Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

PEM28-01 Room:413 Time:April 29 11:00-11:15

MLT dependence in the response of ionospheric electric fields at mid-low latitude during geomagnetic sudden commencement

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The geomagnetic sudden commencement (SC) is one of the geomagnetic disturbance phenomena triggered by an enhancement of the magnetopause current associated with the compression of the magnetosphere due to solar wind disturbances [e.g., Araki, 1994]. Detailed evolution and propagating processes of the electromagnetic field associated with SCs are observed three-dimensionally in the entire geospace. Unlike magnetic storms and substorms which involve complex plasma physical processes, SCs can be identified as distinct magnetic variations that sharply change on a global scale. However, the characteristics of SCs have been extensively investigated mainly by means of the magnetic field variations obtained by ground-based observations, which could be affected by conductivities when deducing electric fields. Thus, investigating the electric field variations is needed to understand the transport of electromagnetic energy (Poynting fluxes, E$\times$B/μ) associated with SCs. In this study, we examined two critical subjects about the ionospheric electric field associated with SCs using the in-situ electric field data.

The in-situ ionospheric electric field was derived from the drift velocity observed by the Ionospheric Plasma and Electrodynamics Instrument (IPEI) onboard ROCSAT-1, which orbited at an ionospheric altitude (about 600 km), with magnetic field from the IGRF-10 model. We also used the geomagnetic field data from ground stations at the subauroral region, mid and low latitudes, and dip equator with a high time resolution of 1 second.

The first subject is the transmission time of the ionospheric electric field from the subauroral region to the dip equator. We found the simultaneous SC onset between the ionospheric electric field by the ROCSAT-1 observations and geomagnetic fields by ground-based observations, and the time delay in the peak amplitudes of the preliminary impulse (PI) and main impulse (MI) occur irrespective of the magnetic local time (MLT). In statistical analyses, we showed that peak signatures of the ionospheric electric field at the low latitude appeared simultaneously with that of the geomagnetic field at the subauroral region. We also found that the peak signature at the equatorial region was observed with the time delay, and its value is about 20-40 seconds in the PI peak and 80-140 seconds in the MI peak. The instantaneous onset can be explained by means of the TM_0 mode waves propagating at the speed of light in the Earth-ionosphere waveguide, while the time delay in the peaks is interpreted as the difference of the time constant L/R of an equivalent circuit. From these results, we demonstrated the transmission of the electric field from the subauroral region and the common energy transport process for both the PI and MI.

The second subject is the global structure of the ionospheric field. Ground-based observations are limited to mid and low latitudes, and provide only the horizontal component (E_{phi}) of the electric field. Thus, it is difficult to estimate the global electric field variation, especially at the terminator sector where SC signatures tend to appear in the radial component (E_r) of the electric field. We found the MLT dependence of the SC amplitude both the PI and MI signatures in the E_r and E_{phi} electric fields. In addition, the dayside characteristics of the PI signature extended to the evening terminator sector (18-21 h MLT) with an enhancement around 20 h MLT. This tendency is consistent with previous results obtained by the ground-based observations and model calculations. We consider that enhancements associated with SCs are influenced by the non-uniform ionospheric conductivity.

In the present study, we revealed the global instant response of the ionospheric electric field during SCs based on the in-situ ionospheric electric field observations. Our results can serve as a basis for understanding energy transmission paths during rapid reconfigurations of ionospheric convection.

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PEM28-02 Room:413 Time:April 29 11:15-11:30

Evolution of convection vortices associated with sudden impulses observed by SuperDARN

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Spatial evolution of transient ionospheric convection induced by sudden impulses (SIs) recorded by ground magnetometers is studied statistically by using SuperDARN (SD) data. An advantage of using SD data instead of ground magnetic fields is that ionospheric flows measured by the radars are not virtually biased by the spatially-varying ionospheric conductance or the magnetospheric currents. First we surveyed the Sym-H index for Jan., 2007 to Dec., 2012 to identify SI events with a peak amplitude |dSym-H|greater than 10 nT. Next we searched all SD data over the northern hemisphere during the SI events for ionospheric backscatters which give us the light-of-sight velocity of horizontal ionospheric flows. For each SI event, the collected ionospheric flow data were sorted into the four periods: the pre-SI period, the pre-Main Impulse (MI), middle-MI, and post-MI periods. In the present study, we examine the differences in flow velocity between the pre-SI period and the three MI periods to clarify how ionospheric flows change in association with SIs. As a result, the ionospheric flow shifts eastward on the dusk side and westward on the dawn side at the higher latitudes during positive SIs (SI+), while it shows a roughly westward/eastward shift on the dusk/dawn side, respectively, during negative SIs (SI-). These polarities of flow shifts are basically consistent with the higher latitude portions of the DP current for the MI phase as shown by Araki [1994] and Araki and Nagano [1988]. The high latitude flow shifts are basically larger for SI events with larger Sym-H variations, in the same fashion as ground magnetic field variations at high latitudes. In addition to the major dependence on SI amplitude, the flow shift magnitude shows a minor dawn-dusk asymmetry particularly under strong IMF-By conditions. We speculate that the interaction with pre-existing convection cells might cause the selective enhancement of either side of flow shifts.

Keywords: sudden impulse, SuperDARN, ionospheric convection

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PEM28-03 Room:413 Time:April 29 11:30-11:45

Global distributions of storm-time ionospheric currents as seen in geomagnetic field variations

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To investigate temporal and spatial evolution of global geomagnetic field variations from high-latitude to the equator during geomagnetic storms, we analyzed ground geomagnetic field disturbances from high latitudes to the magnetic equator. The daytime ionospheric equivalent current during the storm main phase showed that twin-vortex ionospheric currents driven by the Region 1 field-aligned currents (R1 FACs) are intensified significantly and expand to the low-latitude region of ˜30 degrees magnetic latitude. Centers of the currents were located around 70 and 65 degrees in the morning and afternoon, respectively. Corresponding to intensification of the R1 FACs, an enhancement of the eastward/westward equatorial electrojet occurred at the daytime/nighttime dip equator. This signature suggests that the enhanced convection electric field penetrates to both the daytime and nighttime equator. During the recovery phase, the daytime equivalent current showed that two new pairs of twin vortices, which are different from two-cell ionospheric currents driven by the R1 FACs, appear in the polar cap and mid latitude. The former led to enhanced northward Bz (NBZ) FACs driven by lobe reconnection tailward of the cusps, owing to the northward interplanetary magnetic field (IMF). The latter was generated by enhanced Region 2 field-aligned currents (R2 FACs). Associated with these magnetic field variations in the mid-latitudes and polar cap, the equatorial magnetic field variation showed a strongly negative signature, produced by the westward equatorial electrojet current caused by the dusk-to-dawn electric field.

Keywords: geomagnetic storm, convection electric field, shielding electric field, ionospheric disturbance dynamo, interplanetary magnetic field, solar wind

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PEM28-04 Room:413 Time:April 29 11:45-12:00

The forenoon-afternoon asymmetry of DP2 electric field penetrated to the dip equator

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DP2 oscillation is quasi-periodic disturbance whose period is from 30 min to a few hours, and it is well known that DP2 synchronize with IMF Bz oscillation [Nishida, 1968] and can be observed globally from polar to equator [Nishida, 1968], [Kikuchi et al., 1996]. These two characteristics indicate that the disturbance associated with solar wind comes into ionosphere at polar region and M-I coupled current system like penetrating to dip equator is produced, however, this mechanism of the inversion of electric field from polar to equator is not well understood.

The purposes of this study are to clarify how the electric field at polar region is penetrated to dip equator region and to identify the global distribution of DP2 current system. To attain these goals, we analyzed longitudinal and latitudinal distribution of DP2 oscillation observed at dip equator region that is the final destination of M-I coupling system. The electric field is calculated from magnetic field and electric conductivity based on Ohm ' s law, and magnetic field data used in this study are MAGDAS data [K. Yumoto et al., 2006 and 2007] and electric conductivity data are calculated using data of WDC for geomagnetism. We analyzed the real local time distribution of the electric field during DP2 event in 2007 and 2008 using these data. It is used the data Equatorial Magnetometer Network [T.-I. Kitamura, 1985] to derive latitudinal distribution of DP2 oscillation.

The result of this analysis shows that there is an asymmetry of electric field between forenoon and afternoon. It is difficult to explain this asymmetry from the view point of only the electric field at polar region on northern and southern hemisphere which makes global DP2 current system, so this result indicates that there is some mechanism to produce this asymmetry of electric field when the polar electric field is penetrated to equator. As this mechanism, we suggest that the polarization electric field along dip equator and the terminator line of day and night can change global potential structure by Cowling channel model [Yoshikawa et al., 2012, AGU], and the electrostatic potential distribution assumed from our observational result is consistent with the distribution derived from the calculation result based on this model.

Keywords: DP2 oscillation, dip equator, ionospheric current

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PEM28-05 Room:413 Time:April 29 12:00-12:15

Substorm electric fields at nightside low latitude

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The convection electric field penetrates from the polar ionosphere to low latitude and drives the DP2 currents in the global ionosphere with an intensified equatorial electrojet (EEJ). The electric field often reverses its direction, that is, the overshielding occurs and causes the equatorial counterelectrojet (CEJ) during storm and substorms. In this paper we report that the overshielding electric field is detected by the HF Doppler sounders at low latitude on the nightside. We analyzed the Doppler frequency of the HF radio signals propagated over 120 km in Japan at frequencies of 5 and 8 MHz and compared with the equatorial EEJ/CEJ during the substorm expansion phase. We found that the overshielding electric field reaches around 2 mV/m during major substorms (AL <-1800 nT). Taking the geometrical attenuation into account, we estimate the equatorial electric field to be about 1.5 mV/m. We also found that the electric field drives the eastward electrojets in the equatorial ionosphere on the night side. It is to be noted that the overshielding electric field is observed on the nightside at low latitude during the major substorms, while the convection electric field is dominant during smaller size substorms, as the CEJ flows on the dayside. These results suggest that the overshielding electric field associated with the Region-2 field-aligned currents becomes dominant during substorms at low latitude on the nightside as well as on the dayside. On the other hand, we found strong seasonal dependence of the overshielding in the sub-auroral latitudes. Although the substorm CEJs at Huancayo do not depend on season, the overshielding frequently occurs at subauroral latitudes during the winter period from November to February. In contrast, the convection electric field is dominant at the subauroral and low-latitudes during the summer period from April to August. The strong seasonal dependence may suggest that the Region-1 field aligned currents (FACs) have a constant voltage source, while the Region-2 FACs have a constant current source, which results in the convection and overshielding electric fields being dominant in summer and winter, respectively.

Keywords: subsotm, midlatitude ionosphere, convection electric field, overshielding, equatorial counter electrojet

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PEM28-06 Room:413 Time:April 29 12:15-12:30

Comparing the ionospheric plasma drift obtained from the global MHD simulation and that measured by SuperDARN radars

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We present a parameter study of simulated processes of the magnetosphere-ionosphere (M-I) coupling using the global MHD simulation code developed by *Tanaka* (2010).

The boundary conditions for the M-I coupling include some scaling factors. These factors are adjustable and are determined through trial and error. The main goal of this study is optimization of these scaling factors in the boundary condition by use of a data assimilation technique.

In this paper, we combine the MHD simulation and solar wind parameters derived from the ACE satellite, and compare the ionospheric E x B plasma drift obtained from the global MHD simulation and that obtained from the SuperDARN HF Radar Network.

References:

Tanaka, T., A. Nakamizo, A. Yoshikawa, S. Fujita, H. Shinagawa, H. Shimazu, T. Kikuchi, and K. K. Hashimoto (2010), Substorm convection and current system deduced from the global simulation, J. Geophys. Res., 115, A05220, doi:10.1029/2009JA014676.

Keywords: the ionospheric convection, SuperDARN, simulation

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PEM28-07 Room:413 Time:April 29 12:30-12:45

Toward construction of comprehensive proton and electron auroral substorm model: Ground-based observation at Syowa

KADOKURA, Akira[1*] ; FUKUDA, Yoko[2] ; I, Tomofumi[3] ; MIYAJI, Kohei[4] ; MIYAOKA, Hiroshi[1] ; SATO, Natsuo[1]

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National Institute of Polar Research (NIPR) has been constructing an auroral optical observation system at Syowa Station during the 8th project term of 6 years of the Japanese Antarctic Research Expedition (JARE) program. Instruments categorized in the ”Monitoring observation” are (1) 4 sets of All-sky monochromatic digital CCD imagers (427.8, 557.7, 485.0, 481.0 nm) and (2) All-sky color digital camera, and those categorized in the ”Specific purpose observation” are (1) All-sky TV camera and (2) 8-color Scanning Photometer (SPM). Simultaneous observations with 2 electron and 2 proton CCD monochromatic imagers will be carried out in 2014. Interval of the 4 imagers are the same as each other, 15 sec, although the spatial resolution of the 2 proton imagers are reduced into 64x64, comparing with the full resolution of 512x512 of the electron imager.

Center (FWHM) wavelengths of the SPM are 482.5(0.6), 483.5(0.6), 484.5(0.6), 485.5(0.6), 486.5(0.6), 487.5(0.6),670.5(5.0), 844.6(0.6) nm.

Scanning speed and sampling rate are 180 deg/10 sec and 20 Hz, respectively.

Using these electron and proton auroral data observed with all-sky imager and scanning photometer, we would like to construct a comprehensive model of substorm including the information on energy characteristics of precipitating auroral electrons and protons.

Keywords: aurora, substorm, ground-based observation, Syowa Station

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PEM28-08 Room:413 Time:April 29 14:30-14:45

Characteristics of Pi 2 pulsations around the dawn and dusk terminator

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We statistically investigate low-latitude Pi 2 pulsations observed around the dawn and dusk terminator. The main observational results of this study are: (1) Pi 2 pulsations tended to have east-west polarity in the sunlit side of the dawn terminator, while these in the sunlit side of the dusk terminator tended to have north-south polarity. (2) Phase reversals of D-component oscillations occurred near the dawn terminator and 2-3 hours before the dusk terminator. (3) Peaks of D/H (maximum amplitude ratio between D and H component) appear 3 hours after the dawn terminator and near the dusk terminator.

We suggest that there is the dawn-dusk asymmetry of meridional ionospheric currents connecting between equatorial Cowling current and oscillating nightside FACs; meridional currents around dawn is more intense than around dusk. This asymmetry current system can be qualitatively explained by the deformation of potential pattern caused by polarization charges at the terminator.

Keywords: Pi 2 pulsations, The dawn and dusk terminator, Ionospheric currents, FACs

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PEM28-09 Room:413 Time:April 29 14:45-15:00

Automatic identification of Pc5 waves using RBSP mode data from the SuperDARN Hokkaido HF radar

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Ultra-low-frequency Pc5 waves have been observed by many methods such as ground-based magnetometers, HF radars and satellites. It has been demonstrated by numerical experiments that magnetospheric Pc5 waves are globally and directly generated on the dayside by solar wind dynamic pressure variations and/or on the dawn/dusk flank by Kelvin-Helmholtz surface waves. In addition, there are storm-time Pc5 waves on the dusk side magnetosphere that are associated with instabilities in the storm time ring current caused by the particle injection. The Pc5 waves can play an important role in mass and energy transport within the inner magnetosphere such as the radial diffusion of outer radiation belt electrons, as suggested by previous studies. Outstanding problems in Pc5 studies include clarification of their global characteristics and distribution, generation mechanisms, and especially their dependence on the solar wind parameters.

In this study, we try to develop a new automatic identification method of Pc5 waves using ˜20-sec time resolution data obtained by the SuperDARN Hokkaido HF radar operated in the RBSP mode. In this method, we use the Doppler velocity data and the power spectrum density calculated by the wavelet transformation. We set criteria which can detect Pc5 waves even when harmonic oscillations coexist. We show an example for the identification method using the Doppler velocity data obtained by the SuperDARN Hokkaido HF radar in details. Then, the candidates of Pc5 event are verified by inspection. From the rate of error identification, we evaluate the accuracy of the automatic identification method statistically. In the presentation we will also report on the preliminary results of mid-latitude Pc5 characteristics such as frequency distribution and MLT dependence.

Keywords: SuperDARN, Pc5 waves

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PEM28-10 Room:413 Time:April 29 15:00-15:15

A Simultaneous Observation of Pc 4 pulsation by Hokkaido HF Radar and Ground-Based Magnetometers

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We studied a Pc 4 (6.7-22.2 mHz) oscillation of ionospheric Doppler plasma velocity observed around the dawn terminator on 16 Jul 2013 on an east-northeast pointing beam 14 of SuperDARN Hokkaido HF radar in Japan. We compared this ionospheric Pc 4 oscillation with magnetic field variation at St. Paratunka (PTK) in Russia, Kakioka (KAK) in Japan, Guam (GUA), Middlemarch (MDM) and Te Wharau (TEW) in New Zealand. PTK and conjugate points of MDM and TEW are located almost under the radar beam. The waveforms showed high similarity among the HF Doppler, the D (east-west) component of magnetic field at stations in the middle latitude of northern hemisphere (PTK and KAK). While, at the other stations (MDM, TEW, and GUA) the H (north-south) component of magnetic field showed high similarity to the HF Doppler. Using the value of the peak-to-peak amplitude of the HF Doppler velocity, we estimated amplitude of magnetic field variation with assuming a horizontal current sheet infinitely extended in the ionosphere. The estimated amplitude was comparable to the observed amplitude at PTK. We also studied longitudinal variation in amplitude using magnetic field data at Amsterdam Isl. (AMS) in South Indian Ocean and Fredericksburg (FRD) in the United States. The maximum amplitude was found at AMS which located around the midnight.

These results can be interpreted as follows. This event had its source from night side and the Doppler velocity oscillation was caused by an oscillating electric field in the east-west direction. In the northern hemisphere (PTK and KAK), the ionosphere above the observatory was sunlit, thus the ionospheric Hall current induced by the electric field makes D component of magnetic filed oscillation on the ground. On the other hand, in the southern hemisphere (MDM and TEW) and GUA, the ionosphere above the stations was still in the darkness, thus effective ionospheric current could not be induced due to low conductivity. The H component of magnetic field oscillation may reflect direct incidence of magnetic field oscillation from the magnetosphere to the ground.

Keywords: ULF, HF radar, M-I coupling, magnetic pulsation

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PEM28-11 Room:413 Time:April 29 15:15-15:30

Solar zenith angle dependence of relationships between energy inputs to the ionosphere and O+ and H+ ion outflows

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Recent satellite observations and simulations have clarified that plasma outflows play an important role in abrupt changes in the ion composition in the plasmasheet and ring current during geomagnetic storms. Statistical studies by Strangeway et al. [2005] and Brambles et al. [2011] indicated that the flux of ion outflows is correlated well with soft electron precipitation (precipitating electron density and electron density in the loss cone), and DC and Alfvenic Poynting fluxes using the data obtained by the FAST satellite near the cusp region in the dayside during the 24-25 September 1998 geomagnetic storm. To distinguish between O^+ and H^+ ion outflows, we performed statistical studies using the ion composition data in addition to the ion and electron data obtained by the FAST satellite at 3000-4150 km altitude during January 1998 and January 1999. The long-term dataset enables us to identify empirical formulas between the outflowing O^+ and H^+ ion fluxes and the precipitating electron density, the electron density in the loss cone, the net electron number flux, and the DC and Alfvenic Poynting fluxes in a wide solar zenith angle (SZA) range (for dayside, 50-110 degree; and for nightside, 90-150 degree). In the SZA range of 90-110 degrees, the above formulas in the dayside are almost similar to those in the nightside. While SZA dependence of the relationshps between the outflowing O^+ and H^+ ion fluxes and the DC and Alfvenic Poynting fluxes are weak, the empirical formulas between the outflowing O^+ and H^+ ion fluxes and soft electron precipitation, especially the precipitating electron density and the electron density in the loss cone, depend on SZA. Although the precipitating electron density and the electron density in the loss cone that correspond to the outflowing O^+ ion flux of about 10^7 /cm^2/s increase with decreasing SZA, the outflowing O^+ and H^+ ion fluxes become more sensitive to an increase in soft electron precipitation with decreasing SZA.

Keywords: ion outflow, polar ionosphere

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PEM28-12 Room:413 Time:April 29 15:30-15:45

Inversion method for estimating the helium ion density distribution in the plasmasphere based on IMAGE/EUV data

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The plasmasphere exhibits a variety of shapes as a result of the variation in the electric field in the inner magnetosphere due to the coupling processes between the solar wind, the magnetosphere, and the ionosphere. Global imaging observations from outside the plasmasphere provide striking evidence of the variability of the plasmasphere. In particular, the EUV imager on board the IMAGE satellite obtained global EUV images of the plasmasphere, which have provided important insights into the variation of the plasmasphere. Our aim is to obtain the information on the ion density distribution for individual events rather than simply the averaged distribution from IMAGE/EUV data. For this purpose, we propose a linear inversion technique by which to estimate the helium ion density distribution. We applied this technique to a synthetic EUV image generated from a numerical model. This technique was confirmed to successfully reproduce the helium ion density that generated the synthetic EUV data. We also demonstrate how the proposed technique works for real data using real EUV images.

Keywords: plasmasphere, inverse problem, magnetosphere

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PEM28-13 Room:413 Time:April 29 15:45-16:00

Current availability and utilization prospect of data obtained by AKEBONO for the research on lightning whistler

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The AKEBONO spacecraft (EXOS-D) was launched in 1989 to observe particles and plasma waves in the auroral region and the plasmasphere of the Earth. It covers the altitude region from 300 km to about 10,000 km with an orbital inclination of 75 degree, and has been operated for more than 25 years which exceed 2 cycles of solar activity or 1 cycle of solar magnetic polarity reversal. Therefore analyses of the data obtained by AKEBONO enable us to study how the magnetosphere varies comprehensively.

The WBA (Wide Band Analyzer) is one of subsystems of the VLF instruments onboard AKEBONO. It measures 1 component of electric or magnetic analogue waveform in the frequency band of 50 Hz - 15 kHz. Typical waves such as chorus, hiss and whistler were frequently observed by the WBA. Huge amounts of data obtained by the WBA for more than 25 years are originally recorded as analogue waveform format in the magnetic audio tapes. Data conversion from analogue to digital is now carried out and the converted data are stored in our computer storage as digital WAVE format. Total number of the data files of digital WAVE format is more than 6,000, the total file size exceeds 10 terabytes and the processable data amount corresponds to more than 5,000 hours observation.

An automatic detection system to detect lightning whistlers from spectrograms of the WBA was developed. The spectrum intensity is automatically calibrated inside the system referring to the status of automatic gain controller of the receiver before detecting lightning whistlers. The system can output observed time, frequency band and dispersion of each detected lightning whistler. Some statistics of the lightning whistlers such as spatial and local time dependence of the occurrence frequency were already performed and the comparison with lightning activities are now under study. Because the dispersion of lightning whistler strongly depends on the electron density profile along the propagation path of the wave so that global electron density profile can be estimated using trend of dispersions of lightning whistlers. It is also pointed out that the propagation behavior of lightning whistlers is important clue to understand the wave-particle interaction. Thus these data and statistics have potential to achieve more valuable knowledge of the plasma physics in the magnetosphere.

In this presentation, we introduce the current status of data availability of the WBA and the derived results so far. We also discuss prospect of the data utilization.

Keywords: AKEBONO (EXOS-D), VLF, wide band receiver, lightning whistler

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PEM28-14 Room:413 Time:April 29 16:15-16:30

Simultaneous ground-based and satellite observations of MF/HF auroral radio emissions

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Ground-based and satellite observations have revealed that the Earth is a distinct radio source. The terrestrial auroral ionosphere emits electromagnetic waves in the MF/HF ranges (about 1-6 MHz) as well as well-known intense auroral kilometric radiation (AKR) and auroral hiss in the VLF/LF ranges. Terrestrial Hectometric Radiation (THR) is observed by satellite observations in a frequency range of 1-4.5 MHz at high latitudes during geomagnetic disturbances and is regarded as a counterpart of auroral roar which is one type of MF/HF auroral radio emissions observable from the ground. Both THR and auroral roar are attributed to mode conversions of upper hybrid waves favorably generated under the matching condition, $f_{UH} \sim nf_{ce}$, where previous studies confirmed n = 2,3,4 and 5 for auroral roar, and n = 2 for THR. However, no previous studies have tested the simultaneous appearance. In this study, we survey long-term observation data obtained by the ground-based passive receivers installed at the Husafell station, Iceland (after September 2005, latitude 64.67^{o}N, longitude -21.03^{o}E, 65.3^o magnetic latitude) and the Kjell Henriksen Observatory (KHO), Svalbard (after August 2008, latitude 78.15^{o}N, longitude 16.04^{o}E, 75.2^o magnetic latitude) and by the Plasma Waves and Sounder experiment (PWS) mounted on the Akebono satellite. This data set includes several simultaneous appearance events, while the frequency of aurora roar is different from that of THR observed by the Akebono satellite passing over the ground-based stations. This frequency difference supports the previously proposed idea that auroral roar and THR are generated at different altitudes near 250 km and 1000 km, respectively. There is hardly any possibility that simultaneous observations indicate the identical generation region of auroral roar and THR. We also find that auroral roar appearing during the time when the Akebono satellite passes over the ground-based stations tends to be accompanied by THR. However, when the Akebono satellite passing over the stations detects THR, auroral roar does not always appear. This tendency is explained in terms of the fact that the Akebono satellite can detect THR emissions coming from a wider region, and a considerable portion of auroral roar emissions generated in the F region is absorbed in the D/E regions.

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Spatiotemporal distribution of auroral brightening in the cusp

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Previous studies have shown that mesoscale auroral forms occur near the equatorward edge of the background, stable cusp aurora, and that they move in a direction that is consistent with the motion of the magnetic field line after reconnection on the dayside magnetopause. In this study we pay attention to its initial brightening using data from a high-sensitivity all-sky imager at Longyearbyen, Svalbard. The imager has a field-of-view that spans more than 4 hours in MLT, and can observe auroral brightenings that are widely separated in MLT. We determined the position of dayside auroral brightening using the 630-nm auroral images, and examined how these positions are distributed in the cusp, focusing on intervals when IMF was extremely stable. Results of analyses show that brightening occurs over a wide dayside MLT range. We show detailed spatiotemporal patterns for successive brightening events, and discuss the patterns in terms of the formation of intermittent reconnection on the dayside magnetopause.

Keywords: aurora, cusp, particle precipitation, magnetic reconnection, all-sky imager

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Height measurement from stereo imaging of aurora

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A new stereoscopic measurement technique is developed (Kataoka+2013) to obtain an all-sky altitude map of aurora using two ground-based digital single-lens reflex (DSLR) cameras. Two identical full-color all-sky cameras were set with an 8 km separation across the Chatanika area in Alaska (Poker Flat Research Range and Aurora Borealis Lodge) to find localized emission height with the maximum correlation of the apparent patterns in the localized pixels applying a method of the geographical coordinate transform. It is successfully estimated that a typical ray structure of discrete aurora shows the broad altitude distribution above 100 km, while a typical patchy structure of pulsating aurora shows the narrow altitude distribution of less than 100 km. Recent new findings about the time variation of the emission height and further new challenges of February/March 2014 will also be reported.

Reference: Kataoka, R., Y. Miyoshi, K. Shigematsu, D. Hampton, Y. Mori, T. Kubo, A. Yamashita, M. Tanaka, T. Takahei, T. Nakai, H. Miyahara, and K. Shiokawa (2013), Stereoscopic determination of all-sky altitude map of aurora using two ground-based Nikon DSLR cameras, Ann. Geophys, 31, 1543-1548.

Keywords: aurora, ground-based imaging, digital single-lens reflex camera

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Statistical analysis of auroral structures related to the plasma instability based on ground optical observations

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Auroral complex shapes are formed due to the connection of the ionosphere and magnetosphere by geomagnetic field lines which project disturbance of the magnetosphere onto the ionosphere through auroral particles. Thus, study of the auroral dynamics is important in considering the disturbance of the magnetosphere. Shiokawa et al. [JGR, 2010] reported observations of small-scale finger-like auroral structures which appeared on the west side of auroral patches, using a high-resolution narrow field-of-view CCD camera at Gillam (geomagnetic latitude: 65.5 N), Canada. At the recovery phase of substorm in the night side, these structures appeared when the speed of the patches moving to the east was slowed down, due to the macroscopic Rayleigh-Taylor type instability in the magnetosphere. However, statistical characteristics of this phenomenon have not been investigated yet. In this study, based on observations by an all-sky imager at Tromso (magnetic latitude: 67.1 N), Norway from January 2009 to November 2012, we made statistical analysis of the occurrence conditions of 19 events of auroral structures that seem to be driven by pressure-driven plasma instability. We found fourteen large-scale finger-like structures which developed from auroral arcs and six small-scale finger-like structures which appeared in auroral patches. We investigated MLT dependence of the start time of these finger-like structures, their relationship with auroral substorms, scale sizes, eastward drift speeds, development speeds, and so on. The large- scale structures were seen from midnight to dawn and small-scale structures were seen at dawn mainly. Large-scale structures tend to appear at the beginning of substorms' recovery phase and small-scale structures tend to occur at the late recovery phase of substorms. The scale sizes of these large and small structures are larger than the gyro radius of the ions in the magnetospheric equatorial plane, indicating that the finger-like structures are caused by MHD instabilities. The eastward propagation speeds are slower than the typical midnight auroral drift speed. This fact indicates that the low-energy plasma may be source of the structures. However, this consideration may contradict with the idea that the high-energy particles lead to the pressure-driven instability.

Keywords: aurora, pressure-driven plasma instability, ground optical observation

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PEM28-18 Room:413 Time:April 29 17:15-17:30

Auroral vortex street formation and cavity trapping of Alfven waves

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The structuring of auroral arc has been studied to be understood in the context of magnetohydrodynamic (MHD) instabilities and their nonlinear evolution in the magnetosphere-ionosphere (MI) coupling system. It was demonstrated that feedback instability of field-line resonant and ionospheric Alfven resonant modes occurs, by means of linear analysis with non-uniformity of the Alfven velocity (v_A) in the dipole magnetic field and the convection electric field [Hiraki and Watanabe, 2011; 2012, Hiraki, 2013]. We performed 3D reduced-MHD simulations in the MI coupling system to examine nonlinear behavior of the initially assumed arc structure, where v_A is constant along the field line. Results show that i) the initial arc splits, intensifies, and just after that deforming into a vortex street, and ii) the transition of the growth pattern exists at the convection electric field of 20-40 mV/m. We also performed 3D simulations with non-uniformity of v_A, though without the initial arc, to examine changes in auroral structure and properties of Alfven waves due to the magnetospheric and ionospheric cavities. It was found that, if the ionospheric cavity becomes deep, the secondary instability in the magnetic equator side [Watanabe, 2010] is suppressed, alternatively, large-amplitude waves are trapped in the ionospheric cavity. In this talk, we report the initial results of the above two simulations. Furthermore, we would discuss on auroral electron acceleration in the cavity region, by means of extended analyses with two-fluid effects and parallel electric field.

Keywords: Auroral vortex street, Alfven wave, Ionospheric Alfven resonator, Electron acceleration, MHD simulation

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Relative timing of substorm-associated magnetic reconnection in the magnetotail and formation of auroral onset arc

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We have studied the relative timing of magnetic reconnection in the near-Earth magnetotail and formation of auroral onset arc, based on substorm events observed by the THEMIS spacecraft and ground-based all-sky imagers. The THEMIS all-sky imagers can observe auroras over a wide area with temporal and spacial resolutions higher than spacecraft-borne cameras. This enables us to investigate the timing of auroral development in more detail than before. A few min after the appearance and intensification of an auroral onset arc, it begins to form wave-like structure. Then auroral poleward expansion begins another few min later. Based on observations of plasmoids in the near-Earth magnetotail, we clearly show that magnetic reconnection is initiated at X∼-20 Re at least 1-3 min before the appearance of the auroral onset arc. This result suggests that magnetic reconnection plays some role in the formation of auroral onset arc.

Keywords: substorm, auroral onset arc, magnetotail, magnetic reconnection, plasmoid, GEMSIS

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Characteristics of eastward propagating aurora vortices obtained by aurora tomography

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We investigate characteristics of three mesoscale aurora vortices observed in the Northern Scandinavia by aurora campaign observation in March, 2013, which was conducted in collaboration with the Swedish Institute of Space Physics (IRF) and the Finnish Meteorological Institute (FMI). The aurora vortices propagated eastward intermittently at about 15-minute intervals in the post-midnight sector (0:00-0:40 UT; 2:30-3:10 magnetic local time) after the substorm onset. They were simultaneously observed by three monochromatic (427.8nm wave length) all-sky EMCCD imagers at Tromso (69.6N, 19.2E), Norway, Kilpisjarvi (69.0N, 20.9E), Finland, and Abisko (68.4N, 18.8E), Sweden, with an exposure time of about 2 seconds and a sampling rate of about 10 seconds. In addition to these optical data, geomagnetic field data from the IMAGE magnetometer chain were also available.

The propagation speed of these vortices was approximately 3 to 10 km/s at 100 km altitude. The ionospheric equivalent current system accompanied by the aurora vortices indicated a two-vortex structure. By applying tomographic inversion analysis to the events, we also obtained 3D distributions of volume emission rate and ionospheric electron density, as well as horizontal distribution of auroral precipitating electrons. It is also possible to estimate horizontal distribution of the ionospheric conductivity from the electron density distribution at every 10-second interval. In the presentation we will discuss the magnetosphere - ionosphere coupling process of the aurora vortices and the relationship with the omega bands that are generally observed in the post-midnight sector.

Keywords: aurora, tomography, substorm, vortex structure, imager, ionospheric current