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

PEM30-01 Room:304 Time:May 24 13:45-14:00

Energy budget and dynamics in the earth's magnetosphere

OGINO, Tatsuki[1*]

[1]Solar-Terrestrial Environment Laboratory, Nagoya University

Energy transport, accumulation and release, namely energy budgets are important problems in interaction between the solar wind and earth's magnetosphere. We have studied distribution of three kinds of the kinetic, thermal and magnetic energies and three kinds of energy fluxes in the magnetosphere. Most dominant energy flux is Poynting flux in the magnetosphere which is main driver of magnetospheric convection. In the earth side of near-earth neutral line in plasma sheet, thermal energy flux is generally greater than kinetic energy flux, because thermal energy is large and Much number is less than unity. The kinetic energy flux firstly becomes small and the thermal flux does secondly when plasma high speed flows come close to the earth from the neutral line. Poynting flux survives finally and approaches near the earth in the plasma sheet and then carries the energy from nightside to dayside.

At the same time, as the solar wind and IMF becomes abnormal conditions, plasma turbulence are strongly excited in boundary layers on 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 is formed for northward IMF. It is because velocity shear created between the magnetosheath fast flow and magnetopause slow flow. On the other hand, sunward fast flow is produced by tail reconnection for southward IMF. Therefore two types of velocity shears created outside and inside of the magnetopause to excite Kelvin-Helmholtz instabilities in both sides. Moreover 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 of simulation results to

discuss relationship between the currents and vortices in boundary layers.

Keywords: MHD simulation, energy budget, interplanetary magnetic field, magnetic reconnection, magnetospheric dynamics, boundary layer instabilities

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PEM30-02 Room:304 Time:May 24 14:00-14:15

Propagation characteristics of ULF waves into middle latitude driven by solar wind dynamic pressure pulses

MATSUSHITA, Toshinori[1*], SEKI, Kanako[1], NISHITANI, Nozomu[1], KIKUCHI, Takashi[1], MIYOSHI, Yoshizumi[1], HORI, Tomoaki[1], TERAMOTO, Mariko[1], Henri Reme[2], Howard Singer[3], Vassilis Angelopoulos[4]

[1]STEL, Nagoya University, [2]IRAP, CNRS, France, [3]SWPC, NOAA, USA, [4]UCLA, USA

Many ULF waves (Pc5) in the magnetosphere are directly driven by the solar wind. It has been considered that these magnetospheric ULF waves are generated either directly on the dayside by solar wind dynamic pressure pulses, Kelvin-Helmholtz surface waves, or indirectly on the nightside by mechanisms like substorms. ULF waves can play an important role in mass and energy transport within the inner magnetosphere. It is well known that energetic particles in the inner magnetosphere can be significantly affected by ULF waves and many studies have suggested their importance in acceleration process of radiation belt electrons. One outstanding problem in ULF studies is to clarify their global characteristics, especially, how energy is transported from the solar wind to the magnetosphere, and finally to the ionosphere.

We have conducted a survey of high-intensity ULF waves observed around 45 deg MLAT by the SuperDARN Hokkaido HF radar at middle latitudes. The ULF events can be categorized into two types in terms of the solar wind velocity, i.e., high- and low-speed solar wind events. In this study, we focus on a low-speed solar wind event on January 31, 2008 to investigate propagation characteristics of the ULF waves based on multi-point observations from geospace to the ground. The SuperDARN Hokkaido HF radar observed the ULF wave at 3.9mHz at about 14:40UT and at 2.6mHz at about 15:30 at MLT=02:00. In this event, the Cluster spacecraft, located at (X,Y,Z)=(15.8,8.9,-9.4) Re in GSM coordinates, observed pressure pulses driven by the high-density solar wind. The propagation time from Cluster to the ground (radar location) was about 400 seconds. In the magnetosphere, GOES-11 and GOES-12 were at 05:40 and 09:40 MLT at geosynchronous orbit, respectively. THEMIS A and D satellites were located on the nightside at (-5.3, 3.2, -1.5) and (-7.1, -5.0, -2.4) Re, respectively. We will report characteristics of the global propagation of the ULF waves obtained from the time delays between these observations.

PEM30-03 Room:304 Time:May 24 14:15-14:30

Estimation of the spatial structure of the plasmasphere using a data assimilation technique

NAKANO, Shin'ya[1*], FOK, Mei-Ching[2], BRANDT, Pontus[3], HIGUCHI, Tomoyuki[1]

[1]The Institute of Statistical Mathematics, [2]NASA Goddard Space Flight Center, [3]The Johns Hopkins University Applied Physics Laboratory

The plasmasphere is the region of cold dense plasma in the inner magnetosphere. The spatial structure of the plasmasphere is significantly controlled by the electric field in the inner magnetosphere. Therefore, in order to discuss the dynamics of the plasmasphere, it is important to understand the spatial distribution of the electric field in the inner magnetosphere. However, in the magnetosphere, it is basically difficult to observe the static electric field. We are developing a data assimilation technique which incorporates the imaging data of extreme ultra-violet (EUV) from the IMAGE satellite into a two-dimensional fluid model of the plasmasphere using an ensemble Kalman filter. By combining a sequence of EUV images and the dynamic model the plasmasphere, we can estimate the spatial distribution of the electric potential as well as the plasmaspheric plasma. We will overview our approach and demonstrate some examples of the estimates obtained by this approach.

Keywords: plasmasphere, data assimilation, magnetospheric electric field

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PEM30-04 Room:304 Time:May 24 14:30-14:45

Preliminary report of VLF Campaign observation with High-resolution Aurora Imaging Network (VLF-Chain) over Canada

SHIOKAWA, Kazuo[1*], IEDA, Akimasa[1], MIYOSHI, Yoshizumi[1], YOKOYAMA, Yu[1], NOMURA, Reiko[1], LEE, Sungeun[1], Mitsunori Ozaki[2], Kazumasa Ishizaka[2], YAGITANI, Satoshi[2], KATAOKA, Ryuho[3], TSUCHIYA, Fuminori[4], ASAMURA, Kazushi[5], Martin Connors[6], Ian Schofield[6]

[1]Solar-Terrestrial Environment Laboratory, Nagoya University, [2]Kanazawa University, [3]Tokyo Institute of Technology, [4]Tohoku University, [5]Institute of Space and Astronautical Science, [6]Athabasca University

Whistler-mode waves in the VLF/ELF frequency range interact with high-energy (~10 keV) electrons to cause diffuse and pulsating auroras, and with MeV electrons in the radiation belts. However, simultaneous high-time resolution measurements of aurora and these waves have previously not been done sufficiently. We made a campaign observation of such high-time resolution measurements at Athabasca (54.72N, 246.69E, MLAT=61.3) and Fort Vermillion (58.38N, 243.99E, MLAT=64.5) using two loop antennas and several auroral cameras for February 16-26, 2012. The loop antennas at both stations measure east-west and north-south magnetic field variations with a sampling rate of 100 kHz. The panchromatic all-sky cameras at both stations measure auroras with a sampling rate of 30 Hz. The sampling timings of both instruments are corrected by GPS receivers. In addition we installed an oblique looking narrow-FoV EMCCD camera at Athabasca with a sampling rate of 100 Hz, to measure height variation of pulsating aurora. At Athabasca, routine measurements by an induction magnetometer, a proton photometer, an all-sky airglow imager, LF standard wave receiver, were also carried out. We also tried to compare these observations with satellite measurements by REIMEI, THEMIS, NOAA, and DMSP. In this presentation we will show preliminary results obtained from this comprehensive campaign of aurora and radio wave measurements at subauroral latitudes.

Keywords: whistler-mode waves, pulsating aurora, Pc1 geomagnetic pulsations, wave-particle interaction, subauroral latitudes, ground-based observation

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PEM30-05 Room:304 Time:May 24 14:45-15:00

Rising tone chorus emissions without a gap at half the gyrofrequency observed on THEMIS

KURITA, Satoshi[1*], KATOH, Yuto[2], OMURA, Yoshiharu[3], MISAWA, Hiroaki[1]

[1]PPARC, Tohoku Univ., [2]Geophysics, Sci, Tohoku Univ., [3]RISH, Kyoto Univ.

Whistler-mode chorus emissions often consist of discrete rising tone elements in the typical frequency range from 0.1 to 0.8 fce with a gap at 0.5 fce, where fce is the equatorial electron gyrofrequency. The emissions below and above 0.5 fce are called lower- and upper-band chorus emissions, respectively. Based on the duct propagation characteristics of whistler-mode waves, Bell et al. [2009] showed that the gap at 0.5fce can be formed if the lower-and upper-band chorus waves are generated within the enhanced and depleted plasma density region, respectively. While Omura et al. [2009] has suggested that a rising tone chorus element is once generated near the magnetic equator through the nonlinear wave growth mechanism in the purely parallel direction, and that the gap at 0.5 fce is formed by the nonlinear wave damping effect during its propagation away from the equator with a slightly oblique wave normal angle, resulting in the separation of the chorus element into the lower-band and upper-band chorus emissions. Based on the nonlinear wave growth mechanism, chorus emissions without a gap at 0.5 fce are expected to be observed in the source region. In this presentation, we report the presence of rising tone chorus emissions without the gap at 0.5 fce observed by the searchcoil magnetometer (SCM) onboard the THEMIS spacecraft. The propagation angles of the chorus emissions are almost along the background magnetic field in the entire frequency range, indicating that the chorus emissions are observed in the source region. The frequency sweep rates are estimated based on the nonlinear wave growth theory using the observed wave amplitudes and plasma parameters during the observation. We compare them with the instantaneous frequency variation of the elements derived from the SCM data and show that the estimated sweep rates well agree with the observed frequency variations. Furthermore, the frequency profiles of the wave amplitude of the elements are compared with the optimum amplitude proposed by Omura and Nunn [2011]. The comparison shows reasonable agreement between the theory and the observations. These results provide strong observational evidence of the nonlinear wave growth mechanism for the generation of rising tone chorus emissions.

Keywords: whistler-mode chorus, inner magnetoshere, wave-particle interaction

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PEM30-06 Room:304 Time:May 24 15:30-15:45

Seasonal variations of Saturn's auroral acceleration region deduced from spectra of auroral radio emissions

KIMURA, Tomoki[1*], LAMY, Laurent[2], TAO, Chihiro[1], BADMAN, Sarah V.[1], CECCONI, Baptiste[2], ZARKA, Philippe[2], MORIOKA, Akira[3], MIYOSHI, Yoshizumi[4], KASABA, Yasumasa[3], MARUNO, Daichi[3], FUJIMOTO, Masaki[1]

[1]JAXA/ISAS, [2]LESIA, Paris Observatory, [3]Graduate school of science, Tohoku University, [4]Solar Terrestrial Environment Laboratory, Nagoya University

Multi-instrumental surveys of Saturn's magnetosphere by Cassini have indicated that auroral radio emissions (Saturnian Kilometric Radiation, SKR), aurorae at UV and IR wavelengths and Energetic Neutral Atoms (ENA) from the inner magnetosphere exhibit periodic behavior at around Saturn's rotational period with the north-south asymmetry and seasonal variations [e.g., Gurnett et al., 2010; Mitchell et al., 2009; Nichols et al., 2010]. These rotationally periodic phenomena suggest that the magnetosphere-ionosphere coupling process and associated energy dissipation process (aurora & SKR) are dynamically dependent on both magnetospheric rotations and long-term conditions of the magnetosphere/ionosphere.

To reveal the global view of this M-I coupling process, this study investigated seasonal variations of Saturn's auroral acceleration region, which is the interface between the ionosphere and magnetosphere, based on a sufficient data volume of SKR observed by Cassini's Radio and Plasma Wave Science (RPWS) experiment. Morioka et al. [in press] investigated the spatial distribution of the auroral acceleration region along polar magnetic field lines based on spectra of the terrestrial auroral kilometric radiation (AKR). By application of this approach to Saturn, we deduced the height distribution of the auroral acceleration region in the northern and southern hemispheres from SKR spectra acquired during 2004 to 2010. It was found that the southern (summer) SKR spectral density was 10db greater at the peak altitude (~0.9Rs) on average, and harder than in the northern (winter) hemisphere. In addition, the southern and northern spectral densities became comparable with each other around equinox. These results suggest stronger field aligned acceleration and current in the southern hemisphere than north depending on season. The main infrared (H_3^+) auroral oval in IR was similarly more intense in the southern summer hemisphere than in the north [Badman et al. 2011]. Badman et al. [2011] suggested that greater conductivity in the southern polar ionosphere could result in greater precipitating electron flux and/or Joule heating, which are responsible for the stronger southern IR auroral emissions. The north-south asymmetric acceleration region deduced from SKR will be further compared with ionospheric and magnetospheric parameters (e.g., electron density, temperature, conductivity). Finally, comparative discussions of M-I coupling process between Saturn and Earth will also be presented.

Keywords: magnetosphere-ionosphere coupling, Saturn, aurora, radio emissions

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PEM30-07 Room:304 Time:May 24 15:45-16:00

Universal time control of inverted-V acceleration

MORIOKA, Akira[1*], MIYOSHI, Yoshizumi[2], KURITA, Satoshi[1], KASABA, Yasumasa[3]

[1]Planet. Plasma Atmos. Res. Cent., Tohoku Univ., [2]STEL, [3]Dept. of Geophysics, Tohoku Univ.

It has been demonstrated that the spectral behavior of auroral kilometric radiation (AKR) exhibits structure and dynamical evolution of auroral acceleration region along the field line. The auroral acceleration process at substorm onset, revealed from the AKR spectral analyses, showed basically two stages: (1) appearance/intensification of a low-altitude acceleration region at 4000-6000 km accompanied by initial brightening and (2) breakout of high-altitude field-aligned acceleration above the pre-existing low-altitude acceleration region at 6000-12,000 km, which is followed by auroral breakup and poleward expansion.

The former (low-altitude acceleration region) corresponds to so-called inverted-V acceleration, and it appears not only at substorm time but also during the day. We show, in the present study, that the altitude of the inverted-V acceleration varies systematically during a day, that is, UT variation. The systematic variation changes its phase of 180o around equinox. The possible cause of the altitude variation and its phase change can be (1) ionospheric origin due to daily variation of solar illumination in the polar region and/or (2) magnetospheric origin due to the rocking motion of the geomagnetic field in the magnetosphere. In the presentation, the evaluation of these possibilities will be given.

Keywords: inverted-V acceleration region, aurora, M-I coupling region, substorm, UT control, AKR

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PEM30-08 Room:304 Time:May 24 16:00-16:15

Aurora surge at poleward boundary of aurora zone related to Pi2-associated bi-directional flows

SAKA, Osuke[1*], Kanji Hayashi[2]

[1]Office Geophysik, [2]University of Tokyo

From the statistical analyses of Pi2-associated geomagnetic field changes and plasmas at the geosynchronous altitudes, occurrence of the diversion of the fast earthward flows has been suggested (1). We found a possible manifestation of the flow diversion in aurora (2).

Summares of the aurora observations are:

(1) Poleward surges propagating eastward/westward along a thin and narrow aurora arc were observed in the invariant latitudes from 68 to 74 degrees.
(2) The poleward surge repeated at Pi2 periodicities.
(3) The propagation direction of the surge correlated to the sense of Pi2 polarizations (CW/CCW) at geosynchronous altitudes.
(4) Multiple occurrence of the surge was found at adjoining sectors.

From those observations, we concluded:

(1) The bi-directional flows passing at the outer boundary of the inner magnetosphere generated Pi2 polarizations at the geosynchronous altitudes.
(2) Poleward surge was an auroral manifestation of the plasma instabilities, such as Ballooning-Interchange instabilities, in the directed flows.
(3) The mechanism that repeated the poleward surge at Pi2 periods was not related to the FLR.

References:
(1) First 10 min intervals of Pi2 onset at geosynchronous altitudes during the expansion of energetic ion regions in the nighttime sector (Saka, Hayashi, Thomsen, JASTP, 2010).
(2) Periodic aurora surge propagating eastward/westward at poleward boundary of aurora zone during the first 10 min intervals of Pi2 onset (Saka, Hayashi, Koga, JASTP, 2012).

Keywords: Aurora, Diversion of fast earthward flow, Pi2

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PEM30-09 Room:304 Time:May 24 16:15-16:30

Fine scale structures of pulsating auroras in early recovery phase of substorm

NISHIYAMA, Takanori[1*], SAKANOI, Takeshi[1], MIYOSHI, Yoshizumi[2], KATAOKA, Ryuho[3], KATOH, Yuto[4], ASAMURA, Kazushi[5], Donald Hampton[6], OKANO, Shoichi[1]

[1]Planetary Plasma and Atmospheric Research Center, Graduate School of Science, Tohoku University, [2]Solar-Terrestrial Environement Laboratory, Nagoya University, [3]Tokyo Institute of Technology, [4]Department of Geophysics, Graduate School of Science, Tohoku University, [5]Institute of Space and Astronautical Science, Japan Aerospace Exploration Agency, [6]Geophysical Institute, University of Alaska Fairbanks, Fairbanks, Alaska, USA

We have carried out ground-based observations optimized to temporal and spatial characteristics of pulsating auroras (PAs) in micro-meso scale, using an Electron Multiplying Charge Coupled Device (EMCCD) camera with a narrow field of view corresponding to 100km x 100km at altitude of 110 km and high sampling rate up to 100 frames per second. Transient pulsating auroras propagating southward around 1100 UT, in early recovery phase of the substorm, on 4 March 2011 are focused on in this paper. Three independent PAs (PA1-3) with each different periods between 4 and 7s were observed by our EMCCD camera, which means that the periodicity was not bounce motion and strongly depended on local plasma conditions in the magnetosphere, corresponding to 2300 km x 2300 km, or the ionosphere. One more insight is that only PA1 had also a sharp peak of modulations around 1.5 Hz, with a narrow frequency width of 0.30 Hz. In addition, the strong modulations existed as a small spot in the center of PA1, and the spatial distributions of modulations were presented for the first time in this work. We also conducted cross spectrum analysis and obtained coherence and phase maps for auroral variations between 0.1 and 3.0 Hz in order to investigate and quantify the dynamics inside pulsating auroras. The results indicated that low frequency variations from 0.2 to 0.5 Hz inside PA1-3 propagated as a group of flows in the particular directions. The estimated flow velocities were ranged from 80 to 150 km/s at the auroral altitude, corresponding to between 1800 and 3500 km/s at the magnetic equator.

Keywords: Inner magnetosphere, Aurora, Substorm, Wave-particle interactions, Ground observations