

太陽地球系結合過程の研究基盤形成 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 institutes. 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 mainly 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 will be expanded in Asia and Africa to clarify the global flow of energy and materials.

キーワード: 赤道フォウンテン, 赤道 MU レーダー, EISCAT_3D, グローバル観測ネットワーク
Keywords: Equatorial fountain, Equatorial MU Radar, EISCAT_3D, Global observation network

赤道大気レーダーによる下層大気観測のレビュー A Review on Equatorial Atmosphere Radar (EAR) Observations of Lower Atmosphere

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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.

キーワード: 赤道大気レーダー, 赤道 MU レーダー, 赤道大気

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

SEALION と赤道大気レーダーによる電離圏観測 Ionospheric observations by SEALION and the Equatorial Atmosphere Radar

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Equatorial spread F (ESF) is a well-known phenomenon in the equatorial ionospheric 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.

キーワード: SEALION, 赤道大気レーダー, 赤道スプレッド F, 赤道電離圏
Keywords: SEALION, EAR, equatorial spread F, equatorial ionosphere

コトタバングにおける赤道大気レーダー観測等に基づくモンスーンインデックスの開発
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.

キーワード: IMI, 赤道大気レーダー, AUSMI, モデル

Keywords: IMI, EAR, AUSMI, Model

Vertical and horizontal coupling processes in the equatorial atmosphere Vertical and horizontal coupling processes in the equatorial atmosphere

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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.

キーワード: atmosphere vertical coupling, atmosphere observation network
Keywords: atmosphere vertical coupling, atmosphere observation network

赤道大気レーダーによる熱帯対流圏の鉛直流観測 —これまでの観測成果—
Vertical wind measurement in the equatorial troposphere by the Equatorial Atmosphere
Radar: A review

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大気鉛直運動（鉛直流）は、大気中の運動量・エネルギー輸送や雲・降水の力学過程を決定付ける物理量である。50MHz帯大気レーダーである赤道大気レーダー（EAR）は、電波屈折率擾乱に起因するブラッグ散乱を利用して風速を計測する。そのため、晴天域・雨域を問わず鉛直流を計測できる優れた特長を備える。さらに、多周波切替え送信と適応信号処理を組み合わせることで鉛直分解能を向上させるレンジイメージング機能を備える。講演では、これまでに得られたEARの鉛直流観測成果とともに、赤道MUレーダーを活用した鉛直流計測の展望を述べる。

キーワード: 赤道大気レーダー, 赤道MUレーダー, 熱帯大気, 鉛直流観測

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

Science and design overview of the EISCAT_3D radar 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 Tromsø in northern Norway, together with the receiver sites at Kiruna, Sweden and Sodankylä, 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.

キーワード: EISCAT, Incoherent Scatter, Radar, Ionosphere, Solar-Terrestrial Physics, Space Weather
Keywords: EISCAT, Incoherent Scatter, Radar, Ionosphere, Solar-Terrestrial Physics, Space Weather

The EISCAT_3D System and Status The EISCAT_3D System and Status

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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.

キーワード: Incoherent Scatter Radar, ionosphere
Keywords: Incoherent Scatter Radar, ionosphere

Thermospheric neutral density observations using the EISCAT incoherent scatter radars 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.

キーワード: Thermospheric density, Incoherent scatter radar

Keywords: Thermospheric density, Incoherent scatter radar

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

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.

キーワード: ionospheric tomography, ionospheric electron density, ground-based observations, EISCAT 3D
Keywords: ionospheric tomography, ionospheric electron density, ground-based observations, EISCAT 3D

EISCAT_3Dで推進するジオスペースおよび大気科学 Advancement of geospace and atmospheric sciences with EISCAT_3D

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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.

キーワード: 非干渉散乱レーダー, 欧州非干渉散乱レーダー科学協会, 電離圏, 熱圏, 中間圏, 三次元イメージング観測
Keywords: Incoherent scatter radar, EISCAT, Ionosphere, Thermosphere, Mesosphere, 3D imaging observation

EISCAT_3D 及び関連観測に基づくイオン上昇流/イオン流出の研究 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.

キーワード: EISCAT, ionosphere, M-I coupling
Keywords: EISCAT, ionosphere, M-I coupling

大型レーダーによる流星ヘッドエコー観測と流星の精密軌道データベース Meteor head echo observation with a high power large aperture (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 m² 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.

キーワード: 流星, 超高層大気, 大型レーダー

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

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

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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.

キーワード: Cloud propagation, Sumatra, CPEA
Keywords: Cloud propagation, Sumatra, CPEA

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

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.

キーワード: SuperDARN, HF radar, coupling processes, imaging radar, MI coupling, neutral wind

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

Low Latitude Ionospheric Scintillation Research Using GISTM Network over Indonesia

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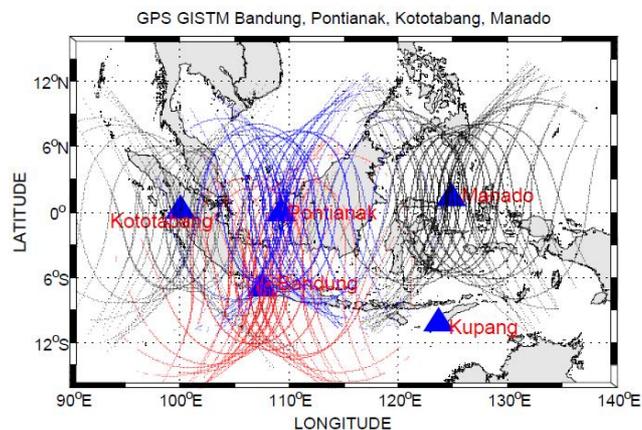
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The ionosphere plays an active role in the space weather relationships, so the permanent monitoring of the ionosphere state on global and regional is required. The advancement of Global Navigation Satellite Systems (GNSS) such as GPS (Global Positioning 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 University. 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



電磁気圏・超高層大気の広域多点観測の将来の方向性 Future direction of the ground-based network observations of the magnetosphere and the upper atmosphere

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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.

キーワード: 広域多点観測, 電離圏, 磁気圏, 超高層大気, 将来計画

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

ICSWSE/ MAGDAS Project: 極域-磁気赤道域電磁結合系の実証的研究 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 auroral 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.

キーワード: 宇宙天気, 磁気圏電離圏結合, 緯度間結合, 全球結合

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

IUGONET データ解析システムの太陽地球結合研究への貢献 Contribution of the IUGONET data analysis system to a study on coupling processes in the solar-terrestrial system

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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.

キーワード: 超高層大気, 長期変動, 太陽活動, メタデータ検索システム, データ解析ツール, 太陽地球系結合

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

Statistical characteristics of nighttime MSTIDs observed by an airglow imager over subtropical site Yonaguni (19.3N dip)
Statistical characteristics of nighttime MSTIDs observed by an airglow imager over subtropical 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°. In this study we investigate the characteristics of MSTID features observed over Yonaguni (24.5°N, 123.0°E; 19.3°N 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.

キーワード: medium-scale travelling ionospheric disturbances, OI 630.0 nm airglow
Keywords: medium-scale travelling ionospheric disturbances, OI 630.0 nm airglow

FPI と IS レーダーで観測された脈動オーロラ中の熱圏風速変動 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.

キーワード: 脈動オーロラ, 熱圏, FPI, IS レーダー

Keywords: pulsating aurora, thermosphere, FPI, IS radar

ISS-IMAPによる撮像観測とレーダーとGPSによる地上観測との同時観測 Coordinated observation of space-borne imaging by ISS-IMAP and ground-based measurement by radars and GPS

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SAITO, Akinori^{1*}; YAMAZAKI, Atsushi²; SAKANOI, Takeshi³; YOSHIKAWA, Ichiro⁴; OTSUKA, Yuichi⁵; YAMAMOTO, Mamoru¹; NAKAMURA, Takuji⁶; AKIYA, Yusuke¹; HOZUMI, Yuta¹

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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 ionospheric 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

南極昭和基地大型大気レーダー計画の現状 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°00'S, 39°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.

キーワード: 大型大気レーダー, 極域大気, 中層大気, 重力波, 大気大循環

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

衛星-地上連携観測の重要性：ERGに向けて Importance of coordinated ground-based, satellite observations

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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 and 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.

キーワード: 衛星-地上連携観測, ERG プロジェクト
Keywords: satellite-ground observations, ERG project

南極広域観測網による太陽-地球系現象の総合研究 Synthetic Study on Solar-Terrestrial Phenomena with Widespread Observation Network in Antarctica

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現在南極域には、SuperDARN レーダー網や地上の有人、無人観測点における様々な観測機器による観測点網など、極を取巻いて、緯度方向にはサブオーロラ帯から極冠域まで、経度方向には、夜側から昼間側の時間帯にまで及ぶ広域観測網が国際協力の下展開されている。こうした広域観測網は南極域独自のものであり、太陽-地球相互作用の結果生じる現象：昼間側カスプ域、極冠域への太陽風エネルギー、運動量の直接的な侵入、サブストーム時の爆発的なエネルギー消費、ストーム時の高エネルギー粒子の大気への侵入、などの研究に適している。また、NOAA、DMSP 衛星などの低高度衛星や、THEMIS/ARTEMIS、Geotail、ERG、MMS 衛星といった磁気圏衛星と連携した観測・研究が期待出来る。本発表では、特に極地研が関係している観測計画の現状や将来計画の紹介を中心に、太陽-地球系結合過程の研究における南極広域観測網の重要性を説明および議論する予定である。

キーワード: 南極, 広域, 観測ネットワーク, 太陽地球系物理学

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

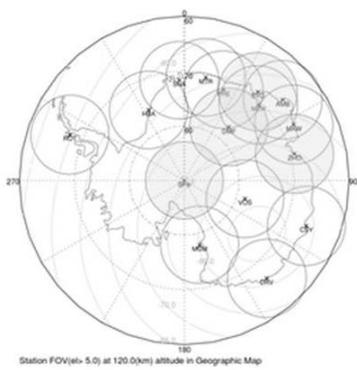


Figure 1. Field of views (FOVs) of Antarctic stations projected at 120 km altitude for elevation above 5 deg. The shaded FOV indicates the station where auroral optical observation is currently carried out. Geomagnetic latitudes are also shown in gray lines.

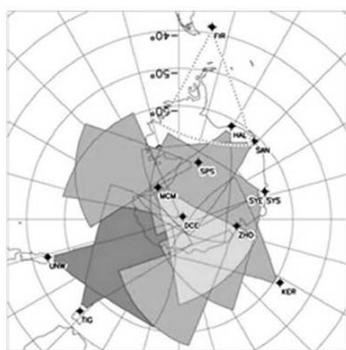


Figure 2. Field of views of the SuperDARN radars in the southern hemisphere in the magnetic coordinates, including two radars at Syowa Station (SYE and SYS).

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

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.

キーワード: Ionosphere, Ionospheric electrodynamics, Ionospheric currents, Data-analysis methods
Keywords: Ionosphere, Ionospheric electrodynamics, Ionospheric currents, Data-analysis methods

オーロラ渦列構造の背景にある電場の微細構造 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.

キーワード: オーロラ, レーダー, 電場
Keywords: Aurora, Radar, Electric Field

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

キーワード: atmospheric tides, tidal signature of ionospheric electron density

Keywords: atmospheric tides, tidal signature of ionospheric electron density

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

キーワード: Wavelike structures, Low Latitude F Region, Plasma Structures, Beacon Satellites
Keywords: Wavelike structures, Low Latitude F Region, Plasma Structures, Beacon Satellites

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

キーワード: GRBR, EIA symmetry, Equatorial, Ionosphere, Ionosonde, SAMI2 model
Keywords: GRBR, EIA symmetry, Equatorial, Ionosphere, Ionosonde, SAMI2 model

赤道大気レーダーとGPS受信機群を用いたVHFレーダーによるプラズマバブル検出の衛星航法補強システムに対する効果の検証
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.

キーワード: 赤道大気レーダー, 衛星航法補強システム, プラズマバブル, 電離圏監視

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

業務的電離圏研究の将来の方向性 Future direction of operational ionospheric research

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We are now facing new aspect of operational 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 unknowns 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 observation 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.

キーワード: 宇宙天気, 電離圏, 国際民間航空機関
Keywords: space weather, ionosphere, ICAO

宇宙天気研究における EISCAT 3D の重要性 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 contribute 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.

キーワード: 宇宙天気, EISCAT 3D, 地上観測
Keywords: Space Weather, EISCAT 3D, Ground-Based Observation

アジア海洋大陸における積乱雲活動と全球雲変動 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 strokes in Asia Maritime Continent (AMC) varies with about month periodicity in the period from February to June 2004 and shows positive correlation ($R \sim 0.8$) 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 strokes 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.

キーワード: アジア海洋大陸, 積乱雲活動, 熱帯, 雲量, OLR, 太陽活動

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