Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

PEM29-01 Room:304 Time:May 21 13:45-14:05

Recent Hinode Observations of Solar Flares

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With starting the new solar cycle, large flares, i.e., X-class and M-class flares, began to occur on the solar disk in 2011. ”Hinode” successfully captured an X2.2 flare in 15 February 2011, followed by other successful observations of some large flares. X-Ray Telescope (XRT) performs high-cadence soft X-ray imaging observations not only during the flares but also in pre-flare phase, by using its flare automatic trigger function. Solar Optical Telescope (SOT) monitors an active region with medium-cadence photospheric magnetic-field and chromospheric Ca II H observations and, in response to the XRT flare trigger, switches to high-cadence observations for white-light flares and chromospheric dynamics. EUV Imaging Spectrometer (EIS) performs so-called flare hunting study, in which an active region is repeatedly and sparsely scanned but with fairly high (about 6 minutes) cadence. The Hinode team is optimizing our flare observations for better observations, although severe limitation of the telemetry volume and narrow telescopes’ field of view make it difficult to hunt large flares. Regions with the potential to produce flares will be given the highest observing priority. The target for the observations may utilize the Maximum Millennium Flare Watch target designation. In addition, Hinode began instituting a Hinode Flare Watch that may be called by the representatives in the Hinode team. In this presentation, we will show some observing data from recent large flares and discuss how Hinode observations are important for flare investigations.

Keywords: solar flare, Hinode, Soft X-ray, UV, Optical

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PEM29-02 Room:304 Time:May 21 14:05-14:25

A prospective vision of future space weather research and operation

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Main methodologies of Space Weather so far are theoretical, experimental and observational, and computer simulation approaches. Recently ”informatics” is expected as a new (fourth) approach to the STP studies. Informatics is a methodology to analyze large-scale data (observation data and computer simulation data) to obtain new findings using a variety of data processing techniques.

At NICT (National Institute of Information and Communications Technology) we are now developing a new research environment named OneSpaceNet. The OneSpaceNet is a cloud-computing environment, which connects many researchers with high-speed network (JGN: Japan Gigabit Network). It also provides the researchers rich resources for research studies, such as super-computer, large-scale disk area, licensed applications, database and communication devices. What is amazing is that a user simply prepares a terminal (low-cost PC). After connecting the PC to JGN, the user can make full use of the rich resources via L2 network. Using communication devices, such as video-conference system, streaming and reflector servers, and media-players, the users on the OneSpaceNet can make research communications as if they belong to a same (one) laboratory: they are members of a virtual laboratory.

We present two initial results using the OneSpaceNet for large-scale computer simulation data transfer and virtual observation data transfer system.

Keywords: Informatics, Space Weather, Science Cloud

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PEM29-03 Room:304 Time:May 21 14:25-14:40

Confined Solar Flares observed by the Solar Dynamic Observatory

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Since coronal mass ejections (CMEs) are main cause of solar energetic particle events and geomagnetic storms, the CME forecasting is essentially important for the space weather. During 2011 February ? 2012 January, 21 major flares (>= M5 level) occurred. We examined their association of coronal mass ejections (CMEs) by viewing the white light images obtained by the LASCO C2 and STEREO COR1 coronagraphs. We found that, out of the 21 major flares, four lacked the associated CMEs. The four confined flares were an M6.6 flare on 2011 February 18, an X1.5 flare on 2011 March 9, an M5.8 flare on 2011 September 24, and an X1.9 flare on 2011 November 3. We examined flare locations in the active region using the SDO/AIA and SDO/HMI data and found that each flare occurred at the center of the AR. We confirmed that the confinement by the overlying magnetic field is responsible for the confined major flares.

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PEM29-04 Room:304 Time:May 21 14:40-14:55

Dynamic behavior of the radiation belt electrons during the big magnetic storm

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Outer radiation belt electrons vary largely at the commencement of the magnetic storm. According to the JAXA satellite observations, followings have been identified; i.e. i) MeV electrons in the outer radiation belt disappear, ii) 300keV electrons disappear largely, iii) 30˜100keV electrons increase intensity, and iv) demarcation energy between increase and decrease may be in between 100keV and 300keV, depending on the individual magnetic storm.

These observation results suggest that loss of highly energetic electrons occurs in a wide energy range together with a transportation of the intermediate energy electrons to the outer radiation belt zone.

We have paid a particular attention to the very big magnetic storms to investigate a dynamical behavior of so-called slot region (L˜2.5). For the very large magnetic storm, 300keV electrons moved to the slot region and the injection of 30˜100keV electrons was also identified till the slot region. The movement of the electrons is likely caused by the terrible large electric field, which appears during the big magnetic storm.

The electrons in the slot region, then, decrease their intensities, and some of them drifted inward to the inner radiation belt region. The inward motion is caused by the radial diffusion and we are trying to estimate time constant by investigating the electron pitch angle characteristics obtained by the JAXA satellite. Outer belt electrons, on the contrary, increase their intensities, which is very common during the normal magnetic storm.

Keywords: Radiation Belt Electron, Magnetic Storm, Slot Region, Electron Accerelation, Doffusion

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PEM29-05 Room:304 Time:May 21 14:55-15:10

Long-term variation in the upper atmosphere as seen in the geomagnetic solar quiet (Sq) daily variation

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It has been well-known that geomagnetic solar quiet (Sq) daily variation is produced by the global ionospheric currents flowing in the E-region from middle latitudes to the magnetic equator. These currents are generated by dynamo process via interaction between the neutral wind and ionospheric plasma in a region of the thermosphere and ionosphere. The motion of the neutral particles is driven by heat convection due to solar irradiance and by tidal force of the sun and moon. From the Ohm's equation, the ionospheric currents strongly depend on ionospheric conductivity, polarization electric field and neutral wind. Then, to investigate the Sq amplitude is essential for understanding the long-term variations in the ionospheric conductivity and 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 % 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. In this talk, we try to clarify the characteristics of the long-term variation in the Sq amplitude using the long-term observation data of geomagnetic field and neutral wind. These observation data have been provided from the IUGONET (Inter-university Upper atmosphere Global Observation NETwork) project which stated in facial 2009. In the present analysis, we used the F10.7 solar flux as a good indicator of the variation in the solar irradiance in the EUV and UV range, geomagnetic field data with time resolution of 1 hour observed at 184 geomagnetic stations. The definition of the Sq amplitude is the difference of the H-component between the maximum and minimum every day when the Kp index is less than 4. As a result, the Sq amplitude at all the geomagnetic stations is closely correlated with the solar F10.7 index, and tends to be more enhanced during the high activities (19- and 22- solar cycles) than during the relatively low activity (20-solar cycle). The Fourier spectrum of the Sq amplitude shows one peak in the high latitude around 1 year and two peaks in the low latitude and at the equator except for solar activity periods (5.5, 7,5 and 10.5 years). The coherence value between the F10.7 index and Sq amplitude gives more than 0.8 around 5.5, 7,5 and 10.5 years. Therefore, it can be concluded that the semi-annual and annual variations of the Sq amplitude is a cause of the upper atmosphere variation. In order to minimize the solar activity dependence on the Sq amplitude, we calculated second orders of fitting curve between the F10.7 and Sq amplitude during 1950-2011, and examined the residual Sq field defined as the deviation from the fitting curve. The residual Sq amplitude clearly showed increase and decrease trends with the periods of 20 years. It should be noted that the residual Sq amplitude around 2010 is almost the same level as that around 1970. On the other hand, the similar tendency can be seen in the diurnal variation of geomagnetic field in the auroral zone and polar cap (Sqp field) driven by the twin vortex of ionospheric currents associated with energy input of solar wind into the ionosphere. Then, it seems that the trends in the residual Sq and Sqp fields are related to the long-term variation in the ionospheric conductivities associated with the secular variation of the ambient magnetic field and the upper atmosphere (for example, plasma and neutral densities). In order to verify qualitatively the above signatures, we need to investigate the long-term variation in the ionospheric conductivities calculated using the IRI-2007 and MSIS-00 models.

Keywords: IUGONET, metadata database, Integrated data analysis software, geomagneitc solar quiet daily variation, ionospheric conductivity, upper atmosphere

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PEM29-06 Room:304 Time:May 21 15:30-15:45

Chromospheric evaporation observed with Hinode/EIS: temperature dependent upflow in the impulsive phase

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The analysis of a chromospheric evaporation in a M-class flare observed with the EUV Imaging Spectrometer (EIS) onboard *Hinode* was conducted. We report for the first time the dependence on temperature of the chromospheric evaporation in the growing flare loops.

The solar flares are the most energetic phenomena in the solar atmosphere, which release the magnetic energy through magnetic reconnection. The coronal plasma is heated up to a few tens of MK in the slow shocks extended from the reconnection point. In that regime, thermal conduction becomes dominant, and the chromosphere at reconnected flare loops, dense and cool (T~10^4K) plasma experiences impulsive heating by reaching thermal conduction front. The gas pressure of the heated chromosphere suddenly raises to around 10MK, which results in so called *chromospheric evaporation*, fast upflow along the flare loop with the sound speed (~500 km s^{-1} at 10MK). This phenomenon has been firstly reported by Antonucci et al. (1982), in which the chromospheric evaporation was detected as the blueshifted component in the emission lines of highly ionized Ca XIX (mainly radiated by a few tens of MK). Although their data has very low spatial resolution, they revealed that the evaporation had occurred at the footpoints of flare loops by using other instruments. In the late 1990's, Czaykowska et al. (1999) firstly reported spatially resolved observation of chromospheric evaporation in the gradual phase observed with the Coronal Diagnostic Spectrometer (CDS) onboard the *Solar and Heliospheric Observatory* (*SOHO*), from which the authors reported relatively strong blueshift (~100 km s^{-1}) of Fe XIX line profiles and the gradient in the Doppler velocity indicating the continuous reconnection. The chromospheric evaporation in the impulsive phase was also observed with *SOHO*/CDS as reported by Teriaca et al. (2003, 2006). They estimated the momentum balance of upflow in the corona and downflow in the transition region, resulting in the good agreement (in the order) which supports the evaporation scenario. Recent observation by *Hinode*/EIS has shown the existence of fast upflow up to 400 km s^{-1} in the Fe XXIII (~10MK) line profiles at the footpoints of flare loops during the early phase of a flare (Watanabe et al. 2010). Fast upflows in the warm line (Fe XVI; 2-3MK) was also discovered in a small B class flare observed with *Hinode*/EIS (Del Zanna et al. 2011). However, the dependence of upflow velocity on temperature has not intensively studied yet.

In this study, we analyzed the ongoing chromospheric evaporation which occurred in the impulsive phase of a M1.2 class flare observed with *Hinode*/EIS on 2011 September 9. This flare had started soon after the filament erupted, followed by the formation of compact flare loops (L~10,000km). Investigating the line profiles carefully, we found the enhanced blue wings in hot emission lines (Fe XXIII and Fe XXIV; a few tens of MK) which indicate the upflow from the solar surface of around 400 km s^{-1}. This value is slightly smaller than the sound speed at the temperature of 10MK (~500 km s^{-1}), which supports the chromospheric evaporation scenario when considering the projection effect. Not only those hot emission lines, other coronal lines at the evaporation site also show the velocities near the sound speed in each formation temperature. The upflow is switched into downflow at several MK, and intriguingly, cooler lines (logT<6.2) show the downflow near the sound speed as same as the upflow. As a collateral evidence, the density derived by Fe XIV line ratio indicated the density of 10^{11} cm^{-3}, which also supports the evaporation from the dense chromosphere. Fortunately, the EIS spectroscopic slit cut across old and new flare loops simultaneously, which enables us to discuss the temporal evolution of the evaporation flow.

Keywords: Sun, flares, chromospheric evaporation, Hinode, emission line, Doppler velocity

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PEM29-07 Room:304 Time:May 21 15:45-16:00

Formation of Cowling channel from Polar to Equatorial Ionosphere

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Possible mechanism for formation of global Cowling channel from polar to equatorial ionosphere along the dawn and dusk terminator line is discussed. In our model, the global (primary) Hall current accompanied by the two-cell type convection has divergent component when they across the conductivity gradient region at the terminator-line and resultant polarization charge are induced along it. The secondary electric field accompanied by this induced charge generates the secondary Hall current, which flows along the terminator line and also diverges when they across it. The induced secondary charges at the end of equator side produces the electric filed along the magnetic dip equator line and becomes the driver of the equatorial electrojet or counter-electrojet components according to the sign of their polarization charge. Resultantly, the global Cowling channel connecting between polar to equatorial ionosphere via the terminator-line and magnetic-dip equator could be formed. This mechanism can be applied to the equatorial electrojet disturbances accompanied by the solar wind variations such as DP2-type magnetic field disturbances and many phenomena associate the equatorial enhancement and depression of the geomagnetic field disturbances.

Keywords: solar wind, poloar ionosphere, equatorial ionosphere, Cowling channel, Global coupling

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PEM29-08 Room:304 Time:May 21 16:00-16:15

A High-Velocity Motion of Active Region Loops Triggered by a 2011 Feb 18 Flare

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We report a high-velocity plasma motion near the lop-top region of large-scale active-region loops after the occurrence of the M-class flare at the solar active region NOAA 11158 on 2011 Feb 18.

The motion was detected during the impulsive phase of the M-class flare by the Doppler-shift measurement in Fe XXIV line at 192A with the Hinode EUV imaging spectrometer (EIS). Hinode/EIS continuously observed this region with a raster scanning mode and a strongly blue-shifted Fe XXIV line was observed in a period of 10:11 to 10:16 UT. We performed a spectral fitting using double Gaussian functions to estimate Doppler velocity and have found that the Doppler velocity near the loop-top region reaches 200-400 km/s.

In order to identify the high-velocity component from the temporal evolution of the coronal structures, we use high-cadence EUV images from Atmospheric Imaging Assembly (AIA) on Solar Dynamics Observatory (SDO), which provides high-resolution full-disk images taken at nine EUV wavelengths bands. The high-velocity motion was clearly recorded in the sequence of images at the AIA 131A band. Before the appearance of the high-speed plasma, we have found that one of the loops that rose vertically up to ˜300 km/s interacted with other loop structures located above it. The configuration between these loops allows the occurrence of a magnetic reconnection in the loop-top region.

We interpreted the high velocity motion in the loop-top region, detected with EIS and AIA, as a bulk motion of reconnected loops toward a relaxed state.

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PEM29-09 Room:304 Time:May 21 16:15-16:30

Whole atmosphere-ionosphere coupled model (GAIA) for space weather research

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Space near the Earth, called geospace, is a highly complex system, consisting of the solar wind, the magnetosphere, the ionosphere, and the neutral atmosphere. Those regions have different physical characteristics with different temporal and spatial scales. In particular, the magnetosphere, the ionosphere, and the neutral atmosphere are strongly coupled with each other, and interaction between the regions is nonlinear and extremely complicated. Even within each region, there are strong interactions between physical processes with different temporal and spatial scales. The geospace environment significantly varies as electromagnetic energy and particles from the sun vary. Furthermore, recent observations have revealed that atmospheric waves generated in the lower atmosphere and variations of the lower and middle atmosphere significantly influence the thermosphere and the ionosphere. In order to quantitatively understand such a complicated system, it is necessary to model the entire geospace region self-consistently. We have developed an atmosphere-ionosphere coupled model, which includes the whole neutral atmosphere and the ionosphere. The model is called GAIA (Ground-to-topside model of Atmosphere and Ionosphere for Aeronomy). Some unsolved phenomena in the upper atmosphere have been already reproduced and studied. The model will be a useful tool for space weather research and forecast. We will report some recent results using GAIA, such as (1) upper atmosphere variation during the annular solar eclipse on May 21, 2012, (2) effects of lower atmospheric phenomena on the ionosphere, and (3) ionospheric variation associated with magnetic storms including effects of disturbances from the lower atmosphere. We will also report our future plans for the development of GAIA.

Keywords: atmosphere, ionosphere, coupling, model, simulation, space weather

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PEM29-P01 Room:Convention Hall Time:May 21 10:45-12:15

Space weather usage in JAXA radiation exposure management for astronauts

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[1]Japan Aerospace Exploration Agency

The International Space Station (ISS) is a habitable artificial satellite that orbits the Earth at an altitude of about 400 km. Six astronauts regularly remain onboard the ISS, and conduct many experiments. Given the high altitude of the ISS, however, astronauts face health risks from space radiation in the form of galactic cosmic radiation, solar particle radiation, trapped radiation, and that from secondary eruptions. Astronauts onboard the ISS receive radiation exposure in one day that is equivalent to what humans on the Earth receive in six months. As these high-energy rays have high potential to adversely affect the health of astronauts, the Japan Aerospace Exploration Agency (JAXA) employs radiation exposure management for JAXA astronauts to minimize the health damage caused by space radiation exposure.

The important aspects of radiation management are space environmental monitoring and space weather forecasts. When a solar particle event and increasing the trapped radiation electrons occurs, astronauts are exposed to radiation several times greater than normal. As such events often occur unexpectedly, we must therefore constantly monitor the space environment. Based on this approach, we have established a system that can steadily monitor solar activity data from satellites in geostationary orbit, in collaboration with pertinent organizations. By using this system, we can receive space environment alerts and take action to minimize space radiation exposure before space radiation increases in the ISS orbit. Because this countermeasure is different based on the type and level of space environment, space weather offers us valid information to analyze the progress of a given situation.

Our system allows us to take action after receiving a space environment alert. By improving the accuracy of predicting space weather and taking action prior to the onset of some activities, we can help make missions safer and more reliable.

In this report, we introduce space radiation exposure management and space weather usage by JAXA.

Keywords: Astronaut, Space radiation exposure

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PEM29-P02 Room:Convention Hall Time:May 21 10:45-12:15

Possibility of interference caused by solar radio bursts

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It is known that strong radio wave with wide frequency range is emitted associated with solar flares. It is called solar radio bursts. There are several reports that strong solar radio bursts affected reception of radio wave from GPS satellites. GPS satellites use radio wave of 1.57542 GHz (L1) and 1.2276 GHz (L2) for positioning and it is necessary for positioning to receive signals from more than four satellites. It is difficult to eliminate the effect of solar radio bursts by directivity of antenna.

We examined how strong solar radio burst affects positioning of GPS. We analyzed how frequently the solar radio bursts which affect GPS positioning occurs using past approximately twenty-five years data from the Nobeyama Solar Radio Observatory of the National Astronomical Observatory.

Keywords: solar radio burst, interference, space weather

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PEM29-P03 Room:Convention Hall Time:May 21 10:45-12:15

Relationship between geosynchronous satellite charging and space environment

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In the social life accompanying rapid social development what depends the improvement in the convenience on satellites are large, and many satellites are going around the near earth. The space weather is various, the thing especially about employment of satellites, solar flare, solar wind, magnetic storm, galactic cosmic ray, etc. are raised. Prediction of space weather and research of evasion of danger are advanced.

It is called a ”space weather forecast.” Moreover, the system of catching the space environment correctly and supervising it in order to perform activity in the universe safely is indispensable, and in order to employ safely the satellite which requires a large amount of expenses for development and employment, the space weather forecast for the satellite has been an important issue. The influence of the global environment on a solar activity changes greatly with kinds of satellites, it pays its attention about the obstacle of a geostationary orbit satellite in this research.

Relationship between space environment and surface charging of geosynchronous satellite was investigated using the Potential monitor (POM) onboard ETS-V. In analyzing, the orbit condition of ETS-V and changes of the operation mode changes the condition of spacecraft charging, we try to remove these effects before our data analysis. As a result, we found that the surface charging of satellite is frequently occurred during 00LT and 06LT. It is thought that it is based on the photoelectric effect discharged by hitting light on the satellite surface and extensive electron injection by a substorm.

Next, we assume that the extensive electron injection by the substorm can be measured by AL index. Therefore, we investigated about the relationship between surface charging phenomena and AL index.

Correlation between spacecraft charging and AL index is not good in general. However, weak correlation is seen only in the time zone between 00LT and 06LT. This result seems to be related to the partial ring current by a substorm. Moreover, we were investigated whether the start time of satellite charging and the rapid growth of AL index are correlated. A result, 120 events of satellite charging is identified. 66 events are well correlated. About half of the events do not show clear correspondence.

Keywords: Space Weather Forecast, Satellite Charging, Substorm, Geosynchronous Satellite

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PEM29-P04 Room:Convention Hall Time:May 21 10:45-12:15

Influence Evaluation of Solar Activity to Seismic Activity by Statistical Models

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Detection of statistical connection between solar activity and seismic/volcanic activities was discussed in the literature. In this talk, statistical models are used to predict seismic energy by the measurements of the solar activity. We used daily data opened to the public.

Auto-regressive models with exogenous variables (ARX models) were used for prediction of the seismic energy. The target variables are the total energy of earthquakes (EQ) of the day after present day, with respective magnitudes 3-3.9, 4-4.9,..., 7-7.9 and 8+. The explanatory variables are solar/space measurements; sunspot numbers, solar wind velocity, Interplanetary Magnetic Field temperature, proton density, solar wind dynamic pressure and energy of solar wind, magnetic field; Dst and polar cap index. Data observed up to present day are used for prediction. The explanatory variables are selected by Bayesian Information Criterion so as to get parsimonious models. The optimal models have the following features:

1) The ARX models are useful for predicting small EQ, whereas poor for big EQ.
2) The most relevant explanatory variable is solar wind velocity.
3) The coefficient of determination for EQ4-4.9 was 53%.

Thus, it is statistically shown that solar activity affects small EQ.

Acknowledgments on data sources
Solar activity: Goddard Space Flight Center, NASA via the OMNIWeb Data Explorer and the Space Physics Data Facility.
Earthquake events: Advanced National Seismic System (ANSS) database.

Keywords: solar activity, seismic activity, solar wind, interplanetary magnetic field, auto-regressive models with exogenous variables

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PEM29-P05 Room:Convention Hall Time:May 21 10:45-12:15

Temporal behavior of the coronal hard X-ray source in solar flares

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In Sui & Holman 2003 and Sui et al. 2004, they analyzed a few flares occurred on the northwest limb (NOAA Active Region 9011) from April 14 to April 16, 2002, which were well observed with Reuven Ramaty High- Energy Solar Spectroscopic Imager (RHESSI). When the impulsive rise in hard X-rays began, the cusp part of the coronal source separated from the underlying flare loop and remained stationary for about 2 minutes. During this period, the underlying flare loops shrank. This phenomenon is very important to understand the energy-release process in solar flares since it might be closely related with magnetic reconnection. This has been reported for the first time by using the RHESSI data, even though Yohkoh observed more than 3,000 flares during its operational period (1991-2001). The purpose of this research is to verify quantitatively this phenomenon by using Yohkoh data.

The hard X-ray telescope (HXT) on board Yohkoh has an advantage to achieve it. This source motion takes place at the early phase of a flare. This means the number of photons is not enough to synthesize a hard X-ray image with a high quality. HXT has so-called fan-beam type sub-collimators. Using them, information on the source location can be derived without image-synthesis process. Also Yohkoh is not a spinning satellite and the time resolution is 0.5 second. Thanks to these characteristics, Yohkoh/HXT enables us to reveal the behavior of the coronal hard X-ray source in the early phase of a flare. First, we checked how this method worked for a well-known flare which has a moving hard X-ray source. In this presentation, we show the result of this test and discuss the limitation of this method.

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PEM29-P06 Room:Convention Hall Time:May 21 10:45-12:15

The evolution of magnetic structure of NOAA AR11158 and M-class flare on February 13, 2011

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We investigate the evolution of magnetic structure of NOAA AR 11158 and the corresponding M6.6 flare occurred on February 13, 2011.

Solar flare, a large energy release in the solar outer atmosphere, has a great influence on the geosphere. Spatially- and temporally-resolved observational data have been obtained by the recently-launched satellites Hinode and Solar Dynamics Observatory (SDO). The solar activity started to rise again in 2011 and a lot of flare data are now going to be accumulated.

NOAA 11158 emerged on the solar surface on February, 2011. It produced a lot of flares including X-class one. Hinode and SDO observed this region in detail from its emergence. Spectro-polarimetric data on the photosphere was obtained by Solar Optical Telescope (SOT) on board Hinode in the vicinity of M6.6 flare. We analyze the time-evolution of the magnetic structure of this region, especially the trigger region of M6.6 flare, and compare the structure with the numerical calculation by Kusano. First we investigate the magnetic field data obtained by Hinode/SOT and SDO/HMI. It is found that this region is formed by a collision of the two emerging fluxes, and that they make a strongly sheared polarity inversion line (PIL), on which a lot of flares occurred. We also found a discriminating magnetic structure on the PIL before the M-class flare. The horizontal field, which has the same direction as the potential field, is formed after the flare. We interpret this relaxation as a result of the magnetic energy release through the flare. Next we investigate Ca images, and find a continuous Ca brightening just above the discriminating magnetic structure. This is similar to the character of pre-flare brightening, which is seen in the ”reverse shear type” flare model suggested by Kusano. Further we make comparison of this brightening with current density in the numerical calculation by Kusano. The spatial distributions of the Ca brightening in the observation and the current density in the simulation are coincided with each other. The relaxed horizontal field continues to be sheared again by the motion of the whole region. We consider this sheared field as a pre-flare coronal arcade of the following X-class flare.

We present a brief summary of the flare observations in 2011 and show detailed results of the comparison between the M6.6-flare observation and the numerical results by Kusano.

Keywords: Sun, Solar Flare, Active Region, Magnetic Field

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PEM29-P07 Room:Convention Hall Time:May 21 10:45-12:15

Hard X-ray and Microwave Emissions from Solar Flares with Hard Spectral Indices

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We analyze ten flare events that radiate intense hard X-ray emission with significant photons over 300 keV to verify that the electrons that have a common origin of acceleration mechanism and energy power-law distribution from solar flares emit hard X-rays and microwaves. Most of these events have the following characteristics. Hard X-rays emanates from footpoints of flare loops, while microwaves from tops of flare loops.

The time profiles of the microwave emission show delays of peak with respect to that of the corresponding hard X-ray emission. The spectral indices of microwave emissions show gradual hardening in all events, while the spectral indices of the corresponding hard X-ray emissions are roughly constant in most of the events, though rather rapid hardening is simultaneously observed in both indices during the onset time and the peak time in some of them. These characteristics suggest that the microwave emission emanates from the trapped electrons. Then, taking account of a role of the trapping of electrons for the microwave emission, we compare the observed microwave spectra with the model spectra calculated by a gyrosynchrotron code. As a result, we successfully reproduce the eight microwave spectra. From this result, we conclude that the electrons that have a common acceleration and a common energy distribution from solar flares emit the both hard X-ray and microwave emissions in the eight events, though microwave emission is contributed by electrons with much higher energy than hard X-ray emission.

Keywords: the Sun, microwave, hard X-ray, particle acceleration

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Longitudinal phase structures of Pc5 on the ground during Relativistic Electron Flux Enhancement at the Radiation Belt

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In this study, the magnetic data observed at H057 (MLat.=-66.42, MLong.=72.29) and Skallen (MLat.=-66.42, MLong.=70.53) in Antarctica are used to estimate the azimuthal wave number(m) of the Pc5 pulsations with the period of 150-600s. These two stations are located at the same latitude and spread in longitudes of 1.7 degrees. In general, the estimation of the azimuthal wave number of the Pc5 pulsations is difficult due to a strong latitudinal dependence of the field line resonance of the Pc5. The pair of the stations used in this analysis is quite suitable to estimate the azimuthal wave number.

In order to compare the temporal variations of Relativistic Electron flux Enhancement (REE) observed by GOES 10 satellite, the superposed epoch analysis for 24 CIR (Corotating Interaction Region) events is conducted for the horizontal component of the magnetic field data. As a result, although the Pc5 power increases corresponding to the increase of the solarwind velocity, the power of the H component becomes predominant after 0.5 days from enhancement of the Pc5 power, which corresponds to the apparent start time of relativistic electron flux enhancement (REE). This indicates that the toroidal oscillation of PC5 becomes predominant in the inner magnetosphere at the start time of the REE. Second, although the phase difference between two stations largely fluctuates before the start of REE, it shows certain values with small variances during the REE events. The estimated azimuthal wave numbers (m) of the H and D components are 1.62+/-0.99 and -2.25+/-2.86, respectively. The eastward propagation of the toroidal Pc5 with the low m number of 1.62 suggests that the relativistic electrons at the inner magnetosphere are accelerated by the drift resonance with the toroidal Pc5 pulsations.

Keywords: radiation belt, relativistic electron, ULF wave

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Relativistic electron flux prediction at geostationary orbit based on multi-variate autoregressive model

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The flux of relativistic electrons at energies of a few to ten MeV in the outer radiation belt often largely increase at geostationary orbit a few days following high speed solar wind approach to the Earth. The enhancement of the relativistic electrons cause the anomalies on numerous geostationary spacecrafts due to deep- dielectric charging. Recent papers reported that solar wind dynamic pressure and north-south component of interplanetary magnetic field also control the amplitude of geostationary relativistic electron flux variation. We developed multi-variate autoregressive model for the prediction of its one-day average flux using time-series of the solar wind speed, dynamic pressure, and north-south component magnetic field observed by the ACE spacecraft and the geostationary electron flux at energies higher than 2 MeV observed by the GOES spacecraft for five years in 1999-2003. The comparison analysis showed that the multi-variate autoregressive model provides more accurate prediction values than commonly-used linear prediction filter which uses solar wind speed only as an input.

Keywords: Outer radiation belt, relativistic electron, prediction model

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Electron precipitation environment in low earth orbit observed by the GOSAT satellite

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The GOSAT satellite was launched on January 2009 into sun-synchronous sub-recurrent orbit with an altitude of 666km and an inclination of 98 deg. The LPT (Light Particle Telescope) installed on the GOSAT measure electrons from tens of keV to MeV and can observe precipitation into the atmosphere. The precipitating electrons are steadily observed in the inner and the outer radiation belt. In the outer radiation belt, the energy of the flux reaches to a few hundreds keV. The flux increases drastically during the magnetic disturbance. We will introduce a global behavior of the electron precipitations.

Keywords: Electron precipitation, Radiation belt electron, wave-particle interaction

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Pc1 band pulsation newly observed by induction magnetometer at magnetic low latitude

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Kyushu University Space Environmental Research Center has been observing geomagnetic data at Kuju(MLat=26.13) with induction magnetometer since 2003.We found some impulsive pulsation(We call this I-type event) during magnetic storm. The characteristic of I-type event similar to that of Intervals of Pulsations of Diminishing Period(IPDP) which observed at high latitude. The goal of this study is to investigate the characteristic of I-type event.

We analyzed data of year 2003,2004,2010 and 2011. The data were characterized based on ”Magnetic storm day data(S-data)” and ”Quiet day data(Q-data)”. There were 21 S-data in the analyzed period.

We found 7 I-type event from 21 S-data. During I-type event frequency increases with time. (delta f=0.8˜5[Hz],t= 10˜30[min])I-type event is only observed from S-data(not from Q-data) and occurred after 5 to 30 minutes from sub-storm onset. Considering these facts, it is clear that I-type event associates with magnetosphere disturbances.

We will discuss the details of I-type event at the presentation.

Keywords: Pc1, Induction magnetometer, magnetic low-latitude, IPDP

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Improvement of time resolution of equivalent ionospheric current system deduced from grand magnetic observation

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In the present study, the equivalent ionospheric current system is estimated by using the geomagnetic data observed at the multi-point grand observatories. As a preparation of the analysis, two kinds of interpolation are taken to the original data. First the observed points are virtually expanded in the longitude by taking the current vectors at every each one hour for six hours. Then the vector field of the ionospheric current system is calculated on the coordinated mesh grid with interval of 5 degrees in both latitude and longitude, by using the trigonometric interpolation.

The electric potential is obtained from the interpolated ionospheric current system by spherical harmonic analysis. As a result, the ionospheric current pattern estimated from 12-orderd spherical harmonic analysis well corresponds with that from the row current vector data which shows the snap shot of the ionospheric current system. It is confirmed that the reduction of the time resolution is not so critical, whereas more careful validation should be required in the future study.

Keywords: Equivalent ionosheric current system, geomagnetic observation