

Atmosphere-Ionosphere Coupling Studied with a High-Resolution Electrodynamics Model

Hidekatsu Jin[1*], Yasunobu Miyoshi[2], Hitoshi Fujiwara[3], Hiroyuki Shinagawa[1], Kaori Terada[3]

[1]NICT, [2]Kyushu University, [3]Tohoku University

Ionospheric electrodynamics plays an important role not only in causing storm-time ionospheric disturbances but in causing day-to-day ionospheric density variation and irregularity. The latter phenomena are known to be related to thermospheric variations, some of which originate from the lower atmosphere. For example, the day-to-day variation of equatorial ionization anomaly (EIA), which affects ionospheric density at low-to-mid latitudes, is driven by low-latitude electric field generated from atmospheric waves via dynamo process. Recently observed 4-wave structure of EIA suggests that some of the variations are of tropospheric origin. The occurrence of equatorial plasma bubble also varies on the day-to-day basis.

We are developing an atmosphere-ionosphere coupled model, which is expected to contribute to the understanding of lower atmospheric effects on the ionospheric day-to-day variation and irregularity. In this presentation, we report some recent upgrades of the electrodynamics model as a component of the atmosphere-ionosphere coupled model.

Keywords: ionosphere, thermosphere, lower atmosphere, electrodynamics, geomagnetic variation, simulation

Japan Geoscience Union Meeting 2011
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PEM032-P14 Room:Convention Hall Time:May 27 10:30-13:00

Correlation of electron temperature with electron density in the low latitude topside ionosphere

Kenta Hayashi[1*], Shigeto Watanabe[1], Yoshihiro Kakinami[2]

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The correlation between electron temperature (Te) and electron density (Ne) in the low latitude topside ionosphere is investigated from the comparison of the satellite observations and the modeling. The observations show that the negative or the positive correlations between Te and Ne occur in the low latitude topside ionosphere during the daytime. The phenomena are associated with the equatorial ionization anomaly (EIA). To understand the generation process of the electron temperature and density distributions, we compared the observations with the physical modeling and an empirical model such as the International Reference Ionosphere (IRI).

Keywords: Demeter satellite, ionosphere, electron density, electron temperature

Japan Geoscience Union Meeting 2011
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PEM032-P15 Room:Convention Hall Time:May 27 10:30-13:00

3D MHD simulations of electromagnetic variations in the ionosphere caused by waves from the lower atmospere

Mitsuru Matsumura[1*], Hiroyuki Shinagawa[2], Toshihiko Iyemori[1]

[1]Kyoto University, [2]NICT

It has been shown from a lot of observation that acoustic and internal gravity waves generated in the lower atmosphere can propagate to the ionosphere [e.g., Davies and Jones, 1971; Heki et al., 2006, Otsuka etal., 2006, Choosakul et al., 2009]. A geomagnetic pulsation was observed at Phimai in Thailand, shortly after the origin time of the Sumatra earthquake on December 26, 2004[Iyemori et al., 2005]. The localized nature and the period of oscillations suggest that the magnetic pulsation was generated by dynamo action in the lower ionosphere, set up by an acoustic wave generated by the earthquake. However, geomagnetic pulsations caused by atmospheric waves excited in the lower atmosphere have hardly ever been observed. Accordingly, the objective of this paper is to estimate the physical mechanism of this phenomenon.

Shinagawa et al. [2007] performed a numerical simulation by using a two dimensional atmosphere-ionosphere model, in which atmosphere is non-hydrostatic and compressible, and ionosphere is single-fluid of O+. Results of the simulation agreed with observational results of ionospheric disturbances caused by atmospheric waves generated by a large earthquake. The numerical model used in this simulation does not include the electromagnetic variations. In this work a MHD model is developed which use the plasma velocity calculated with a three dimensional expanded from the model of Shinagawa et al., 2007. Temporal variations of the magnetic field is considered to investigate whether the geomagnetic pulsations caused by atmospheric waves from the lower atmosphere are due to hydromagnetic waves or not.

In this paper, initial results obtained with this model will be reported.

Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

PEM032-P16 Room:Convention Hall Time:May 27 10:30-13:00

Study on latitudinal profile of TEC and its relationship with plasma irregularity occurrence over Southeast Asia

Michi Nishioka[1*], Yuichi Otsuka[1], Kazuo Shiokawa[1], Takuya Tsugawa[2], Patrick. A. Roddy[3]

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Latitudinal profile of Total Electron Content (TEC) was investigated with ground-based GPS receiver network Southeast Asia. Development of Equatorial Ionization Anomaly (EIA) was compared with occurrence characteristics of plasma irregularity, which is observed with C/NOFS satellite. EIA, which appears around 10-15 geomagnetic latitude as the high plasma density area, is generated through the plasma fountain effect in the ionosphere caused by eastward electric field around the dip equator and diffusion of plasma along the geomagnetic field line. Since the eastward electric field is related to formation of plasma irregularity, plasma irregularity often appears when EIA is well-developed. During solar minimum period, many plasma irregularities have been observed around midnight in June solstice seasons. The occurrence characteristics of the plasma irregularity is different from that of plasma bubble. It has not been understood whether the midnight irregularity is related to plasma bubble or Traveling Ionospheric Disturbance (TID). In this study, we investigated relationship between EIA development and occurrence of the plasma irregularities. In Southeast Asia, several ground-based GPS receivers were operated by several institutes, such as Solar-Terrestrial Environment Laboratory (STEL), National Institute of Information and Communications Technology (NICT), and International GNSS Service (IGS). In order to clarify the latitudinal profile of Total Electron Content (TEC), data of ground-based GPS receivers around 100E meridian was used in this study; KUNM (IGS: 103E, 24N), CMU (NICT: 99E, 18N), CUSV (IGS: 101E, 13N), KMI (NICT: 101E, 13N), CPN(NICT: 99E, 10N), SAMP (IGS: 99E, 3N), NTUS (IGS: 104E, 1N), KTB2 (STEL: 100E, 0N), XMIS (IGS: 106E, 10S), COCO (IGS: 97E, 12S). It was found that EIA was more developed during equinoxes than during solstice seasons. Relationship between EIA development and plasma irregularity occurrence was studied for two sets of three consecutive days; 26-28 February and 4-6 June, 2010. For detection of the plasma irregularities, data of a Planar Langmuir Probe (PLP) on a low-inclination satellite, the C/NOFS satellite, was used. Plasma bubble was observed on 27 Feb while it was not observed on 26 and 28 Feb. Midnight irregularity was observed on 4 and 6 June while it was not observed on 5 June. EIA was more developed on 27 Feb. when plasma bubble was observed than on 26 and 28 Feb. when plasma bubble was not observed by the C/NOFS satellite. On the other hand, EIA was less developed on 4 and 6 June 2010 when midnight irregularity was observed than on 5 June when the midnight irregularity was not observed. It suggests the relationship between EIA and plasma irregularity occurrence was different between plasma bubble and midnight irregularity.

Keywords: Total Electron Content, latitudinal profile, Equatorial Ionization Anomaly, ionospheric irregularity, plasma bubble

Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

PEM032-P17 Room:Convention Hall Time:May 27 10:30-13:00

Comparison between B0 retrieved from FORMOSAT-3 measurements and ground-based observations at equator

Yu-Jung Chuo[1*]

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This study presents the results of a comparison of three ionospheric profile parameters, B0, NmF2, and hmF2, derived from measured ionograms and the FORMOSAT-3 radio occultation measurements collected over Jicamarca during the low-solar-activity period from May 2006 to April 2008. The results show that the B0 values are generally in good agreement with those derived from the true electron density profiles. In addition, correlation analysis revealed seasonal and diurnal variation in B0, which is more pronounced during an equinox and daytime (0800-2000), respectively. A comprehensive discussion on the difference between the values of B0, NmF2, and hmF2 derived from two sources is provided in this paper.

Keywords: B0, COSMIC, Ionospheric dynamics

Japan Geoscience Union Meeting 2011
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PEM032-P18 Room:Convention Hall Time:May 27 10:30-13:00

Amplitude of ionospheric disturbance heights estimated by scintillations of geostationary satellite signals

Hiroaki Taniyama[1*], Ichiro Tomizawa[1], Satomi Kudo[1]

[1]Center for Space Science and Radio Engin

Amplitude scintillations of ionospheric disturbances have been observed at Sugadaira Space Radio Observatory,UEC by using the 1.5GHz band signal of ETS-VIII(146‘E) and MTSAT-2(145‘E). The amplitude scintillation were observed at three separate points to obtain the horizontal velocity of the scintillation pattern on the ground by time lag of waveforms. We independently estimate the heights of of ionospheric irregularities in the following two methods to check the consistency of these estimated heights.

(1)Two satellite method: The irregular heights (h) deduced from time lag (dt) and velocity of irregular structure v. Time lags between two signals by assuming the irregularities moving across the propagation paths. The height h can be calculated by the following equation: d = v ∗ dt , z = (d / sin a) , h = z ∗ sin(El).

(2)Spectral analysis method: As the scintillation spectrum shows the Fresnel filtering characteristics, we can deduce frequency f_n at the n-th minimum value in vibrating part, Fresnel frequency and f_F by the distance z from the observation point to irregular structure, and the velocity v. So the distance z can be estimated as v. f_F{F} = v / sqrt{pi ∗ lambda ∗z} , f_f = f_n / sqrt{n ∗ pi} .

The amplitude scintillation event occurred from 0:00 to 3:00 JST on May 30, 2010 is analyzed by using the horizontal velocity 50 ˜ 250 m/s and direction of 310‘ on the ground obtained by three points observation. The estimated heights from 2:00 to 3:00 of the two methods showed the similar height variation during this period. Therefore, it is concluded that the two height estimation methods can give the actual height distribution of ionospheric irregularities.

Acknowledgment :
The ETS-VIII observations was performed under the JAXA utilization project.

Reference

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Keywords: Ionosphere

Japan Geoscience Union Meeting 2011
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CONTINUAL 24-HOUR OBSERVATIONS OF THERMOSPHERIC WINDS MADE WITH THE SOFDI INSTRUMENT FROM HUANCAYO, PERU

Andrew Gerrard[1], John W. Meriwether[2], Kunihiro Keika[1*]

[1]New Jersey Institute of Technology, [2]Clemson University

The Second generation Optimized Fabry-Perot Doppler Imager (SOFDI), a state-of-the-art triple-etalon Fabry-Perot interferometer, has been sucessfully relocated to Huancayo, Peru and is making continual 24-hour observations. The 630-nm data, originating from layer-integrated OI emission with centroid heights of 250 km at night and 220 km during the day, are analyzed so as to obtain measurements of horizontal winds in the thermosphere. In this paper we report the most recent results from continuous 24-hour observations of these thermospheric parameters and show that the zonal wind reversals at equatorial latitudes are very much like the recent CHAMP observations.

Keywords: thermosphere, Doppler Imager, OI emission, horizontal winds, continuous 24-hour observations, low-latitude zonal wind reversals

Japan Geoscience Union Meeting 2011
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PEM032-P20 Room:Convention Hall Time:May 27 10:30-13:00

Observations of traveling ionospheric disturbances using GPS networks in the Southeast Asia

Takuya Tsugawa[1*], Kornyanat Watthanasangmechai[2], Hiromitsu Ishibashi[1], Kato Hisao[1], Michi Nishioka[3], Yuichi Otsuka[3], Akinori Saito[4], Tsutomu Nagatsuma[1], Ken T. Murata[1]

[1]NICT, [2]KMITL, [3]STEL, Nagoya University, [4]SPEL, Kyoto University

Two-dimensional total electron content (TEC) maps have been derived from ground-based GPS receiver networks and applied to studies of various ionospheric disturbances since mid-1990s. For the purpose of monitoring and researching ionospheric disturbances which can degrade GNSS navigations and cause loss-of-lock on GNSS signals, we have developed TEC maps over Japan using the dense GPS network, GEONET. Using the GPS-TEC maps, we have revealed some severe ionospheric events such as high latitude storm-time plasma bubbles and storm enhanced density events observed over Japan. These events cause loss-of-lock of GPS signals and large GPS positioning errors. The dense GPS receiver networks would be a powerful tool for the nowcast/forecast of ionospheric disturbances.

As a part of Southeast Asia low-latitude ionospheric network (SEALION), four GPS receivers have been operated in Thailand since 2005, collaborated with KMITL, Thailand. We have found that periodic TEC fluctuations (PTF) with the periods of 15-30 minutes are often observed at these GPS stations in the spring (Apr-May) late afternoon. Based on the analysis using multiple GPS receivers in Southeast Asia, we suspect that the PTFs is a manifestation of traveling ionospheric disturbances (TIDs) which propagate at 150-200 m/s away from the equator. However, it has been difficult to reveal the spatial structures and temporal evolutions of such TIDs due to the sparse GPS receiver networks in the Southeast Asia.

We are now developing regional high-resolution TEC maps in the Southeast Asia using GPS receiver networks by installing GPS receivers and/or collecting GPS receiver data, collaborated with KMITL (Thailand), LAPAN (Indonesia), UKM (Malaysia), and HIG (Vietnam). In this presentation, we will show the preliminary results of the two-dimensional TEC observations of TIDs in the Southeast Asia. We also report the current status of future direction of ionospheric monitoring system using GPS receiver networks in the Southeast Asia.

Keywords: ionosphere, southeast asia, GPS, total electron content, ionospheric disturbances

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PEM032-P21 Room:Convention Hall Time:May 27 10:30-13:00

A Preliminary Result of the Ionospheric Observation Using FM/CW Ionosonde on Cebu Island in the Philippines

Hiromitsu Ishibashi[1*], Minoru Kubota[1], Takuya Tsugawa[1], Tsutomu Nagatsuma[1], Ken T. Murata[1], Takashi Maruyama[1]

[1]National Institute of Information and Co

Last September, we reactivated the NICT ionospheric observation at San Carlos University on Cebu Island in the Philippines. A portable FM/CW souder has been in operation. We have already conducted ionospheric observations around western Pacific equatorial region: SEALION Observation Network (SEALION: Southeast Asia Low-latitude Ionospheric Network). Along with these, Cebu ionospheric observation will function as longitudinal network of dense ionospheric observation and contribute a great deal to our understanding physical relationship between the equatorial plasma bubble and large-scale horizontal structure.

In this presentation, we will report a preliminary result after the reactivation.

Keywords: Equatorial Ionosphere, Plasma Bubble, ESF, Space Weather

Japan Geoscience Union Meeting 2011
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Long trend of Sq field and its seasonal variation

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The time variation of the amplitude of geomagnetic Sq field was examined for each month in a long period of more than 50 years at a few observatories. It was found that the amplitude is strongly controlled by the solar activity, and the difference between solar cycles including their fine structures reflected in the Sq amplitude. Although most of the effect of solar activity on the amplitude can be explained by the variation of the ionospheric conductivity, the seasonal variation of the amplitude in response to the solar activity cannot be simply explained by the conductivity effect,.

In the presentation, these results will be discussed with those of the spherical harmonics analysis and the ionospheric conductivity estimation.

Keywords: geomagnetism, daily variation, long trend, seasonal variation, solar activity, ionospheric conductivity

Japan Geoscience Union Meeting 2011
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A study of Sq and EEJ based on atmospheric general circulation model

Yui Aramaki[1*], Saburo Miyahara[1]

[1]Kyushu University

It is known that Sq and equatorial electrojet (EEJ) current systems exist in the E-region and they show day-to-day and seasonal variations. These current systems are mainly induced by atmospheric tidal winds.

Kawano-Sasaki and Miyahara (2008) developed a quasi-three-dimensional dynamo model that is symmetric about the equator. They studied three-dimensional structures of the dynamo currents using the September neutral winds in the middle atmosphere general circulation model at Kyushu University, and showed that variations of the neutral winds induce daily variations of Sq and EEJ.

We extend their model to include anti-symmetric components, and simulate asymmetric three-dimensional dynamo currents. Simulations are also conducted using the wind data for June and December when asymmetric components become dominant. We will mainly discuss about relationships between the day-to-day and seasonal variations of the neutral winds and the simulated current system.

Keywords: Sq, EEJ, ionosphere

Japan Geoscience Union Meeting 2011
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PEM032-P24 Room:Convention Hall Time:May 27 10:30-13:00

Visible airglow observation by VISI on ISS-IMAP: Current status of development and simulation of airglow measurement (4)

Takeshi Sakanoi[1*], Atsushi Yamazaki[2], Yusuke Akiya[3], Yuichi Otsuka[4], Takumi Abe[2], Makoto Suzuki[2], Akinori Saito[3]

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The ISS-IMAP mission is one of the Japanese Experiment Module (JEM) 2nd stage plan which will be launched in January 2012 onto the International Space Station (ISS) with HTV (Konotori). The main scientific subject of this mission is to clarify the energy and physical transfer processes in the boundary region between earth's atmosphere and space with the visible spectrometer and extra ultraviolet imagers.

We have been developing a visible imaging spectrometer instrument (VISI) on ISS-IMAP. VISI will measure three nightglow emissions; O (630 nm, altitude 250 km), OH Meinel band (730 nm, altitude 87km), and O2 (0-0) atmospheric band (762 nm, altitude 95 km) with the two field-o-views which enable us to make a stereoscopic measurement of the airglows looking forward (+45 deg.) and backward (-45 deg.) to subtract contaminations from clouds and ground structures. We designed a bright (F/0.9), wide-angle (field-of-view 90 degrees) objective lens. VISI have a two-line-slit on the first focal plane to perform the stereoscopic measurement. Each slit, i.e., field-of-view, is faced perpendicular to the orbital plane, and its width is about 550 km mapping to an altitude of 100 km. The phase velocity of airglow wave structure is also estimated from the difference between forward and backward data. We will obtain a continuous line-scanning image for all emissions line from + 51 deg to -51 deg. in geographic latitude by the successive exposure cycle with a time interval of 1 - several sec.

Over the last year, we manufactured the flight model of optical system and electronics of VISI, carried out the optical test including the adjustment of focus and alignment, intensity calibration, function check, vibration and vacuum thermal tests. We finally evaluated the accomplishment of the VISI instrument. At this moment, VISI and other instruments were installed on the Multi-mission Consolidated Equipment (MCE) to make integration tests. We present the evaluated specifications of VISI, operation plan and the current status of tests.

Keywords: ISS, airglow, thermoshpere, ionosphere, development

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PEM032-P25 Room:Convention Hall Time:May 27 10:30-13:00

Observation of mesospheric Ca ion by mobile resonance lidar

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Many observations of metal atomic layers such as Na, Fe, K, Ca and Ca ion in the mesopause region have been conducted in many parts of the world. We have also observed several mesospheric metallic layers at Tokyo and Indonesia using resonance scattering lidars consisting of a dye laser and a Ti:Sapphire laser. Especially, in order to solve the formation mechanism of metallic sporadic layers occurred in the mesopause region, the simultaneous observations of Ca ion density, electron density, and wind are necessary. We have developed container based mobile resonance scattering lidar for observations of several mesospheric metallic atoms and an ion. We have started simultaneous observations with the resonance scattering lidar, an ionosonde, and the MU radar at Shigaraki.

Keywords: Ca ion, mesopause, lidar

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Automated Rayleigh lidar observation in Syowa station, Antarctica.

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The dynamics of the middle and upper atmosphere is still not fully understood. In particular, a quantitative estimation of dynamical effects related to energetic particle precipitation such as aurora, disturbances propagated from lower atmosphere, and a global circulation in polar middle atmosphere are not satisfactorily conducted mainly due to the lack of observations.

A new Rayleigh lidar system which can measure a vertical profile of the atmospheric temperature between 15km and 80km is developed for the Antarctic observation. This lidar had been transported to the Syowa Station (39E, 69S) in Dec, 2010 by the 52nd Japanese Antarctic Research Expedition (JARE52) and started operation in Feb, 2011. The transmitter of the lidar system consists of a pulsed Nd:YAG laser (355nm) with 300mJ energy and 20Hz repetition frequency, which emits the beam into the vertical direction with a beam divergence of 0.5mrad. The receiver consists of an 82cm diameter telescope with three photo multiplier tubes (PMTs) which are to detect Rayleigh scattered light from low and high atmosphere at 355nm and N2 Raman emission at 387nm. Additionally, a 35cm diameter telescope is also used for reception with a PMT for N2 RAMAN emission at 355nm. By using these channels, the lidar can deduce the wide range of altitude in a temperature profile.

In addition to these PMT channels, an image-intensified CCD camera (ICCD) with a gating is also installed in the receiving system, in order to monitor the image of scattered light from a certain altitude even in a day-time and to align the laser beam to the center of the field of view of the telescope. An etalon with a transmittance width of 10pm in FWHM and a polarizer are inserted to Rayleigh channels in the day time in order to reduce background scattering from the sky. The daytime observation will be carried out not only for profiling the temperature in the stratosphere in summer, but also profiling polar mesospheric clouds (PMCs) around 80-85km which are formed in summer. The system is controlled and operated with two personal computers and manual operations are minimized. Operation will be carried out by operators in Syowa, who are not experts of lidar system. Therefore, control PC and softwares have been prepared in order to continue observation automatically, with assistance from a remote place. We present details about the lidar system and a current status of the first year observation.

Keywords: stratosphere, mesosphere, lidar, Antarctica, gravity wave, PMC

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Small scale disturbance in the wind field in the polar mesopause region inferred by successive images of a meteor train.

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A fireball meteor with a visual magnitude of over -6 followed by a persistent trail was observed by two all-sky cameras for detecting the aurora and sodium airglow at Syowa Station (69.0^{o}S, 39.5^{o}E), Antarctica, on 6 June 2008. Orbit and other parameters of the fireball were estimated by an all-sky television camera for detecting the aurora. After the passage of fireball, circular train expanded to a diameter of about 50 km in 9 minutes. This omnidirectional expansion allows us to determine the height of each fraction of the meteor train. The combination of 9 sequential images of the meteor train with 1 minute interval and the meteor orbit information estimated from ATV camera has revealed existence of a large atmospheric wave with a vertical wavelength of ~16km and an amplitude of ~30m/s in mesopause region during the event. In addition to the expanding motion due to the wave, the meteor train also showed rapid non-uniform motion with 2~3 minutes frequency along a background wind direction. The amplitudes of these motions are estimated as 50~60 m/s at 87km. Since this frequency is shorter than a typical buoyancy frequency (~5minutes), the oscillation can be an acoustic wave. However, ordinary acoustic waves which can reach mesopause region from an impulsive source such as a thunder storm in the troposphere are likely to have an amplitude of ~10 m/s [eg. Waltersheid et al., 2003]. According to Vadas et al. [2010], the atmospheric wave generated by an impulsive source such as aurora, and meteor impact is also probable. Alternatively, this rapid motion can likely be due to a kind of non-uniformity of winds in the polar mesopause region.

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Keywords: meteor, mesopause, meteor train, gravity wave, acoustic wave, sodium airglow

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Measuring of short-duration meteor trains

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Meteor trains are known as illuminating phenomena appeared along their meteor trajectories, just after appearing of meteors in Earth's atmosphere. Even by our naked-eyes, the illumination can be observed within a few seconds in the shortest, a few minutes in the longest. It can be recorded for about a few tens minutes by professional observation instruments. In order to obtain double-station meteor train images/movies with high spatial/temporal resolution, meteor train observation campaign was conducted by the authors in 1998, during an expected period of Leonids meteor storm, resulting successful archives of train images of numerous values of meteors of train images especially in 2001 .

In double-staion meteor movie data taken by image-intensified (I.I.) video cameras(Shigeno et al., 2003), many video clips of meteors with short-duration meteor trains were found. By using a motion-detection software "UFOCapture" (Sonotaco, 2009), 26 short-duration meteor trains (18 examples of Leonids as well as 8 of sporadic meteors) were picked out, deriving altitude distribution of short-duration meteor trains. As a result, (1) short-duration meteor trains averagely appeared between 120 km and 96 km altitude, (2) altitude distribution of short-duration meteor trains averagely changes in time to be finally centered at around 107 km, with having linear dependence for their upper limit altitudes as well as logarithmic dependence for lower limits, (3) duration time of short-duration meteor trains was in a range between 0.2 s to 4 s, (4) high correlation between absolute magnitudes of parent meteors and duration time of short-duration meteor trains, and (5) the altitude distribution of short-duration meteor trains could be explained with OI557.7 nm luminescence and collision (quenching) process with surrounding upper atmosphere.

Applying the analizing method of Leonids short-duration meteor trains to the other meteor showers, it is expected to obtain altitude distribution of the short-duration meteor trains and its evolution in time for several meteor showers as was studied in Leonids case (Toda et al., 2010), as well as to study comparison in altitude distribution of short-duration meteor trains. Moreover as a suggestion of observing meteor train in near future, we would like to introduce an imaging method with repetition of quick exposure (1s or shorter) with a fixed FOV by high-sensitivity digital cameras, as well as our dating results of meteors and meteor trains.

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Keywords: meteor, meteortrain

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Development of a calibration device for absolute reception power of HRO meteor echoes.

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1.Background and purpose

HRO(Ham-band Radio Observation) is known as an easy meteor observation method using forward-scattering echoes of beacon waves (Maegawa, 1999). In Kochi University of Technology, a 6-channels HRO (North, South, East, West and zenith with 2 polarizations) began in July 2003. A 3-channels radio interferometer was produced and started its observation with direction-findings of meteor echoes in January 2005. (Horiuchi et al., 2005). In January 2009, a 5-channels radio interferometer was developed, resulting more precise calculations of meteor appearance position than the 3-channels radio interferometer as well as quasi-realtime web casting of meteor plasma coordinates in 90 km plane (Noguchi, 2009). However, accurate absolute values of reception power of meteor echoes can not be obtained by these observation tools. Observational data are insufficient for deriving statistical studies of energy estimation of each meteor, mass distribution, and flux. Purpose of the present research is development of absolute reception power by developing a calibration device for HRO echoes.

2.Absolute power calibration device

Reception power of each meteor echo is usually indicated in an intensity graph of the ”HROFFT” (a dedicated software for HRO) corresponding to relative power (dB value) on a noise floor. Intensity of Doppler distribution is indicated on a FFT spectrogram using relative color scale of 13 levels (0 to 12). In HRO, expectation of absolute power of each meteor echo is in a range between -80 dBm and -120 dBm (Usui, 2004). In this study, we develop a signal generator that can output simulated meteor echo signal, creating a descending step-function with 10 dB intervals in 5 seconds per 10 minutes. The developed device will be applied to receiver block of the 5-channels radio interferometer. We can analyze absolute power of each meteor echo by indicating the simulated signal by HRO_IF_View software that can display waveform of each echo.

3.Development

In this study, we produced a circuit using PLL (Phase Lock Loop) technique based on an experiment at Nobeyama observatory (NAOJ) as a reference (Usui et al., 2004). In the PLL circuit, phases are compared between a reference signal of 16 MHz from a crystal oscillator and an output signal from VCO (Voltage Controlled Oscillator). When phases of the both signals are locked by auto-tuning feedback process, the PLL circuit can output a carefully-adjusted 860 MHz signal. Then, the frequency of output signal is down-converted to 1/16 by two frequency dividers. A final output is 53.75 MHz, the observational frequency of HRO. Typical output power of the PLL circuit is about -50 dBm. Therefore, absolute power range of our purpose can be obtained by attenuation and precise calibration process of the output signal by a signal generator (Aglient, 33250A) . In this presentation, we will introduce a preliminary result and detail of the study.

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Keywords: HRO, meteor, forward-scattering, reception power, Phase locked loop, absolute calibration

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Monthly MU radar head echo observation programme for sporadic and shower meteors: 2009 June to 2010 December

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Meteors, or colloquially shooting stars, are caused by particles from space that are heated up and shattered in the atmosphere. Different estimates of how much mass these meteoroids bring to our planet vary by several orders of magnitude. We conducted a systematic set of monthly meteor head echo observations from 2009 June to 2010 December (>500 h), except for 2009 August, by the interferometric Shigaraki Middle and Upper atmosphere (MU) radar in Japan (34.85 degree N, 136.10 degree E). The ultimate purpose of our observation programme is to improve the estimate of the flux of extraterrestrial material into the Earth's atmosphere and to investigate the possible flux of extrasolar meteoroids entering the solar system and crossing Earth's orbit.

Using the interferometric ability of the MU radar we have developed analysis algorithms that give precise geocentric velocities and directions of the observed meteoroids - a few hundreds of metres per seconds and a fraction of a degree, respectively. About 3000 events from a total number of about ten thousand head echoes per 24 h observation have the above mentioned accuracy. The head echoes are detected in the height range of 73-127 km. A total number of more than 100 000 meteor detections allows us to map the seasonal variation of the sporadic meteor influx, as well as its characteristics in form of geocentric velocity and altitude distribution of the deposited material. The initial altitude distribution shows clear velocity dependence, higher velocity meteoroids ablating at higher altitude.

Our data set contains both shower and sporadic meteor detections. Sporadics are those meteoroids that cannot be directly ascribed to a parent body. Sporadics are the most numerous among our observed particles, and the main contributors to the mass influx into the Earth atmosphere.

Head echoes of shower meteors are quite rare in modern high-power large-aperture (HPLA) radar data, primarily because sporadics outnumber shower meteors in the low-mass regime observable with these radar systems. The small collecting area of an HPLA radar system further limits successful observation of shower meteors. Analysis performed on a limited data set may, therefore, contain no or only a few shower meteors due simply to low statistical probability. In this work, we have estimated the MU radar collection area, calculated the flux of Orionid meteors, and show that the Orionid meteoroid stream activity could be accurately tracked with the MU radar when the radiant is at least 10 degrees above the local horizon.

Keywords: meteor, meteoroid, HPLA radar, head echo, meteor shower

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An field test of an improved bistatic observation system with COBRA

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The bistatic Doppler velocity measurement is a useful ways to retrieve 2D wind fields with weather radars. We have examined an improved system to get over some problems of the bistatic measurement system. In this study, we will report a result of an actual experiment of this improved bistatic observation system with COBRA.

Usually the bistatic measurement uses a receiving antenna whose beam width is wide. Due to that, the low gain and false echoes by sidelobe contaminations used to be problems. In this improved system, we are planning to use an array antenna for the receiver, it leads to increase the receiving gain. In case of usual array antenna, the spacing between elements is selected short (less than one wavelength) to form only one strong main lobe and to avoid forming grating lobes. But it is difficult to form a narrow beam enough to reduce the sidelobe contamination with limited number of elements. In this study, we dare to select long spacing (e.g. 10 wavelengths) and to form many sharp grating robes (beams) simultaneously. Sidelobe contaminations near around the strong echoes are expected to be reduced with these sharp beams.

We, National Institute of Information and Communications Technology (NICT), have a full polarimetric Doppler weather radar named COBRA in Okinawa. We are planning to perform actual experiments with this radar system. Simulated results, an experimental system, and preliminary observational results will be presented.

Keywords: weather radar, bistatic, Okinawa, COBRA