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

PEM030-01 Room:303 Time:May 27 16:30-16:45

Study of differential rotation in rapidly rotating stars in mean field model

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We investigate the internal differential rotation in rapidly rotating stars in an axisymmetric mean field model. The background of this study is the suggestion that the sun rotated faster than now in its younger age. The differential rotation is an important factor for the stellar magnetic field, since the shear of the flow bends the magnetic field and gives energy to magnetic field, i.e. dynamo. We are interested in the morphology of the differential rotation in rapidly rotating stars. We use the model which succeeds in reproducing the solar differential rotation with an adequate latitudinal entropy gradient. Our result is: In the rapidly rotating stars, the meridional flow is not so fast that the latitudinal entropy gradient generated by the meridional flow is not large enough to push the differential rotation far from the Taylor-Proudman state where the contour lines of the angular velocity are parallel to the rotational axis.

Keywords: Sun, Differential rotation, Star, Magnetic activity

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PEM030-02 Room:303 Time:May 27 16:45-17:00

The role of Alfven wave for spicule formation, coronal heating, and solar wind acceleration

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We performed MHD simulations for nonlinear Alfven wave propagation in the solar flux tube. Mode conversion of Alfven waves are known to be one of the mechanisms to explain spicules, jet like phenomena in the solar chromosphere. Moreover nonlinear dissipation of Alfven waves has possibility to explain the coronal heating and the solar wind acceleration simultaneously. However, whether the above models succeed or not highly depends on the power spectrum of Alfven waves driven at the photosphere. In this talk, we examined the existing models by using the observed power spectrum of photospheric velocity newly derived from Hinode G-band movies.

To begin with, we performed 1D MHD simulation for nonlinear Alfven wave propagation along a flux tube. We derived the horizontal velocity spectra at the photosphere using G-band movies observed with Hinode/SOT. The observed power spectra are used to drive Alfven waves in our simulations. Using the observed power spectra, we can reasonably explain spicule motion and energy flux necessary to heat the corona. We also found that the region between the photosphere and the transition region becomes Alfven wave resonant cavity, which works efficiently to heat the corona. Then, we applied almost the same model to the solar wind acceleration by extending our numerical domain. The Alfven wave theory is confirmed to maintain the corona and drive the solar wind with Alfven wave generation by the observed power spectra. Finally, we tested the validity of 1D approximation by performing 2D MHD simulation for Alfven wave propagation in the solar flux sheet.

Keywords: Alfven wave, MHD, spicule formation, coronal heating, solar wind acceleration

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PEM030-03 Room:303 Time:May 27 17:00-17:15

Relationship etween Phase Difference of the Ground Pc5 and Enhancement of Relativistic Electron Flux at the GEO

Kentarou Kitamura[1*], Satoko Saita[2], Shinichi Watari[3], Hisao Yamagishi[4], Takahiro Obara[5]

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Pc 5 pulsations observed at the ground stations are analyzed to investigate the relationship with enhancement of the relativistic (>MeV) electron flux (REF) at the geosynchronous orbit. It is frequently reported in the previous studies that the REF increases during the recovery phase of the magnetic storms. The enhancement of REF sometimes causes the serious troubles of the electric circuit onboard the satellites due to the internal charging, so that it is recognized the physical process of the REF enhancement is one of the most important subject of the space weather study. In this study, we use the magnetic data observed at the high-latitude magnetic stations in both the northern and the southern hemispheres, TJOR (Mag. Lat = 66.51), TRO (66.44), Showa (-66.08), H057 (-66.42), and Skallen (-66.42) to compare the REF enhancement observed by GOES 10 satellite and DRTS satellite. In 12 July, 2008, the high speed (< 700km/s) solarwind with Corotating Interaction Region (CIR) causes the small magnetic storms with Dst of -40 nT. At the timing of the main phase of the magnetic storms, the Pc 5 power increased at all the stations and continued the strong PSD during the recovery phase of the storm. For this event, we estimated the phase difference of the Pc 5 between H057 and Skallen which are located exactly same magnetic latitude. The phase difference in the pre-storm period shows the 7-8 degrees and obviously decreased after the onset of storm. In particular, the phase difference discontinuously changed to the small corresponding to the start of the REF enhancement. However, the increasing of the Pc5 power starts 12 hours earlier than the start of REF enhancement. The same characteristics were shown in the Pc5 in the northern hemisphere stations (TJOR, TRO). The present result indicates that the increasing of Pc5 power started at the onset of the main phase of the storm prior to the REF enhance, then the phase structure of the Pc5 changed corresponding to the REF enhancement. These characteristics of the Pc5 and the REF enhancement could be explained by the drift resonance model the REF enhancement.

Keywords: ULF Pulsation, Relativistic Electron, innner magnetosphere

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PEM030-04 Room:303 Time:May 27 17:15-17:30

Statistical Study of Polar X-ray jets from Hinode/XRT

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The X-Ray Telescope (XRT) aboard Hinode had revealed that X-ray jets occur at very high frequency in the polar region. Savcheva et al. (2007) reported the features of the polar X-ray jets based on 104 events that occurred only in polar coronal hole (PCH). Hence, the difference of the features of the polar X-ray jets that occur in PCH and the quiet region (QR) is not clear. In order to reveal the features of the polar X-ray jets in not only PCH but also QR, we investigated the polar X-ray jets based on 848 jets that occurred around the north pole. We also investigated 96 X-ray jets that occurred around the equator for comparing the polar jets with the equatorial jets.

We used the X-ray intensity for dividing the polar region into PCH and QR. However, generally, the magnetic connectivity is used for dividing into the two regions, and it is possible that the boundary based on X-ray intensity is not correct. To evaluate the uncertainty, we derived the frequency distribution of the minimum distance from the jet to the PCH boundary. The distribution shows that the frequency of the jets in the PCH is roughly uniform and the frequency of the jets in the QR immediately decreases around 10^5 km from the boundary. From the result, we divided the QR into [around coronal hole boundary (CHB)] and [pure polar quiet region (PQR)], based on the distance from the coronal hole boundary. Finally, we divided the jet-producing region into the four regions, PCH, CHB, PQR and equatorial quiet region (EQR), and we compared the features of the X-ray jets that occurred in each region.

From comparing the parameters of the X-ray jets, we found that the ranges, the averages and the frequency distributions of the length, the width, the lifetime and the apparent velocity are independent of the producing regions. On the other hand, the occurrence rate and the frequency distribution as a function of the total X-ray intensity of the flare around the footpoint of the jets differ from the parameters. The occurrence rates of X-ray jets in the PCH and the CHB are higher frequency (16 x 10^-12 events/km^2/hour) than that in the PQR and the EQR (6 x 10^-12 events/km^2/hour). If we assume that the frequency distribution of total X-ray intensity of footpoint flare show the power law distribution, the power law indexes of the frequency distribution at the PCH and the CHB are around -1.8 and the indexes at the PQR and the EQR are around -1.3. From the results, we found that we can divide the jet-producing region into two categories based on the occurrence rate and the frequency distribution of the footpoint flares. One is the category that has high occurrence rates and steep slope of the frequency distribution of the footpoint flares. The category includes the PCH and the CHB. The other category has low occurrence rate and flat slope of the frequency distribution of the footpoint flares and includes the PQR and EQR.

Keywords: X-ray jet, Corona, Flare, Magnetic Field

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Yearly Variation of Magnetic Field in the Solar Polar Regions observed with *Hinode*/SOT

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The polar region of the Sun has not been well understood yet despite the long history of the solar observation. The polarity of the polar regions reverses around the maximum of the solar cycle. For several years around the solar activity minimum a stable and large coronal hole is present in each the polar region. The polar regions has the unipolar magnetic fields open to the interplanetary space. The mechanisms of the polarity reversal and to form, to maintain, and to decay the coronal holes remain to be completely clarified. The polar regions have the polarity opposite to each other and almost occupy the unipolar magnetic field. Therefore, the variation of the polar magnetic field is extremely significant for the polarity reversal. Observations of the polar region of the Sun are critically important for understanding the solar dynamo and the acceleration of solar wind. In order to obtain clues of those problems, we investigated the photospheric magnetic field properties using the high-resolution observation with Solar Optical Telescope (SOT) aboard *Hinode* in this study.

we report the yearly time variation (2006 - 2011) of the magnetic field in the polar regions around solar minimum with high spatial resolution of *Hinode*/SOT. The fraction of the dominant polarity in the both polar regions increases with latitude. We examined the time variation (2008 - 2011) of the vertical and horizontal magnetic fields. The comparison of the areal fraction of the intrinsic magnetic field strength showed that those of the kilo-Gauss vertical field and the horizontal field vary in the North polar region. In the South polar region, however, the areal fraction of the kilo-Gauss vertical field and the horizontal field are almost the same. The magnetic flux density of vertical magnetic field fluctuates in both the polar regions, while that of horizontal magnetic field almost stay flat.

Keywords: photosphere, magnetic field, coronal holes, solar activity, Hinode, spectropolarimetry

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GEMSIS project: Database of coronal magnetic fields calculated from magnetograms of Hinode satellite

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We report the database of coronal magnetic fields of solar active regions. This database is a part of the GEMSIS (Geospace Environment Modeling System for Integrated Studies) project of Solar-Terrestrial Environment Laboratory (STEL), Nagoya University (URL, http://st4a.stelab.nagoya-u.ac.jp/gemsis/index.shtml.ja). The GEMSIS project is the modeling project for understanding energy and mass transportation from the Sun to the Earth in the geospace environment. We, the GEMSIS-Sun working team, are preparing database of coronal magnetic fields of solar active regions calculated from magnetic field data obtained by the Hinode satellite, as one of our projects. This is collaboration with Hinode Science Center, National Astronomical Observatory of Japan. We expect that this database could help solarphysicists to understand energy release processes (e.g., acceleration of high energy particles and trigger mechanisms of solar flares) in the corona.

Magnetic field is a main energy source of solar active phenomena (e.g., filament eruption, solar flare, and others). Thus, in order to understand solar active phenomena, we need to investigate temporal evolution of coronal magnetic fields. Reproduction of coronal magnetic fields is considered as an only way to understand coronal magnetic field structure. At present, it is very difficult to obtain three dimensional structures of coronal magnetic fields from polarized light observations, because of small intensity and optical thinness of solar corona. On the other hand, under the rest condition, we can describe coronal magnetic fields with two simple equations (divB=0 and rotB$*$B=0). This is because the Lorentz force is stronger than the gas pressure and gravity forces in the corona. Such magnetic fields are called as the non-linear force free fields (NLFFFs). Since 1960s, scientists have developed schemes to calculate NLFFFs. In this database, we use a scheme developed by Inoue et al. (ApJ, in submitted). Boundary condition on the photosphere is given from magnetic field data obtained by Hinode. Other boundary conditions are given from potential coronal magnetic fields. Potential coronal magnetic fields are calculated from SoHO/MDI magnetograms.

For this database, we now make a program that automatically perform data fitting between Hinode and SoHO/MDI magnetograms, potential field calculation, and NLFFF calculation. The code for NLFFF calculations is provided from Dr. Inoue (NiCT), and the code for potential field calculations is from Dr. Shiota (Riken). We confirmed results of data fitting and potential field calculations, and now test NLFFF calculation. In this presentation, we report these results, and also report primary results for test active regions.

Keywords: corona, magnetic field, sun

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Basic research on space weather alert for space probes: Comparison EUV and X-ray emissions during solar flares

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Space weather researches have become more and more important, according to the expansion of the ”humanosphere” to space. On the other hand, space weather researches are mainly for circumterrestrial space, and it is insufficient to forecast the radiation hazard for deep space probes that are located far from the earth.

We aim to forecast and evaluate the radiation hazard for such space probes far from the earth by using data taken by Extreme Ultra Violet Imager (EUVI) on board Solar Terrestrial RElations Observatory (STEREO). For this purpose, we have to know how much we can predict flares by using only EUV full-disk images. Therefore, we start with validating how accurately we can predict flares by using EUV images taken by Extreme ultraviolet Imaging Telescope (EIT) on board Solar and Heliospheric Observatory (SOHO). We compared EUV fluxes for flares with X-ray GOES fluxes, and found a positive correlation between them. We also examined the temporal properties in EUV emissions both for flare-productive and non flare-productive regions.

Keywords: solar flare, active region, space weather, extreme ultraviolet, soft X-ray

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PEM030-08 Room:303 Time:May 27 18:15-18:30

Long-term variation in the solar quiet geomagnetic field variation and thermospheric wind based on the IUGONET observati

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It has been well-known that geomagnetic solar quiet (Sq) variation is produced by ionospheric currents associated with dynamo process via interaction between the neutral wind and plasma in a region of the thermosphere and ionosphere. The large-scale motion of the neutral particles is caused by heat convection due to solar irradiance and by tidal force of the sun and moon. From the Ohm's equation, the ionospheric currents which lead to the Sq variation strongly depend on ionospheric conductivity, polarization electric field and neutral wind. Then, trend in the Sq amplitude may include information on the long-term trend in the neutral wind of the thermosphere and ionosphere. Recently, Elias et al. [2010] found that the Sq amplitude tends to increase by 5.4-9.9 % at all the stations in the middle latitudes (Apia, Fredericksburg and Hermanus) in a period of 1961-2001. They mentioned that the long-term variation of ionospheric conductivity associated with geomagnetic secular variation mainly determines the Sq trend, but that the rest component is ionospheric conductivity enhancement associated with cooling effect in the thermosphere due to increasing greenhouse gas. However, the research of the long-term variation of Sq amplitude by Elias et al. [2010] includes the following issues: (1) Since they used only the geomagnetic field data obtained from the three geomagnetic stations until 2001, a global signature of the long-term variation of Sq amplitude has been not clarified yet, (2) The quantitative evaluation between the Sq amplitude and sunspot number cannot be performed correctly during the solar minimum when the sunspot number is zero, and (3) they did not compare the long-term trends in the Sq amplitude and the neutral wind in the lower thermosphere and ionosphere. Then, details of physical process of the long-term Sq variation have not been understood yet. In this paper, we try to clarify quantitatively the effect of the Sq variation on the long-term trend in the neutral wind, and to construct a global picture of upper atmosphere variation associated with increasing greenhouse gas using the long-term observation data of geomagnetic field and neutral wind obtained from the ground magnetometer, MF and meteor wind radars. These observation data have been provided from the institutions participating in the IUGONET (Inter-university Upper atmosphere Global Observation NETwork) project which stated in facial 2009. In the present analysis, we used solar F10.7 flux indicating the solar activity, geomagnetic field data with time resolution of 1 hour observed at Memanbetsu, Kakika and Guam. The definition of Sq amplitude is the size of the H-component variation per day when the Kp index is less than 4. As a result, the Sq amplitude observed at three stations strongly depends on 11-year solar activity, and tends to be more enhanced during the high activities (19- and 22- solar cycles) than during the low activity (20-solar cycle). In order to exclude the solar activity dependence on the Sq amplitude, we calculated second orders of fitting curve between the F10.7 and Sq amplitude during 1957-2010, and examined the long-term trend of the deviation of the fitting curve. The deviation showed a clear tendency to increase and decrease during the periods of 1957-1992 and 1993-2010, respectively. Moreover, it should be noted that the deviation around 2010 is almost the same level as that around 1970. This is inconsistent with the result of Elias et al. [2010], who proposed that the long-term variation of Sq amplitude is caused by the ionospheric conductivities enhancement associated with the decrease of the ambient magnetic field intensity and ionospheric electron density due to cooling effect of increasing the greenhouse gas. This result suggests that the variation of the upper atmosphere associated with an extremely quiet solar activity is dominant because the 23-cycle solar activity is the smallest in the period of 1957-2010.

Keywords: Geomagnetic solar quiet variation, Magnetic field intensity, Solar activity, Ionospheric conductivity, Thermospheric wind, Upper atmosphere

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PEM030-P01 Room:Convention Hall Time:May 26 10:30-13:00

Temporal and spatial variations of loop-top microwave sources during the whole period of a solar flare

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We report an analysis result of NSRO-CDAW10 (Coordinated Data Analysis Workshop) that was held at Nobeyama Solar Radio Observatory from Oct. 25 to Oct. 29, 2010.

When a solar flare occurs, a large amount of electrons are accelerated, they emit hard X-rays, gamma-rays and microwaves. Especially, the nonthermal emissions from flare loop-top sources are related to acceleration/transportation processes of electrons under the magnetic reconnection point. So in order to understand acceleration/transportation processes of electrons under the reconnection point, it is important to study temporal and spatial variations of loop-top sources by using data of multiwavelength observation.

We studied an M3.7 class flare which occurred on Jul. 27, 2005. This flare took place behind the limb. So we can see only loop-top source itself without any effects of emissions from the footpoints. We used two frequency data of Nobeyama Radio Heliograph (17GHz and 34GHz, both of them are emitted by MeV electrons). According to a simulation (Minoshima et al. submitted to ApJ), we expect that loop-top microwave source of 34GHz is located lower than that of 17GHz, because higher energy electrons which emit 34GHz microwave can reach to a lower altitude with less collisions during the transportation. But we got a result that the loop-top source of 34GHz was located higher than that of 17GHz during the whole period of the flare. And it was found that around the peak time of the flare, the height difference between the 17GHz and 34GHz loop-top sources became larger. In this presentation, we discuss why the loop-top source of 34GHz is located higher than that of 17GHz, and why the height difference between the 17GHz and 34GHz loop-top sources becomes larger around the peak time of the flare.

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Unresolved Magnetic Flux Removal Process in the Photosphere

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The mutual loss of magnetic flux due to the apparent collision of opposite-polarity magnetic elements is called “magnetic flux cancellation” as a descriptive term. This flux cancellation is essential to the process of replacement of old magnetic flux with newly emerging flux in the quiet Sun on a timescale of a few days, and also to the process of removal of sunspot magnetic flux from the photosphere. An Omega-loop submerging below the surface or a U-loop rising through the photosphere is the usual idea to explain the magnetic flux cancellation. Magnetic reconnection may be crucial for the formation of these loops, especially for the submerging Omega-loop. In fact, chromospheric and coronal activities are often observed at the cancellation sites. We investigate the evolution of 5 cancellation events of the opposite-polarity magnetic elements at granular scales by using accurate spectropolarimetric measurements with the Solar Optical Telescope aboard Hinode. We find that the horizontal magnetic field, which is expected in both submerging Omega-loop model and emerging U-loop model, does not appear between the canceling magnetic elements in 4 of the 5 events. The approaching magnetic elements in these events are more concentrated rather than gradually diffused, and they have nearly vertical fields even while they are in contact each other. We thus imply that the actual flux cancellation is highly time dependent event near the solar surface at scales less than a pixel of Hinode/SOT (about 200 km). At the polarity inversion line formed by the canceling magnetic elements, highly asymmetric Stokes-V profiles are observed. We confirm that such asymmetric profile can be made by the sum of the profiles at the opposite-polarity magnetic elements next to the polarity inversion line. This means that the approaching bipolar flux tubes still keep their nature within the pixel where they come in contact with each other, and thus supports the unresolved flux removal process within the pixel at the polarity inversion line.

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Spectroscopic Observations of Solar Flares with the Hinode EIS

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We review spectroscopic observations of solar flares with the Hinode EUV Imaging Spectrometer (EIS). EIS has been observing two EUV wavelength bands, 17-21 nm and 25-29 nm since Dec 2006. These wavelength bands contain many emission lines that are emitted from hot plasmas with temperatures of the transition region, the corona, and solar flares. A lot of information is indeed included in these emission lines that can simultaneously be observed in EIS observations. We especially introduce results of EIS spectroscopic observations in terms of the hot-plasma generation and flare-plasma dynamics in the impulsive phase with complementary imaging observations.

Keywords: Solar Flares, Corona

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The Relation between type II Radio Burst and Streamer-CME/Flare Interaction

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Solar Radio burst occures with flare of Coronal Mass Ejection(CME), and is classfied with freqency and timescale, and each type has defferent information. Type II radio burst occures when shock wave from flare or CME excites electron and electromagnetic wave occures with the plasma freqency. Type II burst has information of coronal shock wave. Cho et al(2008) suggested that type II burst occures not only from shock wave propagation to tha radial direction but also the interaction between CME and streamer. And at ASJ 2010 autumun anual meeetig, we suggested that the derection of shock wave propagation is associated with appearance of type II burst. We reserch the occurrence of type II burst with MHD simulation. The viewpoint is interaction between streamer and flare or CME, and direction of propagation. We are going to report this analysis.

Keywords: flare, Coronal Mass Ejection, Type II Radio Burst, Streamer

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Ratio of thermal to non-thermal energy in solar flares

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It has been a question in the particle acceleration problem in solar flares how much energy is to non-thermal. In non-thermal dominant cases, flares trend to generate high energy particles, such as electrons that is responsible to strong non-thermal emission in hard X-rays and in microwave as well as protons and alpha particles. Therefore, it is important not only for solar physics but also for space weather studies to understand what the conditions of intense non-thermal energy release are, and to quantify how much energy is. To estimate the ratio of thermal energies to non-thermal energies, we aim for the emissions from solar flares in thermal and non-thermal conditions. We treat other conditions such as duration of solar flares, and we think that the ratio of a flux of the thermal to the non-thermal emission gives a solution of the problem of the ratio of thermal to non-thermal energies.

An empirical raw, so-called the ”Neupert effect”, has a key to connect thermal and non-thermal energies. This suggests that the integration of flux of non-thermal emission (hard X ray, microwave) is consistent with the temporal behavior of thermal emission (soft X ray). However, the soft X-ray emission estimated from non-thermal emission is different from the observed soft X-ray flux and the error is about one order of magnitude. These problems can be thought that the ratio of the energies converted to the non-thermal energy in solar flare is not a constant.

We use the Neupert effect with microwave observation at the beginning of its theory, but now we use it mainly with the hard X rays observations. One of the reasons of this is the complexity of microwave emission mechanisms; microwave flux is depending on magnetic strength, energy of electron in flare loop, line of sight, pitch angle distribution of electrons, and so on. Microwave emission is observed from gyro-synchrotron radiation of electrons trapped in the flare loop, and same trapped electrons may emit microwave continuously. Therefore the flux of microwave is not always proportional to the number of the electrons. Another difference of hard X ray observation is that hard X ray observation watch emission from electrons of few keV to few hundred keV, on the other hand, microwave observation watch emission from electrons of few hundred keV to few MeV. Therefore, which energy gives Neupert effect, or chromospheric evaporation effectively is not revealed yet.

We compare soft X ray, hard X ray and microwave emissions, and evaluate the fraction of non-thermal energy in flares and the effectiveness of Neupert effect. We investigate soft X ray data taken by GOES and RHESSI, hard X ray data by RHESSI, and microwave by Nobeyama Radioheliograph (NoRH). We compare the time integration of non-thermal emissions to maximum flux of thermal emissions statistically. We discuss which energy band range (hard X ray or microwave) is effective for the Neupert effect using data of NoRH, RHESSI. We also investigate the morphology of flare loops and the energy release conditions using data of SOHO MDI/EIT, TRACE.

Keywords: solar flare, microwave, high energy, X-ray

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Properties of magneto-convection on the solar surface revealed with HINODE

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In the solar atmosphere, interaction between magnetic fields and surface convection produces varieties of structures over the broad spatial scale from 100 to 10^5 km. The energy produced by the interaction is transferred to the upper solar atmosphere, and causes coronal heating and solar wind acceleration. Spatial power spectra of velocity and magnetic fields on the solar surface provide a clue to understand in which scale kinetic and magnetic energies are generated, transferred, and dissipated in the solar atmosphere. HINODE is the most suitable instrument to study it observationally because of high and stable image quality and precise measurements of velocity and magnetic fields. We present results of the power spectral analysis of two dimensional fluctuations of surface temperatures, velocities, and magnetic fields, and their implication on properties of magneto-convection in the solar atmosphere.

The two dimensional spatial power spectra of the surface temperatures and velocities clearly exhibit a peak at the granular scale (around 1000km) and a power-law at the spatial scale smaller than granules, which indicates that kinetic energies are injected at the granular scale because of the thermal convection, and they cascades into smaller scale through turbulent action of convection. But the power-law slope of the kinetic energy is stepper than the Kolmogorov's slope of -5/3 in the isotropic turbulence. A power spectrum of magnetic energies has very broad spectrum between super-granular (10000 km) and granular scales (1000 km). The slope of the magnetic energy spectrum is less steep than that of kinetic energies, and it is found that there is a signature of deviation from the power law at the spatial scale smaller than 300km. It suggests that coupling among convection, magnetic fields and radiation becomes important at that scale. The power spectra do not depend on mean magnetic flux in the regions, which suggests that they are universal properties of magneto-convection on the solar surface.

It is suggested that magnetic fields in the quiet Sun is created by local dynamo due to convective turbulence. In order to operate the local dynamo efficiently, kinetic and magnetic energies have to be enhanced at the smaller scale. However the study of the power spectra indicates that these energies are rather suppressed at the smaller scale, and no evidence to support the local dynamo as the origin of magnetic fields in the solar atmosphere.

Keywords: the Sun, photosphere, convection, magnetic fields, HINODE

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Hinode flare catalog and statistical analyses of solar flares

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The catalog of solar flares have been made which were observed by three instruments (SOT, XRT, EIS) onboard the Hinode satellite from October, 2006.

Recently, the catalog or the event list of observing data of satellite are open to the public, and it has been utilized by a lot of researchers for a statistical research and the event extraction of the flare.

Field of view (FOV) of Hinode satellite does not always cover the full sun - that depends on the observing target. So, even if Hinode observes the Sun during the solar flare, that solar flare is not necessarily observed by the Hinode. Therefore, this Hinode flare catalog is expected to be utilized for a lot of researchers for flare analyses.

The procedure to make the Hinode flare catalog is as follows;

(1) Derive the solar flare event to which the flare site is known from the SSW latest image page (http://www.lmsal.com/solarsoft/last events/) of LMSAL.

(2) Derive the observational data during the flare and which flare position was located in the FOV of each instrument, and count the number of observing images.

(3) Compare with the RHESSI flare list, and check the maximum energy range of hard X-rays observed by the RHESSI.

By using the method of (1), we could include the many flares in our flare catalog. Now more than 3000 event was listed in the catalog, and more than 50% of them were observed by the Hinode satellite. These Hinode images and the summary plot of GOES X-ray also will be available on the web site soon.

Next, we introduce the example of analysis by using the Hinode flare catalog. One of these is the statistical analysis of white light flares. In association with a solar flare, we sometimes observe enhancement of visible continuum radiation, which is called a 'white-light flare'. Since close correlations of white light and hard X-ray emissions occur in many events, there is some consensus that the origin of white-light emission is accelerated particles, especially non-thermal electrons.

We analyze one of the white light flares occurred on December 14, 2006 in detail. We use G-band data of SOT as white light emission and hard X-ray data observed by the RHESSI satellite. We compared the white-light power and the electron power assuming a blackbody for the white light and the thick-target model for the non-thermal electrons, obtaining a good correlation (Watanabe et al., 2010).

In this paper, we present a statistical analysis of the SOT white-light events and discuss the flare parameters. We also review models to explain the observations in terms of particle acceleration.

Keywords: solar flare, particle acceleration

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Research activities during the extension peirod of the scientific operation of Nobeyama Radio Heliograph

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The scientific operation of Nobeyama Radio Heliograph has been extended by the end of March 2015. The fiscal year 2010 (April 2010 ? March 2011) is the first year of the extension period. In order to maximize the scientific outcome during this extension period, the Nobeyama Radio Heliograph Scientific Operation Consortium was established and has performed the research plans and the operations which were proposed to National Astronomical Observatory of Japan (NAOJ) by it.

The main research topics during the extension period are ”better understanding of the acceleration/transport/dissipation processes of high-energy (a few hundreds keV ˜ a few MeV) electrons in solar flares”, ”derivation of coronal magnetic fields”, ”research on prominence eruption and its utilization to space weather research”, and ”long-term variation of solar active phenomena through two solar cycles”. Recently several results were achieved on these topics. In this presentation, we briefly introduce them.

In addition to these researches, we proposed the following proposals, ”constitution of a subcommittee on Nobeyama Radioheliograph scientific operation consortium in NAOJ”, ”to hold a users’ meeting each year”, ”to have a CDAW (Coordinated Data Analysis Workshop) each year”, ”encouragement for domestic scientists to of stay for collaborative researches at Nobeyama”, ”collaborative researches with Hinode”, ”teaching and lectures/seminars by the scientists in Nobeyama Solar Radio Observatory”, ”appeal the results to public”, ”to find seeds which expand to a new project in the future”, and ”advertisement of this research field for under-graduate students”. Some of them have already been realized in the fiscal year 2010. In this presentation, we also report such activities.

Keywords: solar radio, solar flare, particle acceleration, solar activity cycle

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On predictive abilities of magnetospheric disturbances based on STEREO-A/B solar wind measurement

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Some recent studies have correlated solar wind data from STEREO-A and ?B, and discussed possible applications for space weather forecast, including predictive ability of solar wind monitor at the L5 point. They reported, in general, a good correlation and suggested its usefulness in forecasting geomagnetic disturbances due to co-rotating structures. However, they never took into account geoeffective solar wind conditions in the correlation studies. It may not be so useful to get a high correlation for quiet intervals. In this paper, we sort solar wind data of ACE by geoeffective grade, evaluate actual ability for forecasting magnetospheric disturbances from STEREO-A and ?B solar wind measurement, and discuss prospect in future operation of space weather forecast.

Keywords: STEREO

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Analysis on solar cell degradation of Akebono satellite due to space radiation

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Instruments on spacecraft have various problems under severe space radiation environment. In our research, we analyze electric current (SCPI) generated by Akebono solar cell panels over 20 years. SCPI was basically decreased from 13 A to about 7 A, but it was not a monotonic decrease. Various variation components are included. Compared with NASA's radiation models, we have found a component of periodic SCPI decrease caused by radiation of trapped energetic protons. There is also a component of irregular variation supposed to be due to temperature effect. Solar energetic protons, in general, causes degradation, and energetic protons observed by GOES are also being analyzed. Through these analyses, we will identify quantitatively all the contributing factors of the solar cell degradation during the interval.

Keywords: Akebono, solar cell, radiation

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Overview of initial observation data of Technical Data Acquisition Equipments on the first Quasi-Zenith Satellite

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TEchnical Data Acquisition equipments (TEDA) on the first Quasi-Zenith Satellite (QZS-1) ”MICHIBIKI” was launched by the H-IIA Launch Vehicle No.18 on September 11, 2010 from the Tanegashima Space Center. The TEDA consist of three types of sensors; Light Particle Telescope (LPT, including Alpha particle and Proton Sensor-B (APS-B) and Electron Sensor-A (ELS-A)), Magnetometer (MAM), and Potential Monitor (POM). The TEDA on the QZS-1 have collected these data of space environment from September 21, 2010, these data will help to identify the cause of the satellite anomaly. This paper describes some results and opinions of these data analysis on the QZS-1 orbit.

Keywords: QZS, TEDA

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Measurement result of the neutron monitor onboard Space Environment Data Acquisition Equipment (SEDA-AP)

Kiyokazu Koga[1*], haruhisa matsumoto[1], Takahiro Obara[1], Tokonatsu Yamamoto[2], Yasushi Muraki[2]

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To support future space activities, it is very important to acquire space environmental data related to space radiation degradation of space parts and materials and spacecraft anomalies. Such data are useful for spacecraft design and manned space activity.

SEDA-AP was mounted on ”Kibo” of ISS (International Space Station) to measure the space environment of the 400 kilometres altitude for 3 years.

Neutrons are very harmful radiation because of their strong permeability attributable to its electrical neutrality. The Neutron Monitor measures the energy of neutrons from thermal to 100 MeV in real time using a Bonner Ball Detector and a Scintillation Fiber Detector. The Bonner Ball Detector discriminates neutrons from other charged particles using 3He counters, which have high sensitivity to thermal neutrons. It also measures neutron energy using the relative response, which corresponds to different polyethylene moderator’s thickness (6 pcs.). The Scintillation Fiber Detector measures the track of incident particles using a cubic arrangement sensor on which are heaped up 512 scintillation fibers. The sensor discriminates neutrons using differences of these tracks, and measures neutron energy by measuring its track length.

This paper reports the development, mission objectives, instrumentation and current status of neutron monitor.

Keywords: Neutron monitor, Kibo, ISS, Exposed facility, SEDA-AP

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Radiation Measurement by the Light Particle Telescope for the Jason-2 Satellite

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[1]Japan Aerospace Exploration Agency

An ocean observation satellite Jason-2 by CNES (France) was launched in June 2008 and carried JAXA's radiation environment monitor called Light Particle Telescope (LPT). The LPT consists of four sensors which can measure electrons with energy from 25keV to 20MeV, protons from 0.3MeV to 230MeV and 4He particles from 0.8MeV/n to 80MeV/n totally. The altitude of Jason-2 orbit is 1,336 km and its inclination is 66 degree. Radiation environment at that altitude was measured for the first time. In addition, another LPT will be onboard a successive satellite Jason-3, which has the same orbit and mission period of 5 years. With Jason-2 and Jason-3, we are able to observe a radiation environment at an altitude of 1336 km through a solar cycle of 11 years. The measurement data are expected to contribute to getting a new knowledge of the radiation belt and to making a new model of the radiation belt.

Analysis of Jason-2 data is in progress. And we are developing the LPT for Jason-3; one of the sensors in the LPT will be improved to be able to count electrons at a high rate environment.

In our presentation, we will introduce the Jason-2 measurement data and the current status of Jason-3 LPT.

Keywords: radiation environment, radiation belt, light particle telescope, Jason-2

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PEM030-P14 Room:Convention Hall Time:May 26 10:30-13:00

Study of Forecasting the Geostationary Plasma Environment and Satellite Surface Charging by Using a Real-time Magnetosph

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In recent geostationary satellites, the bus voltage has become higher (>100 V) than before, and this induces new types of satellite anomalies, e.g., the sustained arcing caused by surface charging. The surface charging is induced by the hot plasma injected from the plasmasheet in the magnetotail into the geostationary orbit during substorms (so-called substorm plasma injection). Therefore, it is important to study methods of forecasting the geostationary plasma environment (mainly the substorm plasma injection) and the resultant satellite surface charging. A real-time magnetospheric simulation has been routinely carried out on the super computer system at National Institute of Information and Communications Technology (NICT). This simulation calculates the magnetosphere by the three-dimensional magnetohydrodynamic (MHD) method using the real-time solar wind data observed by the Advanced Composition Explorer (ACE) spacecraft at the Lagrangian point L1. Since the solar wind reaches the Earth about one hour after it passes the ACE spacecraft by its average speed, this simulation calculates the conditions of the magnetosphere about one hour before.

To confirm whether the simulation reproduces the substorm plasma injections, We compares the simulation data at the midnight point of the geostationary orbit and the data observed in the night side (MLT: 21-3 hour) by the geostationary satellites of Los Alamos National Laboratory (LANL). As the result, the simulation frequently reproduced the substorm plasma injections about one hour before. That means the enhancements of the simulation pressure were consistent with those of the electron pressure about one hour later. Since the electron temperature is a key parameter for the surface charging potential, we have proposed a new method of estimating the upper limit of the electron temperature from the simulation data. Using the electron temperature, we are able to estimate the worst surface charging potential of the geostationary satellites about one hour before.

To examine how accurately the simulation can forecast the substorm plasma injections, I evaluate the correlation of the pressure enhancements between simulation and observation data by varying time delays and intervals. Here we consider that the substorm plasma injection is generated when the pressure is enhanced over a threshold value. If we take the threshold 0.5 nPa, the forecast accuracy, whether the substorm plasma injection is generated or not, was about 83 % where the delay is 25 minutes and the interval is 55 minutes in the best of all other combinations of delays and intervals.

Keywords: Real-time magnetospheric simulation, Geostationary plasma environment, Spacecraft charging, Space weather

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PEM030-P15 Room:Convention Hall Time:May 26 10:30-13:00

Magnetic field depression at the Earth's surface during ENA emission fade-out in the inner magnetosphere

Masahito Nose[1*], Shinichi Ohtani[2], P. C:son Brandt[2], Toshihiko Iyemori[1], Kunihiro Keika[3], D.-Y. Lee[4]

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Using data from the high-energy neutral atom (HENA) imager onboard the IMAGE satellite, we examined the relation between the SYM-H index and the ring current energy during a storm main phase. The energy range of the energetic neutral atom (ENA) flux data used here is 16-120 keV for hydrogen and <180 keV for oxygen. From the data for the period 2000-2002, we selected 24 storm main phase events during which the IMAGE satellite was located at a geomagnetic latitude of >=45 degrees and a geocentric distance of >=6 R_E. According to the Dessler-Parker-Sckopke (DPS) equation, the ring current energy is expected to increase as the SYM-H index decreases. When the ENA energy flux is superimposed as a function of the SYM-H index for all 24 events, their overall correlation is negative; that is, the relation between the ENA energy flux and the SYM-H index is generally consistent with the DPS equation. However, an analysis of individual events showed only 10 events (42%) in which the ENA energy flux was negatively correlated with the SYM-H index (negative correlation events). There were 10 events showing no clear correlation between the ENA energy flux and the SYM-H index (no correlation events), and 4 events which contradicted the DPS equation (positive correlation events). In the superimposed plot, we noted that a smooth curve can be drawn for an upper limit of the data distribution, and data from the no correlation or positive correlation events create downward branches in the distribution. These observational results are not explained by the conventional DPS equation but by the "generalized" DPS equation, which includes a term representing energy stored in the stretched magnetic field. We can reasonably presume that the stretched magnetic field prevents energetic particles from being injected into the ring current. From the generalized DPS equation, we conclude that the total (kinetic and magnetic) energy stored in the stretched field and ring current loss mechanisms are important for understanding the relation between the ground magnetic field variation and ring current energy variation.

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PEM030-P16 Room:Convention Hall Time:May 26 10:30-13:00

A nowcast model of the auroral oval and Kp index

Yasutomo Morii[1], Satoru Nakashima[1], Haruna Aniya[1], Satoshi Taguchi[1*]

[1]Univ. of Electro-Communications

A numerical model of the aurora oval distribution and the corresponding Kp index has been developed. This model is based on an empirical model of the high latitude potentials we have recently constructed using nonlinear functions of the solar wind parameters, and on empirical relations between the precipitation boundary of the aurora particles, i.e., the equatorward latitude of the central plasma sheet and the Kp index. The obtained model of the auroral oval shows its dynamic nature, and the model Kp index, which can be produced from inputs of ACE solar wind parameters, IMF Bz, By, and Vsw shows a good correlation to the official Kp index, especially magnetic active times, Kp>5, which has been thought to be difficult to predict in previous studies.

Keywords: auroral oval, Kp index, solar wind, magnetic storm, nowcast

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PEM030-P17 Room:Convention Hall Time:May 26 10:30-13:00

Significance of Fritz's isochasms deduced from the numerical auroral oval model

Haruna Aniya[1*], Satoshi Taguchi[1], Yasutomo Morii[1], Satoru Nakashima[1]

[1]Univ. of Electro-Communications

We have examined the significance of historical Fritz's isochasms, i.e., lines where the aurora occurs with equal frequency, by using the numerical aurora oval model which we have developed recently. In some meridians our output is in remarkably good agreement with Fritz's distribution, but there is systematic deviation in other meridians. We discuss these results, and show the significance of Fritz's result considering the Earth's magnetic field in the 1800s.

Keywords: auroral oval, numerical model, historical observations

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Relationship between the quiet-time level of magnetic H component at mid-latitudes and long-term solar-wind activity

Shin'ya Nakano[1*], Hiromichi Nagao[1], Tomoyuki Higuchi[1]

[1]The Institute of Statistical Mathematics

Although the Dst index is expected to be near zero during quiet conditions, the quiet-time level of Dst has a long-term (monthly or longer) variation. This variation of the quiet-time level includes not only a seasonal variation but also an irregular variation.

In order to clarify the relationship between the quiet-time level and solar-wind activity further, we analyzed magnetic H-component values for several mid-latitude observatories. We decomposed the time series of monthly quiet-time H values for each observatory into secular, seasonal, and irregular variations using a state space model with the Kalman filter. The result shows that the quiet-level of H is enhanced under long low solar-wind activity for all the observatories. This fact indicates that this enhancement is a global magnetospheric phenomenon. We interpret the result to mean that long low solar-wind activity would cause plasma depletion in the magnetosphere.

Keywords: Dst index, long-term variation

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A visualization of Sq equivalent current system from MAGDAS data

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In order to understand generation mechanisms of day-to-day Sq current variations for space weather study, we tried to visualize (1) daily Sq equivalent currents estimated by MAGDAS/210 MM data, (2) daily Sq patterns obtained by the empirical model (Yamazaki et al., 2010), and (3) the subtraction of (1) - (2), i.e. the daily disturbance driven by changes in the solar wind and atmospheric neutral wind.

The daily Sq currents from 4 January to 31 December 2008, were obtained from magnetic data at 16 stations of MAGDAS/CPMN project, Space Environment Research Center, Kyushu University. In the present paper, we investigated the relationship between the interplanetary electric field (i.e. Ey =- Vsw x Bz(IMF)) and (3) the subtracted Sq currents in the magnetic equatorial region.

It is found that about 20% of 363 days the subtracted Sq currents at the magnetic equator showed a good correlation with the interplanetary magnetic field (IMF), i.e. the eastward EEJ was enhanced during the negative IMF Bz component, while the westward EEJ appeared during the positive IMF Bz component. On the other hand, 66% of 363 days we could not find a good relation between the subtracted Sq current near the dip equator and the IMF Bz variations, indicating the possibility of a coupling mechanism with the atmospheric neutral wind.

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Keywords: Sq, EEJ

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Development of a 2-D ionospheric global potential solver: GEMSIS-POT

Aoi Nakamizo[1*], Yasutaka Hiraki[2], Yusuke Ebihara[3], Akimasa Ieda[1], Tomoaki Hori[1], Takashi Kikuchi[1], Kanako Seki[1], Yoshizumi Miyoshi[1]

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As part of the GEMSIS project, we have developed a two-dimensional ionospheric global potential solver. There has been considerable research on the mid-and low-latitude ionospheric system driven by neutral wind [e.g., Richmond, 1973]. However, there are few researches on the relationship between the high-latitude system and mid-and low-latitude system, which is important for the integrated studies of the magnetosphere-inner magnetosphere system coupled through the ionosphere.

Our model basically follows a methodology provided by Tsunomura [1999]; it solves the Ohm's law under the thin-shell approximated 2-D ionosphere, with FACs in the polar region and height-integrated ionospheric conductivities. The most important extension from previous studies is that our model covers both hemispheres without a boundary at the equator. The values of Pedersen and Hall conductivities are calculated as exactly as possible with the MSIS-2000, IRI-2007, and IGRF-2005 reference models. In addition, we consider the effect of auroral particle precipitation on conductivities with the Hardy model.

In this talk, we report the progress of our model toward the practical studies of Magnetosphere-Ionosphere coupling system during storms and substorms. We will discuss the effect of the equatorial conductivity on the pole-to-pole distribution of the electric potential.

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Relationship between long-period electric and geomagnetic field oscillations observed by FM-CW Radar and MAGDAS

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Long-period oscillations are observed globally by the ground-based magnetometers. In particular, low-latitude and equatorial long-period oscillations (ex. Pc 5 pulsation) have been attributed to DP 2 type current system in the ionosphere. However, observations in the ionosphere are not so much reported. We believe that more extensive use of HF radars will lead to a better understanding of long-period oscillation.

The present study is based on the data from an FM-CW radar located at Sasaguri, Japan (SAS; M. Lat. = 23.2 degree, M. Lon. = 199.6 degree, LT = UT + 9.5 hrs). The FM-CW radar measure reflected radio waves from targets (e.g., ionized layer) as well as Doppler shift of those. East-west electric field in the ionosphere is estimated from the observed Doppler shift.

On 30 October 2003, long-period (1-8 mHz) magnetic oscillation was observed at equatorial station YAP (YAP: M. Lat. = 1.49 degree, M. Lon. = 209.1 degree) and low-latitude station Kuju (KUJ; M. Lat. = 23.6 degree, M. Lon. = 203.2 degree) in ground magnetic horizontal northward components (H). The FM-CW radar at SAS also detected the oscillation of the ionospheric east-west electric field Ey. These stations were located at a daytime sector during the event. The coherence between the Ey with the H at YAP showed higher coherence than that of between the Ey and the H at KUJ. Also the oscillation showed an equatorial enhancement. Thus our results suggested that the oscillation is caused by the DP2-type current system rather than by the global compression or field line resonance. The phase difference between the Ey and the H at YAP decreased with increasing frequency of oscillation. The phase relation is consistent with between currents and electric fields of the LR circuit in the equatorial high conducted ionosphere. In other words, the long-range oscillation in H at daytime was excited by the ionospheric electric fields.