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

PEM07-01 Room:304 Time:May 22 09:00-09:25

What Would Happen to the Ionosphere and Atmosphere if an 1859-Carrington Storm Occurred Today?

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The September 1-2, 1859 magnetic storm following the Carrington solar flare (Carrington, MNRAS, 1859) was the largest storm in recorded history (Tsurutani et al., JGR, 2003). The calculated Dst magnitude was ˜ -1760 nT, more than three times larger than anything most of us have experienced in our lifetimes. Well-documented fires were triggered in both the United States and Europe due to storm-induced electric fields (Loomis, AJS, 1861). In 1859, telegraph communications was the high technology of the day. If a similar storm occurred now, it is reasonably certain that major electrical power grids would go down. Thus, many governmental agencies are presently studying this to determine how to mitigate the damage. However, a little studied area is what would happen to the ionosphere and atmosphere during such a storm? Would there be problems for humankind? This will be the topic of the present talk.

Keywords: extreme magnetic storms, 1859 Carrington storm, extreme ionosphere, atmosphere

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PEM07-02 Room:304 Time:May 22 09:25-09:40

Will Superflares Occur on Our Sun ?

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Supeflares are very big flares that release total energy much greater than that of the biggest solar flares ever observed, ~ 3 x 10^32 erg. The famous Carrington flare in 1859 may correspond to the biggest solar flare. If such superflares will occur on our Sun, we would have extreme space weather events, which might lead to big hazards of terrestrial environments and our civilization. Astronomical observations revealed that young stars or fast rotating stars often show superflares (10^34 ~ 10^38 erg). Hence it has been thought that our Sun would have produced superflares when it was young and rotating faster (> 10 km/s). However it was not clear whether superflares would occur on the present Sun or not, since the present Sun is not young and is now slowly rotating (at 2 km/s). Recent observations of solar type stars with Kepler satellite have revealed existence of superflares (with 10^34-10^35 erg) on solar twins which are quite similar to our Sun on surface temperature (5600 K ~ 6000 K) and slow rotation (< 10 km/s). From the statistical analysis of these superflare observations, it is suggested that superflares with energy 10^34 erg occur once in 500 years and superflares with 10^35 erg occur once in 5000 years on solar twins and/or our present Sun. Finally, we will also give theoretical arguments whether superflares will occur on the present Sun or not on the basis of modern theories of flares and dynamo.

Keywords: flares, space weather, extreme events

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PEM07-03 Room:304 Time:May 22 09:40-09:55

Effects of super solar flare on the Earth's atmosphere

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It is well known that solar flares are frequently observed. Observational and theoretical studies have revealed impacts of solar flares on the general circulation of the thermosphere/ ionosphere. On the other hand, there are only few studies concerning the effects of solar flares on the general circulation of the lower and middle atmosphere. Some theoretical studies suggest that super solar flare whose energy is larger than the energy of the normal solar flare by a factor of 10,000 is rare, but can occur. The solar constant during the super solar flare event is estimated to be 2-4 times larger than the present solar constant. This means that the super solar flare affects significantly the climate of the Earth. Using a general circulation model (GCM) we examine the response of the temperature to sudden increase of the solar constant due to the super solar flare. A GCM that contains the region from the ground surface to the exobase is used to estimate the effect of solar super flare on the general circulation of the Earth's atmosphere. The schemes for the boundary layer processes, the solar radiation and the infrared radiative transfer are included in the GCM. Our simulation results indicate that abrupt temperature increase of 10 K near the surface in low latitudes occurs when the solar constant is doubled. Moreover, the temperature near the surface increases abruptly up to 30-50 K when the solar constant is quadrupled. The solar super flare produces significant impacts on the temperature near the surface. Thus, the effect of the solar super flare on the Earth's atmosphere is one of the important problems in space weather.

Keywords: solar super flare, variation of the Earth's atmosphere, numerical simulation

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PEM07-04 Room:304 Time:May 22 09:55-10:10

Extremely microwave-rich solar flare

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High-energy particle from the sun is one of the important issues of space weather research. Usually the amount of accelerated particles depends on the size of a solar flare like GOES X-ray class. However, this is not always true. In this presentation, we report an extremely microwave-rich flare which particle acceleration effectively work rather than plasma heating.

A compact flare was observed with Nobeyama Radio Heliograph (NoRH) near the west limb around 2:56 UT on 10 March 2011. Its duration was only one minute. The peak values of microwave flux at 17GHz and 34GHz were 210 and 133 SFU, respectively. This level corresponds to the 11th intense flare observed with NoRH in this solar cycle as of the end of January, 2012. All of the ten flares which are more intense than this event are M- or X-class flares. In this event, however, any significant enhance was not found in the GOES X-ray light curve during the flare period. Since the GOES background level was around C1 at that time, so at least we can say the upper limit of this flare was C1. From microwave images, this flare might occur slightly behind the west limb. We check STEREO-A SECCHI EUV images during the flare period. There was almost no signature of a flare. Only in SDO/AIA 131A images, a small loop-brightening was observed. Summarizing these observations, although thermal emissions were very small in this flare, intense microwave emissions were detected. In terms of hard X-ray observations, unfortunately RHESSI was in the shadow of the earth during this flare.

What causes the relatively intense microwave emissions? Considering that the brightness temperature was about 19 MK, the microwave emissions should be gyro-synchrotron emissions by high-energy electrons. Fleishman et al. (2011) reported a cold tenuous flare with acceleration, but without heating. This flare seems to be similar. However, footpoint regions, i.e., strong magnetic field regions, were occulted in the case of this flare. Additionally, in a higher-frequency range like 34GHz, intense microwave emissions were detected in this case. These features are different from the event reported by Fleishman et al. and make more difficult to understand these observational results. We summarize the characteristics of this unique flare and discuss what kind of process/situation produced it.

Keywords: solar flare, particle acceleration, microwave

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PEM07-05 Room:304 Time:May 22 10:10-10:25

Energy transmission from the solar wind to the global ionosphere and inner magnetosphere during space weather events

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When the IMF turns southward, the Region-1 field-aligned currents (R1 FACs) are generated by a dynamo composed of high pressure plasma around the dayside cusp, providing the dawn-to-dusk convection electric field in the polar ionosphere. The convection electric field drives ionospheric Hall currents in high latitudes and Pedersen currents at the daytime geomagnetic equator where the Pedersen current is amplified by the Cowling effect, resulting in the coherent magnetic perturbations at high latitude and dayside dip equator. The convection electric field is transmitted near-instantaneously from the polar to equatorial ionosphere via the Earth-ionosphere waveguide and further transmitted to the inner magnetosphere. The Poynting flux is transported by the Alfven wave propagating upward from the ionosphere, driving the plasma convection in the inner magnetosphere immediately after the enhancement of the polar cap potential. As a result, the ring current develops a few minutes after the increase in the polar cap potential during the substorm growth phase and storm main phase. During the substorm expansion phase, on the other hand, the ionospheric current at mid-equatorial latitudes reverses its direction, that is, the overshielding occurs while the auroral electrojet intensifies. The current reversal is particularly significant at the dayside equator, appearing as the counterelectrojet (CEJ). The CEJ should be connected to the R2 FACs which are driven by the partial ring current associated with the enhanced convection electric field and/or dipolarization in the near-Earth magnetotail. At the onset of geomagnetic storms, the increase in the solar wind dynamic pressure causes the enhancement of the magnetospheric convection. The succeeding southward IMF further intensify the convection electric field, which penetrates to low latitude and drives the stormtime ring current. In the beginning of the recovery phase, overshielding occurs due to the decrease of the southward IMF. The auroral ionospheric currents associated with major storms are so strong as to cause the power outage like in Canada on 13 March 1989. The penetration electric field moves the ionospheric F-region plasma at low latitude and causes anomalous enhancement of the total electron content responsible for the serious GPS positioning errors. The satellite charging due to the auroral electrons during major substorms causes the fatal damage of the satellites, e.g., the damage of the Earth observation satellite, Midori on 25 October 2003. There remain quite a few issues to be addressed in the energy production and transmission in the magnetosphere-ionosphere coupled system. In particular, the physics of the dynamos in the outer and inner magnetosphere should be clarified in the future studies.

Keywords: convection electric field, overshielding electric field, Earth-ionosphere waveguide, equatorial counterelectrojet, geomagnetic storms, substorms

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PEM07-06 Room:304 Time:May 22 10:45-11:00

On the predictability of solar flares

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Solar flares are catastrophic eruptions in the solar corona and sometimes impact the terrestrial environment and our infrastructure. However, what triggers their onset is not yet well understood; this severely limits our capacity to predict flare occurrence. In this study, on the basis of a systematic survey of three-dimensional magnetohydrodynamics simulations, we show how small emerging magnetic flux can trigger solar flares. We find two different processes for the onset of solar flares and furthermore find that their occurrence can be controlled by the orientation of emerging magnetic flux. In addition, it is shown that the two major flares observed by the Hinode satellite are consistent with our simulations. Our findings suggest that forecasting large flares is possible with sophisticated observations of solar surface magnetic field. However, the lead time of deterministic flare forecasts is limited by the growth time of flux emergence, which might be less than several hours. Presumably, flare forecasts for longer duration might be difficult and may be possible only in a probabilistic manner.

Keywords: solar flares, solar corona, magnetohydrodynamics, simulation, Hinode, prediction

PEM07-07 Room:304 Time:May 22 11:00-11:25

Empirical Space Weather Forecast Models Based on Solar Data

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We are developing empirical space weather (solar flare, solar proton event, and geomagnetic storm) forecast models based on solar data. In this talk we will review their main results and recent progress. First, we have examined solar flare (R) occurrence probability depending on sunspot McIntosh classification, its area, and its area change. We find that sunspot area and its increase (a proxy of flux emergence) greatly enhance solar flare occurrence rates for several sunspot classes. Second, a solar proton event (S) forecast method depending on flare parameters (flare strength, duration, and longitude) as well as CME parameters (speed and angular width) has been developed. We find that solar proton event probability strongly depends on these parameters and CME speed is well correlated with solar proton flux for disk events. Third, we have developed an empirical storm (G) forecast model with its probability and strength based on halo CME ? Dst storm data. For this we use storm probability maps depending on CME parameters such as speed, location, and earthward direction. We are also looking for geoeffective CME parameters such as cone model parameters and magnetic field orientation. We find that all superstorms (less than -200 nT) occurred in the western hemisphere with southward field orientations. Finally, we summarize several ongoing works for space weather applications.

Keywords: space weather, flare, solar proton event, geomagnetic storm

PEM07-08 Room:304 Time:May 22 11:25-11:40

3D dynamics of Eruptive phenomena and Particle acceleration In a Solar flare

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Solar flares show intermittent time variability in nonthermal emissions, that means impulsive acceleration of particles in small regions of a fragmented current sheet. We performed 3D MHD simulation of a solar flare and investigated particle behaviors with test particle simulation. A flux rope ejection in 3D simulation generates a current sheet below, in which multiple small-scale plasmoids are formed and ejected upward and downward. These ejections play a role in making a current sheet turbulent and locally enhancing inflow and E-field inside the current sheet. Test particles move in several current sheets and are stochastically accelerated by enhanced E-field. Furthermore, we also found that both reconnection outflow and the additional force by kink instability, i.e. 3D effect, force a flux rope upward harder, resulting in larger ejection speed, larger inflow, larger E-field and harder acceleration of particles. Finally we compared our simulation result with recent Hinode and SDO observations of Solar Flares.

Keywords: Solar Flare, Particle Acceleration, Magnetic Reconnection, Coronal Mass Ejection, Hinode satellite, SDO satellite

PEM07-09 Room:304 Time:May 22 11:40-11:55

Nonlinear spatio-temporal evolution of magnetospheric whistler-mode waves

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Radiation belt dynamics play an important role in space weather science since,for instance,highly energetic radiation belt electrons generated during magnetic storms are potentially hazardous to orbiting spacecraft. In turn, whistler-mode chorus waves are an important ingredient in electron radiation belt physics since chorus waves are considered a prime candidate for generating relativistic electrons in Earth's inner magnetosphere. Whistler-mode chorus waves are generated at the magnetic equator,and here we examine their nonlinear spatio-temporal evolution along a magnetic field line. We solve numerically the wave evolution equations off the equator for the wave magnetic field and wave frequency,subject to boundary conditions at the equator comprising model "chorus equations" that define the generation of a seed chorus element. We assume that the electron distribution function evolves adiabatically off the equator. We find that the adiabatic variation of the distribution function plays an essential role

in the saturation process of nonlinear wave growth. Our study is valuable because wave saturation and dispersion effects cannot currently be monitored by particle simulations. In future extensions of this study,electron energization by wave trapping and associated wave energy loss should be included.

Keywords: nonlinear whistler-mode waves, magnetospheric chorus

PEM07-10 Room:304 Time:May 22 11:55-12:10

Magnetic configuration responsible for solar global eruptions

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The emergence process of the magnetic field into the solar atmosphere plays an essential role in determining the configuration of the magnetic field and its activity on the Sun. This talk is focused on how much the magnetic flux contained by a flux tube emerges into the solar atmosphere, which is key to understanding the physical mechanism of solar eruptions. By comparing a kinematic model of an emerging flux tube to a series of magnetohydrodynamic simulations, we derive the characteristics of the emergence process, showing how it depends on the pre-emerged state of the magnetic field such as the radius of a flux tube, field strength, field-line twist and wavelength of undulation assumed by the flux tube. We also discuss the relationship between magnetic configurations and their stability on the Sun.

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PEM07-11 Room:304 Time:May 22 13:45-14:00

Characteristics of Equatorial Spread-F (ESF) observed with GNU Radio Beacon Receiver (GRBR) in southeast Asia and Africa

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Equatorial spread F (ESF) is intense ionospheric irregularity that occurs around the geomagnetic equator. It can cause intense scintillation to satellite-ground communications, and serious error in the GPS measurements. The ESF has been a hot research topic of the equatorial/low-latitude ionosphere for long time. However, its day-to-day variability is not well understood. Now we deploy a very wide network of GNU Radio beacon receivers (GRBR) at low latitudinal regions over east Africa, southeast Asia, and Pacific region, and observe 150MHz/400MHz beacon signal from C/NOFS and other polar-orbiting satellites. In this paper, we use data from Bac Lieu, Vietnam (9.29N, 105.71E, Dip Lat. 1.67N, observations started in January 2009) and Bahirdar, Ethiopia (11.56N, 37.38E, Dip Lat. 3.93N, observations started in March 2011). We discuss relationships between day-to-day variability of ESF with ionospheric structures, i.e., large-scale wave structure (LSWS), meridional symmetry of the ionosphere density distribution, and VHF/UHF scintillation intensity. Occurrence of ESF is well correlated with enhanced LSWS events in the evening time. At Bahirdar, scintillation level is high, and very intense LSWS events are found. From statistical comparison between Africa and southeast Asia, we found that scintillation level is higher in Africa than in southeast Asia, inferring more enhanced occurrence of the ESF over African region.

Keywords: Satellite beacon experiment, Equatorial spread-F, Low-latitude ionosphere, Africa, Sroutheast Asia

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PEM07-12 Room:304 Time:May 22 14:00-14:15

Statistical Analyses of White-Light Flares Observed by Hinode/SOT

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Using the Hinode Flare Catalog (http://st4a.stelab.nagoya-u.ac.jp/hinode_flare/; Watanabe et al., 2012), we are performing a statistical analysis of white-light flare events.

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.

Hinode/SOT has the capability to observe white-light flares. SOT observes the G-band (4305A) and continuum (Blue: 4505A, Green: 5550A, Red: 6684A) by broadband filter, and we can use these wavelengths for white-light flare observations. We picked up the white-light events using G-band and continuum data, and found 14 events in the 2006 ? 2011 time period.

We analyze one of the white-light flares that occurred on December 14, 2006 in detail. We use G-band data from SOT for 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).

Recent white-light flare observations are being performed using continuum bands. We can determine the temperature of the white-light emission in detail, because we made observations in 3 continuum bands. We estimate the temperature distribution of the white-light emissions that occurred on February 15, 2011 by fitting the 3 points using the Planck formula, and all temperatures are calculated to be between 5000 and 6000K. The temperature of the white-light emissions were estimated as ~10000K in previous studies (Kretzschmar 2011, etc.), however, a much lower temperature was obtained in this study.

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, white-light

PEM07-13 Room:304 Time:May 22 14:15-14:30

A numerical simulation of a negative solar wind impulse

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Response of the magnetosphere-ionosphere system to the negative impulse of the solar wind dynamic pressure (the negative SI) are studied again with foci of periodic variations of the ionospheric convection and appearance of the overshielding potential. When the negative impulse impinges on the magnetopause, the Region 1 (R1)-type field-aligned current (FAC) and R2-type FAC appears alternatively in the lower-latitudes (~ 70 deg) of the dayside ionosphere (~10hLT and 14hLT). These current systems shift nightward and poleward. This alternative appearance of FACs invokes positive and negative ionospheric potential patterns switching alternatively. In addition, the R2-type FAC induced by the negative SI and that by the positive SI tend to yield the shielding electric potential in the ionosphere. This shielding potential has short duration than that for the northward turn of the interplanetary magnetic field does. The duration is longer for the negative SI than for the positive SI.

Keywords: negative SI, numerical simulation, magnetosphere-ionosphere compound system, convection oscillation

PEM07-14 Room:304 Time:May 22 14:30-14:45

Remote Sensing Space Weather Events Through Ionospheric Radio: The AARDDVARK Network

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The Antarctic-Arctic Radiation-belt (Dynamic) Deposition - VLF Atmospheric Research Konsortium (AARDDVARK) provides a network of continuous long-range observations of the lower-ionosphere, principally in the polar regions. The network of sensors detect changes in ionisation levels from ~30-90 km altitude, globally, continuously, and with high time resolution, with the goal of increasing the understanding of energy coupling between the Earth's atmosphere, Sun, and Space. We use the upper atmosphere as a gigantic energetic particle detector to observe and understand changing energy deposition from space weather events. AARDDVARK has contributed to the scientific understanding of a growing list of space weather science topics including solar proton events, solar flares, relativistic electron precipitation, the descent of NOx into the middle atmosphere, substorms, plasmaspheric hiss and EMIC-driven precipitation, CME's, and microbursts. Our recent work has focused strongly on measuring the flux magnitude of energetic electron precipitation from the radiation belts over long time periods. In this talk I will review previous ground based studies our team has undertaken to characterise some space weather impacts on the lower ionosphere. In particular, I will focus on solar protons events and solar flares.

A combination of observations from AARDDVARK and riometers have been used to test our modelling of solar proton event produced ionisation increases in the upper atmosphere and also the way geomagnetic rigidity screens solar protons from accessing mid- and low- geomagnetic latitudes. This is necessary for determining the impact of solar proton events upon the polar ionosphere, communication and navigation systems, and describing the coupling of solar proton events to the neutral chemistry of the polar atmosphere.

Mid-latitude AARDDVARK observations have been used to characterise solar flares, measuring both the solar X-flux and the change in the electron number density in the lower ionosphere. While a mature experimental technique, such observations can still lead to unexpected results. In particular, the subionospheric VLF observations led by Neil Thomson produced one of the few measurements of the great X45 solar flare of 4 November 2003, where the X-ray detectors on the GOES spacecraft saturated. However, the ionospheric D-region will not saturate, allowing a wider dynamic range than existing spaceborne instruments.

Keywords: space weather, solar flares, solar proton events, ionospheric remote sensing

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PEM07-15 Room:304 Time:May 22 14:45-15:00

Investigation of filament eruptions and related coronal disturbances associated with solar flares using data of CHAIN

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Coronal mass ejection (CME) is one of very important sources of disturbances in geospace. The knowledge of structures, velocities and their evolutions of CMEs are crucial for understanding variations of space weather.
On the other hand, coronal disturbances associated with solar flares, such as H-alpha Moreton waves, X-ray waves, EIT/EUV waves, have been discussed in relation to MHD fast mode waves or shocks in the corona. Therefore, it is also very important for space weather researches.
To solve the mechanism of occurrences of CMEs and coronal disturbances, full disk observations with high temporal resolutions in multi-wavelengths are required.

For the purpose of forming the international ground-based solar observation network and enhancing space weather researches, we are promoting "Continuous H-Alpha Imaging Network (CHAIN)" project that is led by Kwasan and Hida Observatories, Kyoto University.
Under the international collaboration of the CHAIN project, the Flare Monitoring Telescope (FMT) was relocated from Hida Observatory to Ica University in Peru.

We selected two typical filament eruptions associated with solar flares that occurred on 2011 March 8 at the active region NOAA11165 and on 2011 February 16 at NOAA11158. The H-alpha full disk images of the flares were taken by the FMT at Ica, Peru.

As for the first event, we obtained 3-D velocity field of erupting filament on the solar limb. According to images obtained with the SoHO/LASCO, a few hours after the flare occurred, a clear CME also appeared.
The time-evolution of the velocity of the filament shows a large change of the direction of the eruption. Just after the change, coronal loops that can be seen in images obtained with the Atmospheric Imaging Assembly (AIA) on board the Solar Dynamic Observatory (SDO) also begin to expand to higher atmosphere.

For the second event, we obtained 3-D velocity field of erupting filament on the solar disk and its time-evolution. Though the Moreton wave was not detected in H-alpha images, we identified oscillations/activations of H-alpha filaments (winking filaments) at distant locations. In the extreme ultraviolet data taken by the SDO/AIA, we could indeed see coronal waves clearly as well as the filament eruption.

In this paper we present the results of the detailed examination of the filament eruptions, expanding coronal loops, winking filaments and the coronal waves.

Keywords: Space weather, solar chromosphere, solar flare, filament eruption, coronal mass ejection (CME), shock wave

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PEM07-16 Room:304 Time:May 22 15:00-15:15

Space weather phenomena in the ionosphere and their effect on GNSS

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The Earth's atmosphere at altitudes from 60 km to 1,000 km is partially ionized by solar EUV, forming the ionosphere. The ionosphere causes group delay, phase advance, and scintillation to space-to-ground radio propagations. The severe ionospheric disturbances can degrade precise Global Navigation Satellite System (GNSS) positioning or navigation. Because the use of GNSS prevails these days, A study of the severe ionospheric disturbances and their effect on GNSS is one of important topics in the space weather. The ionospheric conditions largely vary under the influence of solar, geomagnetic, and lower atmospheric activities. Intense solar flares cause sudden ionospheric disturbance (SID) in the sunlit hemisphere through the ionization process. Geomagnetic storms induce various ionospheric disturbances, such as storm enhanced density (SED), positive and negative ionospheric storms, and large-scale traveling ionospheric disturbances (LSTID). At low latitudes, plasma density depletion region, called plasma bubble, are frequently observed after the sunset during high solar activity period. These severe ionospheric disturbances have been observed with wide-coverage high-resolution total electron content (TEC) maps derived from dense ground-based GNSS receiver networks since mid-1990s. The two-dimensional GNSS-TEC observations have revealed some new aspects of such ionospheric disturbances. We will review severe space weather phenomena in the ionosphere and discuss their effect on GNSS.

Keywords: space weather, ionosphere, GPS, GNSS, TEC, ionospheric storm

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PEM07-17 Room:304 Time:May 22 15:30-15:45

Hard X-ray and Gamma-ray observations of solar flares

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Most of the high-energy particles in the solar system are accelerated in the Sun, and these particles affect space and terrestrial environments. The detailed properties of the energy release processes in solar flares, as well as the mechanisms that accelerates particles, are currently not well understood. Accelerated electrons and ions emit hard X-rays (HXRs) and gamma-rays, therefore HXR and gamma-ray observations provide important information about the energy release process in solar flares. HXR imaging observations reveal the spatial structure of particle acceleration in solar flares, including where flare-accelerated energetic electrons are stopped by the high density of the chromosphere (flare footpoints) and where flare-heated plasmas fill magnetic loops. Thermal SXRs represent magnetic flare loops filled with thermal plasma. In addition to footpoints, a coronal HXR source above the flare loop top was observed by the hard X-ray telescope (HXT) onboard the Yohkoh satellite (operated in 1991-2001). This event is well known as the Masuda flare. This above-the-loop-top source suggests that the origin of solar flares is magnetic reconnection.

In 2002, the RHESSI satellite, providing imaging spectroscopy from 3 keV up to 10 MeV, started to observe solar flares. Simultaneous wide-range HXR imaging and spectroscopy of solar flares can be done for the first time by RHESSI. RHESSI observed solar flares down to the scale of microflares, and the presence of HXRs from accelerated electrons in microflares is shown. In addition, RHESSI observed many coronal HXR sources so far, and their spatial and spectroscopic features are investigated. RHESSI's imaging spectroscopy capability allows us to study the timing and energetics of the above-the-loop-top source relative to the footpoints with much better accuracy than before. In the currently best example of a RHESSI flare that resembles the Masuda flare geometry, the above-the-loop-top source is observed to peak ?10 s earlier than the footpoint sources and decays afterwards while the footpoint source stays bright. This suggests that the above-the-loop-top source provides the precipitating electrons that feed the footpoint source.

To improve the dynamic range for future observations, grazing-incidence HXR focusing optics are a promising new technology for future solar observations. A new sounding rocket mission, the Focusing Optics X-ray Solar Imager (FOXSI, to be launched in March, 2012), will test out grazing-incidence HXR focusing optics combined with position-sensitive focal plane detectors for solar observations. FOXSI will show the presence and energy content of accelerated electrons in the quiescent region nanoflares.

Keywords: solar flare, solar corona, particle acceleration, hard X-ray, gamma-ray

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

PEM07-18 Room:304 Time:May 22 15:45-16:00

Hindcasting, nowcasting and forecasting with the Dynamic Radiation Environment Assimilation Model (DREAM)

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The penetrating radiation environment in Earth's Van Allen radiation belts is highly dynamic and highly orbit-dependent. Los Alamos National Laboratory has developed the Dynamic Radiation Environment Assimilation Model (DREAM) to study this environment and a varsion has been developed for real-time space weather applications. Real-time applications impose some constraints on DREAM but the assimilation of data in physics-based models produces information that has significantly more spatial coverage, accuracy, and utility than either the data or model alone. The minimum data input for DREAM is real-time electron fluxes from a single satellite but data from multiple satellites can improve the model accuracy – particularly when different orbits are included. Data from different sources and different data latencies can also be assimilated asynchronously. Even data that is several days old can affect the real-time assimilated state so, when new data become available, DREAM reprocesses the intervening time period, updating both past and current forecasts. Unlike simple time series of particle fluxes or geomagnetic indices, assimilative models like DREAM produce multi-dimensional data products that require innovations in user interfaces. One example is output that specifies the space environment along a user-selected orbit and time interval. More sophisticated applications can determinethe relationship of the current environment to known statistics and extremes in order to quickly flag environments that have known (or suspected) correlations with anomalies. We will discuss the underlying framework of DREAM, the user interface that we have developed and its use for both hindcasting and nowcasting. We will also discuss future development plans for DREAM and how the same paradigm can be applied to integrating other space environment information into operational systems.

Keywords: space weather, modelling, radiation belt

Japan Geoscience Union Meeting 2012
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PEM07-19 Room:304 Time:May 22 16:00-16:15

Effects of geomagnetically induced current on power grids

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It is known that power grids are affected by geomagnetically induced current (GIC) at the moment of intense geomagnetic storms. Power blackout occurred in Quebec, Canada in March, 1989 associated with the largest geomagnetic storm by value of Dst index since 1957. After this event, many studies on effect of GIC to power grids started in the United States, Canada, and countries of northern Europe. In the United States, a case study is carried out on the effect of an extreme geomagnetic storm, such as the Carrington storm in 1859. Moreover, measurement of GIC to power grids is made in geomagnetically low latitude countries, such as Brazil, South Africa, and Australia. In Japan, GIC of the power grid was measured in Memanbetsu, Hokkaido between 2005 and 2007 by cooperation with the Hokkaido Electric Power Co., Inc. We will report latest research on GIC in this presentation.

Keywords: geomagnetically induced current, geomagnetic storm, power grids, space weather

Japan Geoscience Union Meeting 2012
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PEM07-20 Room:304 Time:May 22 16:15-16:30

Observing the horizontal divergent flow of the sun as a precursor of sunspot emergence

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Solar active regions including sunspots are the origins of flare activities and CMEs. It is widely accepted that active regions are the consequence of the rising magnetic flux from the deep convection zone, i.e., flux emergence.

In this study, we report the detection of the horizontal divergent flow (HDF) at the solar photosphere, prior to the magnetic field appearance in NOAA AR 11081 on 2010 June 11. The HDF has been predicted theoretically through our recent numerical simulations on the flux emergence. The mechanism of the HDF is that the plasma on the rising magnetic flux escapes horizontally around the solar surface.

For the observation, we used the SDO/HMI Dopplergrams and magnetograms, and investigated the differences of each (Doppler and magnetic) profile of this region from that of the quiet Sun. We determined the appearance times of the HDF and the flux emergence as the times when each difference exceeds one standard deviation level (one-sigma) of the reference quiet-Sun profile. As a result, we found that the HDF occurs about 100 min before the associated flux emergence. That is, the HDF can be thought as a precursor of the flux emergence and the sunspot formation. The HDF observation may allow us to predict the flux emergence in the nearest future, which may contribute the space weather study.

Keywords: sun, magnetic field, solar interior, photosphere, space weather

Japan Geoscience Union Meeting 2012
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PEM07-21 Room:304 Time:May 22 16:30-16:45

Excitation of convection as a potential field and consequential restraint to the substorm mechanism

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[1]Takashi Tanaka

Whereas the region 1 FAC is the most important point of issue to construct convection system, its origin and magnetospheric closure are the most poorly understood problem in the magnetospheric physics. In this paper we research this problem based on four natural principles governing in the convection system. They are (1) force balance must be maintained in the convection system among gradient P force, J*B force, and acceleration force, (2) energy conversion process to form a dynamo must work in the magnetosphere to supply the FAC, (3) shear motion must co-exist with the FAC to twist the magnetic field, and (4) electric field equivalent to the magnetospheric convection must coincide with electric field that promotes the ionospheric closure of FAC. The understanding of region 1 FAC generation is also inevitable for the substorm research. Since it is difficult from the observation to confirm the above four principles over the whole M-I system, observational substorm studies tend to attribute the cause of substorm to the local process. On the contrary, we try to understand the substorm as the development and transition of the convection system.

Keywords: convection

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

PEM07-22 Room:304 Time:May 22 16:45-17:00

Spatio-temporal Correlation between Pre-flare Brightening and Magnetic Structure in Flare Productive Active Regions

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Solar flares are explosive phenomena, in which magnetic energy stored in the solar corona is converted to thermal and kinetic energy. Although it is widely accepted that solar flares are driven by magnetic reconnection, the onset mechanism of flares is not yet well understood, and the predictability of flare occurrence is still severely limited. Recently, Kusano et al. (2012) revealed that the trigger process of solar flares is controlled by the orientation of emerging magnetic flux, and they proposed that there are two different types of flare onset, in which different configurations of photospheric magnetic field are relevant to the trigger of flares. In this study, aiming at the examination of this model, we analyzed the spatio-temporal correlation between pre-flare brightening and magnetic structure in several flare productive active regions. We sampled four different major flares (X3.4 on December 13 2006, X1.5 on December 14 2006, M6.6 on February 13 2011, X2.2 on February 15 2011), which were observed by Hinode/SOT , and analyzed the pre-flare brightening of Ca II H line with the filter magnetograms (SOT/FG). As a result, we can find that all the flares had the "flare-triggering regions", which are consistent with the preferential configurations for the flare onset predicted by Kusano's model. Furthermore, we reveal that the 2006 December 13th event and the 2011 February 13th and 15th events could be classified to the different types of flare onset scenarios, which are called Opposite-Polarity (OP) type and Reversed-Shear (RS) type, respectively.

Keywords: Sun, Solar-flare, Solar active region, Magnetic field

PEM07-23 Room:304 Time:May 23 09:00-09:25

Characteristics of trapping boundary of outer radiation belt during geosynchronous electron flux dropout

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Geosynchronous electron flux dropouts are most likely due to fast drift loss of the particles to the magnetopause (or equivalently, the magnetopause shadowing effect). A possible effect related to the drift loss is the radial diffusion of PSD due to gradient of PSD set by the drift loss effect at an outer L region. This possibly implies that the drift loss can affect the flux levels even inside the trapping boundary. We recently investigated the details of such diffusion process by solving the diffusion equation with a set of initial and boundary conditions set by the drift loss. Motivated by the simulation work, we have examined observationally the energy spectrum and pitch angle distribution near trapping boundary during the geosynchronous flux dropouts. For this work, we have first identified a list of geosynchronous flux dropout events for 2007-2010 from GOES satellite electron measurements and solar wind pressures observed by ACE satellite. We have then used the electron data from the Time History of Events and Macroscale Interactions during Substorms (THEMIS) spacecraft measurements to investigate the particle fluxes. The five THEMIS spacecraft sufficiently cover the inner magnetospheric regions near the equatorial plane and thus provide us with data of much higher spatial resolution. In this paper, we report the results of our investigations on the energy spectrum and pitch angle distribution near trapping boundary during the geosynchronous flux dropout events and discuss implications on the effects of the drift loss on the flux levels at inner L regions.

Keywords: Radiation belt, geosynchronous flux dropout, THEMIS SST, energy spectrum, pitch angle distribution, RBSP

Japan Geoscience Union Meeting 2012
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PEM07-24 Room:304 Time:May 23 09:25-09:40

Magnetic Field Evolution in the Solar Polar Regions

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The magnetic field of the polar region of the Sun reverses its polarity near solar maximum. We have been monitoring the polar region of the Sun since 2008 with extremely high spatial resolution and high-sensitivity spectropolarimetric observations taken with the Solar Optical Telescope aboard *Hinode*. Then, we have investigated the yearly variation of the distribution of the vertical and horizontal magnetic flux density in the polar regions. We have found that the decrease of total signed flux density in the polar region mainly results from the attenuation of the flux density in vertical, large flux concentrations (more than 10^{18} Mx) with a dominant polarity in each polar region. The flux decrease is first observed in the North polar region. We also found that the flux distribution of vertical, small field concentrations (of both polarities) and of horizontal field concentrations does not vary with solar cycle. Small-scale, mixed polarity flux concentrations pervade the quiet Sun at disk center. These fields are found in the solar polar regions as well, suggesting that an ubiquitous physical mechanism generates and maintains them.

Keywords: Magnetic field, photosphere

Japan Geoscience Union Meeting 2012
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PEM07-25 Room:304 Time:May 23 09:40-09:55

The electron radiation belt model depending on the mean Dst index

NAKAMURA, Masao[1*], Toshihiko Tanioka[1], TAKADA, Taku[2], ASAI, Keiko T.[3], MATSUOKA, Ayako[4], NAGAI, Tsugunobu[3]

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Electron radiation belt models are important for spacecraft designs to evaluate the total radiation dose. The Akebono satellite has been in the highly elliptical orbit since 1989 and measured almost whole region of the inner radiation belt and the high latitude region of the outer radiation belt over a period of 22 years which is the 2 solar cycles. From the long-term Akebono satellite observation, we find that the logarithm of the annual mean high energy (>2.5MeV) electron flux shows a good correlation with the annual mean Dst index in the slot region and the outer belt. We propose the electron radiation model depending on the mean Dst index.

Keywords: Electron radiation belt model, Akebono satellite, Dst index

PEM07-26 Room:304 Time:May 23 09:55-10:10

Numerical calculation of magneto-chemistry equation based on the observational results in quiet regions of the Sun

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[1]University of Tokyo

We report the results of numerical calculation of magneto-chemistry equation (Schrijver et al., 1997) based on the observed frequencies of merging, splitting, emergence, and cancellation of photospheric magnetic patches in a quiet regions on the Sun.

Parnell et al. (2009) reports the power-law frequency distribution of flux content in magnetic patches with an index of -1.85, which spans from sunspots in active regions to small patches in quiet regions. Two ideas for the explanation of this distribution were suggested: One is that the distribution reflects dependence of flux supply from below the photosphere. Another is that surface magnetic processes maintain the distribution.

The surface processes of the photospheric magnetic field consist of merging, splitting, emergence and cancellation of magnetic patches. We investigated frequencies of these processes by observations of two quiet regions and suggest a qualitative picture of the flux maintenance. It is: 1) Frequency distribution of flux content is dominantly maintained by merging and splitting. 2) Cancellation occurs owing to the random motion of the convection. 3) The flux submerged through a cancellation re-emerges and is recycled to the surface.

The next step is a quantitative investigation for finding a stable equilibrium solution based on these observations, which is our topic in this study. We solve numerically the magneto-chemistry equation, which is suggested by Schrijver et al. (1997) and describe relationship among frequency distribution of flux content and those of magnetic processes. It should be noted that we use an assumption of flux recycling of submerged flux.

We obtain the results that: 1) The frequency distribution reaches a stable equilibrium, which is a power-law distribution with an index of -1.7. 2) The equilibrium solution strongly depends on the input values of the frequencies of magnetic processes. 3) The equilibrium is independent of initial conditions. These results indicate that the observed surface processes can make and maintain the observed frequency distribution of flux content with recycling of magnetic flux in a quantitative sense.

Keywords: sun, photosphere, magneto-convection

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

PEM07-27 Room:304 Time:May 23 10:10-10:25

Toward estimating the plasmaspheric density using data of ground magnetometers and GPS TEC

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The plasmasphere is the region in space, close to the Earth. It is a part of the magnetosphere (region filled with the Earth-origin magnetic field). The plasmasphere is filled with ionosphere-origin plasma, and the shape of the plasmasphere changes in response to the activity of the magnetosphere. It is important to monitor three-dimensional plasma distribution in and near the plasmasphere; for example, the plasmasphere can affect the progress of magnetic storms via plasmasphere-ring current interactions (the ring current is another region in which strong electric currents, carried by plasma there, flow in the shape of a ring surrounding the Earth).

Measures to monitor the three-dimensional density distribution in and near the plasmasphere include ground magnetometers and GPS satellites, as follows. From ground magnetometer data one can identify the eigenfrequency of the field line running through the magnetometer. From thus identified frequency (so-called FLR frequency, where FLR stands for "field line resonance"), one can obtain information on the plasma mass density distribution along the field line. Ground coverage by magnetometers is getting thicker day by day toward two-dimensional ground coverage, from which one can obtain information on three-dimensional plasma density distribution in the region threaded by the field lines running through the ground magnetometers.

Each GPS satellite provides TEC (total electron contents) along the line of sight from the satellite to a GPS receiver; from the TEC one can obtain information on the electron density distribution along the line of sight. There are 24 GPS satellites, and the coverage by GPS receivers (located on the ground and in space) is getting thicker day by day, from which one can obtain information on three-dimensional electron density distribution in the region threaded by the line of sights from the GPS satellites to the GPS receivers.

In this paper we present a method to evaluate the ground-magnetometer information and the GPS-TEC information at the same time and obtain a unified plasmaspheric plasma density distribution. In essence, the method calculates the differences between the observations and the corresponding quantities calculated from the estimated plasma distribution, and minimizes the sum of the differences for the two types of observations. Details will be given at the presentation. We first realize this method in an iterative manner by using the quasi-Newton method. Tests with simulated data are ongoing, and we will show the results at the meeting. Some sample observational data will also be shown.

PEM07-28 Room:304 Time:May 23 10:45-11:00

Coronal disturbances associated with the 2011 August 9 solar flare

ASAI, Ayumi[1*], SHIBATA, Kazunari[1], ISHII, Takako[1], KITAI, Reizaburo[1], ICHIMOTO, Kiyoshi[1], ISOBE, Hiroaki[1], SHIOTA, Daikou[2]

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We report simultaneous observation of an H-alpha Moreton wave, the corresponding EUV fast coronal waves, and a slow and bright EUV wave (typical EIT wave). We observed a Moreton wave, associated with an X6.9 flare that occurred on 2011 August 9 at the active region NOAA 11263, in the H-alpha images taken by SMART at Hida Observatory of Kyoto University. In the EUV images obtained by the Atmospheric Imaging Assembly on board SDO we found not only the corresponding EUV fast "bright" coronal wave, but also the EUV fast "faint" wave that is not associated with the H-alpha Moreton wave. We also found a slow EUV wave, which corresponds to a typical EIT wave. Furthermore, we observed the oscillations of a prominence and a filament, simultaneously, both in the H-alpha and EUV images. To trigger the oscillations by the flare-associated coronal disturbance, we expect a coronal wave as fast as the fast-mode MHD wave with the velocity of about 570-800 km/s. These velocities are consistent with those of the observed Moreton wave and the EUV fast coronal wave.

Keywords: solar flare, solar corona, filament eruption, filament oscillation, shock waves, magnetohydrodynamics

Japan Geoscience Union Meeting 2012
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PEM07-29 Room:304 Time:May 23 11:00-11:25

Ionospheric Weather of S4 Index Observed by FORMOSAT-3/COSMIC during 2006-2011

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The FORMOSAT-3/COSMIC (F3/C) constellation lunched on 15 April 2006, which consists of six micro-satellites in the low-earth orbit, is capable of monitoring the troposphere and ionosphere by using the powerful technique of radio occultation. With more than 2000 observations per day, it provides an excellent opportunity to monitor three-dimensional structures and dynamics of the ionospheric scintillations during 2006-2011. The global F3/C S4 index are subdivided and examined in various latitudes, longitudes, altitudes, and seasons. The F-region scintillations in the equatorial and low-latitude ionosphere start around post-sunset period and often persist till post-midnight hours (0300 MLT, magnetic local time) during the March and September equinox as well as December Solstice seasons. The E-region scintillations reveal a clear solar zenith effect and yield pronounced intensities in mid-latitudes during the Summer Solstice seasons, which are well correlated with occurrences of the sporadic E-layer. There is no obvious scintillation activity observed in the high-latitude ionosphere.

Keywords: Ionospheric Weather, S4 Index, FORMOSAT-3/COSMIC

Japan Geoscience Union Meeting 2012
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PEM07-30 Room:304 Time:May 23 11:25-11:45

Ground-based observations of solar flares; current status

ICHIMOTO, Kiyoshi[1*], Takako, T. Ishii[1], Tomoko Kawate[1], Satoshi Morita[1], Ayumi Asai[1], Shin'Ichi Nagata[1], Yusuke Yoshinaga[1], Masafumi Yamaguchi[1], Satoru Ueno[1], Kazunari Shibata[1], Reizaburo Kitai[1]

[1]Kwasan and Hida Observatories, Kyoto University

Besides the remarkable progress of recent flare observations from space, i.e., those by SDO, Hinode, RHESSI, etc., ground-based observations also take an important role for flare research in the sense that they can provide high spatial and temporal resolutions and spectroscopic information. In the beginning of a flare, a number of bright points called as flare kernels are observed in Ha to rapidly evolve in space and time to form two ribbons of the flare in both sides of the magnetic neutral line. Each flare kernel changes its brightness in a time scale of a second or so is thought to be the location into which high energy particles accelerated in the corona precipitate. Therefore observations of flare kernels in high spatial and temporal resolutions provide valuable information on the structure of the flaring magnetic loop system in corona and sites of particle acceleration in there. The white-light flares are of a particular interest because they are thought to be associated with particles in extremely high energy range. Dopplergram observations in Ha give the velocity vector of erupting filaments associated with a flare, which serve as important information for predicting the following disturbance of interplanetary space. Furthermore, high cadence observations of vector magnetic field in photosphere are of crucial importance for the studies of energy storage and trigger mechanism of flares.

In this presentation, we discuss the current status and results of ground-based flare observations paying some attentions to the on-going projects at the Kwasan and Hida observatories of Kyoto University.

Keywords: sun, flare, h-alpha, ground based observation, particle acceleration

Japan Geoscience Union Meeting 2012
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PEM07-31 Room:304 Time:May 23 11:45-12:00

Solar wind ? radiation belt coupling during the high-speed solar wind

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We investigate the solar wind-radiation belt coupling process during high speed solar wind streams (HSS). Flux enhancements of the outer belt depend on the IMF Bz; the large flux enhancements tend to occur during the HSS with the predominantly southward interplanetary magnetic field (IMF). We consider the internal acceleration process by whistler mode wave-particle interactions as a working model. We show clear differences of key parameters of the internal acceleration process between the southward and northward dominant IMF in HSS; hot electrons for the free-energy source for whistler mode waves, thermal plasma distribution, sub-relativistic electrons for the seed population of MeV electrons, and convection/substorms. Considering these observational results, a model of solar-wind radiation belt coupling is proposed, in which whistler mode wave-particle interactions driven by continuous hot electron injections play an important role for the flux enhancements.

Keywords: outer radiation belt, solar wind - magnetosphere coupling, High speed streams

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PEM07-32 Room:304 Time:May 23 12:00-12:15

Radio observation of solar flares on this solar cycle and space weather

IWAI, Kazumasa[1*], MISAWA, Hiroaki[1], TSUCHIYA, Fuminori[1], MORIOKA, Akira[1]

[1]PPARC, Tohoku University

The solar corona contains many particle acceleration phenomena that are caused by the interactions between coronal magnetic field and plasma. Non-thermal electrons accelerated in the corona emit radio waves in the metric range, resulting in many types of solar radio bursts being observed. One of the main emission processes of metric solar radio burst is a plasma emission. The plasma emission is emitted around local plasma frequency. When non-thermal electrons move in a density varying region, a frequency drift structure is observed. For example, type-III bursts are generated by non-thermal electrons propagating along open field lines. Type-II bursts are generated by non-thermal electrons propagating with a shock in the corona. Therefore, spectrum observations of solar radio bursts are important to observe and forecast space whether phenomena.

Iitate Planetary Radio Telescope (IPRT) is a ground-based radio telescope developed by Tohoku University. Solar radio observation system of IPRT (AMATERAS) enables us to observe radio bursts in the frequency range between 150 and 500 MHz, which is suitable to observe solar radio bursts. We have observed solar radio bursts since 2010 using this system. Many flare associated radio phenomena including two X-class flares have been observed by our observations. Some examples of recent major flares and associated radio phenomena observed by AMATERAS are reported to describe the importance of radio observations on the space weather research.

Keywords: Sun, flare, radio burst, ground-based observation, space weather

Japan Geoscience Union Meeting 2012
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PEM07-33 Room:304 Time:May 23 13:45-14:00

Development of Radiation Belt Prediction Models for Space Weather Forecast

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Dynamic changes of the Earth's Radiation belt is one of the well known but still unsolved issue of solar terrestrial physics.This is also important for the practical point of view because relativistic electron can penetrate into a satellite body and causes deep dielectric charging. This phenomenon is one of the major reasons of satellite anomaly. For prediction of space environment around GEO, we will proceed to develop 1) near real time prediction model of relativistic electron environment, 2) high precision global MHD simulation in this 5-year term from 2011. As for the prediction model of relativistic electron environment, we plan to develop two types of models. One is near real time prediction model based on the AR model that is a kind of the parametric analysis methods for the time-series data. The product of this model is for daily operation of geosynchronous satellite. The other is high time and spatial resolution numerical forecast model based on combination between global MHD simulation code and particle tracing code and others. The product of this model is for post analysis of satellite anomalies. We will introduce an overview and current status of our project.

Keywords: Space Weather Forecast, Radiation Belt Prediction

Japan Geoscience Union Meeting 2012
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PEM07-34 Room:304 Time:May 23 14:00-14:15

SOLAR-C: the planned next solar observing satellite mission

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The solar chromosphere, 10,000 K partially ionized atmosphere, covers above the photosphere of 5,800 K and the fully ionized 1,000,000 K solar corona extends further from the height of a few thousand km above the photosphere. The hot coronal plasma is finally flowing out from the Sun as the solar wind beyond the Earth orbit toward the boundary of the heliosphere. Explosive events on the Sun, solar flares and coronal mass ejections, are the source of disturbance to the space weather.

The solar magnetic field plays the central role in the presence of the hot atmosphere, and it is the energy source of highly dynamic phenomena occurring there. Hinode (SOLAR-B) has revealed the presence of new small-scale structures and dynamic events by high-resolution observations. They are not independent phenomena to the other solar activity, but are key ingredients to understand the presence of hot atmosphere (chromosphere and corona) and the trigger of large-scale explosive events. Major lack of information in Hinode observations is the magnetic field in the chromosphere and the magnetic connectivity from the chromosphere to the corona due to insufficient spatial resolution in coronal observations.

The JAXA SOLAR-C Working Group is planning the next solar observing satellite SOLAR-C that follows Hinode in orbit. SOLAR-C will observe the chromospheric magnetic field as well as the photospheric magnetic field from the high-resolution and high-precision spectro-polarimetric measurements, and realistically connects magnetic structures in the outer atmospheres by coronal imaging and spectroscopy of sub-arcsec resolution. This enables us to observe the entire magnetic coupling among the photosphere, chromosphere, and corona for the first time. In order to obtain such observing capabilities, a large-aperture optical telescope, high-resolution coronal imagers, and a high-resolution spectrometer are to be on-board SOLAR-C. We introduce the science goals and the observing platform of the SOLAR-C mission.

Keywords: Sun, Satellite Observation

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PEM07-35 Room:304 Time:May 23 14:15-14:30

A Report of World-Wide, Regional, and Domestic Activities of Space Weather Operations and Researches

MURATA, Ken T.[1*], WATARI, Shinichi[1], NAGATSUMA, Tsutomu[1]

[1]NICT

Space environment, where satellites and international space stations (ISS) are located, dynamically change due to the effect of solar activities. Disturbances in space occasionally cause satellite malfunctions, tele-communication problems, and error of navigations. The role of space weather forecast is to monitor the current conditions and to predict the future conditions of space environment. As our daily life tend to depend on a variety of electric and electronic devices and systems, the role of the space weather would be inevitable.

NICT is a part of ISES (International Space Environment Service: 14 nations have participated) space weather forecast centers (regional warning centers: RWC). We have been routinely carrying out daily space weather forecast services and provide information on the forecasts of solar flare, geomagnetic disturbances, solar proton event, and condition of radio-wave propagation to public.

As known well, the solar activity changes periodically with 11 years. Now we are at the developing phase of the cycle 24, and the peak of the phase will be around 2013 or 2014. Practical space weather forecast is expected, but unfortunately, our forecasting is not yet perfect. For example, our solar-flare prediction score and geomagnetic disturbance prediction are between 50% and 90% respectively.

For more accurate and practical space weather forecasting, international collaborations would play an important role. During these few years, new international activities have started: One is in UN (United Nations) and the other is in WMO (World Meteorological Organization). Regional collaboration is also necessary, especially for the ionospheric researches and observations in space weather operations. NICT and other 13 organization have kicked off a new alliance for space weather: the Asia-Oceania Space Weather Alliance (AOSWA).

In the present talk, we first review what the space weather is, with focusing on the effect of disturbances in space to our social systems, from spacecraft to GPS navigation systems. We next introduce recent world-wide, regional and domestic activities of space weather.

Keywords: Space Weather, AOSWA, ISES, UN, WMO

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Current Status of the GEMSIS Project: Particle acceleration and regional couplings during geospace storms

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Human activities in geospace (near-Earth space) have become important since the 20th century. The geospace storms, which often take place during the solar maximum, are drastic variation of the space environment caused by dynamic solar activities such as CMEs. During the geospace storms, enhanced regional couplings in the solar-terrestrial system and dynamic energy and mass transport, resulting in change of Earth's radiation belt and various space weather phenomena, are known to take place. Researches into geospace storms, which can cause various natural and artificial phenomena, such as active auroras, satellite communication blackouts, and spacecraft malfunctions, are getting more international focus in preparation for the solar maximum around 2013. International program CAWSES-II (climate and weather of Sun-Earth System, Part 2) is now underway. RBSP (Radiation Belt Storm Probes) and Resonance missions are being conducted in the US and Russia, respectively, aiming at the launch of geospace exploration satellites around 2013. Japan is also preparing for the ERG (Energization and Radiation in Geospace) project. One of characteristics of the ERG project is close collaboration between three task teams, namely, the satellite, ground-based observation, and theory/simulation/modeling teams.

Aiming at understanding of physical mechanisms of the particle acceleration and regional couplings in solar-terrestrial system during the geospace storms as well as providing efficient study environment for the trinity collaboration in the ERG project, we have conducted the GEMSIS (Geospace Environment Modeling System for Integrated Studies) Phase 2 project from FY2010 at STEL, Nagoya University. The project is based on studies conducted in the GEMSIS phase 1 project in FY2007-2009 that focuses on understanding the high-energy particle environment in geospace and developing basic technologies for geospace modeling. In the GEMSIS project, we develop physics-based as well as empirical models using satellite measurements and global ground-based measurements. Comparisons between models and observational results are essential to improve the models and to eventually understand the dynamics of the geospace. In order to understand physical mechanisms of dynamic phenomena taking place in the complicated Sun-Earth system, the GEMSIS project is carried out by three working teams (WTs): The "GEMSIS-Sun" WT, aiming at understanding of whole processes (energy-storage, trigger, energy-release, and particle acceleration) of solar flare, have developed flare-trigger and particle acceleration models, and carried out researches through comparing them with various kind of observations. Aiming at understanding the dynamics of the inner magnetosphere during the geospace storms, the "GEMSIS-Magnetosphere" WT has addressed the development of new physics-based models for the global dynamics of the ring current (GEMSIS-RC model) and radiation belt (GEMSIS-RB model). Integrated data analysis studies on such as topics as supply mechanisms of ring current ions and relativistic electron accelerations are also conducted using various types of geospace observations from space and from the ground. The "GEMSIS-Ionosphere" WT has implemented models of global distribution of the ionospheric electric potential in order to understand the Sun-Earth system. Combined with observations, the ionospheric electric field as well as energy flow is examined.

Another important task of the GEMSIS Phase 2 project is contribution to the ERG Science Center that facilitates the close collaboration between the satellite, ground-based observation, and theory/simulation/modeling for geospace studies by providing integrated data analysis tools and combined database. Contribution to the Hinode Science Center at STEL has also been made by the project. In this paper, research highlights and strategy of the GEMSIS project will be reported.

Keywords: Geospace Environment, Solar Activity, Particle Acceleration, Inner Magnetosphere, Magnetic Storm

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Highlights of Space Weather Services/Capabilities at NASA/GSFC Space Weather Center

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The importance of space weather has been recognized world-wide. Our society depends increasingly on technological infrastructure, including the power grid as well as satellites used for communication and navigation. Such technologies, however, are vulnerable to space weather effects caused by the Sun's variability.

NASA GSFC's Space Weather Center (SWC) (http://science.gsfc.nasa.gov//674/swx_services/swx_services.html) has developed space weather products/capabilities/services that not only respond to NASA's needs but also address broader interests by leveraging the latest scientific research results and state-of-the-art models hosted at the Community Coordinated Modeling Center (CCMC: http://ccmc.gsfc.nasa.gov).

By combining forefront space weather science and models, employing an innovative and configurable dissemination system (iSWA.gsfc.nasa.gov), taking advantage of scientific expertise – both in-house and from the broader community – as well as fostering and actively participating in multilateral collaborations both nationally and internationally, NASA/GSFC space weather Center, as a sibling organization to CCMC, is poised to address NASA's space weather needs (and needs of various partners) and to help enhancing space weather forecasting capabilities collaboratively. With a large number of state-of-the-art physics-based models running in real-time covering the whole space weather domain, it offers predictive capabilities and a comprehensive view of space weather events throughout the solar system. In this paper, we will provide some highlights of our service products/capabilities. In particular, we will take the 23 January and the 27 January space weather events as examples to illustrate how we can use the iSWA system to track them in the interplanetary space and forecast their impacts.

Keywords: Space Weather, Community Coordinated Modeling Center