Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

PEM10-01 Room:A01 Time:May 27 16:15-16:45

Equatorial Fountain in the Middle and Upper Atmosphere

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We are studying coupling processes in the Sun-Earth system, focusing on the behavior of the atmosphere in response to the solar energy inputs to the Earth. The solar energy is mainly divided into two parts: the solar radiation involving infra-red, visible, ultra-violet and X-ray, and the solar wind whose effects are evident in a polar region.

The solar radiation becomes maximum at the equator, then atmospheric disturbances are generated in the troposphere (altitude up to 10-15 km). In particular, over Indian Ocean to western Pacific, centered by Indonesia, cumulonimbus convection is most active in the world. It further excites various atmospheric waves that propagate upward transporting energy and momentum into the upper atmosphere. Various kinds of materials (atmospheric minor constituents) originating at low- and mid-latitude regions converge into the equatorial region, and they are blown upward passing through the equatorial tropopause at about 15 km altitude into the middle atmosphere (10-100 km), and spread to the whole globe. In the upper atmosphere above 100 km, plasma disturbances and equatorial ionization anomaly are generated around the equator. We are trying to capture the energy and material flow that occur in all height ranges of the equatorial atmosphere as Equatorial Fountain.

We constructed the Equatorial Atmosphere Radar (EAR) right over the equator in West Sumatra, Indonesia in 2001 under close collaboration with Indonesian research institutes and universities; LAPAN, BPPT, LIPI, BIG, BMKG and ITB. On the basis of successive achievements with EAR, we have been promoting a project to construct a state-of-the-art large atmospheric radar that is named the Equatorial Middle and Upper Atmosphere Radar (EMU). EMU is 10 times more powerful than EAR, and it will enable us to study the behavior of the troposphere, middle atmosphere and upper atmosphere. We will also enhance collaboration with international community, inviting researchers and students to the EMU observatory in order to study together the scientific mystery of the Equatorial Fountain.

Keywords: Equatorial atmosphere, Equatorial MU Radar, Atmospheric Waves, Tropopause, Middle Atmosphere, Plasma Bubble

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PEM10-02 Room:A01 Time:May 27 16:45-17:00

Current status of Equatorial MU Radar project

YAMAMOTO, Mamoru[1*] ; HASHIGUCHI, Hiroyuki[1] ; TSUDA, Toshitaka[1]

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Research Institute for Sustainable Humanosphere, Kyoto University (RISH) has been studying the atmosphere and ionosphere 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. The EAR, however, had a limited sensitivity to the MU radar as the total output power is just 1/10 to the MU radar. Our new project is to establish ”Equatorial MU Radar (EMU)” just next to the EAR site in Indonesia. The EMU will have an active phased array antenna with the 163 m diameter and 1055 cross-element Yagis. Total output power of the EMU will be more than 500 kW. The EMU is the ”MU radar class” facility, and can detect turbulent echoes from the mesosphere (60-80 km). 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” that is one of the important project in the Master Plan 2014 of the Science Council of Japan (SCJ). We will report current status of the EMU project.

Keywords: Atmospheric radar, Equatorial atmosphere, Low-latitude ionosphere, Indonesia

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PEM10-03 Room:A01 Time:May 27 17:00-17:15

Study on Antenna Arrangement of Equatorial MU Radar for Widening Observation Angle Range

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Cumulonimbus convection is active in the equatorial atmosphere. It generates various atmospheric waves that propagate upward to transport energy and momentum into the upper atmosphere including the ionosphere. The Equatorial Atmosphere Radar (EAR) has been operated in Kototabang, West Sumatra in Indonesia (0.20S, 100.32E) since 2001. The EAR has a circular antenna array of approximately 110 m in diameter, consisting of 560 three-element Yagis. However its peak power is only 100 kW, which is 1/10 of the MU radar in Shigaraki, Japan. It is proposed to construct the Equatorial MU radar (EMU) which has the similar function and performance as the MU Radar. The antenna of EMU consists of 55 groups, and each group consists of 19 three-element crossed Yagi antennas. Its peak output power is 500 kW in total.

We investigate the optimum antenna arrangement of EMU. Antenna arrangement of the MU Radar and EAR, triangular arrangement, has a problem of generating a grating lobe when the beam zenith angle is over 40 degrees. We tried to find the optimum antenna arrangement that has no grating lobe, lower sidelobe level and simple arrangement by using optimization method of trial and error (antenna potential function method) [Nishimura and Sato, 2009]. We use this method under various restricting conditions, and get various antenna arrangements that are possible to be the optimum antenna arrangement.

We conclude that the following arrangement is the best for EMU in this method: Each group (having 19 antennas) is hexagon-shaped triangular arrangement, and groups are arranged so that each ridge of the hexagon is in parallel with ridge of an adjacent hexagon. In the best arrangement, a grating lobe is reduced by 5 dB. Therefore, it becomes possible to observe low elevation angle by using adaptive clutter rejection method [Kamio et al., 2004]. However, sidelobe levels of other directions are increased by 15 dB at most. Further investigation is needed to decide to adopt this arrangement or not to EMU.

Keywords: Equatorial MU Radar, Antenna Arrangement, Grating Lobe

Japan Geoscience Union Meeting 2015
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PEM10-04 Room:A01 Time:May 27 17:15-17:30

Years of the Maritime Continent (YMC): To better understand the weather and climate systems of the Maritime Continent

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It is time to challenge to precisely understand complicated weather and climate systems of the Maritime Continent, which hosts various atmospheric and oceanic phenomena and acts as a heat engine of the global atmospheric circulation. To meet this, a 2-year field campaign Years of the Maritime Continent (YMC) starting from mid-2017 is being proposed. Its overarching goal is to improve understanding and prediction of local multi-scale variability of the MC weather and climate systems and global impact. The following five themes are set to be key for success of the campaign; 1) atmospheric convection, 2) ocean and air-sea interaction, 3) troposphere-stratosphere interaction, 4) aerosols, and 5) prediction improvement. YMC itself is a framework which enables of coordination and collaboration to conduct several intensive observations and numerical modeling challenges among participants. Routine observations by local agencies and long-term deployed measurement systems such as Equatorial Atmospheric Radar will be bases for observation network.

Keywords: Years of the Maritime Continent, YMC, Field campaign

Japan Geoscience Union Meeting 2015
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PEM10-05 Room:A01 Time:May 27 17:30-17:45

Study of the Equatorial Atmospheric Kelvin Waves during El Nino events

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The effect of El Nino Southern Oscillation (ENSO) on equatorial stratospheric Kelvin waves is investigated using temperature data retrieved from Global Positioning System Radio Occultation (GPS RO) observations of FORMOSAT-3/COSMIC during the period from August 2006 to December 2013. Enhanced Kelvin wave activity is observed during the El Nino event of 2009-2010. The easterly winds above the tropopause during this period favored the vertically upward propagation of these waves that induced a fast descending westerly regime by the end of 2010. The zero-wind line is observed to take only 5 months to descend from 10 to 50 hPa. Meanwhile, the Westerly Wind Events (WWEs) are noticed in the western Pacific Ocean that might have participated in the occurrence of El Nino which also pushed the low OLR region into the central Pacific region. This study shows using observational data the effect of El Nino on equatorial Kelvin waves and consequently on the stratospheric quasi-biennial oscillation (QBO) through wave-mean flow interactions. Earlier El Nino events of 1987 and 1998 are also investigated, qualitatively, to understand the effects of ENSO on QBO. It is found that although El Nino events can result in enhanced equatorial wave activity, an effect is observed on QBO only when the ambient zonal winds in the lower stratosphere favor their upward propagation and consequently interact with the mean flow.

Keywords: Equatorial Atmospheric Kelvin Waves, El Nino Southern Oscillation (ENSO)

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PEM10-06 Room:A01 Time:May 28 09:00-09:30

Strateole 2: a long-duration balloon campaign at the Equator

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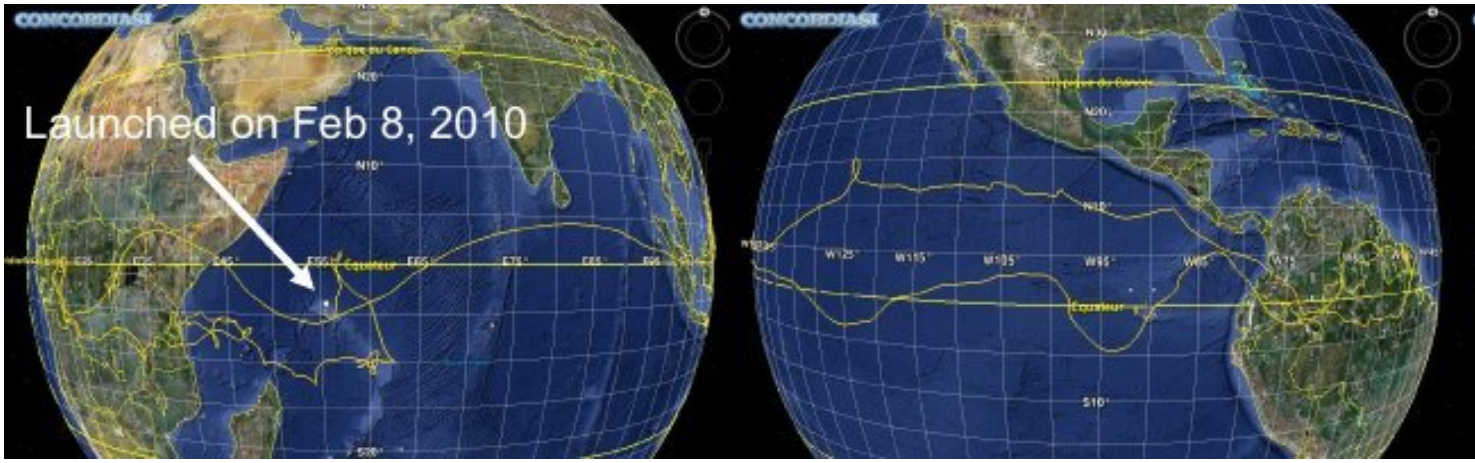
The atmospheric region located between 14 and 20 km altitude in the tropics, called the Tropical Tropopause Layer (TTL), has intermediate properties between those of the tropical troposphere and stratosphere. Air parcels that have been rapidly lofted by deep convection to the bottom of the TTL are radiatively heated in the TTL and ascends to the stratosphere within a few weeks or months. During this timeframe, the air-parcel water vapor mixing ratio decreases to stratospheric values under the influence of a number of dynamical (e.g., planetary and gravity waves) and microphysical (e.g., nucleation) processes that cover a wide range of scales. Despite recent improvements of spaceborne sensors, an accurate global picture of these processes and their interactions is still missing.

Strateole 2 is a superpressure balloon campaign design to improve our knowledge of small and mesoscale processes in the TTL. Superpressure balloons, which have been sucessfully used in previous campaigns in Antarctica (Vorcore 2005, Concordiasi 2010), can fly for several months in the lower stratosphere (18-20 km). They move with the winds on constant-density surfaces, and thus behave as quasi-Lagrangian tracers of air-parcel motions. During Strateole 2, many in-situ and remote-sensing instruments aimed at characterizing the TTL dynamics and composition will be hosted on the balloon and perform high-resolution measurements along the flights.

Strateole 2 observations will be used to document the occurrence of subvisible cirrus clouds in the TTL, as well as the mechanisms responsible for their formation. They will also serve to quantify the momentum flux associated with gravity waves generated by deep convection, and their contribution in the driving of the stratospheric quasi-biennial oscillation. Strateole 2 observations will also be assimilated by operational numerical weather prediction system to improve their representation of the upper-tropospheric lower-stratospheric circulation.

The presentation will provide a description of Strateole 2 scientific objectives and schedule. It will also show results regarding gravity-wave activity obtained during the previous long-duration balloon campaigns.

Keywords: Troposphere-Stratosphere coupling, Equatorial atmosphere, Long-duration balloon, Gravity waves



Japan Geoscience Union Meeting 2015
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PEM10-07 Room:A01 Time:May 28 09:30-09:45

Comparison of Raindrop Size Distributions in Equatorial Indonesia during Convectively Inactive and Active MJO

MARZUKI, Marzuki[1*] ; HASHIGUCHI, Hiroyuki[2] ; SHIMOMAI, Toyoshi[3] ; KOZU, Toshiaki[3] ; TAKAHASHI, Yukihiro[4]

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The variability of rainfall and drop size distributions (DSDs) as a function of MJO phases and storm characteristics is investigated using measurements from the Equatorial Atmosphere Radar (EAR) facility at Koto Tabang, Indonesia. Observations are obtained from a 2D-Video Disdrometer (2DVD) with a near continuous record of operation over eight consecutive years (2003?2010). Vertical profile of DSD is investigated using a Micro Rain Radar (MRR) measurement. Bulk rainfall characteristics are partitioned according to convective and stratiform precipitation classifications, and MJO phase. Notably, on average, the DSD during the inactive phases tends to have the higher concentration of medium and large-size drops (D >3 mm) than the active counterpart. But, the DSD during the active phase has more small raindrops with D <2 mm. The evidence of intraseasonal variation of DSD becomes more obvious during heavy rain. Differences in the DSD for the two MJO phases may indicate the difference in characteristics of microphysical process accompanying the formation and evolution of DSD during each phase. The microphysical processes are investigated using vertical profile of precipitation from 1.3 GHz wind profiler, brightness temperature from satellite, lightning from the World Wide Lightning Location Network (WWLLN), cloud properties from daily MODerate resolution Imaging Spectroradiometer (MODIS), and vertical air motion from EAR measurement.

Keywords: Raindrop size distribution, Equatorial, MJO

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PEM10-08 Room:A01 Time:May 28 09:45-10:00

Vertical coupling by convections over the Indonesian maritime continent

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Observations have shown that surface insolation, tropospheric cloud activity and stratospheric gravity waves take maxima over the Indonesian maritime continent (IMC). The cloud activity has diurnal and annual cycles dominantly on land, in contrast to intraseasonal and interannual variations mainly over oceans. The diurnal-cycle local circulation cell has a horizontal scale of around 100 km, and each major island and the whole IMC have zonal scales of 1,000 and 5,000 km, respectively. 14-year hourly 25 km-resolution cloud-top height data are analyzed to show spectral slopes of around -2 for frequency, and -5/3 and -3 respectively for higher and lower zonal wavenumbers (with a border of about 400 km in zonal wavelength), as have shown already for gravity waves.

Theoretically the insolation may excite two categories of diurnal/annual cycles in the atmosphere. One has globally continuous (day-night and summer-winter hemispheric) phase structure as tides and seasonal marches, and the other has local/regional phase structures mainly due to heat contrasts around coastlines as sea-land breeze and monsoon circulations. All of them are interacted with each other (also with equatorially symmetric Hadley circulation) over the IMC. For example, on land, clear sky from sunrise until noon permits maximum heating by insolation and makes rainy season in the hemispheric summer. The parasol effect is suppressed, because clouds are active on land in the evening. A boreal winter monsoon surge intensifies the northern Hadley cell and also diurnal-cycle rainfall in the austral summer rainy season.

The diurnal-cycle local circulation cell is a superposition of upward and downward propagating gravity waves, and the upward component is propagated toward the stratosphere. The tall cloud tops of conditionally unstable troposphere push the tropopause upward and generate gravity waves in the strongly stable stratosphere.

Keywords: Indonesian maritime continent, cloud convection, gravity waves, diurnal cycle

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PEM10-09 Room:A01 Time:May 28 10:00-10:15

THE STUDY OF CLOUD AND RAINFALL FORMATIONS AT KOTOTABANG IN SOME RANDOM CASES

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Existing of complete equipment at Kototabang space observatory stations is possible to use to study in atmospheric process. Equatorial Atmosphere Radar (EAR) gave three-dimensional wind speed data in horizontal wind (east-west and north-south directions) and vertical wind (updraft and downdraft). Development of convective cells vertically or horizontally can be detailed study with the availability of precipitation echo data from the X-band meteorological radar. EAR data with high resolution, about 8 minutes in time and 150 meters level resolution will contribute to study of the cloud formation and rainfall process. Rainfall events at January 2008, May 2011 and November 2011 that was recorded by Optical Rain Gauge (ORG) which was not initialed by vertical convection, or was not triggered by updraft previously is presumed that rainfall was from cloud that exist in mesoscale area. The rainfall from these process will have high intensity and will happen longer compare to rainfall from clouds that formed vertically above Kototabang. Rainfall from cloud under 2 km in high will create high intensity flow but in short duration.

Keywords: vertical wind, precipitation echo, rainfall, local scale, mesoscale

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PEM10-10 Room:A01 Time:May 28 10:15-10:30

Solar Activity's Role in El Nino Southern Oscillation (ENSO) and Indian Oceanic Dipole (IOD)

MUMTAHANA, Farahhati[1*] ; SULISTIANI, Santi[1] ; YAMAMOTO, Mamoru[2] ; KESUMANINGRUM, Rasdewita[1]

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ENSO (El Nino Southern Oscillation) and Indian Oceanic Dipole (IOD) are oceanic anomaly and atmospheric phenomenon in equatorial pacific and indian ocean causing global climate system variation. ENSO which is indicated by Southern Oscillation Index (SOI) describes the air pressure between Darwin (Australia) and Tahiti (Southern Pacific Ocean). Meanwhile, Indian Oceanic Dipole (IOD), shown by Dipole Mode Index (DMI), desribes the sea surface temperature difference between East region (on the West side of Sumatera) and West region (East side of Africa). Considering these events occur periodically at irregular interval, it might be triggered by the 11-years of solar cycle as an energy source. In this case, the solar activity is represented by the variability of the periodical Sunspot number (R). Changes in the rate of heating and the amount of solar energy package is presumed to be the cause of the ENSO and IOD phenomenon. In this work, we use the data of Sunspot number (R), SOI, and DMI from 1870 to 2013. Derived from those data, spectral analysis of the output energy package has been conducted in order to study its correlation with periodicity of ENSO and IOD, and also the connection between those events.

Keywords: ENSO, IOD, DMI, Sunspot number, Solar energy

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PEM10-11 Room:A01 Time:May 28 10:30-10:45

Climatology of Equatorial plasma bubbles observed from Equatorial Atmosphere Radar (EAR) - New Aspects

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Using the fan sector backscatter maps of 47 MHz Equatorial Atmosphere Radar (EAR) at Kototabang, Indonesia, the spatial and temporal evolution of equatorial plasma bubbles (EPBs) were examined to classify the evolutionary-type EPBs from those which formed elsewhere and drifted into the field of view of radar. A total of 535 EPBs were observed during the low to moderate solar activity years 2010?2012, out of which about 210 (˜39%) are of evolving type and the remaining 325 (˜61%) are drifting-in EPBs. In general, both the evolving-type and drifting-in EPBs exhibit predominance during the post-sunset hours of equinoxes and December solstice. Interestingly, a large number of EPBs were found to develop even a few minutes prior to the apex sunset during equinoxes. Further, the occurrence of evolving?type EPBs exhibits a clear secondary peak around midnight (2300?0100 LT), primarily, due to higher rate of occurrence during the post-midnight hours of June solstices. A significant number (˜33%) of post-midnight EPBs generated during June solstices did not exhibit any clear zonal drift, while about 14% of EPBs drifted westward. Also, the westward drifting EPBs are confined only to June solstices. Further, to understand the rise velocity and growth rate of EPBs, the generation and subsequent development of plasma bubbles were consistently observed and its seasonal and diurnal variation will be presented.

Keywords: Equatorial Plasma Bubbles, Equatorial Atmosphere Radar, Electric Fields, Thermospheric Neutral Winds

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PEM10-12 Room:A01 Time:May 28 11:00-11:15

Spectral parameters estimation in precipitation using VHF atmospheric radars

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Quantitative measurement of spectral parameters (e.g., echo power, Doppler velocity and spectrum width) of the clear air echo is indispensable for clarifying interactions between dynamical and microphysical processes of cloud and precipitation. Atmospheric radars using VHF band have the ability to detect clear air echoes and hydrometeor echoes simultaneously. In order to minimize the interference of the hydrometeor echoes on calculating the spectral parameters of the clear air echo, we proposed two methods (top method and two-echo method).

The top method is used when raindrops or solid hydrometeors with small echo intensity exist. The top method sets an echo cut level (ECL) from the peak level of the clear air echo. The ECL is used for separating the clear air echoes from the hydrometeor echoes. The two-echo method is used when solid hydrometeors with large echo intensity exist. The two-echo method sets the ECL from the minimum echo level between the peak level of the clear air echo and that of the hydrometeor echo. Because parts of the Doppler spectrum points were not used for calculating the spectral parameters, we also proposed functions for correcting the underestimation of echo power and spectrum width. Numerical simulations were carried out for evaluating the performance of these two methods. From the simulation results, the optimum value of ECL is determined. Also, the simulation results indicated that the two methods can calculate the spectral parameters of the clear air echo with improved accuracy.

A case of simultaneous measurement by a 46.5-MHz atmospheric radar (MU radar) and a 1.3-GHz radar during a precipitation event on 26 October 2009 is shown. The 1.3-GHz radar can measure reflectivity-weighted Doppler velocity relative to the ground (V_{air+Z}) and radar reflectivity factor (Z_e) of hydrometeors. By subtracting the Doppler velocity of the clear air echo (W) measured by the MU radar from V_{air+Z}, reflectivity-weighted Doppler velocity relative to the air (V_Z) was retrieved. Correlation coefficient of Z_e and V_{air+Z} is 0.41. After removing the effect of W, correlation coefficient of Z_e and V_Z improves to 0.56. The result indicates that W estimated using our method has sufficient accuracy. The result also indicates that the accurate W measurement is useful for measuring hydrometer fall velocity.

Keywords: Atmospheric radar, Spectral parameters

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PEM10-13 Room:A01 Time:May 28 11:15-11:30

Measurement the momentum flux by using meteor radar and expecting beampair method by EMU

SHINBORI, Atsuki[1*] ; TSUDA, Toshitaka[1]

[1]Naoki Matsumoto

In the equatorial region, atmospheric waves cause the S-QBO(Stratospheric Quasi-Biennial Oscillation) in the lower stratosphere, S-SAO(Stratospheric Semi Annual Oscillation) in the upper stratosphere and M-SAO(Mesospheric Semi Annual Oscillation) in the MLT(Mesosphere Lower Thermosphere).S-SAO and M-SAO is opposite phase.

We investigate the periodic oscillation and random variation of wind in the MLT over equatorial region by using long-term meteor radar observation in Indonesia. Especially, we focus on the peculiar phenomenon that enhance westward wind in Feb.-Apr. once in 2 or 3 years, M-QBE(Mqsosphere Quasi-Biennial Enhancement).M-QBE occur only spring but not fall. We think that there must be 1-year oscillation which restrict the M-QBE to spring.

N.V.Rao et al.[2012] reported that gravity wave enhancement coinside with westward wind enhancement. This result suggest that gravity waves drive the M-QBE. However, we have to measure the momentum flux with gravity waves to reveal the relationship between M-QBE and gravity waves.

Hocking[2005] proposed a new method that enables us to measure the momentum flux by using meteor radar. However, this method has several doubtful points, so we checked the validation.

We have two meteor radars which have the same system and which are in the neighborhood in Indonesia(Koto Tabang and Biak) on the equator. We used these meteor radar data ,calculated the momentum flux, and checked the validation in Hocking method.

We compared the data from two meteor radar, and we got the similar momentum flux results during high acquisition rate. From this result, We are succeeded to measure the momentum flux by using the Hocking method.

On the other hand, we did a composit analysis in Koto Tabang which have 12 years long-term data. This composit analysis suggests that the momentum flux has the periodicity of the half year. This result is consistent with M-SAO.

Keywords: Mesosphere and Lower Thermosphere, momentum flux, meteor radar, Equatorial MU radar

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PEM10-14 Room:A01 Time:May 28 11:30-12:00

An investigation of meteorological characteristics of ULF waves by ULTIMA global magnetometer observations

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[1]Department of Earth Planetary and Space Sciences, UCLA

The ultra-low-frequency (ULF) waves in the magnetosphere are phenomena resulting from the coupling between the solar wind and the magnetosphere as well as processes internal to the magnetosphere, such as magnetic storms and substorms, whose energy comes ultimately from the Sun and the solar wind. The known characteristics of ULF waves are mostly obtained through climatological studies that can be made by using observations from a handful of ground-based magnetometers. These long-term characteristics, however, can greatly deviate from the short-term variations of ULF waves. Behaving differently from one magnetic storm to another, the ULF waves are known to contribute to the acceleration, transport, and loss of electrons in the outer radiation belt.

This study examines the short-term variability of ULF waves observed by magnetometer arrays affiliated with the Ultra Large Terrestrial International Magnetometer Array (ULTIMA) consortium. The global coverage of ULTIMA arrays allows us to examine the meteorological features of storm-time ULF waves in different corners of the magnetosphere. We find that the Pc 5 power can vary by more than 5 orders of magnitude between quiet times and storm times. The Pc 5 wave power at the time of *Dst* maximum tends to peak at highest latitudes. In contrast, the Pc 5 wave power at *Dst* minimum is strongest at auroral and subauroral latitudes. Global magnetometer observations confirm that the enhancement in wave power can be highly variable in the inner magnetosphere, demonstrating the need for future geospace models to address the meteorological characteristics of ULF waves.

Keywords: ground-based magnetometers, ULTIMA, ULF waves, magnetosphere, magnetic storms

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PEM10-15 Room:A01 Time:May 28 12:00-12:15

Ground-based network observations of wind and temperature of the thermosphere using five Fabry-Perot interferometers

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It is well known that dynamic variation of Earth's ionosphere affects human activities in space through interference on the ground-satellite radio communications and degradation of GNSS positioning accuracy. The measurement of wind and temperature of the thermosphere is essentially important to understand dynamic variation of the ionosphere, because collision with neutral atmosphere is a dominant force to cause ionospheric plasma variation. High-resolution interferometry of airglow emissions using Fabry-Perot or Michelson interferometers is the unique technique to make remote sensing of the thermospheric wind and temperature from the ground. Since 2011, the Solar-Terrestrial Environment Laboratory (STEL), Nagoya University have been operating five Fabry-Perot interferometers (FPIs) at Shigaraki (Japan, FP00), Tromsoe (Norway, FP01), Chiang Mai (Thailand, FP02), Kototabang (Indonesia, FP03), and Darwin (Australia, FP04). They measure thermospheric wind and temperature through Doppler shift of the 630-nm airglow emission that has an emission layer at altitudes of 200-300 km. The use of 70mm-diameter etalons for FP02-FP04 makes the cost of the FPIs about three times lower than those with 116mm-diameter etalons for FP00 and FP01. By revising procedure of fringe-center determination we obtained reliable temperature of the thermosphere with accuracies of 10-40 K using these small-etalon FPIs. In this presentation, we show recent results of thermospheric and ionospheric dynamics obtained by these five FPIs.

Keywords: ground-based observation, ground-based network, Fabry-Perot interferometer, thermosphere, ionosphere, upper atmosphere

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PEM10-16 Room:A01 Time:May 28 12:15-12:30

ICSWSE/ MAGDAS Research Project-Exploration of 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. Using this global network data, we are developing many research projects as following

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.

In this talk, we will introduce our some interesting results obtained from above research project.

Keywords: ICSWSE, MAGDAS, Electromagnetic Coupling Process, Cowling channel

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(May 24th - 28th at Makuhari, Chiba, Japan)

PEM10-17 Room:A01 Time:May 28 12:30-12:45

Long-term variation of upper atmosphere using the IUGONET metadata database and data analysis software (UDAS)

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Various kinds of atmospheric and ionospheric disturbances and long-term variation of the Earth's upper atmosphere as seen in several observation parameters (electric and magnetic fields, temperature, wind, density etc.) are caused by energy input from solar radiation, solar wind, momenta and energies from the lower atmosphere via atmospheric waves, and chemical reaction. Such disturbance phenomena and long-term variation observed by various kinds of ground-based and satellite instruments are the result of such complicated physical processes. Then, in order to investigate the mechanisms of the atmospheric disturbances and long-term variation of the upper atmosphere, 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: Solar activity, Upper atmosphere, IUGONET, Metadata database, Data analysis software

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PEM10-18 Room:A01 Time:May 28 14:15-14:30

GNSS network observations of medium-scale traveling ionospheric disturbances

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Recently, GNSS (Glbal Navigation satellite system) receiver is widely used to measure total electron content (TEC). Using densely spaced GPS receivers in Japan, Northern America, Europe, Alaska, and New Zealand, we have investigated two-dimensional maps of TEC perturbations with a high spatial resolution to reveal the statistical characteristics of medium-scale traveling ionospheric disturbances (MSTIDs). We found that MSTIDs can be categorized into three groups: daytime, nighttime, and terminator MSTIDs. Daytime MSTIDs frequently occur in winter and tend to propagate equatorward and eastward in both northern and southern hemispheres. We speculate that daytime MSTIDs are caused by atmospheric gravity waves in the thermosphere. Nighttime MSTIDs frequently occur in December and June solstices and propagate southwestward in the northern hemisphere and northwestward in the southern hemisphere. This propagation direction supports the notion that polarization electric fields could play an important role in generating nighttime MSTIDs. Terminator MSTIDs frequently occur in summer and propagate eastward or north-northwestward. Comparing the MSTID occurrence rates at different longitudinal sectors, we have found that occurrence rate of the nighttime MSTIDs is high around December solstice at European longitudinal sector and around June solstice at Japan and American longitudinal sectors. From comparison with sporadic E activity, we can speculate that activity Es layer in summer hemisphere control occurrence of the nighttime MSTIDs in both northern and southern hemispheres through E and F region electrodynamical coupling. Longitudinal variation of the nighttime MSTIDs could be attributed to that of the sporadic E activity.

Keywords: GNSS, ionosphere, GPS, MSTID, ionospheric disturbance

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PEM10-19 Room:A01 Time:May 28 14:30-14:45

Temporal change of the precise EIA asymmetry in Thailand-Indonesia sector observed by a beacon receiver network

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To reveal a temporal change of the equatorial ionization anomaly (EIA) asymmetry, a multipoint satellite-ground beacon experiment was conducted along the meridional plane of the Thailand-Indonesia sector. The observation includes one station near the magnetic equator and four stations at the off-equator latitudes. GRBR-TECs from 97 polar-orbit satellite passes in March 2012 were analyzed in this study. Successive passes captured the rapid evolution of the EIA asymmetry especially during the geomagnetic disturbances. The penetrating electric field during geomagnetic disturbed days is not the cause of an asymmetry. Such rapid evolution of the EIA asymmetry was not seen during the nighttime when meridional wind mainly controlled the asymmetric structures. The EIA asymmetry had a quasi 3-day variation at 21 LT, which probably suggests the forcing from the lower atmosphere. Precise capturing of the crests' locations and the asymmetry evolution enhances an understanding of the temporal change of the EIA asymmetry in local scale. It leads to a future local modeling of the TEC prediction in Southeast Asia.

Keywords: EIA, asymmetry, geomagnetic disturbances, penetrating electric field, rapid evolution

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PEM10-20 Room:A01 Time:May 28 14:45-15:00

The Ionospheric Space Weather Mission of FORMOSAT-7/COSMIC-2

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With the success of the satellite constellation performing radio occultation experiments of FORMOSAT-3/COSMIC (F3/C), its follow-on mission, FORMOSAT-7/COSMIC-2 (F7/C2), has been planned and in progress of its construction. The follow-on mission will have 12 microsatellites distributed at 24-degree and 72-degree inclination orbits taking radio occultation signals from GPS, GLONASS and Galileo satellites. In addition to space-borne GNSS receivers, secondary payload opportunities for space weather studies are available. The secondary payloads of the first six satellites of 24-degree inclination angle have been planned, and there is a possible opportunity for the second six satellites. In this study, we propose a multiple band imager for studying the atmosphere-ionosphere perturbations and irregularities. As the radio occultation soundings provide global coverage of the ionosphere observations and give the large-scale view of the ionospheric space weather effects. The imagers proposed here, on the other hand, provide opportunity to study the small-scale ionospheric space weather effects.

Keywords: Ionospheric Space Weather, FORMOSAT-3/COSMIC, FORMOSAT-7/COSMIC-2

Japan Geoscience Union Meeting 2015
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PEM10-21 Room:A01 Time:May 28 15:00-15:15

Studies of the polar upper atmosphere from comprehensive observations and GCM simulations

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The polar upper atmosphere is the window on near-Earth space. Since the energy from the solar wind is poured into the polar upper atmosphere through near-Earth space, we can obtain information of the outer world around the Earth from some observations in the polar region. For example, the auroral phenomena are the typical ones which visualize the variations of the space environments. The polar upper atmosphere is also the mirror for the climate change. Global cooling goes on in the upper atmosphere while global warming is the advancing problem in the troposphere. Since the effects of the global warming propagate upward with increasing their amplitudes with height, some people have tried to understand the global warming or climate change from the signals in the upper atmosphere. In particular, remarkable phenomena, such as the noctilucent cloud, have appeared in the polar upper atmosphere due to the changes in the troposphere. Furthermore, recent studies have clarified the effects of the sudden stratospheric warming (SSW) on temperature and wind variations in the mesosphere, thermosphere, and ionosphere. We overview the relationships between external forcing from above and below and variations of the polar upper atmosphere. Then, the recent progress of our understandings from comprehensive observations and GCM simulations are shown. The future targets in our research project will be also shown in this presentation.

Keywords: thermosphere, ionosphere, mesosphere, EISCAT, GCM, Na lidar

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PEM10-22 Room:A01 Time:May 28 15:15-15:45

EISCAT_3D Capabilities and Status

HEINSELMAN, Craig[1*]

[1]EISCAT Scientific Association

The EISCAT Scientific Association has operated incoherent scatter radars in northern Norway, Sweden, and Finland for over three solar cycles. At present, the EISCAT Associate nations include China, Finland, Japan, Norway, Sweden, and the United Kingdom. EISCAT radars have provided new insights into a number of Geospace-related topics by directly measuring the influences of auroral particles on the ionosphere as well as the neutral atmosphere. While many discoveries have been made, there remains a good deal of uncertainty concerning the detailed aspects of the influences, especially at smaller spatial scales and shorter time scales. The EISCAT_3D project was initiated to address some of these issues. An extensive science case for the new instrument is described in the document found at https://www.eiscat3d.se/content/deliverable-36-final-version-eiscat3d-science-case .

EISCAT_3D has new completed both a Design Study and a Preparatory Phase, both funded by the European Commission. The funding for construction of the system is presently being pursued. In addition to describing the system and some of the new Geospace research that it will enable, this presentation will describe the present state of this funding effort.

Keywords: Ionosphere, Aurora, Radar

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PEM10-23 Room:A01 Time:May 28 15:45-16:00

A new perspective on atmospheric and geospace science in the Arctic with EISCAT_3D - Japan's contributions -

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

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The European Incoherent Scatter(EISCAT) radar system in northern Feno-Scandinavia and Svalbard have been playing a pivotal role in advancing cutting edge sciences in various area including atmospheric, ionospheric and geospace studies, space weather and global change. Affiliated in the EISCAT scientific association in 1996, Japanese science community has jointly contributed to understanding of the magnetosphere-ionosphere-thermosphere coupling processes using the coordinated ground-based and rocket/satellite simultaneous observations with EISCAT radars.

EISCAT_3D is the major upgrade of the existing EISCAT mainlamd radars, with a multi-static phased array system composed of one central active (transmit-receive) site and 4 receive-only sites to provide us 50-100 times higher temporal resolution than the present system. The core site will transmit signals at 233MHz with about 10MW power, and all five sites will have sensitive receivers to detect the returned signal using phased-array antenna with10,000 elements.

The construction of EISCAT_3D is planned to implement by 4-staged approach, starting from the core site with half transmitting power about 5MW and 2 receiving sites at Bergfors (Sweden) and Karesuvanto (Finland) at the 1st stage. The transmitter will be upgraded to full-scale of 10MW at 2nd stage, then another receiving sites will be constructed at Andoya (Norway) and Jokkmokk (Sweden) at the 3rd and 4th stages.

In parallel to developing design studies and the science case for EISCAT_3D, associate member countries have been making best efforts to secure their national fundings. The EISCAT_3D program in Japan was applied to the call for Master Plan 2014 as a part of 'Study of Coupling Processes in the Solar-Terrestrial System' (PI: Prof. Tsuda, Kyoto Univ.). After granted as one of 27 high-priority programs of Master Plan 2014 and 10 new Roadmap 2014 programs, National Institute of Polar Research has made a funding proposal to MEXT for EISCAT_3D, collaborating with Solar-Terrestrial Environment Laboratory, Nagoya University.

In this paper, we will overview the current status of Japan's national contribution to the EISCAT_3D program as well as the scientific targets which are focussed by the Japanese science community.

Keywords: incoherent scatter, radar, arctic, geospace

Japan Geoscience Union Meeting 2015
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PEM10-24 Room:A01 Time:May 28 16:15-16:45

Advancing Research of Coupling between Geospace Environment and Atmosphere by the EISCAT 3D Incoherent Scatter Radar

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Incoherent scatter (IS) the most advanced radio method to remotely sense the upper atmosphere and the near-Earth space. Since 1981 the EISCAT IS radars in Northern Fennoscandia provide unique measurements from the upper atmosphere in the polar regions, where forcing both by solar activity and lower atmospheric phenomena are present. The facilities are maintained by the EISCAT Scientific Association, an international research organisation registered in Kiruna, Sweden. The mainland EISCAT system consists of high-power VHF (224 MHz) and UHF (930 MHz) radars and the ionospheric modification facility (3.85 - 8 MHz) in Tromso (Norway), as well as radar receiving sites in Kiruna (Sweden) and in Sodankyla (Finland). In addition, the EISCAT Svalbard Radar (ESR) operates at 500 MHz in the polar region.

The new EISCAT 3D phased-array facility, to be built in near future, will be a 3-dimensionally imaging radar, distributed in Norway, Sweden, and Finland. It will surpass all the current IS radars of the world in technology and act as a pathfinder for other types of radar facilities worldwide. EISCAT 3D will make continuous measurements of the geospace environment and its coupling to the Earth's atmosphere in the polar region and at the southern edge of the polar vortex for the next 30 years. Planning of the new IS radar facility started with the EU-funded Design Study (2005-2009). In December 2008, the European Strategy Forum on Research Infrastructures, ESFRI, selected EISCAT 3D to the Roadmap for Large-Scale European Research Infrastructures. The preparation continued in the EU FP7 Preparatory Phase project (2010 - 2014). Currently EISCAT Scientific Association has applied EU financing in order to study together with manufacturers, the industrial implementation of the technical solution for EISCAT_3D. Construction of EISCAT 3D can start as soon as the international financing for EISCAT_3D will be in place.

The EISCAT 3D will be realised as a multi-sited infrastructure using phased-array antennas and a key aspect is the use of advanced software and data processing techniques. The science case of EISCAT 3D includes studies of atmospheric physics and global change, space and plasma physics, solar system research, space weather and other service applications, development of new radar techniques, and methods for coding and analysis. Here we give a summary of the planned characteristics and science goals of the proposed international research infrastructure, review the current status of preparations towards realizing EISCAT 3D, and give a more detailed perspective to one of the key science themes of EISCAT 3D: Coupling between geospace environment and atmosphere of Earth during high energy particle precipitation into the atmosphere.

Keywords: incoherent scatter, geospace environment, atmosphere, dynamic coupling, high-energy particle precipitation, chemistry of atmosphere

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PEM10-25 Room:A01 Time:May 28 16:45-17:00

Meteor observations with large aperture radars - an outlook for EISCAT_3D and EMU

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Meteoroids deliver various elements into the atmosphere and the meteoric dust particles are of great importance in the terrestrial atmosphere. They act as nuclei for condensation and clouds and affect various atmospheric phenomena in both physical and chemical aspects. We present highlights and experiences from meteor head echo observations conducted with the tristatic EISCAT radar and the interferometric middle and upper atmosphere (MU) radar of Kyoto University at Shigaraki, Japan. The results are used in the context of providing an outlook for meteor observations with EISCAT_3D and the Equatorial MU radar (EMU).

MU radar observations demonstrate that meteors originating from any direction down to a few degrees above the local horizon can be accurately detected with an interferometric phased array. The location of EMU at the equator therefore enables coverage of a large fraction of the celestial sphere during each diurnal cycle. A meteor observation programme at EMU operating in parallel with atmospheric measurements would give excellent overall coverage of the meteor activity and transient outbursts. We present a coverage estimation based on observations conducted with MU and show how an observation programme at EMU would complement observations with radar facilities at other latitudes.

EISCAT_3D will consist of multiple phased arrays located in northern Fenno-Scandinavia. The multi station- and interferometric design offers extended possibilities to investigate the fine details of meteoroid-atmosphere interaction processes, as well as significantly increased accuracy of meteoroid orbit determination capabilities compared to currently available radar facilities.

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

Japan Geoscience Union Meeting 2015
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PEM10-26 Room:A01 Time:May 28 17:00-17:15

Study on ion upflow based on high latitude IS radars and future EISCAT_3D

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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.

The ion upflows have been investigated with incoherent scatter (IS) radars at high latitude. Future 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 IS radars at high latitude, 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, incoherent scatter, EISCAT_3D, upper atmosphere

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PEM10-27 Room:A01 Time:May 28 17:15-17:30

Comprehensive observations on the pulsating aurora from satellite and ground-observations

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The pulsating aurora are caused by intermittent precipitations of tens keV electrons. The modulation for the pitch angle scattering take place at the magnetosphere via whistler mode wave-particle interactions. Usually, it is not possible to detect the electron flux modulation at the magnetosphere because of the small loss cone angle. On the other hand, an integration of several ground instruments provides the data for precipitating electrons. Here, we report an ideal observation for the pulsating aurora in November 2012. During the period,the pulsating aurora are observed at Tromso, Norway. The VHF radar obtained the height-resolved electron density profile during the period, which can be used to estimate the electron energy spectrum. As a result of the EISCAT observations, we identify at least 200 keV electrons precipitate simultaneously associated with the pulsating aurora. The riometer and subionospheric radio wave networks support this observation, and the radio wave network identified that the energetic electron precipitation occurred from 01 MLT to 07 MLT. During this period, the footprint of the Van Allen Probe-A satellite was very close to Tromso and the satellite observed rising tone emissions of the lower-band chorus (LBC) waves near the equatorial plane. Using the satellite observed LBC and trapped electrons as an initial condition, we conducted a computer simulation of the wave-particle interactions. The simulation showed simultaneous precipitation of electrons at both tens of keV and a few hundred keV. And the simulated energy spectrum is consistent with that derived from the EISCAT observation. From a comparison between the simulation and the observations, we specified the strong diffusion at ˜100 keV, and the propagating whistler mode waves cause further precipitation at ˜200 keV. This result revealed that electrons with a wide energy range simultaneously precipitate into the ionosphere in association with the pulsating aurora.

Keywords: pulsating aurora, EISCAT, high energy electron precipiation

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PEM10-28 Room:A01 Time:May 28 17:30-17:45

Study of the upper mesosphere and the lower thermosphere by using the sodium LIDAR at Tromsoe

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We will overview latest results obtained with the sodium LIDAR at Tromsoe (69.6N, 19.2E) in northern Scandinavia. The sodium LIDAR at Tromsoe has been operated since October 2010 for five winter seasons (October-March). About 2800 hours of neutral temperature and sodium density data, and about 1800 hours of wind data between 80 and 110 km are obtained. By utilizing the datasets, we have studied several phenomena occurring in the polar upper mesosphere/lower thermosphere. We will present results about (1) altitude variations of the semidiurnal tide, (2) sporadic sodium layer, (3) response of the upper mesosphere/lower thermosphere to sudden stratospheric warmings (SSW), (4) comparison of the neutral temperature and the ion temperature, and (5) probablity of instabilities.

We have investigated altitude variations of the semidiurnal tide using wind and temperature data, whose temporal length is longer than or equal to 12 hours, obtained by the sodium LIDAR for 62 nights. There appear two typical altitude profiles of the amplitude. We will discuss its causes. Sporadic sodium layer (SSL) is a thin (about 1 km) and dense sodium layer in the normal sodium layer with a wide horizontal extent (typically, about 300 km or so). The generation mechanisms are not well understood, in particular, in the polar upper mesosphere. We have made a case study, and will present the results. Sudden Stratospheric Warming (SSW) is a large disturbance phenomenon occurring in the stratosphere in winter due to breaking of planetary waves. We have analyzed variations of the temperature and wind above Tromsoe during the 2012 SSW interval using sodium LIDAR data, meteor radar data, and EISCAT radar data in the upper stratosphere, mesosphere, and lower thermosphere. We will present those results and discuss differences of timing of the changes at different altitudes. Over five winter observational seasons between 2010 and 2015, simultaneous observations of the sodium LIDAR and the EISCAT UHF radar at altitudes between 100 and 110 km were conducted for 43 nights (about 250 hours). We have compared the neutral temperature obtained by the sodium LIDAR with the ion temperature by the EISCAT UHF radar between 100 and 110 km. We will present the comparison results and also discuss contributions of the Joule heating. By using temperature and wind data, we have investigated probability of the convective and dynamical instabilities in the polar upper mesosphere and lower thermosphere. We will present the results and compare them with published results at middle latitudes. We will also discuss expected improvements by the EISCAT_3D to these kinds of researches.

Keywords: Sodium LIDAR, polar upper mesosphere/lower thermosphere, EISCAT radar, meteor radar, Tromsoe

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PEM10-29 Room:A01 Time:May 28 17:45-18:00

Height-dependent ionospheric variations in the vicinity of nightside poleward expanding aurora after substorm onset

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Polar ionospheric responses to a substorm onset are among the most widely studied phenomena of space physics. An initial brightening appears at the very first phase of the substorm and tends to take place at magnetic midnight or slightly earlier in the auroral oval or at its lower latitudes. After initial brightening of the aurora that is located at the most poleward side of the oval, near the polar cap boundary, the oval expands poleward and then a westward traveling surge forms.

Auroral morphology and some ionospheric parameters responding to substorm onsets have been studied with various instruments, such as the Super Dual Auroral Radar Network radars, incoherent scatter radars, and satellites, generally focusing on spatiotemporal developments of the auroral forms, the ionospheric plasma convection, and the auroral particle spectra. By contrast, this paper addresses other ionospheric parameters such as the electron density in the F region, electron and ion temperatures, and the relationships of the large-scale time-dependent aurora and electric-field structures. This approach is important for achieving further understanding of the energy budget in the magnetosphere-ionosphere-thermosphere coupled system. The analysis is directed to the height dependency of the ionospheric variations, because the ionization rate and the collision frequency significantly change with heights.

Statistical analysis was made of data from the European Incoherent Scatter UHF radar at Tromsϕ, Norway, and International Monitor for Auroral Geomagnetic Effects magnetometer for finding common features in electron density, ion and electron temperatures and relating these to currents and associated heating. This paper particularly focused on the height dependencies. Results show clear evidences of large electric field with corresponding frictional heating and Pedersen currents located just outside the front of the poleward expanding aurora, which typically appeared at the eastside of westward traveling surge. At the beginning of the substorm recovery phase, the ionospheric density had a large peak in the E region and a smaller peak in the F region. This structure was named as *C form* in this paper based on its shape in the altitude-time plot. The lower altitude density maximum is associated with hard auroral electron precipitation probably during pulsating aurora. We attribute the upper F region density maximum to local ionization by lower energy particle precipitation and/or long-lived plasma that is convected horizontally into the overhead measurement volume from the dayside hemisphere.

Keywords: ionosphere, substorm, polar region, incoherent scatter radar, aurora, Joule heating

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

PEM10-P01 Room:Convention Hall Time:May 27 18:15-19:30

Retrieval of Raindrop Size Distribution Parameters by Combining Rainfall Rate and Electromagnetic Wave Attenuation Data

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Rain attenuation of down-link radio wave signals of satellite Superbird C (144oE in orbit) and surface rainfall data are used to estimate the parameter of exponential raindrop size distribution (DSD) at Koto Tabang (KT), west Sumatera, Indonesia. Rainfall rate and temperature during rain event are measured by an optical rain gauge (ORG). The effect of rain type on path length estimation is first examined using Simple Attenuation Model (SAM) and the ITU-R. Mie extinction efficiency is calculated by assuming raindrop shape being a spherical. Result shows that taking 5 km as a constant equivalent path length for stratiform rain at KT is generally acceptable in which the model-generated attenuation has been found to closely follow the measured attenuation. For deep and shallow convective rains, the equivalent path length varies, i.e., 5-4 km and 3-2 km, respectively. Combination of specific rain attenuation and rainfall rate successfully estimated the DSD parameters of stratiform rain with steady intensity, indicated by small difference between the parameter derived from rain attenuation and that from 2D-Video Disdrometer (2DVD). For deep convective rain with a short duration, the result also showed a good agreement with the 2DVD. Low performance of the method was observed for stratiform with strong rain intensity fluctuation and for shallow convective rain, indicated by high discrepancy with the 2DVD data. This phenomenon was probably due to the bias in estimating the specific rain attenuation. The bias can be caused by a constant path length assumption throughout the rain.

Keywords: Raindrop size distribution, Rainfall rate, Rain attenuation

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E-F REGION FIELD ALIGNED IRREGULARITIES OBSERVED WITH EQUATORIAL ATMOSPHERIC RADAR AND IONOSONDE

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The irregular plasma density and velocity fluctuations often occur in the Earth's ionosphere regions. When radio signals propagate through that region, they cause a fade in received signal power known as scintillation. The generation of these plasma irregularities is one of the important manifestations of space weather. Recently, research of the mechanism and the morphology of plasma irregularities has progressed. In this study, we analyzed E and F region field aligned irregularities (FAI) observed by a VHF backscatter radar with operating frequency 47 MHz have been operated at Kototabang (0.20^{o}S, 100.32^{o}E; dip lat 10.36^{o}S), Indonesia. Seasonal variation of E and F region field aligned irregularities observation compared with sporadic E (E_s) and equatorial spread F (ESF) occurrences observed by ionosonde. The ionosonde provide various E and F region parameters such as the critical frequency of F_2 layer (f_oF_2), the critical frequency of sporadic E layer (f_oE_s), and the maximum height of F_2 layer (hmF2). We analyzed for equinox (March, April, September, and October), June solstice (May-August), and December solstice (November-Februry) of data observations during 2011-2012. We also discussed correlation between sporadic E (E_s) and equatorial spread F (ESF) occurrences to understand morphological of coupling between E and F region of the Earth's ionosphere.

Keywords: plasma irregularities, ionosphere, E-F region, coupling

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Development of MU radar real-time processing system with adaptive clutter rejection

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Strong clutter echoes from a hard target such as a mountain or building sometimes cause problems of observations with atmospheric radars. In order to reject or suppress clutter echoes, it is effective to use DCMP-CN (Directionally Constrained Minimum Power-Constrained Norm) method, which makes null toward the direction of the clutter, if we can receive signals independently from plural antennas. It has been demonstrated that the DCMP-CN method is effective to real observation data with the MU (Middle and Upper atmosphere) radar, but it was processed in off-line. The objective of this study is to implement the clutter rejection by DCMP-CN method into the on-line processing system of the MU radar. Namely, we can adaptively suppress clutter echoes in real time without changing any MU radar hardware.

The MU radar which located in Shigaraki, Shiga Prefecture, Japan is one of the most powerful VHF-band atmospheric radars, which can observe atmospheric motion and circulation between the troposphere and the upper atmosphere and which has contributed to a wide variety of research areas. Its operational frequency, occupied frequency bandwidth, and peak output power are 46.5 MHz, 3.5 MHz and 1 MW, respectively. The MU radar has an active phased array system. Its antenna consists of 475 elements of crossed Yagi antennas and is divided into 25 groups. Each group has 19 antenna elements. After installing the ultra multi-channel digital receiving system in 2004, we can receive signals from each 25 group, independently.

We cannot apply simple DCMP method for the MU radar signals. Because DCMP method suppresses clutter echoes too much to break main robe of antenna pattern in high SNR case. In order to solve this problem, Nishimura et al. supposed DCMP-CN method, which can maintain the shape of main robe with suppressing clutter echoes to add pseudonoise and demonstrated its effectiveness for atmospheric radar observations. So far we sum up independent signals without weighting from 25 channels (groups). Applying DCMP-CN method before summing enables on-line processing. Now, we are implementing DCMP-CN method into observation system and expect to show test results in our presentation. In order to apply DCMP-CN method appropriately, we have to change constraints which depend on desired SNR. Through the real observation data, we will optimize constraints. In this presentation, we have taken account of clutter echoes from only fixed targets such as mountain, but we are going to deal with airplane and meteor echoes. Furthermore, we can apply the achievement of this study to the Equatorial MU radar (EMU), which is proposed to be constructed at West Sumatera, Indonesia. The EMU system is the similar as the MU radar, but its antenna consists of 1045 Yagi antennas with 55 groups.

Keywords: Atmospheric radar, Clutter rejection, DCMP-CN method, MU radar

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PEM10-P04 Room:Convention Hall Time:May 27 18:15-19:30

Measurement of Temperature Profiles Using Equatorial Middle and Upper Atmosphere (EMU) Radar with Radio Acoust

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Because of intense solar radiation, the equatorial atmosphere involves various atmospheric disturbances with a wide range of temporal and spatial scales. The tropopause located at 15-17 km altitude separates the troposphere (0-15 km) and the stratosphere (15-60 km). There are a number of interesting phenomena in the upper troposphere ? lower stratosphere (UTLS) region, including transport and exchange of energy and atmospheric minor constituents. Thus it is important to observe structure and variations of wind velocity and temperature in the UTLS region.

We have been promoting to construct the Equatorial Middle and Upper Atmosphere (EMU) Radar in Koto Tabang (-0.204 deg, 100.320 deg), Indonesia. The EMU radar is a high power Doppler radar similar to the MU radar in Shigaraki, Japan, and it can measure three components of wind velocity up to about 25 km altitude. In addition, we plan to apply the radio acoustic sounding system (RASS) to the EMU radar. RASS is an advanced radar observation method, by combining an acoustic transmitter and a radar, to measure a temperature profile. Adding RASS in the EMU radar makes it possible to observe the height profiles of temperature in the entire troposphere and lower stratosphere with good accuracy and high time resolution.

In order to estimate a possible height range of RASS measurements in the equatorial region, we analyzed the sound propagation characteristics using ray-tracing method, assuming realistic profiles for horizontal winds and temperature. Equatorial region is known that wind velocity is relatively weak. However, the zonal winds sometimes become strong at around 5 km and 15 km altitude, and a sharp bent in the temperature gradient near the tropopause affect the RASS observation. The quasi-biennial oscillation (QBO) of the zonal winds in the stratosphere also affects the observation height range of RASS.

We summarized the effects of zonal wind and temperature on RASS measurements. We further investigated that steering of radar antenna beam and relative position between an acoustic speaker and the radar enable us to observe temperature from the ground up to height 25 km throughout a year, where the speakers should be moved along the wind direction by 200 to 500 m.

Keywords: EMU, RASS, Temperature profile, Equatrial atmosphere, Troposphere, Stratosphere

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Lidar observations of ozone profile in the tropopause region for study of coupling processes over the equatorial region

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Tropospheric ozone in the tropics zone is significant in terms of the oxidizing efficiency and greenhouse effect. However, in the upper troposphere, the ozone budget in the tropics has not been fully understood yet because of the sparsity of the range-resolved observations of vertical ozone concentration profiles.

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. 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 lidar observations started from 2004, and routine observations of clouds and aerosol in the troposphere and stratosphere are continued now.

We have installed DIAL (differential absorption lidar) system for high-resolution measurements of vertical ozone profiles in the equatorial tropopause region over Kototabang. There were many ozone DIAL systems in the world, but their systems are almost optimized for stratospheric ozone layer measurement or tropospheric ozone measurement. Because of deep ozone absorption in the UV region, the wavelength selection is important. Over the equatorial region, the tropopause height is almost 17km. So we use 314nm for on-line and 355nm for off-line using second harmonics of dye laser and third harmonics of Nd:YAG laser.

We have observed large ozone enhancement in the upper troposphere, altitude of 13-17km in June 2014, concurring with a zonal wind oscillation associated with the equatorial Kelvin wave around the tropopause[1] at equatorial region.

REFERENCES

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Keywords: coupling process, tropical tropopause region, lidar