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PEM29-P01 Room:Convention Hall Time:May 22 18:15-19:30

Variations of scale height at F-region peak based on ionosonde measurements during solar maximum over the EIA region

Yu-Jung Chuo[1*]

[1]Department of Information Technology, Ling Tung University

Scale height is an important parameter in characterizing the shape of the ionosphere and its physical processes. In this study, we attempt to examine and discuss the variation of scale height, Hm around the F-layer peak height during high solar activity at the northern crest of the equatorial ionization anomaly (EIA) region. The data analyzed in this investigation, including Hm, the bottomside profile parameter, the F2-layer maximum critical frequency, and its peak height are derived from ionograms recorded at Chung-Li ionosonde station (geographical coordinate 24.9oN, 121.1oE) in 1999. Hm exhibits a day-to-day and seasonal variation, with a greater average daily variation during daytime in summer. Furthermore, the diurnal variation of Hm exhibits an abnormal peak at pre-sunrise during all the seasons, particularly in winter. This increase is also observed in the F2-layer peak height for the same duration with an upward movement associated with thermospheric wind toward the equator; this upward movement increases the N2/O ratio and Hm, but it causes a decrease in the F2-layer maximum critical frequency during the pre-sunrise period. In addition, the results show a strong/weak correlation between the bottomside/equivalent slab thickness and Hm throughout the year. Furthermore, we present a comprehensive discussion of the physical processes regarding the variation of Hm during high solar activity periods.

Keywords: scale height, ionospheric physics, EIA, ionospheric dynamics

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PEM29-P02 Room:Convention Hall Time:May 22 18:15-19:30

Sporadic E detection with GPS TEC and estimation of its horizontal and vertical structure

Jun MAEDA[1*], Kosuke Heki[1]

[1]Dept. of Science, Hokkaido University

Sporadic E

Ionosphere is often divided into three parts (layers) depending on its electron density. F-layer is the most ionized layer at the highest altitude of 130˜500 km, followed by E-layer at 90˜130 km and D-layer at 70˜90 km. During the summertime in mid-latitude region in where Japan is located, sudden increase of electron density in E-region of ionosphere which is called sporadic E often occurs.

Observations of sporadic E

Ionosonde has long been taking the main role of ionospheric and sporadic E observation for a long time, now we have another method to monitor ionosphere, that is, GPS (Global Positioning System) satellites. We used TEC (Total Electron Content) which is derived from L1/L2 phase data to detect the sudden increase of electron density caused by Sporadic E. With the expansion of GNSS (Global Navigation Satellite System) and the dense network of GEONET GPS receivers in Japan, it is possible to watch ionosphere more spatially than ever before.

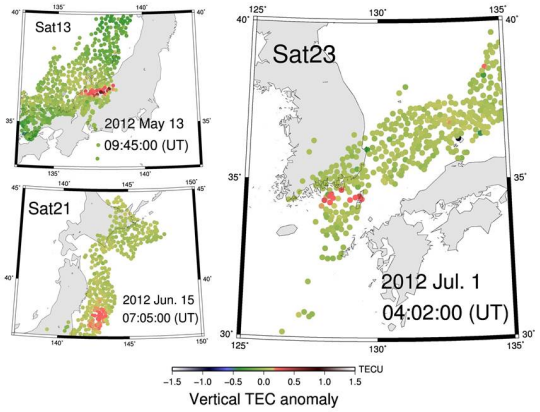
Results of sporadic E observation with GPS TEC

We observed sporadic E with GPS TEC method which has mainly been used for ionospheric disturbances in F-region of ionosphere. This study provides first results of sporadic E observation with GPS TEC.

With the data from the dense array of GEONET GPS receivers, firstly, GPS TEC has revealed the horizontal structures of sporadic E. One of the characteristics of the horizontal structure of sporadic E is the East-West belt-like shape with the length of ˜100 km and the width of ˜20 km. Secondly, the results comes about sporadic E motion. The speed and the direction of sporadic E motion do not look uniform. Some sporadic E moves southwestward at the speed of ˜50 m/s and some moves eastward at ˜150 m/s.

We are also reporting the first results of thickness estimation of sporadic E with GPS TEC in combination with Ionosonde.

Keywords: Sporadic E, Ionosphere, GPS TEC, ionosonde, GEONET



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PEM29-P03 Room:Convention Hall Time:May 22 18:15-19:30

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

Taketoshi Miyake[1*], Takahiro Kurokawa[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. We are going to compare simulation results and results observed by S-310-40 sounding rocket, launched at Dec. 2011, and then estimate spatial structure of Es layer.

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

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PEM29-P04 Room:Convention Hall Time:May 22 18:15-19:30

Observation of the wave-front structure of Es March 10, 2012 by VHF long-distance propagation

Takuya Yamahata[1*], Ichiro Tomizawa[1]

[1]Center for Space Science and Radio Engineering

We reported in the SGEPSS-2012 meeting that the development of the Es-structure observation system in wide area by receiving VHF(VOR/ILS,108˜118MHz) long-distance propagation signals as the Es wavefront structure moving in southward for the intense Es on March 10, 2012 around 12h JST[1]. We were analyzed the waveform data from 20 stations in the vicinity of the received field strength of Shanghai.We had derived the structure and movement of wide-area Es obtained by fitting a straight line to the peaks of field strength.

In the paper, we report the results of detailed analysis of the internal structure of the Es wavefront based on observed waveform.

At the first, we cut the data at 12 JST of two VOR station of higher S/N in the event to make a feature extraction by waveform correlation. In the same time, the presence of Es structure of more than 1000km has been confirmed with HFD, VHF band, Ionosonde, and the frontal Es has the moving speed of 92 m/s and the direction angle of 170 degree from north [2]. Since the duration of the Es front is 28 minutes, the entire width of the wave front could be confirmed with 163km. Since the entire wavefront is divided into two parts, it was found the presence of the entire half, 74 km structure. Further Analyzed the internal structure using cross-correlation, we were confirmed that Es has a width of about 14 km short wavefront structure ,since has a period of about 150 seconds It is similar to the value of the observations of Goodwin (1966) [3]. On the other hand, it was found that structure of peaks and troughs at intervals of 2 ˜ 3km, this can be interpreted as a small structure less than the diameter of the Fresnel zone that is moving from the north to south direction.

Detailed analysis of other Es horizontal structures will be presented at the meeting.

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Keywords: Es, VOR, ILS, VHF long-distance propagation, Sporadic E

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PEM29-P05 Room:Convention Hall Time:May 22 18:15-19:30

Accuracy improvement of reflection height and moving characteristics of frontal Es by oblique ionosonde and HF Doppler

Atsushi Ohtani[1*], Ichiro Tomizawa[1]

[1]SSRE, Univ. Electro-Comm.

The HF Doppler observation using 5006 and 8006 kHz transmitted from to the Chofu campus of UEC has been conducted at eleven stations including Sugadaira to observe of varieties ionosphere disturbances. However, it has the weak point that the wave reflection height cannot be specified by the HFD observation itself.

Fortunately, the distance between the HFD transmitting station (JG2XA) and the NICT Kokubunji ionosonde station is close to each other in only 8 km. Those Fresnel zones have an overlap area so that the two observations has the same reflection height. In this observation, we used a software defined radio receiver to receive ionosonde pulses from 7 to 9MHz around the 8006kHz HFD signal. The pulse transmission timing of ionosonde which is precisely scheduled in UTC were observed by mixing with the GPS synchronised 1sec pulse in the 1 micro-second accuracy. The propagation distance from Kokubunji to Sugadaira was measured by the arrival delay of ionosonde pulses. This method was applied to estimate the height and moving characteristics of Es. The reflection height can be determined from propagation distance and the reflection position of Es which were calculated from the movement speed and the direction angle through the HFD network. As the propagation path both to the ionosonde and the chofu HFD transmitter can be deduced by applying the method of Cornelius and Essex(1979) [1], we can deduce the same reflection height.

Around 20h JST(UT+9h) on July 28, 2012, the frontal Es with more than 200 km length passed over Sugadaira to Chofu by the speed of 60 m/s in the 182 degree from north was observed in this observation system. We obtained the accurate reflection height of the frontal Es as 115 km in matching the propagation path to the oblique ionosonde.

Acknowledgement: We are grateful to NICT for the ionosonde signal transmission.

Reference

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Keywords: ionosphere, ionosonde, sporadic E

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PEM29-P06 Room:Convention Hall Time:May 22 18:15-19:30

Total electron content of plasmasphere and ionosphere before and after geomagnetic storm by using Quazi-Zenith satellite

Natsuki Kinugasa[1*], Fujinobu Takahashi[1]

[1]Yokohama National University

Quasi-Zenith satellite system (QZSS) is the regional navigation satellite system covering Japan and Oceania. Altitude of QZS is 32,000km at the perigee and 40,000km at the apogee. Thus, QZS observation is affected by both ionosphere and plasmasphere. Plasmaspheric contribution on QZS observations is considered to be different from that on GPS observations because altitude of GPS(global positioning system) satellite is 20,200km.

In this research, we're trying to measure QZS total electron content from dual-frequency propagation delay. And we will present the results of measured QZS- and GPS-TEC especially before and after geomagnetic storm.

Keywords: QZS, TEC, GPS

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PEM29-P07 Room:Convention Hall Time:May 22 18:15-19:30

Development of TEC observation method using small differences of arrival angles of geostationary-satellites

Takafumi Yokoyama[1*], Ichiro Tomizawa[1], Michi Nishioka[2], MAHO NAKAMURA[1]

[1]SSRE, Univ. Electro-Comm, [2]NICT

We have been observing Total Electron Contents (TEC) with the Faraday rotation method using positioning signals transmitted from geostationary satellites, ETS-VIII and MTSAT-2 [1]. On the other hand, to observe a slight change in angle of arrival when geostationary satellite positioning signal to pass through the ionosphere, caused by ionosphere refraction of radio wave propagation path, it can be converted into TEC values are known [2].

But most of all reports [3] do not argue about absolute values, but about fluctuations. In this study, to examine the relevance of numerical value between the Faraday and the angle-of-arrival methods, we set up the interferometer by the three parabolic antennas were installed at the intervals of 50 ~ 80 m as well as the Faraday measurement [4].

When we made a presentation last year, angle-of-arrival method was twice as Faraday method. So we re-examine a phase difference method between each antennas. And we recalculate orbital calculation. As a result, angle-of-arrival method was similar to Faraday method.

In addition, we compare QZS-TEC and IRI model with angle-of-arrival method. And we observed sporadic-E by arrival angle method. This result was same as GEONET in July 4th 2012. We speak these results.

Acknowledgment

We can get QZS-data from Dr. Michi Nishioka. Thank you very much.

The study had received the support of NICT as an experimental project using ETS-VIII.

We can get GEONET data from Geospatial Information Authority of Japan. Thank you very much.

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Keywords: Ionosphere, TEC, Faraday rotation method, Angle-of-arrival method, sporadic-E

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Frequency characteristics of the variations of ionospheric total electron content after earthquakes using 1-second TEC

Yuki Shimizu[1*], Hiroyuki Nakata[1], Keigo Abe[1], Toshiaki Takano[1], Takuya Tsugawa[2], Michi Nishioka[2]

[1]Graduate shool of Engineering, Chiba University, [2]National Institute of Information and Communications Technology

There are many reports that ionospheric disturbances occur by giant earthquakes, such as the 2011 off the Pacific coast of Tohoku Earthquake. It is important to examine the ionospheric disturbance excited by earthquakes. Since this study is enable to monitor the tsunami from satellites, and arise a social concern.Therefore, purpose of this study is examination of the ionospheric disturbances after earthquakes by frequency analysis of temporal variations of TEC observed by GEONET. In previous studies, frequency band have been limited to less than 15 mHz because of using 30-second GPS-TEC. While in this study we use 1-second GPS-TEC to examine high-frequency band temporal variations that can not examined by using 30 seconds GPS-TEC. We cover the earthquakes larger than M6.0 occurred in March 2011. We used GPS data where the elevation angle of satellites was larger than 30 degrees observed by 800 GPS receivers of GEONET. We derived a frequency characteristic of GPS-TEC by Fast Fourier Transform.

As a result, the variations by earthquakes are shown in two events over M6.5. We analyzed a frequency characteristics of the variations above the epicenters and 300km far from the epicenters. It is shown that the variation at 3.9 mHz and 4.9 mHz are observed above the epicenters in both events. These frequencies are close to those observed after the Pacific coast of Tohoku Earthquake, by using 30-seconds GPS-TEC.

Additionally, in Sanriku Earthquake on March 9 and the Pacific coast of Tohoku Earthquake on March 11, we detected the oscillation around 15 mHz and 20 mHz above the epicenter. It is thought that the variations at these frequency are not excited by the resonance in the neutral atmosphere that have ever been reported.

Keywords: ionosphere, TEC, earthquake, atmospheric gravity wave, acoustic wave

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PEM29-P09 Room:Convention Hall Time:May 22 18:15-19:30

Causal link of the seismic surface waves in the lithosphere and TEC perturbation in the ionosphere during the 2011 Tohok

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

[1]Department of Earth Sciences, National Cheng Kung University, Tainan, Taiwan, [2]Department of Geophysics, Kyoto University, Kyoto, Japan, [3]Institute of Space Science, National Central University, Chung-Li, Taiwan

1Hz ground-based Global Positioning System (GPS) measurements from the Japan GOENT and Taiwan CWB are used to study the 2011 Mw 9.0 Tohoku earthquake at 05:46:23 UT on March 11, 2011. The high-rate GPS measurements can provide more detail information on the seismic fault of the earthquake. In this study, the propagation of seismic surface waves and ionospheric total electron content (TEC) perturbations generated by the Tohoku earthquake as well as their relationship are investigated by using the high-rate GPS measurements. It is found that the seismic surface waves and the initial ionospheric disturbances can transport from Japan to Taiwan. Results further found that there are time delay and deflection angle between the surface waves and the ionospheric disturbances when the earthquake waves transported from Japan to Taiwan. These results can help us to speculate the propagation path of the acoustic wave from the lithosphere to the ionosphere.

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PEM29-P10 Room:Convention Hall Time:May 22 18:15-19:30

Frequency dependence of the variations of total electron content associated with earthquakes

Keigo Abe[1], Hiroyuki Nakata[1*], Toshiaki Takano[1], Akinori Saito[2], Takuya Tsugawa[3]

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

Variations of total electron content (TEC) associated with earthquakes have been reported [e.g. Calias and Minster,1995; Afraimovich et al., 2001]. The common feature of the variations of TEC is periodic variations with a period of several minutes which is caused by the atmospheric gravity waves. On the other hand, the spatial scales of these variations are not clear. Dense GPS network system, such as GPS Earth Observation Network System (GEONET), is very useful for studying the special scales of the variations. In the 2011 off the Pacific coast of Tohoku Earthquake occurred on 11 March 2011, TEC fluctuations spreading from the epicenter was observed using GPS-TEC data determined by GEONET.[Tsugawa et al., 2011]. This clear variation of TEC is rarely observed. In this study, spatial scales of the spectral density of the GPS TEC variation is examined for the earthquakes ($M > 6.0$) occurred in the inland and adjacent area of Japan during 2000. Ionospheric pierce points at the height of the 350 km are determined. FFT is applied to 32 minutes of TEC data obtained from GEONET receivers. As a result, the variation of TEC was observed near the epicenter of the earthquake ($M > 6:8$) in 15 events out of 19 events. The variation in the frequency of 4.17 mHz is frequently observed in particular. This frequency is consistent with the resonance frequency of the atmosphere and earth. Thus, the main reason of the variation is probably acoustic waves generated by the displacement of the ground or tsunami by the earthquake. Next, the relationship between the displacement of the ground surface and TEC oscillations is examined. The displacement of the ground surface is calculated from their acceleration which was measured from the seismometers installed by NIED when the earthquakes were occurred in the inland. When the earthquakes occurred in sea area of Japan, the height of tsunami around the epicenter is estimated from the wave gauge settled by Japan Meteorological Agency. Considering the distance between the wave source and the ionospheric pierce point which show the maximum value of TEC variations, h'F2 and foF2, the height of tsunami and the TEC variation are highly correlated each other.In addition, the propagation of TEC variations from the epicenter is observed in three events(the 2011 of the pacific coast of Tohoku Earthquake(M9.0), the Tokachi-oki Earthquake in 2003 (M7.4), Kii-hantou Earthquake in 2004 (M7.4). These three events are the top three tsunami heights. Considering that the TEC variations spread from the epicenter are due to gravity waves, it is estimated that the height of tsunami is correlated with the generation of the gravity waves. The variation of TEC is not correlated with the displacement of the ground surface in the earthquakes occurred in land or those without tsunami occurred in the sea. However, TEC variations are observed when the displacement of the ground near the source region is large.Therefore, the displacement of the ground is related to the variation.

Keywords: ionosphere, TEC, earthquake, atmospheric gravity wave, acoustic wave, FFT

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PEM29-P11 Room:Convention Hall Time:May 22 18:15-19:30

Effects of heavy weather conditions on the total electron content in the ionosphere: the case of typhoons

Hiroyuki Nakata[1*], Keigo Abe[1], Toshiaki Takano[1], Takuya Tsugawa[2], Akinori Saito[3]

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

Many researchers have reported that the total electron contents (TEC) are perturbed by earthquakes. It is known that the acoustic wave and/or atmospheric gravity wave excited by the ground perturbations cause the variations of TEC. This means that the variation of TEC can be excited by the other heavy weather conditions, such as Typhoon. In fact, in association with typhoon, the following perturbations are reported; foF2 anomaly (Rice et al., 2012), the electric field variation in high altitude of the ionosphere (Isaev et al., 2006), and TEC variation (Voeykov et al., 2008). Therefore, GPS-TEC variation above typhoons were determined in order to examine the effect of typhoons on the ionospheric electron density. GPS-TEC are derived from GEONET receivers installed by the Geospatial Information Authority of Japan. Since GEONET has constructed quite dense network of GPS receivers, the horizontal distribution of the TEC perturbation can be determined.

In this study, we selected strong typhoons (> Category 5). For example, Typhoon PRAPIROON (the 21st typhoon in 2002) generated in the south of Japan. Typhoon PRAPIROON moved northward and hit Kanto, Tohoku regions. When Typhoon PRAPIROON was crossing Japan, the enhancement of the power spectrum of TEC variations was observed. As the intensity of the typhoon was weaker, the intensity of the power spectrum also decayed. However, the intensity of the power spectrum was larger in the western side of typhoon eye, which is opposite of the wind intensity.

Keywords: Ionosphere, Total electron content, acoustic wave, atmospheric gravity wave, typhoon

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PEM29-P12 Room:Convention Hall Time:May 22 18:15-19:30

The Altitudinal Structure of Storm Enhanced Density observed by Space-borne and Ground-based GPS Receivers

Yukari Goi[1*], Akinori Saito[1], Takuya Tsugawa[2], Michi Nishioka[2]

[1]Kyoto University, [2]National Institute of Information and Communications Technology

The altitudinal structure of Storm Enhanced Density(SED) was studied using TEC data of the GPS reveiver on GRACE satellite and the ground-based GPS receivers. SED is the high plasma density phenomenon which extend toward north-west direction from the equatorial ionization anomaly during geomagnetic disturbed times. The westward ExB plasma drift, which is driven by the poleward electric field in the sub-auroral region during the geomagnetic storm, causes the extended structure toward the west direction.

It is still not clear that the physical process of the transport the plasma from low-latitudes to high-latitudes. This carrying process could be attributed to the upward and polarward ExB drift, which derived from the eastward electric field in low-latitude, and the diffusion along the geomagnetic line. The resultant velocity of two vectors, the ExB drift velocity and the diffusion velocisty, would decide the extension of SED from low-latitude to high-latitude. When the ExB drift effect is stronger than the diffusion effect, the plasma of SED is lifted up by the ExB drift, after that the lifted plasma diffuses along the geomagnetic line at the altitude where the ExB drift velocity is zero. To clarify the physical process of the carrying out the plasma from low-latitude to high-latitude, we focus on the altitudinal distribution of the density strucutre of SED. GRACE-TEC data is the TEC data, which was derived from the GPS receiver on GRACE satellite, between GRACE satellite altitude and GPS satellite altitude.Two events of SED were observed simultaneously by MIT-TEC, which is the ground-TEC data on North-America continent, and GRACE-TEC during May in 2003. The amplitude of TEC enhancement was compared between GRACE-TEC and MIT-TEC.

In the first case, SED was observed in three orbital path of GRACE satellite around 15LT on 21 May. The TEC enhacement of 20 TEC unit, which derived from SED, was observed in MIT-TEC in the first orbital path around 21UT. the TEC enhancement of 13 TEC unit was observed in GRACE-TEC at the same time and at the same location. In the second case, SED was observed in two orbital path of GRACE satellite around 15LT on 29 May. The TEC enhancement of 30 TEC unit was observed in MIT-TEC in the first orbital path around 21UT. Similar results were obtained by the comparison using the other orbital path. These results indicates that more than 30 percent of TEC enhancement was occurred above GRACE satellite. We will compare the amplitude of TEC enhancement using GRACE-TEC and MIT-TEC in 2003 so that the averaged altitudinal structure of SED would be obtained at the every latitude. The balance between the upward and poleward ExB drift velocity, which was derived from the eastward electric field, and the downward diffusion velocity along the geomagnetic line would decide the altitudinal structure of SED.

Keywords: GPS, TEC data, ionosphere, Storm Enhanced Density

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A model of small scale field aligned currents in the middle and low latitudes as observed by the CHAMP satellite

Kunihito Nakanishi[1*], Toshihiko Iyemori[2], Hermann Luhr[3]

[1]Department of Geophysics, Graduate School of Science, Kyoto University, [2]Data Analysis Center for Geomagnetism and Space Magnetism, Graduate School of Science, Kyoto Univers, [3]GeoForschungsZentrum, GFZ, Potsdam, Germany

We have reported that the magnetic field observation by the CHAMP satellite shows the ubiquitous existence of small scale (1 nT - 5 nT) magnetic fluctuations with period around a few tens seconds along the satellites orbit and they can be interpreted as the spatial structure of small scale field-aligned currents generated by the ionospheric dynamo driven by atmospheric gravity waves propagating from the lower atmosphere. The mechanism is as follow: First, the gravity waves generated by the lower atmospheric disturbance propagate to the ionosphere. Then the neutral winds oscillate causing the ionospheric dynamo, and the Pedersen and the Hall currents flow. Because the dynamo region is finite, the electric charge accumulate at the boundary of the finite dynamo region and cause polarized electric fields.The temporal change of the polarized electric fields make them propagate along the geomagnetic filed as the Alfven wave, at the same time, the ionospheric currents divert to the filed aligned currents. The CHAMP satellite observes the spatial structure of the filed aligned currents generated in this way as a temporal change along the path.

We report a result of verification of the model compared with the observed data, in addition to physical quantity including the current and amplitude of the neutral wind oscillation estimated by the model using the data.

Keywords: spatial structure of field aligned currents, middle and low latitudes, the CHAMP satellite, atmospheric gravity wave, the lower atmospheric origin

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Low energy electron observation -over cusp region by LEP-ESA on Norwegian sounding rocket ICI-3

junpei takeshima[1*], Yoshifumi Saito[2], Shoichiro Yokota[2]

[1]Department of Earth and Planetary Science, The University of Tokyo, [2]Institute of Space and Astronautical Science

The cusp region is a boundary between dayside and nightside magnetic field lines where solar wind directly enters into the ionosphere. E-t spectrogram of the precipitating electrons observed in the northward of the cusp region sometimes shows energy-time dispersion where high-energy electrons are observed earlier than low energy electrons. Kletzing et al.(2001) suggested that these precipitating electrons were accelerated at an altitude of thousand km by the field aligned electric field generated by Inertial Alfven wave(IAW). Tanaka et al.(2005) also suggested that acceleration altitude was between 2000km and 6000km,and the observation agreed with the numerical simulation by assuming IAW model. According to the IAW model,the altitude where electrons are accelerated is different between the electrons with different energy.

ICI-3 sounding rocket was launched on 3 Dec 2012 from Svalbard, Norway and it succeed in obtaining precious data in the RFC(Reverse Flow Channel) where plasma flow was opposite to the background convection in the high latitude ionosphere. Six science payloads including Fixed Bias Langmuir probe (FBL), Low Energy Particle experiment Electron Spectrum Analyzer (LEP-ESA), Multi-Needle&Sphere Langmuir Probe, AC/DC Magnetometer (ADM), Electric Field and Wave Experiment (E-field), and Sounding Rocket Attitude Determination System (SRADS) were on ICI-3. LEP-ESA measured the electron pitch angle distribution in the energy range between 10eV and 10keV with high time resolution of 11ms. During the flight, we repeatedly observed energy-time dispersion of the precipitating electrons that had time duration of about 1second. Different from the previously reported energy-time dispersion of the precipitating electrons where the dispersion was convex downward, most of the dispersion observed by ICI-3 LEP was convex upward. We have tried to understand the reason why the observed dispersion was convex upward. Assuming that the electrons with different energy are simultaneously accelerated, we have found that the higher the electronenergy, the higher the acceleration altitude of the electrons. We will investigate if IAW model with some altitude distribution of the electron density can explain the observed dispersion that was convex upward.

Keywords: energy-time dispersion, Inertial Alfven wave, acceleration Altitude

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Electron density perturbation near the Sq focus observed by S-310-37 sounding rocket

Manabu Shimoyama[1*], Takumi Abe[2]

[1]Nagoya University, Solar Terrestrial Environment Laboratory, [2]Japan Aerospace Exploration Agency, Institute of Space and Astronautical Science

The layers of anomalously high electron temperature are often observed near the Sq focus in winter hemisphere in lower E-region. Theoretical studies suggest that the electric potential near the center of the Sq focus in winter hemisphere is higher than that in summer hemisphere. The filed-aligned electric filed generated in lower E-region, where the electric conductivity is low compared with higher altitude, would accelerate electrons, and ambient electrons could be heated through direct collisional processes or plasma waves. The S-310-37 sounding rocket was launched to elucidate the generation mechanism of the electron temperature enhancement. Several electrostatic probes and electric filed detector (EFD) were installed. Fast Langmuir Probe (FLP) and Electron Temperature Probe (TEL) were used to obtain the profiles of electron temperature and electron density with high time resolution. Fixed Bias Probe (FBP) is to detect fluctuations of electron density with high time resolution up to 800 Hz. Suprathermal Plasma Analyzer (SPA) aims to measure energy distribution function of thermal and suprathermal electrons and to verify the existence of electrons heated by accelerated electrons. EFD aims to measure three-dimensional electric field.

The rocket successfully passed near the Sq focus during the rocket upleg, and FLP and TEL identified the electron temperature enhancement around 95-100 km in altitude. Although some data were slightly contaminated or partly saturated due to unexpectedly large fluctuation of electron density, all instruments worked properly and obtained data successfully during the rocket flight. Electrostatic probes observed abrupt increase of electron density fluctuation at 95-100 km in the rocket upleg up to the rocket apogee of 138 km. According to FBP, the ratio of the fluctuated component to the background reached the maximum value 8% at 98 km. From analyses of FLP and SPA data, large fluctuation occurred at a specific rocket spin phase when the instrument faced toward the geomagnetic field which was connected to summer hemisphere. From these results, it is suggested that accelerated electrons along the geomagnetic field from summer to winter hemisphere may excite plasma waves though beam plasma instabilities, which was detected as an electron density fluctuation.

Keywords: sounding rocket, electron heating, beam plasma instability, lower E-region, electrostatic probe

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PEM29-P16 Room:Convention Hall Time:May 22 18:15-19:30

Changes of the electron temperature in the region of high electron with Fixed Bias Probe on the S-310-40 Sounding Rocket

Yusuke Yatsukawa[1*], ABE,Takumi[2], MIYYAKE,Watary[1]

[1]Tokai University, [2]ISAS/JAXA

The electron temperature and electron density are important parameters as the basic characteristics of the ionospheric plasma, which has been observed by the sounding rocket, scientific satellite and ground-based radar for several decades. However, there are many unresolved problems about spatial distribution and temporal variation of the plasma. The S-310-40 sounding rocket was launched from Uchinoura Space Center at 23:48:00 on December 19, 2011 to investigate high-density plasma layer in the nighttime lower ionosphere, which can cause extra ordinal propagation of Medium Frequency radio wave. Among eight onboard instruments, Fixed Bias Probe (FBP) measures incident current to the probe in high time resolution, which is suitable to observe small-scale electron density perturbation. Fast Langmuir Probe (FLP) measures the current-voltage relationship of a cylindrical probe with a length of 200 mm and a diameter of 3 mm.

The electron density and temperature were derived from the current-voltage relationship through the rocket flight. The altitude profile of the electron density shows an existence of the high electron density layer at the altitude of ˜100 km. A comparison with the ordinal sporadic E layer suggests that electron density inside the high density layer are not as large as sporadic E. The electron temperature inside the high density layer is observed to be 20 % lower than that in the surrounding region. In addition, the thickness of the layer is 2-3 times larger than the averaged thickness of the sporadic E layer. Therefore, the high density layer seems to have different feature compared to well-known sporadic E layer. In order to confirm this result and also to investigate the detailed energy distribution of electrons, we try to evaluate validity of fitting procedure to the current-voltage relationship obtained inside the high-density layer.

In the past, data points above the noise level in the probe current were used to estimate the electron temperature by evaluating a gradient of the electron current in the semi-logarithmic plot. The electron density was calculated by evaluating the electron saturation current in addition to a retarding region of the electron current. However, when the electron energy distribution is different from Maxwellian and has different gradient depending on the electron energy, the estimated temperature may be different from a real value. Therefore, we have tried to analyze a variation pattern of the electron current with the probe voltage in the retarding region. In this presentation, we report a result of the detailed evaluation and discuss an interpretation of the result.

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PEM29-P17 Room:Convention Hall Time:May 22 18:15-19:30

Electric filed measurements in ionosphere by S-520-26 sounding rokcet

Keigo Ishisaka[1*], Kousuke Suda[1], Mamoru Yamamoto[2], Takumi Abe[3], Shigeto Watanabe[4]

[1]Toyama Prefectural University, [2]RISH, Kyoto University, [3]ISAS / JAXA, [4]Hokkaido University

S-520-26 sounding rocket experiment was carried out at Uchinoura Space Center (USC) in Japan at 5:51 JST on 12 January, 2012. The purpose of this experiment is the investigation of the bonding process between the atmospheres and the plasma in the thermosphere. S-520-26 sounding rocket reached to an altitude of 298 km 278 seconds after a launch. The S-520-26 payload was equipped with Electric Field Detector (EFD) with a two set of orthogonal double probes to measure both DC and AC less than 200 Hz electric fields in the spin plane of the payload by using the double probe method. One of the probes is the inflatable tube structure antenna, called the ITA, with a length of 5 m (tip-to-tip). And ITA is very lightweight (12.5g per one boom). The ITA extended and worked without any problems. It was the first successful use of an inflatable structure as a flight antenna. Another one is the ribbon antenna with a length of 2 m (tip-to-tip). The electrodes of two double probe antennas were used to gather the potentials which were detected with high impedance pre-amplifier using the floating (unbiased) double probe technique. The potential differences on the two main orthogonal axes were digitized using 16-bit analog-digital converter, sampled at 800 samples/sec with low pass filter at cut-off frequency of 200 Hz.

Results of measurements of DC electric fields by the EFD have the large sine waves that result from the payload rotation at the spin period. The largest contribution to the electric field measurements by double probes moving through the ionosphere at mid-latitudes is that due to the $\boldsymbol{v}$ X $\boldsymbol{B}$ fields created by their motion across the ambient magnetic field, where $\boldsymbol{v}$ is the rocket velocity in the Earth-fixed reference frame and $\boldsymbol{B}$ is the ambient magnetic field. The sum of the squares of the two components represents the magnitude of the DC electric field in the spin plane of the payload. These data reveal abrupt, large-scale variations which can immediately be attributed to changes in the geophysical electric field since the $\boldsymbol{v}$ X $\boldsymbol{B}$ fields are slowly varying. The sum of the squares data also reveals contributions at the spin frequency and its harmonics. These contributions result primarily from distortions of the waveforms in the raw data. Then we obtained three components of natural DC electric fields by subtracting the $\boldsymbol{v}$ X $\boldsymbol{B}$ fields from raw data. As a result, the magnitude of DC electric field on a rocket orbit during the ascent was about 1mV/m, and the direction was for north-east.

Keywords: DC Electric Field, Ionosphere, Rocket experiment

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PEM29-P18 Room:Convention Hall Time:May 22 18:15-19:30

Measurement of propagation characteristics of MF band radio waves in lower ionosphere by S-310-40 sounding rocket

Keigo Ishisaka[1*], Tatsuya Fukazawa[1], Takumi Abe[2], Ken Endo[3], Atsushi Kumamoto[3], Takayuki Ono[3]

[1]Toyama Prefectural University, [2]ISAS/JAXA, [3]Tohoku University

The ionospheric D region is important in radio wave propagation because it absorbs energy from waves at MF, HF and VHF, and it reflects LF and VLF signals. Then D region is present only during daylight hours. Therefore, in the night-time, the MF band radio waves are propagated as far as an area where its radio waves cannot be propagated in the daytime. This reason why the radio waves cannot receive is that the D region is disappeared at night. However, the MF band radio waves that transmit from distant place have not been often received at the mid latitude in the night-time. In this time the sporadic E region cannot be observed by the ionogram. We guess that the D region appear in the lowest ionosphere like a daytime. To farther study the structure of the lowest ionosphere, we propose a method to measure the very low electron densities that occur at altitudes from 50 km to 90 km using the partial and perfect reflection characteristics of electromagnetic waves.

S-310-40 sounding rocket experiment was carried out at Uchinoura Space Center (USC) at 23:48 JST on 19 December, 2011. The purpose of this experiment is the investigation of characteristics of radio wave propagation in the ionosphere and the estimation of electron density structure in the lower ionosphere, when the intensity of radio wave measured on the ground will be attenuate at night-time. In order to measure the radio waves, a LF/MF band radio receiver (LMR) is installed on the sounding rocket. The LMR has measured the propagation characteristics of four radio waves at frequencies of 60 kHz (JJY signal from Haganeyama radio station), 405 kHz (NDB station from Minami-Daito), 666 kHz (NHK Osaka broadcasting station) and 873 kHz (NHK Kumamoto broadcasting station) in the region from the ground to the lower ionosphere. The LMR consists of a loop antenna, a pre-amplifier and a detector circuit. The loop antenna is set up in the nose cone, which is transparent to the LF/MF band radio waves, and is not deployed during the flight. Therefore, the LMR can measure the relative attenuation of radio waves from the ground up to the ionosphere. Furthermore theree components of four radio waves measure by using three loop antennas. We can obtain the propagation directions of radio waves in the ionosphere directly.

We will explain a new radio wave receiver with the loop antenna system (LMR) on-board S-310-40 sounding rocket and show the results of propagation characteristics of radio waves in the ionosphere. And the approximate electron density profile can be determined from the comparison between propagation characteristics observed by the LMR and propagation characteristics calculated by the full wave method. The most probable electron density profile in the ionosphere is demonstrated in this study.

Keywords: Propagation characteristic of radio wave, Ionosphere, Rocket experiment

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PEM29-P19 Room:Convention Hall Time:May 22 18:15-19:30

Observation of the 2012 Geminids shower, and trial of meteor detection

Masayuki Toda[1*], Masa-yuki Yamamoto[2], Yoshihiro Higa[1], Yoshihiro Kakinami[2], Daiki Kihara[2], Junya Yamada[2], Jun-ichi Watanabe[3]

[1]Nippon Meteor Society / Meteortrain Observation Team, [2]Department of systems engineering, Kochi University of Technology, [3]Public Relation Center, National Astronomical Observatory of Japan

Observation of meteors and meteor trains with a high sensitivity digital single-lens reflex camera was performed at Kiso observatory, University of Tokyo, form 13h43m to 20h39m UT on December 13, 2012. Single station observation was carried out there by using Nikon D3 and D4 digital cameras with lenses of 28 mm, f/1.4. The camera setting was ISO=25,600, shutter speed 1/1.3 seconds (0.769 s) with an interval of 1 s. As long as the capacity of CF cards allowed, continuous shooting of 1/1.3 s exposures was performed, resulting 24,868 frames recorded on Dec. 13. All of the images were checked frame by frame by viewing manually on the screen of PC, and meteors and relating meteor trains were picked up on the successive images. Many meteors and their meteor trains which belong to the Geminids was successfully detected from these images. Magnitude of the meteors and the meteor trains were determined in comparison with a star chart for visual meteor observation. The magnitude of a meteor and its meteor train is not absolute magnitude, but the apparent magnitude. The meteor train was divided into three parts and assumed the each range the upper end, the center, the bottom end, from the appearance side. The brightest part was determined from the three parts for each meteor and meteor train.

The number of appearances of the green short-duration meteor trains which is considered to be luminescence of OI 557.7 nm is counted. Observation of the meteor and meteor train by a high sensitivity digital single lens reflex camera was started in December, 2007. According to the peak day of main meteor showers, it is observing after it. Furthermore, development of an automatic meteor detection software which can discover a meteor from the huge number of pictures taken by quick repetition is also introduced in this paper.

Reference

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(in Japanese, English Abstracts)

[2]Masayuki Toda, Observation of the a meteor train with the high sensitivity digital single-lens reflex camera, The Astronomical Herald, Vol.105, No.11, 716-718, 2012.
(in Japanese, Astronomical Society of Japan)

Keywords: Geminids, Meteor, Meteortrain, Meteor auto-detection software

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PEM29-P20 Room:Convention Hall Time:May 22 18:15-19:30

Development of notification system for bright meteor signals by using wide angle and time series images

atsushi iyono[1*], Naoki Wada[1]

[1]Dept. of Fundamental Science, Okayama University of Science

1. Purpose and Background

The Sky monitoring system by using wide angle lens camera have been maintained until Nov. 2011 at Okayama University of Science. Images are obtained by the CCD camera system which provide the slow shutter image, and they have been transferred to data storage PC system via the Internet connection. This system enables us to monitor the real time condition of the sky. We can now operate this system with 90% duty cycles. In the obtained images, bright meteors and sometimes fir balls were registered. Now we analysed these images by offline analysis software. In this report, we are going to describe our new system which can provide quick analysis results for meteor and fire ball at the moment of observations.

2. System

In the sky monitor system, CCD camera with wide angle (fish eye) lens and image server system have been operated in 24 hours/day. The exposure of CCD cameras has been set to 256 frames or 128 frames which correspond to 7 second or 4 second, respectively. The acquired image data have been stored in PC system via the internet ftp command. 28,800 images(500MB data size) are stored in each day. In offline mode, images are processed with contrast enhancement module, image differentiating and object detection module.

3. Development

In this researches, we develop new analysis system for online image processing and for providing meteor signal detection, arrival direction determination and brightness profile information. We are going to present new system and analysis result in this reports.

Reference

K.Noguchi, ”High-accuracy direction findings of meteors and development of an automatic meteor observation system by 5-channels radio interferometer”, Kochi University of Technology, Graduate School of Engineering, 2009

Keywords: meteor, fire ball, image processing, simultaneous observation

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Optimization for airglow imaging in an urban area

Hidehiko Suzuki[1*], Shuka Sakurai[1], Makoto Taguchi[1]

[1]Rikkyo University

An airglow imaging technique is a quite common and powerful tool for upper atmospheric study, since it can deduce horizontal wavelength and direction of phase propagation of atmospheric gravity waves. For example, a coordinated imaging observation by OMTI (Optical Mesosphere Thermosphere Imagers) system is conducted by Nagoya University in Japan. A combined field-of-view (FOV) of the imagers covers almost entire sky above Japan, and therefore, provides information about long traveling atmospheric waves such as ducted waves and TIDs [S. Suzuki et al., SGEPSS Fall Meeting, 2012]. However, there is no airglow imager which has a FOV centered in the central part of Japan (Tokyo and Kanto area). The difficulty of airglow imaging in the urban area arises from strong contamination by artificial lights in the city. In particular light pollution is severe in the visible wavelength region which is also the most sensitive band for Si CCD device. However, luminosity of city light is relatively weak in the near infrared region (800˜950 nm). Thus, imaging observation of some of the OH bands in this region can avoid the severe city light pollution. We performed spectra survey on both city lights and airglow during nighttime in the spectral region of 350˜970 nm using a grating spectrometer in the central area of Tokyo (Ikebukuro). As a result we found that the OH7-3 band near 890 nm is the most adequate for an airglow imaging observation using a typical CCD sensor in the urban area.

Keywords: Airglow, Mesopause, OH airglow, Atmospheric gravity wave, spectroscopy

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PEM29-P22 Room:Convention Hall Time:May 22 18:15-19:30

Analysis of gravity waves observed by airglow imaging at Syowa Station (69S,39E), Antarctica

Takashi Matsuda[1*], Takuji Nakamura[2], Mitsumu Ejiri[2], Masaki Tsutsumi[2], Kazuo Shiokawa[3], Shin Suzuki[3], Yoshihiro Tomikawa[2]

[1]The Graduate University for Advanced Studies, [2]National Institute of Polar Research, [3]Solar-Terrestrial Environment Laboratory, Nagoya University

Atmospheric gravity waves (AGWs), which are generated in the lower atmosphere, transport significant amount of energy and momentum into the mesosphere and lower thermosphere and cause the mean wind accelerations in the mesosphere. This momentum deposit drives the general circulation and affects the temperature structure. Airglow imaging is a useful technique for investigating the horizontal structures of AGWs at around 90 km altitude. However, observations of airglow imaging in Antarctica are very limited because of lack of observation sites. The Japanese Antarctic Research Expedition (JARE) has operated airglow imagers at Syowa Station (69S, 39E), Antarctica in 2002 and between 2008 and 2012.

Statistical analysis of image data in 2011 was performed. Observation was carried out from March to September at 139 nights, out of which 71 nights were with clear sky. We picked up 81 wave events in sodium images. Horizontal characteristics such as propagation directions, phase speeds, wavelengths, and observed periods were determined. Distributions of horizontal wavelength and observed period were similar to those obtained by imaging observations at middle and low latitudes, but the distributions of propagation direction and horizontal phase speed showed zonal anisotropy and seasonal variation.

The observed waves propagating eastward had faster phase speed (0m/s -150m/s) than those propagated westward (0m/s -60m/s) and faster waves (30m/s -150m/s) were only observed in July and August. The zonal anisotropy of the phase velocity distribution could be explained if wave sources are located at the eastward wind such as stratospheric polar night jet.

We will report analysis of the data in 2012 and discuss inter-annual variation of the phase velocity distribution and analysis using spectral techniques.

Keywords: atmospheric gravity wave, airglow imaging

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PEM29-P23 Room:Convention Hall Time:May 22 18:15-19:30

Statistical characteristics of MSTIDs using a 630-nm airglow imager at Magadan

Ryota Kumeno[1*], Kazuo Shiokawa[1], Yuichi Otsuka[1], Shin Suzuki[1], Boris M. Shevtsov[2], Igor Poddelsky[2], Sergey Smirnov[2]

[1]Solar-Terrestrial Environment Laboratory, Nagoya University, [2]IKIR

Medium-Scale Traveling Ionospheric Disturbance (MSTID) is a wavy phenomenon in the ionosphere, which has a horizontal wavelength of 100-200 km and a period of a few hours. To date many observations of nighttime MSTIDs using all-sky airglow imagers have been conducted in Japan. Since OI 630-nm airglow emission is sensitive to the variation in the F-layer altitude and plasma density, 630-nm airglow images can monitor the two-dimensional structure of the MSTIDs. According to the previous studies, nighttime MSTIDs at Stecolny near predominantly propagate southwestward. However, their propagation characteristics at higher latitudes is still unclear. The Solar-Terrestrial Enviroment Laboratory, Naogoya University has made airglow imaging observations of MSTIDs in Magadan, Russia (60.1N, 150.7E), since November 2008, as part of the Optical Mesosphere Thermosphere Images (OMTIs) in collaboration with Institute of Cosmophysical Research and Radiowave Propagation (IKIR).

In the presentation, we will report statistics of MSTIDs over Magadan from January 2009 to August 2012 (630 nights). The ratio of clear-sky intervals to the total observations was 51% and data of 2149 hours of clear sky are available for the analysis.

Keywords: Medium-Scale Traveling Ionospheric Disturbance

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PEM29-P24 Room:Convention Hall Time:May 22 18:15-19:30

Thermospheric vertical wind and temperature observed by a Fabry-Perot imager

Kousuke Nakazaki[1*], Makoto Taguchi[1], Yasunobu Ogawa[2], Hidehiko Suzuki[1]

[1]Rikkyo University, [2]National Institute of Polar Research

Vertical wind and temperature in the mesopause and lower thermosphere were measured with a Fabry-Perot Imager (FPI) at Tachikawa, Tokyo. The FPI observed the OI 557.7 nm and OI 630.0 nm airglow. An all-sky camera (ASC) simultaneously observed OI 557.7 nm airglow. The data were obtained in the night of January 18/19, 2013, and reveal atmospheric gravity waves with periods of ˜1 hour and vertical wind amplitudes of up to ˜7 m/s. These values and the values obtained in the night of December 22/23, 2011 are consistent with past studies [cf. Mitchell and Howells, 1998] and the Cospar International Reference Atmosphere (CIRA-86). The FPI will be used in observations of slight perturbations in vertical wind and temperature due to gravity waves or local energy input in the auroral zone.

Keywords: lower thermosphere, mesopause, atmospheric gravity wave, Fabry-Perot imager

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PEM29-P25 Room:Convention Hall Time:May 22 18:15-19:30

Optimization of an etalon system for Rayleigh lidar daylight observations with an 82-cm telescope

Akihiro Yamamoto[1*], Taku D Kawahara[1], Hidehiko Suzuki[2], Makoto Abo[3], Takuji Nakamura[4], Mitsumu Ejiri[4]

[1]GSI, Shinshu University, [2]College of Science, Rikkyo university, [3]Tokyo Metropolitan University, [4]NIPR

A Rayleigh lidar to monitor atmospheric temperature from the troposphere to the mesosphere and upper clouds (PSC, PMC) in high altitudes was installed at Syowa Station in February January 2011 by the 52nd Japanese Antarctic Research Expedition (JARE 52). In the first season of the Syowa Rayleigh lidar observation, Polar Mesospheric Summer Echoes (PMSEs) observation by the lidar and the HF radar was successfully conducted [Suzuki et al. in prep]. A new receiver system of 35 cm telescope with a combination of a polarizer and an etalon was placed in Syowa by JARE 53 and started taking data. With this system, we confirmed an improvement of the signal to noise ratio by a factor of three. To detect weaker signal with an 82cm-telescope, an optimized etalon was simulated (air gap: 100 micrometer, reflection: 89%). In this presentation, we discuss this etalon and the expected signal to noise ratio.

Keywords: Syowa station, Rayleigh lidar, etalon, daytime observation

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PEM29-P26 Room:Convention Hall Time:May 22 18:15-19:30

Observations of three-dimensional structures of MLT wind fields based on meteor echo measurements using the PANSY radar

Masaki Tsutsumi[1*], Kaoru Sato[2], Toru Sato[3], Takuji Nakamura[1], Akinori Saito[4], Yoshihiro Tomikawa[1], Koji Nishimura[1], Hisao Yamagishi[1], Takashi Yamanouchi[1]

[1]National Institute of Polar Research, [2]Graduate School of Science, The University of Tokyo, [3]Graduate School of Informatics, Kyoto University, [4]Graduate School of Science, Kyoto University

In this study we will develop a high quality meteor echo observation technique using the PANSY (Program of the Antarctic Syowa MST/IS Radar) system (47MHz) located at Syowa station (69S,39E), Antarctica. The radar started its initial observations in early 2011 and is currently operated for troposphere, stratosphere and mesosphere studies as one quarter system, being already the largest atmospheric radar in the Antarctic. The final configuration is to be an active phased array system with 1045 crossed-Yagi antennas, a peak transmitting power over 500kW and 55 digital receivers. By fully utilizing the versatility of the radar an unprecedented number of meteor echoes, that is, a few tens of times more echoes than that of conventional meteor radars, are expected. This will widen the possibility of meteor echo observation technique, which has been mostly limited to wind observations on a height profile basis, and enable the direct measurement of time-evolving three dimensional structures of wind and temperature fields in the polar mesosphere and lower thermosphere within a large horizontal area of about 500 km wide.

Keywords: MST/IS radar, Antarctic atmosphere, mesosphere, lower thermosphere, meteor echoes

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PEM29-P27 Room:Convention Hall Time:May 22 18:15-19:30

A study on development of statistical analysis system for variations of atmospheric environment

Ryota Hamaguchi[1], Atsuki Shinbori[2*], Toshitaka Tsuda[2]

[1]Graduate School of Infomatics, Kyoto University, [2]Research Institute for Sustainable Humanosphere, Kyoto University

Integrated data analysis of various observations is important to understand the atmospheric environment, which requires cross-reference of data-base archived at different institutes. The Inter-university Upper atmosphere Global Observation NETwork (IUGONET) project has been conducted in FY 2009-2014 in order to enhance data exchange among the Japanese universities and research institutes. This project aims at establishing a meta-database system for ground-based observations as well as the data analysis software (UDAS). This thesis is concerned with development of the statistical analysis system as a part of UDAS, consisting of five functions as follows:

(1) A test for the difference in the mean values between the two data distributions.
(2) Cross-correlation coefficient and a test for non-correlation.
(3) Analysis of coherence and phase for each frequency component.
(4) S(Stockwell) transform analysis : Temporal variations of spectral density and dominant frequency for transient phenomena.
(5) Trend test for the slope of a linear regression.

Because the sampling interval of observations is not always constant and missing data are sometimes included, a linear interpolation is adopted on the data before applying the statistical analysis system.

We applied this analysis system for the two meteor radars in Indonesia. The same radar systems are operated on the equator in west Sumatra and west Papua, Indonesia in 2003-2013. These data-sets are unique and useful to study longitude variations of the wind fields.First, we tested the altitude distribution of meteor echoes, and found no difference in the mean altitude, but a slight long-term trend. Frequency spectrum indicated that the quasi-two day wave is dominant at 90 km altitude for the meridional wind component, where the long-term envelope of the wave amplitudes correlated well between the two radars. This statistical analysis system can clarify trends and variations of atmospheric conditions. Therefore, it is expected to advance our understanding on the global changes as well as the effects of solar activities on the lining environment.

Keywords: IUGONET, analysis software, statistical test, frequency analysis, trend test, meteor radar

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PEM29-P28 Room:Convention Hall Time:May 22 18:15-19:30

Climatology of the middle atmosphere over Alaska in winter season: quantitative comparison with other indexes

Kazuyo Sakanoi[1*], Yasuhiro Murayama[2], Richard L. Collins[3], Kohei Mizutani[2], Seiji Kawamura[2]

[1]Faculty of Arts and Sciences, Komazawa University, [2]National institute of Information and Communications Technology, [3]the Geophysical Institute, the University of Alaska, Fairbanks

Purpose of this research is to clarify climatology of the middle atmosphere over Alaska in winter season. This work includes analysis and discussion about the role of atmospheric waves which affects disturbance of the middle atmosphere and about the relationship between disturbance of the middle atmosphere and activities of solar and lower atmosphere. So far we analyzed Rayleigh lidar and MF radar data at Poker Flat Research Range (65.1N, 147.5W) in Alaska, which are conducted by NICT (National institute of Information and Communications Technology) and GI/UAF (the Geophysical Institute, the University of Alaska, Fairbanks), and stratospheric assimilation data provided by the United Kingdom Meteorological Office on a period that extends from November 1998 to April 2012, which period covers over one solar cycle of 11 years.

We derived the results listed below:

∗ Over ten major stratospheric sudden warmings (SSW) occurred during analyzed period.

∗ Before major SSWs temperature increasing of 10 - 30 K in the lower mesosphere was observed by the lidar.

∗ Just before major SSWs disappear of temperature peak as stratopause and temperature was almost constant from 40 - 80 km altitude range was seen in the results of two-event observations by the lidar.

∗ During major SSWs temperature decreasing of 10 - 20 K in the lower mesosphere was observed by the lidar at two events.

∗ Intermittent reversals of East-West wind were also observed by the MF radar at all major SSW events.

∗ At all major events East-West wind reversal (eastward to westward) from 30 - 90 km altitude range was seen by the MF radar observations. This wind reversal starts and descends from mesosphere to upper stratosphere and occasionally to troposphere.

∗ Remarkable elevation of the center altitude of middle atmosphere jet occurred in the 2003/2004, 2005/2006, 2008/2009 winters.

∗ The elevation of the stratopause (˜ 55km to 70km) also observed in the 2003/2004 winter.

We compared occurrence time of these above and other phenomena which presented in papers during disturbed period in the Arctic middle atmosphere with the sun spot number and the QBO index in terms of SSW categorization. However, no clear relationship was found between occurrence time of disturbance in the Arctic middle atmosphere and two indexes. This results suggests that two SSW categorization, major or not, is not suited for quantitative comparison. Therefore we will do futher analysis of the lidar and MF radar data, stratospheric assimilation data and some indexes in order to find most suitable value in quantitative comparison.

Keywords: Middle atmosphere disturbance, Atmospheric waves, Lidar, MF radar, Arctic region, Stratospheric sudden warming

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Improvement of Radio Acoustic Sounding System aiming to the operational meteorological instruments

Jun-ichi Furumoto[1*], Hiroyuki Hashiguchi[1], Mamoru Yamamoto[1], Toshitaka Tsuda[1]

[1]Research Institute for Sustainable Humanosphere, Kyoto University

Radio Acoustic Sounding System (RASS) is one of the most promising remote-sensing techniques to measure atmospheric temperature profile by combining a wind profiling radar and acoustic source. RASS has an advantage in the availability in the temperature measurement regardless the weather condition and day-and-night.

The reduction of noise from the ground-based acoustic source is very important subject to make a RASS measurement for practical use. Authors introduced the high-directional speaker system (LRAD-1000) into the RASS measurement of L-band wind profiling radar to reduce the noise pollution problem. LRAD-100 has very low side-lobe emission by combining DSP-controlled acoustics at two center frequencies. This paper demonstrates the performance of noise reduction and temperature measurements by applying LRAD-100 to L-band wind profiling radar.

The vertical resolution of RASS measurement is determined by the pulse-width of wind profiling radar. This paper also aims to improve the vertical resolution of RASS measurement to detect the distinct peak of inversion layers. We propose a new method to use oversampled data to obtain high-resolution temperature profile. The improvement of height resolution can be derived by extracting the information of overwrapped height from the over-sampled data. The results is presented in the paper.

Keywords: RASS, wind profiling radar, atmospheric temperature

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)
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PEM29-P30 Room:Convention Hall Time:May 22 18:15-19:30

Primary observation results of potassium layer by a tunable resonance scattering lidar

Mitsumu Ejiri[1*], Takuo Tsuda[1], Makoto Abo[2], Taku D Kawahara[3], Takuji Nakamura[1]

[1]National Institute of Polar Research, [2]Graduate School of System Design, Tokyo Metropolitan University, [3]Faculty of Engineering, Shinshu University

The National Institute of Polar Research (NIPR) is leading 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”. Profiling dynamical parameters such as temperature and wind, as well as minor constituents is the key component of observations in this project, together with a long term observations using existent various instruments in Syowa, the Antarctic (39E, 69S). As one of insturuments in this project, we are developing a new resonance scattering lidar system with multiple wavelengths and plan to install and operate it at Syowa (69S), Antarctica. The lidar transmitter is based on injection-seeded, pulsed alexandrite laser for 768-788 nm (fundamental wavelength) and a second-harmonic generation (SHG) unit for 384-394 nm (second harmonic wavelegth). The laser wavelengths are tuned in to the resonance wavelengths by a wavemeter that is well calibrated using a wavelength-stabilized laser. The lidar will measure temperature profiles using resonance scatter of atomic potassium (K, 770 nm) and density variations of minor constituents such as atomic iron (Fe, 386 nm) and K, calcium ion (Ca^+, 393 nm), and aurorally excited nitrogen ion ($N_2{}^+$, 390-391 nm). Currently, the laser pulses are transmitted with approximately 120 mJ/pulse at 25 Hz and the backscattered signal is received with a 35 cm diameter telescope. We got the first light from the K layer on January 28, 2013 and have started test operation to measure K density profiles at National Institute of Polar Research in Tachikawa. We will show the primary observation results and discuss nightly variations of K densities.

Keywords: resonance scattering lidar, mesosphere lower thermosphere, tunable, Potassium

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PEM29-P31 Room:Convention Hall Time:May 22 18:15-19:30

Optical axis alignment between laser light and a receiver for a resonant scattering lidar observation

Taku D Kawahara[1*]

[1]Faculty of Engineering, Shinshu University

A method of laser light and a telescope alignment for a resonant scattering lidar is typically done by monitoring signal with an oscilloscope. The temporal signal intensity variation is seen on the screen when the screening is triggered by laser shots. In the case of a sodium lidar, we typically confirm the signal around 90 km which is all by resonant scattering. However, the method depends on how clearly one can see the signal from the Na layer. In this talk, a more practical alignment method is presented by watching not Na signal but Rayleigh signal.

Keywords: resonant scattering, lidar, laser, field of view alignment

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PEM29-P32 Room:Convention Hall Time:May 22 18:15-19:30

Preliminary results of multi-direction lidar system experiments

Wataru Muranaka[1*], Taku D Kawahara[1], Satonori Nozawa[2]

[1]Faculty of Engineering, Shinshu University, [2]STE Lab., Nagoya University

Shinshu University, Nagoya University and RIKEN developed an all solid-state, high-power Na lidar for the temperature/wind measurements in the MLT region over EISCAT radar site in Tromso (69N), Norway. The lidar has a higher power (~4W@589nm) compared with other Na lidars. This high power laser enables us to acquire the data with quite high temporal resolution (~3 min) , even if we use a standard size telescope (35 cm diameter). This suggests a new observation method like a scanning lidar using a multi-direction telescope such as Meade LX200-ACF35. The laser transmitter has two rotary stages, which are horizontally/vertically placed. Two 45-degree mirrors are on each rotation axis which enable laser to transmit all the direction. In this talk, we show some preliminary results of directing laser and the telescope.

Keywords: sodium, lidar, three diminutional