Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

PEM031-P01 Room:Convention Hall Time:May 26 14:00-16:30

Relationship between Solar and Seismic Activities

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Solar activities play significant roles in electromagnetic coupling of the Sun-Earth system. By comparing the 11-year sunspot cycles and earthquake events during 1963 to 2010 period, it is possible to reveal the correlation of solar and seismic activities. In the present paper, the monthly values of sunspot cycles number 20 to 23 and earthquake events at different magnitude scales were analyzed to examine the relationship of these values and to understand the coupling mechanisms in solar and geomagnetic activities. The sunspot numbers are obtained from Marshall Space Flight Center, NASA database, and earthquake events are extracted from Advanced National Seismic System (ANSS) database. We found a significant correlation between high speed solar wind (velocity greater or equal to 500 km/s) and great earthquake events (magnitude greater or equal to 8.0 Richter scale). We will discuss the statistical results in details.

Keywords: 11-year sunspot cycle, Earthquake event, High speed solar wind

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PEM031-P02 Room:Convention Hall Time:May 26 14:00-16:30

Spatiotemporal variations of flickering aurora obtained from imaging observations with a high-speed EMCCD camera

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We conducted high-speed imaging observations of flickering aurora at 100 Hz sampling rate using electron multiplying charge-coupled device (EMCCD) in Alaska during 2009-2010 winter season. We detected various types of flickering aurora, including drifting and rotating features at a frequency below 15 Hz. We identified, for the first time, flickering stripes and some other unusual flickering events at frequency of higher than 20 Hz on the imaging observations. A dispersion relation derived from a statistical analysis of observed images is compared with the theoretical dispersion curve of O+ electromagnetic ion cyclotron (EMIC) waves. The frequencies and spatial scales calculated from a coherence/phase analysis based on an interference theory are consistent with the wave dispersion relation derived from the statistical analysis, suggesting that the obtained results are essentially consistent with the scenario that the interference of EMIC waves produces the observed dispersion relation of flickering aurora. Furthermore, flickering frequencies higher than 20 Hz are confirmed from our observations, which are higher than expected frequency of O+ EMIC waves at altitudes of several thousands km. We therefore suggest that high frequency waves such as He+ and H+ EMIC waves may also contribute to produce a significant fraction of flickering aurora.

Keywords: Flickering aurora, EMCCD, alfven waves, EMIC waves, magnetosphere, ionosphere

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PEM031-P03 Room:Convention Hall Time:May 26 14:00-16:30

Analyses of aurora images observed from a cockpit of jet airliner

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We present a possibility of optical observations of aurora from a jet airliner flying along polar routes with an altitude of 12km. The aircraft-based optical observation from such a high altitude has several advantages comparing ground observations. The visibility above the tropopause is extremely high because of the clear and rarefied air. It is possible to detect the light of aurora down to an elevation of -2 degrees below the horizon. It means that very clear images of aurora in wide area can be observed from the aircraft.

Thousands of pictures were taken by a still camera installed just inside of a cockpit rear window of the jet airliner in the period of September 1999 to March 2005. The pictures were taken automatically every 20 seconds during night flights over the polar region. We select a number of pictures in which aurora and stars are clearly taken. Assuming an altitude of 100 km for the bottom of aurora, positions of aurora can be calculated from azimuth and elevation angles obtained from stars in the picture. We present very interesting aurora images from the cockpit, and compare them with conjugate data observed by the FAST satellite.

Keywords: aircrft observation, aurora, the FAST satellite

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PEM031-P04 Room:Convention Hall Time:May 26 14:00-16:30

Observations of large flow shears around small-scale auroral beads observed at substorm onset

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We present, for the first time, a fine-scale electrodynamic structure behind the auroral beads observed at substorm onset, as inferred from high spatial and temporal resolution measurements of substorm aurora with an all-sky TV camera (ATV) and a coherent HF radar of SuperDARN in Iceland. On the night of September 24, 2006, the ATV observed eastward propagating auroral beads in the initial brightening arc of a substorm just prior to the poleward expansion. During the sequential passage of the beads across the radar beams, the radar detected large velocity flow shears whose magnitude was in excess of 1.5 km/s. The observations suggest that flow shears were located very close to the center of the beads; thus, they corresponded to the horizontal electric fields converging toward the beads, which is consistent with the existence of upward field-aligned currents (FACs) flowing out of the beads. The temporal and spatial resolutions of the current radar measurement were still insufficient for fully resolving the detailed electrodynamic structure behind the fast moving auroral beads. At least, however, we can suggest the existence of localized filamentary FAC structures behind the beads, which played a very important role in connecting the auroral beads in the ionosphere and their source perturbation in the magnetosphere.

Keywords: Substorm, Radar Observations

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PEM031-P05 Room:Convention Hall Time:May 26 14:00-16:30

Event and statistical studies on energy and pitch angle distribution properties of electrons in Inverted-V structures

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Inverted-V electrons are accelerated by field-aligned potential difference. It is thought that these fine structures of their energy and pitch angle distribution are due to electrostatic structures and their variations. Lin and Hoffman(1979) investigated the time variations of flux ratio of downward electron component to perpendicular electron component in the Inverted-V region. There are, however, also the results which are inconsistent with the acceleration process due to field-aligned potential difference. For example, Whalen and Daly(1979) showed that the pitch angle distributions of precipitating electrons are field-aligned near the edge of an auroral arc, while they are isotropic pitch angle distributions at the center of the arc. These variations of pitch angle distributions are very interesting in terms of the existence of an additional acceleration mechanism but there are few data focused on the fine scale pitch angle distributions of Inverted-V electrons. It is also important to compare auroral emissions to pitch angle distributions for more advanced understandings of auroral acceleration region. We used the data based on Reimei simultaneous observations for auroral particles and emissions with high spatial and time resolutions in our study.

In this presentation, we will summarize statistically the variation patterns of the energy and pitch angle distribution in the Inverted-V region. We found the characteristic variations of pitch angle distribution. Energy fluxes of downward electrons are distinguished at the edges of Inverted-V structures. It is difficult to understand that electrons are accelerated along the magnetic field at these regions because the electric field is perpendicular to the magnetic field. As REIMEI moves toward the center of Inverted-V region, perpendicular energy fluxes of electrons increase and their characteristics energies increase at the same time. These signatures also exist even when field-aligned electrons by the inertial Alfven wave acceleration are not observed.

We estimated the origin of collimated electrons at the edges of Inverted-V structures and find that it is the ambient electrons existing at the altitudes of the acceleration region. These electrons are continuously supplied in the acceleration region. We analyzed the relations of these electrons and type of auroras at the edges of Inverted-V structures considering the effect of the electrostatic field-aligned potential drop. The statistical studies show that collimated electrons are observed despite types of discrete auroras. If we only think the effect of electrostatic field-aligned potential drops, we consider that the electrostatic field-aligned potential drop exists in the polar magnetosphere.

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PEM031-P06 Room:Convention Hall Time:May 26 14:00-16:30

Study of the aurora and precipitation particles before the aurora breakup: Reimei observations

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In this study, we investigated the characteristics of aurora and precipitation particles during the steady condition before auroral breakup. The statistical analysis was made, using the optical aurora, precipitation electron and ions, field-aligned currents observed by REIMEI satellite and AU/AL indices. Then we find that even in the steady condition the aurora appears depending on the global magnetospheric conditions and discuss it in detail.

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PEM031-P07 Room:Convention Hall Time:May 26 14:00-16:30

Coordinated ground and multi-satellite observations of eastward drifting auroral forms in the post-midnight sector

Tetsuo Motoba[1*], Keisuke Hosokawa[2], Yasunobu Ogawa[1], Akira Kadokura[1], Natsuo Sato[1]

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We present eastward drifting auroral forms in the post-midnight sector on 21 September 2009 and the associated in-situ signatures in the near-Earth tail. All-sky cameras (ASC) at the Iceland-Syowa geomagnetic conjugate stations observed successive eastward passage of optical auroral forms similar to omega bands. The auroral forms had dimensions of 100-200 km in longitude and less than 100 km in latitude, and an eastward propagation speed of ˜1.5 km/s. The ground magnetometer measured magnetic field fluctuation with period of ˜2 minutes and amplitude of ˜10-20 nT, which were generated by the passage of brighter auroral forms. During this interval, the Cluster satellites were located in the central near-Earth tail (X= -11˜-14 Re) conjugate to the ground-based ASCs. The Cluster 2 and 4, which were longitudinally separated by ˜7700 km in Ygsm (Cluster 2 was closer to the midnight), detected similar local magnetic field variations with a time delay comparable to the eastward propagation time of the observed auroral forms. The in-situ magnetic field variations are probably attributed to a series of oppositely directed field-aligned currents responsible for the auroral forms. In addition to the above-mentioned features, we will discuss more detailed relationship between the eastward drifting auroral forms and the counterparts in the near-Earth tail.

Keywords: arurora, ground-satellite observations, magnetotail configuration

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Intervals of pulsations of diminishing periods (IPDP) and related aurora observed at Athabasca

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Intervals of pulsations of diminishing periods (IPDP) is the geomagnetic pulsation with varying their frequency from ~100mHz to ~1Hz for about a half an hour. The mechanism of IPDP is that electromagnetic ion cyclotron (EMIC) waves excited at the equatorial region in the magnetosphere by the ion cyclotron instability propagate along the magnetic field to the Earth. Proton particles resonated with these waves also propagate to the Earth and are observed as proton auroras [e.g., Yahnin et al., 2009]. The cause to make the variation of IPDP frequency has been considered that the magnetospheric source region moves earthward by the dawn-to-dusk electric field with the enhancement of the magnetospheric convection [Kangas et al., 1998].

However, Yahnin et al. [2009] pointed out using data from ground magnetometers and the IMAGE satellite that the frequency variation calculated from the latitudinal variation of proton aurora as a projection of magnetospheric source region for IPDP is much smaller than the frequency variation of IPDP observed on the ground.

In order to investigate in more detail of the relation between the frequency variation of IPDP and the motions of proton aurora, we compared IPDP observed by a 64-Hz sampling induction magnetometer and proton auroras observed by an all-sky imager at Athabasca (ATH, 54.7N, 246.7E, magnetic latitude: 61.7N), for 6 events identified from January 2009 to December 2010. We found that proton auroras associated with IPDP appeared within less than 1 degree apart from the equatorward boundary of aurora oval and that southward motion of aurora oval is correlated with southward motion of position of proton aurora. In the presentation, we will discuss the variation of position of proton aurora, and the IPDP frequency in relation with the plasma sheet dynamics.

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Conjugate observations of field-aligned current evolution with Space Technology 5 and Greenland magnetometer chain

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It is believed the field-aligned current in the cusp and polar cap responds quickly to the change in IMF, and that a new field-aligned current state is established within several minutes. The purpose of this paper to understand what kind of a transitional state occurs during such a relatively short period of time using the magnetic field measurements from Space Technology 5 mission and the Greenland west magnetometer chain. ST5 mission is a three microsatellite constellation [e.g., Slavin et al. 2008]. Taking advantage of this constellation, we have taken several events in which the cusp/polar cap field-aligned current pattern changes above the Greenland magnetometer chain within approximately 10 min. The ground magnetometer data for these simultaneous events show that gradual variations occur beneath the change of the field-aligned current. These variations are caused by temporal change of the Hall currents, suggesting that a transitional state exists in which the electric field, which is related to the closure of the field-aligned current, evolves. We present results about the detail of the electrodynamics in this state.

Keywords: field-aligned current, ground magnetic perturbations, cusp, polar cap, IMF

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A statistical survey of terrestrial hectometric radiation generated in the topside auroral ionosphere

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The terrestrial auroral ionosphere emits electromagnetic waves in the MF and HF bands (about 1-5 MHz), some of which can reach to the ground level or escape to space. Ground-based observations indentified two types of MF/HF auroral radio emissions: auroral roar and MF burst. Both auroral roar and MF burst are usually attributed to mode-conversion radiation from upper hybrid waves generated by interaction with auroral electrons in the bottomside ionosphere. Several papers reported satellite observations of MF/HF auroral radio emissions radiating from the topside ionosphere to space: 2-MHz, 4-MHz noise [*James et al.*, 1974], terrestrial hectometric radiation (THR) [*Oya et al.*, 1985, 1990], and topside ionospheric MF/HF radio emission [*Bale*, 1999]. Recently, *Sato et al.* [2010] showed typical spectrum and polarization features of THR emissions by case studies using the Akebono satellite data. However, there is no consensus regarding their statistical characteristics and relations with auroral roar and MF burst, both of which are observable from the ground.

We analyze long-term data of the Akebono satellite, which has been operated since its launch on February 1989, for the statistical characteristics of THR emissions. The initial result is as follows: The frequency distribution shows a bimodal pattern which has a dip near 2.3-3.0 MHz and broad peaks near 1.4 MHz and 3.6 MHz. While the lower-band THR ($<$ 2.5 MHz) has a higher occurrence rate than the upper-band THR ($>$ 2.5 MHz), both have a similar distribution pattern of magnetic local time (MLT) and invariant latitude (ILAT). THR emissions are detected at any hour in MLT, and the higher occurrence is concentrated to the afternoon and nightside sectors between 12 and 01 MLT. The ILAT distribution is concentrated to the auroral latitude between 45 and 90 deg with a peak near 70-75 deg. THR emissions are detected over the entire altitude range of the Akebono satellite pass (275-10500 km). This result suggests that THR emissions are generated in the topside auroral ionosphere in the nightside sector. We will show the statistical characteristics of THR emissions, such as polarization and distributions in altitude, frequency spectrum, bandwidth, MLT, and ILAT, to examine the source region and propagation features of the THR emissions.

Keywords: auroral ionosphere, auroral radio emissions, radio propagation, plasma instability

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On the relation between particle precipitation and heat flux in the polar ionopshere

Yasunobu Ogawa[1*], Yoshimasa Tanaka[1], Tetsuo Motoba[1], Hiroshi Miyaoka[1], Akira Kadokura[1]

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We have investigated characteristics of particle precipitation and heat flux based on the European Incoherent Scatter (EISCAT) radar data. The soft particle precipitation is often accompanied by electron heating due to the heat flux from the magnetosphere, and both can be a trigger of ionospheric ion upflow. However, little is known about the relation between the particle precipitation and heat flux (for example, relative locations between them). In this paper, we show their characteristics and relations to auroras using data obtained with EISCAT and optical measurements in November 2008 and February 2011, and discuss the plausible mechanisms determining the relative locations between electron heating and auroras in the polar ionosphere.

Keywords: polar ionopshere, particle precipitation, heat flux, EISCAT

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Low energy electron observation by LEP-ESA on Norwegian sounding rocket ICI-3

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There exists large-scale plasma convection in the high latitude ionosphere such as two-cell pattern. Moen's group in Norway found the existence of Reverse Flow Events (RFEs) where plasma flow is opposite to the background convection pattern by EISCAT Svalbard Radar. RFEs are ˜100-200 km wide east-west elongated channels that have an average life time of ˜18 minutes. On the other hand, coherent HF radars obtain backscatter echoes from field-aligned plasma irregularities of decametre scale length. The strong coherent HF backscatter echoes are a well-known characteristic of the polar cusp. Although there exist several candidate processes including gradient drift instability, the generation mechanism of backscatter targets has not yet been agreed upon. The RFE phenomenon may be a very important facilitator of HF backscatter irregularities in the cusp ionosphere. Since the Reversed Flow Events (RFEs) are relatively long lived and do not move much in latitude during their lifetime, they are ideal as target for a rocket investigation. In order to prove the hypothesis that the RFE phenomenon plays an important role in plasma irregularity formation, ICI-3 sounding rocket experiment was proposed. ICI-3 will be launched in December 2011 from Ny Alesund, Svalbard, Norway. The main objective of ICI-3 is to obtain a better physical description of instabilities and wave phenomena driven by the RFEs in the winter cusp ionosphere. We are now preparing low energy electron energy spectrometer LEP-ESA for ICI-3 sounding rocket. LEP-ESA measures the electron distribution function in the energy range between 10eV and 10keV with time resolution as high as 11msec. We will report the design of LEP-ESA and its performance based on the results obtained by calibration experiment. We will also report the observation results obtained by the similar low energy electron analyzer on ICI-2 sounding rocket that was launched into cusp region in December 2008.

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Visualization model of the 3D electron density distribution and its application to remote sensing observations

Yuuki Sagawa[1*], Satoshi Taguchi[1], Yasutomo Morii[1], Kei Sasaki[1], Yuuki Harano[1], Satoshi Suzuki[1]

[1]University of Electro-communications

We have constructed a visualization model of the 3D electron density distribution in the polar ionosphere. This model is based on the empirical model of the auroral oval we have developed, and several established models regarding the precipitation energy/energy flux of the auroral particles, and the production rate, which is dependent on the altitude, have been utilized. Our visualization model shows that variable ”islands” exist in the 3D distribution. We assume that the line of sight direction of the radar passes through the island, and discuss how the island can be detected by the assumed radar.

Keywords: ionospheric electron density, auroral particles, modeling, visualization

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Interhemispheric comparison of cross-polar cap potentials

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Cross polar cap potentials in the polar ionospheres are important physical parameters showing magnetospheric conditions depending on solar wind energy input, energy dissipation in the magnetosphere and strength of plasma convection in the magnetosphere, etc. The potential drop at northern hemisphere and one at southern hemisphere is thought to be identical in the zero's order approximation. However, it is not clear whether they are always completely the same values or not because of the existence of difference in ionospheric conductivity in both hemisphere due to seasonal difference, the effect of dipole tilt angle, and asymmetries in phenomena in a variety of spatial scales between both hemispheres. In the past, some possible seasonal differences have been discussed with statistical analyses mainly using satellite data, and a recent study using SuperDARN data pointed out that an effect of dipole tilt angle on the differences, but no comprehensive physical understanding has been made yet. We here use SuperDARN data simultaneously obtained at both hemispheres from 1999 to 2006 and try to obtain essential physical understanding of this potential differences especially on dependencies on interplanetary magnetic fields, geomagnetic activities, seasons, dipole tilt angle, and substorm phases, and so on. We first show the initial results of this interhemispheric comparison this time particularly on whether the two simultaneous values show any statistical differences, and whether there exist any examples where large differences exist and discuss the possible reasons if any in detail.

Keywords: SuperDARN, Cross polar cap potential, interhemispheric, symmetry, asymmetry, polar ionosphere

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Saturation effects incorporated in the modeling of the high-latitude potential distribution

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We have developed an empirical model of the electric potentials in the high-latitude ionosphere which can express the distribution for superstorms. Our model is the numerical solution of the Laplace's equation with the boundary conditions obtained from the statistical analysis of the DE 2 electric field data, and the use of nonlinear functions for data fitting. For the determination of the boundary condition, we also used the data of the location of the precipitation particle boundary detected by DMSP spacecraft during several superstorms. The method used in our modeling can include the potential saturation effect. The model shows that polar cap potential reaches about 250 kV, which is in agreement with previous observations. Another advantage of our model is the ability to produce the distribution of the auroral oval corresponding to the potential distribution. By comparing between the potential distribution and the equatorward boundary of the modeled auroral oval, we can define the subauroral region. Our result shows that subauroral potential is large in the dusk sector, and saturated approximately at 70 kV. This is consistent with recent radar observations.

Keywords: potential, plasma convection, saturation effect, superstorms, solar wind

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Variation of Sq focus latitudes for the active sun year 2001

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Variations of Sq focus latitudes for the northern and southern hemispheres have been broadly investigated by utilizing magnetic observation networks. The relation of the Sq focus latitude and the equatorial electrojet strength has also been discussed because the electrojet results from the Sq current in the equatorial day side of the ionosphere. The day-to-day variation of the Sq focus latitude has been evaluated during the quiet days or weak disturbance days. In order to evaluate the seasonal variation of the Sq focus, the contribution of the magnetic disturbance must be as little as possible through the year. For example, Stening et al. [2007] used the data corrected for the magnetic disturbance by subtracting the Dst index for the quiet sun year 1997. The similar method using the Dst index had been applied in a study of the Japan Meteorological Agency (JMA) for the active sun year 1958 and for the quiet sun year 1964; The results, however, might have been entangled with the errors. In the previous work, we examined the characteristics of the variability in the Sq focus latitudes on data from the JMA observatories for 17 active sun years, using a wavelet analysis which retrieves the Sq variation approximately. In this study, we examine the relation between the northern and southern Sq foci during the active sun year 2001 on data from both the JMA and the INTERMAGNET: MMB, KAK, KNY, CBI, GUA, KDU, CTA, ASP, and CNB.

Our results are as follows:

1. We found the approximate-synchronization in the poleward and equatorward movements of the northern and southern Sq foci during spring and during autumn.
2. We found the out-of-phase synchronization in the poleward and equatorward movements of the Sq foci during February and during December. This result overlaps that of Stening et al. [2007].
3. We found various poleward and equatorward shifts in the Sq focus latitudes, showing a poleward shift of the northern focus in February and an equatorward shift of the southern focus in November (Stening et al., 2007).
4. The strength of the equatorial electrojet was obtained representatively from data at the Huancayo observatory. On the occasional cases that the Sq focus moves equatorward, the strength of the electrojet increases. These agree with the previous works. The poleward and equatorward shifts of the Sq foci might be correlated with the enhancements of the electrojet strength during spring and during autumn.
5. The periodicity of about 10 days (or about 30 days) in the variation of Sq focus latitudes can be directly attributed to that of the Sq variation retrieved by the wavelet analysis.

Keywords: Sq current system, Sq focus latitude, seasonal variation, equatorial electrojet, wavelet analysis

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Identification of full-substorm onset from ground-magnetometer data by singular value transformation

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Pi 2 magnetic pulsations are defined as impulsive hydromagnetic oscillations with a period of 40-150s. It is well-known that Pi 2 pulsations has one-to-one correspondence with auroral breakups (Jacobs et al., 1964; Saito, 1969; Li et al., 1998). Although Pi 2 pulsations have been accepted as a good indicator of auroral breakups, they correspond to not only full-substorm onsets but also most pseudobreakups. Hsu and MacPherron (2007) examined statistical properties of Pi 2 pulsations. They reported that the most probable number of Pi 2 bursts per substorm is 2. In the previous substorm researches, geophysical differences between pseudobreakups and full substorms have been studied. However, the physical difference in the magnetosphere and on the ground has not been clarified yet. In other words, to figure out the physical difference is a key subject for understanding the substorm onset mechanism. From this viewpoint, it is important to detect Pi 2 pulsations that correspond to full-substorm onset.

Another well-known substorm related phenomenon measured on the ground is positive bays. At the onset of the substorm expansion phase, the crosstail current is diverted down the magnetic filed lines. The current then flows in the ionosphere as the westward electrojet and returns to the tail along the magnetic field line. The perturbation of tail current can be represented by an equivalent eastward current, which completes the three- dimensional current wedge. The mid-latitude and low-latitude signature of this wedge is a positive perturbation in the north-south component. It is widely accepted that the sudden formation of the current wedge is essential to complete substorm onset. Hence, positive bays at mid and low latitudes could be an evidence for the occurrence of full substorms. From these arguments, we can say that Pi 2 pulsations accompanied by positive bays are one of the most reliable indicators of full-substorm onsets.

In order to identify full-substorm onsets from ground-magnetometer data, we propose a new algorithm to screen Pi 2 pulsations that accompanied by positive bays. As mentioned earlier, there are some works about automatic detections of Pi 2 pulsations. However, these methods are limited only to detecting wave packets. To screen Pi 2 pulsations that accompanied by positive bays, we should detect wave packets and changes of slopes simultaneously in ground-magnetometer data. Recently, singular spectrum analysis (SSA) has been used for change-point detections in time series (Moskvina and Zhigljavsky, 2003). Ide and Inoue (2005) developed the SSA-based change-point detection method, named singular spectrum transformations (SST), and showed that it was useful in knowledge discovery of causal relationships from a set of heterogeneous time series. Recently, the SST has been applied to determine the onset of positive bays (Tokunaga et al., 2010a, b). Unlike other conventional approaches, the SSA is data adaptive and does not employ any specific generative models. Further, SSA can extract simultaneously complex trends and periodic components. Hence, SSA-based change-point detection method likely fills our purpose, that is, to detect wave packets and changes of slopes simultaneously. In this paper, we introduce a new SSA-based change-point detection method, named Singular Value Transformation (SVT), to screen Pi 2 pulsations that accompanied by positive bays.

The outline of this paper is as follows. First, we describe the basic concept of SSA. Further, we introduce bay-score that provides information to determine whether the Pi 2 pulsation accompanied by the positive bay is present or not. Then, we define the framework of SVT. Next, we apply our algorithm to the ground-magnetometer data and compare the result with auroral images obtained by Polar Ultra Violet Imager (Polar/UVI). Furthermore, we evaluated the practical performance of the algorithm in a statistical study.

Keywords: substorm, positive bay, Pi 2 pulsations, SVT

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PEM031-P18 Room:Convention Hall Time:May 26 14:00-16:30

Plasma mass density profile of the inner magnetosphere estimated from the frequency of standing Alfven waves

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The study of plasma density profile in the inner magnetosphere has been based on electron and H^+ density, and the contribution of heavy ions was mostly neglected. Observations by the retarding ion mass spectrometer (RIMS) onboard Dynamic Explore (DE-1) in 1981-1982 showed that there is heavy ion enhancement near the plasmapause identified by electron or H^+. In recent years, these cold heavy ions have attracted attention of researchers as the cause of the ring current ion composition change during magnetic storms. Unfortunately, however, there are no direct observations of the ion composition profile of the plasmasphere, since the DE-1 observations in 1980s. In this study, we intend to estimate the heavy ion composition profile in an indirect method. We determined the plasma mass density profile from the fundamental frequency of the harmonic of toroidal standing Alfven waves, using magnetic field data obtained by the magnetometer on the TSUBASA satellite (MDS-1, Mission Demonstration Test Satellite-1) which had the geo-stationary transfer orbit. We obtained the plasma mass density profile over L=3-6 from around 40 orbital passes on the noon side to the dusk side. We will show statistical results and discuss the existence of the cold heavy ions.

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Simultaneous ground-geosynchronous observation of Pi 2 pulsations associated with the substorm current wedge

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The formation of a substorm current wedge (SCW) is one of the fundamental processes in the expansion phase of the magnetospheric substorm [e.g. *McPherron et al.*, 1973]. A Pi 2 magnetic pulsation always occurs at the expansion onset [*Saito*, 1969]. High- and mid-latitude Pi 2s in the *D* (east-west) component, which are observed away from the auroral breakup region, have been understood as an oscillation of the field-aligned currents (FAC) associated with SCW [*Lester et al.*, 1983; *Uozumi et al.*, 2009]. *Sakurai and McPherron* [1983] examined Pi 2s that observed at the geosynchronous orbit, and presented that the initial perturbation in the azimuthal component of a Pi 2 is in the same sense as the perturbations caused by the SCW. *Uozumi et al.* [2010] found that the ground Pi 2 timeseries had high coherencies with simultaneously observed AKR timeseries, regardless of whether the Pi 2 timeseries were associated with upward FAC or downward FAC; this fact suggests that the upward SCW and the downward SCW oscillated in a synchronized manner. This aspect was deduced from ground observations, and should be verified by a simultaneous observation on the ground and in the magnetosphere. In order to clarify the timing relation of Pi 2s that are associated with SCW oscillations, we made a comparative study by combining the ground and satellite data.

We analyzed simultaneous ground-satellite observation of Pi 2 pulsations at the ETS-VIII geosynchronous orbit (GGLon=146.0E) [*Koga and Obara*, 2008] and at MAGDAS/CPMN [*Yumoto and the MAGDAS Group*, 2006] high-, mid- and low-latitude stations, CST (GGLat.=68.5N, GGLon.=179.2E), ZYK (65.8N, 150.8E) and KUJ (33.1N, 131.2E). ETS-VIII was located in the geomagnetic southern hemisphere (GMLat = ˜ 12S), and a foot point of the magnetic field line is estimated as GGLat = 70.5N, GGLon = 152.9E by using Tsyganenko 96 model. The nearest ground station to the foot point was ZYK. We picked up Pi 2 events that exhibited a high coherency in the waveform among the ground and satellite Pi 2s. Pi 2s occurred around 1250 and 1300UT on May 5, 2008. MLT of each ground station and ETS-VIII at the occurrence of the first Pi 2 was as follows: KUJ: 21.4h, ZYK: 22.4h, ETS-VIII: 22.5h and CST: 23.6h. ETS-VIII was located at almost the same magnetic meridian as ZYK. The first Pi 2 occurred without any significant magnetic bay. The second Pi 2 was accompanied with magnetic bay signature. Characteristics of the Pi 2s are summarized as follows: (1) the initial deflection of the ground Pi 2s at ZYK and CST indicate the signature of the upward and downward FAC of the SCW, respectively. (2) Pi 2 oscillated in- or 180deg out-of-phase among the *D* (eastward) on the ground and *N* (eastward) components at the geosynchronous altitude. (3) Pi 2 oscillations in the *H* (northward) and *P* (parallel to the earth rotation axis) components exhibited phase (time) difference among them (d*T* = 10˜30s). We found other Pi 2 events that have the same characteristics.

By taking into account that the polarity of the *D* and *N* components Pi 2 oscillations were demarcated by the direction of the SCW FAC (upward or downward) and the sign of the geomagnetic latitude (northern- or southern-hemisphere), the present results suggest that the entire part of the SCW system oscillated in a synchronized manner. On the other hand, the time differences in the *H* and *P* components Pi 2 can be explained by a characteristic of Pi 2 propagation in the magnetosphere, which was examined by *Uozumi et al.* [2000 and 2009].

Keywords: Pi 2, substorm current wedge, simultaneous ground-geosynchronous observation, substorm, MAGDAS/CPMN, ETS-VIII