Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

PEM31-P01 Room:Convention Hall Time:May 24 13:45-15:15

Photoelectron flows in the polar cap during geomagnetically quiet and weakly disturbed periods

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On the open magnetic field lines in the polar cap, downgoing electrons with energies lower than about 100 eV, which are considered to be photoelectrons reflected by a field-aligned potential drop above the satellite, had been identified in some case studies [e.g., Winningham and Gergiolo, 1982]. To examine the typical characteristics of the photoelectron flows and the field-aligned potential drop, we statistically investigated photoelectrons in the polar cap using the data obtained by the FAST satellite in an altitude range of 3000-3900 km in July 2002 (solar maximum) during geomagnetically quiet and weakly disturbed periods. In this period, the apogee of the FAST satellite located at high latitudes in the northern (summer) hemisphere. 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, while the weakly disturbed period is defined as the times when the *Kp* index ranged between 4- and 5. The polar cap is defined by the lack of energetic ions [Andersson et al., 2004]. We found counter-streaming photoelectrons of up to more than 10 eV, indicating existence of a field-aligned potential drop (reflection potential drop) above the satellite altitude. Such distributions were frequently (quiet: 83%, weakly disturbed: 65%) observed in the polar cap. The estimated typical reflection potential drop above the satellite is about 20 V. In respect of the presence of a field-aligned potential drop at high altitudes, this result is consistent with the modeling results by Wilson et al. [1997] and Su et al. [1998], although the field-aligned distribution of the potential (e.g., presence of a potential jump) cannot be investigated from only the photoelectron observations in the present study. The typical observed reflection potential drop during geomagnetically quiet periods (about 22 V) is smaller than these modeling results by a factor of 2-3, while the median of net escaping electron number fluxes during geomagnetically quiet periods ($1.7 * 10^8$ /cm^2/s) is larger than these models by a factor of 2.8-3.5. During weakly disturbed periods, the net escaping electron number flux tends to increase (median: $2.8 * 10^8$ /cm^2/s), while the magnitude of the reflection potential drop tends to decrease (median: about 17 V), compared to those during geomagnetically quiet periods.

The net escaping electron number flux negatively correlates with the reflection potential drop. This relation corresponds to the fact that only high-energy photoelectrons can overcome the potential drop and escape when the reflection potential drop becomes large. On the other hand, the net escaping electron number flux, which should be nearly equal to the flux of the polar wind ions under small FAC conditions, negatively correlates with the upward electron number flux. This relation is contrary to the modeling results by Khazanov et al. [1997] and Tam et al. [1998]. An increase in downgoing electrons and their backscatter in the ionosphere with increasing reflection potential drop may explain the negative correlation. A potential drop at high altitudes, which was not considered by Khazanov et al. [1997] and Tam et al. [1998], would provide a polar wind system regulated by a negative feedback, and the most appropriate balance for polar wind ions would be achieved near the median of the reflection potential drop.

Keywords: polar wind, ion outflow, polar ionosphere

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PEM31-P02 Room:Convention Hall Time:May 24 13:45-15:15

In-situ measurement of cusp plasma irregularity by sounding rocket - ICI-3 campaign -

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The ICI-3 (Investigation of Cusp Irregularities-3) campaign was conducted in Svalbard, Norway on December 2011. Science objective of ICI-3 is to obtain a better physical description of instabilities and wave phenomena driven by the newly discovered Reversed Flow Events (RFEs) in the winter cusp ionosphere. In particular, we would like to elucidate the following unresolved problem: 1)whether the RFEs are associated with a tangential discontinuity or a rotational discontinuity, 2)if the RFE-Birkeland current sheets are related to inverted-Vs, and 3)Identification of wave phenomena and non-linear saturation. In-situ measurements by sounding rockets will be needed to understand inherent cause of such phenomena.

The ICI-3 sounding rocket was launched at 07:21:31 UT at Ny-Alesund in Svalbard on December 3, 2011, and it successfully intercepted the cusp aurora region. All onboard systems functioned flawlessly. Measurements of the electron density and its perturbation, low energy electron flux, AC and DC electric fields, and field-aligned currents were made to conduct a comprehensive study with the aim to exploit the potential role of the gradient drift instability versus the other suggested mechanisms for the cusp plasma irregularity. An independent attitude determination system was prepared to define the orientation of the payload in order to derive vector field measurements.

We present a result obtained from a fixed-bias Langmuir probe which was installed to measure fine-scale (˜1 m) electron density perturbation.

Keywords: Ionospheric cusp, plasma irregularity, electron density, sounding rocket

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PEM31-P03 Room:Convention Hall Time:May 24 13:45-15:15

Poleward-propagating magnetic perturbations in the cusp

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Poleward-propagating magnetic perturbations are often observed on the ground in the cusp latitudes. Some previous studies suggested that these phenomena are the ionospheric current signature of flux transfer events [e.g., Milan et al., 2000]. However, our recent study on the mesoscale plasma injection in the cusp, which is typical of a flux transfer event, has shown that poleward-propagating nature is not clear despite that a vortical feature is identified [Taguchi et al., 2010]. In this study, using large data set obtained from the Greenland magnetometer chain, we identify statistical characteristics of poleward-propagating magnetic perturbations in the daytime sector, and understand what produces this signature. We took poleward-propagating events using cross-correlation of data from different stations in the Greenland chain. Results from the statistical analysis of these events show that the occurrence frequency is high around 12 MLT, as is expected, and that a typical poleward propagation speed is 0.5-2 km/s, which is consistent with the convection velocity. What is interesting is that there are a significant number of events that occur both in the East and West chains with no time lag. This shows that the longitudinal extent is more than about 1,000 km, which is much larger than the extent of the typical scale size of the possible signature of a flux transfer event. The east-west component of the magnetic perturbations of these events is generally small, which suggests that the perturbations are not produced simply by the enhancement of the anti-sunward convection in the longitudinal wide extent. We will show the detailed characteristics of the poleward-propagating phenomena including the longitudinally wide events, and discuss what drives these phenomena.

Keywords: ground magnetic perturbations, ionospheric current, cusp, polar cap, IMF

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PEM31-P04 Room:Convention Hall Time:May 24 13:45-15:15

Periodic structures of the electron density in the F region cusp

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Structured plasma density in the dayside cusp is known to be collocated with ”soft” precipitating particles, that is, electrons with energy less than about roughly 500 eV. When the energy and flux change over time, the structured density becomes even more irregular. In this study, using high time resolution data from the EISCAT Svalbard radar, we understand whether or not some periodic features exist in the irregular density distribution in the cusp. First, we derived the raw electron density profile with the shortest time resolution (of 3.2/6.4 s) from the radar data. We then examined the electron density profile using wavelet analysis. The result of wavelet analysis shows that several periodic variations exist in the structured density, and that a variation of 40-80s is prominent. We will show the detailed result about this variation, and discuss why this is prominent.

Keywords: F region, electron density, cusp, plasma convection, IS radar observations

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PEM31-P05 Room:Convention Hall Time:May 24 13:45-15:15

All-sky imaging polarimetry of OI 630 nm aurora

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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.*, *Polarization in aurorae*, 2008]., and the polarization is maximized in the magnetic perpendicular direction [*Barthelemy et al.*, *Polarisation in the auroral red line during coordinated EISCAT Svalbard Radar/optical experiments*, 2011]. However, past experiments were carried out with a photometer mainly in the polar cap region, and examples were limited. To measure polarization degrees continuously from the magnetic perpendicular direction to the magnetic parallel direction, the all-sky imaging polarization observation combined with a fish-eye lens and 2-D CCD or CMOS detector is the most feasible.

We plan to carry out a campaign measurement of imaging polarimetry of auroral 630 nm emission at Poker Flat Research Range, Alaska during a new moon period of 2012-13 winter with a newly developed all-sky polarization imager. In addition, we will make a model to estimate atmospheric scattering along the line-of-sight path between aurora and the ground. The instrument will be precisely calibrated since its optical system may produce artificial polarization. All-sky imaging auroral polarization data bring us to examine the dependence of the polarization degree on the magnetic field angle. In this talk, we report our plan of the auroral polarimetry measurement, and the current status of the developments in detail.

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PEM31-P06 Room:Convention Hall Time:May 24 13:45-15:15

Relationship between auroral curl/spiral and particle precipitaion: Reimei observation

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One of the most attracted properties of the aurora is its wave-like structures and the various scales of its wave structures are observed, such as an auroral curl or spiral. In this study, we focused on the precipitated particle behaviors when the aurora curl or spirals are observed at its footprint. Statistical analysis, using Reimei observations, shows that the inverted-V structures, low-energy electron dispersion, and plasma sheet electron precipitations are closely associated with the well-developed auroral wave structures.

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Electron properties of Inverted-V structures and their vicinities based on Reimei observations

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Electrons accelerated by the field-aligned potential difference are referred to as Inverted-V electrons. It is thought that fine structures of their energies and pitch angle distributions are due to electrostatic potential structures and their variations. Scientists have addressed outstanding problems such as how the potential difference is supported or how they are distributed along the magnetic field line. The purpose of this study is to understand how Inverted-V electrons are formed by focusing on not only Inverted-V regions but also their vicinities. The Reimei satellite for simultaneous observations of auroral particles and emissions with high temporal and spatial resolutions observed beam electrons at the edge of Inverted-V regions. At first their pitch angles are 0 to 20 degree. As Reimei moves toward the center of Inverted-V regions, their pitch angles broaden up to ˜120 degree, and their characteristic energy becomes higher. This electron beam is observed with non-accelerated diffuse electrons. To investigate electron properties around and in Inverted-V regions, we estimated the density and temperature of the source electrons. To observed electron energy fluxes we fitted the Maxwellian distribution for diffuse electrons and the accelerated Maxwellian distribution for Inverted-V electrons and electron beams.

An event observed on February 2, 2006 shows Inverted-V electrons with the width of ˜0.6 LAT at 73 ILAT and 0.4 MLT. At the high latitude of these electrons, diffuse electrons with energies of ˜400 eV and the isotropic distribution were observed. The estimated temperature and density of source diffuse electrons are ˜300 eV and ˜0.6/cc, respectively. In addition, those of energetic Inverted-V electrons are ˜300-˜400 eV and ˜0.1 /cc, respectively. For beam electrons, on the other hand, they are $<$100 eV and $<$0.1 /cc, respectively. These results indicate that source regions of diffuse electrons and energetic Inverted-V electrons are the magnetosphere such as the plasma sheet, and source electrons of the electron beam exist at altitudes of the topside ionosphere consisted of lower temperature electrons. To form electron beams, we figure out that a small amount of electrons are needed to supply into the acceleration region. From observations of auroral emissions, the poleward motion of the auroral arc with a low speed (˜0.5 km/s) was captured. Thus electron beams are likely explained by a drift of the electrostatic potential drop in the latitudinal direction. In other events, the similar signature of electron beams indicates that their source region is the topside ionosphere. Some static auroras, however, are also observed. In these cases, we consider that these ionospheric electrons are supplied into the potential drop due to the fallen bottom of equipotential planes toward lower altitudes. In this presentation, we will show some inverted-V events including diffuse electrons and electron beams and discuss about formations of electron beams.

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A Study of ULF pulsations observed at a New Magnetometer Array in the Tasmania and New Zealand Region

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In order to observe ULF pulsations and its spatial distribution, we are constructing a new magnetometer array in New Zealand and Tasmania region. In February 2011 and March 2012, we installed (or will install) magnetometers in Middlemarch and Wairarapa, respectively. Some magnetometers have been operated by previous projects in Tasmania and its conjugate point. Coordination of their and our magnetometers will 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: ULF, plasmasphere, Inner Magnetosphere, Magnetosphere-Ionpsphere coupling

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Development of ULF wave database conjugately observed at Syowa and Iceland

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The Energization and Radiation in Geospace (ERG) satellite will be launched in 2014 or 2015 to observe the inner magnetosphere. In conjunction with this, the existing observation network on the ground is to be redeveloped. As part of these developments, observation data from induction magnetometers installed in Antarctica and Iceland have been arranged. There are three observation points in Iceland and one station in Antarctica. In Iceland the sampling frequency is 2 Hz; on the other hand, at Syowa station, the sampling frequency is 20 Hz. Induction magnetometers are installed along with fluxgate magnetometers and riometers. The data are sent to Japan in a quasi-real-time manner. By making dynamic spectra from these data, we are developing a database of ultralow-frequency (ULF) waves. In the future, we intend to create a database environment that can compare the ERG satellite data with the ULF observation data simultaneously in a quasi-real-time manner. Currently, dynamic spectra have been developed for the period from February 2003 to January 2011. This period is consistent with that of CDF data files from the Syowa station. The frequency ranges of the developed dynamic spectra are 0-1 Hz and the durations are 24 h. To remove the effects of DC and anti-aliasing filters whose cutoff is 1 Hz, the averaged background is deducted from the FFT spectra data from the Iceland stations. Frequency ranges of FFT spectra from Syowa station are 0-10 Hz. Therefore, frequency ranges of 0-1 Hz are extracted from these data in addition to the aforementioned deducting procedure. As a feature of the conjugate observations, differences in attenuations of received signals between the summer and winter hemispheres are indicated. The intensities of the observed phenomena in the dynamic spectra of the summer hemisphere are weaker than those observed in the winter hemisphere. These attenuations are considered to be related to propagating processes in the ionospheric waveguide. Development of the database is proceeding, and we intend to publish it on a website in the near future.

Keywords: conjugate observation, ultralow-frequency, database development

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Wp index: A new substorm index derived from high-resolution geomagnetic field data at low latitude

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Geomagnetic field data with high time resolution (typically 1 s) have recently become more commonly acquired by ground stations. Such high time resolution data make it possible to identify Pi2 pulsations which have periods of 40-150 s and irregular (damped) waveforms. It is well-known that pulsations of this type are clearly observed at mid- and low-latitude ground stations on the nightside at substorm onset. Therefore, with 1-s data from multiple stations distributed in longitude around the Earth's circumference, substorm onset can be regularly monitored. In the present study we propose a new substorm index, the Wp index (Wave and planetary), which reflects Pi2 wave power at low-latitude, using the geomagnetic field data from 11 ground stations (Tucson, Honolulu, Canberra, Kakioka, Learmonth, Urumqi, Iznik, Fuerstenfeldbruck, Ebro, Tristan da Cunha, and San Juan). We compare the Wp index with the AE and ASY indices as well as the electron flux data and the magnetic field data at geosynchronous altitude for 11 March 2010. It is found that significant enhancements of the Wp index mostly coincide those of the other data. Thus the Wp index can be considered as a good indicator of substorm onset. The Wp index, other geomagnetic indices, and geosynchronous satellite data are plotted in a stack for quick and easy search of substorm onset. The stack plots and digital data of the Wp index are made available from the web site (http://s-cubed.info) for public use.

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Long-term variations of quiet-time geomagnetic H components on the nightside at mid latitudes

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Magnetic H-component values for several mid-latitude observatories were analyzed using the principal component analysis. It was found that there exists a seasonal variation in the opposite sense between the northern and southern hemispheres. The amplitude of the seasonal variations is larger at higher latitudes. This fact possibly indicates that the seasonal variation is caused by a electric current system at high latitudes such as the Region-1 current system. It was also found that there exists an irregular variation in the same sense between the two hemispheres, which is likely to anti-correlate with solar-wind activity.

Keywords: geomagnetic variation, long-term variation, field-aligned current

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Syowa SENSU SuperDARN imaging radar and the future perspective

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SENSU Syowa HF radars are important ocmponents 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 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 and fine height profile of neutral wind distributions have been increasing, higher spatial (and temporal) resolution obervations have been essentially desired. Imaging radar technique has been tried to be applied and developed to overcome this issue. 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, MLT region dynamics, MI coupling, aurora