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

PEM28-01 Room:302 Time:May 28 12:00-12:15

Outflow structure of 3D magnetic reconnection

FUJIMOTO, Keizo[1*]

[1]Division of Theoretical Astronomy, NAOJ

Magnetic reconnection is believed to be a key process in magnetospheric dynamics of the Earth, in particular, in magnetospheric substorms. Fast earthward flows are frequently observed in the near-Earth region of the magnetotail in association with substorms and are attributed to magnetic reconnection. The fast earthward flows are usually termed the bursty bulk flows (BBFs) and have a typical spatial scale in the y (GSM) direction with 2-3 Re (Re: Earth radii). The BBFs are considered to be the main transporter of the plasma momentum and energy in the magnetotail, and be responsible for the plasma heating at the depolarization fronts and aurora breakup in the polar ionosphere. However, the relation between the BBFs and magnetic reconnection is poorly understood yet. Main issue arises in the 3D characteristics. It is clear from the observations that the BBFs have a 3D structure, while the 3D dynamics of reconnection has not been revealed clearly, mainly because of the limitation of computer resources.

Since the BBFs have an MHD scale (much larger than the ion inertia length) in the y direction, the 3D MHD simulations have been carried out to investigate the generation mechanism in the course of magnetic reconnection. However, it has been suggested that the scale of the BBFs depends sensitively on the resistivity which is provided artificially at the x-line. Furthermore, for the case without the artificial resistivity, no BBFs arise in the system. These results from the MHD simulations imply that the BBF is an MHD-scale dynamics originated from kinetic physics, therefore the kinetic simulations are needed.

The 3D kinetic simulations of magnetic reconnection so far have focused on the dissipation mechanism at the x-line. Our previous particle-in-cell (PIC) simulations have found that the anomalous resistivity is generated due to a current sheet shear mode at the x-line and is enhanced significantly in association with plasmoid ejections. However, the system size in the y direction was only 10 ion inertia length in the previous simulations, so that the outflow structure was almost uniform along the y axis. The present study has challenged larger-scale PIC simulations in 3D with the help of the adaptive mesh refinement (AMR). The simulations are performed on the K, the state-of-the-art supercomputer of Japan. The system size is 40 ion inertia length in the y direction which is larger than the typical BBF scale. It is found that a larger-scale kink mode evolves around the x-line, in addition to the current sheet shear mode, and is enhanced due to plasmoid (flux lope) ejections. As a result, the thin current layer becomes more turbulent in the present simulations. The plasmoid ejections are three dimensional and have a scale of 10-20 ion inertia length in y, corresponding to the wavelength of the large-scale kink mode. This scale is roughly consistent with the BBFs scale. The ion outflow jets are also three dimensional and are regulated by the kink mode. The present results from large-scale 3D PIC simulation suggest that the outflow structure of 3D reconnection is determined by the large-scale kink mode arising along the x-line, which wavelength is comparable with the BBFs observed frequently in the near-Earth magnetotail.

Keywords: magnetic reconnection, particle-in-cell simulation, 3D dynamics, turbulence, outflow jet

Japan Geoscience Union Meeting 2015
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PEM28-02 Room:302 Time:May 28 12:15-12:30

The Magnetic Reconnection Outflow in the Near-Earth Plasma Sheet

KONDOH, Koji[1*]

[1]RCSCE, Ehime University

In the near-Earth plasma sheet, earthward fast plasma flows over several hundred km/s are observed by in-situ satellites. These plasma flows are suddenly decelerated by the dominant dipolar magnetic field at around 10 Re. The following tailward rebound flows are also observed by them. In this paper, we studied the three dimensional evolution of these earthward and tailward flows using MHD simulation and analyses of GEOTAIL observation data during from 1995 to 2005.

Keywords: Near Earth Plasma Sheet, Magnetic Reconnection, Plasma Flow, Bursty Bulk Flow, Bounce Flow

PEM28-03 Room:302 Time:May 28 12:30-12:45

Energy budget of the plasma sheet during auroral substorms

KATAOKA, Ryuho[1*] ; TANAKA, Takashi[2] ; FUJITA, Shigeru[3] ; EBIHARA, Yusuke[4]

[1]National Institute of Polar Research, [2]Kyushu University, [3]Meteorological College, [4]Kyoto University

Where is the magnetic energy for the expansion phase of auroral substorms accumulated? This question was raised by Akasofu (2013), and it was concluded that the magnetic energy must be accumulated in the plasma sheet within a distance of 10 Re to meet the large total energy consumption by the ionosphere. Many different features of substorms are reasonably reproduced by the new global MHD simulation (Tanaka et al., 2010), where high-pressure regions such as cusps and inner plasma sheet are essentially important to maintain the enhanced Region1 and Region2 field-aligned current systems. Both magnetic energy and thermal energy are therefore important to understand the energy budget during the substorm, and that is the motivation of the present study. The purpose of this paper is to evaluate the energy budget of the plasma sheet in a simulated substorm. Magnetic energy and thermal energy of the plasma sheet, as well as the energy consumption by the ionosphere are evaluated. Possible important role of dipolarization in the energy conversion is also discussed.

Using the global MHD simulation, it is found that magnetic energy release rate and thermal energy accumulation rate are balanced in the plasma sheet during the early expansion phase of the simulated substorm. Around the peak of the expansion phase, energy release rate in the plasma sheet does not meet the energy consumption rate in the ionosphere. External energy source from outside of the plasma sheet is needed to maintain the high auroral activity. The JxB force of the dipolarization does the work to increase the thermal energy inside. This is how the accumulated magnetic energy within a distance of 10 Re is converted into the thermal energy during the early expansion. The increase of the thermal energy is the source of enhanced Region-2 field-aligned current system. Region1 field-aligned current must be supplied from outside of the plasma sheet to maintain the high auroral activity in the ionosphere. The dynamo of Region1 is slow-mode expansion in the cusp-mantle region. The enhanced conductivity plays the essential role to introduce the large Region 1 field aligned current because the dynamo has the nature of voltage-generator.

Keywords: Substorm, plasma sheet, aurora, Magnetohydrodynamics

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PEM28-04 Room:302 Time:May 28 14:15-14:30

Intensity distribution of AE and Dst and its relation to solar wind parameters

MORIOKA, Akira[1*] ; MIYOSHI, Yoshizumi[2] ; NOSE, Masahito[3]

[1]PPARC, Tohoku University, [2]STEL, Nagoya University, [3]WDC for Geomag, Kyoto University

Storm-substorm relationship and related solar wind-magnetosphere coupling process are studied on the basis of statistical analyses of AE, Dst, epsilon parameter and Em using OMNI data base from 1995 to 2013 and Wp index data from 2005. The statistical relationship between AE and Dst is examined to clarify the difference between CME storm and CIR storm. The intensity distribution of AE and Dst for a year is compared with that of epsilon and Em parameters in the solar wind.

The obtained major results are,

1). Relationship between AE at substorm and Dst is rather linear.

2). AE vs Dst relationship at CIR storm is different from that at CME storm.

3). Intensity distribution of AE and Dst for a year shows the exponential distribution.

4). Intensity distribution of epsilon parameter for a year shows the power low distribution.

5). Intensity distribution of Em for a year shows the exponential distribution.

6). The results 3) to 5) suggest that magnetospheric disturbances are mainly controlled by the solar wind electric field rather than by solar wind Poynting flux.

Keywords: substorm, magnetic storm, solar wind interaction

Japan Geoscience Union Meeting 2015
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PEM28-05 Room:302 Time:May 28 14:30-14:45

Possible Formation Scenario of Transpolar Aurora

OBARA, Takahiro[1*] ; TANAKA, Takashi[2] ; SAGAWA, Eiichi[3]

[1]Planetary Plasma and Atmospheric Research Center, Tohoku University, [2]Kyushu University, [3]National Institute of Information Communications Technology

There might be two types of transpolar auroras, they say. 1) One type of the transpolar aurora appears in the pole ward edge of electron precipitations, which expanded from dawn side aurora oval or dusk side aurora oval depending on the IMF by polarity, as mentioned by Makita ea. al. (1991). The evidences were inferred from the satellite particle data together with aurora images taken by the low altitude polar satellites. This type of transpolar aurora, which is associated with relatively intense electron precipitations near the pole ward boundary, tends to become much more luminous, forming so-called theta aurora. 2) Another type of transpolar aurora is theta aurora, which appears under the conditions of strong northward IMF. This type of theta aurora is cause by a sign change of IMF By . (Tanaka et al, 2004) This transition includes a lobe field line replacement from old IMF originating fields to new IMF originating fields, rotation of plasma sheet to the opposite inclination, and reformation of ionospheric convection cell. In the midst of the reconfiguration, old and new convection systems must coexist in the magnetosphere-ionosphere system and 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. The growth of new lobes results in the blocking of the return path toward the 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 accumulate on the nightside. The theta, then, appears at the foot points of these accumulated closed field lines. We have joined NASA IMAGE project, receiving real time telemetry data over Japan from 2000 to 2005. By investigating IMAGE data, we confirmed that two different processes actually exist. In the talk, we like to report our examination and discuss on the relationship between above mentioned two types of transpolar auroras.

Keywords: Theta Aurora, IMAGE satellite, MHD simulation

Japan Geoscience Union Meeting 2015
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PEM28-06 Room:302 Time:May 28 14:45-15:00

Coexistence of a polar cap arc and a polar cap patch

SAKAI, Jun[1*] ; HOSOKAWA, Keisuke[2] ; TAGUCHI, Satoshi[3] ; OGAWA, Yasunobu[4]

[1]Center for Space Science and Radio Engineering, University of Electro-communications, [2]Department of Communication Engineering and Informatics, University of Electro-Communications, [3]Department of Geophysics, Graduate School of Science, Kyoto University, [4]National Institute of Polar Research

A polar cap arc aligned with the trailing edge of a polar cap patch was observed at 2350 UT on 23 December 2014 by an all-sky imager (ASI) installed at Longyearbyen, Svalbard. It is known that polar cap patches are manifestation of southward interplanetary magnetic field (IMF) while polar cap arcs are manifestation of northward IMF. It is also known that both polar cap patches and polar cap arcs may appear simultaneously when the direction of IMF reverses from southward ($Bz<0$) to northward ($Bz>0$). Known cases of such events showed that a patch and an arc were not far from each other, i.e. they were within the field of view of the instrument, but they were separated. In our observation, on the other hand, a patch and an arc were very close to each other. All-sky images of 630.0 nm emission showed that the brightness of the trailing edge of a patch suddenly increased just before entering the auroral oval. These images indicated that there was a narrow strip of auroral emission along the edge of the patch. The variation of the F-layer peak electron density (NmF2), deduced from F-layer critical frequency (foF2) data observed by Svalbard Dynasonde, was in good agreement with the variation of 630.0 nm brightness at the zenith, indicating that the patchy object in the ASI image was actually the plasma patch. At the same time, the ASI-measured 557.7 nm brightness data suggest that the bright arc along the patch edge had an auroral nature. Almost exactly an hour before this event, the direction of IMF measured by ACE satellite reversed from southward to northward. Furthermore, Svalbard Dynasonde data showed a reversal of the east-west component of F-layer drift velocity at almost the same time as the arc appeared, suggesting that there was a horizontal velocity shear in the F region above Svalbard. This also suggests that the observed bright arc was indeed an auroral arc. One peculiarity of this event is that the observed arc was extended from east to west, unlike the well-known north-south polar-cap arcs. With these observational facts we will discuss the possible origin of the arc.

Keywords: polar cap patch, polar cap arc, polar ionosphere, magnetosphere, arc origin

PEM28-07 Room:302 Time:May 28 15:00-15:15

Substorm Pi2 pulsations: Polarization patterns caused by azimuthal propagation of ionospheric loop currents

SAKA, Osuke[1*]

[1]Office Geophysik

The map of polarizations of high latitude Pi2 in Samson and Harrold (1983) presented patterns of the ellipticity and major axis orientations in the horizontal plane, covering from auroral zone to mid-latitude over the nighttime sector spanning 5.3 MLT. The substorm processes caused complexities in the polarization map of Pi2 pulsations.

We show that the polarization map of Samson and Harrold (1983) at first seem impossible will explain the Pi2 pulsations in simple way. These ground polarization patterns convey much information on the energy source of Pi2 pulsations and mode of oscillations in the magnetosphere.

References:
Samson, J.C., and B. G. Harrold (1983), Maps of the polarizations of high latitude Pi2s, J.Geophys.Res., 88, 5736-5744.

Keywords: Pi2 pulsation, Loop currents in auroral zone

Japan Geoscience Union Meeting 2015
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PEM28-08 Room:302 Time:May 28 15:15-15:30

Comparisons of Pi pulsations and substorm developments observed on the ground and in the near-earth magnetotail

SAKURAI, Tohru[1*] ; KADOKURA, Akira[2] ; TANAKA, Yoshimasa[2] ; SATO, Natsuo[2]

[1]Tokai University, [2]National Institute of Polar Research

We present unique results of recent work for comparisons of Pi pulsations and their relation to substorm developments observed on the ground and in the night-side magnetotail. The observations of Pi pulsations and aurora on the ground and of the magnetic field oscillations at the geosynchronous orbit and in the near-earth magnetotail are examined in detail. The expansion onset of a substorm examined was registered at 0512 UT on 4th April 2009. Pi pulsations appeared to oscillate from 0502 UT about 10 minutes earlier than the expansion onset. The Pi pulsations initiated with a small amplitude oscillation in association with faint appearance of auroral luminousity oscillations concurrently to the Pi 2 oscillations. The auroral luminousity oscillations became clear from 0506 UT in association with the clear appearance of the Pi 2 oscillations, particularly in the magnetic field D component oscillations. The large amplitude Pi 2 oscillations began to appear suddenly from 0509 UT accompanied with a slight poleward movement of the auroral activity, and then the aurora began to move suddenly poleward from 0512 UT with the auroral luminosity enhancement, which is the expansion onset. For about 3 minutes after the expansion onset the aurora continued to activate at the poleward site. Then the aurora became weak and moved gradually to the lower latitude side from 0515 UT, but the Pi 2 oscillations still continued to oscillate. During this substorm activity Pi 2 oscillations were clearly observed simultaneously at the geosynchronous orbit by GOES 11 and GOES 12 in the pre and post midnight sector, respectively, which provided very interesting oscillation signatures, i.e., the antiphase oscillations in the horizontal components of the magnetic field, implying that the polarization of the magnetic field horizontal components was opposite each other, suggesting the opposite flow direction of the field-aligned currents (FACs), that is upward and downward in the pre and postmidnight sector. Thus these observations at the synchronous orbit represent clear evidence of Pi 2 oscillations as substorm current wedge FAC oscillations. While, the observations by the THEMIS satellites located in the near-earth magnetotail at the radial distance from – 10 Re to – 13 Re provided a very important indication concerning to the growth of Pi oscillations and substorm processes in the near-earth magnetotail. For the most earthward satellite, THEMIS A (THA) observed small amplitude magnetic field perturbations from 0505 UT almost simultaneous to the clear appearance of the Pi 2 oscillations on the ground and at the geosynchronous orbit, and then the magnetic field perturbations became to oscillate gradually in the amplitude, which continued until 0513UT, when the dipolarization signature appeared at this site. While, the THEMIS E (THE) satellite located a little tailward nearest to the THA observed the gradual increase of the magnetic field intensity from 0504 UT and then observed the field decrease from 0507 UT associated with the plasma pressure increase. The dipolarization and associated plasma depression appeared at 0512UT. Thus, the dipolarizations observed at the THEMIS satellites was almost coincident to the expansion onset on the ground. These are summaries in this work, which indicate the close relation between Pi oscillations observed on the ground and substorm processes in the ionosphere, at the synchronous orbit and in the near-earth magnetotail.

Keywords: Pi oscillations, substorm, magnetosphere

Japan Geoscience Union Meeting 2015
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PEM28-09 Room:302 Time:May 28 15:30-15:45

Lower-thermospheric wind variations in auroral patches at the substorm recovery phase

OYAMA, Shin-ichiro[1*] ; SHIOKAWA, Kazuo[1] ; MIYOSHI, Yoshizumi[1] ; HOSOKAWA, Keisuke[2] ; WATKINS, Brenton J.[3] ; KURIHARA, Junichi[4] ; TSUDA, Takuo[2]

[1]Solar-Terrestrial Environment Laboratory, Nagoya University, [2]Department of Information and Communication Engineering, University of Electro-Communications, [3]Geophysical Institute, University of Alaska Fairbanks, [4]Department of Cosmosciences, Graduate School of Science, Hokkaido University

Measurements of the lower-thermospheric wind with a Fabry-Perot interferometer (FPI; 557.7 nm) at Tromsϕ, Norway found the largest wind variations in a night during appearance of the auroral patches at the substorm recovery phase. Taking into account magnetospheric processes of plasma energy accumulation and release in the substorm evolution (i.e., principal part of the energy accumulated in the plasmasheet at the growth phase is released for a short time of the expansion phase), it is an attractive result of the largest amplitude in the measured winds at the latter part of the substorm or the recovery phase. We think that this phenomenon is essentially important for understanding the energy transfer and dissipation processes in the magnetosphere and the upper atmosphere at high latitudes.

Our researching activity is the first detailed investigation regarding the magnetosphere-ionosphere-thermosphere coupled system at the substorm recovery phase using comprehensive data sets of solar wind, geomagnetic field, auroral pattern, and FPI-derived wind. This study selected five events between November 2010 and January 2012, particularly focusing on the wind-variation signatures in the auroral morphology, and detected three clear evidences in all of the events: (1) wind fluctuations were isolated at the edge and/or in the darker area of the auroral patch, and the largest vertical amplitude and the longest oscillation period were about 20 m/s and about 10 minutes, respectively, (2) the convection electric field was smaller than 15 mV/m, and (3) wind fluctuations accompanied the pulsating aurora. These characteristics suggest that the energy dissipation to produce the wind fluctuations is localized in the auroral pattern. Joule heating and Lorentz force are not the principal mechanism because of small electric field. That is a notable characteristics different from the mechanism at the substorm growth and expansion phases. Particle heating must be a minor component in the energy dissipation because of the isolated wind fluctuation in the darker area. Some other mechanisms should play a principal role at the substorm recovery phase; but unknown yet.

Keywords: aurora, substorm, Fabry-Perot interferometer, ionosphere, thermosphere, polar region

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PEM28-10 Room:302 Time:May 28 15:45-16:00

Quasi-periodic spatial modulation of pulsating aurora

FUKUDA, Yoko[1*] ; KATAOKA, Ryuho[2] ; MIYOSHI, Yoshizumi[3] ; KATOH, Yuto[4] ; NISHIYAMA, Takanori[2] ; SHIOKAWA, Kazuo[3] ; EBIHARA, Yusuke[5] ; DONALD, Hampton[6] ; IWAGAMI, Naomoto[1]

[1]Earth & Planet. Sci., The Univ. of Tokyo, [2]NIPR, [3]Nagoya Univ., STEL, [4]Dept. of Geophys., Tohoku Univ., [5]Kyoto Univ., RISH, [6]GI, Univ. of Alaska Fairbanks

A quasi-periodic intensity modulation of pulsating auroras has been considered to be formed by pitch-angle scattered electrons with whistler-mode chorus waves, because the intensity modulation is consistent with the time scale of chorus elements. A 2-D simulation study showed the latitudinal displacement of chorus elements from the magnetic field line, and the Cluster satellites observed oblique propagations of chorus waves close to the equator. These oblique chorus waves may be seen as the quasi-periodic spatial modulations of the pulsating aurora in the ionosphere. The purpose of this study is to examine the oblique propagation of chorus elements as a possible mechanism of the spatial modulations of the pulsating aurora. We used data obtained by a highly sensitive sCMOS camera installed at Poker Flat Research Range (PFRR) in Alaska from February to April 2014. The imaging sensor of 2048 x 2048 pixels and the narrow field of view of 15 x 15 degrees enable us to identify the smallest auroral structure ever observed. The field of view approximately corresponds to 27 km x 27 km at 100 km altitude, and the spatial resolution is ˜52 m when 4 by 4 binning is used. From the initial analysis of a magnetic storm event on February 19, 2014, we found several events of spatial variations of small-scale (5 km across on average) elongated patches during the ON-phase of the main pulsating patch. The typical propagation speed of the small elongated patches is an order of 50 km/s at the 100 km altitude, which corresponds to an order of 1000 km/s in the magnetosphere. In the presentation we add some more storm events to show statistical results of the propagation directions and the speed, the scale-size, and the periodicity of small-scale pulsating auroral patches to compare with the simulated results of chorus wave-electron interactions which may form the spatial variations of pulsating patches in the ionosphere.

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PEM28-11 Room:302 Time:May 28 16:15-16:30

Characteristics of polarization in auroral emissions based on wide-field polarization spectroscopic observation

TAKASAKI, Shimpei[1] ; SAKANOI, Takeshi[1*] ; KAGITANI, Masato[1]

[1]Graduate School of Science, Tohoku University

Recently the linear polarization (up to 17 %) of auroral 630 nm emission has been reported from ground-based measurements (Bommier et al., 2011). However, characteristics of auroral polarization, such as substorm dependence, are not understood well. This study we focus on the polarization in auroral 557.7nm emission as well as 630 nm emission, and developed the wide-field (130 deg) north-south meridian imaging polarization spectrograph. In addition, we also developed the polarization telescope with Wollaston prisms to calibrate polarization effect additionally caused by air particle in the line-of-light direction.

The wide-field imaging spectrograph consists of a fish-eye lens, wire-grid linear polarizer, VPH grating and EMCCD camera, covering 450 ? 710 nm range with 2.0 nm resolution. To obtain the auroral polarization with accuracy better than 1%, we developed the calibration LED lamp with a rotating linear polarizer and carried out the precise calibration of instrumental (artificial) polarization for the whole 130 deg FOV with interval of 3 deg.

We have performed continuous measurement of auroral polarization since November 2014 at Poker Flat, Alaska. For geomagnetically disturbed event on Nov. 20, 2014, the polarization in auroral 630 nm emission was maximized up to 8% at low-elevation angle (~10 deg), and decreased toward the magnetic zenith, where the polarization was ~1%. On the other hand, there was strong polarization in 557.7 nm emission (greater than 10%), which should not polarized from the theory of magnetic quadra-pole emission process.

We estimated the relative energy of precipitating electrons from the ration of 630nm and 557.7nm emissions, and found that the polarization of auroral 630nm emission increased as the energy of precipitating electron decreased. I this talk we will give the recent results and discuss issues for further study on auroral polarization.

Keywords: aurora, polarization, development

PEM28-12 Room:302 Time:May 28 16:30-16:45

Antarctic large area network observation of auroral phenomena using unmanned system

KADOKURA, Akira[1*] ; YAMAGISHI, Hisao[1] ; OKADA, Masaki[1] ; OGAWA, Yasunobu[1] ; TANAKA, Yoshimasa[1] ; MOTOBA, Tetsuo[2] ; HOSOKAWA, Keisuke[3] ; SAITA, Satoko[4] ; MIYOSHI, Yoshizumi[5] ; YUKIMATU, Akira sessai[1] ; MIYAOKA, Hiroshi[1] ; KATAOKA, Ryuho[1]

[1]National Institute of Polar Research, [2]Johns Hopkins University Applied Physics Laboratory, [3]Department of Communication Engineering and Informatics, University of Electro-Communications, [4]National Institute of Technology, Kitakyushu College, [5]Solar-Terrestrial Environement Laboratory, Nagoya University

Space and upper atmospheric sciences group in the National Institute of Polar Research (NIPR) is now planning to carry out a ground-based network observation project of auroral phenomena using unmanned observation system during the next term of the Japanese Antarctic Research Expedition (JARE) programme.

At present, 8 unmanned magnetometers have been deployed within the area of 66 to 72 degree magnetic latitude and 60 to 85 degree magnetic longitude around Syowa Station. Along the inland route to Dome Fuji Station, 3 BAS (British Antarctic Survey) type unmanned magnetometers are deployed, while along the coast area, 5 NIPR type ones are deployed. At these 8 points, 1 sec resolution magnetic observations are carried out continuously through the year with a 3-axis fluxgate magnetometer.

Within this JARE programme term (the 8th term), a new unmanned auroral observation system, which is equipped with 3-axis fluxgate magnetometer, all-sky auroral imager, and GNSS/TEC receiver, has been developed by NIPR, and one set of the system will be deployed around Molodezhnaya Station located about 300 km east from Syowa Station. In the next 9th term, another set will be deployed around the SerRondane area located about 800 km west from Syowa. In addition to the observations at these unmanned sites, we will promote a collaboration with the observations at Indian Station Maitri and South African Station Sanae, which are located further westward from SerRondane area at sub-auroral latitudes, to construct a large area auroral observation network within the area of 62 to 72 degree magnetic latitude and 45 to 85 degree magnetic longitude.

Scientific purposes of this large area network observation are as follows:

1. To observe phenomena which appear around the time of substorm onset.
2. To observe temporal variation of conjugacy of auroral phenomena.
3. To observe phenomena associated with various wave-particle interactions during the storm and substorm times in the inner magnetosphere region.

Keywords: unmanned observation, large area network, auroral phenomena, conjugacy

PEM28-13 Room:302 Time:May 28 16:45-17:00

Properties of energetic ion PSD during magnetic storms observed by Van Allen Probes

MITANI, Kenji[1*] ; SEKI, Kanako[1] ; KEIKA, Kunihiro[1] ; LANZEROTTI, Louis J.[2] ; GKIOULIDOU, Matina[3] ; MITCHELL, Donald G.[3] ; KLETZING, Craig A.[4]

[1]Solar-Terrestrial Environment Laboratory, Nagoya University, Japan, [2]New Jersey Institute of Technology, USA., [3]Applied Physics Laboratory, Johns Hopkins University, USA., [4]Department of Physics and Astronomy, University of Iowa, USA.

It is observationally known that the contribution of O+ ions to the ring current increases with increasing size of magnetic storms, while H+ is the main component of the ring current ions during small storms. Ion injection from the magnetotail caused by substorms is considered as one of the principal mechanisms that supply energetic ions to the ring current region. However, the dependence of the ion injection properties on ion species (such as the depth of ion injection into the inner magnetosphere) is far from well understood as is the role of injection itself. To characterize the ion supply to the ring current during magnetic storms, we investigate in this study the properties of energetic H+ and O+ phase space densities (PSDs) during geomagnetic substorms observed by the Van Allen Probes mission. We examine substorms that occurred during the periods of April 23, 2013 to April 28, 2013, April 29, 2013 to May 5, 2013, and March 15, 2013 to March 20, 2013. Using energetic ion (greater than 50 keV) and magnetic field data obtained by the RBSPICE and EMFISIS instruments onboard Van Allen Probes, we study the temporal variations of H+ and O+ PSD spatial distributions and compare their properties during each of the substorm events.

We calculated the first adiabatic invariant, mu, and PSD for ions within a pitch angle range from 70 to 110 degrees. PSDs for specific mu values (mu = 0.3, 0.5 and 1.0 keV/nT) were obtained as a function of L for each ion species for each orbit of Van Allen Probes during each substorm. We identified a sudden increase in each PSD spatial distribution as an injection boundary. The results for the period of April 23-28, 2013 show that both H+ and O+ ions penetrated directly down to $L<5$ during the main phase of the magnetic storm (minimum Dst greater than -65 nT). The penetration boundary of H+ ions was located at smaller L at dusk than at dawn. We also find that H+ ions with smaller mu values (mu = 0.3 and 0.5 keV/nT) penetrated earlier than those with larger mu values (mu = 1.0 keV/nT). In contrast, the timing of O+ penetrations is almost the same for all O+ ions regardless of the mu values. The results also show that O+ ions penetrated more deeply in L and earlier in time than do the H+ ions. These results taken together suggest that the source of the injected O+ ions is located closer to Earth than that of the protons (the inner edge of the plasma sheet) and therefore suggest the importance of the contribution of subauroral O+ ions to the storm-time ring current.

PEM28-14 Room:302 Time:May 28 17:00-17:15

Statistical analysis of magnetosonic waves from the Van Allen Probes data

NOMURA, Koji[1*] ; MIYOSHI, Yoshizumi[1] ; KEIKA, Kunihiro[1] ; SHOJI, Masafumi[1] ; KITAMURA, Naritoshi[1] ; KURITA, Satoshi[1] ; MACHIDA, Shinobu[1] ; SANTOLIK, Ondrej[2] ; KLETZING, Craig[3]

[1]Solar-Terrestrial Environment Laboratory, [2]Institute of Atmospheric Physics AS CR, [3]The University of Iowa

Magnetosonic waves (MSWs) are X mode electromagnetic emissions seen at between the proton cyclotron frequency and the lower hybrid resonant frequency. Their magnetic field fluctuations have a linear polarization. It has been suggested that MSWs can contribute to the acceleration of relativistic electrons in the radiation belts. In this study, we statistically investigate plasmaspheric MSWs using data from the EMFISIS instrument onboard the Van Allen Probes. The MSWs occur at all local times but in this study we observe them mainly on the dayside and during both magnetically quiet and active periods. We also investigate the polarization of MSWs using the spectral matrix. At $L<1.5$, the polarization of at the lower frequency component of MSWs changes from R-mode to X-mode. At the same location, there are some L-mode waves that may be converted from the R-mode waves below the cross-over frequency. These L-mode waves may contribute to the plasmaspheric EMIC waves deep in the plasmasphere.

Keywords: MSW, inner magnetosphere, Van Allen Probes, EMIC

PEM28-15 Room:302 Time:May 28 17:15-17:30

Loss processes of outer radiation belt electron: Contribution of magnetopause shadowing

CHIBA, Takashi[1*] ; OBARA, Takahiro[1] ; KURITA, Satoshi[2] ; MIYOSHI, Yoshizumi[2]

[1]Planetary Plasma and Atmospheric Research Center,Tohoku University, [2]Solar-Terrestrial Environement Laboratory, Nagoya University

The Earth's radiation belts consist of the inner and outer radiation belts, and these regions are composed of highly energetic electrons. Especially in the outer radiation belt, the energetic electron fluxes are highly variable during magnetic storms. Energetic electrons in the radiation belts sometimes cause satellite charging, resulting in gradual degradation of instruments and devices onboard satellites. Therefore, it is important to understand basic physics of the energetic electron variation in the outer radiation belt from the point of view of space weather. It has been considered that the drastic change of the outer radiation belt is controlled by the delicate balance between transport, acceleration and loss processes. However, each process has complex physical mechanisms and there remain still much outstanding questions.

In this study, we particularly focused on the loss processes. As a possible loss process, (i) precipitation to the atmosphere, (ii) Dst-effect and (iii) direct loss from the magnetopause (magnetopause shadowing) have been considered. The correlation between the magnetopause location and the outer boundary of the outer radiation belt was reported by Matsumura et al. [2011]. Turner et al. [2012] suggested that a rapid depression of outer belt electrons is caused by the sudden inward shift of the magnetopause and subsequent enhancement of outward radial diffusion. However, the regions where electrons escape and how the magnetopause shadowing effect reaches smaller L-value are still open questions.

In order to understand the effect of magnetopause shadowing, we used the concept of the drift shell splitting. Due to the asymmetric configuration of Earth's magnetosphere, charged particles which have different pitch angles drift along the different drift shells. On the dayside, particles whose pitch angles are closer to 90 degrees have drift shells closer to the magnetopause. It is expected that, as a result of magnetopause shadowing, the pitch angle distribution will be the butterfly distribution. To investigate this hypothesis, we used Solid State Telescope (SST) onboard the THEMIS satellite and analyzed pitch angle distributions of energetic electrons.

Our result shows inward shift of dominant region of butterfly distribution when the magnetopause is compressed. We consider that this change is caused by the effect of inward shift of the magnetopause. However, the correlation coefficient between the magnetopause standoff distance and the shadowing region (the region where the effect of magnetopause shadowing is observed in the pitch angle distributions) is relatively low. It is because the effect of drift shell expansion due to the enhancement of the ring current. Then we calculate the largest $L*$ which has last closed drift shell, $L*max$ [Koller and Zaharia, 2011] and compared $L*max$ with shadowing regions. The result shows good correlation and it supports the scenario that the electron loss is caused by the magnetopause shadowing.

However, our result also shows a little difference between loss and shadowing region. It means that the other loss processes are necessary to explain the total loss of outer belt electrons. We investigate this difference of the two by calculating 1-D Fokker Planck radial diffusion model. The simulation result supports the Turner's scenario, magnetopause shadowing and subsequent enhancement of outward radial diffusion. However, strong radial diffusion coefficients are required to explain observation.

We also consider the precipitation loss to the atmosphere by using POES. POES can detect strong precipitation events. However, these precipitation events are not detected for all the events, there are some events which we can rarely detect strong precipitations. Thus, it is suggested that precipitation loss is not the main cause of loss but just the subsequent loss. However, we need to investigate further about precipitation loss.

Keywords: radiation belt, magnetopause shadowing, drift shell splitting, loss process

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Topside sounding of upper ionosphere by EXOS-D/PWS in 2015

KATOH, Yuto[1*] ; KUMAMOTO, Atsushi[1]

[1]Graduate School of Science, Tohoku University

We present initial results of sounder experiments by the Akebono (EXOS-D) satellite conducted in March-April 2015.
Plasma wave sounder experiments have been conducted by Stimulated Plasma Wave experiment (SPW) subsystem of Plasma Wave and Sounder experiments (PWS) on board the Akebono satellite in the topside ionosphere and plasmasphere [Oya et al., JGG 1990]. The sounder experiments have two main purposes: One is the remote sensing of the topside ionosphere including polar region and inner plasmasphere, and another is active experiments by the stimulation of plasma waves in space. Both of them have been successfully conducted by the SPW subsystem of Akebono/PWS.
During March-April 2015, we carry out sounder experiments by the Akebono satellite in both polar region and equatorial region of ionosphere/plasmasphere. In this paper we study echoes obtained by the experiments and derived altitude profile of the plasma density of the topside ionosphere. We also investigate plasma resonances appeared in ionograms and discuss their generation mechanism based on the weak turbulence theory of the sequence of diffuse plasma resonances [e.g., Oya, 1970].

Keywords: topside sounding, upper ionosphere

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Seasonal dependence of the plasmaspheric density along the 210MM: Continuous observations by ground magnetometers

KAWANO, Hideaki[1*] ; YAMADA, Tetsuro[2] ; KITAGAWA, Yuichiro[3] ; SHEVTSOV, Boris[4] ; KHOMUTOV, Sergey[4] ; PODDELSKIY, Igor[4] ; YOSHIKAWA, Akimasa[1] ; MAGDAS/CPMN, Group[5]

[1]Department of Earth and Planetary Sciences, Kyushu University, [2]Department of Earth and Planetary Sciences, Kyushu University, [3]Department of Earth and Planetary Sciences, Kyushu University, [4]IKIR FEB RAS, Russia, [5]International Center for Space Weather Science and Education, Kyushu University

In this paper we have applied the cross-phase method and the amplitude-ratio method to the MAGDAS/CPMN ground magnetometers MGD (Magadan) and PTK (Paratunka, Kamchatka), located in the Russian Far East along the 210MM (Magnetic Meridian), and identified FLR (field-line resonance) events. MGD is located at (53.6, 219.1) magnetic latitude and longitude [deg], and PTK is located at (46.2, 226.2). Their L values are 2.9 and 2.1. We have identified the FLR events by using both visual inspection and an automatic-identification computer code.

Although the two magnetometers are separated by about seven degrees in magnetic latitudes, which is larger than the typical separation (about 1-2 degrees) for which the cross-phase and amplitude-ratio methods are efficient, but we could identify more than a hundred FLR events a year from the MGD/PTK-pair data, and the FLR events had a fairly continuous coverage from January to December.

In this paper we estimate the plasmaspheric density from thus obtained FLR frequencies, and examine their seasonal dependence. The result suggests a weak, but marginally significant seasonal dependence with maxima in winter and minima in summer. More details will be discussed at the presentation.