Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

PEM28-01 Room:302 Time:May 23 09:00-09:15

Structuring and nonlinear dynamics of auroral arc

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The dynamics of auroral arcs in the magnetosphere-ionosphere coupling system has been vigorously studied on the basis of magnetohydrodynamic instabilities and their nonlinear evolution. The feedback instability was proposed for a mechanism [Sato, 1978; Lysak, 1991], where destabilization of shear Alfven waves is induced through a resonant coupling with density waves propagating in the ionospheric convection electric field. Recently, two-dimensional simulations demonstrated formation of small-scale arcs and ionospheric cavity modes [Streltsov and Lotko, 2004; Lu et al., 2008]. Treating nonlinear terms appropriately, a three-dimensional simulation showed that Kelvin-Helmholtz type vortex structures are spontaneously excited in the magnetosphere [Watanabe, 2010]. A linear analysis with non-uniformity of the Alfven velocity clarified eigenmode properties of the field-line and cavity resonances [Hiraki and Watanabe, 2011; 2012]. Furthermore, their relationship to the occurrence of auroral vortices has been investigated with nonlinear simulations.

In this study, the magnetospheric plasma is described by the reduced-MHD equations, and nonlinearity of Alfven wave appears in the convective derivatives with Poisson brackets terms. The field-aligned current of the Alfven wave flows into the ionosphere, producing an internal uniformity of plasma density or conductivity. The ionospheric plasma motion is described by the compressible two-fluid equations and is characterized by the Pedersen and Hall currents; nonlinearity appears in the divergence of these currents. The purpose of this study is to understand effects of the above nonlinearities on the development of feedback unstable modes. Auroral structuring as a result of these instabilities could be related to observing phenomena: splitting of arc and spiral or vortex (bead) structures. Properties of cavity modes and field line resonances associated with auroral structuring can be understood in the nonuniform flux-tube system. Furthermore, the relationship between long-lived auroral arcs and feedback-unstable modes that grow up in a strong convection is investigated. Characteristics of vortex structures appearing in auroral break-up would be pursued.

Keywords: auroral arc, Alfven wave, nonlinear simulation

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

PEM28-02 Room:302 Time:May 23 09:15-09:30

Observation of aurora polarimetry at OI 630 nm

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Auroral polarimetry potentially contributes to bring us new information on electron collision with atmospheric particles and local process in the ionosphere. Recent ground-based measurement data showed that auroral emission at OI 630 nm probably polarized with a degree of 1-4 % [Lilensten et al., 2008]., and the polarization is maximized in the magnetic perpendicular direction [Barthelemy et al., 2011]. However, past experiments were carried out with a photometer mainly in the polar cap region, and examples were limited and there are no observation of circular polarization like all-sky imager.

We carried out observation of aurora polarimetry at OI 630 nm at Poker Flat Research Range in Alaska from 6 to 19 January 2013 with a newly developed all-sky polarization imager and meridian scanning photometer. We developed all-sky imager what measures polarization component (stokes vector) consists of fish-eye lens, the liquid crystal variable retarder difference which controls polarization electrically, polarization beam splitter, and CCD camera by joint development with the Institute for Astronomy, University of Hawaii. The photometer consists of wave plate on rotating stage, polarization beam splitter and measures polarization components.

In this talk, we report our result of this auroral polarimetry measurement, and the design of the observational instrument in detail. We will analyze and compare with geomagnetic data and precipitation particles data observed by the satellite and explore the application of aurora polarization measurement.

Keywords: aurora, polarimetry

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

PEM28-03 Room:302 Time:May 23 09:30-09:45

Spatial distribution of the plasmaspheric ions estimated by assimilation of IMAGE/EUV data

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The IMAGE satellite observed EUV radiation at 30.4 nm which is scattered by helium ions in the plasmasphere. The imaging data of extreme ultra-violet (EUV) from the IMAGE satellite provides the information about the global structure of the plasmasphere. We are developing a data assimilation technique which incorporates the IMAGE/EUV data into a two-dimensional fluid model of the plasmasphere. Our approach consists of two steps. First, we estimate the initial state of the plasmasphere by the linear inversion. Second, we estimate the temporal evolution of the plasmasphere from a sequence of EUV images by using the ensemble transform Kalman filter, which is one of sequential data assimilation algorithms. By combining a sequence of EUV images and the dynamic model the plasmasphere, we estimate the spatial distribution of the plasmaspheric herium ions and the electric potential. We will show the structure of the plasmasphere for some events, which are estimated with the data assimilation technique.

Keywords: plasmasphere, data assimilation

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(May 19-24 2013 at Makuhari, Chiba, Japan)

PEM28-04 Room:302 Time:May 23 09:45-10:00

Solar activity dependence of quiet-time photoelectron outflows and the field-aligned potential drop in the polar cap

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Counter-streaming photoelectrons with energies of about a few tens of electron volts are present on the open field lines in the polar cap, and the precipitating component is reflected photoelectrons by a field-aligned potential drop above the satellite [e.g., Kitamura et al., 2012]. To examine solar activity dependence of the photoelectron flows and the magnitude of the field-aligned potential drop, we statistically investigate photoelectrons in the polar cap using the data obtained by the FAST satellite in an altitude range of 3000-4200 km during geomagnetically quiet periods under small field-aligned current conditions. We selected 30 months when the apogee of the FAST satellite was located in the summer hemisphere from the months between July 1997 and January 2009. The geomagnetically quiet period is defined as the times when the *Kp* index is less than or equal to 2+ for the preceding 3 hours and when the *SYM-H* index ranges from -10 to 40 nT. The polar cap is defined by the lack of energetic ions [Andersson et al., 2004]. The typical magnitude of the field-aligned potential drop during geomagnetically quiet periods tends to decrease with decreasing solar activity (F10.7). Near the solar maximum, the typical magnitude of the field-aligned potential drop is 20-30 V, while it is about 10 V or smaller near the solar minimum. The flux of upgoing photoelectrons increases with increasing solar activity. In contrast, the median of the net escaping electron number flux in each month during geomagnetically quiet periods is almost unaffected by solar activity. This relation suggests that larger field-aligned potential drop prevents most of them from escaping.

Keywords: Polar wind, Ion outflow

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PEM28-05 Room:302 Time:May 23 10:00-10:15

A Parametric Sensitivity Study for Magnetosphere-Ionosphere Coupling Process in a Global MHD Simulation

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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 examine the effects of varying the scaling factors to the ionospheric electric field potential map using a global MHD simulation.

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: global MHD simulation, sensitivity analysis, ionospheric electric field potential map, aurora, ionospheric conductivity, field-aligned current

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

PEM28-06 Room:302 Time:May 23 10:15-10:30

Seasonal variation of the amplitude of geomagnetic sudden commencements from low latitude to the magnetic equator

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Seasonal dependence of diurnal variation of the main impulse (MI) of geomagnetic sudden commencements (SCs) has been investigated using the long-tern geomagnetic field data with high time resolution of 1 sec within a period from 1996 to 2008 provided from the NSWM [Kikuchi et al., 2008] and CPMN [Yumoto and the CPMN group, 2001] chains and the WDC for Geomagnetism, Kyoto. In the present analysis, we used the geomagnetic field data obtained from the 6 stations: Pohnpei (geomagnetic latitude, MLAT = 0.27 degree), Yap (MLAT = 0.38 degree), Cebu (MLAT = 0.85 degree), Guam (MLAT = 5.22 degree), Okinawa (MLAT = 16.54 degree), Kakioka (MLAT = 27.18 degree). In this study, the SC events have been defined as a rapid increase with its amplitude of more than 5 nT within 10 minutes in the SYM-H index. In this case, 4158 events of the magnetic field disturbance are found in a long period from January 1996 to October 2012, which has no Pi 2 signature around 10 minutes at the SC onset. Details of the analysis method have been described in the paper of Shinbori et al. [2009]. Moreover, the SC amplitude obtained at the above 6 stations has been normalized by that in the SYM-H index with latitude correction in order to minimize the different contribution of the rapid change in solar wind dynamic pressure. We also used solar wind data obtained from the IMP-8, Geotail, Wind and ACE satellites within the same period. As a result, the diurnal variation of SC amplitude in the equatorial region (0.27-5.22 degree) showed an equatorial enhancement in the daytime (6-18 h) with its maximum around 11 h produced by the enhanced eastward ionospheric currents due to the Cowling effect. The local time showing the peak amplitude tends to shift from the noon to the morning side by 1 hour. The equatorial enhancement was observed in an off-dip equatorial region (dip latitude: ˜15 degrees). The seasonal variation of the equatorial enhancement of SC amplitude shows that the SC amplitude tends to become relatively smaller in the summer than in the equinox or winter. This variation is different from that in the middle latitudes reported by Shinbori et al. [2012], and suggests that the intensity of the equatorial electrojet current does not simply depend on the solar zenith angle. One of the implications of the equatorial seasonal dependence is that the penetration polar electric field tends to become weak in the summer, compared with that in the winter and that there exists a contribution of ionosphere current flowing in the lower F-region. In future, in order to verify this feature, we will need to perform a comparable analysis between the SC amplitude and ionospheric conductivity calculated with the IRI-2007 and NRLMSIS-00 models.

Keywords: Sudden commencement, Magnetic equator, Seasonal variation, Ionospheric conductivity, Solar zenith angle, Cowling effect

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

PEM28-07 Room:302 Time:May 23 10:30-10:45

Relationship between low latitude electric field and global currents during geomagnetic pulsations

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The PC5 is often observed at low latitude with enhanced amplitude at the dayside dip equator, consistent with the DP2 currents driven by the dawn-dusk electric field [Motoba et al., 2002]. The electric field associated with the DP2 currents has been observed by the HF Doppler measurements at low latitude [Motoba et al., 2004]. In the present study, we show that the HF Doppler frequency deviations at low latitude are out of phase with the equatorial PC5 in the same meridian in the period range of 1-10 min. The PC5 at the nightside low latitude shows little latitudinal change, implying major contribution of the compressional MHD waves propagated from the magnetosphere. However, appreciable currents were found to be driven by the dawn-dusk electric field in the nightside equatorial ionosphere. These results raise an issue on the dynamo for the PC5 which supplies the electric field and currents in the ionosphere.

Keywords: PC5 pulsation, HF Doppler frequency, ionospheric electric field and current, PC5 dynamo

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

PEM28-08 Room:302 Time:May 23 11:00-11:15

Seasonal variation of equivalent current in the polar ionosphere

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We have statistically studied an equivalent current system in the polar ionosphere derived from ground-based magnetometer network. It is well known that the ionospheric current system forms a twin-vortex pattern with flow cells on the dawn and dusk sides. The anti-sunward current flow in the polar cap region tends to be tilted toward dawn even during negative IMF-By condition. This deformation of the current pattern is generally interpreted to be caused by non-uniform ionospheric conductivity.

Our results show that the current intensity is greater in summer than in winter and the tilt angle of the current flow is greater in winter than in summer. Furthermore, we found that diurnal variation of the magnetic field in the polar cap region averaged during the geomagnetically quiet condition is similar to the solar quiet (Sq) variation observed at low to middle latitudes. These results imply a possibility that the ionospheric current system in the polar region may be affected by the Sq current system.

Keywords: ionospheric current system, polar ionosphere, Sq current system, magnetometer network

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

PEM28-09 Room:302 Time:May 23 11:15-11:30

Solar zenith angle dependence of tweek reflection height during magnetically quiet time and magnetic storms

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Reflection height of tweek atmospherics is an indicator of the height of the ionospheric D-layer. Variations in tweek reflection height through the day-night boundary at Antarctic station were reported by Saini and Gwal (2010). The tweek reflection height gradually varied from 64 km to 79 km at Indian Maitri station in Antarctica through three months (January-March) in both 2003 and 2005, showing variations of the tweek reflection height under the midnight sun at polar region. The descent (rise) of the reflection height corresponds to increase (decrease) in electron density in the ionospheric D- and lower E-regions. Singh et al. (2011) reported the variations of the tweek reflection height observed in India during a solar eclipse of 22 July, 2009, which occurred just after sunrise. The tweek reflection height decreased from about 94 km to 90 km during the sunrise. However, solar zenith angle dependence of the tweek reflection height has not been studied statistically. In this study, we statistically investigate the solar zenith angle dependence of the tweek reflection height, using long-term tweek data of 1976-2010 during magnetically quiet time, and for 7 major magnetic storms occurred in 1978 - 1999. We pick up major magnetic storms with the Dst minimum of less than -200 nT to know the difference between the storm time and quiet time. The tweek reflection height in the magnetically quiet time rises from about 88 km to 96 km with increasing the solar zenith angle from 80 degrees to 105 degrees. In the solar zenith angle range of 105 - 170 degrees, the tweek reflection height keeps at the height of 96 km. This shows that the tweek reflection height under the sunset/sunrise condition is lower than that in complete nighttime, indicating the increase in the electron density in the lower ionosphere due to the sunset/sunrise. The tweek reflection height during the magnetic storms also shows similar solar zenith angle dependence with that in magnetically quiet time. However, the tweek reflection height during magnetic storms is systematically entirely lower by about 2 km than that during magnetically quiet time. This shows the electron density increase during magnetic storms.

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

PEM28-10 Room:302 Time:May 23 11:30-11:45

Current conservation of Equatorial Electrojet coupling to R1 current system

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Possible mechanism for current closure from polar to equatorial ionosphere via global Cowling channel is discussed. In our model, a global (primary) Hall current accompanied by two-cell type ionospheric convection induces polarization chargee at the conductivity gradient region of dawn-dusk conductivity terminator and magnetic dip-equator. The secondary electric field accompanied by this induced charge generates the secondary Hall current flows along the dawn-side terminator line to the magnetic dip-equator. Resultantly, the global Cowling channel from polar to equatorial ionosphere via the terminator-line and magnetic-dip equator could be formed. Our model shows that growing of equatorial electrojet (EEJ) is due to the converging Hall current from polar region to the dawn side dip-equator and decaying of EEJ is due to the diverging Pedersen current from dusk-side dip-equator to the polar region. This mechanism can be applied to the EEJ disturbances accompanied by the solar wind variations such as DP2-type magnetic field disturbances and many phenomena associate the equatorial enhancement and/or depression of the geomagnetic field disturbances.

Keywords: Equatorial electrojet, Field aligned current, Magnetosphere-Ionosphere coupling

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

PEM28-11 Room:302 Time:May 23 11:45-12:00

Overshielding Electric Fields at Low Latitude as Observed with the HF Doppler Measurements

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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. The overshielding electric field has been observed at the equator with the incoherent scatter radar in Jicamarca and SuperDARN radars in mid latitude. In low latitude, on the other hand, the HF Doppler measurements have been used to detect the electric field associated with the short-period disturbances such as the sudden commencements and geomagnetic pulsations (1-10min), but the overshielding electric field with time scales of several 10s of min have not been reported. To detect the overshielding electric field in the low latitude ionosphere, we analyzed the Doppler frequency of the HF radio signals propagated over 120 km in Japan at frequencies of 5 and 8 MHz. We compared the Doppler frequency deviations with the equatorial EEJ/CEJ and found that the overshielding electric field is comparable to or even stronger than the convection electric field. These results suggest that the overshielding electric field would play an important role in the ionospheric disturbances at low latitude.

Keywords: ionospheric convection, overshielding electric field, equatorial counter electrojet, HF doppler, low latitude ionosphere

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

PEM28-12 Room:302 Time:May 23 12:00-12:15

Characteristics of azimuthally polarized Pi 2 pulsations on the morning side

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Pi 2 pulsations are globally observed on the ground at the onsets of substorms. On the morning side, the amplitude of the D-component Pi 2 pulsation increases due to the sunrise effect (Saka et al., [1980]). However, there are few studies about this phenomenon, and its mechanism is still unknown. We analyzed azimuthally polarized Pi 2s on the morning side using data from the MAGDAS global magnetometers network. The following results are found; (1) D-component oscillations at low-latitude station were synchronized among D-component high-latitude oscillations and H-component dip-equator oscillations. (2) The amplitude of the D-component oscillation increases with latitude. (3) The oscillations in the D-component shows the out-of-phase relationship between postmidnight and morning side. (4) The oscillations in the D-component shows the out-of-phase relationship between the southern and northern hemispheres. From the result (3), the D-component oscillations on the morning side are deferent from magnetic fluctuations caused by the downward FAC oscillation of a substorm current wedge. We suggest that the north-south ionospheric current controls the azimuthal oscillation on the morning side.

Keywords: Pi 2 pulstaions, ULF waves, ionospheric current, substorm current wedge, multipoint ground-based observation

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

PEM28-13 Room:302 Time:May 23 12:15-12:30

Relationships between auroral beads evolution and Pi pulsations at substorm onset

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Auroral beads often appeared during presubstorm onset phase, which has been considered as one of important auroral phenomena relating to substorm expansion onset. Recently Motoba et al.,(2012) have reported optical signatures of auroral beads evolution in all ? sky images observed at a conjugate pair ? station, Syowa in Antarctica and Tjornes in Iceland, in which auroral beads appeared almost at the same time, as an inter ? hemispheric signature and the evolution was stable in the first stage, and then developed to a larger scale spiral form (undulations), at the same time at both the conjugate stations. These interhemispheric similarities suggest that there must be a common driver in the magnetotail equatorial region. On the other hand, it has been well known that Pi pulsation is another important signature at substorm onset. In this paper we examined relationships between auroral beads evolution and Pi pulsation onsets during a few minutes before the substorm expansion onset for the 30 September 2012 substorm event. Results show that there exist very good relationships between Pi pulsation onsets and auroral beads evolutions, particularly on the signatures for auroral beads sudden evolution to spiral structures and/or undulations, which was coincident to appearance of Pi 2 pulsation, and auroral beads brightness enhancement, which accompanied Pi 1 pulsation onset. The appearances of these Pi 1 and Pi 2 pulsations show a good conjugacy. These results show very good one-to-one correspondence between auroral beads dynamics and Pi 1 and 2 onsets, suggesting a common physical mechanism controlling their dynamics in the magnetotail equatorial region.

Keywords: substorm, aurora, pulsations

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

PEM28-14 Room:302 Time:May 23 12:30-12:45

Convection and Birkeland currents associated with theta auroras: MHD modeling

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When the interplanetary magnetic field (IMF) is northward, there occasionally occurs a peculiar auroral configuration which is called the theta aurora. The theta aurora consists of a ring of auroral luminosity (auroral oval) and the transpolar arc that crosses the polar cap from the nightside to the dayside. One mechanism that describes the theta aurora formation is the IMF By (dawn-dusk component) variation. When the IMF By polarity switches, the theta aurora is formed during the reconfiguration of the magnetosphere-ionosphere system. There are many observational studies that supports this idea, and global magnetohydrodynamic (MHD) simulations do reproduce the theta aurora configuration. However, details of the magnetosphere-ionosphere coupling process are not well known. Also, because of the observational constraints, it is not straightforward to advance the research deductively from observations. The purpose of this paper is, using numerical MHD simulations, to investigate the detailed processes of the magnetosphere-ionosphere coupling associated with the theta aurora formation and to show the evolution of convection and field-aligned currents (FACs) in a form to permit comparison with observations.

We set the IMF magnitude to 10 nT and switched the IMF clock angle from -45 to +45 degrees and vice versa. In this paper we define the theta aurora as the ionospheric projection of the closed field line region in the magnetotail (i.e., the plasma sheet). When IMF By switches from negative to positive, in the northern ionosphere, the theta aurora is detached from the dawnside auroral oval and drifts duskward in the polar cap. In the southern hemisphere, the dawn-dusk relation reverses. The characteristics of ionospheric convection and FACs are summarized as follows.

(1) In general, when IMF By is significant, quasi-stationary ionospheric convection exhibits the basic round/crescent cell pattern. In the theta aurora formation, the round cell plays a crucial role. Twenty minutes after the IMF By switch, the new round cell associated with the new IMF By is established. The theta aurora drifts with this round cell. The convection speed is faster in the rear side of the theta aurora motion (the new-lobe side) than the foreside (the old-lobe side). After the full development of the theta aurora, sunward convection occurs only at the dayside tip of the theta aurora (the theta crossbar is not connected to the dayside auroral oval). In the nightside part of the theta aurora, the round cell flow turns its direction from antisunward to sunward, so both sunward and antisunward convection coexist. The theta is often attributed to sunward convection; however this picture is not necessarily correct.

(2) The FAC reconfiguration precedes the convection reconfiguration. Fifteen minutes after the IMF By switch, the NBZ system associated with the new IMF By is already established. An FAC system with the same current polarity as the NBZ system extends antisunward along the rear side (with respect to the drift motion) portion of the theta aurora. If we trace the current lines to the magnetosphere, the FAC region is mapped to the foreside part of the protruded plasma sheet boundary (the old-lobe side). There the dot product of the current vector and the electric field vector is negative, meaning that that region is (part of) the dynamo of the FAC system. In addition, in the plasma sheet boundary on the old-lobe side, Dungey-type reconnection associated with the old IMF still continues to supply closed magnetic flux, which is one factor of the theta aurora growth. In the ionosphere, on the other hand, the FAC associated with the theta aurora largely closes with the region 1 FAC associated with the new crescent cell. This ionospheric closure of FACs drives the fast flow in the rear side of the theta aurora drift motion. That is, in the ionosphere, the theta aurora is ”pushed” from the rear side by the round cell convection.

Keywords: theta aurora, field-aligned current, ionospheric convection, MHD simulation

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

PEM28-15 Room:302 Time:May 23 14:15-14:30

Production of polar cap patches

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A highly sensitive all-sky EMCCD airglow imager has been operative in Longyearbyen, Norway (78.1N, 15.5E) since October 2011. One of the primary targets of this optical observation is a polar cap patch which is defined as an island of enhanced plasma density in the F region drifting anti-sunward across the central polar cap. Since the electron density within patches is often increased by a factor of 2?10 above that in the surrounding region, all-sky airglow measurements at 630.0 nm wavelength are capable of visualizing their spatial distribution in 2D fashion.

Although, in the last two decades, several efforts were made to capture the birth of patches in their generation region near the dayside cusp, it has been very difficult to directly image such an instant because the dayside part of the polar cap ionosphere is mostly illuminated by the Sun even in winter. In Longyearbyen, however, it is well-known that daytime aurorae can be observed using ground-based optical instruments in a limited period near the winter solstice. This enables us to directly image how polar cap patches are born near the dayside cusp region.

We present an event of polar cap patches on November 24, 2012, in which patches were generated within the field-of-view of the all-sky camera located on the dayside. During a 4-h interval from 0500 to 0900 UT on this day, we identified several signatures of poleward moving auroral forms (PMAF) in the equatorward half of the field-of-view, which are known as ionospheric manifestations of dayside reconnection. Interestingly, patches were directly produced from such poleward moving auroral signatures and propagated poleward along the anti-sunward convection near the cusp. From this observation, we strongly suggest that polar cap patches can be directly produced by poleward moving aurora forms, i.e., the periodic occurrence of dayside equatorial reconnection process.

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

PEM28-16 Room:302 Time:May 23 14:30-14:45

Accelerated motion of a poleward-moving auroral form in the cusp

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Poleward-moving auroral forms (PMAF), the ionospheric signatures of flux transfer events (FTEs), are intermittent phenomena observed in the cusp during negative interplanetary magnetic field intervals. Previous observations from ground-based optics showed that PMAFs emerge from the poleward boundary of the stable cusp precipitation region, and move poleward, often having a strong azimuthal component. In this paper, taking the advantage of a high-sensitivity all-sky imager, which is situated at Longyearbyen, Svalbard, Norway, we present observations in which PMAFs can be distinguished inside the stable cusp precipitation region. The 630.0-nm all-sky images taken with a time resolution of 4 s reveal that one of the PMAFs that occurred at ~1100 MLT on 17 December 2012 moves poleward quasi-steadily inside the stable cusp region during approximately 3 min after its appearance near the equatorward edge, and then accelerates eastward immediately after it exits from its poleward boundary. Prominent acceleration is seen during approximately 2 min, suggesting that the duration in which the tension force works on the newly opened field lines is a few minutes.

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

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PEM28-P01 Room:Convention Hall Time:May 23 18:15-19:30

Spatio-temporal of the O+ outflow caused by enhancement of the solar wind dynamic pressure : KAGUYA UPI-TEX observation

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In 1980s, terrestrial Oxygen ion (O+) outflow was observed much more than expected amount in the polar region where the magnetic field connects to interplanetary space. However, it is not yet obvious when and how much O+ outflow are produced. The purpose of this study is to observe changing O+ outflow from the polar region when solar wind came with Upper Atmosphere and Plasma Imager -Telescope of Extreme ultraviolet (UPI-TEX). Observed spatio-temporal of O+ rexonance scattering emission is mapped with magnetic field model. Because O+ estimated by changing emission in and out magnetic line. As a result, O+ outflow observed by increasing the solar dynamic pressure. After it, O+ increased in magnetic line and it correlated with an aurora.

Keywords: KAGUYA Satellite, UPI-TEX, Oxygen ion, Magnetic field model, Geomagnetic activity

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PEM28-P02 Room:Convention Hall Time:May 23 18:15-19:30

Study of the relationships between auroral wave structures and the auroral acceleration region: Reimei observations

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Auroral wave structures are very dynamic phenomena: its growth and decay processes are complicated and attractive. Auroral electrons are considered to be accelerated in the accelerated region at several thousand km altitude. That is, potential structure in the acceleration region might affect the wave growth. However, the relationships between auroral wave structures and the auroral acceleration region, is not fully understood.In this study, we examined the growth process of the auroral wave structure during a quiet period of the magnetosphere.Using the Reimei observations, the 13 aurora waves events are selected during 2007 data. The characteristic energy is derived based on the inverted-V electron structures in the energy-time diagrams. Assuming the U-shaped potential structures, we then calculated an electric field perpendicular to the magnetic field from the space variations of the electron energy gain. As a result, we found that the time variations of the auroral wave is more active when the electric field and/or potential of the auroral acceleration region is enough strong.

Keywords: REIMEI Satellite, Aurora wave structure, Characteristic Energy, Inverted-V type electronic structure, Electron acceleration region

Japan Geoscience Union Meeting 2013
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PEM28-P03 Room:Convention Hall Time:May 23 18:15-19:30

The polarization of 4fce auroral roar emissions

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This is a report on the first polarization measurements of auroral radio emissions near 4 times the electron cyclotron frequency (f_{ce}) in the Earth's polar ionosphere. Sato et al. [2012] discovered auroral roar emissions near ionospheric $4f_{ce}$, which were detected with a passive receiver installed in Svalbard, Norway (Invariant LAT 75.1N). The initial observations, performed for about a year, showed that $4f_{ce}$ roar emissions were detected from 5.27 to 5.70 MHz during moderate geomagnetic disturbances in 22 days between May and September 2011 only from noon to evening, while no event occurred during the 2010-2011 winter season. Examination of 2011-2012 polarization measurement data in Iceland (Invariant LAT 65.3N) reveals four events of $4f_{ce}$ roar emissions. $4f_{ce}$ roar in two events was observed to be left elliptically polarized with respect to the local magnetic field during daylight hours. This polarization is consistent with the idea supported by the observation in Svalbard; the origin of $4f_{ce}$ roar is mode conversion to the L-O mode of upper hybrid waves favorably generated under the condition of $f_{UH} \sim 4f_{ce}$. The other two events showed that $4f_{ce}$ roar was right elliptically polarized during darkness hours. This polarization indicates that nonlinear coupling of two upper hybrid waves may also works in the bottomside auroral ionosphere to generate R-X mode $4f_{ce}$ roar.

Keywords: aurora, radio propagation, ground-based observation

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(May 19-24 2013 at Makuhari, Chiba, Japan)

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Ionospheric Alfven resonance observed at a low-latitude station, Wakuya

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Ionospheric Alfven resonance (IAR) can be identified in dynamic power spectrum plot as a spectral resonance structure in the frequency range of 0.1 Hz - 7.0 Hz. Most of previous studies about IAR were done for mid- to high-latitudes. Only a few studies reported IAR at low latitude station, Creta (33.1 deg geomagnetic latitude (GMLAT)) [e.g., T. Bosinger et al., 2004]. There is a report that no IAR was found near Tokyo [Hayakawa, 2004]. We, however, observed a clear signature of IAR in data obtained by an induction magnetometer at Wakuya (29.7 deg GMLAT). To our knowledge, this is an IAR observed at the lowest geomagnetic latitude. Then we performed a statistical study using the induction magnetometer data recorded at Wakuya from 2007 to 2009. The sampling rate of the data is 15 Hz. We identified IAR by a criterion that a spectral harmonic structure has three bands. IAR occurred from evening to dawn with the maximum occurrence rate around 0300 LT. There is a seasonal variation that few events were found in May to September, but there were a lot of events in October to April. The harmonic frequency gradually increases over evening to post midnight, reaches the maximum around 0300 LT, and then decreases until dawn. The average frequency difference between two adjacent harmonics dF also has seasonal change. dF is larger in winter than in summer. The occurrence rate of IAR has no clear relation to the Dst index, while it has a weak negative correlation with the Kp index.

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

PEM28-P05 Room:Convention Hall Time:May 23 18:15-19:30

A Study of Field Line Resonances using data from the Magnetometer Array in the Tasmania and New Zealand Region

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In order to observe ULF pulsations and its spatial distribution around the terminator, we constructed a new magnetometer array in New Zealand and Tasmania region. In February 2011 and March 2012, we installed magnetometers in Middlemarch and Te Wharau, respectively. Coordination of them and other magnetometers operated by other projects allow us to study temporal variations of frequency of field line resonances in the Tasmania and New Zealand meridian lines. In this paper, our latest results are introduced.

Keywords: field line resonance, plasmasphere, inner magnetosphere, ULF wave, magnetosphere-ionosphere coupling

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(May 19-24 2013 at Makuhari, Chiba, Japan)

PEM28-P06 Room:Convention Hall Time:May 23 18:15-19:30

Stereo measurement of auroral emission altitudes using circular fisheye digital cameras

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The 3D structures of aurora tell us important information on the energy of precipitating electrons as well as the mechanisms. The purpose of this study is to estimate the emission altitude of aurora using pictures by digital cameras. It is fundamental to pursuing the altitudes and morphology of aurora in detail using new imaging instruments to advance our understanding of the generation mechanism of the aurora. We have been challenging a stereo imaging of aurora since 2009 using digital cameras equipped with fish-eye lens in Alaska. We installed two digital cameras for the time lapse observations with 3-60 s intervals; one is installed at the Poker Flat Research Range (PFRR) of University of Alaska, Fairbanks and the other is installed near the PFRR. For three winter seasons, we conducted a variety of experiments with different separation distance (3-8 km) and with a different set of cameras using Nikon D90, D7000, D3s, D3x,and D4. There are several advantages of digital cameras against to usual CCD observations such as high spatial resolution, full-color observations, and low-cost operations. A number of images more than 3 TB have been obtained for three seasons. In order to estimate the emission altitudes, we firstly estimate the camera parameters to calibrate the fish-eye images into absolute coordinate using the star positions [Mori et al.,2012]. We then apply plane sweep method to find the altitudes of maximum correlation of two images changing the mapping altitude and estimate the possible altitudes of aurora. We estimated the possible auroral altitudes for 13 examples, and the altitudes are distribute in 110-160km.

Keywords: auroral altitude, plane sweep, stereo fisheye digital cameras

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

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Simultaneous measurement of auroral O I 630.0nm polarization using an all-sky polarimeter and a scanning polarimeter

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Auroral O I 630.0nm emission is expected to be polarized at a maximum polarization degree of 15% when it is collisionally excited by directive electron (Percival and Seaton 1958; Bommier et al., 2011). Because observed maximum polarization degree is mainly a function of pitch angle distribution of impact electrons, a polarimetry of aurora could be a new remote-sensing technique to derive impact electron information, especially for its pitch angle distribution. In this study, we aimed to establish procedures of all-sky polarimetry and to derive all-sky distribution of polarization.

Observation of auroral polarimetry was made at Poker Flat Research Range in Alaska from 6 through 19 February 2013 using a all-sky polarimeter and a scanning polarimeter. The all-sky polarimeter which consists of an all-sky imaging optics, two liquid-crystal variable retarder, a polarization beam-splitter and two CCD cameras enables to measure Stokes four parameters (IQUV). The scanning polarimeter which consists of a quarter-wave retarder with a rotation stage, a polarization beam splitter, and two photon multipliers enables to measure Stokes four parameters as well.

Based on a preliminary result from all-sky polarimeter, degree of linear polarization increases from 0 to 2% with increase of angle between line-of-sight and local magnetic field. The result indicates that the measured distribution of polarization would be made by precipitating electron impact. In the presentation, we will introduce a typical substorm event on 10 January to see some relationship between degree of polarization and pitch angle distribution of precipitating electron.

Keywords: polarimeter, auroral, O I, 6300

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

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Observation of low-latitude aurora by color digital cameras in Hokkaido

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Auroras observed in the middle latitude regions during a strong geomagnetic storm are called ”low latitude auroras”. Characteristics and mechanism of the low latitude aurora are still not fully understood due to a relatively low occurrence probability. Shiokawa et al. [2005] summarized low latitude aurora events observed with a sensitive optics (an imager and a photometer) at Moshiri (44.4^{o}N) and Rikubetsu (43.5^{o}N) in Hokkaido during 1999-2004. According to Shiokawa et al. [2005] several events in which OI 630.0 nm auroral emission showed visible level brightness ($>$ several kR) were recorded while SAR arcs appeared during the recovery phase of a geomagnetic storm. Although there are no explicit reports of naked eye observations during the events in their report, several color images of low latitude aurora were taken at the Nayoro observatory in Hokkaido (44.4^{o}N) in the same periods (6 nights between Mar 31 2001 and Nov 10 2004). In this presentation comparison between parameters estimated from these new color images and results from Shiokawa et al. [2005] are performed.

Keywords: Low latitude aurora, magnetosphere, imaging, Hokkaido, Nayoro

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

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Statistical analysis of auroral breakups during magnetic storm

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On average, auroral breakups typically initiate near 67deg magnetic latitude (MLAT) and in the pre-midnight region (23 hour in magnetic local time (MLT)). We statistically studied locations of auroral breakups during magnetic storms.

Auroral breakups were identified using global images taken by the ultraviolet imager onboard Polar satellite. We divided auroral breakups into storm-time events and other events, and then studied their differences. We identified magnetic storms with using Sym-H geomagnetic index and the sudden commencement(SC).

Our results show that auroral breakups occur at later MLT during the storm main phase than during other phases. This result is supported by preliminary studies of associations between the interplanetary magnetic field and breakups MLT.

Keywords: aurora, agnetic storm

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Status report on the SuperDARN Hokkaido East / West radars (2013.2)

Nozomu Nishitani[1*], Tomoaki Hori[1], Mariko Teramoto[1], Tadahiko Ogawa[2], Takashi Kikuchi[1], Akira Sessai Yukimatu[3], Masaki Tsutsumi[3], Katsuya Sakoyama[1]

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Latest status report on the SuperDARN Hokkaido East / West radars will be presented. The Hokkaido East radar has been operating since Nov. 2006 continuously. The Hokkaido West radar has been approved for funding.

Keywords: SuperDARN Hokkaido East / West radars, ionosphere, magnetosphere, thermosphere, dynamics, international collaboration

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(May 19-24 2013 at Makuhari, Chiba, Japan)

PEM28-P11 Room:Convention Hall Time:May 23 18:15-19:30

Syowa SENSU SuperDARN imaging radar and the future perspective (2)

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SENSU Syowa HF radars are important components of SuperDARN, the international HF radars network since 1995 and have significantly contributed to understanding not only magnetosphere-ionosphere system and their couplings but also MLT region dynamics. As SuperDARN radars were originally designed to reveal global polar ionospheric plasma convection patterns in both hemispheres in real time, its spatial resolution has been relatively low. As the number of new scientific targets like comparison with mid and small scale aurora phenomena, meso scale transient phenomena, elementary generation and decay process of field aligned irregularities, PMSEs and fine height profile of neutral wind have been increasing, higher spatial (and temporal) resolution observations have been essentially desired and of great importance. Imaging radar technique has been tried to be applied and developed to overcome these issues. We show the current status of our preparation of the SENSU imaging radar system, and will discuss particularly on the scientific targets and the future perspectives which can be revealed by this new technique using SuperDARN.

Keywords: SuperDARN, Syowa, imaging, MI coupling, aurora, MLT region

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(May 19-24 2013 at Makuhari, Chiba, Japan)

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Deriving maps of field-aligned current from IMAGE FUV and SuperDARN

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Many efforts have been made for deriving the spatial distribution of field-aligned currents (FACs) in the high-latitude ionosphere. To date, however, it has been still difficult to construct a map of FACs as a snap shot without any assumptions. In this study, we employ the ionospheric conductances estimated from the IMAGE/FUV auroral images together with the electric field deduced from Super Dual Auroral Radar Network (SuperDARN), and then derive a map of FACs in the high-latitude. The primary objective is to visualize the mesoscale structure of FACs in the vicinity of auroral bulges. If the 2D distribution of the bulge-associated FACs is clarified, the closure of the substorm currents can be discussed in terms of the magnetosphere-ionosphere coupling system. We have estimated the distribution of FACs for two case examples, one on September 25, 2001 and the other on January 12, 2002. During both intervals, nicely developing auroral bulges were observed by the IMAGE satellite and lots of backscatter echoes were obtained by the SuperDARN radars, which is a favorable condition for estimating the distribution of FACs in the vicinity of auroral bulge. We demonstrate how the procedure works in deriving the FAC system and discuss the closure of the substorm current system from the initial results.

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

PEM28-P13 Room:Convention Hall Time:May 23 18:15-19:30

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

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SC is caused by MHD waves transmitted toward the ionosphere associated with the compression of the magnetosphere due to solar flare disturbances. The characteristic of its variation is explained by the 3-demensional current systems composed of the Chapman-Ferraro current, the field-aligned current, and the ionospheric current[Araki,1994]. It is known that SC is accompanied with the instant transmission of the electric field, which is found in the ionosphere derived by the HF Doppler[Kikuchi,1986] and in the plasmasphere observed by Akebono[Shinbori et al.,2006]. Nishimura et al.(2010) indicated the upward Poynting flux at the plasmaspheric electric field derived by Cluster observation. They showed the electric field transmission from ionosphere to polar magnetosphere, and estimated that plasmaspheric electric fields during SC originate in the ionosphere. The ROCSAT-1 is rare satellite in terms of in-situ observation of the ionospheric electric field. It had orbited at the altitude of 600km, and observed during the solar maximum, thus it has detected many SC events[Shinbori et al.,2009]. This data indicates the Preliminary Impulse(PI) or Main Impulse(MI) electric field variation[Su et al.,to be submitted]. However, the simultaneity to geomagnetic variation and the MLT distribution of the electric field have not investigated. We need to clear them to understand the convection process of the electric field. Therefore, we will eliminate effects of the magnetospheric current and the ionospheric conductance by in-situ observation, and analyze the time and spatial evolution during SC. Underlying data are the drift velocity observed by the Ionospheric Plasma and Electrodynamics Instrument(IPEI) onboard ROCSAT-1, and we derived in-situ electric fields with the IGRF-10 model. We referred geomagnetic field variations from 8 stations where has sampled per a second. We selected the SC events from the list of Shinbori et al.(2009), with the following criteria; (1) IPEI observation is available(1999/3/11˜2004/6/13), (2) the PI amplitude more than 2nT near the dayside magnetic equator, and (3) the Preliminary Reverse Impulse(PRI) signature at both high latitude and daytime magnetic equator. We identified 203 events under the above conditions, and 44 events showed that SC signatures detected on the ground is synchronized to the onset at the ionospheric electric field. At these events we could detect the ionospheric electric field variation corresponding to the PI and MI signature of geomagnetic fields. This result indicates that PRI and MI signatures of the electric field are potential fields associated with conduction currents, and instantly transmit globally. We confirmed that the ionospheric electric field was changed simultaneously with geomagnetic variations even if they observed at different MLT locations. For events which are seen relatively massive electric fields, we pursued Superposed Epoch Analysis. We extracted events which PI was detected in the electric field, and derived the LT distribution of PI in the electric field after regarding the PI peak time of each electric field as the time reference. Therefore, we showed that the PRI appears at 6-21 LT, while the Preliminary Positive Impulse(PPI) at 21-6 LT, which is consistent with Kikuchi et al.(1985) senario. Also we first detected the evening enhancement by in-situ electric field observation. This result is similar to the daily variation of equatorial ionospheric electric fields[Fejer et al.,1991], and we estimate the relation of the electric field originated by the magnetosphere. Our results show that equatorial ionspheric electric fields transmit instantly, and that it is caused by the transmission of convection electric field from polar region. And the detection of the evening enhancement means that the transmission process during SC is similar to what causes the daily variation, and suggests that its process is affected by the electric field transmission from magnetosphere.

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

PEM28-P14 Room:Convention Hall Time:May 23 18:15-19:30

Ionospheric current identified by propagation characteristics of Pc5 and DP2

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It is well known that DP2 variation observed at the equator is a result of constructing of ionospheric current between polar regions and equator [Kikuchi et al., 1996]. Furthermore, Motoba et al., [2002] mentioned that global Pc5 can be caused by current systems similar to DP2 current system in Ionosphere. However, mechanism and propagation path of such global current especially between polar regions and equatorial ionosphere are not well known.

To clarify connection path of ionospheric current system between polar and equatorial ionosphere, we analyzed global distribution of ULF pulsations using MAGDAS/CPMN network [K. Yumoto et al., 2006 and 2007]. In this study, we especially focus on polarization, amplitude and LT dependence of ULF pulsations. The electric field data observed by HF radars are used for identification of Cowling effect at the dip-equator and dawn-dusk terminator.

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

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Multi-timescale statistical analysis of ionospheric trough with long-term EISCAT dataset

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The statistical analysis to northern ionospheric auroral/subauroral trough has been conducted for the purpose of clarifying the controlling mechanism of the trough's basic structure.

Ionospheric trough, known as an electron density depletion region in ionosphere, is considered as one of the important phenomena driving the coupling system between ionosphere and magnetosphere via magnetic-field-lines. Therefore the trough research is not only restricted to ionospheric physics but also could contribute to magnetospheric physics, especially magnetosphere-ionosphere coupling system. Moreover, it is indicated that sharply decreasing of electron density over the tough wall region could influence the HF radio wave propagation and GPS navigation system. Thus the trough research is expected to make contribution to radio communication science.

It is commonly accepted that the dissociative recombination caused by ionospheric heating generates the trough's basic structure. However, it is very difficult to reveal the causal relationship between several heating mechanisms and trough's characteristics because various physical and/or chemical processes could drive depletion of ionospheric density. In this study, therefore, we have used EISCAT database which covers 29-years (1983~2011) ionospheric data and conducted long-term statistical analysis of the ionospheric trough. In particular, we focus on investigations of the characteristics of the trough's spatial structure by using multi-timescale statistical analysis. We have obtained the following results so far.

(1) Nighttime trough is steadily structured in all seasons, while structure of daytime trough has seasonal dependence because ionization rate is controlled by solar zenith angle.

(2) The longitudinal structure of trough shifts equatorward and toward pre-midnight with increasing Kp index.

(3) While the background electron density becomes higher in F-region, the depth of trough becomes deeper with increasing F10.7 index.

In this paper, we present the analysis method and the obtained results, and discuss how the characteristics are generated.

Keywords: EISCAT, Ionosphere, Trough

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Plasma density structure at scales of a few kilometers in the cusp

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We have examined kilometer size density structure in the dayside cusp by using in-situ measurements made by DE 2 spacecraft. We analyzed high time resolution (16 milli-second) ion density data, and examined the occurrence characteristics of relatively large amplitude structures at scales of a few kilometers in terms of the background plasma density gradient, ion drift, and electron temperature. The result shows that the occurrence of the plasma density structure is high in the fast flow region, which is typical for the cusp, and in the region adjacent to and poleward of that region.

Keywords: cusp, plasma density structure, plasma flow, electron temperature

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Observation of GNSS scintillation in Tromso

Yusaku Ito[1*], Yuichi Otsuka[1], Kazuo Shiokawa[1], Keisuke Hosokawa[2], Yasunobu Ogawa[3]

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A radio signal passing through small-scale irregularities in the ionospheric electron density fluctuates in amplitude and phase because the irregularities act as diffraction gratings. This phenomenon is known as scintillation. The GNSS(Global Navigation Satellite System) scintillation is caused by irregularities with scale-size of several hundred meters. In this study, we install GNSS receivers at the EISCAT radar site in Tromso, Norway, where optical and radio measurements are carried out. On January, 2012, we have installed a GNSS receiver at EISCAT radar site in Tromso, Norway. The receiver has an ability to measure phase and signal-to-noise ratio of the radio wave at dual frequency (L1 and L2) at 50 Hz, so that total electron content and phase and amplitude scintillations can be obtained. On September, 2012, we have installed two more receivers. Mutual distances between the GNSS receivers are 172m, 242m and 218m, respectively. Drift velocities of irregularities can be measured using cross-correlation analysis with the time series of the GNSS signal intensity and phase obtained from the three receivers.