PEM07-01 Room:105 Time:May 22 09:00-09:15

Geospace Exploration Project ERG

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The ERG (Exploration of energization and Radiation in Geospace) is a geospace exploration project in Japan. The mission is especially focusing on the relativistic electron acceleration mechanism of the outer belt in the context of the cross-energy coupling via wave-particle interactions. The project consists of the satellite observation team, the ground-based observation team, and integrated-data analysis/simulation team. The ERG satellite will be planned to launch in 2015. The comprehensive instruments for plasma/particles, field and waves are installed in the ERG satellite to elucidate the electron acceleration processes. The newly developed system will directly measure the energy exchange between particles and waves in the wave-particle interactions. The Japanese ground-network teams join the ERG project. The integrated data analysis and simulation team is now developing the simulation tools which can be compared directly with the observations. In this talk, we will present the science objectives and current status of the project and possible collaborations with other geospace satellite missions such as Van Allen Probes, THEMIS, RESONANCE, as well as the ground-based observations and simulation studies.

Keywords: Geospace Exploration Project, Inner magnetosphere, Radiation belts, wave-particle interactions

PEM07-02 Room:105 Time:May 22 09:15-09:30

Space plasma/particle experimental suite for the Japanese Geospace exploration mission "ERG"

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The Japanese mission for the Geospace exploration was formally approved by JAXA in 2012, which is now under development toward the launch in 2016. The satellite is named "ERG", standing for the satellite observing "Energization and Radiation in Geospace", and will carry six sensors for the space plasma/particle experiment (PPE), four for electrons and two for ions. This presentation is devoted to an overview of PPE.

The space plasma/particle experimental suite (PPE) consists of XEP-e, HEP-e-H&L, MEP-e, LEP-e for the electron measurements in a wide energy range from 10 eV to 20 MeV, and MEP-i, LEP-i for the magnetospherically typical composition of ions with energies of 10 eV - 180 MeV. The first letter of each sensor name means the energy range, i.e., extremely high (X), high (H), medium (M), low (L) energy ranges. HEP-e has two types of sensor configuration to cover the higher (0.7 - 2 MeV) and lower (0.07 - 1 MeV) energy ranges of electrons with appropriate geometrical factors (larger for higher energy and smaller for lower), which are correspondent to HEP-e-H and -L. All of sensors except for XEP-e could cover most of 4-pi sr in a satellite spin motion because of their wide field-of-views over more than pi rad. The energy analysis techniques for higher and lower energy particles are the pulse height analysis using scintillator and/or solid state detectors and the energy sweep method with electrostatic energy analyzers, respectively. We will also apply some countermeasures based on double/triple coincidence methods, sufficient passive shielding, and miniaturized detection areas, against the background noises due to the radiation-belt particles.

One of the prominent properties of the ERG mission is the first challenge to directly and quantitatively evaluate the energy transfer process between plasma waves and particles (electrons) based on the wave-particle interaction analyses using the wave form measurements and the three-dimensional velocity information for each incident electron. Individual data for each particle measured by XEP-e, HEP-e, and MEP-e are sent to a data storage device for the science instruments and statistically analyzed together with the plasma wave data in a high time accuracy (10 micro sec.) in the mission data processor.

We will report the basic characteristics of ERG-PPE and the current plan/status.

Keywords: Geospace, Space Storm, Particle Acceleration, Space Plasma, Plasma Wave, Exploration Mission

PEM07-03 Room:105 Time:May 22 09:30-09:45

ERG/PWE: Plasma Wave Experiment - from Mercury (BepiColombo/MMO-PWI) to Earth's Radiation Belt

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The Plasma Wave Experiment (PWE) aboard the ERG mission, just in the design phase, is introduced.

PWE will observe the electric field (from DC to 10 MHz) and magnetic field (from few to 100 kHz) for the clarification of global plasma dynamics, energetic processes, and wave-particle interactions in the radiation belt. It is based on the FM design of Plasma Wave Investigation (PWI) aboard BepiColombo Mercury Magnetospheric Orbiter (MMO), which FM is just now tested at ISAS.

Some parts are also extended to the future Jovian mission studies with European and US colleagues.

The key issues are: (a) Examination of the theories of high-energy particle acceleration by plasma waves, (b) Diagnosis of plasma density and temperature, and (c) Investigation of wave-particle interaction and mode conversion processes. Those issues were produced from the long researches by ISAS Akebono satellite from 1989 to now.

PWE provides the waveform and spectrum of electric field (2 components) and magnetic field (3 components).

The signal is also served to the MDP, and analyzed by the Software Wave Particle Correlator (S-WPIA).

The coordinated analyses with magnetic field and low/mid/high energy plasma particles by this on-board data correlation efforts will add the key information of the contribution of plasma waves to the relativistic particle acceleration in the radiation belt, under the coordination with the RBSP mission.

Keywords: ERG, electric field, plasma wave, radio wave, wave-particle interaction, radiation belt

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PEM07-04 Room:105 Time:May 22 09:45-10:00

Magnetic Field Experiment in the Inner Magnetosphere by ERG

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The acceleration process of the charged particles in the inner magnetosphere is considered to be closely related to the deformation and perturbation of the magnetic field. Accurate measurement of the magnetic field is required for the understanding of the acceleration mechanism of the charged particles, which is one of the major scientific objectives of the ERG mission. We are designing a fluxgate magnetometer which is optimized to investigate following topics;

(1) accurate measurement of the background magnetic field - the deformation of the magnetic field and its relationship with the particle acceleration.

(2) MHD waves - measurement of the ULF electromagnetic waves of frequencies about 1mHz (Pc4-5), and investigation of the radiation-belt electrons radially diffused by the resonance with the ULF waves.

(3) EMIC waves - measurement of the electromagnetic ion-cyclotron waves of frequencies about 1Hz, and investigation of the ring-current ions and radiation-belt electrons dissipated by the interaction with the EMIC waves.

A fluxgate magnetometer (MGF) will be installed on the ERG satellite to measure DC and low-frequency magnetic field. The design is based on MGF-I, one of the magnetometers for MMO, Mercury orbiter, which would also suffer high radiation on the Mercury orbit.

Keywords: inner magnetosphere, magnetic field, radiation belt

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PEM07-05 Room:105 Time:May 22 10:00-10:15

ERG Modeling/Theory Team and ERG Science Center: A basis to investigate the dynamics of the inner magnetosphere

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Geospace storms are the largest electromagnetic disturbances in the near-Earth space caused by CMEs and CIRs accompanied by the strong southward IMF. During the geospace storms, it is observationally known that the particle acceleration up to the relativistic energies are taking place as a consequence of dynamic interactions of the magnetic and electric field and particles. Aiming at understanding of physical mechanisms of the particle acceleration and regional couplings in solar-terrestrial system during the geospace storms the ERG project is underway in Japan. One of characteristics of the ERG project is close collaboration between three task teams, namely, the satellite, ground-based observation, and modeling/theory teams.

The ERG modeling/theory team has developed several numerical models for geospace studies. For example, we have developed new physics-based models for the global dynamics of the ring current (GEMSIS-RC model) and radiation belt (GEMSIS-RB model) as a part of the GEMSIS phase-2 project at STEL. GEMSIS-RC is a self-consistent and kinetic numerical simulation code solving the five-dimensional collisionless drift-kinetic equation for the ring-current ions in the inner-magnetosphere coupled with Maxwell equations. GEMSIS-RBW model implement the wave?particle interaction process into the three-dimensional relativistic gyrokinetic test particle simulation code. ERG modeling/theory team has also conducted comparative studies of simulation results and ERG-related ground observations.

In order to provide efficient study environment for the trinity collaboration in the ERG project, we have also developed ERG science center function as a part of the GEMSIS phase-2 project at STEL in collaboration with the THEMIS and IUGONET teams. One of important tasks of the ERG science center is to provide integrated data analysis tools and combined database not only for the ERG satellite but also for related ground-based observations and numerical modeling. The CDF (Common Data Format) is adopted as data format for the ERG database, and the CDF database is incorporated into integrated data analysis tools based on TDAS (THEMIS data analysis software suite). We report the current status of the ERG science center and some of modeling/theory team activities in the presentation.

Keywords: geospace, ERG, modeling, theory, science center, integrated studies

PEM07-06 Room:105 Time:May 22 10:15-10:30

Long-term variation of relativistic electrons at geostationary orbit

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It is well known that highly energetic electron at geostationary orbit altitude flux increases very much when the solar wind velocity is high. However, by closer inspection, the increase of highly energetic electrons likely to have dependence on seasons as well as on IMF (interplanetary magnetic field) polarity. We have examined relativistic electron data obtained by JAXA satellites and confirmed a significant dependence on IMF sector polarity; i.e. a large increase of highly energetic electron flux took place during a toward sector in the spring season, while the increase took place during an away sector in the autumn. This dependence is to be explained by so-called Russell-McPherron effect.

We also examined a long-term variation of highly energetic electrons based on the JAXA satellite data for twenty years. Results demonstrate that total intensity of highly energetic electrons depends on solar activity in a long time scale. We have newly identified that the minimum flux of highly energetic electrons in the last solar cycle was seen in December, 2009, which coincides with the time of the geomagnetic aa index minimum. Actually, highly energetic electron flux at geostationary orbit altitude decreased so much by two orders of magnitude around the December, 2009. The sub-storm activity in that month was minimum by looking at AE index. We are considering that completely no acceleration process took place in that month, resulting in an extremely low flux of energetic electron density.

To consider a basic physics to explain a large increase of relativistic electrons at geostationary orbit altitude, we have referred other satellite data: i.e. GPS and MDS-1, for instance. Results demonstrate that 1) radial increase of energetic electrons took place in low energy first, followed by the increase in higher energy and 2) increase of energetic electrons took place in low L region first, followed by the increase in high L region, showing outward expansion of energetic electrons in terms of L value.

We next examined Pc-5 power to investigate a relationship with a large enhancement of highly energetic electrons. Increase of Pc-5 power starts at the arrival of high speed solar wind and continues for a long time. We checked a correlation of Pc-5 power and highly energetic electron flux. Results demonstrate the increase of highly energetic electrons had a significant time delay with respect to the increase of Pc-5 power; i.e. 2 days. This means that Pc-5 fluctuation may have an important role in the radial diffusion of highly energetic electrons from the center of outer radiation belt to the geostationary orbit altitude. Such expansion was confirmed beyond the geostationary orbit altitude by the quasi-zenith satellite.

One of the major issues remained unanswered is the acceleration process of highly energetic electrons in the outer radiation belt. According to the MDS-1, which is a geostationary transfer orbit satellite, we have confirmed that a peak portion of newly formed outer belt was inversely proportional to the magnetic storm intensity; i.e. a large magnetic storm results the peak position closer to the Earth, while a small magnetic magnetic storm results the peak position far from the Earth. We investigated a spatial distribution of the intensity of very low frequency waves and confirmed that it was strongest at the peak position of highly energetic electrons. We are suggesting that low wave frequency waves have an important role in the acceleration of electrons up to the MeV energy range.

Keywords: relativistic electron, geostationary orbit, long-term variation

PEM07-07 Room:105 Time:May 22 10:30-10:45

Statistical analysis of lightning whistlers observed by VLF/WBA onboard AKEBONO

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The AKEBONO spacecraft was launched on 1989 to observe particles and plasma waves in the auroral region and plasmasphere of the earth. The AKEBONO has been operated for nearly 24 years, which are 2 cycles of solar activity or 1 cycle of solar magnetic polarity reversal.

The WBA (Wide Band Analyzer) is one of subsystems of the VLF instruments onboard AKEBONO. It measures 1 component of electric or magnetic analogue waveform at frequency band of 50 Hz - 15 kHz. Lightning whistlers are frequently observed mainly in the plasmasphere by the WBA and their dispersions depend on electron density profile along their propagation paths. Therefore it is possible to estimate the electron density profile in the plasmasphere statistically using the trend of whistler dispersions along the trajectories.

In this study, we developed an automatic detection system of lightning whistlers from the spectrogram of the WBA receiver. We statistically analyzed the characteristics of lightning whistlers observed from 1989 to 1991 detected by the system. We found that lightning whistlers are hardly observed in the dayside, while they are mainly observed in the lower magnetic latitude range below 30 degree. It was also found that the dispersion of lightning whistler tends to be larger at higher altitude region.

We briefly introduce the detection system, and report the results of statistical study. Finally we discuss the propagation characteristics of lightning whistlers depending on the condition of electron density in the plasmasphere.

Keywords: AKEBONO, VLF, wideband receiver, lightning whistler, dispersion

PEM07-08 Room:105 Time:May 22 11:00-11:20

New Insights on the Inner Magnetosphere from the Van Allen Radiation Belt Storm Probes Mission

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The Van Allen Radiation Belt Storm Probes Mission consists of two identically-instrumented satellites in a near geosynchronous transfer orbit (apogee ~ 5.7 Re). Each satellite has a full complement of particle, fields, and waves instruments designed to answer some of the fundamental questions about radiation belt acceleration, transport, and loss as well as providing key measurements of the general inner magnetosphere dynamics in which they operate. The two satellites have slightly different orbital periods which provides different phasing of the satellites and the wide range of radial and azimuthal separations that allow unambiguous separation of spatial and temporal features. Many of these measurements are the first ever of their kind. Within the first few months of operation the Van Allen mission has achieved several of its primary science objectives as well as having discovered new features that raise new questions. In this overview we will present some of the key science results to date including definitive evidence of local acceleration by wave-particle interactions, an analysis of the unstable plasma distributions responsible for wave generation, and plasmaspheric structure as a function of ion composition. We will also present several newly-discovered features of the radiation belts and inner magnetosphere that illustrate how much more there is to learn.

Keywords: Radiation Belts, Space Weather, Magnetosphere, Energetic Particles, Wave-Particle Interactions, Storms

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PEM07-09 Room:105 Time:May 22 11:20-11:40

Initial Results From The Electric and Magnetic Field Instrument Suite and Integrated Science on the Van AllenProbes

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The physics of the creation, loss, and transport of radiation belt particles is intimately connected to the electric and magnetic fields which mediate these processes. A large range of field and particle interactions are involved in this physics from large-scale ring current ion and magnetic field dynamics to microscopic kinetic interactions of whistler-mode chorus waves with energetic electrons. To measure these kinds of radiation belt interactions, NASA implemented the two-satellite Van Allen Probes mission. As part of the mission, the Electric and Magnetic Field Instrument Suite and Integrated Science (EMFISIS) investigation is an integrated set of instruments consisting of a tri-axial fluxgate magnetometer (MAG) and a Waves instrument which includes a tri-axial search coil magnetometer (MSC). These wave measurements include AC electric and magnetic fields from 10Hz to 400 kHz. We show examples of plasmapause identification and variation determined by the upper hybrid resonance, low frequency ULF pulsations, and whistler mode waves including upper and lower band chorus. These data are compared with particle measurements to show relationships between wave activity and particle energization.

Keywords: radiation belt, inner magnetosphere, wave measurements

PEM07-10 Room:105 Time:May 22 11:40-12:00

ULF wave environment of the inner magnetosphere

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The magnetosphere is filled with ULF waves in the Pc3-5 pulsation band and these waves are considered to play an important role in the formation and decay of the ring current and the radiation belts. In this presentation, we will first review our current understanding of the morphology and generation mechanisms of ULF waves in the inner magnetosphere (geostationary orbit and inward). Examples from studies using AMPTE/CCE, CRRES, GOES, and THEMIS will be used to illustrate how the state of the solar wind and the magnetosphere affects the amplitude, frequency, polarization, and field line mode structure of ULF waves. We will then identify outstanding remaining questions, and discuss how observations with the recently launched Van Allen Probes can be used to answer the questions.

Keywords: ULF waves, Inner magnetosphere, Spacecraft observations

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PEM07-11 Room:105 Time:May 22 12:00-12:15

Characteristics of mid-latitude Pc5 pulsations observed on the nightside with the SuperDARN Hokkaido radar during a sudd

Mariko Teramoto[1*], Nozomu Nishitani[1], Kazuo Shiokawa[1], Tsutomu Nagatsuma[2], Ken T. Murata[2]

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Sudden commencements (SC) cause quasisinusoidal ULF waves in the wide range of periods from 1 to 600 s. Using the magnetic field data observed by ground magnetometers over wide latitudinal and longitudinal extension and/or by the satellites in the magnetosphere, a scenario of these ULF waves suggested by previous studies is that compressional waves propagate from the dayside to the nightside in the magnetosphere and shear Alfven waves are excited. Characteristics of ULF waves associated with a SC in the ionosphere are poorly understood while a number of studies have investigated characteristics of ULF waves on the ground and/or in the magnetosphere.

In this study, we focus on Pc5 pulsations associated with the SC which occurred at 11:09 UT on 8 March 2012. The Pc5 pulsations with 200 s periods appeared in the SuperDARN Hokkaido radar field of view at unusually low latitudes (41-53 degrees magnetic latitude) on the nightside. We obtained azimuthal wave number for Pc5 pulsations in the radar Doppler velocity using the azimuthally separated pair of Hokkaido radar beams and found that this Pc5 pulsation had a low azimuthal wave number of 9.6 with westward propagation. Pc5 pulsations observed by the SuperDARN Hokkaido radar were not similar to geomagnetic perturbations on the nearby ground station, St. Paratunka. On the other hand, the UK Sub-Auroral Magnetometer Network (SAMNET) located on the noonside observed clear Pc5 pulsations, which had high coherence with those observed by the SuperDARN Hokkaido radar at 5.5mHz. Details of the analysis will be presented.

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PEM07-12 Room:105 Time:May 22 12:15-12:30

Study of SAPS dynamics observed by the midlatitude SuperDARN radars

Nozomu Nishitani[1*], Mariko Teramoto[1], Tomoaki Hori[1]

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The SuperDARN Hokkaido (East) radar has been operating for more than 6 years, and has been yielding many new scientific findings. Several of them deal with Sub Auroral Polarization Streams (SAPS), defined as fast westward subauroral ionospheric plasma flow in the dusk to midnight sector. Several studies discussed possible generation mechanism of SAPS structures, although details of their dynamics are not fully understood yet. In this paper, latest results of the study of SAPS dynamics observed by the SuperDARN Hokkaido (East) radar, as well as other midlatitude SuperDARN radars, will be presented.

Keywords: midlatitude SuperDARN, SAPS, sub-auroral ionosphere, inner magnetosphere, disturbed geomagnetic activity

PEM07-13 Room:105 Time:May 22 12:30-12:45

Pc5 Observations using ST-APOG mode of King Salmon HF radar

Tsutomu Nagatsuma[1*], Kaori Sakaguchi[1], Manabu Kunitake[1]

[1]NICT

The Pc5 geomagnetic pulsation is one of the causes of enhancement of the relativistic electron enhancement in the outer radiation belt. Radial diffusion and/or drift bounce resonance driven by Pc5 geomagnetic pulsations can accelerate electrons. Therefore, to understand the generation mechanism of Pc5 and current condition for the global distribution of Pc5 is important. For these purposes, special mode of observations (ST-APOG) are being operated by SuperDARN during the conjunction of Van Allen Probes (VAP) in the field of view of the HF radars. In this special mode, we use three camping beams for high-time resolution observations for Pc5 and 2-min. scan for the global distribution of plasma convection. Based on this observations, ground-based magnetometer network, VAP, and other satellite data, we can examine the three-dimensional distribution of electromagnetic variations of Pc5. Initial results of ST-APOG mode observations by King Salmon HF radar will be reported in our presentation.

Keywords: Geomagnetic Pulsation, Magnetosphere, Radiation Belt, Ground-Satellite Observations, HF Radar

PEM07-14 Room:105 Time:May 22 14:15-14:35

Modulation of EMIC Waves by Plasma Plumes and Pc5 ULF Waves

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Electromagnetic ion cyclotron (EMIC) waves play an important role in contributing to localized ring ion current loss during geomagnetic storms, and radiation belt MeV electron losses. It is therefore important to understand the magnetospheric conditions under which EMIC waves are generated and propagate. GOES and POLAR satellite observations show EMIC waves associated with extended plasma drainage plumes in the plasmasphere and magnetosphere. The properties of EMIC waves seen by the fluxgate magnetometer onboard the CRRES elliptically orbiting satellite will be presented with emphasis on the relationship between EMIC waves and associated plasma drainage plumes observed in the CRRES plasma wave experiment electron density data and LANL satellite thermal energy plasma data. In particular wave generation by ring current ions and cold plasma propagation mechanisms by which Pc5 mixed mode ULF waves may modulate EMIC waves will be considered in detail.

Keywords: Magnetosphere dynamics, Plasma waves and instabilities, Space plasma physics

PEM07-15 Room:105 Time:May 22 14:35-14:50

Low-latitude Pi2 pulsations during the intervals of quiet geomagnetic conditions (Kp < 1)

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Several case studies reported Pi2 pulsations during the interval of extremely quiet geomagnetic condition (Kp = 0). Until now, however, no statistical study has been reported for Pi2 activity during quiet geomagnetic interval. In our study we statistically examine the properties of Pi2 pulsations observed at low-latitude Bohyun (BOH, L = 1.35) station in South Korea. 772 Pi2 events were identified for the intervals of Kp less than 1 in 2008 when BOH was on the nightside from 1800 to 0600 local times. Comparing Pi2 parameters and solar wind conditions, it was found that Pi2 frequencies decrease with decreasing solar wind speed. We also found that Pi2 pulsations quasi-periodically occur with about 30-min recurrence time. We will discuss why the Pi2 frequency depends on solar wind speed and what determines the 30-min recurrence time of Pi2 pulsations under quiet geomagnetic conditions (Kp < 1).

Keywords: Pi2, Low-latitude, Substorm, Solar wind

PEM07-16 Room:105 Time:May 22 14:50-15:05

Magnetic fluctuations embedded in dipolarization inside geosynchronous orbit and their possible role in selective accele

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Magnetic field dipolarization is a distinct phenomenon observed in the magnetosphere at substorm onset. According to previous studies, magnetic field dipolarization can be mostly seen at the geosynchronous altitude or farther down the tail (i.e., radial distance of $>$=6.6 R$_E$), and is accompanied by strong magnetic fluctuations. The characteristic time scale (T$_C$) of the magnetic fluctuations is reported to be a few seconds to a few tens of seconds, that is, T$_C$=0.3-30 s at r=7-9 R$_E$ by AMPTE/CCE [Lui et al., 1992; Ohtani et al., 1995], T$_C$=8-28 s at r~8 R$_E$ by SCATHA [Ohtani et al., 1998], T$_C$~5 s at X=-8 to -11 R$_E$ by Geotail [Shiokawa et al., 2005], T$_C$~10 s at X=-8.3 R$_E$ by THEMIS [Lui et al., 2008], and T$_C$=10-50 s at X=-17.5 R$_E$ by Cluster [Huang et al., 2012]. These time scales are longer than local gyroperiods of H^+ by a factor of 2-20, and rather close to those of He^+ and O^+ ions. A recent study employing the MDS-1 satellite revealed that magnetic field dipolarization can be observed in the deep inner magnetosphere (L=3.5-6.0) and is accompanied by the magnetic fluctuations that have a period range between the local gyroperiods of He^+ and O^+ ions [Nose et al., 2010]. To our knowledge, there are few studies reporting T$_C$ just inside geosynchronous orbit (L=5.0-6.6).

In this study, we analyze magnetic fluctuations embedded in dipolarization events at the geosynchronous altitude, using the ETS (Engineering Test Satellite)-VIII satellite. From the period of 2010-2012, we select 6 dipolarization events that showed an increase of the northward magnetic field more than 60 nT. It is found that all of the events are accompanied by strong magnetic fluctuations with T$_C$ close to the local O^+ gyroperiods. We also study a dipolarization event in the inner magnetosphere (L~4.9) observed by the AMPTE/CCE satellite on December 10, 1987. This event is found with magnetic fluctuations that have a period range between the local gyroperiods of He^+ and O^+ ions. When the fluctuations appear, the O^+ flux is enhanced in the energy range of $<$ 10 keV.

These results suggest that magnetic fluctuations associated with dipolarization have generally T$_C$ close to the local gyroperiod of heavy ions, and may play an important role in selective acceleration of O^+ ions.

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PEM07-17 Room:105 Time:May 22 15:05-15:20

Electromagnetic ion cyclotron waves related to minor ion composition in the inner magnetosphere observed by Akebono

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According to observations by GEOS1 and GEOS2, it was reported that ELF waves, which were assumed to be ElectroMagnetic Ion Cyclotron (EMIC) waves, were observed below the proton cyclotron frequency near the geomagnetic equator in the magnetosphere. In the recent study, it is pointed out that EMIC waves are deeply related to loss mechanism of relativistic electrons of radiation belt. As representative classical studies of the EMIC waves around the equatorial region, it was suggested that EMIC wave has a close relation to heavy ions (e.g., He^{+}, O^{+}), and that polarization reversal of EMIC is caused by these ions at the crossover frequency. It was also pointed out that EMIC wave has a lower cut-off at so-called lower-hybrid frequency. It is important to note that these characteristic frequencies change depending on the ion constituents in plasma. This fact suggests that we can estimate the ion constituents measuring these characteristic frequencies of EMIC.

The Akebono satellite has been successfully operated for the purpose of observation of the auroral region and inner magnetosphere for more than 23 years since its launch in 1989. The ELF receiver, which is a sub-system of the VLF instruments onboard Akebono, measures waveforms below 50 Hz for one component of electric field and three components of magnetic field, or waveforms below 100 Hz for one component of electric and magnetic field, respectively. It was reported that ion cyclotron waves were observed near magnetic equator by the receiver.

In this paper, we introduce EMIC waves which have characteristic cut-off frequency observed in the vicinity of geomagnetic equator by the Akebono satellite along its trajectory during a magnetic storm on 1989. These waves repeatedly observed within a half days after sudden decreases of Dst, but they disappeared when the Dst index recovered nearly to 0. This fact suggests that the generation of the wave was closely correlated with fresh energetic particle injection. The cut-off frequencies of each event are stable on approximately equal to half of cyclotron frequncy of proton in spite of disturbance of inner magnetosphere represented by sudden Dst decrease and electron density fluctuation. We study dispersion relation of EMIC under the condition of multiple species of ions and demonstrate that there exists a few percent of alpha particle (He^{++}) or deuteron (D^{+}) which causes the lower cut-off of EMIC in the inner magnetosphere.

Keywords: electromagnetic ion cyclotron wave, Akebono satellite, inner magnetosphere, heavy ion

PEM07-18 Room:105 Time:May 22 15:20-15:35

Modeling the Plasmasphere

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Satellite observations have revealed that ions are heated in the ionospheric polar region and are flowing to the magnetosphere. The fluxes of H+, He+, and O+ are ˜1011 ions m-2 s-1, ˜1011 ions m-2 s-1, ˜1010 ions m-2 s-1, ˜1010 ions m-2 s-1 during the solar maximum and ˜1010 ions m-2 s-1, ˜109 ions m-2 s-1, ˜109 ions m-2 s-1 near the solar minimum condition, respectively, from Akebono satellite observations. The large amount of ions, including heavy ions such as O+, may affect the structure and dynamics of plasmasphere and inner magnetosphere. The ions are formed often as conics / transversely accelerated ion in the topside polar ionosphere. To understand the refilling process, the refilling time scale and the effects to the structure and dynamics of plasmasphere and inner magnetosphere, we have developed a three dimensional model of Atmosphere ? Plasmasphere including Electrodynamics (APE model). The model calculates densities, velocities and temperatures for electron, O2+, N2+, NO+, O+, He+ and H+ at altitudes from 90 km to 10 Re and for N2, O2, O, He and H in the thermosphere, and electric fields in the ionosphere, plasmasphere and inner magnetosphere. We calculate also parallel and perpendicular components of ion and electron temperatures to include the effect of perpendicular heating of ion in the polar ionosphere. The results show clearly the structure of plasmasphere which is affected by the magnetic disturbance. The structure of plasmasphere, the refilling time and the response to the magnetic disturbance vary depending on the ion species.

Keywords: Plasmasphere

PEM07-19 Room:105 Time:May 22 15:35-15:50

Energization of oxygen ions in the inner magnetosphere

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Rapid enhancements of energetic ions during a substorm are one of the unsolved issues in the magnetospheric research. Previously, two distinct processes have been suggested to explain the enhancements. The first one is transport from the near-earth plasma sheet, and the other one is local acceleration. To test the latter process, we traced oxygen ions under the electric and magnetic fields that are self-consistently obtained by the global MHD simulation developed by Tanaka et al. (2010, JGR). Test particle simulation shows the ions with non-adiabatic motion are efficiently accelerated under the presence of the electric field. Simulation also suggests this non-adiabatic acceleration depend on their initial position, energy, and pitch angle. We will discuss in detail the pitch angle and energy distributions of the accelerated ions as a function of time.

Keywords: Substrom, Magnetic moment

PEM07-20 Room:105 Time:May 22 16:15-16:30

Relativistic electron microbursts induced by EMIC triggered emissions in the Earth's radiation belts

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Pitch angle scattering of relativistic electrons arising from the anomalous cyclotron resonance with left-hand polarized electromagnetic ion cyclotron (EMIC) waves contributes to the sharp decrease of the relativistic electron flux in the outer radiation belt in the main phase of magneticstorms. We have derived the second-order resonance condition for interaction between a relativistic electron and a coherent Electromagnetic Ion Cyclotron (EMIC) wave with a variable frequency [1]. We perform test particle simulations of relativistic electrons interacting with EMIC waves with a fixed frequency and a rising-tone frequency such as EMIC triggered emissions [2] observed in the inner magnetosphere. Trapping of resonant electrons leads to rapid and efficient pitch angle scattering of relativistic electrons, resulting in bursty precipitation of relativistic electrons. The efficiency of the pitch angle scattering depends on the gradient of the magnetic field, the frequency sweep rate, and the wave amplitude. Although resonant electrons may not be scattered into the loss cone in a single passage through the wave packet. repeated interactions with a series of wave packets through the bounce motion between the mirror points result in scattering of relativistic electrons into the loss cone. The time scale of precipitation of a relativistic electron by a single passage through the wave packet is about 0.03 seconds, while the bounce time period is about 0.2 second. Test particle simulations with a large number of electrons demonstrate strong precipitation takes place over 1 ? 3 seconds, corresponding to relativistic electron microbursts observations.

[1] Omura, Y., and Q. Zhao (2012), Nonlinear pitch angle scattering of relativistic electrons by EMIC waves in the inner magnetosphere, J. Geophys. Res., 117, A08227, doi:10.1029/2012JA017943.

[2] Omura, et al. (2010), Theory and observation of electromagnetic ion cyclotron triggered emissions in the magnetosphere, J. Geophys. Res., 115, A07234, doi:10.1029/2010JA015300.

Keywords: radiation belts, EMIC, triggered emission, precipitation, relativistic electron, wave-particle interaction

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PEM07-21 Room:105 Time:May 22 16:30-16:45

Triggering Process of Electromagnetic Ion Cyclotron Rising Tone Emissions in the Inner Magnetosphere

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Spacecraft observations and simulations show generation of coherent Electromagnetic ion cyclotron (EMIC) triggered emissions with rising-tone frequencies. In the inner magnetosphere, the spontaneously triggered EMIC waves are generated by the protons with large temperature anisotropy. We reproduced EMIC triggered emissions in the Earth's magnetosphere by real scale hybrid simulations with cylindrical magnetic geometry. We obtained spontaneously triggered nonlinear EMIC waves with rising frequencies in H+ band of the EMIC dispersion relation. The proton holes in the phase space are formed. We have also derived the theoretical optimum wave amplitude for triggering process of the EMIC nonlinear wave growth. The optimum wave amplitude and the nonlinear transition time show a good agreement with the present simulation result. The nonlinear wave growth over a limited time forms a sub-packet structure of a rising tone emission. The formation process of a sub-packet is repeated because of a new triggering wave generated by the phase-organized protons, which are released from the foregoing sub-packet. Then the EMIC triggered emission is observed as a train of sub-packets generated at different rising frequencies.

Keywords: EMIC wave, triggered emission, wave particle interaction, hybrid simulation

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PEM07-22 Room:105 Time:May 22 16:45-17:00

Electron hybrid simulations of whistler-mode chorus emissions with real parameters in the Earth's inner magnetosphere

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In the Earth's inner magnetosphere, whistler-mode chorus emissions are observed mostly on the dawn side and are enhanced during geomagnetically disturbed periods. Chorus emissions are narrow band emissions observed in the typical frequency range of 0.2 to 0.8 f_{ce0} with a gap at the half f_{ce0}, where f_{ce0} represents the electron gyrofrequency at the magnetic equator.

The generation process of chorus has been explained by the nonlinear wave growth theory [see review by Omura et al., in AGU Monograph "Dynamics of the Earth's Radiation Belts and Inner Magnetosphere, 2012]. Recent self-consistent numerical experiments reproduced the generation process of chorus emissions [e.g., Katoh and Omura, GRL 2007; Hikishima et al., JGR 2009].

In the present study, we show the result of electron hybrid simulation of the generation process of whistler-mode chorus emissions under realistic initial conditions. We refer in-situ observation by Cluster [Santolik et al., 2003] for the initial parameters of energetic electrons and the spatial inhomogeneity of the background magnetic field. In the simulation results, chorus emissions with rising tones are reproduced, while the spectral characteristics is consistent with the observation. We also find that the simulation result is consistent with threshold and optimum wave amplitudes of chorus elements estimated by the nonlinear wave growth theory.

Keywords: whistler-mode chorus, numerical experiments, wave-particle interactions

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PEM07-23 Room:105 Time:May 22 17:00-17:15

Radiation belt electron acceleration by whistler chorus in three-dimensional magnetic field

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It is thought that whistler chorus waves accelerate radiation belt electrons efficiently. Test-particle simulation results also support the electron acceleration by whistler chorus and explain time scale of acceleration observed in the radiation belt. However, it is still unclear how the whistler chorus waves affect radiation belt electron distributions in both energy and pitch angle in three-dimensional geomagnetic field in long-time scale. To better understand the scattering processes, we study electron scattering by whistler chorus waves propagating parallel to magnetic field lines in the three-dimensional dipole magnetic field. For this study, we use three-dimensional relativistic gyrokinetic test particle simulation code including wave (whistler)-particle (electrons) interaction process which is developed under Geospace Environment Modeling System for Integrated Studies (GEMSIS) project in Solar-Terrestrial Environment Laboratory in Nagoya University. We demonstrated that a fraction of several hundred keV electrons are accelerated to a few MeV energy and some other electrons decrease their kinetic energy through interaction with whistler waves with a constant frequency in less than 1-hour, where the emission region of the chorus is localized in local times (delta LT is about 2-3 hours). We will further show the pitch angle and energy distribution of radiation belt electrons, and discuss how global distribution of the radiation belts changes through scattering by whistler chorus waves.

Keywords: whistler chorus, acceleration, radiation belt, wave-particle interaction

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PEM07-24 Room:105 Time:May 22 17:15-17:30

Ground-based VLF wave observations at subauroral latitudes - VLF-CHAIN Campaign

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We report observations of very low frequency (VLF) waves during the VLF Campaign observation with High-resolution Aurora Imaging Network (VLF-Chain) of February 17-25, 2012, at subauroral latitudes at Athabasca (54.72N,246.69E, MLAT=61.3). Continuous measurements of VLF waves with a sampling rate of 100 kHz have been made since then to monitor daily variations of chorus waves and their detailed structures. We found quasi-periodic (Q-P) emissions for which their repetition period rapidly changes within one hour without corresponding magnetic pulsations and for which their intensity suddenly increased associated with a storm sudden commencement without changing their frequency. Patchy burst in the upper-band frequency ranges are often observed during magnetically disturbed times. Falling tone chorus whose rate of frequency change varies on a timescale less than a minute was observed. Clear systematic correlation of these various chorus waves with cosmic noise absorption was not seen throughout the campaign period. These observations indicate existence of several new types of VLF wave phenomena at subauroral latitudes.

Keywords: VLF wave, subauroral latitudes, ground-based observation

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PEM07-25 Room:105 Time:May 22 17:30-17:45

Comparison of energetic electron fluxes at Earth and Saturn

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Energetic electron fluxes (18 keV-21 MeV) observed by the MIMI/LEMMS instrument on the Cassini mission during 2004-2008 are analyzed. We consider all 101 orbits and we select portions of the orbits that lie within 0.5 R of the magnetic equatorial plane,where R is Saturn's radius. We determine the average electron differential flux and integral flux at specified L-shells in the range $4.5 < L < 11$. Comparisons are made between the observed fluxes and the corresponding relativistic self-limiting values developed from Kennel-Petschek theory. These comparisons suggest that (1) at lower L-shells particle injection is relatively weak, (2) at intermediate L-shells, sufficiently strong particle injections generate whistler-mode waves to self-limit trapped fluxes,and (3) at larger L-shells, intense particle injections result in trapped particle fluxes well in excess of the Kennel-Petschek limit. Further,we compare the properties of energetic electron fluxes at Earth and Saturn.

Keywords: observed electron fluxes at Earth , Saturn, Kennel-Petschek limit