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

PEM06-01 Room:312 Time:April 30 11:00-11:30

Study of Coupling Processes in the Solar-Terrestrial System: Project Overview

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We promote a project named ”Coupling Process in the Solar-Terrestrial System” under close collaboration among universities and research institutess. We aim to study the solar energy inputs to the Earth, and responses of the Geospace (magnetosphere, ionosphere and atmosphere) to them. The solar energy can manly be divided into two parts; the solar radiation, involving infra-red, visible, ultra-violet and X-ray, and the solar wind, which is a high-speed flow of plasma particles.

The solar radiation becomes the maximum on the equator, then, atmospheric disturbances are actively generated near the Earth’s surface. They further excite various atmospheric waves, which propagate upward carrying energy and momentum. On the other hand, electro-magnetic energy associated with the solar wind converges into the polar regions. Disturbances are also generated there, and a part of the energy is transported toward lower latitudes and lower atmospheric regions. We propose to establish large atmospheric radars with active phased array antenna on the equator and the Arctic region. Among the equatorial regions, we focus on Indonesia where the atmospheric disturbances are most intense in the world, and we will establish a comprehensive observatory in Indonesia with the Equatorial MU radar as its main facility. While, we will also construct the state-of-the-art radar, called EISCAT-3D, in Scandinavia under international collaboration. An observation network of portable equipment for will be expanded in Asia and Africa to clarify the global flow of energy and materials.

Keywords: Equatorial fountain, Equatorial MU Radar, EISCAT_3D, Global observation network

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PEM06-02 Room:312 Time:April 30 11:30-11:45

A Review on Equatorial Atmosphere Radar (EAR) Observations of Lower Atmosphere

HASHIGUCHI, Hiroyuki[1*] ; TSUDA, Toshitaka[1] ; YAMAMOTO, Mamoru[1] ; YAMAMOTO, Masayuki[1] ; SHIBAGAKI, Yoshiaki[2] ; SHIMOMAI, Toyoshi[3] ; EDDY, Hermawan[4]

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The Equatorial Atmosphere Radar (EAR) is an atmospheric radar located in Kototabang, West Sumatra in Indonesia (0.20S, 100.32E). The EAR has a circular antenna array of approximately 110 m in diameter, consisting of 560 three-element Yagis. It is an active phased array system with each Yagi driven by a solid-state transceiver module. It is operated by collaboration between the Research Institute for Sustainable Humanosphere (RISH), Kyoto University and National Institute of Aeronautics and Space of Indonesia (LAPAN), Indonesia since 2001. RISH has conducted a collaborative research program (EAR collaboration) by using the EAR and its related facilities since 2005. The EAR can observe winds and turbulence in the lower atmosphere and echoes from ionospheric irregularities. In the presentation, observation results of the lower atmosphere with the EAR are reviewed.

Keywords: Equatorial Atmosphere Radar, Equatorial MU Radar, Equatorial Atmosphere

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PEM06-03 Room:312 Time:April 30 11:45-12:00

Ionospheric observations by SEALION and the Equatorial Atmosphere Radar

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[1]National Institute of Information and Communications Technology

Equatorial spread F (ESF) is a well-known phenomenon in the equatorial ionoshperic F region. As it causes severe scintillation in the amplitude and phase of radio signals, it is important to understand and forecast the occurrence of ESF from a space weather point of view. Ionospheric observation with the 47-MHz Equatorial Atmosphere Radar (EAR) in West Sumatra, Indonesia (0.20S, 100.32E, 10.36S dip latitude) has been conducted since 2001, and its unique observational data has been obtained for more than one solar cycle. The EAR is sensitive to 3-m scale ionospheric irregularities, which can be regarded as a tracer of ESF. Along with the EAR observations, Southeast Asia Low-latitude Ionospheric Network (SEALION) project by NICT started in 2003 for the purpose of monitoring and forecasting ESF. The SEALION consists of multiple ionosondes, GPS receivers and several other instruments in the Southeast Asian region. Since the developed ESF usually drifts eastward, monitoring ESF in this region can provide important space weather information for the Japanese longitude sector. We will summarize observational results with the SEALION and EAR, and discuss future potential of the ionospheric observation in the Southeast Asian region.

Keywords: SEALION, EAR, equatorial spread F, equatorial ionosphere

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

PEM06-04 Room:312 Time:April 30 12:00-12:15

Development of Indonesian Monsoon Index (IMI) Based on EAR and other Facilities at Kototabang

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This study is mainly concerned on developing of the Indonesian Monsoon Index (IMI) based on the Equatorial Atmosphere Radar (EAR) at Kototabang, West Sumatera (0.2S; 100.32E, 865 m from MSL). We have analyzed the zonal and meridional wind data of EAR for period of July 2001 to July 2008. By applying the bandpass filtering method that we call as the Fast Fourier Transform (FFT) and Wavelet (WL) technique, we have identified the characteristics of meridional wind velocity in frequency domain. The predominant peak oscillation that appear is Annual Oscillation (AO) for the meridional wind velocity between 8 to 18 km above mean sea level (MSL). While, the strongest is located around 14.1 km from MSL (It's equal to 200 hPa). At the same time period observation of EAR, we analyzed also the Global Monsoon Index as represented by the Indian Summer Monsoon Index (ISMI), Western North Pacific Monsoon Index (WNPMI), and Australian Monsoon Index (AUSMI), respectively. We found a 12 months oscillation for Global Monsoon Index that we call as the AO. By comparing them with meridional wind velocity of EAR, we found a good agreement between AUSMI and the meridional wind velocity of EAR, especially. By this preliminary result, we suspect that we can use the AUSMI parameter to detect the Monsoon Signal over Indonesia, especially for the Western part of Indonesia region, especially at about the 200 hPa. We wish to develop these results by investigating the Monsoonal Onset, especially, including their anomalies, since we know that Monsoon is still a pre dominant peak oscillation at the Indonesian Maritime Continent (IMC) which have big effect to control the complexity of atmospheric dynamic over Indonesia. If it looks possible, we wish also to develop the IMI model that suitable for Indonesia region. Detailed information due to that preliminary results including the basic idea of this proposal research will be discussed at our presentation.

Keywords: IMI, EAR, AUSMI, Model

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

PEM06-05 Room:312 Time:April 30 12:15-12:30

Vertical and horizontal coupling processes in the equatorial atmosphere

YAMANAKA, Manabu D.[1*]

[1]JAMSTEC/Kobe U

Future targets of the equatorial atmosphere dynamics are discussed from viewpoints of recent progress of the lower-atmospheric parts including increase of climatological interests and rapid developments of tropical countries. From recognition of the importance of land-sea heat contrast on Earth we must consider again two types of diurnal cycles: sea-land breeze circulations and atmospheric tides, which have local and global phase structures, respectively. We must consider also two types of Earth rotation effects: solar radiation heating and Coriolis force, which are stronger and weaker, respectively, in the equatorial region. Furthermore, in the lower atmosphere, clouds govern winds in the equatorial region, in contrast to opposite relationship in middle and high latitudes. Because the equatorial convective clouds are dependent not only on dynamical and thermal instabilities but also by water and electrical budgets, we need to study again dynamical-chemical and atmosphere-ionosphere couplings.

Keywords: atmosphere vertical coupling, atmosphere observation network

Japan Geoscience Union Meeting 2014
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PEM06-06 Room:312 Time:April 30 12:30-12:45

Vertical wind measurement in the equatorial troposphere by the Equatorial Atmosphere Radar: A review

YAMAMOTO, Masayuki[1*] ; HASHIGUCHI, Hiroyuki[1] ; YAMAMOTO, Mamoru[1]

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Measurements of vertical wind are important not only for clarifying transportation processes of energy and momentums but also for quantifying dynamical processes of precipitation and clouds. Because 50-MHz atmospheric radars measure vertical and horizontal wind velocity by using scatterings caused by irregularities of radio refractive index, they can measure vertical wind both in clear and precipitation regions. Using the capability, EAR has resolved the fine-scale vertical wind motions in the equatorial troposphere. In the presentation, the measurement results of vertical wind obtained by the EAR are reviewed. Future plans of vertical wind measurement using the Equatorial MU radar are also proposed.

Keywords: Equatorial Atmosphere Radar, Equatorial MU Radar, equatorial atmosphere, vertical wind measurement

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

PEM06-07 Room:312 Time:April 30 14:15-14:45

Science and design overview of the EISCAT_3D radar

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For thirty years, the EISCAT Scientific Association (www.eiscat.se) has operated a network of leading facilities for ground-based research in solar-terrestrial physics. The UHF and VHF radars at Tromso in northern Norway, together with the receiver sites at Kiruna, Sweden and Sodankyla, Finland and the EISCAT Svalbard Radar near Longyearbyen, represent a uniquely capable group of instruments serving a worldwide user community. The EISCAT mainland radars in particular, however, are based on ageing transmitters and antennas which are slow-moving and increasingly hard to maintain. For several years now, EISCAT (with support from international partners including the European Union) has been planning to replace the current set of mainland radars with a new state-of-the-art radar system, better suited to the current needs of the research community. EISCAT_3D (www.eiscat3d.se) will be the next-generation radar for the high-latitude atmosphere and geospace, with capabilities going beyond anything currently available. The facility will consist of large phased arrays in three countries. EISCAT_3D will comprise tens of thousands, up to more than 100 000, antenna elements. The new facility combines volumetric imaging and tracking, aperture synthesis imaging, multistatic configuration, improved sensitivity and transmitter flexibility. EISCAT_3D will be the first multistatic phased array ISR. A network of five sites is planned, with receivers located around 120 km and 250 km from the active site, providing optimal geometries for vectors in the middle and upper atmosphere. At the passive sites, the design allows the transmitted beam to be imaged using multi-beam techniques. EISCAT_3D will be a modular system, allowing an array to be split into sections for imaging. The result will be a new data product, range-dependent images of small structures, with sizes down to a few tens of metres. The antenna gain and array size will deliver large increases in the figure-of-merit relative to the existing EISCAT radars. An active site comprising 16,000 elements will exceed the sensitivity of the present VHF radar by an order of magnitude. In this talk the technical specifications and science case for EISCAT_3D will be discussed and the current progress reviewed. Studies of the atmospheric energy budget, exploration of small-scale and large-scale processes, as well as geospace environment monitoring and potential space weather service applications will be presented.

Keywords: EISCAT, Incoherent Scatter, Radar, Ionosphere, Solar-Terrestrial Physics, Space Weather

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

PEM06-08 Room:312 Time:April 30 14:45-15:00

The EISCAT_3D System and Status

HEINSELMAN, Craig[1*]

[1]EISCAT Scientific Association

The EISCAT Scientific Association has been operating incoherent scatter radars in the arctic since the early 1980s. Those systems have been extremely productive over the decades, supporting a wide range of scientific topics within geospace research and resulting in more than 2000 publications in peer-reviewed journals. For the past several years the EISCAT community, with significant support from the European Commission, has been working toward a new set of radar systems to replace the now aging infrastructure. This distributed radar, called EISCAT_3D, will provide the scientific community with new measurement capabilities that far exceed, both quantitatively and qualitatively, those presently available.

EISCAT_3D, when it is fully implemented, will consist of five phased array antennas strategically positioned in northern Norway, Sweden, and Finland. One of the antennas will include a distributed 10 MW peak power transmitter with full polarization capabilities, rapid steering, and antenna aperture coding options. The receive antenna arrays will be capable of instantaneously covering the entire transmit beam, thus providing a large number of intersecting volumes for vector drift measurements. The overall system will, furthermore, have sufficient sensitivity to provide order of magnitude improvements in both spatial and temporal resolution over the present radars.

We will present an overview of the system in this talk along with an update on the present status of the overall project.

Keywords: Incoherent Scatter Radar, ionosphere

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

PEM06-09 Room:312 Time:April 30 15:00-15:15

Thermospheric neutral density observations using the EISCAT incoherent scatter radars

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We exploit a recently-developed technique, based on ion-neutral coupling, to estimate the thermospheric neutral density at ˜350 km using measurements of ionospheric plasma parameters made by the EISCAT radars. The passive version of the technique is applied to a 13-year long data set from the EISCAT Svalbard Radar (ESR). Here we show that the thermospheric density in the polar cap is decreasing, consistent with satellite drag estimates at lower latitudes. The active version of the technique requires the EISCAT Heater to artificially induce ion up-flow by heating the electrons, with observations from the EISCAT UHF radar. Here we show that ion up-flow is consistent with the plasma pressure gradient, and we extract the thermospheric neutral density. At an altitude of ˜500 km, where neutral composition is not always pure atomic oxygen, problems with the technique are discussed.

Keywords: Thermospheric density, Incoherent scatter radar

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

PEM06-10 Room:312 Time:April 30 15:15-15:30

3D ionospheric electron density determination in Scandinavia with TomoScand and EISCAT 3D

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The TomoScand network for ionospheric tomography in Scandinavia consists of a network of newly designed Beacon receivers and an extensive, dense array of GPS receivers. A novel tomographic inversion technique allows for a multi-frequency analysis for reconstruction of ionospheric electron densities, and is also able to include information of a multitude of ground-based measurements into the inversion, such as data from ionosondes, from the EISCAT radar, and from the magnetometers of the MIRACLE network in Scandinavia. We present the current status of the TomoScand network, and show latest inversion results on 2D profiles in meridional direction, together with test results that allow to evaluate the performance of the inversion technique. Further, we discuss the future development into a full 3D inversion scheme, and how the TomoScand network can be used as a ”partner instrument” for the upcoming EISCAT 3D radar.

Keywords: ionospheric tomography, ionospheric electron density, ground-based observations, EISCAT 3D

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PEM06-11 Room:312 Time:April 30 15:30-15:45

Advancement of geospace and atmospheric sciences with EISCAT_3D

MIYAOKA, Hiroshi[1*] ; NOZAWA, Satonori[2] ; OGAWA, Yasunobu[1] ; OYAMA, Shin-ichiro[2] ; NAKAMURA, Takuji[1] ; FUJII, Ryoichi[2] ; HEINSELMAN, Craig[3]

[1]National Institute of Polar Research, [2]STEL, Nagoya University, [3]EISCAT Scientific Association

The EISCAT(European Incoherent SCATter) Scientific Association is an international research organization, which operates incoherent scatter radars at 931MHz, 224MHz and 500MHz in northern Scandinavia and Svalbard for studies of physical and environmental processes in the middle/upper atmosphere and near-Earth space. Affiliated in the EISCAT scientific association in 1996, Japanese science community has jointly contributed to achieve further understanding of the magnetosphere-ionosphere-thermosphere coupling processes using the integrated ground-based instruments and rocket/satellite simultaneous observations with EISCAT radars.

EISCAT_3D is the major upgrade of the existing EISCAT radars in the northern Scandinavia.With a multi-static phased array system composed of one central active (transmit-receive) site and several receive-only sites, the EISCAT_3D system is expected to provide us 10 times higher temporal and spatial resolution and capabilities than the present radars.

In this presentation, we will overview our scientific activity and achievements with the EISCAT facility and our strategic plan of national funding for EISCAT_3D as well as the science targets which we expect to be unraveled by EISCAT_3D.

Keywords: Incoherent scatter radar, EISCAT, Ionosphere, Thermosphere, Mesosphere, 3D imaging observation

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

PEM06-12 Room:312 Time:April 30 15:45-16:00

Study on ion upflow and outflow based on EISCAT_3D and its related observations

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An important phenomenon of magnetosphere-ionosphere coupling is the formation of upwelling ions in the topside polar ionosphere. These upflows can be a significant loss of atmospheric gasses into interplanetary space and a significant source of magnetospheric plasma, which may also affect the dynamics of the magnetosphere. Key processes for upward ion flows in the topside ionosphere are suggested to be frictional heating, ambipolar diffusion driven by a heated electron gas, and transverse ion acceleration produced by plasma waves. It is critical to determine the relative importance of the different mechanisms in operation and to understand the 3D distribution and composition of the upflowing ions and neutrals. Moreover, there are several transitions of upflowing ions, for examples, from chemical to diffusion dominance at 500-800 km altitude, from subsonic to supersonic flow at 1000-2000 km altitude, and from collisional to collisionless region at 1500-2500 km altitude.

EISCAT_3D is one of the most suitable measurements to investigate such transitions because of its wider height coverage (up to about 2000 km) along the field line. EISCAT_3D will have more transmitter power density and higher sensitivity than those of the current Tromso UHF radar, and will give information of accurate thermal ion velocity, upward flux, and ion composition (O^+, H^+, and hopefully NO^+). A combination of the EISCAT_3D, ground-based optical instruments, and in-situ measurements is definitely essential to solve several key questions of ion upflow and outflow study. In this paper, we show potential investigations of ion upflow and outflow using the EISCAT_3D, and also discuss a desirable combination of the EISCAT_3D and its related observations for the ion upflow and outflow study.

Keywords: EISCAT, ionosphere, M-I coupling

Japan Geoscience Union Meeting 2014
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PEM06-13 Room:312 Time:April 30 16:15-16:30

Meteor head echo observation with a high power large aparture (HPLA) radar and an open database of precise meteor orbit

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Mass influx from the space into the terrestrial atmosphere is mainly caused by meteors. Meteors delivers various elements into the atmosphere, but the meteoric dust particles are also of great importance in the terrestrial atmosphere, as they act as nucleus for condensation and clouds and affect the various atmospheric phenomena both in physical and chemical aspects. Thus, to investigate the meteor flux, orbits and their interactions in the upper atmosphere is very important but at the same time the method of investigation is limited, especially for the precise measurements.

A high power large aperture (HPLA) radar technique is one of the recent technique to provide useful information on meteor influx and orbital information, as well as interactions with atmosphere. The recent development of the technique carried out using the middle and upper atmosphere radar (MU radar) of Kyoto University at Shigaraki (34.9N, 136.1S), which is a large atmospheric VHF radar with 46.5 MHz frequency, 1 MW output transmission power and 8330 m^2 aperture array antenna, has established very precise orbit observations with meteor head echoes. Since 2009, orbital data of about 120,000 meteors have been collected. A database is now being created as an open database for research and education. In this

study, we present the physical quantities and precisions obtained by our radar meteor head echo observations and the detail of the database.

Keywords: meteor, upper atmosphere, high power large aperture radar

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

PEM06-14 Room:312 Time:April 30 16:30-16:45

Comparison of Cloud Propagation over Sumatera during CPEA-I and II

MARZUKI, Marzuki[1*] ; RAHAYU, Aulya[1] ; VONNISA, Mutya[1] ; HASHIGUCHI, Hiroyuki[2] ; K. YAMAMOTO, Masayuki[2] ; D. YAMANAKA, Manabu[3] ; MORI, Shuichi[3] ; KOZU, Toshiaki[4] ; SHIMOMAI, Toyoshi[4]

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Maritime Continent of the Indonesian (MCI) archipelago is one of the world's most convectively active areas and thereby affects the global climate system. It consists of thousands of islands with different size. The island coastlines' complex shape and geography, as well as their orientation, contribute to the uniqueness of this region. Not surprisingly, maritime continent receives a large amount of rainfall throughout the year, and the precipitation varies considerably across the region. Global climate models exhibit systematic errors in their mean precipitation over the MCI due to such variability. In this study, the behavior of convective activity over Sumatera during the Coupling Processes in the Equatorial Atmosphere (CPEA) campaign I and II is examined using 1-hourly satellite infrared data. Sumatra Island is elongated and oriented from northwest to southeast and its elevated orography temporarily blocked the eastward propagation of precipitation system. The dynamics of Sumatra weather systems remains poorly understood and part of the problem lies in the lack of atmospheric data and high-resolution gridded data analyses and realistic model simulations. Therefore, the data of two intensive observation periods as the international observation campaign of the CPEA will also be used. Cloud propagation statistics (speed, span, life time, size, etc.) of the individual cloud episodes and the physical basis behind the results will be discussed.

Keywords: Cloud propagation, Sumatra, CPEA

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PEM06-15 Room:312 Time:April 30 16:45-17:00

SuperDARN global observation of energy input and coupling processes and recent technical development

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SuperDARN (Super Dual Auroral Radar Network) [Greenwald, et al., 1995] is an international collaborative HF-radar network [Greenwald, et al., 1985] operated by more than 15 institutions in over 10 countries, and the number of the radars is currently more than 30 and it is still growing and the fields-of-view (FOVs) have been expanding to both higher and mid-latitudes covering considerable portions of global upper atmosphere in both hemispheres.

SuperDARN was originally designed to measure line-of-sight plasma Doppler spectra and ionospheric electric field to obtain global large scale two-dimensional polar ionospheric plasma convection patterns and polar cap potential drop in both hemispheres with a temporal resolution of 1 to 2 minutes in real time since 1995, which have never been possible by any other observational techniques, and this capability provides us very important and essential information on solar energy input to our geospace, magnetosphere and polar ionosphere, which has greatly contributed to basic understanding of coupling processes in Sun-Earth system as well as space weather researches.

SuperDARN is a powerful tool to be applied to many scientific issues [Chisham, et al., 2007 and references therein]. It can be used not only to deduce dynamics of global large-scale convection patterns, but also to study dynamics of transient meso-scale phenomena like FTEs and TCVs, and polar cap boundary or open-closed field line boundary (OCB), to detect reconnection sites and to deduce reconnection rates, to study substorms, storms and phenomena related to subauroral regions like sub-auroral polarisation stream (SAPS), to deduce field aligned currents (FACs), to study MHD waves in a variety of frequency ranges, and also to study ionospheric irregularities in D-, E-, and F-regions. Moreover, it can be utilised not only to ionospheric researches but also to neutral atmospheric studies, e.g., on atmospheric waves like TIDs, tides and gravity waves, neutral winds around mesopause region, and also polar mesospheric summer echoes (PMSEs), etc.

These days, the fields-of-view (FOVs) of SuperDARN have been expanded to higher latitude (PolarDARN) and mid-latitude (StormDARN) which covers considerable portions of mid- and polar latitudes of earth's ionosphere in both hemispheres and enables us to address much wider ranges of scientific questions including inner magnetospheric physics. There are also ongoing discussions to expand the SuperDARN radars field of view to even lower latitudes, up to low latitude and equatorial regions.

SuperDARN has extensively evolved successfully and has been extremely productive by strong cooperation and competitions within the community and also by collaborative studies with other ground-based and satellite/rocket observations and theoretical researches, which has greatly contributed to a variety of studies especially on magnetosphere-ionosphere coupling processes and ionosphere and neutral atmosphere coupling.

As SuperDARN could have provided basic and important physical parameters in global upper atmosphere, collaborative studies with other projects like IS-radars like EISCAT and PANSY providing many detailed physical parameters at fix points as well as satellite missions like THEMIS, VAP, and ERG and rocket campaigns providing in-situ measurements will be particularly important to contribute to our deeper understanding of the Sun-Earth coupling processes.

Also some SuperDARN radars has developed new technical upgrade including imaging radar capabilities providing higher spatial resolution. New science targets with SuperDARN with new capabilities will also be discussed.

Keywords: SuperDARN, HF radar, coupling processes, imaging radar, MI coupling, neutral wind

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PEM06-16 Room:312 Time:April 30 17:00-17:15

Low Latitude Ionospheric Scintillation Research Using GISTM Network over Indonesia

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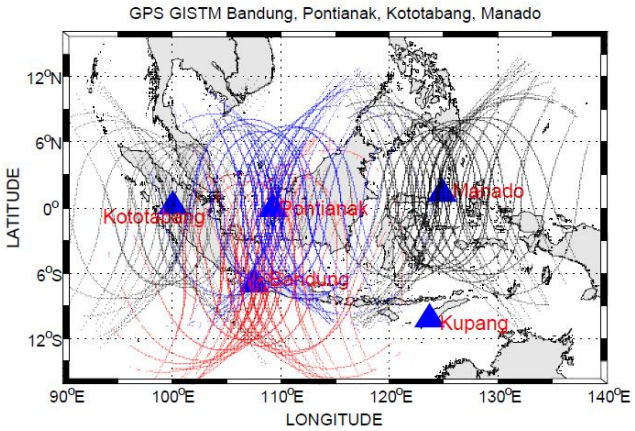
The ionosphere plays an active role in the space weather relationships, so the permanent monitoring of the ionosphere state on global and regional is required. The advancement of Global Navigation Satellite Systems (GNSS) such as GPS (Global Positioning System) receiver technology provides a low cost solution for monitoring and research the ionosphere on global and regional basis. National Institute of Aeronautics and Space (LAPAN) Indonesia has been installed GPS Ionospheric Scintillation and TEC Monitor (GSV4004b) to monitor and study ionospheric irregularities.

This paper reports a statistical study of the occurrences characteristic of GPS ionospheric scintillation and irregularity in low latitude Indonesia sector. These measurements were made by GPS Ionospheric Scintillation and TEC Monitor System (GISTM) at Pontianak (0.03S 109.33E), Bandung (6.93S 107.6E), Manado (1.34N 124.83E), Kupang (10.16S 123.66E), and Kototabang (0.12S 100.12E). For the GPS station at Kototabang, we use ISM (ionospheric scintillation monitor) under collaboration with STELAB Nagoya Univeristy. We distinguish scintillation occurrences rate between post sunset and after midnight by using S4 index during maximum solar activity period in 2013. We analyze the occurrence rate using azimuth-elevation coordinate (sky plot). The following figure is to show observation geometry which is used in this study.

Keywords: Ionospheric Scintillation, Indonesia, GPS receiver



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PEM06-17 Room:312 Time:May 1 09:00-09:30

Future direction of the ground-based network observations of the magnetosphere and the upper atmosphere

SHIOKAWA, Kazuo[1*] ; OTSUKA, Yuichi[1]

[1]Solar-Terrestrial Environment Laboratory, Nagoya University

Multi-point ground-based instruments are powerful tools to investigate global dynamics of the magnetosphere, ionosphere, and the upper atmosphere. Airglow imagers and multi-point GPS receivers provide two- and three-dimensional view of these regions. The ring-current and radiation-belt particles in the inner magnetosphere round the earth with a time scale from a few tens of minutes to a few hours. Interactions of these particles with Pc5 (times scale of ˜minutes), Pc1 (˜Hz) and VLF/ELF chorus (˜kHz) causes acceleration and loss of these particles. Thus, longitudinal chain of ground-based stations to observe these various waves and auroras is essentially needed to understand the acceleration and loss of the plasma in the inner magnetosphere. The auroral energy input from the solar wind and magnetosphere to the high-latitude ionosphere is a major energy source of the dynamic variation of the upper atmosphere. Intense convective activity in the equatorial troposphere gives another energy source of the dynamic variation of the upper atmosphere. Thus, meridional chain stations are essentially needed to understand these dynamic variations and their global coupling. In this presentation we discuss possible future directions of these ground-based network observations to understand the global dynamics of the magnetosphere, ionosphere, and the upper atmosphere.

Keywords: ground-based network observation, ionosphere, magnetosphere, upper atmosphere, future direction

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

PEM06-18 Room:312 Time:May 1 09:30-09:45

ICSWSE/ MAGDAS Project: Research for global electromagnetic coupling from polar to equatorial ionosphere

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International Center for Space Weather Science and Education (ICSWSE) has developed a real time magnetic data acquisition system (the MAGDAS project) for space environment monitoring around the world. The number of observational sites is increasing every year with the collaboration of MAGDAS host countries. Now at this time, the MAGDAS Project has installed 73 real time magnetometers ? so it is the largest magnetometer array in the world.

Applying equivalent current method to this network data, we analyze a global ionospheric current system from polar to equatorial ionosphere. Our results suggest that Dp2 type disturbances excited by solar wind variation, Pi2 type pulsations accompanied by aouroral substorm onset process and Pc3 type pulsations accompanied by dayside cavity type oscillation show the same type of global current system, which are produced by primary bipolar electric field accompanied by field-aligned current system and Hall polarization electric field excited at the dawn-dusk conductivity terminator and at the magnetic dip equator.We will discuss how the electromagnetic coupling between polar and equatorial ionosphere is regulated by the formation of global Cowling channel in the ionosphere.

Keywords: Space Weather, Magnetosphere-Ionosphere-Atmosphere Coupling, Global Coupling

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

PEM06-19 Room:312 Time:May 1 09:45-10:00

Contribution of the IUGONET data analysis system to a study on coupling processes in the solar-terrestrial system

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

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Various kinds of disturbance phenomenon and long-term variation as seen in several observation parameters (electric and magnetic fields, temperature, mean wind etc.) in a wide area from space surrounding the Earth to the atmospheric layers are caused by energy input from solar radiation, solar wind, momenta and energies from the lower atmosphere via atmospheric waves, and chemical reaction. Such a disturbance phenomenon and long-term variation observed by various kinds of ground-based and satellite instruments are the result of such complicated processes. Then, in order to investigate the mechanisms of these phenomena in this region, researchers need to conduct comprehensive analyses with various kinds of long-term observation data that have been continued by means of a global network of radars, magnetometers, optical sensors, helioscopes, etc. The IUGONET (Inter-university Upper atmosphere Global Observation NETwork) project initiated in 2009 aims at the establishment of a cross-reference system for various kinds of ground-based observation data obtained from different techniques. The IUGONET participants consist of five universities/institutes: the National Institute of Polar Research (NIPR), Tohoku University, Nagoya University, Kyoto University, and Kyushu University. We have developed metadata database (MDB) and IUGONET data analysis software (UDAS) of ground-based observation data managed by these IUGONET universities/institutes with an international collaboration in order to promote a study on coupling process in the Sun-Earth system. The MDB provides researchers in a wide range of disciplines with a seamless data environment to link databases spread across the IUGONET universities/institutes. In particular, UDAS will be of great help in conducting integrated analyses and visualization of various kinds of solar-terrestrial observation data to investigate the long-term variation in the upper atmosphere throughout the Sun-Earth system. Then, the IUGONET products will greatly contribute to a study on coupling process in the Sun-Earth system on the basis of integrated analysis of various kinds of long-term observation data covering a wide region from both the pole to the equator. In this talk, we introduce a brief overview of the IUGONET project, and an application of the IUGONET products to typical examples of upper atmospheric researches.

Keywords: Upper atmosphere, Long-term variation, Solar activity, Metadata search system, Data analysis tool, Coupling process in the Sun-Earth system

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

PEM06-20 Room:312 Time:May 1 10:00-10:15

Statistical characteristics of nighttime MSTIDs observed by an airglow imager over sub-tropical site Yonaguni (19.3N dip)

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The nighttime medium-scale travelling ionospheric disturbances (MSTIDs) are frequently observed in the mid-latitude ionosphere. They very often moves toward the southwest direction in the northern hemisphere with phase fronts aligned along the northwest to the southeast. However they do not extend to the equatorial latitudes and are rarely sighted at dip latitudes below 15^o. In this study we investigate the characteristics of MSTID features observed over Yonaguni (24.5^oN, 123.0^oE; 19.3^oN dip latitude), Japan with all-sky imaging of OI 630.0 nm airglow emission. We selected two year period for analysis in which one year corresponds to the solar minimum conditions and another year corresponds to solar maximum conditions. It is found that the MSTIDs occur more frequently during solar minimum conditions. The observed range of wavelengths, phase speeds and directions of MSTIDs are similar to those observed at typical mid-latitude sites. On many occasions the phase fronts of the observed MSTIDs do not extend over the whole field of view of imager indicating that some process hinders their extension to further lower latitudes. Herein, we also investigate the possible reason for the disappearance of phase fronts when they reach lower latitudes.

Keywords: medium-scale travelling ionospheric disturbances, OI 630.0 nm airglow

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

PEM06-21 Room:312 Time:May 1 10:15-10:30

Thermospheric wind variations in the pulsating aurora measured with FPI and IS radars

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Pulsating aurora is a typical phenomenon of the recovery phase of magnetic substorm and is frequently observed in the morning sector. While our understanding of pulsating aurora has not yet reached maturity, the widely accepted generation mechanism causing pulsations in precipitating electrons is related to wave-particle interactions around the equatorial plane in the magnetospheric tail. The closure current system in pulsating aurora may not be as strongly evolved as compared to that in the discrete arc because of smaller precipitation flux (or upward field-aligned current) and weaker perpendicular electric field (or the Pedersen current). Thus one may assume that Joule energy dissipation and/or Lorentz force does not play an important role for modifications of the thermospheric wind dynamics in pulsating aurora. However, we found thermospheric-wind variations in the pulsating aurora during simultaneous observations with a Fabry-Perot Interferometer (FPI; 557.7 nm), an all-sky camera (557.7 nm), and the European Incoherent Scatter (EISCAT) UHF radar. Of particular interest is that the location of the fluctuations was found in a darker area that appeared within the pulsating aurora. During the same time period, the EISCAT radar observed sporadic enhancements in the F-region backscatter echo power, which suggests the presence of low-energy electron (1 keV or lower) precipitation. Using other data sets archived by the EISCAT radar, a statistical analysis shows that the F-region enhancement tends to coexist with hard-particle precipitation or the pulsating aurora. This presentation will summarize our experimental evidences showing several events of the pulsating aurora, and discuss application of the phased-array IS radar to this study.

Keywords: pulsating aurora, thermosphere, FPI, IS radar

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

PEM06-22 Room:312 Time:May 1 10:30-10:45

Coordinated observation of space-borne imaging by ISS-IMAP and ground-based measurement by radars and GPS

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ISS-IMAP mission is a space-borne mission to investigate the mesoscale structures in the ionosphere, the mesosphere, and the plasmasphere by imaging observations of instruments on International Space Station. It consists of two imaging instruments. Visible-light and infrared spectrum imager (VISI) observes the airglow in the MTI region. Extra ultraviolet imager (EUVI) observes the resonant scattering from ions in the ionosphere and the plasmasphere. The objective of this mission is to clarify the upper atmospheric structures whose horizontal scale is 50-500km, and the effect of the structures on the space-borne systems in the low- and mid-latitude regions. VISI observes the airglow of 730nm (OH, Alt. 85km), 762nm (O2, Alt 95km), 630nm(O, Alt.250km) in the Nadir direction to investigate the mesoscale structures in the mesosphere and the ionosphere. The coordinated observations of ISS-IMAP with ground-based measurements have been carried out. The MU radar and Equatorial Atmosphere Radar (EAR) observe the ionosphric density structures and field-aligned irregularities while ISS-IMAP observe the large and mesoscale ionospheric structures with the 630nm airglow, and the atmospheric gravity waves in the mesosphere with the 762nm airglow. The two-dimensional distribution of total electron contents derived with the ground-base GPS receiver array is also compared with the ionospheric and mesospheric structures observed by ISS-IMAP. The results of the ISS-IMAP mission by VISI and EUVI, and its coordinated observations with the ground-based instruments will be introduced in the presentation.

Keywords: Ionosphere, Airglow, Atmospheric Gravity Wave, Plasma Bubble, Radar, GPS

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

PEM06-23 Room:312 Time:May 1 11:00-11:30

Current status of Program of the Antarctic Syowa MST/IS radar (PANSY)

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The PANSY radar is the first Mesosphere-Stratosphere-Troposphere/Incoherent Scatter (MST/IS) radar in the Antarctic. It is a VHF monostatic pulse Doppler radar operating at 47 MHz, consisting of an active phased array of 1,045 Yagi antennas and an equivalent number of transmit-receiver modules with a total peak output power of 500 kW. The first stage of the radar was installed at Syowa Station (69^{o}00'S, 39^{o}35'E) in early 2011, and is continuously operating with 228 antennas and modules since April 2012. The full radar system operation will start in 2015. This paper reports the project's scientific objectives, technical descriptions, and the preliminary results of observations made to date. The radar is designed to clarify the role of atmospheric gravity waves at high latitudes in the momentum budget of the global circulation in the troposphere, stratosphere and mesosphere, and to explore the dynamical aspects of unique polar phenomena such as polar mesospheric/stratospheric clouds. The katabatic winds as a branch of Antarctic tropospheric circulation and as an important source of gravity waves are also of special interest. Moreover, strong and sporadic energy inputs from the magnetosphere by energetic particles and field-aligned currents can be quantitatively assessed by the broad height coverage of the radar which extends from the lower troposphere to the upper ionosphere. From engineering points of view, the radar had to overcome restrictions related to the severe environments of Antarctic research, such as very strong winds, limited power availability, short construction periods, and limited manpower availability. We resolved these problems through the adoption of specially designed class-E amplifiers, lightweight and tough antenna elements, and versatile antenna arrangements. We will show highlights of several interesting results from the radar observations regarding severe snow storms, gravity waves, multiple tropopauses, and polar mesosphere summer/winter echoes.

Reference

Sato, K., et al., *J. Atmos. Solar-Terr. Phys.*, doi:10.1016/j.jastp.2013.08.022, 2013.

Keywords: MST/IS radar, polar atmosphere, middle atmosphere, gravity waves, general circulation

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

PEM06-24 Room:312 Time:May 1 11:30-11:45

Importance of coordinated ground-based, satellite observations

MIYOSHI, Yoshizumi[1*] ; OYAMA, Shin-ichiro[1] ; SAITO, Shinji[1]

[1]STEL, Nagoya University

The ERG (Exploration of energization and Radiation in Geospace) is Japanese geospace exploration project. The project focuses on the geospace dynamics in the context of the cross-energy coupling via wave-particle interactions. The project consists of the satellite observation team, the ground-based network observation team, and integrated-data analysis/simulation team. The ERG satellite will be launched in FY2015. Comprehensive instruments for plasma/particles, and field/waves are installed in the ERG satellite to understand the cross-energy coupling system. In the ERG project, several ground-network teams join; magnetometer networks, radar networks, optical imager networks, etc. Moreover, the modeling/simulations play an important role for the quantitative understanding. In this presentation, we will discuss the importance of coordinated observations toward the ERG era. As an example, we show the cooperative observations between the geospace satellite Van Allen Probes an EISCAT to observe the pulsating aurora. The EISCAT measured the height profile of the electron density that can provide the energy of the precipitating electrons. The Van Allen Probes measured the plasma waves in the magnetosphere, which can be used to investigate the origin of the pulsating aurora. In fact, the GEMSIS-RBW simulation that used the observed plasma waves as an input reproduces characteristics of the observed precipitation. Such coordinated observations including the modeling provide a comprehensive view on cause and result.

Keywords: satellite-ground observations, ERG project

Japan Geoscience Union Meeting 2014
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PEM06-25 Room:312 Time:May 1 11:45-12:00

Synthetic Study on Solar-Terrestrial Phenomena with Widespread Observation Network in Antarctica

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A large observation network with the SuperDARN radars and other ground-based instruments at manned and unmanned stations is currently developed in the Antarctic area from sub-auroral latitudes to polar cap region and from nightside to dayside hours under international collaboration. Such a widespread circumpolar observation network is very unique and powerful for studies on the phenomena which occur due to the Sun-Earth interaction, e.g., direct entry of solar wind energy and momentum into the cusp and polar cap regions, explosive energy dissipation during substorm-time, highly energetic particle precipitation into the atmosphere during storm-time. Coordinated observations with several low-altitude satellites (e.g., NOAA, DMSP, etc.) and magnetospheric satellites (e.g., THEMIS/ARTEMIS, Geotail, MMS, ERG, etc.) can be also expected In our presentation, current status and future plan of NIPR-related project will be introduced, and importantce of such a widespread ground-based observation network in Antarctica will be explained and discussed.

Keywords: Antarctica, large area, observation network, Solar-Terrestrial Physics

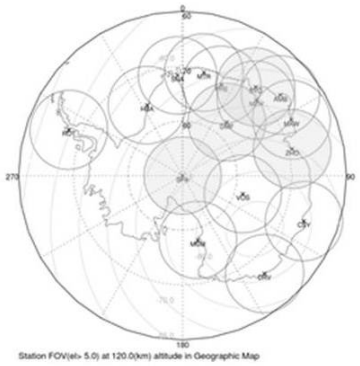

Figure 1. Field of views (FOVs) of Antarctic stations projected at 120 km altitude for elevation above 5 deg. The shaded FOV indicates the station where auroral optical observation is currently carried out. Geomagnetic latitudes are also shown in gray lines.

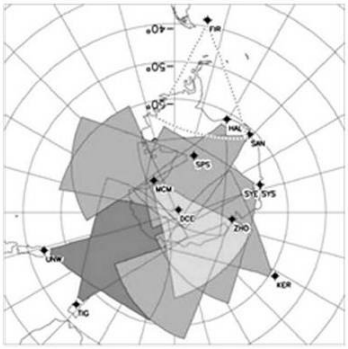

Figure 2. Field of views of the SuperDARN radars in the southern hemisphere in the magnetic coordinates, including two radars at Syowa Station (SYE and SYS).

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

PEM06-26 Room:312 Time:May 1 12:00-12:15

A review of selected data-analysis techniques for determining ionospheric electrodynamic parameters on mesoscales

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We present a review of selected data-analysis methods that are applied in studies of ionospheric electrodynamics and magnetosphere-ionosphere coupling using ground-based and space-based data sets. At present, there is no single measurement device that can measure all ionospheric electrodynamic parameters directly and simultaneously, with good spatial and temporal resolution and coverage. Therefore data-analysis techniques are needed to combine different types of measured data and to obtain unobserved ionospheric parameters from the observed ones, possibly using some additional assumptions in the process. We concentrate on methods that are data driven and applicable to single events (not simulations or statistical models), and which can be used in mesoscale studies, where the analysis area is typically some hundreds or thousands of km across.

The primary focus of this review is in ionospheric electrodynamics, so we do not include variables like chemical composition, temperature, etc. in our discussion. Furthermore we concentrate on analysis techniques that have been developed to be used with data from the MIRACLE network (Magnetometers - Ionospheric Radars - All-sky Cameras Large Experiment) situated in Northern Europe, possibly in combination with satellite observations, such as Cluster or CHAMP. However, the techniques can be applied to data from any other mesoscale network with similar observations.

The full set of ionospheric electrodynamic parameters that we are interested in consist of the ionospheric horizontal electric field, height integrated Hall and Pedersen conductances, horizontal sheet current and field aligned current (FAC). Additionally, the ground magnetic perturbation is an important input parameter in many analysis methods.

Most of the reviewed methods are used in 2-dimensional (latitude - longitude) regions of the ionosphere, but some methods have also 1-dimensional variants. In 1D analysis it is assumed that ionospheric parameters vary only in one horizontal direction (e.g. as a function of geomagnetic latitude), so input data is required along a single chain or a satellite track only. The 1D methods are especially useful when analyzing data from an overpassing satellite or from a meridional magnetometer chain.

Keywords: Ionosphere, Ionospheric electrodynamics, Ionospheric currents, Data-analysis methods

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

PEM06-27 Room:312 Time:May 1 12:15-12:30

Fine-scale electrodynamic structure behind auroral vortex street

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One of the primary scientific objectives of the planned EISCAT_3D system would be “3D imaging of aurora”, especially 3D imaging of dynamically moving auroral arcs at the time of substorm expansion phase onset. In order to discuss the specification of the EISCAT_3D system in detail, we have to know how such an effort of multi-dimensional imaging of aurora has been made by using currently-working radar systems in the high-latitude region. For this purpose, I present a fine-scale electrodynamic structure behind an auroral vortex street observed immediately before substorm expansion phase onset, as inferred from high spatial and temporal resolution measurements of auroral breakup with an all-sky TV camera (ATV) and a coherent HF radar of Super Dual Auroral Radar Network (SuperDARN) in Iceland. During the interval of interest, the ATV observed eastward propagating auroral vortices in the initial brightening arc of a substorm just prior to the poleward expansion. During the sequential passage of the vortices across the radar beams, the radar detected large velocity flow shears whose magnitude was in excess of 1.5 km/s. The observations suggest that flow shears were located very close to the center of the vortices; thus, they corresponded to electric fields converging toward the vortices, which is consistent with the existence of upward field-aligned currents (FACs) flowing out of the vortices. The temporal and spatial resolutions of the current radar measurement were still insufficient for fully resolving the detailed electrodynamic structure behind the fast moving auroral vortices. At least, however, the observations suggest the existence of highly localized filamentary FAC structures behind the auroral vortex street. Such a fine-scale structuring process of an auroral arc would be one of the possible targets of the 3D imaging observations of the planned EISCAT_3D system.

Keywords: Aurora, Radar, Electric Field

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PEM06-28 Room:312 Time:May 1 12:30-12:45

Study of the physical meanings of ionospheric tidal signatures using theoretical models

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Variations the ionospheric electron density structures related to the tidal forcing propagating upward from the lower atmosphere have been studied intensively recently. The longitudinal variations of ionospheric electron density are related to the themospheric nonmigrating tidal signatures produced in-situ or propagating upward from below. During a stratospheric sudden warming, thermospheric migrating tidal signatures are modified and lead to the phase shift of ionospheric electron density structures at low latitudes. With the increasing number of global ionospheric observations, it is desirable to relate the thermospheric tidal signatures to corresponding tidal signatures of ionospheric electron density, since the neutral thermospheric temperature and wind observations are rather limited. In this paper we perform theoretical simulations to study the interconnections between tidal modes in thermospheric neutral parameters and ionospheric plasma. The migrating and nonmigrating tides of thermospehric winds output from NCAR GSWM/TIEGCM runs are incorporated to NRL SAMI-3 to investigate the responses of corresponding tidal modes in ionospheric electron density and their physical meanings.

Keywords: atmospheric tides, tidal signature of ionospheric electron density

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

PEM06-29 Room:312 Time:May 1 14:15-14:45

Wavelike Structures in the Low-Latitude F region Using Beacon Satellites

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The low-latitude F-region plasma is produced by solar radiation, and its gross structural features arise from plasma transport and re-distribution (1) along geomagnetic field (B) lines by a meridional neutral wind, and (2) in planes transverse to B by an electric field (E). The fundamental process is often referred to as the equatorial fountain, in which an eastward electric field, applied over the magnetic dip equator, drives the plasma upward; this transverse transport is accompanied by downward and outward transport along B, which is driven by gravity and diffusion. The enhancements in plasma density that form, one in each hemisphere, are known as the equatorial ionization anomalies. Embedded within these largest-scale structures is a hierarchy of smaller-scale wavelike perturbations that extend downward from perhaps 1000 km to nearly 10 cm. These structures include large-scale wave structure, traveling ionospheric disturbances, equatorial plasma bubbles, as well as the small-scale irregularities that are responsible for radio wave scintillations and radar backscatter. Because of the complex hierarchy of structures that can be present, comprehensive investigations require a network of sensors that can provide both spatial and temporal information with adequate spatial resolution, while providing the necessary geographical coverage. A brief review of some of the recent results regarding wavelike structures, obtained from studies using a broad network of instruments distributed throughout the Southeast Asian sector, is presented.

Keywords: Wavelike structures, Low Latitude F Region, Plasma Structures, Beacon Satellites

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

PEM06-30 Room:312 Time:May 1 14:45-15:00

Preliminary study of equatorial ionization anomaly characteristic from GRBR chain in southeast Asia

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To study the equatorial ionization anomaly (EIA) characteristic, comparison of total electron content (TEC) obtained from the GNU Radio Beacon Receiver (GRBR) network in southeast Asia with the data from SEALION ionosonde network, Equatorial Atmosphere Radar (EAR), and the SAMI2 model are employed. Five GNU Radio Beacon Receivers (GRBRs) were aligned along 100 degree geographic longitude. Their observations started in March 2012 to enable monitoring the ionosphere during the high solar activity. The GRBR network in southeast Asia is a unique observation network of which the field of view covers $\pm$ 20 degree magnetic latitude including the magnetic equator to capture the ionospheric irregularities including the EIA. As a preliminary result, the day-to-day variability of the EIA was captured by GRBR chain. The asymmetry of the EIA was investigated. As generally known, the neutral wind is a primary source of the EIA asymmetry, while the zonal electric field is the secondary one. Using the GRBR network, the EIA asymmetry is compared with the data from SEALION ionosonde network and from SAMI2 model to clarify the source mechanism of the EIA asymmetry.

Keywords: GRBR, EIA symmetry, Equatorial, Ionosphere, Ionosonde, SAMI2 model

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PEM06-31 Room:312 Time:May 1 15:00-15:15

Performance evaluation of plasma bubble monitoring by VHF radars for GNSS augmentation systems

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For global navigation satellite systems (GNSS), ionospheric plasma is one of the most serious error sources. Especially in air navigation where safety is extremely important, augmentation systems corresponding to flight phases are used. Even with augmentation systems of current design, such as ground-based augmentation system (GBAS) or satellite-based augmentation system (SBAS), probability of miss-detection of ionospheric anomalies prevent them from more advance operations. In the low latitude region, ionospheric anomaly detection is a challenge because of frequent occurrence of plasma bubbles.

In this study, plasma bubble detection by a VHF backscatter radar is proposed as an external ionospheric monitor. Multi-beam observation of plasma bubbles can detect two dimensional shapes of plasma bubbles in a plane perpendicular to the magnetic field. When satellite-receiver path of GNSS signals pass crosses the magnetic field line, the signals shall be discarded because it may be affected by plasma bubble.

To evaluate the performance of this system, a VHF radar-GNSS receivers combined experiment has been conducted. The Equatorial Atmosphere Radar (EAR) is used to detect plasma bubbles. Sets of GNSS receivers around the EAR and in Bangkok are used as the pseudo-user and reference station. The observation started from
October 2012, and continues with some technical interruptions.

At the meeting, first results of the experiment will be presented.

Keywords: Equatorial Atmosphere Radar, GNSS augmentation system, plasma bubble, ionospheric monitoring

Japan Geoscience Union Meeting 2014
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PEM06-32 Room:312 Time:May 1 15:15-15:30

Future direction of operational ionospheric research

ISHII, Mamoru[1*]

[1]NICT

We are now facing new aspect of oprational ionospheric research. International Civil Aviation Organization (ICAO) is planning to revise their protocol and in near future all civil aviation must use space weather information for their operation.

Space weather information is important for aviation mainly in the following three factors; HF communication, aviation and radiation. Space weather phenomena in polar region are tend to be focused on in many cases, however, it is important also in equatorial region, e.g., equatorial plasma bubbles.

There are still some unknown process in space weather and they make the forecast difficult and low precision. We are required two different approach; understand the unknows process, and make empirical forecast methods which works even though we have still unknown process. Especially we need domestic/international cooperation in the former approach e.g., EISCAT-3D and Equatorial MU radar, because it is impossible to cover these ovservation in only one institute. ICAO issue is one of the important outcome for space weather and we should unify our activity to contribute the operation.

Keywords: space weather, ionosphere, ICAO

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

PEM06-33 Room:312 Time:May 1 15:30-15:45

Importance of EISCAT 3D as space weather reseach

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These days, importance of space weather is significantly realized by international community, such as ICAO, WMO etc. NICT has been responsible for national space weather forecast in Japan for a long time. Since NICT's space weather forecast center belongs to the International Space Environment Service (ISES) as the Regional Warning Center (RWC) Japan, our operational activities are supported by international cooperation. To understand the current conditions of "space weather", monitoring networks of space weather observations are operated and used. For future objective and advanced space weather monitoring, we have been developing a space weather numerical simulation codes, too. These activities are strongly related to the space weather research for improving space weather forecasting.

EISCAT 3D is a quite unique facility to measure many kinds of physical parameters which cannot be obtained from other instruments. Therefore, it is expected that the EISCAT 3D can contirbute to the evaluation and improvement of space weather models. The future perspective of space weather research and our expectation to EISCAT 3D are introduced in our presentation.

Keywords: Space Weather, EISCAT 3D, Ground-Based Observation

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PEM06-34 Room:312 Time:May 1 15:45-16:00

Thunderstorm Activity in Asia Maritime Continent and Global Cloud Variation

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Global relationship among the thunderstorm activities especially in Asia Maritime Continent, cloud variations in tropical regions and solar parameters was examined based on lightning data measured by Global ELF observation Network (GEON) operated by Hokkaido University and Outgoing Longwave Radiation (OLR) intensity. A correlated analysis between the number of the lightning strokes, cloud variation in the tropical regions, and solar parameters was examined, looking into the variation with ˜one month periodicity. 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, OLR in the central Africa shows 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 shows 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 between lower and upper atmospheres. The radars distributed globally would provide some essential information for this hypothesis, such as conductivity in the lower ionosphere, which may determine the strength of electrical connection in the vertical and horizontal directions.

Keywords: Maritime Continent, thunderstorm, tropical region, cloud amount, OLR, solar activity

Japan Geoscience Union Meeting 2014
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PEM06-P01 Room:Poster Time:April 30 18:15-19:30

Equatorial MU Radar project

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Research Institute for Sustainable Humanosphere, Kyoto University (RISH) has been studying the atmosphere by using radars. The first big facility was the MU (Middle and Upper atmosphere) radar installed in Shiga, Japan in 1984. This is one of the most powerful and multi-functional radar, and is successful of revealing importance of atmospheric waves for the dynamical vertical coupling processes. The next big radar was the Equatorial Atmosphere Radar (EAR) installed at Kototabang, West Sumatra, Indonesia in 2001. The EAR was operated under close collaboration with LAPAN (Indonesia National Institute for Aeronautics and Space), and conducted the long-term continuous observations of the equatorial atmosphere/ionosphere for more than 10 years. The MU radar and the EAR are both utilized for inter-university and international collaborative research program for long time. National Institute for Polar Research (NIPR) joined EISCAT Scientific Association together with Nagoya University, and developed the PANSY radar at Syowa base in Antarctica as a joint project with University of Tokyo. These are the efforts of radar study of the atmosphere/ionosphere in the polar region. Now we can find that Japan holds a global network of big atmospheric/ionospheric radars. The EAR has the limitation of lower sensitivity compared with the other big radars shown above. RISH now proposes a plan of Equatorial MU Radar (EMU) that is to establish the MU-radar class radar next to the EAR. The EMU will have an active phased array antenna with the 163m diameter and 1055 cross-element Yagis. Total output power of the EMU will be more than 500kW. The EMU can detect turbulent echoes from the mesosphere (60-80km). In the ionosphere incoherent-scatter observations of plasma density, drift, and temperature would be possible. Multi-channel receivers will realizes radar-imaging observations. The EMU is one of the key element in the project ”Study of coupling processes in the solar-terrestrial system” for Master Plan 2014 of the Science Council of Japan (SCJ). We show the EMU project and its science in the presentation.

Keywords: Atmospheric radar, ionosphere observation, Indonesia, MST radar

Japan Geoscience Union Meeting 2014
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PEM06-P02 Room:Poster Time:April 30 18:15-19:30

Development of a configurable digital receiver for atmospheric radars

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[1]Research Institute for Sustainable Humanosphere, Kyoto University

Recent progress in radar imaging techniques enables high-resolution measurements of wind and turbulence by atmospheric radars. In order to implement radar imaging techniques to existing atmospheric radars, a cheap multi-channel receiver needs to be developed. Further, for improving and verifying radar imaging techniques, a digital receiver which can change its real-time signal processing is highly useful. We are now developing a low-cost configurable digital receiver. Because the digital receiver comprises a general-purpose software-defined radio receiver and a personal computer, its purchase cost is low and its real-time signal processing is easy to be implemented. In the presentation, we report the current development status of the digital receiver.

Keywords: atmospheric radar, wind profiler radar, digital receiver, software-defined radio technique, Universal Software Radio Peripheral (USRP)

Japan Geoscience Union Meeting 2014
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PEM06-P03 Room:Poster Time:April 30 18:15-19:30

Statistical study of F-region field-aligned irregularities based on Equatorial Atmosphere Radar in Indonesia

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I examined the statistical characteristics of Field-Aligned Irregularities (FAIs) echoes from the F-region of Ionosphere using Equatorial Atmosphere Radar (EAR) in Indonesia during three years from 2010 to 2012. We investigated the differences between post-sunset and post-midnight FAIs. Some results are analyzed in the daily and monthly average of echo power, spectral width, and Doppler velocity. We found that post-midnight FAIs occurred mostly in summer solstices from May to August in 2010 and 2011, and only in June and July in 2012. We realized some different characteristics between post-sunset and post-midnight FAIs observed from EAR as follow. (1) Echo intensity of the post-midnight FAIs is weaker than that of post-sunset FAIs. (2) The post-sunset FAIs often exceed an altitude of 450 km, whereas the post-midnight FAIs mostly occur in a range from 200 to 450 km in F-region. (3) Spectral width of the post-midnight FAIs is smaller than that of the post-sunset FAIs. These results suggest that plasma instability operates more actively at post-sunset than at post-midnight.

Keywords: F-region Ionosphere, Field-Aligned Irregularities (FAIs), VHF radar

Japan Geoscience Union Meeting 2014
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PEM06-P04 Room:Poster Time:April 30 18:15-19:30

Statistical study of ionospheric irregularities by using Equatorial Atmosphere Radar

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[1]RISH, Kyoto University

The equatorial region is the source of many unique atmospheric processes that couple the entire atmosphere vertically from bottom to top and horizontally from equator to pole. The dynamical, electrodynamical, and electrical process of lower and upper atmosphere of equatorial region contribute to ionospheric irregularities through propagation of atmospheric waves, and magnetosphere-ionosphere interaction. Those process are responsible for the large degree of variabilities observed in the low latitude ionosphere.

Study of ionospheric irregularities was made during 2008-2013 by using 47 MHz Equatorial Atmosphere Radar (EAR) in Kototabang, Indonesia (0.20S, 100.32E; 10.36S dip latitude). Characteristic of echoes from ionospheric Field Aligned Irregularities (FAI) classified based on structure of E and F backscattered echoes power of EAR radar both of spatially and temporally. The results base on intermittent observations (2008-2010) and continuous observations (2011-2013). During the observations were obtained percentage of Equatorial Spread F (ESF) occurrences, diurnal and seasonal characteristics of ionospheric irregularities from the E region and also from F region. Furthermore, occurrence correlation between E and F region irregularities are also observed.

Keywords: Ionospheric Irregularity, Equatorial Atmosphere Radar, Statistical Study

Japan Geoscience Union Meeting 2014
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PEM06-P05 Room:Poster Time:April 30 18:15-19:30

Lidar observations for study of coupling processes over the equatorial region

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[1]Tokyo Metropolitan University

Stratosphere-troposphere exchange is important for the budget of ozone in the lower stratosphere as well as in the troposphere. Upward transport occurs in the tropical region (Brewer-Dobson circulation), but the exact mechanism controlling the transport is not clear. We have constructed the lidar facility for survey of atmospheric structure over troposphere, stratosphere, mesosphere and low thermosphere over Kototabang (100.3E, 0.2S), Indonesia in the equatorial region [1]. The lidar system consists of the Mie and Raman lidars for tropospheric aerosol, water vapor and cirrus cloud measurements, the Rayleigh lidar for stratospheric and mesospheric temperature measurements and the Resonance lidar for metallic species such as Na, Fe, Ca ion measurements and temperature measurements in the mesopause region. The laser system included in this lidar facility consists of three pulsed Nd:YAG lasers, a pulsed Ti:Sapphire laser seeded by a ring Ti:Sapphire laser and a dye laser. The most parts of this lidar system are remotely controlled via the Internet from Japan. The full lidar observations started from 2004. The routine observations of clouds and aerosol in the troposphere and stratosphere are continued now.

We found the top height of the stratospheric aerosol layer descend with time, synchronized with the QBO in the zonal wind. The QBO signals of the aerosol layer are noticed in the altitude range from 30 to 40 km. In addition, the tropospheric aerosol amount observed around the tropopause over Kototabang is much more than at mid-latitudes. They suspect that this is an evidence of active material exchange between the troposphere and the stratosphere over the equatorial region.

We have installed DIAL (differential absorption lidar) system for high-resolution measurements of vertical ozone profiles in the equatorial tropopause region over Kototabang, Indonesia. We will contribute to the elucidation of the climate change by getting observational information about high-resolution ozone density profiles, and the wave-propagation and material transportation using ozone as a tracer from the troposphere to the lower stratosphere over the equator.

There were many ozone DIAL systems in the world, but almost systems are optimized for stratospheric ozone layer measurement [2] or tropospheric ozone measurement [3]. Because of deep ozone absorption in the UV region, the wavelength selection is important. Simulation results show that we can measure above 20km with height resolution of 500m within 5% random error.

Acknowledgments

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Keywords: coupling process, equatorial region, lidar

Japan Geoscience Union Meeting 2014
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PEM06-P06 Room:Poster Time:April 30 18:15-19:30

Microstructure of Precipitation over Indonesia from a Network of Parsivel disdrometers

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Insight into the regional variability of raindrop size distribution (DSD), is of primary importance for estimation of rainfall using remote sensing techniques, cloud/precipitation microphysical processes and numerical weather modeling. In order to quantify the regional variability of the DSD over Indonesia, a network of 4 Parsivel disdrometers along equatorial Indonesia has been designed. The disdrometers were installed at Kototabang (KT; 100.32E, 0.20S), Pontianak (PT; 109.37E, 0.00S), Manado (MN; 124.92E, 1.55N) and Biak (BK; 136.10E, 1.18S). It was found that the DSD at PT has more large drops than at the other three sites. The DSDs at the four sites are influenced by both oceanic and continental systems, and majority of the data matched the maritime-like DSD that was reported in a previous study. Continental-like DSDs were somewhat dominant at PT and KT. The combination of World Wide Lightning Location Network, wind profiler and the Tropical Rainfall Measuring Mission (TRMM) Precipitation Radar (PR) allows a discussion on physical basis behind the regional variability of DSD over Indonesia.

Keywords: Indonesia, Parsivel, Raindrop

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PEM06-P07 Room:Poster Time:April 30 18:15-19:30

Feature studies of the polar lower thermosphere by EISCAT_3D

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The new EISCAT_3D radar will give us with great opportunities. Its 3D volumetric observations of ion velocity will provide high quality neutral wind data in the lower thermosphere. Furthermore, its continuous observations will make it possible to study planetary waves in the lower thermosphere in more detail as well as day-to-day variabilities of tides. In this talk, we will describe our future study targets.

The lower thermospheric wind dynamics has been paid great attention for several decades to understand the Magnetosphere-Ionosphere-Thermosphere coupling, since the neutral atmosphere plays a key role. In particular, it has been an issue how the lower thermosphere will response to the solar wind energy input. IS radar measurements of the polar lower thermosphere begun about 40 years ago by a pioneer work of Brekke et al. [JGR, 78, 8235, 1973], and significant number of studies have been conducted since then. However, our understanding of the lower thermosphere is still limited. One of reasons is that the lower thermosphere is significantly influenced by atmospheric waves propagating from below. Thus, the day-to-day variability is very prominent. Owing to high running cost, long term datasets are hard to be obtained by IS radar a decade ago. In 2007-2008, EISCAT Svalbard radar was operated almost continuously for 1 year. However, only about 20% of the data sets can be used for deriving the ion velocity vector. If we have wind velocity datasets on daily basis like meteor and MF radars usually made for the mesospheric wind measurements (70-100 km), our understanding of the lower thermosphere wind dynamics will be much more progressed. EISCAT_3D will make it possible.

Furthermore, the EISCAT_3D radar will give us higher temporal resolution data sets of neutral winds in the lower thermosphere with multi volumes. The observations will allow us to distinguish the temporal and spatial variations of winds. One of scientific targets is to investigate wind variations nearby the auroral arc in the E-region. By combining sodium and Rayleigh LIDARs as well as meteor and MF radars, which provide neutral temperature and wind velocity, respectively, we expect we can investigate dissipation process of gravity waves in more details as well as effects of auroral precipitation on the middle atmosphere.

Keywords: EISCAT_3D, polar ionosphere, lower thermosphere, planetary wave, tidal wave, gravity wave

Japan Geoscience Union Meeting 2014
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PEM06-P08 Room:Poster Time:April 30 18:15-19:30

Observation of non-thermal planetary radio emissions with EISCAT 3D

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[1]Tohoku University

EISCAT 3D is developing as incoherent scatter radar to study the terrestrial ionosphere and atmosphere. Due to large aperture area and low noise temperature of the receiving system of EISCAT 3D and the uniqueness of the receiving frequency of 233 MHz, it can also be a useful tool to study non-thermal radio emissions from the solar system planets. In this paper, feasibility and advantage of EISCAT 3D for observing non-thermal planetary radio emissions are presented. Following topics will be discussed. (1) Time variability of Jovian synchrotron radiation, (2) Radio emissions from lightning discharges occurred in the atmospheres of Mars and Saturn, and (3) Recent trials to detect incoherent radio emissions from extra-solar planets.

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PEM06-P09 Room:Poster Time:April 30 18:15-19:30

Numerical simulation of Generalized Auroral Computed Tomography toward its application to the EISCAT_3D project

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The EISCAT_3D is a next-generation phased-array incoherent scatter radar, which is capable of measuring three-dimensional (3D) ionospheric plasma parameters at ten-times higher temporal and spatial resolution. Thus, it is expected that the EISCAT_3D will provide new insights into auroral physics. On the other hand, optical imaging observation will be still useful for studying the auroral dynamics, because high-sensitivity camera can generally measure horizontal 2D distribution of the aurora at higher temporal resolution than the radars. We demonstrate by numerical simulation how useful monochromatic auroral images taken at multi-point camera network are for the study of aurora dynamics in the EISCAT_3D project. We apply the generalized - aurora computed tomography (G-ACT) to simulated observational data from real instruments, that is, the Auroral Large Imaging System (ALIS) and the EISCAT_3D radar. The G-ACT is a method to reconstruct three dimensional (3D) distribution of auroral emission and ionospheric electron density (corresponding to horizontal 2D distribution of energy spectra of precipitating electrons) from multi-instrument data. It is assumed that a core site of the EISCAT_3D radar is located at Skibotn (69.35N, 20.37E), Norway, and scans an area of 0.8 degrees in geographic latitude and 3 degrees in longitude at 130km altitude with 21x21 beams. Two neighboring discrete arcs are assumed to appear in the observation region of the EISCAT_3D radar. The reconstruction results from the G-ACT are compared with those from the normal ACT as well as those from only the electron density observed by the EISCAT_3D radar. It is found that the G-ACT can interpolate the ionospheric electron density at much higher spatial resolution than the original one observed by the EISCAT_3D radar. Furthermore, the multiple arcs reconstructed by the G-ACT are more precise than those by the normal ACT. Even for the case that the reconstruction by the ACT is difficult due to unsuitable location of the camera sites relative to the discrete arcs and/or a small number of available images, the G-ACT allows us to achieve the reconstruction.

Keywords: aurora computed tomography, EISCAT_3D, simulation, multi-point camera observation

Japan Geoscience Union Meeting 2014
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PEM06-P10 Room:Poster Time:April 30 18:15-19:30

Aurora-induced sodium layer variation detected by coordinated observation with sodium lidar and EISCAT radar

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Sodium atom layer is generally distributed at 80-100 km. One of mysterious subjects on high-latitude sodium layers is relationship between auroral particle precipitation and sodium atom layer variation. A previous study suggested a sodium column density decrease during a geomagnetic active period due to that the particle precipitation accompanied by electron density enhancement could induce ionization of sodium atom through their ion-molecule chemistry. Another study pointed a possibility of sodium density increase. For this reason, it is suggested that auroral precipitating particle bombardment on meteoric smoke particles can sputter sodium atoms from the smoke particles. On the other hand, ionospheric electric field, which may become more significant near auroral precipitating regions, could induce ion motions (i.e. can generate sodium ion convergence and/or divergence), and then also could affect generation and/or loss processes of sodium atoms through their ion-molecule chemistry. Thus, for the examination of the causality, it is vitally important to distinguish the effects of auroral particle precipitation and ionospheric electric field. Using a sodium lidar (which was installed in early 2010) and European incoherent scatter (EISCAT) radar at Tromsoe, Norway (69.6N, 19.2E), we have investigated, for the first time, that the actual effect of the particle precipitation to the sodium density variations without electric filed injection. In the nighttime observation on 24-25 January 2012, we detected a significant decrease of sodium atom density coincied with electron density enhancements (implying strong particle precipitations) and low ion temperatures (implying no electric field injections). These results strongly suggested that auroral particle precipitations induced sodium atom density decrease. Furthermore we discuss observed time response in the sodium density decrease.

Keywords: Na lidar, EISCAT radar, Na layer, Auroral particle precipitation, Ionospheric electric field

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PEM06-P11 Room:Poster Time:April 30 18:15-19:30

The spatial and temporal evolution of equatorial plasma bubble observed using ground based GPS TEC measurement.

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The equatorial plasma bubble (EPB) commonly occurs near the equatorial region after post sunset period. The generation process of EPB has been well understood where it is commonly developed near the magnetic equator and elongated along magnetic field lines through Rayleigh-Taylor instability mechanism. However, the source of seeding perturbation leads to the generation of Rayleigh-Taylor instability is still unknown. The temporal and spatial properties of EPB have been well studied using airglow imager. However, the observation using airglow imager is impossible during sunset time where the EPB starts to develop due to light from the sun while the observation during night time is always interfered by moon and clouds.

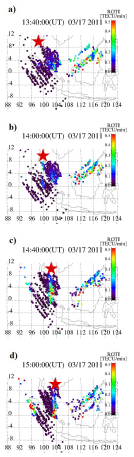
In this study, we obtain the GPS data from Malaysia Real-Time Kinematics GNSS Network (MyRTKnet), International Ground Station (IGS) network and Sumatera GPS Array (SUGAR) network. The networks contains 127 receivers in South East Asia (SEA) region covers 8^{o}N to -8^{o}S latitude and 92^{o}E to 120^{o}E longitude geographic coordinates. In this study, we detected the structure of EPB using two-dimensional map of rate of TEC index (ROTI) calculated from ground based GPS TEC measurement in. The average ROTI value for all visible satellites at 300 km altitude is binned into 0.45^o x 0.45^o grid in geographic latitude and longitude. The advantage of this technique is the GPS data is always available and we are able to observe the spatial and temporal properties of EPBs continuously without distracted by light.

On the 17th March 2011, we observed the appearance of EPB structure pass through the SEA territory for 5 hours from 1300 UT (2100 LT) - 1900 UT (0200 LT). The initial ROTI-enhancement region is at 1300 UT is propagating to eastward direction and the information of the structure is lost due to the limited coverage of GPS receiver. At 1340 UT, a new ROTI-enhancement region appeared as a point source at geographic coordinate 2^{o}N and 98^{o}E as shown in Figure (a). After 20 minutes, the point source of ROTI-enhancement region expand to ˜600 km in the North and ˜200 km South direction as shown in Figure (b) while the zonal size ˜50 km remains the same. The perturbation region is expanding faster towards dip magnetic equator might associated with field-aligned irregularities. The structure travelled in eastward direction with velocity ˜133 ms^{-1} until the development process stopped. After 60 minutes, we assumed the structure is fully developed as illustrated in Figure (c) when no development in zonal size and ROTI value is observed anymore. The developed structure has 200 km zonal size continuously moves to eastward directions with slower velocity ˜111 ms^{-1}. The slower velocity incidentally with no development in zonal size and ROTI value might indicates the ”fossil” bubble where the plasma density is equal with background density and the structure velocity following the background plasma density. At 1440 UT the second structure is coming ˜600 km away from the first structure with velocity ˜111 ms^{-1} and zonal size 200 km same as the previous structure as shown in Figure (d). The first and second structure has the same zonal sizes and velocities might due to the same temporal and spatial evolution during the generation process.

The two-dimensional structure of EPB has been presented using GPS networks in SEA region is an alternative tool to observe the temporal and spatial properties of EPB structure from the initial perturbation until the decaying process without being distracted by light. The temporal and spatial properties of EPB can contribute towards understanding the generation mechanism of the Rayleigh-Taylor instability process.

Keywords: equatorial plasma bubble, rate of TEC index, GPS TEC measurement

PEM06-P11 Room:Poster Time:April 30 18:15-19:30



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PEM06-P12 Room:Poster Time:April 30 18:15-19:30

Relationship between Latitudinal Extension of Scintillation and Pre-reversal Enhancement in the Southeast Asian Region

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We have investigated the relationship between the maximum latitude extension of observed scintillations (Lmax) and the maximum altitude of the equatorial F-region bottomside (h'Fmax), peak of eastward electric field (Emax), and time duration of eastward electric field (TE) during PRE period in the equatorial region. We used three GPS receivers installed in Kototabang (0.2S, 100.3E; 10.0N magnetic latitude), Pontianak (0.02S, 109.3E; 8.9S magnetic latitude), and Bandung (6.9S, 107.6E; 17.5S magnetic latitude), Indonesia for observing scintillation activity in period 18.00-22.00 LT (LT=UT+7h) and two frequency modulated-continues wave (FM-CW) ionosondes installed near equator magnetic, Chumphon (10.7N, 99.4E; 3.3N magnetic latitude), Thailand and Bac Lieu (9.3N, 105.7E; 1.7N magnetic latitude), Vietnam for measuring PRE parameters, such as h'F, vertical drift (dh'F/dt) which indicates eastward electric field, and TE. Our observation period is during equinox months (March, April, September, and October) in 2010, 2011, and 2012. We divide the relationships into two groups; 1) the relationships between PRE parameters obtained from Chumphon ionosonde and Lmax observed by Kototabang and Bandung GPS receivers and 2) PRE parameters obtained from Bac Lieu ionosonde and Lmax observed by Pontianak and Bandung GPS receivers. The following table is to show the coefficient correlation (R) of the relationships for each group. The results indicate that duration of eastward electric field does not play an important role for extension of the plasma bubble or latitudinal extension of scintillation, and that the peak of h'F and magnitude of E at the initial phase of plasma bubble generation (PRE period) is a primary factor for the plasma bubble extension. Therefore, the maximum latitude of scintillation is determined at the initial phase of plasma bubble generation (PRE period) in the equatorial region.

Relationship	R (group 1)	R (group 2)
h'Fmax vs Lmax	0.596	0.471
Emax vs Lmax	0.489	0.270
TE vs Lmax	0.054	0.090

Keywords: Ionosphere, Scintillation, Pre-reversal enhancement

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PEM06-P13 Room:Poster Time:April 30 18:15-19:30

Geolocation of lightning discharge in the Maritime Continent based on radio observation in 0.1-40 kHz band

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Recent researches based on observation and data assimilation of lightning discharge indicate a possibility of now-cast and forecast of severe weather such as torrential rain. In these works, lightning data is focused on as a proxy for the presence or absence of deep convection which generates thunderstorm.

In previous works, occurrence of cloud-to-ground (CG) lightning discharges has been mainly used due to the ease of data availability. However, lighting observation based on electromagnetic measurement shows that there is extremely huge scale lightning whose scale is more than hundreds times bigger than that of averaged event. Lightning data including ″ occurrence ″ and ″ scale ″ enable us to evaluate not only existence but also intensity of atmospheric convection. Quantitative evaluation of atmospheric convection would make it possible to make a now-cast and forecast for intensity distribution of precipitation.

The Maritime Continent (MC) is one of the most important regions for lightning observation in the world. Thunderstorm activity causes enormous human and economic damage to countries in MC. However, until now, only few statistical studies on the lightning activity with scale information of lightning discharge have been done.

In this works, lightning observation network in the MC based on electromagnetic measurement in 0.1-40 kHz band is summarized. This network is developed to estimate not only spatial distribution but also scale one of lightning discharges. We have already constructed observation stations at Tainan in Taiwan (23.1N, 121.1E), Saraburi in Thailand (14.5N, 101.0E), Pontianak in Indonesia (0.0N, 109.4E), Los Banos in Philippines (14.2N, 121.25E) and Son Tay in Viet Nam (21.1N, 105.5E). Data obtained by multipoint observation is synchronized by GPS receiver installed at each station.

At the presentation, we show evaluation of accuracy for geolocation and detection efficiency of signal radiated from lightning discharge based on comparisons with World Wide Lightning Location Network (WWLLN) data.

Keywords: lightning discharge, thunderstorm, severe weather, VLF, the Maritime Continent

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A study on a low Earth orbit (LEO) satellite mission using radio propagation characteristics

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We study in this paper an Earth observation mission with a low Earth orbit (LEO) satellite using radio propagation characteristics on L (1.2-1.6 GHz for GPS) and Ka (17.3-20.2 GHz for O3b satellite) bands . In particular, applying GPS radio occultation (GPS RO) technique, we aim to obtain profiles of atmospheric parameters (humidity, temperature and electron density) with a good height resolution, covering a wide area. We also measure cloud water content and vapor distribution by using radiometer technique on Ka-band.

Radio occultation employs propagation delay and bending of radio waves in the atmosphere. Though GPS satellites hitherto has been used for observing radio occultation, we use not only GPS but also other GNSS satellites (GLONASS, Galileo, Beidou, and QZSS), moreover we further use O3b(Other 3 billion people), which is a communications satellite, then, we can increase number of observation points of RO.

Because the observation point of RO is determined by the relative location between the LEO satellite and transmitting satellites, we used a numerical model to investigate the data distribution of RO and proposed an optimal satellite orbit for a new LEO satellites mission. The model analysis shows that using GNSS and O3b satellites for RO the total number of RO data becomes approximately three times larger than those by using only GPS satellites. The analysis also shows that the longitudinal distribution of RO data does not depend on orbit of the LEO satellite, but, the latitudinal distribution is largely affected by an inclination angle of LEO satellite. Data distribution as function of local time varies by inclination and longitude of ascending node of LEO satellite.

We also investigate application of O3b operated on Ka-band, which is approximately ten times higher than L-band. So Ka-band is less sensitive to the ionosphere, but it is greatly attenuated by cloud water and vapor. In GPS RO on L band, atmospheric profiles at high-altitude (50km-) are not determined accurately because of influence of ionosphere. But using Ka-band of O3b we will be able to increase the maximum height of the profiles. Moreover, we expect to measure cloud water content and vapor distribution by using attenuation of Ka-band.

Keywords: GPS radio occultation, Low Earth orbit satellite, Global Navigation Satellite System, Ka-band