Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

PEM09-01 Room:211 Time:April 28 09:00-09:15

VarSITI - Variability of the Sun and Its Terrestrial Impact

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The Scientific Committee on Solar Terrestrial Physics (SCOSTEP) is an interdisciplinary body of the International Council for Science (ICSU) to run international interdisciplinary scientific programs and promotes solar-terrestrial physics research. The last solar minimum in 2008-2009 and the current solar maximum of sunspot cycle 24 show much lower activities compared with the previous two solar cycles 22 and 23. The scientists in the solar-terrestrial physics are watching very low solar activities and their consequences on Earth, which have never been observed since modern scientific measurements become available. The SCOSTEP program "Variability of the Sun and Its Terrestrial Impact (VarSITI)" (2014-2018) will focus on this particular low solar activity and their consequences on Earth, for various times scales from the order of thousands years to milliseconds, and for various locations and their connections from the solar interior to the Earth's atmosphere. In order to elucidate various sun-earth connections, we encourage communication between solar scientists (solar interior, sun, and the heliosphere) and geospace scientists (magnetosphere, ionosphere, and atmosphere). Campaign observations will be promoted for particular interval in collaboration with relevant satellite and ground-based missions as well as modeling efforts. Four scientific projects will be carried out in VarSITI as (1) Solar Evolution and Extrema (SEE), (2) International Study of Earth-Affecting Solar Transients (ISEST/Minimax24), (3) Specification and Prediction of the Coupled Inner-Magnetospheric Environment (SPeCIMEN), and (4) Role Of the Sun and the Middle atmosphere/thermosphere/ionosphere In Climate (ROSMIC).

Keywords: VarSITI, solar activity, climate change, magnetosphere, ionosphere, atmosphere

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PEM09-02 Room:211 Time:April 28 09:15-09:30

Specification and Prediction of the Coupled Inner-Magnetospheric Environment (SPeCIMEN)

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Specification and Prediction of the Coupled Inner-Magnetospheric Environment (SPeCIMEN) is a focus group of next SCOSTEP project: VarSITI. The goals and objectives are the quantitative prediction and specification of the Earth inner magnetospheric environment based on Sun/solar wind driving inputs. Our question is how the inner magnetosphere responds as a coupled system to Sun/solar-wind driving, which will be solved by a combination of physical and statistical modeling, theory and observations from various platforms under this project. The satellite missions such as NASA/Van Allen Probes (US), JAXA/ERG (Japan) and ground-based network observations provide a comprehensive picture on the dynamical evolutions of geospace and reveal processes and consequences of the inner magnetosphere. Anticipated outcome should be a series of coupled, related models that quantitatively predict the dynamical evolution of the inner magnetospheric state including radiation belts, ring current, plasmasphere, plasma sheet. In this presentation, we give an overview of the SpeCIMEN project and the strategy of the project to gain the science output.

Keywords: future mission, inner magnetosphere

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PEM09-03 Room:211 Time:April 28 09:30-09:45

Geotail observation of magnetic reconnection

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The spacecraft Geotail was launched on July 24, 1992. The main objective of the Geotail mission is to explore magnetic reconnection with in situ observations, and the Geotail mission has revealed various physical processes of magnetic reconnection. The ion-electron decoupling region where electron outflow speed differs from ion outflow speed is formed in the magnetic reconnection site. Ion and electron dynamics in the ion-electron decoupling region is derived with magnetic field and plasma observations by the spacecraft Geotail in near-Earth magnetotail magnetic reconnection. The ion-electron decoupling region has a spatial extent of approximately 11 ion inertial length along the GSM x direction, and the dawn-dusk current sheet with main current carriers of electrons exists over this region. An intense electron current layer with a spatial extent of 0.5?1 ion inertial length occupies in its center around the X line. High-speed electron outflow jets are formed just outside the central intense electron current layer. They are decelerated and become non-jet outflows with speed slightly higher than ion outflow speed. Electrons have flattop distribution functions indicating heating and acceleration in both the outflow jets and the non-jet outflows; however, heating and acceleration are weak in the central intense current layer. Inflowing ions enter the central intense electron current layer, and these ions are accelerated up to 10 keV inside the electron outflow jet regions. Ion acceleration beyond 10 keV and thermalization operate mostly in the non-jet electron outflow regions. Electrons show thermal distributions without any heating/acceleration signatures immediately beyond the edge of the ion-electron decoupling region, while higher-energy ions pervade even beyond the edge and hot MHD plasma flows are produced.

Keywords: magnetic reconnection, space plasma, substorm, magnetotail

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PEM09-04 Room:211 Time:April 28 09:45-10:00

Global dynamics of the inner magnetosphere derived from long term observation by Akebono

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Akebono is a Japanese scientific spacecraft which was launched in February, 1989 for observations of the Earth's magnetosphere, and has been operated successfully for 25 years. The regular data acquisition of MGF, PWS, VLF, TED, and RDM is still continued at stations in Japan and Sweden. The operation of the Akebono will be extended until March, 2015 (FY2014) in order to realize collaborative measurements with the Van Allen Probes, and further extension to the end of FY2016 is expected as an optional mission. Because of its unique orbit, the stored data is quite valuable for studying plasma physics in the auroral region as well as the radiation belt. In the present paper, we introduce important achievements of Akebono observation and discuss future science to be obtained from the long term observation data.

Keywords: Akebono, Inner Magnetosphere, Radiation belt, Aurora, Plasma wave

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PEM09-05 Room:211 Time:April 28 10:00-10:15

ERG Science Center

KEIKA, Kunihiro[1*] ; MIYOSHI, Yoshizumi[1] ; SEKI, Kanako[1] ; HORI, Tomoaki[1] ; MIYASHITA, Yukinaga[1] ; SHOJI, Masafumi[1] ; SEGAWA, Tomonori[1] ; SHINOHARA, Iku[2] ; TAKASHIMA, Takeshi[2] ; TANAKA, Yoshimasa[3] ; ERG, Science center team[4]

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ERG (Exploration of energization and Radiation in Geospace) is a Japanese geospace exploration project, and the ERG satellite will be launched in Japanese FY 2015. The project consists of the satellite observation team, the ground-based network observation team, and the integrated data analysis/simulation team. Besides these research teams, the ERG Science Center has been organized to promote close collaborations of these teams and thereby maximize scientific output. For studies of geospace, where different plasma populations are dynamically coupled with one another via cross-energy and cross-regional couplings, the environment for integrated data analysis is critical for comprehensive understanding using various kinds of data sets including data from physics-based models developed by the GEMSIS (Geospace Environment Modeling System for Integrated Studies) project of the Solar-Terrestrial Environment Laboratory, Nagoya University.

A standard data format and integrated data analysis tools are essential to realize the seamless data analysis environment. The ERG project data after Level-2 will be open to the public in the NASA CDF format. The integrated data analysis tool is developed as a plug-in tool of SPEDAS (Space Physics Environment Data Analysis System) in collaboration with the THEMIS (Time History of Events and Macroscale Interactions during Substorms) and IUGONET (Inter-university Upper atmosphere Global Observation NETwork) teams. It should be noted that other project data, such as THEMIS and Van Allen Probes, can be easily analyzed with SPEDAS if the data are converted to the CDF format. Thus the integrated data analysis using many kinds of data is truly realized through SPEDAS. Other useful tools in the web browser have been developed by the science center: ERGWAT (ERG Web Analysis Tool) is an interactive visualization tool, and CEF (Conjunction Event Finder) is a web-based tool enabling users to easily find conjunctions between satellites and ground-based observations. These tools will contribute to a part of the capacity building activity of the SPeCIMEN (Specification and Prediction of the Coupled Inner-Magnetospheric Environment) project carried out under the VarSITI (Variability of the Sun and Its Terrestrial Impact) program for 2014-2018.

Keywords: ERG, GEMSIS, IUGONET, Integrated analysis tool, SPEDAS, SPeCIMEN

Japan Geoscience Union Meeting 2014
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PEM09-06 Room:211 Time:April 28 10:15-10:30

ICSWSE/MAGDAS Research Projects During the VarSITI Program Interval

KAWANO, Hideaki[1*] ; YOSHIKAWA, Akimasa[1] ; ABE, Shuji[1] ; UOZUMI, Teiji[1] ; CARDINAL, Maria gracita[1] ; MAEDA, George[1] ; YUMOTO, Kiyohumi[1] ; MAGDAS/CPMN, Group[1]

[1]International Center for Space Weather Science and Education

International Center for Space Weather Science and Education (ICSWSE) has developed a real time magnetic data acquisition system (the MAGDAS project) to monitor the space environment around the world. The number of observational sites is increasing every year in collaboration with MAGDAS host countries. Up to now, the MAGDAS Project has installed 73 real time magnetometers: It is the largest magnetometer array in the world. Using data from this global network, we are developing many research projects. In this talk, we introduce our research projects planned during the VarSITI program interval, as follows:

(1) Global electromagnetic coupling from polar to equatorial ionosphere
(2) Vertical coupling among the atmosphere, the ionosphere and the magnetosphere
(3) Plasmaspheric diagnosis using the Field line resonance
(4) Magnetospheric diagnosis using geomagnetic disturbances
(5) Monitoring of Space weather phenomena using solar and magnetospheric indices
(6) Modeling of Space weather parameters
(7) Sun-atmosphere coupling

Keywords: VarSITI, MAGDAS, CPMN

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PEM09-07 Room:211 Time:April 28 10:30-10:45

Energetic electron precipitation during magnetic storm and substorm: Subionospheric VLF/LF observation

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Subionospheric VLF/LF radio observation is useful probe to investigate precipitation of high-energy (>100keV) electrons into the atmosphere and the observation at Ny-Alsound, Norway (NAL) and Athabasca, Canada (ATH) are used to detect energetic electron precipitation in auroral and sub-auroral regions during storm and substorm. At the NAL station, radio signals which are transmitted in mid-latitude and propagate across the auroral and sub-auroral regions are recorded. During magnetic storms, the strong phase variation associated with the substorm induced electron precipitation has been detected and the phase change quantitatively corresponds to the precipitating energetic electron flux observed by the NOAA/POES satellites over the radio propagation path. Onsets of the phase change were delayed by ten to several tens of minutes from the substorm onset in the morning and noon sectors, which is consistent with the drift time of energetic electrons with energy of ˜100 keV. On the other hand, the phase change in the dusk sector occurred shortly after the substorm onset and is often accompanied by Pc1 or Pi1B observed on the ground station near the radio path. These results show that the energetic electron precipitation is strongly connected with the dynamics of energetic ions and electrons and wave generations in the inner magnetosphere. The ATH station is located in the subautoral region and subionospheric signals from lower latitude are measured. The phase fluctuations with time scales of Pc5 or longer period were sometimes found during main and early recovery phases of magnetic storms. The phase fluctuations found on 5 June 2011 show good correlation with the GOES magnetic field data, suggesting Pc5 modulation of either electron injection or precipitation rates. Subionospheric radio observation provides opportunities to investigate various kinds of energetic electron precipitation processes. Part of observed data is provided through the IUGONET metadata database.

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PEM09-08 Room:211 Time:April 28 11:00-11:15

A longitudinal network of VLF/ELF antennas and induction magnetometers at subauroral latitudes - Contribution to VarSITI

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We report observations of VLF/ELF chorus waves (~kHz) using loop antennas and Pc1 waves (~Hz) using induction magnetometers at longitudinally-distributed stations at subauroral latitudes. Continuous measurements of VLF waves with a sampling rate of 100 kHz have been made since September 2012 to monitor daily variations of chorus waves and their detailed structures at Athabasca (54.72N, 246.69E, MLAT=61.3). We observe various chorus emissions, such as quasi-periodic (Q-P) emissions, patchy burst emissions, rising and falling tone emissions at Athabasca. New loop antennas will be installed at Fredericton in the east-coast of Canada and at Zhigansk in the east-Siberia in Russia in 2014-2015. The induction magnetometer chain observes Pc1 geomagnetic pulsation which corresponds to electromagnetic ion cyclotron (EMIC) waves in the inner magnetosphere. The magnetometers have deployed in Athabasca, Magadan and Paratunka in far-eastern Russia, Moshiri and Sata in Japan, and will be deployed at Fredericton in the east-coast of Canada in 2014. These chorus waves and EMIC waves are known to contribute to the acceleration and loss of radiation belt particles. The longitudinal network of these measurements will provide continuous monitor of global distribution of the occurrence of these waves. These observations will contribute the next SCOSTEP program VarSITI, particularly to the SPeCIMEN Project.

Keywords: chorus wave, EMIC wave, Pc1 geomagnetic pulsations, ground-based multi-point observation, subauroral latitudes

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PEM09-09 Room:211 Time:April 28 11:15-11:30

Solar Evolution and Extrema (SEE) under VarSITI Scientific Program

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Following the recent unsual solar activities, the next SCOSTEP international scientific program 'Variability of the Sun and Its Terrestrial Impact (VarSITI)' was launched as a 5 years program covering 2014-2018. It will focus on the the unusual solar activities and their consequences on Earth, for various times scales from the order of thousands years to milliseconds, and for various locations and their connections from the solar interior to the Earth's atmosphere.

The program consists of four elements:

(1) Solar Evolution and Extrema (SEE), (2) International Study of Earth-Affecting Solar Transients (ISEST/Minimax24), (3) Specification and Prediction of the Coupled Inner-Magnetospheric Environment (SPeCIMEN), and (4) Role Of the Sun and the Middle atmosphere/thermosphere/ionosphere In Climate (ROSMIC).

Among these elements, SEE will address, by promoting coordination of various projects between the Sun and the Earth, the following scientific questions:

(a) Are we at the verge of a new grand minimum? If not, what is the expectation for cycle 25? (b) Does our current best understanding of the evolution of solar irradiance and mass loss resolve the "Faint Young Sun" problem? What are the alternative solutions? (c) What is the largest solar eruption/flare possible? What is the expectation for periods with absence of activity?

An overview of SEE element will be presented.

Keywords: VarSITI Program, SEE Element, SCOSTEP, solar evolution, extreme solar events

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PEM09-10 Room:211 Time:April 28 11:30-11:45

Solar Magnetic Activity and Their Influence on the Earth's Environment

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The Sun affects the environment of the Earth in diverse ways. In a time scale of a few days, XUV emission and energetic particles from solar flares and disturbances in the solar wind (coronal mass ejections) cause various phenomena in the ionosphere and the magnetosphere. In a time scale of 2-4 weeks, the rotation of the Sun modulates its irradiance and solar wind properties. In a time scale of 11-year solar cycle, total and spectral irradiance changes in phase with the sunspot number. In this presentation I will pick up new results obtained with the Hinode mission and other ground-based instruments.

Hinode, launched on 23 September 2006, is a Japan-US-UK joint mission with contributions for downlink connections from ESA. The three primary instruments on Hinode are

(1) solar optical telescope/magnetograph (SOT),

(2) soft X-ray telescope (XRT), and

(3) extreme ultraviolet imaging spectrometer (EIS).

Ulysses spacecraft showed in 1998 that fast and steady solar wind comes from polar regions, and slow and variable solar wind comes from low-latitude regions. Since low-latitude regions are basically characterized by closed magnetic field lines by the presence of active regions with bipolar magnetic field configuration, it was not clear how the solar wind could flow out of the regions. However, Hinode/XRT discovered continuous outflow from the edges of active regions. Later, EIS observations confirmed the outflow by its Doppler shift. Now this outflow is believed to be the long-sought source of the slow solar wind.

The fast solar wind originates from polar regions which are basically unipolar. Since quiet-sun magnetic field of 10 gauss or less was known to consist of intense flux tubes with a kilo-gauss field strength occupying 1% of the area, the same might be expected for polar fields. Hinode/SOT showed clearly with its high spatial resolution observations of vector magnetic fields that it is the case. Hinode/SOT observations also track the polar field reversal with an unprecedented accuracy. The time delay of the south pole reversal compared with the north pole is seen in Hinode/SOT polar field observations as well as other indices, and is speculated to be related to an unusually low activity of the present solar cycle.

Coronal mass ejections (CMEs) are the major source of geomagnetic disturbances. How such an ejection of plasma cloud takes place is explained by several models. In one scenario, a solar magnetic configuration evolves by supplies of magnetic flux and magnetic helicity from below the surface. The accumulation of magnetic helicity leads to abrupt instability of magnetic configuration, leading to a CME. Magnetic helicity is distributed basically anti-symmetrically with respect to the equator, but anomaly is often observed. Long-term observations of magnetic helicity by ground-based instruments and high accuracy measurements of helicity by Hinode/SOT are providing interesting information on the nature of magnetic field generation in the solar convection zone.

Keywords: Sun, solar activity cycle, solar wind, solar magnetic field, helicity

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Modeling of the geomagnetically induced electric field in Japan

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The geomagnetically induced current (GIC) happens to damage transformers of electrical power line systems in high-latitude countries like Canada and Sweden where the geomagnetic disturbances are enhanced. Thus, since it is important to evaluate the GICs associated with geomagnetic disturbances in these countries, there have been many works about GIC [Pulkkinen et al., 2005]. On the other hand, the low-latitude countries like Japan seem to be regarded to be free from dangers of the GIC disasters [Pulkkinen et al., 2008]. Indeed, Watari et al. [2009] revealed that the GICs measured along the power line in Hokkaido (the northernmost part of Japan) are as small as several Ampere. These values are negligibly small compared with the permissible current of a transformer. It is noted that the measurements by Watari et al. [2009] were carried out in the period of extremely quiet solar activity.

The result by Watari et al. [2009] seems to indicate that Japan is safe from the GIC disasters. However, it should be noted that the ground conductivity structure is quite different between Hokkaido and other Japanese areas like the most industrialized and highly-populated Kanto plain. This difference invokes the following geoelectric characters in Japan; the geomagnetically induced electric field at Kakioka in Kanto plain is sometimes about 10-times larger than that at Memambetus in Hokkaido. This difference probably comes from difference in the ground conductivity structure. As a result, we have to employ a realistic 3D ground conductivity model to present a reliable conclusion on the GIC.

In the talk, we will present the first numerical result of the geomagnetically induced electric field in Japan based on the 3D electric conductivity in the Earth. The conductivity is compiled after the resistivity suitable to the characteristic layers based on the crustal layer structure after the database on the bathymetry and that on the thickness of the sediment layer together. Our initial results reveal several localized enhancements of the induced electric field in the coastline regions when the induced electric current tends to converge into a bay-shaped area. The enhanced electric field appears in the different areas depending on the direction of the external source current in the magnetosphere. Combination of the induced electric field calculated and quantities of the severe space weather event yields the info for evaluation of the extreme severe GIC in Japan.

References

Pulkkinen, A. et al. (2005), Space Weather, 3, S08C03, doi:10.1029/2004SW000123.
Pulkkinen, A. et al. (2008), Space Weather, 6, S07001, doi:10.1029/2008SW000388.
Watari, S., et al. (2009), Space Weather, 7, S03002, doi:10.1029/2008SW000417.

Keywords: geomagnetically induced current, space weather, electric conductivity, numerical modeling, nonuniformity

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PEM09-12 Room:211 Time:April 28 12:00-12:15

Role of magneto-convection from the point of view of large-scale magnetic structure formation on the solar surface

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The roles of magneto-convection on the solar surface in the formation of large scale magnetic field, which are revealed by the recent observation, are reported in this presentation.

Many energetic activities on the solar surface, e.g. filament formation, solar jet, and slow solar wind etc., root in the large-scale magnetic configurations. The circumstances around the photosphere, e.g. actual visible surface, is at high plasma beta condition. So the magnetic field is transported mainly by the surface convection there. Simultaneously its configuration is significantly affected and changed from its birth to solar surface. Hence, understanding of magneto-convection on the solar surface is thought to be a basic but an important issue in the solar physics for long time.

Despite of its importance, it is very difficult to give the conclusion to roles of solar surface convection to global structure, namely to answer how does it transport magnetic field and how does it change states of magnetic field. The difficulties come from the smallness and short time scale of the element structures of magneto-convection on the solar surface (<1,000km and order of minutes). The first difficulty is its smallness and short time scale in absolute value. We need stable high spatial and temporal resolution to catch up their element structure. We can say this difficulty is nearly solved thanks to the recent satellite observation. However, there is the second difficulty, smallness and short time scale compared to large scale structure (˜700,000km and order of years). We need a new method of analysis to overcome the problem, huge scale difference.

To solve this problem, we develop auto-recognition and tracking method of patches and apply it to the actual data. In the presentation, we report the results about reformation of patch structures by surface convection, especially the frequency distribution of flux content in each patch structure. We find that it is re-formed in 30 minutes, which is much shorter than flux supply time scale. This result indicates that most magnetic structures on the solar surface is decided by the local convection nature.

Keywords: the Sun, magnetic field, convection

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PEM09-13 Room:211 Time:April 28 12:15-12:30

Solar Magnetism: Exploration with Local Convective Dynamo Modeling

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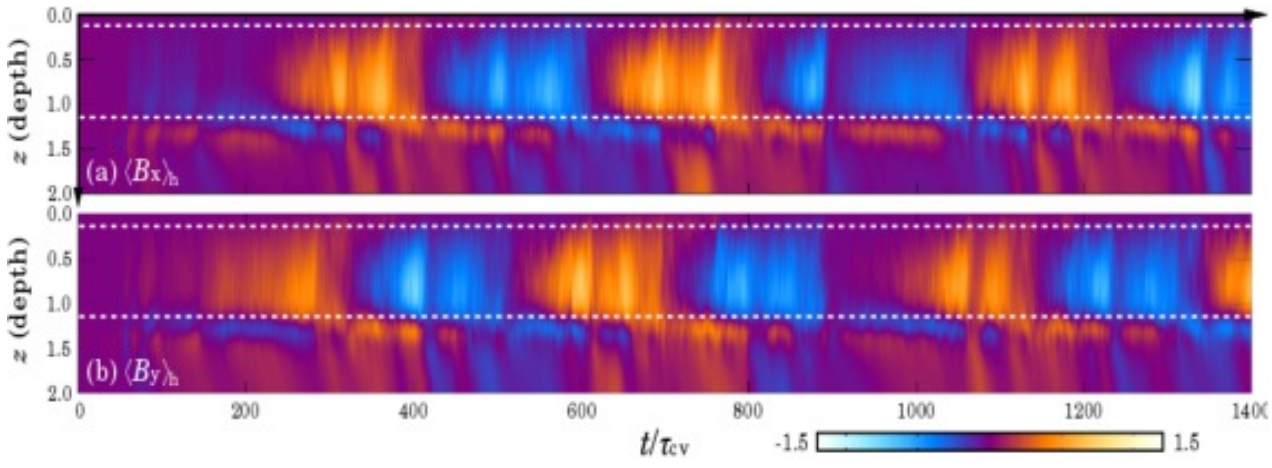
A grand challenge in astrophysics is the origin of self-organizing properties of the magnetic field in highly turbulent flows. The solar magnetism is the front line in this area. The solar magnetic field shows a remarkable spatiotemporal coherence though it is generated by turbulent convective dynamo operating within its interior. Our understanding on the solar magnetism has been accelerated over the past decade in response to broadening, deepening and refining of numerical dynamo modelings. However, it is still unclear what dynamo mode is excited in the solar interior and how it regulates magnetic cycle with equatorward sunspot migration and periodicity of 22 years. To gain a deeper understanding of the solar dynamo mechanism, we are currently working on the convective dynamo simulation in a local stratified system.

Here we report a successful direct numerical simulation (DNS) of oscillatory large-scale dynamo spontaneously excited in a rotating stratified convection. The figure shown below is the simulation result; the time-radius diagram of the mean horizontal magnetic fields. Our simulation model consists of three layers like as the solar interior: bottom and top stably stratified layers and mid-convection zone (the area between white-dashed lines). It is found that the large-scale magnetic field is organized in the bulk of the convection zone and shows a well-regulated oscillatory behavior. The mean-field component is the strongest at around the mid-convection zone and propagates from there to top and base of the convection zone. The polarity is then gradually reversed over the period of about 200 convective turn-over time. It is noteworthy that there is a phase difference of about $\pi/2$ between B_x and B_y . The simulated spatiotemporal evolution of the large-scale magnetic field is quite reminiscent of the solar butterfly diagram although there is a difference in the propagation direction between the simulated field and the sunspot field.

To explore the underlying dynamo mechanism, we construct a mean-field electrodynamics model with dynamo coefficients directly computed from the DNS. The nonlinear back-reaction of the mean-field on the dynamo coefficients (both α- and η-quenching) is self-consistently taken into account. We demonstrate that the simulated large-scale dynamo is quantitatively reproduced by our DNS-driven mean-field dynamo model, and is interpreted as a manifestation of oscillatory α^2-dynamo mode. We will describe the basic physics which characterizes the cycle period and amplitude of the large-scale magnetic field sustained by the α^2-dynamo, and then discuss its playing role in the solar magnetism. This is the first to quantitatively demonstrate the presence of the oscillatory α^2-dynamo mode as a natural outcome of the rotating stratified convection, and raises an unignorable question about the conventional solar dynamo model relying strongly on the profiles of the mean flows, such as the differential rotation and meridional circulation.

Keywords: Sun, MHD, Convection, Dynamo



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PEM09-14 Room:211 Time:April 28 12:30-12:45

From Deep Space Explorer DESTINY towards Solar Polar Region Observer SOLAR-D

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DESTINY which stands for "**D**emonstration and **E**xperiment of **S**pace **T**echnology for **IN**terplanetary vo**Y**age" is a mission candidate for the next space science small program. The next mission is planned to be decided in 2014, and the select one is scheduled to be launched in 2018.

As illustrated in the Figure, DESTINY will be launched by an Epsilon launch vehicle and firstly placed into a low elliptical orbit, where then its altitude raised by the use of ion engine. When the orbit raising reaches the Moon, DESTINY subsequently is injected into transfer orbit for L_2 Halo orbit of the Sun-Earth system by using lunar gravity assist. Upon arrived at L_2 Halo orbit, DESTINY will conduct its engineering experiment as well as scientific observations for at least a half year. If conditions permit, DESTINY will leave L_2 Halo orbit, and transfer to the next destination.

On the way to L_2 Halo orbit, DESTINY will conduct demonstration and experiment on key advanced technologies for future deep space missions. Major items of the technology demonstration are listed as follows.

1) Ultra-Lightweight solar panel.

In order to generate large electric power to run μ20 ion engine, "Ultra-Lightweight Solar Panel", which is under development at JAXA, is applied and its performance is evaluated. This solar panel is estimated to achieve power to mass ratio at least double to conventional ones. Future application is expected in outer planet probes (JMO, MELOS) or probes with large ion engines.

2) Large scale ion engine μ20.

DESTINY is inserted into an elliptical orbit and reaches to a Halo orbit by its own orbital maneuver. For this maneuver, a large ion engine (μ20) which is under R&D at JAXA will be adopted and its performance is evaluated. This ion engine has thrust five times as much as μ10 used by Hayabusa and will be expected to be applied to large probes such as SOLAR-D or Hayabusa Mk2.

3) Advanced thermal control.

In order to manage large amount of heat generated by the large ion engine, advanced thermal control techniques by way of Loop Heat Pipe will be adopted.

4) Orbit determination under low thrust operation.

DESTINY will reach to Halo orbit by running ion engine over long duration. In order to reduce burdens to shut down the ion engine each time of orbit determinations, orbit determination under ion engine operation is conducted and its performance is evaluated.

5) Automatic/autonomous onboard operation.

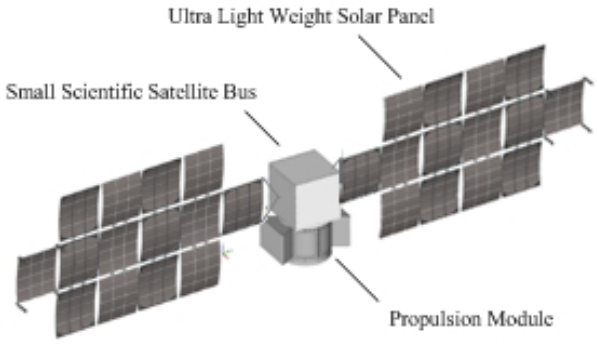
In order to increase the efficiency of operation, autonomous and highly functioned spacecraft management system is developed demonstrated on board. This technique is expected to be adopted especially in the deep space missions usually operated under severe communication condition.

The technologies demonstrated by DESTINY will be applied to various future solar system exploration programs. One of them is a solar polar region observer, SOLAR-D, which is planned to be launched in 2020s.

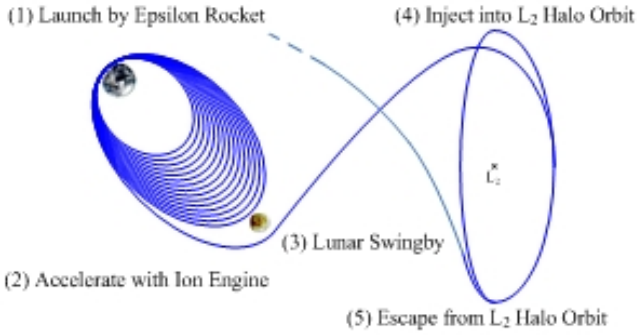
SOLAR-D aims at the observation of the polar region of the Sun from out-of-ecliptic view point. It requires the observation from the high latitude point of the Sun, namely 45deg. To observe the Sun from the high latitude point, the space observatory (spacecraft) must be on the orbit largely inclined with the ecliptic plane. It is not an easy task to inject the spacecraft into the orbit largely inclined with the ecliptic plane. The mission plan under consideration supposes the use of solar electric propulsion, whose major technology challenges are going to be demonstrated in DESTINY.

The over view of DESTINY mission, and its effect on the future SOLAR-D mission will be introduced in the presentation.

PEM09-14 Room:211 Time:April 28 12:30-12:45



DESTINY Overview



Mission Profile

Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

PEM09-15 Room:211 Time:April 28 14:15-14:30

Overview of CAWSES II: Advancing the understanding of the Sun-Earth interaction

TSUDA, Toshitaka[1*]

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CAWSES (Climate and Weather of the Sun-Earth System) was established as an international program by SCOSTEP (Scientific Committee on Solar-Terrestrial Physics) in order to enhance our understanding of the Solar Terrestrial relations, which impacts on life and society. In particular, we put special emphasis on the short and long-term variability of solar activity and its effects on the geospace and Earth's environment.

We carried out the first five-year project of CAWSES in 2003-2007. On the basis of its successful achievements, we conducted the second phase of CAESES during 2009-20013. CAWSES-Phase II especially promoted science and application of the following four themes, which are related to the fundamental questions of the Sun-Earth system.

TG1: What are the solar influences on the Earth's climate?
TG2: How will geospace respond to an altered climate?
TG3: How does short-term solar variability affect the geospace environment?
TG4: What is the geospace response to variable waves from the lower atmosphere?

We have enhanced international collaboration of ground-based observations, numerical modeling and satellite missions. Database is also very important for CAWSES-II. We also help capacity building activities to involve researchers in developing countries as well, and provide educational opportunities for students of all levels. We review in this talk recent achievements of CAWSES-II.

Keywords: CAWSES, SCOSTEP

Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

PEM09-16 Room:211 Time:April 28 14:30-14:45

The Role of ICSU World Data System in VarSITI

WATANABE, Takashi[1*]

[1]Solar-Terrestrial Environment Laboratory, Nagoya University, [2]ICSU-WDS International Programme Office (NICT)

Solar-terrestrial physics is a typical example of interdisciplinary science, covering a wide variety of research fields. Interdisciplinary usage of observational data and information are essential in the research works to be conducted under VarSITI. ICSU has a long history to promote international collaborations in long-term provision of interdisciplinary data and information. In the IGY era (1957-58), the initial World Data Center (WDC) System was created under the policy of Full and Open Access to data and information. By the early 2000s, about 50 data centers were registered as WDCs, mainly for geophysical researches. ICSU also had another international data-oriented service under the name of Federation of Astronomical and Geophysical data-analysis Services (FAGS), which was created also in the IGY era, including ten services, e.g. International Space Environment Service (ISES). The World Data System (WDS) has been created by the 29th General Assembly of ICSU in 2008 as an Interdisciplinary Body to expand the range of data and information activities conducted by WDC and FAGS to much wider research fields, including social sciences. WDS strives to become a world-wide community of excellence providing trusted data services for global science with searchable common data directories and catalogues, which ensures the long-term stewardship and provision of quality-assessed data and data services. The VarSTEP will be one of the important partners of WDS because WDS includes many data centers came from former WDC and FAGS communities.

Keywords: VarSITI, Database, International collaboration, Interdisciplinary collaboration

Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

PEM09-17 Room:211 Time:April 28 14:45-15:00

International Study of Earth-affecting Solar Transients (ISEST)/MiniMax24

KATAOKA, Ryuho[1*] ; SHIMIZU, Toshifumi[2] ; ASAI, Ayumi[3] ; ZHANG, Jie[4] ; MANUELA, Temmer[5] ; GOPALSWAMY, Nat[6]

[1]NIPR, [2]JAXA, [3]Kyoto University, [4]George Mason University, [5]University of Graz, [6]NASA/GSFC

We introduce the project ISEST (International Study of Earth-affecting Solar Transients)/Minimax24 of VarSITI, internationally led by Jie Zhang (USA), Manuela Temmer (Austria), and Nat Gopalswamy (USA). Goals and objectives are to understand the propagation of solar transients through the space between the Sun and the Earth, and develop space weather prediction capability. How do coronal mass ejections (CMEs) and corotating interaction regions (CIRs) propagate and evolve, drive shocks and accelerate energetic particles in the heliosphere? To answer this question, we need data/theory/modeling as follows: Establish a database of Earth-affecting solar transient events including CMEs, CIRs, flares, and energetic particle events based on remote sensing and in-situ observations from an array of spacecraft, run observation campaigns such as MiniMax24, develop empirical, theoretical, and numerical models of CME propagation and prediction, validate models using observations. As anticipated outcome, a comprehensive database of Earth-affecting solar transients will be created, and space weather prediction capability will be significantly improved.

Keywords: coronal mass ejection, corotating interaction region, flares, solar energetic particles

Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

PEM09-18 Room:211 Time:April 28 15:00-15:15

The next-generation space solar observatory SOLAR-C

HARA, Hirohisa[1*]

[1]National Astronomical Observatory of Japan

The SOLAR-C is a planned satellite mission that is led by the JAXA SOLAR-C working group as the 4th Japanese space solar observatory that follows the 3rd satellite mission, Hinode. Hinode equips three major science payloads to cover from the photosphere to the corona simultaneously and has revealed the ubiquitous emergence/submergence of small-scale bipolar fields and the formation of kilo Gauss magnetic flux tubes from vector magnetic field measurements on the photosphere, unexpected dynamical phenomena in the chromosphere, spectral signatures of small-scale coronal heating events near the chromosphere below its spatial resolution, and so forth. These are the universal magnetized plasma activity in the nearest star, and the essential energy source of the phenomena is of magnetic-field origin coupled with photospheric convective motion. To elucidate the newly-found solar active phenomena and the problems that have been tackled for a long time in solar physics, we try to understand the causal linkage between solar magnetic fields and active phenomena on the Sun in the true sense by high-resolution (0.1-0.3 arcsecs) instruments in space. SOLAR-C will observe photospheric and chromospheric activity by imaging and measure chromospheric magnetic fields by spectro-polarimetry, in addition to photospheric magnetic fields. It visualizes the site of dynamical events for chromospheric and coronal heating by imaging and spectroscopy with comparable resolution and by high-resolution chromospheric magnetometry. In addition, SOLAR-C essentially contributes to space weather by estimating the stored magnetic energy in the corona via measurements of chromospheric magnetic fields.

Japan Geoscience Union Meeting 2014
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PEM09-19 Room:211 Time:April 28 15:15-15:30

Statistical analysis of the gyroresonance sources using Nobeyama Radioheliograph and sunspot sketches

OTSUJI, Kenichi[1*] ; SHIBASAKI, Kiyoto[1] ; TANAKA, Yuuki[2] ; MIYAGOSHI, Takehiro[3]

[1]NAOJ, [2]Kyoto University, [3]JAMSTEC

Nobeyama Solar Radio Observatory of National Astronomical Observatory of Japan has continued the solar fulldisk observation using Radioheliograph (NoRH) since 1992. NoRH can measure the intensity and circular-polarization intensity of solar radio waves and identify the regions where the gyroresonance occurs. Gyroresonance is the mechanism in which the strongly circular-polarized radio waves are emitted from the resonance of the electrons gyrating around the magnetic field lines of sunspots. The radio flux coming from the gyroresonance mechanism depends on the magnetic field strength of its source and the observing wavelength. NoRH adopts 17 GHz radio waves and detects the gyroresonance emission from the strong magnetic field region with more than 2000 gauss. The statistical analysis combining gyroresonance sources and their magnetic field, or identifying them as the NOAA (National Oceanic and Atmospheric Administration) active region, however, has not been done sufficiently. So, the database including these informations is urgently needed.

In this study, we developed the database which combines the gyroresonance sources with NOAA active region number and the photospheric field strength. We listed up the location, radio flux and the circular-polarization ratio of each gyroresonance source with its area, using NoRH observation data. We also examined the area, McIntosh sunspot group classification, sunspot number and the magnetic classification of sunspots of each active region corresponding to the gyroresonance source. We used the sunspot sketches from Mt.Wilson and Crimea observatories because of the merits of covering solar fulldisk and being free from the saturation effect at the strong field. The temporal coverage of our database is from 1992 to 2013, which corresponds to almost two solar cycles.

The statistical analysis using our database clarified that the ratio of the active regions accompanied by the gyroresonance emissions increases in the latter half of cycle 23 (2002-2007). This phenomenon is not confirmed in cycle 22. There is a quadratic correlation between the number of occurrences of gyroresonance and the total number of active regions. This means that the ratio of the active regions accompanied by the gyroresonance emissions is proportional to the total number of active regions. Furthermore, we classified the active regions with the gyroresonance by their magnetic classification of sunspots and found that the complex magnetic configurations (beta-gamma-delta etc.) were predominant. Our statistical analysis provides new diagnostics to the past solar cycles and the prediction for the future solar activities.

Keywords: Sun, Radio, Sunspot

Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

PEM09-20 Room:211 Time:April 28 15:30-15:45

Particle acceleration in a 3D current sheet of a Solar flare and comparison with solar radio observations

NISHIZUKA, Naoto[1*] ; NISHIDA, Keisuke[2]

[1]National Astronomical Observatory of Japan, [2]Kwasan and Hida observatories, Kyoto Uni.

Solar flares show intermittent time variability in nonthermal emissions, because particles are impulsively accelerated in small acceleration regions, i.e. multiple X-points, reconnection outflows, colliding plasmoids and internal shocks in a fragmented current sheet. We performed 3D MHD simulation of a solar flare, in which a horizontal flux rope in an unstable but equilibrium state are triggered by small amplitude of perturbation to be flown upward. The eruption of a flux rope forms a current sheet just below the flux rope, and when the width of a current sheet becomes enough thin, it becomes unstable for the tearing instability and generate small scale plasmoid inside. The formation and interaction of the plasmoids make the current sheet complex and turbulent structure. When a small scale plasmoid is ejected out or when two plasmoids collide with each other, the electric field in a current sheet is locally and intermittently enhanced.

In this 3D MHD simulation result, we inserted test particles, which are forced by electromagnetic field varying in time. Particles are trapped in the turbulent current sheet, or more exactly between multiple plasmoids, and accelerated by locally enhanced electric field along the current sheet. At that time, particles are intermittently accelerated at several heights and repeat multistep acceleration moving to other X-points. Sometimes, particles escape upward into the erupting flux rope and propagate along the field line of the flux rope. Particles are slightly accelerated by the curvature drift acceleration in the erupting flux rope and finally precipitate to another X-point connected to the different pair of loop-foot points. We also compared this simulation result with radio spectrograph data observed in Ondrejov observatory in Czech Republic. The radio spectrograph data shows similar intermittent time variability of type III bursts, i.e. electron beams, and sometimes slowly drifting pulsating structures, i.e. trapped electron beams in a plasmoid.

In this talk, we mainly talk about the test particle acceleration in 3D MHD simulation of an erupting solar flare and the comparison with the radio observation data. We are also aiming at simulating the propagation of a flux rope eruption into the interplanetary space, i.e. coronal mass ejection, forming a shock at the propagation front and reconnecting with open field in the interplanetary space. We welcome discussion and collaboration in VarSITI.

Keywords: Solar Flare, Coronal Mass Ejection, Particle Acceleration, Space Weather, Numerical Simulation, Radio Observation

Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

PEM09-21 Room:211 Time:April 28 15:45-16:00

Role of the Japanese SuperDARN network in the VarSITI Program

NISHITANI, Nozomu[1*] ; YUKIMATU, Akira sessai[2] ; NAGATSUMA, Tsutomu[3]

[1]Solar-Terrestrial Environment Laboratory, Nagoya University, [2]National Institute of Polar Research, [3]National Institute of Information and Communications Technology

The Super Dual Auroral Radar Network (SuperDARN) is a network of HF radars operated under the international collaboration of 12 countries. At present, total of 33 radars have been operating in both hemispheres, monitoring important ionospheric parameters such as the global convection pattern and plasma density perturbations with high time (1 to 2 min) resolution. In addition to normal operaration modes, SuperDARN frequently operates special observation modes for conjunction studies with spacecraft programs, such as THEMIS, VAP and ERG missions. Japan has been operating total of 4 radars in Antarctica, Alaska and Hokkaido, contributing to the operation of the network. Judging from the characteristics of the network, it is expected to play important roles in several projects of the VartSITI programs, such as: ISEST (International Study of Earth-affecting Solar Transients/MiniMax24), SPeCIMEN (Specification and Prediction of the Coupled Inner-Magnetospheric Environment), and ROSMIC (Role Of the Sun and the Middle atmosphere/ thermosphere/ionosphere In Climate). Details of the SuperDARN network's role in the VarSITI program will be presented.

Keywords: SuperDARN, midlatitude, ionosphere, thermosphere, dynamics, VarSiti

Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

PEM09-22 Room:211 Time:April 28 16:15-16:30

What determines the severity of space weather?

NANAN, Balan[5*] ; SKONG, R.[2] ; TULASI RAM, S.[3] ; RAJESH, P. K.[5] ; SHIOKAWA, Kazuo[1] ; HSU, R.[5] ; SU, T. H.[5] ; LIU, J. Y.[4]

[1]Solar-Terrestrial Environment Laboratory, Nagoya University, [2]Los Alamos National Laboratory, [3]Indian Institute of Geomagnetism, [4]National Central University, [5]National Cheng Kung University

Thanks to the works of a number of scientists it is known that severe space weather can cause extensive social and economic disruptions in the modern high-tech society. It is therefore important to understand what determines the severity of space weather, and whether it can be predicted. We present the results obtained from the analysis of solar-geophysical data during 30 space weather events that occurred since 1957 and produced geomagnetic storms of intensity less than -275 nT, and the Carrington event of 1859. The results seem to indicate that (1) space weather can become severe occasionally (7 since 1957) as experienced by satellite systems, Earth-based systems and Earth's environment. (2) It is the impulsive energy (or power) at the leading edge of the CMEs (coronal mass ejections) mainly due to impulsive leading edge velocity and partly due to density that determines the severity of space weather in the heliosphere; the higher the impulsive velocity (sudden increase by over 275 km s-1 over the background), the more severe the space weather. (3) Such CMEs with IMF Bz also southward from the leading edge cause severe space weather on Earth though the magnitude of southward Bz does not seem important, and the minimum impulsive velocity for severe space weather on Earth seems higher than that for severe space weather in heliosphere. (4) CMEs having northward IMF Bz at the leading edge do not seem to cause severe space weather on Earth though they can lead to geomagnetic storms of long duration main phase with intensity less than even -420 nT. Measurements of the rate of energy release during CME eruption (or measurements of the velocity and density of CMEs as close to the Sun as possible) and orientation of IMF Bz in CMEs may be used for predicting severe space weather.

Keywords: Severe space weather, solar flare, CME, geomagnetic storm

Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

PEM09-23 Room:211 Time:April 28 16:30-16:45

Research and operatoinal activity of NICT space weather

ISHII, Mamoru[1*]

[1]NICT

ICT has been managing operational space weather forecast
since 1988 as a member of Inernational Space Environment Services (ISES). We provide the space weather forecast information every day including holidays with email and web site, and the number of subscribers is over 9,000.

In addition to these operational activity, we have research activities for improving the performance of space weather forecast.
We have three research projects, (1)sun and solar wind (2)magnetosphere, and (3)ionosphere with three approaches as follows: observation, simulation and informatics. These activities are progressing under the cooperation with domestic/international organizations which is suitable to the concept of VarSITI. Especially the connection to the operational users of space weather is important but very few institute only works for that including NICT. In this meaning we NICT can contribute to the activity of VarSITI.

Keywords: space weather

Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

PEM09-24 Room:211 Time:April 28 16:45-17:00

Researches on solar eruptive phenomena and solar activities using chromospheric imaging data with the CHAIN

UENO, Satoru[1*] ; SHIBATA, Kazunari[1] ; ASAI, Ayumi[1] ; KITAI, Reizaburo[1] ; MORITA, Satoshi[2] ; OTSUJI, Kenichi[2] ; CABEZAS, Denis P.[3] ; G. ESCATE, Maria V.[3] ; ISHITSUKA I., Jose K.[4] ; YAMAGUCHI, Masashi[1] ; WATANABE, Hiroko[1] ; KIMURA, Goichi[1] ; ICHIMOTO, Kiyoshi[1] ; NAGATA, Shin'ichi[1] ; NAKATANI, Yoshikazu[1]

[1]Kyoto University, Japan, [2]NAOJ, [3]Presbiteriana Mackenzie University, Brazil, [4]Institute of Geophysics in Peru

In 2010, Kyoto University moved the Flare Monitoring Telescope (FMT) from Japan to Peru, and currently we are technically supporting two projects of building new solar telescopes in Saudi Arabia and Algeria under the Continuous H-Alpha Imaging Network (CHAIN) project. We also held international data analysis workshops three times during this four years to train foreign and domestic young researchers to analyze the data obtained by the FMT and Solar Magnetic Research Telescope (SMART) at Hida Observatory in Japan.

Current main scientific themes of the CHAIN project are

(1) 3D velocity field measurement of eruptive phenomena on the solar surface:
By applying "cloud model fitting" to multi-wavelength H-alpha chromospheric images, we can calculate physical parameters of moving features on the chromosphere. We especially focus on the 3D velocity field of erupting filaments to understand the process of growth and propagation of CMEs. Morimoto & Kurokawa (2003) statistically investigated time evolution of 3D velocity field of disappearing phenomena of chromospheric H-alpha filaments, and they observationally showed that if H-alpha filaments actually erupted, then CMEs necessary appears. On the other hand, however, when filaments are disappeared without eruption, sometimes CMEs occur. We have to know how to CMEs are generated in such a case, comparing with other observational data or MHD simulations. Moreover, we will statistically investigate relationship between characteristics of filament eruptions and geo-effectiveness of the CMEs .

(2) Detection of shock waves (Moreton wave) generated by solar explosive phenomena:
The FMT is quite effective to detect Moreton wave that was explained as the intersection of coronal shock wave on the solar chromosphere. Narukage et al. (2002) and Asai et al. (2012) observationally showed that Moreton waves detected in H-alpha chromospheric images actually correspond to foot-point of coronal shock waves observed with X-ray telescope or EUV telescope on satellites. On the other hand, even if flares that has almost the same intensity, sometimes they are accompanied by Moreton waves and sometimes they are not accompanied by them. We are investigating what are differences between flares "with" and "without" Moreton waves. According to our preliminary statistical study, the angle of filament eruption from the solar surface seems to be the most important parameter. We promote more investigation for more cases more accurately by combining with other satellite data or MHD simulations. Moreover, after that, we want to compare with characteristics of radio bursts and to investigate time evolution of various shock waves from solar surface to interstellar space.

(3) Estimation of solar UV radiation and comparison with ionospheric variation:
Solar radiation is also one of very important element for understanding the change of space weather. Especially solar UV around from 50 to 140 nm has strong influence for the ionosphere of the earth. One of good index of the change of ionosphere is the "geomagnetic solar daily quiet variation (Sq)". It basically changes well obeying the variation of solar UV radiation. When we investigate long-term variation of solar component and terrestrial component of Sq, currently we usually use F10.7 flux, sunspot number etc. as indexes of solar activity, because actual UV observations started just after around 1995. However, the indexes such as F10.7 do not accurately express variation of UV radiation and we cannot know accurate variation of terrestrial component of Sq. Therefore, we are currently trying to reproduce UV intensity from chromospheric images that have been obtained during longer-term than UV data. After this, by using estimated variation of solar UV radiation, we want to investigate relationship between solar activities and other physical parameters of ionosphere, too.

In this talk, we introduce our recent results and plans in VarSITI period on these themes.

Keywords: CHAIN, solar flare, filament eruption, Moreton wave, chromosphere, solar UV radiation

Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

PEM09-25 Room:211 Time:April 28 17:00-17:15

The EISCAT_3D project

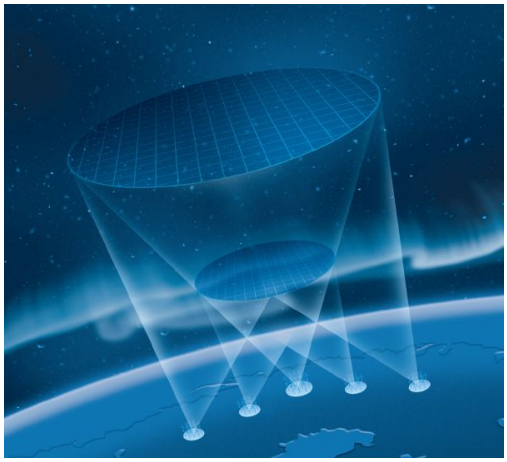
NOZAWA, Satonori[1*] ; MIYAOKA, Hiroshi[2] ; OGAWA, Yasunobu[2] ; OYAMA, Shin-ichiro[1] ; NAKAMURA, Takuji[2] ; FUJII, Ryoichi[1]

[1]STEL, Nagoya University, [2]NIPR

The EISCAT (European Incoherent SCATter) Scientific Association is an international research organization, which operates incoherent scatter (IS) radars in northern Scandinavia and Svalbard for studies of physical and environmental processes in the middle/upper atmosphere and near-Earth space. Since 1996, National Institute of Polar Research, in collaboration with STEL, Nagoya University, has promoted EISCAT collaborations for the user community in Japan to utilize the EISCAT facility as well as EISCAT data for their scientific subjects. Japanese scientists have been studying several scientific topics such as 3-D ionospheric current system, aurora dynamics, ion upflow, neutral wind dynamics, using EISCAT data, and published 110 papers from1995 to 2013.

EISCAT_3D is the major upgrade of the existing EISCAT radars in northern Scandinavia. The EISCAT_3D radar is a new phased array IS radar using the center frequency 233 MHz. The idea was firstly presented as 'E-prime' in 2003. The EISCAT community has been doing large efforts to make it happen since then. The design study was conducted from 2005 to 2009, and the preparatory phase program has been conducting since 2009 (until September 2014). With a multi static phased array system composed of one central active (transmiter-receiver) site and four receiver sites, the EISCAT 3D system is expected to provide us 10 times higher temporal and spatial resolution and capabilities than the present EISCAT radars. Furthermore, continuous observations can be made, and will provide us with long-term data sets of the polar ionosphere, which can be used to investigate variations of the ionosphere as well as the neutral wind dynamics (in particular, studies of planetary waves and tidal waves). In this presentation, we will overview the EISCAT_3D project, and present our strategic plan of national funding for the EISCAT_3D as well as science targets.

Keywords: EISCAT_3D, Incoherent Scatter radar, polar ionosphere, Magnetosphere-Ionosphere-Thermosphere coupling, 3D imaging observation, Mesosphere



Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

PEM09-26 Room:211 Time:April 28 17:15-17:30

Introduction of ROSMIC project in SCOSTEP/VarSITI program

OTSUKA, Yuichi[1*] ; NAKAMURA, Takuji[2] ; TAKAHASHI, Yukihiro[3] ; LUEBKEN, Franz-josef[4] ; WARD, William[5] ; SEPPALA, Annika[6]

[1]Nagoya University, [2]National Institute of Polar Research, [3]Hokkaido University, [4]Leibniz Institute of Atmospheric Physics, Germany, [5]University of New Brunswick, Canada, [6]Finnish Meteorological Institute, Finland

ROSMIC (Role Of the Sun and the Middle atmosphere/thermosphere/ionosphere In Climate, co-leaders: F.-J. Luebken, A. Seppala, W. Ward) is one of the four projects in VarSITI started in 2014 as a five year project. The goal of the project is to understand the impact of the Sun on the terrestrial middle atmosphere/lower thermosphere /ionosphere (MALTI) and Earth's climate and its importance relative to anthropenic forcing over various time scales from minutes to centuries. ROSMIC project consists of four sub-projects: 1) Coupling through solar variability (radiative, electrodynamics, ionospheric and photochemical effects), 2) Coupling by dynamics, 3) Trends in Mesosphere and Lower Thermosphere, 4) Trends and solar cycle effects in the thermosphere (incl. technological aspects). The project will be conducted under close collaborations between observations and modelings. Observations include both usage of existing data records and new measurements from a wide range of ground based (lidars, radars, mappers), in-situ (rockets, balloons, aircraft), and satellite (e.g., AIM, TIMED) instruments. Dedicated models are used and developed for a better understanding of specific processes (e.g. gravity wave breaking, ice formation). Global scale models will be modified and applied from the ocean to the thermosphere. Through the five year projects, we expect better understanding of the impact of solar activity on the entire atmosphere, relative to anthrogenic forcing and natural long term variability. In the paper, we will introduce outline of ROSMIC project and discuss how Japanese activities contribute to the ROSMIC project.

Keywords: Sun, middle atmosphere, thermosphere, ionosphere, climate

Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

PEM09-27 Room:211 Time:April 28 17:30-17:45

Contribution of IUGONET to the VarSITI program

TANAKA, Yoshimasa[1*] ; YATAGAI, Akiyo[2] ; SHINBORI, Atsuki[3] ; KOYAMA, Yukinobu[4] ; ABE, Shuji[5] ; UMEMURA, Norio[2] ; SATO, Yuka[1] ; YAGI, Manabu[6] ; UENO, Satoru[7] ; HORI, Tomoaki[2]

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The Variability of the Sun and Its Terrestrial Impact (VarSITI) program aims at understanding the current extremely low solar activity and its influence on the Earth for various time scales and locations. In order to achieve these goals, it is necessary to conduct an interdisciplinary study that uses various types of data from multiple regions, such as solar interior, solar surface, heliosphere, magnetosphere, ionosphere, and atmosphere. The Inter-university Upper atmosphere Global Observation NETwork (IUGONET) project has developed the research infrastructure to promote such an interdisciplinary study. The IUGONET is an inter-university project by five Japanese institutes and universities (Tohoku University, Nagoya University, Kyoto University, Kyushu University, and the National Institute of Polar Research) that have been developing a worldwide ground-based observation network of the upper atmosphere, Sun and planets. The main tools developed by the IUGONET are metadata database and data analysis software.

The IUGONET metadata database (IUGONET-MDB) enables cross-searching of data distributed across the member institutes/universities of IUGONET. The metadata of various ground-based observational data have already been registered not only by the members of IUGONET but also by the other Japanese institutes, for example, the National Institute of Information and Communications Technology (NICT), the Solar Observatory of National Astronomical Observatory of Japan (NAOJ), and the Kakioka magnetometer observatory, Japan Meteorological Agency. We also consider including data from the satellites and the numerical simulation in the future. The iUgonet Data Analysis Software (UDAS) is a plug-in software of Space Physics Environment Data Analysis System (SPEDAS), which is an integrated analysis platform for visualizing and analyzing the ground-based and satellite observation data. The UDAS has provided many routines to load the ground-based observational data from various types of instruments, including solar telescope, solar radio telescope, ionosphere and atmosphere radars, imagers, magnetometers, and so on. The SPEDAS also includes a plug-in tool from a Japanese satellite mission, Energization and Radiation in Geospace (ERG), which will explore the dynamics of the radiation belts in the Earth's inner magnetosphere. Thus, they will be powerful tools for four projects of the VarSITI, in particular, Specification and Prediction of the Coupled Inner-Magnetospheric Environments (SPeCIMEN) and Role Of the Sun and Middle atmosphere thermosphere/ionosphere in Climate (ROSMIC). In the presentation we will show some examples of scientific researches that the IUGONET has done using the upper atmospheric data and discuss our possible contribution to the VarSITI program.

Keywords: IUGONET, upper atmosphere, ground-based observation, metadata database, data analysis software, interdisciplinary study

Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

PEM09-28 Room:211 Time:April 28 17:45-18:00

Characteristics of airglow and auroral emissions in the lower- and upper-thermosphere obtained with IMAP/VISI on ISS

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We report the recent highlights of results on airglow and auroral distribution in the lower- and upper-thermosphere based on IMAP/VISI measurement data, and also report the current status of the operation VISI. IMAP/VISI is a visible imaging spectrometer which aims to measures nightglow emissions from ISS (˜400 km altitude) covering the wide range from +51 deg. to ? 50 deg. in geographical latitude. VISI adopts two field-of-views (+/-45 deg. to nadir) to make a stereoscopic measurement of the airglow and aurora emission to subtract background contaminations from clouds and ground structures. Each field-of-view has 90 deg width faced perpendicular to the orbital plane, which is mapped to ˜600 km width at 100 km altitude and ˜300 km width at 250 km altitude. A continuous line-scanning for all emissions lines in the nightside hemisphere in the latitudinal range from +51 deg. to -51 deg. is carried out by VISI with the successive exposure cycle with a time interval of 1 - several sec, which corresponds to a spatial resolution of 10 km ? a few tens km. From VISI data, we obtain the global distribution of airglow emissions (O 630 nm at 250 km alt., OH Meinel band 730 nm at 87km alt., and O2 (0-0) atmospheric band 762 nm at 95 km alt.) and auroral emissions (O 630 nm at 250 km alt., N2 1P 730 nm at ˜110 km alt. and O2 762 nm at ˜120 km alt.).

Since the successful launch of IMAP on August 2012, we found that meso-scale (˜10 - 50 km) wave pattern is always seen in the airglow emission at O2 762 nm mainly at mid-latitudes. The typical O2 airglow intensity is several hundreds R to several kR. Most of O2 airglow shows straight-shaped pattern, which indicates plane atmospheric gravity waves. In addition, we found more than 30 events on the concentric gravity wave (CGW) pattern in O2 airglow emission, which suggests that the local generation source in the lower-atmosphere. 26 CGW events out of total 30 events happened in March and April in 2013, which suggests its seasonal effect.

VISI sometimes measured auroral emissions at high-latitudes during geomagnetically disturbed period. One of major purposes of auroral measurement with VISI is to understand the generation process of gravity wave by auroral activity. However, we could not obtain the gravity wave event caused by aurora so far. Another target of VISI high-latitude measurement is SAR arc in the sub-auroral region. Even though the solar activity is expected to be maximum in 2012 ? 2013, we could not obtain the SAR arc data so far. However, we still expect to measure the SAR arc event caused with a major storm during a solar declining phase.

In addition, in the low-latitude region around the magnetic equator, we frequently obtained the enhanced O630 nm emission associated with equatorial ionization anomaly (EIA) overlapped with small-scale dark filament pattern, i.e., plasma bubble. We found the seasonal dependence of O630 nm intensity in the EIA which is consistent with the vertical motion of ionospheirc plasma due to the dragged by thermospheric day-to night tidal winds. The O630 nm intensity associated with EIA significantly decreased during the main phase of magnetic storm when the Dst index is larger than 90 nT. This fact suggests that the westward electric field associated with Region-2 current system penetrates to the ionosphere in the lower latitude that reduce the upwelling of EIA. We also obtained the MSTID pattern in O 630 nm emission in the eastside of North America on August 1 2013 by comparing the O 630 nm emission and TEC map. We carried the special operation for the measurement of MSTID last winter, and will summarize the result.

Acknowledgements

We thank the IMAP science team and the MCE team for their kind support.

Keywords: ISS, airglow, thermosphere, ionosphere, JEM, gravity wave

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(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

PEM09-29 Room:501 Time:April 29 11:00-11:15

The effect of Solar radiation on the Climate of Yakushima

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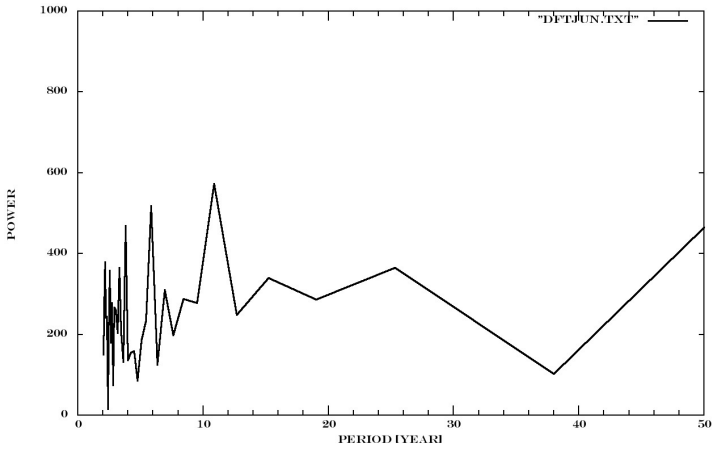
Yakushima (Yaku-island) is located to the south of Kyushu in Japan and is known as one of the world natural heritages of UNESCO. There are mountains on the island with heights of about 2,000m where cedar trees have lived for more than 2000 years. We analyzed meteorological data for the island from 1938 to 2013 and found several interesting results:

(1) Eleven and 20-30-year-periodicities are present in the data on daylight hours. Similar periodicities are, however, not seen in the data on temperature or water vapor pressure.
(2) The 11-year-periodicty appears strongly in June, the rainy season of the island, while the 20-30-year-periodicty is seen throughout the year except in April.
(3) An 11-year-periodicty can be also seen in the data for June and July at the other remote island Hachijyojima situated 300km to the south of Tokyo. Both islands are located on the Kuroshio warm current.
(4) The daylight hour data for January increased systematically around 1976. This may be related to the change of the North Hemisphere Temperature (NHT) in 1976.

In order to explain the observations, we examined the following hypothesis. Ocean waves produce large numbers of tiny salty droplets which contain plankton on the sea surface. These droplets (aerosols) are winded up and reach at the top of the mountain. They may act as cloud condensation nuclei (CCN).
It is known that the intensity of the UV light from the Sun is modulated by solar activity. It is also possible that the growth rate of CCN is affected by the solar UV radiation in the early stage of the aerosol formation process.
We speculate that this may be why solar activity is recognized in the daylight hour data. We have not accounted for the 20-30-year-periodicity in the data, but we speculate that this could be related to the Pacific Decadal Oscillation (PDO).
Details will be presented at the conference.

Keywords: solar activity, solar Ultra-Violet light, cloud, daylight hours, aerosols, Passific Decadal Oscillation

PEM09-29 Room:501 Time:April 29 11:00-11:15



Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

PEM09-30 Room:501 Time:April 29 11:15-11:30

Sounding rocket observation of the thermosphere-ionosphere-magnetosphere coupling

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The polar ionosphere is an open window of the Earth atmosphere to the outside space such as the magnetosphere and the solar wind, because energy and/or mass tends to be injected along the magnetic fields via various physical processes. In this connection, there exist numerous unique and unrevealed phenomena in the polar ionosphere.

Sounding rocket is a powerful platform which provides opportunity to make a vertical sounding through the lower thermosphere, ionosphere and magnetosphere while satellite generally flies in a horizontal direction, and it has an advantage so that it can enable us to make a brief survey of the upper atmosphere in the vertical direction. The Institute of Space and Astronautical Science (ISAS) of Japan Aerospace Exploration Agency (JAXA) has conducted sounding rocket experiments in Norway to investigate the upper atmospheric dynamics and chemistry induced by the auroral energy input. The primary objectives of these experiments include various topics; pulsating aurora, ozone chemistry affected by the auroral activity, fine structure of the auroral arc, and the cusp ion outflow. These subjects arise from phenomena that is caused by interaction between the solar wind or magnetospheric plasma and the upper atmosphere. It is necessary to make a comprehensive observation of the energy input, the response and consequences for better understanding of the causal relationship.

There are several candidates of the sounding rocket experiment which should be conducted in the auroral region for a direct measurement of the energy input from higher altitudes and the ionospheric response. To obtain the high-time resolution data of the ionospheric ion outflow which is one of the most significant phenomena of the magnetosphere-ionosphere coupling, it is necessary for the sounding rocket equipped with plasma and field instruments to reach up to 1000 km altitude. For such an experiment, it will be a key to get information on the wave-particle interaction which may play an important role in accelerating ionospheric ions. It is well known that the polar lower thermosphere has a significant response to auroral energy input from higher altitudes. This indicates an existence of energy inputs from the magnetosphere probably in the form of electric fields or energetic particles. It is important to understand quantitatively the momentum transfer between the neutrals and plasma by observing the neutral wind and ion drift simultaneously. The sounding rocket experiment to elucidate such a neutral-plasma coupling is also under consideration.

Thus, we are considering several candidates of the sounding rocket experiments which should be conducted in the auroral region to investigate the upper atmospheric response against the energy input from higher altitudes. In this presentation, we will briefly introduce some of the promising experiments.

Keywords: sounding rocket, thermosphere, M-I coupling, in-situ observation, aurora

Japan Geoscience Union Meeting 2014
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PEM09-31 Room:501 Time:April 29 11:30-11:45

Trend of SST anomalies and Solar Activity

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The tendency of anomalies of SST during the fluctuation of Sunspot numbers are studied using composite SST and fluctuation of SSN.

In general, El Nino tendency is observed during Sunspot numbers (SSN) minimum, while La Nina tendency is observed in SSN maximum. It is generally accepted that the frequency of Solar Activity varies in 11 years, during those years there are SSN maximum and minimum. On the other hand, SST anomalies do not correspond well to the frequency of the solar activity. In addition, the thermal structure of sea surface temperature (SST) varies during El Nino and La Nina. Moreover, the impact of large-scale solar flare on the SST has not been clearly evident for the 4 days backward and forward comparison for the flare event on 2 April 2001 and 28 October 2003 on SST, wind velocity and OLR. Since the ocean has higher heat capacity, this might prevent the appearance of immediate SSN effect through the surge of any frequency in any band of electromagnetic waves from the SUN. The subtle impact might be confirmed either through cloud or wind. The long-term impact should also be considered by precise integration of the total energy on each wavelength. Numerical simulation is also expected to validate this issue.

Keywords: Solar activity, SST, Anomalies

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PEM09-32 Room:501 Time:April 29 11:45-12:00

Recent observations by Rayleigh/Raman lidar and developments of tunable resonance scattering lidar system in JARE

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The National Institute of Polar Research (NIPR) is leading a six year prioritized project of the Antarctic research observations since 2010. One of the sub-project is entitled ”the global environmental change revealed through the Antarctic middle and upper atmosphere”. Profiling dynamical parameters such as temperature and wind, as well as minor constituents is the key component of observations in this project, together with a long term observations using existent various instruments in Syowa, Antarctica (69S, 39E). As a part of the sub-project, Rayleigh/Raman lidar was installed at Syowa Station in January, 2011 and has been operated at more than 350 nights ($>$3000 hours clear sky) by February, 2014. The Rayleigh/Raman lidar observes temperature and clouds in the mesosphere, the stratosphere and part of the troposphere, and providing seasonal and yearly variations of temperature profiles and data of gravity wave characteristics in the middle atmosphere, as well as high altitude clouds of PMC (polar mesospheric clouds) and PSC (polar stratospheric clouds). In order to extend the height coverage to include mesosphere and lower thermosphere region, and also to extend the parameters observed, a new resonance scattering lidar system with tunable wavelengths is developed at NIPR in Tachikawa (36N, 139E). The lidar transmitter is based on injection-seeded, pulsed alexandrite laser for 768-788 nm (fundamental wavelengths) and a second-harmonic generation (SHG) unit for 384-394 nm (second harmonic wavelengths). The laser wavelengths are tuned in to the resonance wavelengths by a wavemeter that is well calibrated using a wavelength-stabilized He-Ne laser. The new lidar has capabilities to measure density variations of minor constituents such as atomic iron (Fe, 386 nm), atomic potassium (K, 770 nm), calcium ion (Ca^+, 393 nm), and aurorally excited nitrogen ion ($N_2{}^+$, 390-391 nm) and temperature profiles in the mesosphere and lower thermosphere (MLT) region using resonance scatter of K. Currently, the fundamental laser pulses are transmitted with 120-160 mJ/pulse at approximately 25 Hz (i.e., $\sim$3-4 W) and the backscattered signal is received with a 35 cm diameter telescope. The new lidar system will be installed two years later at Syowa Station and provide information on the mesosphere and lower thermosphere as well as the ionosphere. This unique observation is expected to make important contribution to studies on the atmospheric vertical coupling process and the neutral and charged particle interaction. In this talk, current status of the research, observations, and system developments will be presented.

Keywords: Lidar, Resonance scatter, Rayleigh/Raman, Antarctic observation, Syowa Station

Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

PEM09-33 Room:501 Time:April 29 12:00-12:15

400 years interval of amplification in quasi bi-decadal climate variability: a case of summer precipitation in Japan

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Introduction

Quasi bi-decadal climate variability, often found in palaeoclimatological time series, should be not only attributed to internal climate variation such as ocean-atmosphere interaction, but also owing to astronomical climate forcing like 22 year cycle of solar activity. In long human history, the multi-decadal climate variations are sometimes enhanced to cause long abnormal meteorological conditions and result in numerous famines, wars and political regime shifts. Why does the amplitude of natural climate variation change? If we can understand mechanism of the amplitude modulation in climate variability and predict its future, it must be very helpful for improvement of our adaptability to climate change. In this presentation, I will discuss climatic mode of 400 year intervals of amplification in quasi bi-decadal climate variability found in last two millennial records of summer precipitation which were reconstructed annually by tree-ring cellulose isotope ratios.

Reconstruction of summer precipitation by tree-ring oxygen isotope ratio

Until recently, paleoclimatologists in Japan could not reconstruct precipitation before Edo era when weather descriptions in numerous diaries enable us to discuss climate change precisely. However, it is now possible to elucidate historical changes in summer precipitation with annual time resolution using tree-ring cellulose oxygen isotope ratios all over Asia monsoon area including Japan. Last two millennial summer precipitation variations have been reconstructed in central Japan using many wood samples of Japanese cypress from living trees, old architectures, archaeological remains and buried logs.

Amplification of quasi bi-decadal variability occurring at 400 years intervals.

By wavelet analysis of the two millennia length of summer precipitation record in central Japan, I have found that there are distinct periods of amplitude modulation for the multi-decadal variability, especially at quasi bi-decadal periodicity, in 2nd, 6th, 10th, 14th and 18th centuries when long lasting flood and drought occurred. In fact, 2nd, 6th and 14th centuries correspond to the end of Yayoi, Kofun eras and the medieval upheaval period (Namboku-cho, twin dynasty, era) in Japan, respectively. 10th and 18th centuries are also known as periods of the collapse of centralized political system and the occurrence of giant famines all over Japan, respectively. The amplitude modulation in quasi bi-decadal periodicity occurring at 400 years intervals always started with sudden decrease in tree ring d18O, accompanied with sudden increase and decrease in its d13C and 14C content, respectively. At present, I can propose the sudden enhancement of summer monsoon activity bringing tropical air mass to explain all signals of sudden changes in tree-ring isotope records. Especially, sudden increases in temperature during 14th century, which is corresponding to the precipitation increase in Japan, are found at low and middle latitudinal areas in both hemispheres, illustrating that they are actually owing to the summer monsoon enhancement originating from tropical areas. If the amplification in quasi bi-decadal variability at 400 year intervals is related to the periodical change in solar activity such as 800 year cycle, it must be very important to elucidate astronomical and climatic mechanisms combining cause (solar cycle) and effect (amplitude modulation) precisely.

Keywords: tree ring, oxygen isotope, bi-decadal change, precipitation

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PEM09-34 Room:501 Time:April 29 12:15-12:30

Ionospheric studies using high-resolution GPS total electron content observations

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Two-dimensional total electron content (TEC) observations using dense GPS receiver networks have been applied to studies of various ionospheric disturbances since mid-1990s. For the purpose of monitoring and researching the ionospheric disturbances, we have developed high-resolution TEC maps using dense GPS receiver networks. We have been collecting all the available GNSS receiver data in the world to expand the TEC observation area. These GNSS data are provided by IGS, UNAVCO, SOPAC, and other regional data centers. Currently, we are providing global and regional maps of absolute TEC, detrended TEC, and rate of TEC change index (ROTI). These data and quick-look maps are archived and available in DRAWING-TEC website (http://seg-web.nict.go.jp/GPS/DRAWING-TEC/).

These high-resolution GPS-TEC maps have been applied to studies of various ionospheric disturbances. Sudden increase in TEC caused by solar flares were studied using global TEC observations. Regional TEC observations have revealed new characteristics of large- and medium-scale traveling ionospheric disturbances (LSTIDs and MSTIDs). Recently, clear concentric waves and short-period oscillations were observed after huge earthquakes/tsunamis and massive tornadoes, indicating that acoustic and/or gravity waves propagate upward from the lower atmosphere and reach the ionosphere.

These GPS-TEC observations will contribute the next SCOSTEP program VarSITI, particularly to the ROSMIC (Role Of the Sun and the Middle atmosphere/thermosphere/ionosphere In Climate) project.

Keywords: ionosphere, GPS, TEC, thermosphere

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PEM09-35 Room:501 Time:April 29 12:30-12:45

Modulation of Greenland temperature through changes in solar activity

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During the past decades, Greenland climate has undergone rapid warming and ice sheet ablation in coastal region with a nearly 1 mm/y sea level contribution. For sea level projection, it is critical to understand the mechanisms of Greenland temperature variability. Greenland temperature is known to be affected by the North Atlantic Oscillation (NAO), and it is also highly correlated with North Atlantic average temperature. Using the Greenland temperature reconstructed from argon and nitrogen isotopes in occluded air in GISP2 ice core (Kobashi et al., 2011), we found Greenland temperature deviated negatively (positively) from North Hemispheric (NH) temperature trend during stronger (weaker) solar activity over the past 800 years (Kobashi et al., 2013b). We also confirmed this effects continued over the past 4000 years (Kobashi et al., 2013a). Climate modeling suggests that the deviation was caused by solar induced atmospheric circulation changes (like NAO). The model also suggests that Atlantic meridional circulation weakens during the stronger sun by similar processes as enhanced greenhouse effect (Kobashi et al., 2013b). From the past relation between Greenland temperature anomaly and solar variability, it can be speculated that future gland solar minimum may induce additional 2 ^{0} C warming in Greenland with increased melting of the ice-sheet.

Kobashi, T., Kawamura, K., Severinghaus, J. P., Barnola, J.-M., Nakaegawa, T., Vinther, B. M., Johnsen, S. J., and Box, J. E.: High variability of Greenland surface temperature over the past 4000 years estimated from trapped air in an ice core, Geophysical Research Letters, 38, 10.1029/2011GL049444, 2011.

Kobashi, T., Goto-Azuma, K., Box, J. E., Gao, C.-C., and Nakaegawa, T.: Causes of Greenland temperature variability over the past 4000 years: Implications for Northern Hemispheric temperature change Climate of the Past, 9, 2299-2317, 2013a.

Kobashi, T., Shindell, D. T., Kodera, K., Box, J. E., Nakaegawa, T., and Kawamura, K.: On the origin of Greenland temperature anomalies over the past 800 years, Climate of the Past, 9, 583-596, 2013b.

Keywords: solar activity, Greenland, temperature, ice core, climate change

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PEM09-36 Room:501 Time:April 29 14:15-14:30

Study of equatorial atmosphere/ionosphere under RISH/LAPAN collaboration

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[1]RISH, Kyoto University, [2]National Institute of Aeronautics and Space (LAPAN)

The Earth's atmosphere is vertically coupled with atmospheric waves. Momentum/energy transfer from lower to upper atmosphere through wave propagation plays an big role of determining the dynamics of the atmosphere. The energy input from the sun is the maximum at the equator that leads to the intense convection, and then variety of atmospheric waves are generated in the region. The equatorial atmosphere could be regarded as an engine for dynamics of the whole atmosphere. RISH-LAPAN started collaboration for the study of equatorial atmosphere/ionosphere since mid 1980s, and conducted radiosonde observation campaigns, meteor and MF radars, etc. The Equatorial Atmosphere Radar (EAR) was installed over the geographic equator on Sumatra Island in 2001. We continued long-term experiment for more than 10 years, and have found that troposphere-stratosphere airmass exchange is controlled by the modulation of the tropopause by Kelvin waves. Turbulent structures of the tropopause region is also revealed by the EAR. In the ionosphere, spatial and temporal variability of the equatorial Spread-F are clearly observed by the multibeam experiment. With research collaboration with other Japanese university/institutes, the EAR site now became a complete observatory that consists of many instruments, i.e., a meteor radar, a boundary-layer radar, a meteorological radar, lidars, an ionosonode, GPS receivers, etc. The next big project of our own is to improve the EAR ability by building the Equatorial MU radar (EMU) aside of the EAR, which is now included in the Japanese Master Plan. RISH-LAPAN recently obtained a fund of "JSPS Bilateral Joint Research Projects" for FY2014-2016. We will have more chances to discuss collaborative research program for the equatorial atmosphere/ionosphere. In the presentation we summarize our collaboration, and discuss future direction of research including the new EMU.

Keywords: Atmosphere, Ionospphere, Indonesia, Equatorial Atmosphere Radar

Japan Geoscience Union Meeting 2014
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PEM09-37 Room:501 Time:April 29 14:30-14:45

Monitoring of molecular compositions in mesosphere with a network of ground-based millimeter-wave radiometers

NAGAHAMA, Tomoo[1*] ; MIZUNO, Akira[1] ; NAKAJIMA, Tac[1] ; OHYAMA, Hirofumi[1] ; ISONO, Yasuko[1] ; KOJIMA, Yasusuke[1] ; TSUTSUMI, Masaki[2] ; NAKAMURA, Takuji[2] ; MAEZAWA, Hiroyuki[3] ; OGAWA, Hideo[3]

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Chemical composition in mesosphere and lower thermosphere (MLT) region is strongly affected by changes of solar-terrestrial environment; for example, energetic particle precipitation into the earth atmosphere induces composition change in the mesosphere and lower thermosphere. Changes of gravity-wave activities also make the composition changes caused by temperature variations in various timescales.

To investigate these changes related to environment changes in the altitude region, we have started a project of network measurements of the distribution of mesospheric minor constituents, such as ozone, by using ground-based millimeter-wave spectral radiometers with a high-sensitivity superconducting (SIS) mixer receiver. We have been operating three millimeter-wave radiometers in the southern hemisphere; Atacama highland in Chile (23S, 68W), Rio Gallegos in Argentina (52S, 69W), and Syowa station in Antarctica (69S, 39E), and one radiometer in Rikubetsu, Japan(44N, 144E). Especially, at Syowa station, we have been monitoring ozone and nitric oxide (NO) spectra in 250 GHz band, and we have clearly detected temporal variations of NO column density in the MLT region including sudden enhancements of NO suggested to be associated with the energetic electron precipitation events.

In the presentation, we report features of observed variations of mesospheric ozone and NO as well as details of instruments, data validation and future extensions.

Keywords: mesosphere, composition change, millimeter-wave measurement

Japan Geoscience Union Meeting 2014
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PEM09-38 Room:501 Time:April 29 14:45-15:00

Observations and modeling studies for understanding atmospheric responses to unusual solar activities

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As pointed out by many researchers, the recent solar activities are very unusual; the solar activity during the last minimum in 2008-2009 was extremely low and that during the next maximum of sunspot cycle 24 shows much lower activities compared with the previous two solar maximums in cycle 22 and 23. In order to understand the complex system of the Earth's middle and upper atmosphere, these solar activities will give us important information and/or good opportunities for searching the basic states of the system both from the observations and GCM simulations. Comprehensive studies by observations from space, ground-based ones, and numerical simulations will enable us to understand the polar mesosphere, thermosphere, and ionosphere quantitatively. In order to understand variations of the polar ionosphere from the solar minimum to maximum periods, we have made EISCAT experiments in January 2011, March, 2012, and March 2013. For example, ionospheric variations were observed during solar flare and CME events on March 12, 2012. These EISCAT data clearly show an example of the solar wind, magnetosphere, and ionosphere coupling. In addition to the EISCAT observations, we have also investigated variations of the polar thermosphere during periods of significant solar activities from GCM simulations. In this presentation, we will introduce our research activities mainly related to the "Role Of the Sun and the Middle atmosphere/thermosphere/ionosphere In Climate (ROSMIC)" project in VarSITI.

Keywords: thermosphere, ionosphere, middle atmosphere, GCM, radar, aeronomy

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PEM09-39 Room:501 Time:April 29 15:00-15:15

Enhancing our understanding of the atmosphere-ionosphere coupling with Low Earth Orbiting satellite missions

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Low Earth Orbiting (LEO) satellites provide unique opportunities to observe the near-Earth space environment. Recent LEO satellite mission have been making rapid contribution to our understanding of the coupled atmosphere-ionosphere system by providing unprecedented observational evidences for the connection between ionospheric/thermosphric phenomena and their meteorological causes. This talk will briefly summarize the achievements of the decade-long CHAMP mission from the vertical coupling point of view, which is followed by a scientific perspective on the newly launched 3-satellite constellation SWARM mission.

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Multipoint airglow imaging measurements of mesospheric gravity waves over Japan

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Atmospheric gravity waves significantly contribute to the wind/thermal balances in the mesosphere and lower thermosphere (MLT) through their vertical transport of horizontal momentum. It has been reported that the gravity wave momentum flux preferentially associated with the scale of the waves; the momentum fluxes of the waves with a horizontal scale of 10-100 km are particularly significant. Airglow imaging is a useful technique to observe two-dimensional structure of small-scale (<100 km) gravity waves in the MLT region and has been used to investigate global behavior of the waves. The Solar-Terrestrial Environment Laboratory, Nagoya University, has made long-term airglow imaging observations with ground-based all-sky airglow imagers using the Optical Mesosphere and Thermosphere Imager (OMTI) system. Each airglow imager of OMTI has interference filters on rotating wheels to observe airglow emissions in the vicinity of the mesopause (OI 557.7-nm, emission height ∼96 km; OH Meinel-bands, ∼86 km) and the ionosphere (OI 630.0-nm, ∼250 km). Four airglow imagers, which each has the field-of-view with a size of 5 deg x 5 deg in longitude and latitude at the mesopause height, has been in operation in Japan and, as a whole system, they nearly cover all part of Japan. This multipoint network enables us to detect propagation signatures and the spatial extent of MLT waves over a much wide range than ever.

In the presentation, we will report recent results of the MLT gravity waves having a very large spatial extent based on the OMTI multipoint measurements, such as a coherent gravity wave ducting and large concentric gravity wave rings possibly induced by a typhoon; these results offer new insight into dynamical coupling process between the lower and upper atmosphere.

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Exploration into evolution of solar-planetary environments: Solar variation and a variation and atmospheric escape

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How has the atmosphere of terrestrial planets responded to the evolution of the sun, a center star of our solar system? In order to answer the question of the coevolution of our sun and the planetary environment " planetosphere ", planetary exploration missions have been promoted and related interdisciplinary researches are rapidly developing worldwide. It is scheduled that NASA ' s Mars mission MAVEN arrives at Mars in September 2014 and Venus weather explorer AKATSUKI arrives at Venus at the end of 2015. These missions will provide us new observations and insights in this field. Moreover, the solar evolution is included in one of the next emphasized problems in VarSITI program that starts in 2014, and the time of international collaborations is expected to come. On the other hand, the past researches in the solar-terrestrial sciences have had large emphasis on understanding of dynamic variations of the present sun and planetary environment. The interdisciplinary researches of understanding the coevolution of the sun and planetosphere over past four billion years or so are in the incunabula but start to develop rapidly. In this presentation, we will introduce an attempt to investigate the coevolution of the sun and planetosphere by combining large-scale numerical simulations and the latest observations based on international collaborations and cooperation of solar physics, solar-terrestrial physics, aeronomy, and meteorology.

Keywords: solar evolution, planetosphere, atmospheric escape, coupling of lower and upper atmosphere, climate change, evolution of planetary atmosphere

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Role of global electric circuit in solar-climate connection

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Global electric circuit model was proposed log time ago, in 1930s, in which thunderstorm plays a role of generator, and the ground and the ionosphere work as a spherical capacitor. We need to reconstruct this simple model, taking into account 3 aspects: 1) global-scale nonuniformities both of ionospheric conductivity and of the distribution of the generators, 2) connections between the troposphere and D-region, considering the effects of TLEs, such sprites and blue jets, 3) establishing the observational methodology for global electric field, excluding the effect of cloud existing just above the observation sites. Recently, the relationship between the global circuit and solar-climate connection was pointed out. Here we introduce an example, which indicates the roles of thunderstorm or its resultant electric circuit in solar-climate connection. Global relationship between thunderstorm/cloud activities and solar parameters are examined based on lightning measurement by Global ELF observation Network (GEON) operated by Hokkaido University and Outgoing Longwave Radiation (OLR) intensity. It was found that the number of lightning stokes in Asia Maritime Continent (AMC) varies with about month periodicity in the period from February to June 2004 and shows positive correlation (R= ˜0.8) with OLR in the Western Pacific Warm Pool (WPWP). On the other hand, OLRs in the central Africa and some other tropical areas show negative correlation with the number of lightning stokes in the AMC in that period. It is also found that the galactic cosmic rays or UV intensity associated with solar activity indicates good correlation with tropical OLR or lightning activity in AMC. One explanation to connect such global variations in thunderstorm / cloud amount with solar parameters would be the electrical circuit involving lower and upper atmospheres. If the ionospheric electric field modulates the potential gradient in the lower atmosphere, it could cause the re-distribution of ionized atmospheric particles, which may, in turn, change the generation / reduction speed of cloud particles.

Keywords: global electric circuite, solar-climate connection, TLEs, thunderstorm activity, Asia Maritime Continent

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A Realistic Whole Atmosphere-Ionosphere Modeling and Collaboration with Observations

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There has been an increasing number of collaboration between modeling and observation for the study of upper atmospheric variability and its relation to the lower atmosphere. Observations are used as the forcing inputs to models as well as for their validation. Outputs from models can be useful for the interpretation of observed phenomena owing to their sufficient spatial and temporal coverage, especially for the analysis of phenomena whose effects extend beyond the several atmospheric layers. Recently, we have examined the effects of a prominent stratospheric sudden warming (SSW) in January 2009 on the upper atmospheric variability, by using a whole atmosphere-ionosphere coupled model called GAIA. The model used the meteorological reanalysis data as realistic lower atmospheric forcing, and we compared the model outputs with the satellite observations of upper atmosphere [Jin et al., 2012; Liu et al., 2012]. The comparison suggests that the model can reproduce the overall major features of the observed perturbed variations in the upper atmosphere during the SSW period, which ensures the usage of model output for the detail analysis of vertical coupling mechanism during the event.

In this study, we applied the same method for the inclusion of realistic lower atmospheric forcing and carried out a whole atmosphere-ionosphere simulation for longer period. We will show the relation of ionospheric variability to the climatological and irregular variations in the lower atmosphere including several SSW events. Initial results from data assimilation experiment will also be shown as an example of model-observation collaboration.

Keywords: ionosphere, thermosphere, atmospheric vertical coupling, simulation, data assimilation, space weather

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Contribution of the Optical Mesosphere Thermosphere Imagers (OMTIs) to VarSITI

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The Optical Mesosphere Thermosphere Imagers (OMTIs) consist of thirteen all-sky cooled-CCD imagers, five Fabry-Perot interferometers (FPIs), three meridian scanning photometers, and four airglow temperature photometers. They measure two-dimensional pattern, Doppler wind, and temperature through airglow emissions from oxygen (wavelength: 557.7 nm) and OH (near infrared band) in the mesopause region (80-100 km) and from oxygen (630.0 nm) in the thermosphere/ionosphere (200-300 km). They are in automatic operation at Australia, Indonesia, Thailand, far-east Russia, Japan, Canada, Hawaii, and Norway. Station information and quick look plots are available at http://stdb2.stelab.nagoya-u.ac.jp/omti/. We show recent results obtained by OMTIs particularly focusing on the penetration of short-period gravity wave from the lower atmosphere to the thermosphere and the ionosphere, which are often recognized as meridum-scale traveling ionospheric disturbances (MSTIDs) in the ionosphere. We also show some results obtained by the multi-point Fabry-Perot interferometers. These observations will contribute the next SCOSTEP program VarSITI, particularly to the ROSMIC Project.

Keywords: airglow, ionosphere, thermosphere, mesosphere, gravity wave, traveling ionospheric disturbance