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

PEM37-01 Room:414 Time:April 30 11:00-11:15

A coherent modulation of pulsating aurora at Pc5 frequency

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Ground and satellite magnetometer observations and all-sky video images revealed that the Pc5 pulsations that occurred in 17 January 1994 showed a wide distribution in longitude from Alaska, USA (0 MLT) to the Hudson bay, Canada (11 MLT) and in latitudes from 62N (L=4.5) to 70N (L=8.5).

Auroras in all-sky image were composed of field line resonance (FLR) in higher latitudes in 67-70N and pulsating aurora (PsA) in lower latitudes in 62-67N.

It is found that the PsA, FLR, and field magnitude at the geosynchronous altitudes were all oscillated coherently at Pc5 periodicities.

We conclude that the coherent modulation of FLR and PsA are attributable to toroidally and poloidally polarized Pc5 pulsations, respectively, generated by the polarization splitting of the Alfven spectrum by the finite plasma pressures.(1), (2).

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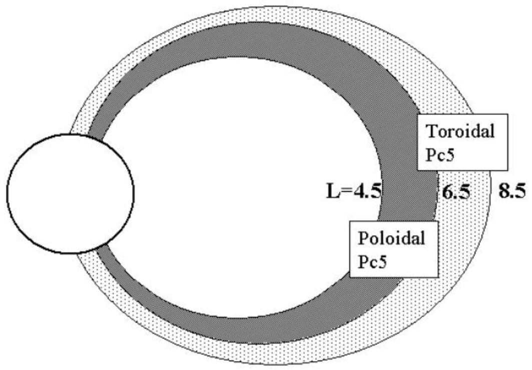
Keywords: Pc5 pulsations, pulsating aurora, poloidal mode



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PEM37-02 Room:414 Time:April 30 11:15-11:30

Generation of pulsating aurora: Role of cold electron and electric field

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Pulsating auroras are common phenomena, which are observed universally during the recovery phase of substorm in the auroral and subauroral zones. But, even today, generation mechanism of fundamental characteristics of pulsating aurora, such as, their periodicity, their shapes, and their motion are not understood. Simultaneous observations onboard satellites and on the ground are important method to examine such fundamental characteristics of pulsating aurora. We examined some selected pulsating auroral events, which obtained onboard THEMIS spacecraft and the THEMIS ground-based all-sky camera network. THEMIS satellites were located in the post midnight sector near the equatorial plane in the magnetosphere. We found following signatures of particle, field and wave in the magnetosphere at the onset and during pulsating aurora; 1) All pulsating aurora associate with high-energy (>5 keV) electron flux enhancement, 2) Cold electron flux (<20 eV) and electric field intensity show QP (quasi-periodic) modulation in association with pulsating aurora, 3) and their QP modulation sometimes show one-to-one correspondence to QP modulation of ELF wave intensity, for both type of electromagnetic lower-band chorus wave and electrostatic ECH (electron cyclotron harmonic) wave, 4) But, not all pulsating aurora associate with ELF wave enhancement.

In this talk we focus on the event which THEMIS-A, D, E spacecraft crossed a clear boundary between strong pulsating auroral region and non-pulsating auroral region. In this strong pulsating auroral region, electric field, ULF-ELF (<300Hz) electric field waves, and cold electron flux are modulated in association with pulsating aurora, but the activity of lower-band chorus wave is very low or nothing. When the spacecraft entered into non-pulsating auroral region all of QP activity became quiet/stop. It is interesting to note that high-energy electron (>10 keV) flux was almost the same for both of the regions, but cold electron flux suddenly decreased and temperature suddenly increased when the spacecraft entered into non-pulsating auroral region. We will discuss the role of cold electron, electric field and ELF waves for the generation of pulsating aurora.

Keywords: aurora, pulsating aurora, chorus wave, magnetosphere, ionosphere, polar region

PEM37-03 Room:414 Time:April 30 11:30-11:45

High-resolution correlation analysis between VLF/ELF chorus waves and pulsating aurora observed at Athabasca, Canada

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We investigate dynamic switching of arrival time difference between pulsating aurora intensity and chorus waves which were observed on 7 February 2013 at Athabasca in Canada (L=4.4), using a crossed-loop antenna and a narrow field-of-view EMCCD camera. Power spectra of pulsating auroral intensity and chorus wave intensity at 1.5-2.5 kHz show a same pulsation period at 0.1-0.15 Hz. Arrival time difference between pulsating aurora intensity and chorus waves are evaluated by using cross-correlation analysis. We found that two patterns of arrival time difference switches with a time scale of a few tens seconds. One pattern shows that electrons reached ionosphere later than the associated chorus waves with a delay time of 2 s, consistent with the theoretical value for south-going electrons reflected at the ionosphere in the southern hemisphere. The other pattern shows that electrons reached ionosphere earlier by 4.5 s than the associated chorus waves, consistent with the theoretical value for south-going chorus waves reflected at the ionosphere in the southern hemisphere. These results firstly show that interaction process of high-energy electrons and chorus waves are changing with a time scale of a few tens seconds.

Keywords: pulsating aurora, chorus waves, Wave-particle interactions, ground-based observation

PEM37-04 Room:414 Time:April 30 11:45-12:00

Relativistic electron precipitations in association with diffuse aurora

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It has been widely thought that diffuse auroras are generated by electron precipitations in the energy range from a few keV to tens keV. Recent simulation results based on the quasi-linear theory showed that the scattering by whistler-mode waves plays an important role in the production of precipitating electrons responsible for diffuse auroras. A test particle simulation on electron-whistler interactions shows that relativistic electrons can be scattered into the loss cone simultaneously with the electrons in the energy range from a few keV to tens keV. Thus, it is expected that relativistic electrons precipitate into the atmosphere in association with diffuse auroras if whistler-mode waves contribute to generation of diffuse auroras. To examine this hypothesis, we investigated conjugate observations of SAMPEX and the all sky camera at Syowa Station on the dawn side, where diffuse auroras are frequently observed. In this study, we show a case study that relativistic electron (>1 MeV) precipitations observed by SAMPEX are associated with the diffuse aurora observed at Syowa Station. The SAMPEX observation shows that the enhancement of precipitating relativistic electrons are well correlated with that of precipitating >150 keV electrons, indicating that electrons in the energy range from a few keV to 1 MeV precipitate into the atmosphere simultaneously. It is observational evidence that whistler mode waves contribute to generation of diffuse auroras.

Keywords: diffuse aurora, whistler mode wave, relativistic electron, radiation belts, wave-particle interaction

PEM37-05 Room:414 Time:April 30 12:00-12:15

Refilling of Plasmasphere

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Satellite observations have revealed that ions are heated in the ionospheric polar region and are flowing to the magnetosphere. The fluxes of H+, He+, and O+ are ˜1011 ions m-2 s-1, ˜1011 ions m-2 s-1, ˜1010 ions m-2 s-1, ˜1010 ions m-2 s-1 during the solar maximum and ˜1010 ions m-2 s-1, ˜109 ions m-2 s-1, ˜109 ions m-2 s-1 near the solar minimum condition, respectively. The large amount of ions, including heavy ions such as O+, contributes the refilling of plasmasphere and inner magnetosphere. The ions are formed often as conics / transversely accelerated ion in the topside polar ionosphere. To understand the refilling process, the refilling time scale and the effects to the structure and dynamics of plasmasphere and inner magnetosphere, we have developed a three dimensional model of Atmosphere ? Plasmasphere including Electrodynamics (APE model). The model calculates densities, velocities and temperatures for electron, O2+, N2+, NO+, O+, He+ and H+ at altitudes from 90 km to 10 Re and for N2, O2, O, He and H in the thermosphere, and electric fields in the ionosphere, plasmasphere and inner magnetosphere. We calculate also parallel and perpendicular components of ion and electron temperatures to include the effect of perpendicular heating of ion in the polar ionosphere. The results show clearly the importance of ion heating in the polar region for the structure of plasmasphere, the refilling and the response to the magnetic disturbance.

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PEM37-06 Room:414 Time:April 30 12:15-12:30

M/Q=2 Ion Cyclotron Whistlers Observed by Akebono

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It is well known that lightning whistler wave is caused by lightning discharge, and propagates along geomagnetic field lines as R-mode plasma wave below several tens kHz. Ion cyclotron whistler wave, which is one of Electromagnetic Ion Cyclotron (EMIC) mode waves, has close relation to lightning whistler [1]. One of most important features is the lowest frequency of ion cyclotron whistler which denotes the local crossover frequency of the EMIC mode wave. R-mode lightning electron whistler is converted into L-mode ion cyclotron wave at local crossover frequency between electron whistler and ion cyclotron branches along the propagation path. Propagation characteristics of ion cyclotron whistler strongly depend on ion concentrations in plasma as well as nature of general EMIC waves. These facts suggest that we can estimate ion species and concentrations at observation point and/or along the propagation paths of the ion cyclotron whistlers.

Watanabe at al. [2] reported first observation of M/Q=2 ion cyclotron whistler measured by the ISIS-2 satellite. According to their analysis, M/Q=2 ion cyclotron whistlers were observed at an altitude region around 1,360 km. They suggested that these M/Q=2 ion cyclotron whistlers are caused by deuterons (D^+) from ionosphere of the Earth, and they named them "deuteron whistlers".

In the current study, we report M/Q=2 ion cyclotron whistlers observed by the Akebono satellite at an altitude region around 4,500 km, which is the highest altitude where M/Q=2 ion cyclotron whistlers were observed so far. We found that these events had obvious frequency gap near the cyclotron frequency at half of cyclotron frequency of H^+. Hence, these events are precious evidence that some amount of M/Q=2 ion exists in the inner magnetosphere.

In this paper, we study ion concentration in the inner magnetosphere estimated from crossover frequencies of ion cyclotron whistlers observed by Akebono. Recently, it is pointed out that wave-particle interaction is important process to control innermagnetospheric physics. Our results become prior information of future satellite mission such as ERG [3] in the inner magnetosphere and/or simulations such as ray tracing method.

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Keywords: ion cyclotron whistler, M/Q=2 ion, EMIC wave, Akebono satellite

PEM37-07 Room:414 Time:April 30 12:30-12:45

Sub-packet structures in the EMIC triggered emission observed by the THEMIS probes

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We analyse Electromagnetic Ion Cyclotron (EMIC) triggered emission by the data from the THEMIS probes. These phenomena have recently received much attention because of the possibility of their strong interaction with energetic particles in the inner magnetosphere in spite of their scarceness in observations[1,2,3]. For 1400-1445 UT on 9 September 2010, THEMIS A, D and E observed strong EMIC waves with rising tone emissions. The probes were located near the dayside magnetopause at 8 R_E of the radial distance from the Earth, 13 MLT, and a few degrees of the geomagnetic latitude. During this time interval, the geomagnetic field was very distorted by the variation in the solar wind. We assume these emissions were excited around minimum-B pockets in accordance with the magnetospheric compression. It is found the rising tone emissions comprise of some smaller rising tones, which are called "sub-packet structures"[4]. We compare these observed sub-packet structures with the nonlinear wave growth theory developed by Omura et al. [5]. The observed relationship between the amplitudes and frequencies of the emissions are well explained by the theory, and it is also found that the threshold and optimum amplitudes for the nonlinear growth agree well with the observed dynamic spectra.

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PEM37-08 Room:414 Time:April 30 14:15-14:30

Statistical analysis of ionospheric Pi2 pulsations observed at mid and low latitude by the SuperDARN Hokkaido radar

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Ultra-low-frequency waves with the periods of 40-150 s are categorized as Pi2 pulsations, which occur over a wide rage of latitude in the night side at substorm onsets. To identify the generation mechanism of Pi2 pulsations, a number of studies using different devices such as ground-based magnetometers and satellites have been carried out. These study provide spatial properties of Pi2 pulsations on the ground and in the inner magnetosphere and suggested that high- and mid-latitude Pi2 pulsations are associated with Alfven waves in the auroral region, while the cavity mode resonance established in the plasmasphere by the fast mode waves has been proposed as a possible Pi2 source at mid and low latitudes.

The interaction of Pi2 pulsations with the ionosphere creates current systems that modify the amplitude and spatial scale size of the waves. In order to construct a coherent view of Pi2 signals measured by ground-based magnetometers, radars and satellites, the effect of the ionosphere needs to be understood.

In present study, statistical studies of Pi2 pulsations in the ionosphere were performed with the SuperDARN Hokkaido radar at Rikubetsu (AACGM magnetic coordinates: 36.5○, 214.7○). The radar can observe the Doppler velocity of ionospheric plasma due to the electric field of Pi2 pulsations in the mid- and low-latitude ionosphere. We investigated the spatial characteristics of the similarity, amplitude ratio, and cross phase between Pi2 pulsations observed by the radar and a ground magnetometer Memanbetsu (MMB) which is located close to the radar site. We will present the results and discuss the interaction of Pi2 pulsations with the ionosphere.

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PEM37-09 Room:414 Time:April 30 14:30-14:45

Pi pulsations in the near-earth magnetotail at substorm onset

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The THEMIS satellite observations showed that Pi 1 and Pi 2 period range oscillations of the magnetic and electric fields play an important role at a substorm onset in the near-Earth magnetotail. They associated energetic particle accelerations toward the inner magnetosphere. The energetic particle accelerations were observed with very similar oscillation signatures to the Pi 1 and Pi 2 period range oscillations observed in the magnetic and electric fields.. This observation suggests that the Pi 1 and Pi 2 period range oscillations might play an important role for contribution to the auroral particle accelerations at substorm onset in the near-Earth magnetotail . The examination has been done on a substorm event observed on 28 February, 2009 at a THEMIS GBO station, Kuujjuaq (KUUJ) (Mag. Lat.=66.89 N, Mag. Lon.=13.23 E, Mag. Midnight =4.15 UT, L-value = 6.4) in the west coast at the high latitude of the North America Continent. This substorm event was simultaneously observed in the near-Earth magnetotail by the three THEMIS satellites, THEMIS-A, -E, and ?D located in the midnight region at ˜8 Re, ˜8 Re and ˜11 Re, respectively. The data examined in this study are the magnetic field, all-sky images (ASI) and keograms (ASK) obtained at KUUJ and the satellite observations of the magnetic field, electric field, and the electron and ion energy spectra in the ESA peir, and peer data. The results show very interesting facts of the Pi 1 and Pi 2 period range oscillations in the magnetic field and auroral activities observed on the ground and their conjunctions of the magnetic, electric fields, and the associated accelerated particles in the near-Earth magnetotail. The implication of this work provides the importance of the Pi 1 and Pi 2 period range oscillations for controlling the substorm onset plasma processes in the near-Earth magnetotail.

Keywords: Magnetospheric Physics, Substorm, Pi pulsations

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PEM37-10 Room:414 Time:April 30 14:45-15:00

Substorm onset process: Ignition of auroral acceleration and related substorm phases

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The substorm onset process was studied on the basis of the vertical evolution of auroral acceleration regions derived from auroral kilometric radiation (AKR) spectra and Pi pulsations on the ground. The field-aligned auroral acceleration at substorm onset demonstrated two distinct phases. Low-altitude acceleration (h~3000-5000 km), which accompanied auroral initial brightening, pre-breakup Pi2, and direct current of ultra-low frequency (DC-ULF) pulsation, was first activated and played an important role (pre-condition) in the subsequent substorm expansion-phase onset. Pre-breakup Pi 2 is suggestive of the ballooning-mode wave generation, and negative decrease in DC-ULF suggests increasing field-aligned current (FAC). We called this stage the substorm initial phase. A few minutes after this initial phase onset, high-altitude acceleration, which accompanied auroral breakup and poleward expansion with breakup Pi 1 and Pi 2 pulsations, suddenly broke out in an altitude range from 8000-16000 km. Thus, substorm expansion onset originated in the magnetosphere-ionosphere (M-I) coupling region, i.e., substorm ignition in the M-I coupling region. It is suggested that current disruption and subsequent violent energy release from the tail region take place after this ignition. Statistical investigations revealed that about 65% of earthward flow bursts observed in the plasma sheet were accompanied by enhanced low-altitude AKR, suggesting that flow braking of bursts causes FAC and resulting low-altitude field-aligned acceleration in the M-I coupling region. On the basis of these observations, we propose a substorm onset scenario in which FAC that originated from the braking of plasma flow bursts first enhances low-altitude acceleration (substorm initial phase onset), and then the increasing FAC induces current-driven instability in the M-I coupling region, which leads to high-altitude acceleration and resulting substorm expansion-phase onset.

Keywords: substorm, aurora, acceleration region, substorm onset

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PEM37-11 Room:414 Time:April 30 15:00-15:15

drivers of the magnetospheric convection

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We present here the role of the plasma bulk flow in generation of the magnetosphere-ionosphere convection. Traditionally, the magnetospheric convection is studied with the perpendicular flow because this flow is equivalent with the speed of migration of the magnetic field. For example, the perpendicular force balance equations are utilized in discussion of the dynamo generation (E*J<0) in the cusp-mantle region [Tanaka, 1995]. However, since the plasma kinetic energy flux and the internal energy flux are transported along the plasma bulk flow, it is evident that the plasma bulk flow should be considered in generation of the magnetospheric convection. In

addition, the global MHD simulation reveals that the plasmas are accelerated into the cusp from the magnetosheath along the magnetic field. Thus, the plasma bulk flow transports energy into the magnetosphere.

At first, we discuss the dynamo in the cusp-mantle region based on the full set of physical principles (mass conservation, momentum conservation, and energy conservation). As a result, the load in the lower-latitude side of the cusp is invoked by plasma compression due to sudden deceleration of the field-aligned flow from the magnetosheath. The adiabatic assumption invokes pressure enhancement associated with plasma compression. Thus, energy should be supplied to compensate increase in the plasma pressure. As the kinetic energy is much smaller than the electromagnetic energy in the magnetosphere, the electromagnetic energy is converted to the thermal energy. Therefore, the load appears in the lower-latitude side of the cusp. On the other hand, in the cusp-mantle region, plasmas are squeezed with the field-aligned flow toward the lobe region. This yields plasma rarefaction, which eventually invokes energy conversion from the thermal energy to the electromagnetic energy. Thus, the dynamo appears. This process is also explained in terms of the slow mode expansion fan in the cusp-mantle region.

Next, we define an unique magnetospheric energy convection in the dayside magnetosphere. It is noted that the Poynting flux activated in the cusp-mantle region is transported across the dayside magnetosphere to the dayside magnetopause. The electromagnetic energy is totally deposited here. The deposited electromagnetic energy is converted into the thermal energy in the magnetopause. Then we need a mechanism of transporting this thermal energy elsewhere. The MHD simulation shows the thermal energy and the high-speed solar-wind kinetic energy are transported into the cusp from the magnetosheath. This flow goes to the mantle region. Then, the thermal energy transported from the magnetosheath via the cusp is partially converted into the electromagnetic energy in the cusp-mantle region. Finally, the loop of energy convection is completed.

The magnetospheric energy convection is unique because the energy convection and the mass convection show quite different behavior. On the other hand, in the normal fluid like the atmosphere, the energy convection is related to the mass convection in the atmospheric global circulation (convection).

Keywords: magnetospheric convection, MHD simulation, bulk flow, energy conversion, magnetospheric energy convection, cusp dynamo

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PEM37-12 Room:414 Time:April 30 15:15-15:30

Sudden pressure enhancement and tailward retreat in the near-Earth plasma sheet: THEMIS observation and MHD simulation

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Plasma pressure enhancement is one of the drastic substorm-associated phenomena in the inner magnetosphere. In a substorm occurred on 1 March 2008, four of THEMIS (Time History of Events and Macroscale Interactions during Substorms) probes were almost aligned along the sun-Earth line, which was suitable for investigating spatial-temporal evolution of the near-Earth plasma sheet in a substorm. They observed a sudden increase in the plasma pressure at the inner probe (at $\sim$7.2 Re), followed by the outer probes (at $\sim$7.5, $\sim$8.3, and $\sim$10.4 Re), that is the high pressure region propagates tailward. Hereinafter, we call this sudden pressure enhancement (SPE). We compared the observations with simulation results of a global magnetohydrodynamics (MHD) simulation, and found a fairly good agreement between them in terms of the followings. (1) Tailward propagation of the SPE can be seen only at off-equator after the substorm onset. In the equatorial plane, an earthward propagation of the SPE precedes the tailward propagation. (2) Observations from the three inner probes show that the SPE consists of two enhancements. The first one is attributed to the convergence of bulk flow energy flux, namely flow braking. The latter one is due to the convergence of the thermal energy flux and subsequent inflation of the plasma sheet. (3) Plasma flow turned from the tailward-and-toward-the-equatorial-plane to earthward-and-away-from-the-equatorial plane near the onset from the simulation results. We discuss the spatial-temporal evolution of the plasma flow and the magnetic field during the substorm.

Keywords: substorm, THEMIS observation, Global MHD simulation, Sudden pressure enhancement

PEM37-13 Room:414 Time:April 30 15:30-15:45

Evolution of theta aurora during strong positive IMF Bz and varying IMF By condition

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Formation of the theta aurora, which appears under the condition of northward IMF and greater IMF magnitude, is investigated from the analysis of the numerical MHD simulation. The theta aurora is caused by the transient convection after a sign change of IMF By. This transient convection must include a replacement of lobe field lines from old IMF orienting fields, a rotation of plasma sheet to opposite inclination, and a reformation of ionospheric convection cells. In the midst of these reconfigurations, old and new convection system must coexist in the magnetosphere-ionosphere system. In this stage, the polar cap and tail lobes are continuously encroached by the new open field lines connected to the new IMF. Whereas magnetic field lines accumulated in new lobes tend to rotate the outer plasma sheet in the opposite direction, the old merging cell convection still continues to generate closed field lines that must return to dayside against the new lobe formation. As time progresses, the growth of new lobes results in the blocking of the return path toward dayside of closed field lines generated in the old merging cell to form the kink structure in the plasma sheet. Losing their return path, these closed field lines generated from old lobes accumulated on the night side. The theta aurora appears at the foot point of these accumulated closed field lines. In the presentation, we will demonstrate some observational results brought by satellites and ground based instruments, which support above mentioned hypothesis for theta aurora foramation.

Keywords: IMF, Strong northward IMF, Varying IMF By, Theta aurora, Simulation, Observation

PEM37-14 Room:414 Time:April 30 15:45-16:00

Substorm Onset: Correlation between Ground and Space Observations

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The observations of substorm onset phenomena in the magnetosphere and ionosphere are examined to study their correlation and to understand the substorm onset mechanism. In particular, we examine the Pi2 wave structure, propagation, frequency and growth rate in the magnetosphere observed by the THEMIS satellites in the near-Earth plasma sheet and the structure and propagation of the substorm auroral onset arcs. We show the correlation between the substorm onset wave-like arcs and the Pi2 pulsations in terms of wave structure, propagation, and the exponential growth of arc intensity and Pi2 wave amplitude. In particular, the azimuthal mode numbers of the Pi2 waves and the wave-like arc structure are estimated to be ˜100-200. The correlation between the ground and space phenomena strongly supports the kinetic ballooning instability (KBI) as the cause of substorms. KBI is the most natural mechanism for explaining the unstable Pi2 waves in the strong cross-tail current region and the KBI parallel electric field can accelerate electrons along the magnetic field lines into the ionosphere to produce the substorm onset wave-like arcs.

Keywords: substorm, magnetospheric dynamics, THEMIS observation

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PEM37-15 Room:414 Time:April 30 16:15-16:30

Investigation of substorm triggering mechanism based on THEMIS data

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In this study, we show the result of superposed epoch analysis on the THEMIS probe data during the period from November, 2007 to April, 2009 by setting the origin of time axis to the substorm onset determined by Dr. Toshi Nishimura based on the THEMIS all sky imager (THEMS/ASI) data. We have restricted the time interval from t = -100 sec to t = 100 sec and the region to -7.5 >X(Re) >-23, and investigated various variations associated with substorm onset.

It was confirmed that earthward flows start at t = -60 sec in the region around X = -14 Re, and then they move toward the Earth. At t = 0, the dipolarization of the magnetic field starts at X ˜-10 Re, and simultaneously the magnetic reconnection starts at X ˜-20 Re. These variations support the validity of our Catapult Current Sheet Relaxation model for substorm onset.

Interestingly, the absolute value of dawnward plasma flow velocity |Vy|decreases in the plasma sheet and the plasma sheet boundary layer during the interval -20 <t(sec) <20. By analyzing individual event of |Vy|decrease, it was confirmed that the plasma flows turn from the duskward convective flows (Vy >0) to the dawnward flows (Vy <0) on average, associated with substorm onset, so that the value of Vy once becomes to zero around t = 0. This variation was found to be related to the deflection of the flows when they encounter with the Earth's dipole magnetic field as they approach to the Earth, which is the same reason already known to cause the tailward flows around X = -10 Re when the earthward flows reach that region.

Keywords: substorm, magnetotail, magnetic reconnection, dipolarization, THEMIS probes

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

PEM37-16 Room:414 Time:April 30 16:30-16:45

Global MHD simulations of magnetosphere and 3-dimensional visualization

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A study on perpendicular and parallel current generation mechanism in the magnetosphere is important problems in interaction between the solar wind and earth's magnetosphere-ionosphere. Moreover, classification to fundamental MHD quantities and MHD modes is also essential for understandings of the mechanism. Thus we have executed a high resolution global 3D MHD simulation and a 3D graphic diagnostics.

As the solar wind and IMF becomes abnormal conditions, plasma turbulence are strongly excited near boundary layers in the magnetosphere. In the plasma sheet magnetic reconnection occurs in patchy and intermittent manner to produce streamer-like structure. At the magnetopause, more regular vortex train in association with current generation is formed for northward IMF.

Dayside reconnection occurs in patchy and intermittent manner to give seeds of plasma turbulence. As the results, complicated and strong vortex turbulence appears in flank magnetopause. We will demonstrate those phenomena from 3-dimensional visualization method of simulation results to discuss relationship between the currents and vortices in boundary layers. In particularly we will stress relationship among parallel and perpendicular components of vorticity and current, and also compressibility in order to understand the fundamental picture of magnetospheric dynamics. Moreover we will separate the fundamental MHD quantities to various MHD modes in the whole volume, which can make clear their roles on the vorticity and current generation mechanisms.

Keywords: global MHD simulation, current generation mechanism, vorticity and compressibility, roles of MHD modes, magnetic reconnection, magnetospheric dynamics

PEM37-17 Room:414 Time:April 30 16:45-17:00

Two-spacecraft reconstruction of a three-dimensional magnetic flux rope at the Earth's magnetopause

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We present first results of a data analysis method, developed by Sonnerup and Hasegawa [2011], for reconstructing three-dimensional (3-D), magnetohydrostatic structures from data taken as two closely spaced satellites traverse the structures. The method is applied to a flux transfer event (FTE), which was encountered on 27 June 2007 by at least three (TH-C, TH-D, and TH-E) of the five THEMIS probes and was situated between two oppositely directed reconnection jets near the subsolar magnetopause under a southward interplanetary magnetic field condition. The recovered 3-D field indicates that a magnetic flux rope with a diameter of about 3000 km was embedded in the magnetopause. The FTE flux rope obviously had a significantly 3-D structure, because the 3-D field reconstructed from the data from TH-C and TH-D (separated by 390 km) better predicts magnetic field variations actually measured along the TH-E path than does the 2-D Grad-Shafranov reconstruction [Hau and Sonnerup, 1999] using the data from TH-C (which was closer to TH-E than TH-D and was at about 1000 km from TH-E). Such a 3-D nature suggests that reconnected field lines from the two reconnection sites may have been entangled in a complicated way through their interaction with each other. The generation process of the observed 3-D flux rope is discussed on the basis of the reconstruction results and anisotropy of observed electron pitch-angle distributions.

Reference:

Hau, L.-N., and B. U. O. Sonnerup (1999), Two-dimensional coherent structures in the magnetopause: Recovery of static equilibria from single-spacecraft data, J. Geophys. Res. Space Physics, 104, 6899-6917.

Sonnerup, B. U. O., and H. Hasegawa (2011), Reconstruction of steady, three-dimensional, magnetohydrostatic field and plasma structures in space: Theory and benchmarking, J. Geophys. Res. Space Physics, 116, A09230, doi:10.1029/2011JA016675.

Keywords: magnetopause, magnetic flux rope, magnetic reconnection, magnetohydrostatic equilibrium, formation-flying observations

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

PEM37-P01 Room:Poster Time:April 30 18:15-19:30

Auroral vortex, auroral surge, and vortical current in the ionosphere associated with the Pi2 pulsations

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The auroral breakup event occurred at 0500UT 27 January 1986 in central Canada is studied using all-sky video image from two optical stations (GWR and SHM) and magnetometer data from three ground stations including the optical stations.

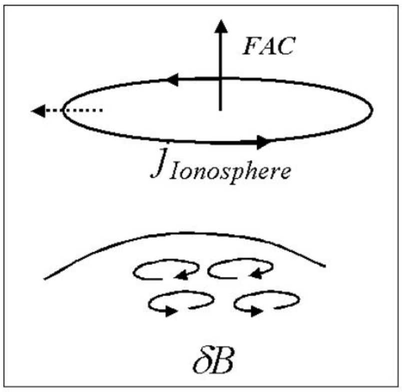
The spatiotemporal motion of the ionospheric vortical current explained the ground magnetometer data in the auroral zone. During the activation of the current vortex, auroras composed of the shear layers rotating clockwise and the auroral surge propagating westward were observed.

It is found that the auroral surge first appeared at the onset latitudes propagated poleward passing through the auroral vortex and became the poleward boundary aurora-surge (PBAS)(1).

References

1. Saka, O., K. Hayashi, D. Koga (2012), JASTP.

Keywords: Aurora dynamics, Pi2 pulsation, Ionospheric current vortex



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PEM37-P02 Room:Poster Time:April 30 18:15-19:30

Generation mechanism of steady-state field-aligned currents: A general theory in terms of plasma convection

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It is well known that field-aligned currents (FACs) play an important role in that they transfer electromagnetic energy and momentum from the magnetosphere to the ionosphere. Recent global magnetohydrodynamic (MHD) simulations indicate that in almost all cases the pressure gradient force is the major driver of FACs [Tanaka, 2003, 2007]. The inertia force becomes appreciable only in very special cases such as the preliminary impulse (PI) in sudden commencements (SCs) [Fujita et al., 2003]. Thus the pressure gradient mechanism is working universally and represents the essence of the dynamical nature of the magnetosphere. What is less or not at all understood, however, is the role of plasma convection in FAC generation. One misconception is that plasma convection is irrelevant to pressure gradient-driven FACs. In fact, convection plays a vital role in energy conversion. This paper describes a general theory of steady-state FACs, with an emphasis on the importance of plasma convection. FACs are created and maintained through the following two processes that occur spatially contiguously with each other. (1) A "dynamo" process in which plasma thermal energy is converted to electromagnetic energy. A magnetospheric dynamo is necessary in order to sustain a steady-state FAC system. This dynamo is generated by expanding plasma flow (div($\mathbf{v}$) $>$0) that is characterized by the slow mode in MHD waves. The wave normal is directed to the $-$ grad(B) direction, and the flow speed in the wave normal direction (the "normal" component) becomes the phase speed of the slow mode wave. Slow mode disturbances do not associate FACs. (2) A process in which field-perpendicular currents transform into field-aligned currents. This process occurs by a mode conversion of the waves from slow to Alfvenic. If the pressure gradient has a component perpendicular to both the wave normal and the magnetic field (the "tangential" component), it produces a magnetic tension and consequently excites Alfven mode disturbances. The flow speed in the wave normal direction becomes the phase speed of the Alfven mode wave. The Alfven mode is associated with tangential plasma flow, and consequently the plasma motion becomes rotational.

References
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Tanaka (2007), Space Sci. Rev., 133, 1, doi:10.1007/s11214-007-9168-4.

Keywords: field-aligned current, dynamo, convection

PEM37-P03 Room:Poster Time:April 30 18:15-19:30

Multi-spacecraft analysis of tailward plasma flows in the near-Earth plasma sheet : THEMIS observations

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In the near-Earth's plasma sheet, the magnetic field is abruptly dipolarized, associated with an aurora activity. In this region, most of plasma flows are earthward, while some are tailward. Although the candidate mechanism for such tailward flow is considered as rebound flows and/or a part of vortex flows, the quantitative occurrence rate is not fully understood. In this work, we selected events that THEMIS spacecraft observed tailward flows near the magnetic dipolarization region, and then categorized in flow patterns before the tailward flows. Based on the results, we statistically analyzed the categolized events, and estimated the space structure of tailward flows by multi-spacecraft analysis. Consequently, we show the occurrence rate of such rebound flows and the vortex flows.

Keywords: Dipolarization, Tailward flow

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

PEM37-P04 Room:Poster Time:April 30 18:15-19:30

Simultaneous observation of a field-aligned current by the JAXA QZS satellite and a MAGDAS ground observatory

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In this paper we conduct a QZS-MAGDAS conjunction study of a field-aligned current (FAC). QZS (Quasi-Zenith Satellite) is operated by JAXA, and MAGDAS is the ground magnetometer network mainly operated by ICSWSE (International Center for Space Weather Science and Education), Kyushu Univ.

There have been only limited number of papers on satellite-ground conjunction studies of FACs, because satellites usually passes overhead at a ground observatory in a short time.
On the other hand, the footpoint of QZS stays near one ground point in Siberia, Russia, because the orbit of QZS is close to that of geosynchronous satellites on the Japanese meridian. Moreover, a few Siberian MAGDAS observatories exist near the QZS footpoint.

Another advantage of QZS is that, unlike geosynchronous satellites, QZS has 41deg inclination and 0.1deg eccentricity which enable QZS to stay for a long time at northern high latitudes in the magnetosphere; this high-latitude feature increases the detectability of FACs, because the FAC magnitude is in general smaller near the equator, i.e., the FAC source region in the magnetosphere. Thus, the pair of QZS and Siberian MAGDAS is expected to have more chances of simultaneously observing the same FAC than past satellite-ground pairs.

We have been searching for events in which, when QZS and a Siberian MAGDAS observatory were located near the same field line (calculated by the Tsyganenko 96 model), QZS and MAGDAS simultaneously observed transient magnetic field perturbations.

In this paper we present such an event observed by QZS and a Siberian MAGDAS observatory CHD (Chokurdakh). We have found that the transient magnetic perturbations of this event can be interpreted to have been generated by the motion of a local current circuit consisting of line FACs and an ionospheric current. More details will be presented at the meeting.

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PEM37-P05 Room:Poster Time:April 30 18:15-19:30

Comparison between particle environment around GEO from global MHD simulation and that from LANL satellite

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Substorm injection is one of the important element of magnetospheric substorm, like auroral break up. Studying substorm injection is important to understand the physics of substorms. Also, substorm injection temporaly changes the particle environment around satellites at GEO. And dynamical variations of particle environment around GEO is one of the causes of satellite anomaly due to surface charging. We try to evaluate our magnetospheric global MHD simulation code by comparing output from global MHD code and LANL satellite particle data. Previous work has be done by Nakamura [2009]. We will examine the possibility of substorm injection prediction using global MHD simulation. Detailed comparison between simulation and observation will be shown in our presentation.

Keywords: Space Weather Forecast, Magnetosphere, Substorm, Modeling, Global MHD simulation, Geosynchronous orbit

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PEM37-P06 Room:Poster Time:April 30 18:15-19:30

Energy dispersion and trajectory of particles injected from the magnetotail in magnetospheric quiet conditions

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Particle injection is sudden enhancement in flux of energetic charged particles, commonly observed at geosynchronous orbit (6.6R$_E$), and associated with magnetospheric substorms. Since 2007, dispersive particle injections have been observed in the further dawnside of the magnetosphere (>10R$_E$) than geosynchronous orbit in quiet conditions with the spacecraft Geotail and THEMIS. Although only electron injections are observed in most cases, both electron and ion injections are observed in some cases. The injected population displays energy dispersion in which more energetic particles arrive at a given location earlier than less energetic particles. This dispersion occurs because of energy dependence of particle drift in the magnetospheric magnetic field. In order to investigate the time delay, we have calculated electron trajectories in the inner magnetosphere. We assume that the magnetospheric magnetic field is a simple dipole and the magnetospheric electric field is sum of a convection electric field and a corotation electric field, and obtain the particle trajectories in the equatorial plane using particle drift velocity. We find that the time delay is related to the intensity of the convection electric field. The simulations and observations show that electrons drift from the nightside through the dawnside to the dayside while ions drift from the nightside through the duskside to dayside. However, in the range given by the dipole field, it is not possible to explain the energy dispersion as observed. The shape of the magnetic field is different from the magnetic dipole in the magnetic tail region because the magnetosphere is stretched by the solar wind. In order to provide a more realistic magnetic field model in the magnetosphere, we use the Tsyganenko model that is an empirical magnetic field model of the magnetosphere. In this study, multi-satellite observations and test particle simulations are carried out to explore mechanisms in energization and transport of electrons in the quiet magnetosphere.

Keywords: magnetosphere, perticle injection, energy dispersive, Tsyganenko, quiet condition, trajectory

PEM37-P07 Room:Poster Time:April 30 18:15-19:30

Time development of the Dipolarization Front and its interactions with the dipole-field region obtained by 2-1/2 dimensi

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Bursty bulk flows with increasing B_z (northward component of the magnetic field), which are caused by magnetic reconnections in the magnetotail, are called Dipolarization Front (DF). Under the picture of the Near Earth Neutral Line model, which is one of the models explaining the triggering of substorms, the compression of the dipole region by DF and the pileup of DF itself around the near-Earth plasma sheet boundary cause a wide increase of B_z in the night magnetosphere. Although there are many observational studies of DFs by spacecraft, there are no full-particle simulations that examine the case in which the DF approaches to the dipole region.

In this context, we have performed two-dimensional full-particle simulations for the initial magnetic configuration which is akin to Earth's dipole magnetic field together with a stretched magnetic field by the thin current sheet. We have generated the magnetic reconnection and earthward plasma flows accompanied by B_z, and examined the time development of the flows and the interactions with Earth's dipole-field.

In our simulations, a minimal region of the northward magnetic field where B_z does not increase have been formed between the dipole region and flux pileup region, different from the common picture of Dipolarization. The reason of this can be considered as follows; (1) the earthward flows transport and accumulate the plasmas of the current sheet around the near-Earth plasma sheet boundary, (2) the pressure of the accumulated plasmas decelerate the flow, (3) B_z piles up in the tailward of the boundary. This result is different from the common effect of the DF that it broadly increases B_z in the night side of the magnetosphere. Because of the two-dimensionality in our simulations, the accumulated plasmas cannot leave in the Y-direction (eastward), producing such characteristic region. We also discuss on the structure of the particle flow velocity and particle density distributions near the DF by comparing with observational results.

Keywords: Substorm, Dipolarization Front, Dipolarization

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PEM37-P08 Room:Poster Time:April 30 18:15-19:30

3D Full kinetic simulations of plasma flow interaction with meso- and micro-scale magnetic dipoles

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Plasma flow response to a magnetic dipole and the resulting formation of a magnetosphere depends on the intensity of the magnetic moment of the dipole. In this study, we examined plasma flow interactions with a magnetic dipole which is much smaller than the Earth's intrinsic magnetic dipole by performing three-dimensional full Particle-In-Cell simulations. The size of a magnetic dipole immersed in a plasma flow is characterized by distance L from its center at which the equilibrium is satisfied between the pressure of the magnetic field of the dipole and that of the plasma flow. In the Earth's magnetosphere, L implies the magnetopause location. We particularly focused on meso- and micro-scale magnetic dipoles in which L is comparable to and smaller than the gyroradius of ions in the flow. In the meso-scale case, ions kinetics should be dominantly considered while electrons whose gyroradius is sufficiently small can be treated as fluid. In the micro-scale, however, electrons as well as ions should be treated particles because L becomes small and the electron kinetics cannot be ignored either. Our interest is in the formation of current layer at the magnetosphere boundary in the both scales. Corresponding to the formation of a magnetosphere, the boundary current also depends on the size of the magnetosphere.

In the meso-scale case, the boundary current is dominated by the electron diamagnetic current at the large density gradient found at the distance of L. This signature is similar to the case of the Earth's magnetosphere. In the micro-scale case, however, the trajectories of ions and electrons gyration play an important role to determine the boundary current. Since the ion's gyroradius is larger than L, charge separation between ions and electrons occurs in the upstream region. As particles approach to the inner dipole, the electron gyroradius becomes small and electron drift motion becomes dominant. It is also confirmed that static electric field caused by the charge separation affect the plasma dynamics and the resulting current flow.

Keywords: Magnetic dipole, Meso-scale, Plasma response, Boundary current layer, Plasma particle simulation

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

PEM37-P09 Room:Poster Time:April 30 18:15-19:30

Estimation of the plasma sheet thickness in the Mercury's magnetosphere from the MESSENGER observations: IMF dependence

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Only two of spacecraft arrived at the Mercury until now: NASA's MESSENGER which went into orbit around Mercury in 2011 and Mariner 10 which investigated Mercury for two years from 1974. Although the Mercury's magnetosphere was first found by the Mariner 10, the magnetosphere has not been quantitatively understood. With the observations of magnetic field, we deduced the thickness of the plasma sheet and examined its dependence on the IMF (Interplanetary Magnetic Field) As a result, the plasma sheet thickness is estimated as 0.12-0.19 R_M during the northward IMF, and 0.02-0.08 R_M during the southward IMF. Bi-polar magnetic field signatures, which can be associated with the plasma flow in the plasma sheet, are observed both during northward and southward IMF. We then discuss the substorm-related phenomena in the Mercury's plasma sheet.

Keywords: MESSENGER, Mercury's Magnetsphere, plasma sheet, plasma flow, substorm