Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

PEM09-01 Room:302 Time:May 27 11:00-11:15

Secondary instability in the magnetosphere-ionosphere feedback coupling

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The Alfvenic coupling with the feedback mechanism from the ionosphere to the magnetosphere provides us a potential framework to describe spontaneous growth of auroral arc structures. The shear [1] (or kinetic [2]) Alfven wave is destabilized though the feedback instability, providing growth of auroral arc structures in the polar ionosphere. The spontaneous growth of auroral arcs is accompanied with enhancement of ionospheric density perturbations, localized field-aligned currents, and sheared ExB flows. When the feedback instability has grown to a large amplitude, a nonlinear mode coupling leads to deformation of the arc structure [3]. In the present study, we have made a perturbation analysis for the secondary unstable mode, numerically solving the initial value problem. It is shown that the secondary mode can be destabilized when the primary mode amplitude exceeds a critical level, and that the typical growth rate can be several times higher than that of

the primary one. We also discuss the secondary mode structure embedded in the linear eigenfunction of the feedback instability.

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[2] T.-H. Watanabe, Geophys. Res. Lett., 41, doi:10.1002/2014GL061166 (2014).
[3] T.-H. Watanabe, Phys. Plasmas, 17, 022904 (2010).

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

PEM09-02 Room:302 Time:May 27 11:15-11:30

Long-term trends in ionospheric parameters measured by the EISCAT radars

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Incoherent scatter radar measurements are an important source for studies of ionospheric plasma parameters. Data from the EISCAT Svalbard Radar (ESR), which covers the polar cap and cusp, and the UHF and VHF radars, which cover the auroral zone, can be used to obtain information about the electron density, electron- and ion temperature, and line-of-sight plasma velocity from an altitude of about 50 and up to above 1600 kilometers. As the ESR radar has been operational since 1996 and the UHF and VHF radars since the early 1980s, the accumulated database covers more than one solar cycle in the polar cap and cusp and several solar cycles in the auroral zone.

Results from the study of long-term trends in the ionospheric parameters both from the ESR and UHF/VHF will be shown and a comparison with the IRI-model will be discussed.

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

PEM09-03 Room:302 Time:May 27 11:30-11:45

Cusp aurora as a backward-elongated image of the moving region of electron precipitation

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We present high time resolution observations of the red-line moving cusp aurora made on 27 November 2011 by an all-sky imager at Longyearbyen, Svalbard, and their comparison with EISCAT observations. The EISCAT radar pointing in the magnetic field-aligned direction detected several enhancements of electron temperatures whose durations are 1-5 min. The all-sky imager data obtained with a time resolution of 4 s allowed us to determine a one-to-one correspondence between electron temperature enhancements and cusp aurora intensifications. The radar beam entered the moving cusp aurora structure from its forward side, and exited from the backward side in some events, while in others the beam skimmed the moving aurora. Further analyses of the former events revealed that the enhancement of the electron temperature, which was produced by the intense electron precipitation, terminated 60-90 s earlier than the exit of the radar's field-of-view from the moving aurora. This duration is consistent with the lifetime of the O(^{1}D) state. Our observation provides evidence demonstrating that the cusp aurora is a backward-elongated image of the moving region of electron precipitation. The enhancement of ion temperature was also found to be in the moving cusp aurora structure. On the basis of these results we discuss the spatial relationship between electron precipitation and fast plasma flow, which causes the ion temperature enhancement.

Keywords: aurora, cusp, plasma flow, electron precipitation, electron temperature, ion temperature

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

PEM09-04 Room:302 Time:May 27 11:45-12:00

Towards quantification of auroral properties based on image data with high temporal resolution

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We are developing a technique to extract various information from aurora image data with temporal resolution of 1 second. The variations of aurora can be decomposed into a persistent component and residual fluctuations. We thus aim at quantifying various auroral properties by analyzing each of the components. For example, the motion of the persistent component would provide the information on the convection electric field. The properties of the convection can thus be obtained using optical flow analysis of this component. On the other hand, the residual fluctuations are mainly attributed to pulsating aurorae. It could therefore be possible to obtain the information on the frequency and amplitude of a pulsating aurora. We will report the current status and outlook.

Keywords: aurora, magnetospheric convection, pulsating aurora

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

PEM09-05 Room:302 Time:May 27 12:00-12:15

Tomography analysis of eastward propagating auroral vortices

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We have studied characteristics of mesoscale auroral vortices observed in the Northern Scandinavia by aurora campaign observation using multi-point camera network with the EISCAT UHF radar in March, 2013. Three eastward propagating auroral vortices were observed intermittently at about 15-minute intervals in the post-midnight sector (0:00-0:40 UT; 2:30-3:10 magnetic local time) on March 9 just after the substorm onset. They were simultaneously detected by monochromatic (428nm wave length) all-sky EMCCD imagers at Tromso (69.6N, 19.2E), Norway, Kilpisjarvi (69.0N, 20.9E), Finland, and Abisko (68.4N, 18.8E), Sweden, with an exposure time of about 2 seconds and an sampling interval of about 10 seconds. We showed the difference between the eastward propagating auroral vortices and typical omega bands/torches: (1) The auroral vortices occurred during the expansion phase of the substorm, coincident with Pi 2 pulsations at the magnetic equator. The omega bands/touches are usually observed during the substorm recovery phase. (2) The drift velocity of the vortices was approximately 3 - 10 km/s at 100 km altitude, which is much faster than the typical velocity of the omega bands. (3) The ionospheric equivalent current systems derived from the magnetometer data indicated the upward FAC in the dark region inside the vortices, whereas the downward FAC is typically detected in the dark region between the torches. We speculated that the eastward propagating aurora vortices might be transient phenomena that are related to the generation process of the omega bands.

In this study, we further investigated three-dimensional (3D) structure of the auroral luminosity and energy distribution of the precipitating electrons. The generalized aurora computed tomography technique (e.g., Aso et al., 2008; Tanaka et al., 2011) was applied to the second vortex event observed at 0:15-0:18 UT. We found that the average energy of the precipitating electrons tends to be higher for thinner auroral arcs. To confirm that this tendency is common for all auroral arcs, we apply the tomography analysis to the other vortex events. In addition, we perform the numerical simulation to check if this result is not due to the analysis techniques.

Keywords: aurora, tomography analysis, vortex structure, 3D distribution, energy distribution, post-midnight

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

PEM09-06 Room:302 Time:May 27 12:15-12:30

Visualization of wave-particle interactions by high-speed imaging of aurora

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A variety of wave-particle interactions working in the magnetosphere-ionosphere coupled region and in the magnetosphere cause many different types of fast and fine-scale auroras, such as flickering and pulsating aurora as well as curls and folds. Some compound microstructures have also been found from the cutting-edge optical instrument (Kataoka et al., 2015, EPS Frontier Letter). We review our new challenges of ground-based high-speed imaging observations using EMCCD and sCMOS cameras as a new tool of the visualization of wave-particle interactions to diagnose the local plasma environment.

Keywords: aurora

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

PEM09-07 Room:302 Time:May 27 12:30-12:45

Omega band pulsating auroras observed simultaneously onboard THEMIS and on the ground

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Omega band auroras were observed with the THEMIS ground based All-Sky Imagers array at SNKQ in Canada at ˜0230 MLT on 1st March 2011. We could find almost whole processes of the generation of omega band aurora from the initial growth phase to the declining phase through enhancement phase. Scale size of the omega band aurora during the maximum phase was ˜500 km and ˜200 km for north-south and east-west direction, respectively. Growth of omega band-like structure started in the western sky of SNKQ field of view. Then the auroras enhanced their intensity and drifted eastward with speed of 0.15 km/sec. Fine structure of the omega band aurora consists of intense pulsating auroras with ON-OFF period of about 10 sec. Ps 6 magnetic pulsations with a period of ˜600 sec were observed in association with the omega band auroras. Footprint of THEMIS-D spacecraft crossed poleward part of the omega band aurora. THEMIS-D observed significant signatures on electromagnetic field and particles in association with the time when the spacecraft crossed the omega band pulsating aurora. In particular it is very interesting and important that DC electric field intensity modulated with almost the same period of optical pulsating auroras. In this presentation we will demonstrate characteristics of optical features of omega band pulsating aurora obtained by all-sky imagers and also particle and field signatures onboard spacecraft when the footprint of THEMIS-D crossed the omega band aurora.

Keywords: aurora, pulsating aurora, omega band aurora, THEMIS, magnetosphere, ionosphere

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

PEM09-08 Room:302 Time:May 27 14:15-14:35

Remote sensing of the dynamic plasmasphere by ground-based magnetometer arrays with the magnetoseismic technique

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Ground-based magnetometers can monitor the dynamic plasmasphere through the use of the normal-mode magnetoseismic technique, which infers the equatorial plasma mass density from the observed field line resonance (FLR) frequencies. When two ground magnetometers are located at similar local times and separated by one or a few degrees in latitude, even the weak hum of closed magnetospheric field lines can be detected on a daily basis by comparing the phase differences at the two sites.

By using the magnetoseismic technique, we have observed variations in plasmaspheric density over different time scales, including the annual cycle, the diurnal cycle, and the phases of magnetic storms. In particular, the depletion or density enhancement in the plasmasphere during magnetic storms is found to correlate with concurrent changes in the ionosphere. The diurnal variation in plasmaspheric density at low L shells may be a consequence of the similar variation in the mass density of the thermosphere.

To better understand the coupling between the plasmasphere and the ionosphere using the ground-based magnetometer data, we have developed automated procedures to extract FLR frequencies from data as well as to calculate the equatorial plasma density. We have also extended the magnetoseismic technique to producing two-dimensional snapshots of plasmaspheric density using observations collected by a two-dimensional magnetometer network. We conclude by presenting a new database of plasmaspheric density named ”Ground-based Observations of the PlasmaspHEre through Resonance Sounding (GOPHERS).” The density data are derived from the geomagnetic field observations collected by AUTUMN/AUTUMNX, CARISMA, Falcon, GIMA, McMAC, THEMIS, and USGS stations in North America. We will present examples of the plasma densities in the GOPHERS database, demonstrating the spatio-temporal variations of the plasmasphere in response to solar and geomagnetic activities.

Keywords: plasmasphere, magnetoseismology, magnetic storms, plasmasphere-ionosphere coupling, ground-based magnetometer arrays, remote sensing

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

PEM09-09 Room:302 Time:May 27 14:35-14:55

Plasmapause location under quiet geomagnetic conditions (Kp $\leq$ 1): THEMIS observations

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Since the radial distance of the plasmapause is strongly controlled by geomagnetic activity, empirical plasmapause models have used geomagnetic Kp index to determine the average location of the plasmapause. In previous empirical models, the number of plasmapause crossings under quiet geomagnetic conditions is very small comparing to that under moderate geomagnetic conditions. Thus, quiet-time plasmapause locations estimated from previous models have a large uncertainty. In this study, we statistically examined the plasmapause location under quiet geomagnetic conditions (Kp $\leq$ 1) using the electron density inferred from the THEMIS spacecraft potential. Two-year period (2008 and 2009) was chosen for analysis because both years were marked by extremely weak solar wind conditions. A total of 1193 plasmapause crossings were obtained when Kp $\leq$ 1. We examine the average plasmapause location in radial distance and along the longitude under such quiet geomagnetic conditions. The average plasmapause location determined in our study is compared with that in previous studies.

Keywords: Plsmapause, Kp index, Geosynchronous orbit, Solar wind, Geomagnetic condition, Plasmasphere

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

PEM09-10 Room:302 Time:May 27 14:55-15:10

Quarter Waves Localized in the Plasmasphere

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The latitudinal distribution of quarter-wave mode ULF pulsations was investigated. We examined the diurnal variation of the local field line eigenfrequency over the latitude range L=1.7-6.8 using cross-phase analysis of magnetic data from the MEASURE, THEMIS, CANMOS, and CARISMA magnetometer arrays. The detected eigenfrequencies for L-shell in middle latitudes were remarkably low (1.5-2 times lower than usual daytime value) near the dawn terminator. This occurred when a field line was mapped into the plasmasphere, and one end of the field line was sunlit while the other end was in darkness. However, the eigenfrequencies for higher L-shells were not extraordinarily low. These results suggest that resonant quarter-wave modes were localized in the mid-latitude region, in the plasmasphere, but were not generated at high latitudes even though the ionospheric conditions were strongly asymmetric there. Our previous study showed that the mode transition from quarter wave to half wave depends on the ratio of ionospheric Pedersen conductances between sunlit and dark sides, and the typical value is approx. 10. The ionospheric conductances in this study seem to have satisfied this generation condition for stations at all latitudes. Therefore another condition may be necessary to explain the latitudinal localization of the waves. Some properties of quarter wave modes were examined using computer simulations. Our simulation results suggested that the resonance properties of heavily damped quarter mode waves may be masked by cavity mode energy when the cavity resonance is effective. This may control localized distribution of the quarter waves.

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

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

PEM09-11 Room:302 Time:May 27 15:10-15:25

Effect of escaping photoelectrons on the polar wind outflows

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A statistical analysis using a long-term (over one solar cycle) photoelectron dataset obtained by the Fast Auroral SnapshoT (FAST) satellite (3000-4200 km altitude) during geomagnetically quiet periods demonstrates that the polar wind ion flux estimated from electron outflows does not change with increasing photoelectron production due to increasing solar activity, while the magnitude of the field-aligned potential drop (~15-25 V), which reflects low-energy photoelectrons back to the ionosphere, increases with increasing solar activity. The magnitude of the field-aligned potential drop is likely developed by photoelectrons themselves so as to equilibrate electron fluxes with the ion fluxes. Another statistical analysis using the thermal ion data obtained by the Akebono satellite at solar maximum implies that contribution of O^+ ions to the total ion flux in the polar cap is small owing to almost zero upward bulk velocity at least below ~7000 km altitude during geomagnetically quiet periods. Thus, the polar wind ion flux is dominated by H^+ ions, and the H^+ ion flux has been predicted to be regulated by the production rate in the topside ionosphere. The combination of these results indicates that it is the source region of H^+ ions in the topside ionosphere and not the photoelectron flux that control the polar wind outflow.

Keywords: Polar wind, Ion outflow

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

PEM09-12 Room:302 Time:May 27 15:25-15:40

Dayside ionospheric current system of Pi2 pulsations: Comparison between equivalent currents and numerical simulation

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We present the two-dimensional distribution of equivalent currents of Pi2 pulsations in the dayside middle-to-equatorial latitude regions (|geomagnetic latitude|<60 degrees and sunlit region at 100 km in altitude), using magnetic data from globally distributed magnetometers. Equivalent current vectors of Pi2s are determined by rotating filtered horizontal magnetic field vectors by an angle of 90 degrees clockwise. We found that meridional equivalent currents in the prenoon and postnoon sectors are in antiphase, and they close with an enhanced zonal current near the magnetic equator forming a global equivalent current system oscillating with a period of Pi2s. The current system shows the prenoon-postnoon asymmetry, that is, meridional equivalent currents in the prenoon sector is larger than in the postnoon sector. We also numerically simulated the distribution of ionospheric currents produced by a pair of field-aligned currents (FACs) around midnight under the assumptions that the ionosphere is a thin spherical shell and the electric field can be described as the gradient of an electrostatic potential. The essential features of the simulated ionospheric current on the dayside are consistent with the observed equivalent current system. In the simulation Hall currents and their polarization charges at the terminator contribute essentially to the prenoon-postnoon asymmetry. The east-west magnetic perturbations expected from the FACs and meridional ionospheric currents in the simulation may explain the observed four longitudinal phase reversals of east-west magnetic fields around midnight, noon, dawn and dusk. We thus conclude that the oscillatory ionospheric current system produced by the nightside FACs is the dominant source of dayside Pi2 pulsations.

Keywords: Pi2 pulsation, ionospheric current, current oscillation, equatorial enhancement, global potential solver, solar terminator

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

PEM09-13 Room:302 Time:May 27 15:40-15:55

Dawn-dusk asymmetry of SI-induced transient ionospheric convection

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The statistics based on SuperDARN (SD) observations revealed that the transient oscillation of ionospheric convection associated with sudden impulses (SIs) showed some dawn-dusk asymmetric structures. The previous study showed that the higher latitude portion of the twin vortex-shaped convection perturbation has a dawn-dusk asymmetry depending on the combination of IMF-By polarity and SI polarity. In addition to the asymmetry depending on IMF-By polarity, the lower latitude portion of the induced twin vortices has a dawn-dusk asymmetry in such a way that the dawn side flow perturbation is always weaker than the dusk side one. Interestingly, our statistical study shows that this feature does not depend on either the IMF-By polarity or SI polarity, existing more or less for all conditions. This fact suggests that a different mechanism causes the difference in flow magnitude of lower latitude side of vortices between dawn and dusk. We perform a set of global MHD simulation runs to examine physical mechanisms causing the response of ionospheric convection associated with SIs. The simulations basically reproduce a weaker flow at the lower latitude portion of the dawn-side vortex, quite similar to those observed by SD. In addition to the realistic situations, a simulation run without the ionospheric Hall conductance (only with finite Pedersen conductance) shows a fairly dawn-dusk symmetric pair of flow vortices. This result strongly suggests that the Hall current closure in the ionosphere plays an important role in causing the dawn-dusk asymmetry of the vortex pair induced by SIs.

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

PEM09-14 Room:302 Time:May 27 16:15-16:35

Direct observations of the full Dungey convection cycle in the polar ionosphere for southward IMF

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Tracking the formation and full evolution of polar cap ionization patches in the whole polar ionosphere, we directly observe the full Dungey convection cycle for southward interplanetary magnetic field (IMF) conditions. The patches were segmented from the tongue of ionization (TOI) at the equatorward edge of the cusp by the expansion and contraction of the polar cap boundary (PCB) due to the pulsed dayside magnetopause reconnection indicated by in-situ THEMIS observations. Convection leads to the patches entering the polar cap and being transported antisunward across the polar cap along the streamlines continuously monitored by the globally distributed arrays of GPS receivers and SuperDARN radars. The pulsed nightside reconnections, occurring as part of the magnetospheric substorm cycle, modulated the exit of the patches from the polar cap, as confirmed by the coordinated observations of the magnetometer at Tromso and EISCAT Tromso UHF Radar. After exiting the polar cap, the patches broke up into a number of plasma blobs, and returned sunward in the auroral flow of the dawn and/or dusk convection cell. The full evolution time, corresponding to the full circulation of energy and momentum from the solar wind to the magnetosphere, is about three hours.

Keywords: Dungey convection cycle, Magnetic reconnection, polar cap patches

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

PEM09-15 Room:302 Time:May 28 09:00-09:15

Dynamics of the three-dimensional separator reconnection in the dayside magnetosheath-magnetopause region

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We have studied a driving mechanism of the magnetosphere-ionosphere coupling convection in the southward IMF condition. This study is divided into two parts. One is energy conversion in the null-separator structure in the dayside magnetosheath-magnetopause region. The other is transport of mass, momentum, and energy from the solar wind to the magnetosphere as well as a dynamo mechanism of the Region1 field-aligned current. Now, the former issue is discussed from the viewpoint of the three-dimensional separator reconnection.

The global MHD simulation reveals that interaction between the solar wind and the magnetosphere always exhibits a special magnetic field configuration called as the null-separator structure. This structure is essentially derived from a superposition of the dipole field and a uniform magnetic field (namely, the uniform IMF). Therefore, the structure is naturally generated from superposition of two source-free magnetic fields. This fact indicates that the null-separator structure does not yield significant energy conversion from the magnetic energy to others. We confirmed no energy conversion in the vicinity of the null point from the numerical simulation. This feature is quite different from the two-dimensional reconnection such as that in the plasmasheet at the substorm onset. On the other hand, the separator reconnection exhibits substantial energy conversion in the region apart from the null point. As this energy conversion is a mild one, it does not modify the plasma structure in the magnetosheath so much. Whereas, for the two-dimensional reconnection, the plasma structure consisting of anti-parallel magnetic fields and a sheet current after the reconnection onset is altered considerably after the onset. In the last, we confirm that the plasma structure in the dayside magnetosheath-magnetopause region is essentially formed by the solar wind dynamic pressure. The separator reconnection just modifies the plasma structure.

Keywords: null-separator structure, separator reconnection, three dimensional reconnection, magnetosphere-ionosphere coupling convection, MHD simulation

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

PEM09-16 Room:302 Time:May 28 09:15-09:30

Generation of geomagnetic Pc5 pulsations by compressional waves penetrating from the solar wind: a case study

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It was considered the development of compression geomagnetic pulsations in the Pc5 range during the recovery phase of the magnetic storm on May 23, 2007. Pulsations were excited in the spatially localized region: the maximum amplitude (150-200 nT) observed at latitudes 63-66 ^{o} in the midnight-morning sector 23-05 MLT, outside this region experienced a sharp decline in the oscillation amplitude. Region of pulsations excitation coincided with the location of the westward electrojet.

There were two maxima ~1.3 mHz and ~1.7 mHz in the spectra of the oscillations in the interplanetary medium, in the magnetosphere and on the ground. In the interplanetary medium the compression oscillations corresponding to the slow magnetosonic wave were recorded. According to the observations in the magnetosphere (in noon and evening sectors), the maximum amplitude of the oscillations of the magnetic field has been registered in the compression component. Modulation of energetic protons fluxes was caused by pulsations. Anti-phase variations of the magnetic field and plasma pressure were registered.

Pulsations by both ground and satellite observations in the magnetosphere in the morning sector were circularly polarized corresponding to the formation of vortices in the ionosphere and magnetosphere. The change of polarization to the opposite at latitudes above 66 ^{o} was observed.

By ground-based observations in the morning sector, the geomagnetic pulsations accompanied by modulation of intensity of riometer absorption and VLF emission at latitudes 66 ^{o} and 56 ^{o}, correspondingly.

The results of the data analysis indicated the resonance excitation mechanism of pulsations due to the penetration of compression waves from the interplanetary medium to the magnetosphere.

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Keywords: geomagnetic pulsations, ULF waves, substorm, energetic particles

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

PEM09-17 Room:302 Time:May 28 09:30-09:45

Characteristics of sudden commencements observed by Van Allen Probes in the inner magnetosphere (L <6)

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It has been known that sudden commencement (SC) is produced by an interplanetary shock passing over the Earth's magnetosphere. Understanding its characteristics in the electric and the magnetic fields is one of the important research topics. Until now, there are many studies for SC using the data on the ground at high to low latitudes and in space at and beyond geosynchronous orbit. However, few SC studies have been done using the data obtained in the inner magnetosphere (L <6). In this study we use the magnetic and electric field data acquired from the Van Allen Probes in the inner magnetosphere. During two year intervals from September 2012 to September 2014, 55 SC events were identified. The local time variations of SC-associated magnetic field perturbations in the inner magnetosphere are similar to those at geosynchronous orbit. Unlike previous studies at geosynchronous orbit, however, we observed only few numbers of negative perturbation ($\triangle B_H$) 15% (3 of 19events) in the B_H component (positive north) in the VDH coordinates near midnight (MLT = 21-03), while the majority of nighttime GOES 67% (12 of 18events) showed negative perturbation. This indicates that main contribution of SC near midnight in the inner magnetosphere is the dayside magnetopause current rather than nightside SC-associated cross tail current. Regardless of the L-value, the dayside electric field revealed a dawnward(negative) direction with higher amplitude around the noon, while nightside electric field showed a slightly duskward(positive) amplitude for all events, which is consistent with previous studies.

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PEM09-18 Room:302 Time:May 28 09:45-10:00

Earthward and tailward propagation of high plasma pressure region as pre-cursor and post-cursor of substorm onset

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Cause of substorm expansion onset is one of the major problems in the magnetospheric study. On the basis of a global magnetohydrodynamic (MHD) simulation, Tanaka et al. [2010] suggested that substantial accumulation of the plasma pressure caused by the state transition in the plasma sheet could cause sudden intensification of the Region 1 an 2 field aligned currents and the westward auroral electrojet. In this sense, the accumulation of the plasma pressure is a key in understanding the substorm onset in the magnetosphere. On 5 April 2009, three probes of the Time History of Events and Macroscale Interactions during Substorms (THEMIS) were located at $X_{GSM} \sim$ — 11 Re around the equator, which provide unique opportunity to investigate the spatial-temporal evolution of the high-pressure region (HPR) near the substorm expansion onset. Just before the onset, a positive excursion of the plasma pressure appeared at the outermost probe first, followed by the innermost one. Just after the onset, the opposite sequence took place. These features are consistent with the simulation result that the HPR implodes earthward before the onset associated with the plasma sheet collapse, and expands tailward after the onset. A positive excursion of the Y-component of the current density was observed, which is also consistent with the simulation. These results may provide evidence for the accumulation of the plasma pressure predicted by the MHD simulation, and suggested that the earthward implosion of the HPR may be regarded as a pre-cursor of the substorm expansion onset and the tailward expansion as a post-cursor.

Keywords: High plasma pressure region, Substorm expansion onset, THEMIS satellite, Global MHD simulation

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High current density observations in the near-Earth plasma sheet and substorm dynamics

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The statistical properties of the near-Earth current sheet from 8 Re to 12 Re were recently revealed by the THEMIS multi-spacecraft measurements. A typical cross-tail current density was found to be ~2 nA/m^2, while in some cases, the current density increased above 4 nA/m^2. In contrast to the commonly accepted picture, these high current densities appeared in two magnetic configurations: tail-like and dipolar structure. The former configuration is a typical feature during the substorm growth phase and quiet times. Although the high current density was associated with the tail-like structure, we ruled out the notion that the high current density is caused by plasma sheet compression. Instead, we discuss that an alternative process of plasma sheet thinning proposed by *Hsieh and Otto* [2014], which is caused by an erosion of the magnetic flux in the dayside rather than the loaded magnetic flux in the tail, is relevant. The latter configuration of dipolar structure is a typical feature during the substorm expansion phase. A strong field aligned current was also associated with the high cross-tail current density observations. These high current densities lasted several to a few tens of minutes after the local dipolarization onsets. While the dipolarization is a fast process with a time scale of $<$1 min, diminishing the growth phase current sheet, which is a measure of the magnetic energy, is found to be a slower process.

Keywords: substorm, THEMIS, magnetotail, current sheet

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PEM09-20 Room:302 Time:May 28 10:15-10:30

Statistical analysis of magnetic field fluctuations in the near-Earth magnetotail by THEMIS

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Abstract. We made a statistical analysis of severe magnetic field fluctuation around the inner magnetosphere (X = – 6 ∼ – 12 R_E), which is considered as a necessary cause for current disruption in the substorm model raised by *Lui* (2001). We used two-year magnetic field data of 2013 and 2014 with a sampling rate of 4 *Hz*, which were obtained by the FGM instrument aboard the TH-E (P4) probe of THEMIS. The occurrence rates of severe magnetic-field fluctuation events with C >0.5 were estimated for the nightside near-earth tail at (X_{GSM}, Y_{GSM}, Z_{GSM}) = (– 9 ± 3, ± 5, ± 3) R_E, where C was defined as a ratio between standard deviation and average value of magnetic field intensity during 10-s interval. We found that the occurrence rates are extremely low, of 0.011% for all regions, 0.002% for $|X_{GSM}|$= 6 – 8 R_E, 0.010% for $|X_{GSM}|$= 8 – 10 R_E, and 0.017% for $|X_{GSM}|$= 10 – 12 R_E. We also compared these fluctuation events with simultaneous ion velocity and spectrum data from the ESA instrument on the same probe, and found that magnetic field fluctuation and ion acceleration do not always happen synchronously. Assuming that two substorms occur every day with a 5-min duration of current disruption, we suggested that the low occurrence rate (0.011%) of severe magnetic field fluctuations may indicate that the current disruption region is very localized (∼ 2.6 $R_E{}^3$) in the tail, or the current disruption model is not suitable for most substorm cases. In the presentation, we will show results of similar statistical analysis to magnetic field fluctuations with time scales faster than the local ion cyclotron periods by using higher time-resolution data, in order to investigate the importance of non-MHD processes in the near-Earth tail dynamics.

Reference

A. T. Y. Lui., A multiscale model for substorms, *Space Sci. Rev.,* 95, 325-345, 2001.

Japan Geoscience Union Meeting 2015
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PEM09-21 Room:302 Time:May 28 10:30-10:45

Tailward leap of magnetic reconnection: A THEMIS case study

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A multiple-onset substorm is studied using observations of aurora and the magnetotail. Four successive auroral brightenings were identified in all-sky images roughly every 10 minutes starting at 0219 UT on 27 March 2009. The first brightening was ”initial brightening” while other brightenings were auroral breakups. Corresponding reconnection signatures are studied using THEMIS satellites observations betwee 8 and 24 Re down the tail. At the time of the initial brightening, no fast plasma flows were observed by THEMIS satellites. It is thus unclear whether reconnection is involved in the initial brightening from a classical point of view. An auroral breakup occurred 6 min later and was accompanied by a tailward fast flow observed THEMIS-1 satellite at 24 Re down the magnetotail. This breakup is thus associated with reconnection in the tail as previously reported.

Another auroral breakup occurred 12 min further later at a latitude higher than the previous breakup. At the same time a change of the flow direction from tailward flow to earthward flow was observed by the THEMIS-1 satellite. This flow reversal is often interpreted as the tailward retreat of a single magnetic reconnection site. However, another THEMIS satellite located 5 Re earthward from THEMIS-1 observed the earthward flow 1 min later. Thus, the observed sequence rather corresponds to a tailward leap of the reconnection site. We suggest that the poleward leap of auroral breakup is associated with the tailward leap of reconnection site as a consequence of the magnetic flux pileup in the dipolarization region.

Keywords: magnetotail, magnetic reconnection, substorm, auroral breakup

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PEM09-22 Room:302 Time:May 28 11:00-11:15

Ion accelerations due to two approaching flow fronts: Application to high-energy ion production in the magnetotail

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In some cases, high-energy ions ($\sim$ MeV) are observed in the magnetotail during disturbed time of the magnetosphere. Such ions, however, cannot be produced by the duskward electric field in flows due to the limitation of the dawn-dusk scale length of the flows in the magnetotail. We propose that such high-energy ions can be produced if there exist two flow fronts which approach together by ExB drift. Namely, some ideal ions are repeatedly reflected by the two fronts and accelerated to high energies exceeding the energy given by the product of the duskward electric field and dawn-dusk scale length of the flows.

By performing spatially 1-D (2-D in velocity) test particle simulations where we assumed a couple of approaching ExB-drift flows, we have confirmed the production of high-energy ions as well as the change of the energy spectrum of ions associated with the acceleration. The simulation result shows that such high-energy ions are produced with scale length shorter than the magnetotail diameter. Furthermore, we find that the maximum energy of the accelerated ions depends on the distance of the two flow fronts and the dawn-dusk scale lengths of the flows. If the dawn-dusk scale length is infinite, the energy spectrum of accelerated ions is well fitted by the analytically calculated spectrum. Our simulation results and analytical calculation indicate that the distance and dawn-dusk scale length of two flow fronts can be estimated from the observations of electromagnetic field and flow speed, the maximum ion energy and the change of the energy spectrum of ions in the magnetotail, where such two approaching flow fronts commonly exist.

Keywords: magnetotail, high-energy ion, substorm

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Non-active flow reversals in magnetotail

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Geotail observation over 20 years in magnetotail provides us with about 200 rapid flow reversal events where tailward flow (<-500 km/s) turns to earthward flow (>+300 km/s) within 10 minutes. Nagai et al. (2013) proposed that V_{ey} <-1000 km/s is an important criterion to select active X-lines. As a result, we get 30 active X-line crossing events. Active X-line events show electron acceleration during flow reversals and existence of ion-electron decoupling region. These features are consistent with the collisionless reconnection model demonstrated by recent full kinetic numerical simulations. In contrast, other 16 flow reversal events do not present any of them. No visible ion-electron decoupling is found in these non-Active flow reversal events. In this presentation, we will discuss physical meaning of the difference between active X-line and non-active flow reversal events.

Keywords: magnetotail, flow reversal, magnetic reconnection

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Kink-type oscillations of the magnetotail current sheet with a quasi-continuous magnetic reconnection jet

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We present and analyze quasi-periodic crossings of the magnetotail current sheet observed by the Geotail spacecraft at (-26, 9, 0) Re in GSM on 11 October 2014. The event occurred when the magnetosphere was moderately driven by the solar wind and southward interplanetary magnetic field, i.e., during a period of so-called steady magnetospheric convection. Reconnection jets with an earthward velocity ∼700 km/s, comparable to the lobe Alfven speed, were observed almost continuously in the plasma sheet for an interval 0900-1100 UT. In order to reveal the orientation and structure of the observed current sheet, whose crossings occurred with a period of 2-3 minutes, we applied the Grad-Shafranov reconstruction technique [Hau and Sonnerup, 1999; Hu and Sonnerup, 2002] assuming 2-D structures. The results indicate that kink-type waves were propagating approximately earthward in the plasma sheet, with a wavelength of ∼15 Re and amplitude of order 1 Re. To the best of our knowledge, this is the first identification of sunward-propagating MHD-scale kink-mode waves in the magnetotail. The generation mechanism of the observed oscillations is discussed based on the nature of the reconstructed current sheet structures, ion velocity distributions observed in the current sheet, and results from other single-spacecraft methods such as minimum variance analysis and minimum Faraday residue method [Terasawa et al., 1996; Khrabrov and Sonnerup, 1998].

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Keywords: magnetic reconnection, magnetotail, current sheet, kink-mode, Grad-Shafranov equation, steady magnetospheric convection