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

PEM27-01 Room:106 Time:May 21 09:00-09:15

WASAVIES: WArning System of AVIation Exposure to SEP

KATAOKA, Ryuho[1*], YASHIRO, Seiji[2], SATO, Tatsuhiko[3], YASUDA, Hiroshi[4], Takao Kuwabara[5], SHIOTA, Daikou[6]

[1]Tokyo Tech, [2]CUA, [3]JAEA, [4]NIRS, [5]Univ. Delaware, [6]RIKEN

The prediction of solar energetic particles (SEP) is important to mitigate the space weather hazard toward increasing solar activities, and is also an ultimate problem for physics-based modelers because of the hybrid nature of MHD fluid and particles. We are developing a two-step forecast system called Warning System of AVIation Exposure to SEP (WASAVIES) as follows: 1) Detect ground level enhancement (GLE) onset by multiple ground-based neutron monitors [Kuwabara et al., Space Weather, 2006] and obtain the GLE, solar wind, and flare parameters to publish the preliminary forecast within one hour after X-ray flare detection. At this stage we have only a small number of necessary parameters, and available forecast may be limited about the anisotropic GLE dose map and the maximum level of SEP fluence during coming 7 days. 2) Within 6 hours after the flare onset, automatically obtain the CME parameters such as speed and direction parameter to predict the CME driven SEP profiles during the 7 days in the energy range from 10 MeV to 10 GeV. The modified MHD Cube model [Kataoka et al., J. Geophys. Res., 2009] calculates the time-varying CME shock strength and the magnetic field connectivity to Earth for a particle model to estimate the SEP spectra, and also estimate the weekly profiles of solar wind parameters which are necessary inputs for T05 storm model to estimate the cutoff latitudes. Using the SEP energy spectra and cutoff latitudes, the aviation dose map are evaluated by modified PARMA model [Sato et al., Radiat. Res., 2008]. The real-time data of SEP, solar wind, and geomagnetic activities are also utilized properly. In the presentation, we report the current situation of the development of WASAVIES.

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

PEM27-02 Room:106 Time:May 21 09:15-09:30

Verification of the Air Shower Simulation Induced by Solar Energetic Particles

SATO, Tatsuhiko[1*], YASUDA Hiroshi[2], KATAOKA Ryuho[3], YASHIRO Seiji[4], KUWABARA Takao[5], SHIOTA Daiko[6]

[1]JAEA, [2]NIRS, [3]Tokyo Tech, [4]CUA, [5]University of Delaware, [6]RIKEN

When solar energetic particles (SEP) are incident to the atmosphere, they can induce air showers by generating varieties of secondary particles. Such secondary particles can reach conventional flight altitudes (˜12 km), and hence, aircrews are exposed to enhanced level of radiations. In order to precisely estimate the aircrew doses, the Monte Carlo simulation for air shower is indispensable. We therefore simulated air showers induced by mono-energetic protons, using a general-purpose Monte Carlo particle and heavy ion transport simulation code system PHITS [1], and developed a database of particle fluxes in the atmosphere. Combining the database with the proton fluxes measured by PAMELA during the GLE event occurred on Dec. 13th 2006, the count rates of the neutron monitor located at Thule were calculated. The calculated count rates agree with the measured data fairly well, verifying the accuracy of our simulation technique.

[1] http://phits.jaea.go.jp/

Keywords: SEP, radiation dose, airshower simulation, solar flare, GLE

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

PEM27-03 Room:106 Time:May 21 09:30-09:45

Statistics of Ground Level Events

WATARI, Shinichi[1*], Takashi Watanabe[1], KUBO, Yuki[1], DEN, Mitsue[1], MURATA, Ken T.[1]

[1]National Institute of Information and Communications Technology

It is possible for a cosmic ray monitor on the ground to detect solar energy particles which exceed 500MeV. Flux enhancement of the cosmic ray monitor by solar energetic particles is called Ground Level Event (GLE). Although number of GLEs increase near solar maximum, it may occur even near solar minimum. Ground-based cosmic ray observation started around the 1940s and approximately seventy GLEs have been observed until now. Many statistical analyses on GLEs have been carried out using those events. They are solar longitudinal distribution of GLE sources, relations with flares or coronal mass ejections, relations with solar radio bursts in microwave range, and so on. We will review the previous results and show our results on GLE.

Keywords: GLE, solar flare, solar microwave burst, space weather

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

PEM27-04 Room:106 Time:May 21 09:45-10:00

Performance Evaluation of Automated Flare-CME Event Recognition System for WASAVIES

YASHIRO, Seiji[1*], GOPALSWAMY, Nat[2]

[1]The Catholic University of America, [2]NASA Goddard Space Flight Center

Solar Energetic Particles (SEPs) are accelerated by interplanetary shocks driven by coronal mass ejections (CMEs). The intensity of the SEP events is closely related to the CME speed, width, and source location. SEPs pose significant radiation hazard to space systems and aviation, so it is important to predict the SEP events. The WArning System of AVIation Exposure to SEPs (WASAVIES) is an initiative to forcast the expected exposure to SEP events at the latitude of commercial aircraft. The aim of this work is to obtain the CME parameters in real-time for better prediction of SEP events. The work involves the identification of CME source regions using soft X-ray flares and CME kinematics using automatic recognition of CMEs.

NOAA Space Weather Prediction Center has issued X-ray flux alert when flare X-ray flux exceeds the M5 level. Twenty four major flare alerts were issued between February 2010 and January 2012. Out of the 24 flares, 18 were associated with the CMEs. Our automated CME recognition system could detect all the CMEs but the obtained CME speeds were significantly lower than the CME speed measured by human eyes. We need to optimize parameters in the CME recognition system to obtain the better results.

Keywords: Space Weather, CMEs, Flares

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

PEM27-05 Room:106 Time:May 21 10:00-10:15

Development of automatic daily MHD simulation system of inner heliosphere

SHIOTA, Daikou[1*], KATAOKA, Ryuho[2], MIYOSHI, Yoshizumi[3], TAO, Chihiro[4]

[1]RIKEN, [2]Tokyo Institute of Technology, [3]Solar-Terrestrial Environement Laboratory, Nagoya University, [4]Institute of Space and Astronautical Science, Japan Aerospace Exploration Agency

Interplanetary magnetic field (IMF) plays an essential role for energetic particle transport. Global IMF in the heliosphere is originated from open coronal magnetic field and dragged by solar wind. Coronal mass ejections (CMEs) changes IMF as they propagate in the inner heliosphere in addition to generating energetic particles. Therefore realistic modeling of solar wind and CMEs is an essential part of energetic particle modeling.

We recently have developed 3 dimensional global MHD simulation system of inner heliosphere. The simulation is based on minimal input, daily synoptic map of photospheric magnetic field. As a first step, we calculate coronal magnetic field with potential field source surface model and obtain maps of open magnetic field and expansion factor. Applying empirical models (such as Wang-Sheeley-Arge model), we obtain solar wind synoptic map. Using time series of the solar wind maps as the inner boundary(25 solar radii), we perform the global MHD simulation in 2 AU. MHD parameters at the Earth position are passed to a radiation belt model. These programs are executed everyday on a server in STEL, Nagoya university. We have been developing additional module to inject CMEs containing magnetic flux ropes.

Keywords: space weather, solar wind, magnetic field, photosphere

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

PEM27-06 Room:106 Time:May 21 10:15-10:30

Low-altitude SEP precipitation associated with interplanetary shocks

MIYOSHI, Yoshizumi[1*], KATAOKA, Ryuho[2]

[1]STEL, Nagoya University, [2]Tokyo Institute of Technology

Enhancements of solar energetic particle (SEP) associated with interplanetary shocks are investigated using the low-earth orbit POES satellite data. The POES satellites have ion detectors that can measure from 30 keV to 7 MeV. We demonstrate the superposed epoch analysis of MeV ions associated with the interplanetary shocks during solar cycle 23. The enhancements can be seen at the invariant latitudes larger than 60 deg. It is expected that these ions are accelerated by the interplanetary shock.

Keywords: low-altitude SEP, interplanetary shock

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

PEM27-07 Room:106 Time:May 21 10:45-11:00

Development of GLE alarm system and observation of recent SEP events by neutron monitors

KUWABARA, Takao[1*], John Bieber[1], Paul Evenson[1], John Clem[1], Roger Pyle[1]

[1]University of Delaware

We have developed a system that watches for count rate increases recorded in real time by eight neutron monitors, which triggers an alarm if a ground level enhancement (GLE) is detected. In this work, we determine optimal strategies for detecting the GLE at a very early stage, while still keeping the false alarm rate at a very low level. The highest level alarm, which we term an ”alert,” is generated when a 4% increase is recorded at 3 stations in 3-min averaged data. At this level the false alarm rate obtained by backtesting over the 4.4 years from October 2000 to May 2005 is zero. Ten GLEs occurred in this period, and our system produced GLE alarms for nine events. Alarm times for these nine events are compared with satellite proton data. The GLE alert precedes the earliest alert from GOES (100 MeV or 10 MeV protons) by 10-30 min. An automated e-mail alert system is now under beta testing at http://www.bartol.udel.edu/˜takao/neutronm/glealarm/index.html. Real-time GLE data may be viewed at http://neutronm.bartol.udel.edu/spaceweather. We also report the recent observation of solar energetic particle events in this year.

Keywords: GLE, SEP, Neutron Monitor, Cosmic Ray

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

PEM27-08 Room:106 Time:May 21 11:00-11:15

Numerical simulation of energetic particle transport in solar wind

KUBO, Yuki[1*], WATARI, Shinichi[1], NAGATSUMA, Tsutomu[1], DEN, Mitsue[1], MURATA, Ken T.[1]

[1]National Institute of Information and Communications Technology

Solar energetic particles are accelerated at a region of a solar flare and a shock wave in a solar corona and/or a solar wind. Especially, particles can be sometimes accelerated to GeV energy at the flare region and the coronal shock wave. These extremely energetic particles are propagated to the Earth in the solar wind and cause ground level enhancement (GLE). As turbulent magnetic fields exist in the solar wind together with a back ground magnetic field (Parker magnetic field), the energetic particles are transported in the solar wind along the back ground magnetic field suffering pitch-angle scattering by turbulence. The energetic particle transport in the solar wind is often described by a focused transport equation. We have developed a numerical simulation code to solve the focused transport equation to reproduce a particle flux observed near the Earth. In the presentation, we introduce our developing numerical simulation code and give some results of numerical simulations of GeV particle transport in the solar wind.

Keywords: energetic particle, solar wind, stochastic differential equation

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

PEM27-09 Room:106 Time:May 21 11:15-11:30

Particle diffusion process around collisionless shocks

SUGIYAMA, Tooru[1*]

[1]JAMSTEC

We have studied the transport properties of energetic particles around parallel shocks considering the possibility of anomalous diffusion where the density decay pro?le has not an exponential pro?le but a power-law behavior.

Keywords: shock wave, particle diffusion

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

PEM27-10 Room:106 Time:May 21 11:30-11:45

Evaluation of solar energetic particles exposure on the Venus orbiter Akatsuki

HADA, Yuko[1*], ISOBE, Hiroaki[2], ASAI, Ayumi[2], ISHII, Takako[1], SHIOTA, Daikou[3], IMAMURA, Takeshi[4], Hiroyuki Toyota[4]

[1]Kwasan and Hida Observatories, Graduate School of Science, Kyoto University, [2]Unit of Synergetic Studies for Spase, Kyoto University, [3]RIKEN, [4]Japan Aerospace Exploration Agency, Institute of Space and Astronautical Science

Space weather researches have become more and more important, according to the expansion of the ”humanosphere” to the space. On the other hand, current space weather researches are mainly for circumterrestrial space, not for the deep space probes that are located far from the earth. We aim to forecast and evaluate the radiation hazard to such space probes far from the earth by using the data taken by the Solar Terrestrial RElations Observatory (STEREO). STEREO provides the images of the part of the Sun that is invisible from the Earth, but only EUV images and coronagraph images are available.

First, we examine the possibility of the evaluation of the radiation hazard by using EUV and coronagraph images. It is known that solar energetic particles (SEPs) flux is well correlated with the speed of coronal mass ejection (CME) measured by a coronagraph. We focused on two successive flare/CME events occurred on June 4th, 2011. It occurred in an active region that located on the invisible side of the Sun, and near the disk center as seen from Akatsuki (PLANET-C), the Venus Climate Orbiter that was orbiting the Sun at around 0.7AU. On June 5th, an abrupt decrease in the electric power of Akatsuki was observed, which may be attributed to the effect of SEPs associated with the flare/CME events.

We measured the velocity of the two CMEs using the coronagraphic images from STEREO and found that the second CME was much faster (about 2200 km/s) than the first one (about 1000 km/s). Considering the time difference between the two events, it is likely that the second CME caught up the first one before they arrived at 0.7AU. The estimated arrival time is consistent with the timing of the power decrease of Akatsuki. According to a statistical study of CMEs and SEPs preformed by Gopalswamy et al (2004) SEP flux tends to become large if a preceding CME have been launched within 24 hours ahead of the onset time of the primary CME. Using the empirical relationship between the SEP flux and the CME velocity derived by Gopalswamy et al. (2004), we estimate the SEP flux of 10ˆ2-10ˆ4 cmˆ-2 sˆ-1 srˆ-1. We are also analyzing other large events that may potentially affected Akatsuki such as that occurred on January 23 2012.

Keywords: Solar flare, CME, SEP, Space weather

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

PEM27-11 Room:106 Time:May 21 11:45-12:00

Influence of solar energetic particles on unmagnetized celestial bodies

FUTAANA, Yoshifumi[1*]

[1]Swedish Institute of Space Physics

High energy particles associated with solar flares (solar energetic particle; SEP) significantly influence the atmosphere and the surface of non-magnetized planetary bodies. In this presentation, we will show recent observations conducted in the vicinity of Mars and Venus demonstrating the importance of the SEPs on those bodies. In addition, we will also discuss the expected SEP effects on non-atmospheric bodies, such as the Moon.

Without the shielding by the magnetosphere, unmagnetized bodies are directly exposed to the SEPs. As a result, the response of the planetary bodies to the SEPs would be expected to be immediate and harsh. During the famous Halloween event in 2003, Mars Global Surveyor observed a compression of the Martian plasma environment and resulting enhancement of the magnetic field in the ionosphere caused by SEPs and CMEs (Crider et al., 2005). Signatures of the entry of the solar wind protons into the low altitude in the dayside and the enhancement of cyclotron waves associated with proton and oxygen ions in the nightside were found (Espley et al., 2005). These imply the increase of the atmosphere erosion, mainly oxygen ions, into space. During other moderate SEP events, Morgan et al. [2006] reported evidence for an additional ionospheric layer using active radar experience on board Mars Express, indicating the extrordinaly ionization of the atmosphere by the SEPs.

On December 5, 2006, one of the largest flares erupted from the east limb of the Sun. This was a geo-effective flare, but it influenced a wide area of the inner solar system including Mars (about 160? west of the Earth) and Venus (about 160? east of the Earth). Plasma sensor packages, ASPERA-3 and -4 on board Mars Express and Venus Express respectively, detected signatures of the SEPs as a high background count rate of the sensors. The high background condition lasted for a few days, and a higher (about 10 times more than usual) flux of outflowing oxygen ions was detected directly in the plasmatail for the first time. The increasing outflow of oxygen ions occurred before the arrival of the associated CMEs (Futaana et al., 2008). These observations indicate that the SEPs do influence the upper atmosphere to increase the escape of oxygen ions eventually, and thus, the high energy particle environment is one of the significant keys to investigate the atmospheric evolution of the solar system bodies in geological time scales.

Keywords: Solar Energetic Particle, Mars, Venus, Erosion, Moon