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^o N to 15^o 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

Japan Geoscience Union Meeting 2011
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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

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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 northeastward 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

Japan Geoscience Union Meeting 2011
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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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PEM032-17 Room:103 Time:May 27 08:30-08:45

Summary of observational results obtained with the new Tromso sodium LIDAR

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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

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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

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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

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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

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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

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

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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