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

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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PEM030-P02 Room:Convention Hall Time:May 26 10:30-13:00

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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PEM030-P03 Room:Convention Hall Time:May 26 10:30-13:00

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

Wataru Miyake[1*], Tsutomu Nagatsuma[2]

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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

Satoshi Furuhata[1*], haruhisa matsumoto[2], Takahiro Obara[3]

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

Tomo Sakata[1], Masao Nakamura[1*], Hiroyuki Shinagawa[2], Shigeru Fujita[3], Takashi Tanaka[4]

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

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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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A nowcast model of the auroral oval and Kp index

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

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

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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]

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

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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.