Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

PEM30-P01 Room:Convention Hall Time:May 20 18:15-19:30

Low-frequency waves in the near-Earth magnetotail before substorm dipolarization onsets

Yukinaga Miyashita[1*], Miho Saito[1], Yasutaka Hiraki[2], Shinobu Machida[3]

[1]STEL, Nagoya Univ., [2]National Institute for Fusion Science, [3]Dept. of Geophys., Kyoto Univ.

Dipolarization which occurs in the near-Earth magnetotail is an important process for understanding the substorm triggering mechanism. In the present study we have investigated low-frequency waves that were observed at X˜-10 Re before substorm dipolarization onsets. First, we analyzed Geotail data for 43 substorm events. We find that there are small-amplitude Alfven and slow-mode magnetosonic waves with a period of 1-2 min from at least 10 min before dipolarization onset. These waves substantially grow after onset. The amplitude of the waves before onset is relatively large in the off-equator plasma sheet and the plasma sheet boundary layer, while it is smaller at the equator and in the lobe. We also analyzed multi-point observations from THEMIS. Based on these results, we discuss the relationship between the low-frequency waves, dipolarization, and substorm expansion onset.

Keywords: substorm, magnetotail, dipolarization, low-frequency waves

PEM30-P02 Room:Convention Hall Time:May 20 18:15-19:30

Statistical properties of Pc5 waves in the mid-latitude ionosphere observed by the SuperDARN Hokkaido HF radar

Toshinori Matsushita[1*], Kanako Seki[1], Nozomu Nishitani[1], Takashi Kikuchi[1], Yoshizumi Miyoshi[1], Tomoaki Hori[1], Mariko Teramoto[1], Kazuo Shiokawa[1], Kiyohumi Yumoto[2]

[1]STEL, Nagoya University, [2]ICSWSE, Kyushu University

The Pc5 wave, which is one of ULF waves, is defined as the continuous pulsation in the frequency range between 1/600 and 1/150 Hz. It has been considered that the magnetospheric Pc5 waves are globally and directly generated either by solar wind dynamic pressure variations on the dayside or by Kelvin-Helmholtz surface waves on the dawn/dusk flank, and partially and indirectly on the nightside by wave-particle interactions. Pc5 waves can play an important role in the mass and energy transport in the inner magnetosphere. The radiation belt electrons in the inner magnetosphere can be significantly accelerated by the Pc5 waves, as suggested by previous studies. One of outstanding problems in Pc5 studies is to clarify its global distribution, generation mechanisms, and especially their dependence on the solar wind parameters.

We conducted a statistical analysis of data from the SuperDARN Hokkaido HF radar in mid-latitude ionosphere. The beams 5 and 14 data of the HF radar and the OMNI solar wind data for the period from January, 2007 to December, 2012 are used. We identified Pc5 wave events through an automatic Pc5 selection with criteria to extract coherent variation over a certain range of the magnetic latitude and by the visual inspection after the automatic selection. Out of the 60 events identified, and we examined 55 events during which the OMNI data are available. As a result, the Pc5 waves in the mid-latitude ionosphere are roughly categorized into two types, i.e., events under low-speed solar wind and high-speed solar wind conditions. The amplitude of the high-speed solar wind Pc5 events tends to increase with increasing solar wind velocity. This result is consistent with the idea that they are driven by the Kelvin-Helmholtz instability at the magnetopause. On the other hand, the amplitude of the low-speed solar wind Pc5 events has a positive correlation with the variances of the solar wind dynamic pressure. It is thus implied that the Pc5 events under the low-speed condition in the low-latitude are directly driven by the solar wind dynamic pressure variations.

Keywords: inner magnetosphere, ULF wave, SuperDARN Hokkaido HF radar, Pc5 wave

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PEM30-P03 Room:Convention Hall Time:May 20 18:15-19:30

Calibration of the KAGUYA/WFC data for AKR polarization analysis

Kazuaki Uda[1*], Yoshitaka Goto[1], Yoshiya Kasahara[1]

[1]Kanazawa University

The KAGUYA spacecraft frequently observed auroral kilometric radiations (AKR) which were originated from the Earth's auroral region. It is well-known that the AKR is dominated by right-handed (R-X) mode wave with small contribution of left-handed (L-O) one. Observation probability for magnetic local time and latitude, intensity, frequency range depend on the polarizations. The KAGUYA mission gave a good opportunity to make a stochastic analysis of such dependences from lunar orbits.

The WFC was a plasma wave receiver onboard the KAGUYA spacecraft. The frequency sweep receiver WFC-H, which was a subsystem of the WFC, continuously observed power spectrum and polarizations of waves in a frequency range from 1 kHz to 1 MHz during the whole mission period. However, there is a serious problem in the obtained polarization data. Because of differences of onboard-processing timings between two orthogonal antennas X and Y, the polarization data cannot be used at all. In the present study, we develop a calibration method on these data to derive exact AKR polarizations.

The processing time lag between X-Ych was caused by asynchronous operation of two onboard ICs called PDCs (programmable down converters) which were assigned to X-Ych signals, respectively. The role of the PDCs is to divide the frequency range from 1 kHz to 1 MHz into 26 narrow bands.

In order to estimate the time (phase) differences between X-Ych signals in these bands, we used overlapped-frequency range data in the adjacent two bands. We statistically calculated differences of the "XY phase difference" in the adjacent two bands. As a result, the differences had linear property for frequency, which means that the time lags between X-Ych are constant in all the 26 narrow bands. The delay time of Ych signal to Xch one is 1.1 microseconds. We also estimated time delays of three low pass filters in the PDC in each narrow band. According to these results, all the WFC-H polarization data can be calibrated.

Before calibration, the polarization depends on only the frequency. This result seems strange because the AKR polarization is stable for frequency in principle. After calibration, on the other hand, the polarization depends only on time and exhibits a 2-hour periodicity. This result is reasonable because the arrival direction of the AKR varies depending on the satellite attitude. Using the calibrated data, we obtained the AKR polarizations for ambient magnetic field. It is possible to study the AKR polarizations propagating from the northern and southern hemispheres independently using the occultation of the Moon.

Keywords: KAGUYA, AKR, calibration

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PEM30-P04 Room:Convention Hall Time:May 20 18:15-19:30

Poloidal component of Pi2 in the meridian planes

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

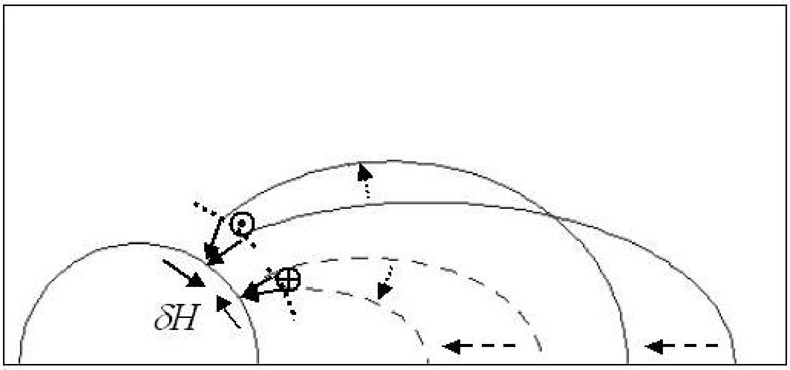
[1]OFFICE GEOPHYSIK, [2]University of Tokyo

It is well known that Pi2s demonstrate the reversal of the H amplitudes and polarization in H-D plane in auroral zone. Recently, it is shown that these characteristic Pi2 properties are attributed to the poloidal component (∗). We emphasize:

(1) The poloidal component related to the H amplitude reversal on the ground was excited by the diamagnetic currents in the magnetosphere flowing eastward.
(2) The onset latitudes of the poleward expansion inferred from auroral observations and diamagnetic currents in the magnetosphere are correlated.

References
∗ Saka, Hayashi, Koga, (JGR, 2012).

Keywords: Pi2 pulsation, aurora breakup, substorm, poloidal component



Deformation of field lines in the meridian planes

Japan Geoscience Union Meeting 2013
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PEM30-P05 Room:Convention Hall Time:May 20 18:15-19:30

Multi-scale temporal variations of pulsating auroras: on-off pulsation and a few-Hz modulation

Takanori Nishiyama[1*], Takeshi Sakanoi[1], Yoshizumi Miyoshi[2], Donald L. Hampton[3], Yuto Katoh[4], Shoichi Okano[1]

[1]Planet. Plasma Atmos. Res. Cent., Tohoku Univ., [2]Solar-Terrestrial Environment Laboratory, Nagoya Univ., [3]Geophysical Institute, University of Alaska Fairbanks, [4]Department of Geophysics, Graduate School of Science, Tohoku University

Pulsating aurora (PA) is characterized by the periodically changing emission amplitudes with on-off pulsations of less than 1 s to a few tens of seconds. PA is also well-known as its patchy structure with the horizontal size of 10-200 km. The energy of precipitating electrons ranges from one to a few tens of keV, which is thought to result from pitch angle scattering due to wave-particle interactions near the magnetic equator. Recently, Nishimura et al. [2010] found a one-to-one correspondence between the intensities of PA and amplitudes of whistler mode chorus near the equator. Similarly, electron cyclotron harmonics (ECH) were observed with on-phase of PA. ULF wave is expected to control the excitation of both the whistler mode chorus and ECH by the modulation of the local plasma density. However, an important problem, identifying which mechanism is the most dominant, remains unsolved. In addition, since PA has the distinctive properties in a variety of spatial and temporal scales, we should investigate such multi-scale properties statistically to further understandings of the generation mechanism of PA. The purpose in this study is to reveal the precise spatial-temporal properties and to establish a generation mechanism of PA using ground-based instruments. We developed an EMCCD camera with a wide field-of-view (FOV) and 100-Hz sampling, which is optimized to spatio-temporal properties such as the small-scale structures ($<$ 10-30 km) and rapid temporal variations (3-Hz modulations) in a 2-D plane.

The statistical study on the cross-scale properties was presented based on 53 events observed at Poker Flat Research Range during the period from December 1st, 2011 to March 1st, 2012. The observed modulation frequency ranged from 1.5 to 3.3 Hz. Any strong modulations were not seen in frequency range higher than about 3 Hz in our study, which may suggest that the TOF of electron makes the time-smoothing effect on the rapid variations higher than 3 Hz. Furthermore, the frequency of modulation showed relatively strong correlation to auroral intensity with the correlation coefficient of 0.52, and it can be explained with non linear wave growth theory suggesting that higher modulation frequency with larger wave amplitude of whistler mode chorus. In contrast, the on-off pulsations showed no significant correlations with any of other properties of PA. This result implies that the on-off periods may be determined by the balance of a variety of factor, such as a spatial size on the flux tube, a drift velocity of an energetic electron. Alternatively, long-term variations of the cold plasma density would control the condition for wave-particle interactions in the temporal scale of the on-off pulsation periods.

Keywords: Aurora, Inner magnetosphere, Wave-particle interactions, Ground-based observations, ULF waves

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PEM30-P06 Room:Convention Hall Time:May 20 18:15-19:30

Simulation on the IMF Bz control of the chorus wave excitation during the high-speed coronal hole streams

Yoshizumi Miyoshi[1*], Vania Jordanova[2], Ryuho Kataoka[3], Yuto Katoh[4], Michelle Thomsen[2]

[1]STEL, Nagoya University, [2]Los Alamos National Laboratory, [3]Tokyo Institute of Technology, [4]Tohoku University

Electron flux of the outer belt tends to increase when the high-speed solar wind interacts with the magnetosphere. The flux enhancement depends not only on the solar wind speed but also on the offset in the north-south component of the interplanetary magnetic field, i.e. the southward offset causes larger flux enhancement than the northward offset, although large-amplitude Alfvenic fluctuations always exist in the high-speed solar wind. If the acceleration process of the outer-belt electrons via the whistler-wave particle interaction is dominant, the populations of hot electrons, plasmasphere, and whistler waves enhance all together during the SBz stream, while they weakens all together during the NBz stream. We have observationally shown the north-south IMF dependence. In this study, we use the relativistic-RAM electron model to confirm the north-south IMF dependences of the key parameters. The data measured by LANL/MPA is used as a boundary condition at L=6.6. As a result, in the SBz stream, there are enhancements of hot electrons of ~30 keV and lower-band whistler mode waves around L=4 at dawn-side, while they are at L>5 in the NBz stream. It is found that, in our simulations, these differences are primarily originated from the magnetospheric convection. We further discuss an assessment of non-linear whistler wave growth based on the threshold of the non-linear growth and the optimum wave amplitude [Omura and Nunn, 2011]. The regions for the non-linear growth are different from that for the intense linear growth. The assessment of non-linear whistler wave growth is useful to identify when and where we can observe chorus waves.

Keywords: inner magnetosphere, whistler chorus, simulation, solar wind - magnetosphere coupling

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PEM30-P07 Room:Convention Hall Time:May 20 18:15-19:30

Use of magnetic field measurements as an indicator of spacecraft locations

Satoshi Kurita[1*], Hiroaki Misawa[1], Christopher M. Cully[2], Olivier Le Contel[3], Uli Auster[4], John Bonnell[5], Vassilis Angelopoulos[6]

[1]Planet. Plasma Atmos. Res. Cent., Tohoku Univ., [2]University of Calgary, Canada, [3]Laboratoire de Physique des Plasmas, France, [4]IGEP, TUBS, Germany, [5]SSL, UCB, USA, [6]IGPP, UCLA, USA

It is known that the configuration of the magnetosphere is more complicated than that of the intrinsic magnetic field only due to highly dynamical and time-dependent magnetospheric currents. There are empirical magnetospheric models derived from statistical analysis of large data sets. However, the models give us average states, which often results in deviation from instantaneous magnetospheric configurations. It is important to construct a technique to show where spacecraft is located in the magnetosphere, especially, how far from the magnetic equator spacecraft is when we interpret the observational results since the distance from the equator is a significant controlling factor for evolution of plasma temperature anisotropy and plasma wave intensities. In this study, using the data obtained by the THEMIS spacecraft, we show a simple method to estimate spacecraft location relative to the magnetic equator using local magnetic field measurements. The method uses the ratio of Br to |B|, where Br and |B| is the radial component of the magnetic field vector and total magnetic field intensity, respectively. When we choose a simple dipole magnetic field as a reference, we can analytically estimate the magnetic latitude from the measured ratio Br/|B|. Since rising tone chorus emissions are generated in the region close to the magnetic equator and propagate higher latitudes in both the Northern and Southern hemispheres, the method was tested by deriving the latitudinal distribution of propagation direction of rising tone chorus emissions measured by THEMIS. We analyzed 246 rising tone chorus events and statistically derived the latitudinal distribution referring to both the dipole magnetic latitude and the magnetic latitude estimated by Br/|B|. The latitudinal distributions based on the dipole magnetic latitude and estimated magnetic latitude show that 77 % (190 events) and 98 % (241 events) of the events are observed to propagate from the equator to higher latitudes, respectively. It indicates that the magnetic latitude based on the magnetic field measurements is more reliable than the dipole magnetic latitude to show the spacecraft location relative to the magnetic equator. We will test and discuss the performance of our method by comparing the latitudinal distribution of propagation direction of chorus emissions based on the estimated magnetic latitude with that based on the empirical magnetospheric models. We will also discuss capabilities of the method and applications to magnetospheric studies, especially plasma wave phenomena.

PEM30-P08 Room:Convention Hall Time:May 20 18:15-19:30

Long-Term variations of Saturn's Auroral Radio Emissions by the Solar Ultraviolet Flux and Solar Wind

Tomoki Kimura[1], Chihiro Tao[1*], Sarah Badman[1], Satoshi Kasahara[1], Akira Morioka[2], Yoshizumi Miyoshi[3], Daichi Maruno[2], Yasumasa Kasaba[2], Masaki Fujimoto[1]

[1]Institute of Space and Astronautical Science, Japan Aerospace Exploration Agency, [2]Graduate school of science, Tohoku University, [3]Solar-Terrestrial Environment Laboratory

The long-term variations of Saturn's auroral current system have been suggested to be controlled by the seasonal variations of the polar ionospheric conductivities and atmospheric conditions associated with the solar ultraviolet (UV) flux. However, that long-term variations are not investigated in terms of the other controlling factors such as the solar wind variations in the timescale of the solar cycle. This study investigated the long-term variations of Saturnian Kilometric Radiations (SKR) as a proxy of the auroral current, which were observed by Cassini's radio and plasma wave experiment mostly during the southern summer (DOY 001, 2004 to DOY 193, 2010). We deduced the height distribution of the SKR source region in the northern (winter) and southern (summer) hemispheres from the remote sensing of SKR spectra. It was found that on average the southern (summer) SKR was 7 dB grater than the north (winter) in the spectral density, and the altitude of the southern flux peak (0.7 Rs) was lower than the north (0.9 Rs). The southern and northern spectral densities became comparable with each other around the equinox in August, 2009. These results suggest the stronger field aligned acceleration during the summer than the winter by the seasonal UV effect as opposed to the terrestrial one. The long-term correlation analysis was performed for the SKR and solar wind parameters extrapolated from Earth's orbit by the MHD simulation focusing on variations at timescales beyond several weeks. We found the clear positive correlations between the solar wind parameters and peak flux density in both of the southern and northern hemispheres during the declining phase of the solar activities. It is concluded that the solar wind variations in the timescale of the solar cycle controls the SKR source region in addition to the seasonal solar UV effect. The variation of SKR activity over both seasonal and solar cycles are discussed comparatively to the terrestrial case.

Keywords: Saturn, aurora, radio, magnetosphere, solar activity

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Importance of correctly removing the underground-conductivity effect in the gradient methods

Hideaki Kawano[1*], PILIPENKO, V. A.[3], MANN, I. R.[4], MILLING, D. K.[4]

[1]Dept. Earth Planet. Sci., Kyushu Univ., [2]International Center for Space Weather Science and Education, [3]Institute of the Earth Physics, Russia, [4]Department of Physics, University of Alberta, Canada

There are methods called the hodograph method and the amplitude-phase gradient method (APGM below) that are used to obtain the latitude dependence of the field-line-resonance (FLR) frequency by using data from two ground magnetometers latitudinally separated by ~100km. They both apply FFT to the two magnetometers' data, and calculate the amplitude ratio and the cross phase between the two stations' data as functions of the frequency. From there the two methods use different ways to estimate the latitude dependence of the FLR frequency; the hodograph method fits a circle to the obtained ratio (as a complex number including both the amplitude ratio and the cross phase) to separate out the non-FLR signal in the data, while APGM assume that the obtained amplitude ratio and phase difference include no non-FLR signal and obtains the FLR frequency (as a function of latitude) in an algebraic manner. In this paper we discuss the differences between the two methods by using example events, and show that the both methods need precise enough removal of the effects of the underground conductivity, superposed on the signal from space, in the magnetic field data before applying the method. More details will be presented at the meeting.

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Characteristics of energy conversion and electron acceleration around the fast plasma flows in near-Earth magnetotail

Tatsuya Shikiji[1*], Taku Takada[1]

[1]Electrical Engineering and Information Science, Kochi National College of Technology

Fast earthward flows accompanied by large B_Z enhancement, are sometimes observed in the near-Earth magnetotail. Such B_Z enhancements are called "dipolarization front". In some cases, earthward flows are instantly followed by the tailward flows. We call such events as "flow reversal", where the earthward flow seems to reverse to the tailward flow. However, the energy conversion and electron acceleration mechanisms during the flow are not fully understood. In this study, the two types of events were analyzed using THEMIS spacecraft data from Dec., 2008 through Mar., 2009. The number of events is 25 for dipolarization front events [1] and 16 for flow reversal events. Based on the results of j dot E and electron distribution function, we discuss energy conversion and electron acceleration mechanisms during the dipolarization front events or flow reversal events.

[1] A.Runov, V.Angelopoulos, X.-Z.Zhou, X.J.Zhang, S.Li, F.Plaschke and J.Bonnell, A THEMIS multiscale study of dipolarization fronts in the magnetotail plasma sheet, J. Geophys. Res., 116, A05216, 2011.

Keywords: energy conversion, fast plasma flow, electron distribution function