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

MIS29-01 Room:203 Time:May 24 09:00-09:15

Equaorial Fountain

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We discuss in this paper the behavior of various processes of the equatorial fountain, on the basis of intensive observations in the tropical regions in Asia-Oceania by means of the Equatorial Atmosphere Radar (EAR) and complementary measurements.

Keywords: equatorial atmosphere, atmospheric waves, atmospheric composition, cumulous convection, plasma fountain

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

MIS29-02 Room:203 Time:May 24 09:15-09:30

Current Status of Program of the Antarctic Syowa MST/IS Radar (PANSY)

SATO, Kaoru[1*], TSUTSUMI, Masaki[2], Toru Sato[3], NAKAMURA, Takuji[2], SAITO, Akinori[4], TOMIKAWA, Yoshihiro[2], Koji Nishimura[2], YAMAGISHI, Hisao[2], YAMANOUCHI, Takashi[2]

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Since 2000, we have developed an MST/IS radar to be operational in the Antarctic and have made feasibility studies. After solving various significant problems such as treatment against strong winds, energy saving, weight reduction, and efficient construction method, we reached the final system design which is a VHF Doppler pulse radar with an active phased array consisting of 1045 Yagis. This project was authorized as a main observation plan for JARE (Japanese Antarctic Research Expedition) 52-57 in 2008, and finally funded by Japanese government in 2009. The radar construction started in late December, 2010. Here we will present hot results from this radar and discuss the uniqueness of the MST radar observation on the middle atmosphere research. The observation will continue for 13 years covering one solar cycle.

Keywords: Antarctic atmosphere, MST/IS radar, katabatic wind, ozone hole, gravity wave, polar mesospheric cloud

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

MIS29-03 Room:203 Time:May 24 09:30-09:45

Ten years on ionospheric observation with the Equatorial Atmosphere Radar

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Equatorial ionospheric observation with the Equatorial Atmosphere Radar (EAR) has been conducted since 2001, and its unique observational data has been obtained for almost one solar cycle. The EAR is sensitive to 3-m scale ionospheric irregularities, which can be regarded as a tracer of equatorial spread F (ESF) or plasma bubbles. ESF is one of the long-standing subjects in the low-latitude ionosphere particularly because plasma irregularities associated with ESF cause severe scintillation on satellite signals which results in communication/navigation outages. The rapid beam steering capability of the EAR, along with simultaneous ground-based and satellite observations, has revealed important aspects such as spatial/temporal structures of ESF and other intriguing phenomena. During solar maximum period, ESF plumes are observed just after sunset and traverse eastward until around midnight. During solar minimum period, on the other hand, the radar backscatter echoes are commonly observed around or after midnight and traverse westward, which are quite similar to the midlatitude-type irregularities observed with the MU radar in Japan. We will summarize observational results with the EAR during solar maximum and minimum periods, and discuss future potential of the ionospheric observation with the EAR.

Keywords: Equatorial Atmosphere Radar, plasma bubble, equatorial spread F, ionosphere, EAR

MIS29-04 Room:203 Time:May 24 09:45-10:00

Current status and future plan of NICT's ionospheric observations in the Southeast Asia by SEALION and GNSS-TEC

TSUGAWA, Takuya[1*], NISHIOKA, Michi[1], ISHIBASHI, Hiromitsu[1], MARUYAMA, Takashi[1], Pornchai Supnithi[2], Buldan Muslim[3], SAITO, Akinori[4], OTSUKA, Yuichi[5], YAMAMOTO, Mamoru[6], NAGATSUMA, Tsutomu[1], MURATA, Ken T.[1]

[1]NICT, [2]KMITL, [3]LAPAN, [4]SPEL, Kyoto Univ., [5]STEL, Nagoya Univ., [6]RISH, Kyoto Univ.

National Institute of Information and Communications Technology (NICT), Japan has developed the Southeast Asia low-latitude ionospheric network (SEALION) and ionospheric observation system using GNSS receiver networks in the Southeast Asia for the purpose of monitoring and researching severe ionospheric disturbances, such as plasma bubble. These ionospheric disturbances can affect satellite-to-ground radio propagation, degrade GNSS navigations, and cause loss-of-lock on GNSS signals. SEALION consists of six ionosondes, four GPS receivers, two GPS scintillation monitors, and two magnetometers, and one all-sky imager in Indonesia, Thailand, Vietnam, Philippines, and China. SEALION is a unique ionospheric observation network in having the conjugate observational points in the northern and southern hemispheres and around the magnetic equator. Developing dense GNSS receiver networks in the Southeast Asia would make it possible to reveal spatial structures and temporal evolutions of the several 100 km scale ionospheric disturbances in the wide area of 2,000-3,000 km in latitude and longitude in this Southeast Asia. We will introduce the current status of the SEALION and the GNSS-TEC observations and present some recent researches related with plasma bubbles, mid-night ionospheric irregularities, and late-afternoon periodic TEC fluctuations. A future plan of NICT's ionospheric observations and a proposal of GNSS-TEC data sharing in this region will be also presented.

Keywords: ionosphere, equator, plasma bubble, irregularity, GPS, ionosonde

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

MIS29-05 Room:203 Time:May 24 10:00-10:15

Radio and optical observations of equatorial ionosphere and thermosphere in Indonesia

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

In order to understand the coupling processes between the tropospheric activity and ionospheric disturbances and irregularities over the equatorial region, we have been operating optical instruments, VHF radar and GPS receivers at Kototabang Indonesia since 2002. Based on the observations using these instruments, following results were obtained. (1) A comparison between GPS scintillation and Earth's brightness temperature suggests that plasma bubble occurrence over Kototabang can be related to tropospheric disturbances over the Indian Ocean to the west of Kototabang. (2) Quasi-periodic poleward-propagating waves were observed in the 630-nm airglow images. These waves could be caused by atmospheric gravity waves propagating from mesosphere or lower atmosphere. (3) Following the large earthquake that occurred near Sumatra Island in Indonesia on December 26, 2004, we observed TEC variations propagating from the epicenter. These TEC variations could be caused by acoustic waves launched from the epicenter. (4) Continuous observation of the Field-Aligned irregularities (FAIs) with a VHF radar reveals that the F-region FAIs frequently occur at post-midnight between May and August during a solar minimum period.

Fabry-Perot interferometers were installed at Kototabang and its geomagnetic conjugate point, Chiang Mai in Thailand on February and June 2010, respectively in order to measure the thermospheric neutral winds at the geomagnetic conjugate points in northern and southern hemispheres. In 2009, five additional receivers for the VHF radar were installed to make radar imaging observations of the E- and F-region FAIs. We also installed three GPS receivers at Pontianak, Indonesia to measure the GPS scintillation drift velocities and compare them with the results obtained at Kototabang. We present the recent results obtained by using these instruments.

Keywords: ionosphere, thermospshere, equatorial region, plasma bubble, airglow, ionospheric disturbance

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

MIS29-06 Room:203 Time:May 24 10:15-10:30

Upper thermosphere coupling with the lower atmosphere: features revealed by the 10-year CHAMP mission

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Recently rapidly growing observations have revealed clear evidences for a close coupling between the upper thermosphere and the lower atmosphere. Some of these evidences are seen in the spatial structures (e.g. the terminator wave, the wave-4 structure), while others are more prominent in the temporal variations (e.g.16-day wave, and the Stratospheric Sudden Warming effect). In this presentation, I try to review several aspects of the coupling by focusing on results obtained from the 10-year CHAMP mission.

Keywords: thermosphere, vertical coupling, CHAMP mission

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

MIS29-07 Room:203 Time:May 24 10:45-11:00

Research Enhancement and System Establishment for Space Weather in Indonesia

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Space weather is a program to observe, assess, and forecast the space environment. Global and regional observations are both important for the space weather. The Equatorial Atmosphere Radar (EAR) is a VHF atmospheric radar located in Kototabang, West Sumatra, Indonesia. It is operated by collaboration between the Research Institute for Sustainable Humanosphere (RISH), Kyoto University of Japan and National Institute of Aeronautics and Space of Indonesia (LAPAN) since 2001. The EAR is not only used for the atmospheric studies, it has also been utilized for the studies of the ionosphere. The Grant-in-Aid for Scientific Research on Priority Areas "Coupling Processes in the Equatorial Atmosphere (CPEA)" leaded by Prof. S. Fukao (2001-2007) contributed a lot to fulfill the EAR site by installing number of supporting instruments, i.e., a meteor wind radar, an all-sky airglow imager, several lidars, 30MHz FAR radar, etc. From 2004, NICT started SEALION (SouthEast Asia Low-latitude IOnospheric Network) over Thailand, Vietnam, and Indonesia. One of the SEALION ionosondes is located at the EAR site. STE Laboratory, Nagoya University also supports us by providing several instruments of OMTI (Optical Mesosphere Thermosphere Imagers) to the SEALION and the EAR sites. Recently LAPAN runs their own project to start the space weather service in Indonesia. In relation to this movement, we have started a new project "Research Enhancement and System Establishment for Space Weather in Indonesia" since 2010 under the framework of Strategic Funds for the Promotion of Science and Technology. In the presentation we overview the project and current status, and discuss future expansion of the project.

Keywords: Equatorial Atmosphere Radar, Ionospheric study, Space weather, Strategic Funds for the Promotion of Science and Technology, Indonesia

MIS29-08 Room:203 Time:May 24 11:00-11:15

Monitoring plasma bubbles by a VHF radar for advanced use of GNSS

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Spatial gradient of the ionospheric total electron content (TEC) is one of the most important error source of differential GPS (DGPS) systems. It is especially important for augmentation systems where very high safety is required, such as a ground-based augmentation system (GBAS) or a space-based augmentation systems (SBAS).

The plasma bubble which frequently occurs in the low latitude ionosphere is one of the most important phenomena that accompany sharp ionospheric gradients. Its frequent occurrence makes it difficult to implement such augmentation systems with high availability in low latitude regions.

Among a number of techniques, the incoherent scatter radar which can directly measure electron density distribution is the most powerful but the most expensive one. Instead, we have propose a VHF coherent backscatter radar for the external ionosphere anomaly monitor.

In this study, the effects of the VHF radar monitoring for GBAS is studied by a simulation study with a 3-D ionosphere model including plasma bubbles.

The concept will be verified by using the EAR and GNSS measurements in the region.

Keywords: Equatorial Atmosphere Radar, plasma bubble, GNSS augmentation system, TEC gradient, ionosphere anomaly monitoring, field-aligned irregularities

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

MIS29-09 Room:203 Time:May 24 11:15-11:30

Lidar for equatorial atmosphere measurements

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[1]Tokyo Metropolitan University

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 most parts of this lidar system have been remotely controlled via the internet from Japan.

Recently, we are preparing DIAL (differential absorption lidar) system for ozone measurements in the tropopause region over Kototabang.

Keywords: lidar, equatorial region, cloud, aerosol, metallic layer

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

MIS29-10 Room:203 Time:May 24 11:30-11:45

Meteor echo observations by a large atmospheric radar

NAKAMURA, Takuji[1*], TSUTSUMI, Masaki[1]

[1]National Institute of Polar Research

Meteor scatter echo of VHF radio wave from 80 - 120 km altitude has been used over 60 - 70 years for wind velocity measurement for atmospheric dynamics studies and meteor flux/orbit studies for interplanetary dust studies. More recently, high power large aperture (HPLA) radars for atmospheric studies, i.e., large atmospheric radars have extensively been used to detect more faint meteor echoes, and precision of measurement, for both atmospheric and meteor science studies, has been improved significantly. In this paper, we introduce the progress of the radar meteor echo observation, and discusses possible application to the future equatorial radar system.

Keywords: radar, meteor, equator, mesosphere, atmospheric wave, atmospheric radar

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

MIS29-11 Room:203 Time:May 24 11:45-12:00

Conceptual Study of L-band new Equatorial Atmosphere Radar System

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[1]Research Institute for Sustainable Humanosphere

In this paper, the conceptual study of the extremely new style radar system will be discussed for considering the next generation Equatorial Atmosphere Radar. To monitor the wide spatial distribution of ionosphere and lower atmosphere, the pair of high-elevation antenna array facing the opposite azimuth direction is very useful. The high power antenna beam with the elevation of 10-15 degrees is required to observe the ionosphere over the geomagnetic equator. To elucidate the detailed behavior of the columns convection in the Equatorial region, Comprehensive horizontal distribution of radial wind velocity and turbulence intensity is also very important to elucidate the detailed behavior of columns convections and their impact on the atmospheric activity in TTL region. This radar enables us to monitor the radial wind velocity by detecting clear-air echo in the no precipitation conditions.

The required total power of this radar with L-band radiowave is roughly estimated to 1 MW in peak power to monitor the lower atmosphere from the atmospheric boundary layer to the tropopause region and ionosphere.

The detailed concept of this new radar system will be explained. We are very welcome to discuss the advantage/disadvantage and feasibility of this new concept radar system.

Keywords: Equatorial Atmosphere Radar, Radar System

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

MIS29-12 Room:203 Time:May 24 13:45-14:00

Innovations on radar convection dynamics and Japan-Indonesia collaboration

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Planetary fluid dynamics has two categories: (i) vortex or Rossby waves, and (ii) convection or gravity waves. Radars including UHF/VHF bands have been used as standard tools for (ii). Because (i) and (ii) are dominat respectively in mid-/high- and low-latitudes on Earth, radars are essentially important in the equatorial region. In particular the Indonesian maritime continent (IMC) is the convection center due to systematic diurnal-cycle along the warld's longest coastlines, which affects equatorial atmosphere over oceans (intraseasonal and interannual variations), mid-/high-latitudes (monsoons and teleconnections) and middle/upper atmospheres (upward propagating waves). Such significance of IMC had been already noticed far before construction of EAR, and now many radars including our HARIMAU radars have been used to clarify each category of convection dynamics. Asian countries developing far rapidly than expected before EAR construction need much accurate weather/climate predictions to sustain their development against their own vulnerability as well as global crisis. The two G20-member archipelagic nations must consider new collaborations including atmospheric science and technology.

Keywords: convection, gravity waves, cumulonimbus, climate, disaster prevention, international relationship

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

MIS29-13 Room:203 Time:May 24 14:00-14:15

Estimation of raindrop size distribution profile using EAR and BLR

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Raindrop size distribution (DSD) is important and useful to analyze precipitation microphysics and to improve the accuracy of estimating rainfall rate from the radar observation. Estimation of DSD in Koto Tabang has been done using single-frequency algorithms by Kozu et al., 2003, Renggono et al., 2006, and Marzuki et al., 2009. Now this study presents estimation of DSD using a dual-frequency algorithm with two radars, i.e., the Equatorial Atmosphere Radar (EAR) that oparates at 47 MHz to measure the back-ground clear-air motions and a Boundary Layer Radar (BLR) that operates at 1357.5 MHz to provide precipitation return. We present a comparison of DSD estimates between dual-frequency versus single frequency algorithm and some results of vertical DSD profiles using the dual-frequency algorithm.

Keywords: DSD, Radar, Equatorial atmosphere

MIS29-14 Room:203 Time:May 24 14:15-14:30

Raindrop size distribution observations with Parsivel and Micro Rain Radar (MRR) over Sumatra

MARZUKI, Marzuki[1*], HASHIGUCHI, Hiroyuki[1], YAMAMOTO, Masayuki[1], KOZU, Toshiaki[2], SHIMOMAI, Toyoshi[2], YAMANAKA, Manabu D.[3], MORI, Shuichi[3]

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The variability in the observed drop size distribution (DSD) or its integrated parameters is attributable to two main sources: instrumental effects and natural (diurnal, intraseasonal and seasonal) variability [1]-[2]. The aim of the present study is to compare the performances of various instruments, based on different measuring principles, in the rainfall-rate (R) and DSD estimates. It is also to investigate the variability of the DSD over Sumatra, Indonesia.

We collect the precipitation data by using Parsivel, Micro Rain Radar (MRR) and Optical Rain Gauge (ORG). The Parsivel disdrometer is a laser optical device which - in theory - can measure the size and fall speed of hydrometeors. The size category goes up to 25 mm, with 32 size classes of varying diameter intervals, and the velocity category

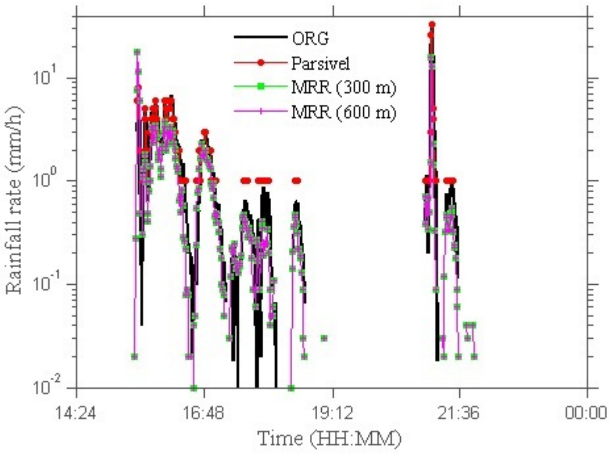
goes up to 20m/s, again with 32 classes, and again with varying velocity intervals. Parsivel provides several parameters such as rainfall rate and DSD. The instrument at Koto Tabang (Sumatra) has been installed since January 2012. In the present study, MRR data is used to classify the precipitating systems and to retrieve the microphysical parameters. The DSDs are parameterized by normalized gamma distribution [2]

Figure 1 shows an example of rainfall rate (R) time series for rain event on 11 January 2012. In general, R of ORG and Parsivel is in good agreement ($r^2 > 0.9$). On the other hand, MRR provides lower R than ORG and Parsivel. The difference in R between MRR and ORG/Parsivel is significant during heavy rain which is probably due to strong rain attenuation in the frequency of MRR (24 GHz) in this condition. Detailed analysis regarding the comparison between the instrument performance and the variability of the DSD over Sumatra will be presented in the meeting.

[1] Marzuki, Randeu, W.L., Schoenhuber, M., Bringi, V.N., Kozu, T., Shimomai, T., 2010. Raindrop Size Distribution Parameters of Distrometer Data With Different Bin Sizes, IEEE Trans. Geosci. Remote Sens. 48, 3075–3080.

[2] Marzuki, Randeu, W.L., Kozu, T., Shimomai, T., Schoenhuber, M., 2011. Raindrop axis ratios, fall velocities and size distribution over Sumatra from 2D-Video Disdrometer measurement, Atmospheric Research., doi: 10.1016/j.atmosres.2011.08.006.

Keywords: Raindrop size, Parsivel, MRR



Japan Geoscience Union Meeting 2012
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MIS29-15 Room:203 Time:May 24 14:30-14:45

Characteristics of precipitation systems associated with intra-seasonal variability observed with the EAR and rain radar

SHIBAGAKI, Yoshiaki[1*], KOZU, Toshiaki[2], SHIMOMAI, Toyoshi[2], HASHIGUCHI, Hiroyuki[3], HAMADA, Jun-Ichi[4], MORI, Shuichi[4], YAMANAKA, Manabu D.[4], FUKAO, Shoichiro[5]

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In the tropics, the dominant intra-seasonal variability with a period of 30-60 days is characterized by a large-scale convective system propagating from the eastern Indian Ocean to the western Pacific. When the ISV arrived at the mountainous region of western Sumatera, its structure and movement are suddenly changed owing to the organization of meso-scale convective system and topographic effects of Sumatera, while the evolution of meso-scale convective systems occurring over the mountainous region is strongly influenced by a low-level environmental wind associated with the ISV. In the present study, we investigated evolution features of meso-scale convective system and the associated wind behavior in relation to ISV phase, using the long-term (2002-2010) observational data of the equatorial atmosphere radar (EAR) and X-band rain radar at Kototabang over the mountainous region. In the analysis period, 110 convective events with diurnal cycle were observed within 30 km from the X-band rain radar. According to the duration and size of typical convection in each event, we classified organized convections into four convective types (long-lasting and short-lasting convective systems in meso-beta and gamma scale). In the presentation, we will describe the development and organization mechanism of each convective type in relation to the low-level environmental wind of ISV and local circulation over the mountainous region of west Sumatera.

Keywords: Equatorial Atmosphere Radar, Convective system, Intra-seasonal variability

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

MIS29-16 Room:203 Time:May 24 14:45-15:00

Vertical wind and hydrometeor characteristics measurement in and around melting layer by the EAR and polarization lidar

YAMAMOTO, Masayuki[1*], ABO, Makoto[2], SHIBATA, Yasukuni[2], HASHIGUCHI, Hiroyuki[1], YAMAMOTO, Mamoru[1], FUKAO, Shoichiro[3]

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Simultaneous measurement of vertical air velocity (W), particle fall velocity, and hydrometeor phase was carried out using a 47-MHz wind profiling radar and a polarization lidar installed at Sumatra, Indonesia (0.2S, 100.32E, 865 m MSL) in December 2008. The 47-MHz wind profiling radar, referred to as the Equatorial Atmosphere Radar (EAR), measured W and reflectivity-weighted particle fall velocity relative to the air (Vz) simultaneously. The lidar measured linear depolization ratio (LDR), which is an indicator of hydrometeor sphericity. A stratiform precipitation case on 8 December 2008 and that on 16 December 2008 were compared to describe differences of W, Vz, and LDR.

Surface rainfall intensity was greater than 2 mm/h in the 16 December case, while raindrops evaporated until they reached to the ground in the 8 December case. Upward W above the melting level was greater than 0.2 m/s in the 16 December case, while it was weak (less than 0.1 m/s) or absent in the 8 December case. Vz of 1.6 m/s at 300 m above the 0 degC altitude (5.2 km MSL) in the 16 December case was greater than the 8 December case (1.3 m/s). The thickness of melting layer in the 16 December case (900 m) was greater than the 8 December case (300 m). Because Vz is an indicator of particle size, the results suggests that the size growth of hydrometeors under the presence of upward W contributed to the formation of thick melting layer in the 16 December case. Owing to complex interfaces of water-coated ice crystal branches, LDR at the melting level increased 0.17-0.20 in the two cases. Lidar dark band was also observed in the two cases.

Vz of raindrops in the 16 December case (7.0-7.5 m/s) was greater than that in the 8 December case (3.7-3.9 m/s) due to larger sized raindrops in the 16 December case. LDR of raindrops in the 8 December case was less than 0.01, while it was up to 0.10 in the 16 December case. A possible reason for the LDR difference is discussed.

Keywords: Equatorial Atmosphere Radar, lidar, precipitation, melting layer

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

MIS29-P01 Room:Convention Hall Time:May 24 17:15-18:30

Solar activity and latitude dependence of plasma bubble occurrence in South-East Asia

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To reveal the solar activity and latitude dependence of plasma bubble occurrence, a statistical study of the rate of TEC change index (ROTI) and the radio wave scintillation was made by using GPS and beacon receiver networks in the South-East Asia (SEA) region. It is known that the growth rate of plasma bubble is large if the ionosphere is high in altitude. The more it grows the more small-scale fluctuations inside the plasma bubble affects radio signal from satellites to ground-based receivers. To clarify the altitudinal structure of the plasma bubble, and its solar activity dependence, the plasma bubble height on the dip equator (HODE) was studied using GPS and beacon receiver networks. The receivers were distributed from 20N to 10S and 98E to 109E in the geographic coordinates. The data from 2008 to 2011 are used. During this period, the solar activity increased gradually. Plasma bubble was frequently observed during the equinox seasons. In 2010 and 2011, which is in relatively high solar activity period, plasma bubble was detected at all stations from 20N to 10S. In 2009, it was detected at latitudes lower than 12N. It was the case in the September equinox in 2008. No plasma bubble was observed in the March equinox in 2008. These results indicate that the height of the plasma bubble on the dip equator depends on the solar activity. During the low solar activity period, plasma bubble cannot raise up to high altitude. In addition to these radio receivers' data, ionosondes were used to detect the occurrence of the equatorial spread-F, and the Equatorial Atmospheric Radar was used to capture the shape of the plasma bubble.

Keywords: Plasma bubble, TEC, ROTI, South-East Asia, Digital Beacon Receiver (DGBR), Equatorial Atmosphere Radar (EAR)

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

MIS29-P02 Room:Convention Hall Time:May 24 17:15-18:30

High-resolution lidar measurements of ozone profiles in the equatorial tropopause region

NAGASAWA, Chikao[1], ABO, Makoto[1*], SHIBATA, Yasukuni[1]

[1]Tokyo Metropolitan University

Stratosphere-troposphere exchange is important for the budget of ozone in the lower stratosphere as well as in the troposphere. Upward transport occurs in the tropical region, but the exact mechanism controlling the transport is not clear. We found the top height of the stratospheric aerosol layer descend with time, synchronized with the QBO in the zonal wind. The QBO signals of the aerosol layer are noticed in the altitude range from 30 to 40 km (Abo et al., 2006). In addition, the tropospheric aerosol amount observed around the tropopause over Kototabang (100.3E, 0.2S), Indonesia is much more than at mid-latitudes. They suspect that this is an evidence of active material exchange between the troposphere and the stratosphere over the equatorial region. We are preparing DIAL (differential absorption lidar) system for high-resolution measurements of vertical ozone profiles in the equatorial tropopause region over Kototabang, Indonesia.

Keywords: ozone, lidar, equatorial region, trpopause

MIS29-P03 Room:Convention Hall Time:May 24 17:15-18:30

Seasonal and local time variations of E-region field-aligned irregularities observed with 30.8-MHz radar in Indonesia

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A VHF backscatter radar with operating frequency 30.8 MHz has been operated at Kototabang, Indonesia, since February 2006. We analyzed E-region field-aligned irregularities (FAIs) observed by this radar through a year of 2007, and found that the E-region FAI observed at Kototabang can be classified into two groups. One is "descending FAI". Altitude of the FAI echo region descends with time from 102 km to 98 km altitude during 0700-1000 and 1900-0000 LT in June solstice season. The other is "low-altitude FAI", which is observed in an altitude range from 88 to 94 km mainly during nighttime. The observed Doppler velocity show distinct local time and altitude dependence. The seasonally-averaged zonal velocity above (below) approximately 94 km altitude is westward (eastward) during daytime and eastward (westward) during nighttime. Meridional/vertical velocity perpendicular to the geomagnetic fields is upward during daytime and downward during nighttime. The direction of the FAI velocity above approximately 94 km altitude is consistent with that of the background ExB plasma drifts reported previously.

Keywords: FAI, ionosphere, VHF radar, Indonesia

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

MIS29-P04 Room:Convention Hall Time:May 24 17:15-18:30

Range imaging observation of the equatorial atmosphere by the Equatorial Atmosphere Radar

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Range imaging is a technique that improves radar range resolution using frequency diversity. The Equatorial Atmosphere Radar (EAR), a 50-MHz band atmospheric radar operated with a 100-kW peak output power, has a function necessary for range imaging. In a range imaging observation mode, the EAR transmits five frequencies which range from 46.50 to 47.50 MHz with 0.25 MHz spacing. The frequencies hop every transmission. At radar subranges which have smaller interval than that determined by the transmitted pulse width, the received time series collected at each frequency are synthesized with optimized weight. For determining the weight, the Capon method, an adaptive signal processing which attains both reduced calculation cost and high accuracy, is used. Though the typical transmitted pulse width of the EAR is 1 us (i.e., 150 m range resolution), by using the range imaging, the range resolution can be increased up to several ten meters. In the presentation, an overview of range imaging using the EAR is shown. Especially, measurement results of Kelvin-Helmholtz instability in the tropical tropopause layer are focused.

Reference: Mega, T., M. K. Yamamoto, H. Luce, Y. Tabata, H. Hashiguchi, M. Yamamoto, M. D. Yamanaka, and S. Fukao, Turbulence generation by Kelvin-Helmholtz instability in the tropical tropopause layer observed with a 47 MHz range imaging radar, J. Geophys. Res., 115, D18115, doi:10.1029/2010JD013864, 2010.

Keywords: Equatorial Atmosphere Radar, atmospheric turbulence, range imaging, equatorial atmosphere

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

MIS29-P05 Room:Convention Hall Time:May 24 17:15-18:30

Development of Signal Processing Software for New Turbulence Profiler Radar

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Radar wind profiler is a useful means to measure altitude profiles of vertical and horizontal wind velocities with high time and vertical resolutions. Range imaging (RIM) is a technique that improves range resolution down to several ten meters by using frequency diversity and adaptive signal processing. RIM is useful for resolving fine-scale structure of atmospheric instability such as Kelvin-Helmholtz billows. Therefore RIM can be used for realizing new turbulence profiler radar. Further, oversampling capability is necessary to avoid the range weighting effects caused by finite transmitted pulse width. In order to develop an algorithm that detects small-scale turbulence automatically, we are developing a software using Python with SciPy and NumPy libraries.

Data collected by USRP2 (Universal Software Radio Peripheral 2) and LQ7 transmission system will get through the online signal processing which executes ranging, pulse decoding and coherent integration. In offline signal processing, clutter signal is removed using DC removal (using scipy.fftshift and scipy.fftpack) and high-pass filtering by running mean (using numpy.mean). In spectral parameter estimation, the following procedures are taken. (i) Noise level calculation, (ii) 5 points running mean to the Doppler spectra, (iii) peak search, (iv) determination of continuous Doppler velocity range where received power is greater than threshold, and (v) spectral parameter estimation using the moment method. In the all procedures, numpy.where and numpy.max are used. In the presentation, we show detailed measurement results.

This research is supported by Adaptable and Seamless Technology Transfer Program through Target-Driven R&D (A-STEP) Exploratory Research (Research No. AS232Z00186A).

Keywords: radar, turbulence

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

MIS29-P06 Room:Convention Hall Time:May 24 17:15-18:30

Characteristics of diurnal precipitation cycle over Indonesia using 1.3-GHz wind profiling radar network

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Variations in the diurnal precipitation cycle over equatorial Indonesia were investigated using 1.3-GHz wind profiling radars (WPRs) and rain gauges located at Pontianak (109.37E, 0.00S), Manado (124.92E, 1.55N), and Biak (136.10E, 1.18S). These WPRs were installed in the project of Hydrometeorological ARray for ISV-Monsoon AUtomonitoring (HARIMAU) on February 22, 2007, Setptember 18, 2009, and March 11, 2007, respectively.

Since 1.3-GHz WPR is high-sensitive to hydrometeor, the precipitation cloud type can be classified from vertical profile of vertical beam Doppler velocity and spectral width observed by WPRs for each precipitation observed by rain gauges. At all three WPR sites, peak rain rate was detected during 1300-1500 LT by rain gauges. WPR observations showed that deep convective clouds were predominant during that period. There was a clear difference in the afternoon-to-evening precipitation among the three WPR sites. At Pontianak, there was a clear transition from the convective-type clouds to the stratiform-type clouds during 1500-2000 LT. The afternoon-to-evening precipitation has the characteristics of a mesoscale convective system (MCS). At Manado and Biak, the peak rain rate in the early afternoon was characterized by a short period (within 3 h), and the precipitation after the convective precipitation was not clear.

Tbb data showed that the horizontal scale of cloud systems differs from Pontianak to Manado and Biak. The horizontal scale of the landmass around Pontianak is more than 100 km, while that of Manado and Biak is 10-100 km. The diurnal precipitation cycle was also investigated using 11 years of Tropical Rainfall Measuring Mission (TRMM) data. TRMM data showed that the midnight to morning precipitation at Biak was caused by northward propagation of cloud system from northern coastal region of New Guinea Island. The rain rate peak was distributed in the land region of peninsula in Sulawesi Island, and the whole region in Biak Island.

At Pontianak, zonal wind variation was dominant below 1.5 km, which can be explained by sea-land breeze of Borneo (Kalimantan) Island. At Manado, zonal and meridional wind variation below 1 km can be explained by the sea-land breeze of Sulawesi Island, and the wind variation of meridional component in 1-3 km can be explained by return flow of sea-land breeze. At Biak, meridional wind variation below 2 km altitude was dominant, which can be explained by sea-land breeze of New Guinea (Papua) Island, not of Biak Island itself. At Biak, the diurnal variation of meridional wind was suggested to make a convergence in the lower troposphere, and acts an important role in northward propagation of precipitation system from northern coastal region of New Guinea Island. At Manado and Biak, upward atmospheric motion clearly increased in the daytime, which suggest that upward atmospheric motion plays an important role in the daytime precipitation.

The relationship between horizontal scale of landmass and precipitation feature from afternoon-to-evening was discussed based on this study and previous studies. In the case of landmass with a horizontal scale of less than 10 km, afternoon precipitation is not predominant. In the case of landmass with a horizontal scale of 10-100 km (like Manado and Biak), even though afternoon precipitation caused by localized convection occurs, cumulus convection is not well organized enough to produce a stratiform region after the peak of the deep convective rain rate. In the case of landmass with a horizontal scale of more than 100 km (like Pontianak), cumulus convection is well organized enough to produce a stratiform region of MCS in the afternoon to evening precipitation.

Keywords: Maritime Continent, Precipitation, Diurnal variation, Wind Profiler

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

MIS29-P07 Room:Convention Hall Time:May 24 17:15-18:30

Study on mountainous enhancement to the precipitation systems in Indonesia by using an X-band Doppler radar

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West Sumatera is located in the western part of Sumatera Island. This region is facing directly to the Indian Ocean. West Sumatera has a complex topography which is including mountainous areas, particularly in the area near Bukit Barisan. Heavy rain occurs frequently in this region. Some studies have suggested this extreme event was caused by orographic rain, the amount of precipitation that forced to deposit due to mountain blockage.

The purpose of this study is to figure out the behavior of orographic precipitation in West Sumatera. The data of X band doppler (XDR) radar will be employed. The XDR was installed at Sungai Puar (0.36_S, 100.41_E, 1121 m above mean sea level), located 20 km to the south-southeast of the EAR site at Kototabang (0.20_S, 100.32_E). The XDR collected three-dimensional reflectivity and Doppler velocity data every 4 min, through a series of conical scans with antenna elevation angles from 0.6 degree to 40 degree. The observation range of the XDR is 83 km in radius (Kawashima et al., 2006).

The data obtained during 10-22 April, 2004, was chosen for this study. The results shows that strong precipitation occurred at some high altitude areas. The temporal variability of precipitation shows that heavy rainfall occurs frequently in the afernoon.

Keywords: radar, orographic, precipitation, enhancement

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

MIS29-P08 Room:Convention Hall Time:May 24 17:15-18:30

Averaged images and seasonal variation of atmospheric boundary layer observed by Lower Troposphere Radar

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The atmospheric boundary layer (ABL) is defined as an atmospheric layer in which the turbulence flow generated by the effects of friction of the ground dominates. ABL is one of the most important atmospheric layers that has direct influence on our life, and has the different feature in each region by topographic effects. Therefore, it is very important to measure the atmospheric motion of ABL in each region, however, the atmospheric motion of ABL has not been fully investigated because of its immense complexity.

One of powerful tools for exploring ABL is Lower Troposphere Radar (LTR) developed by Kyoto University. LTR radiates the pulse-modulated radio wave with the center frequency of 1.35GHz and can detect the turbulence with spatial scale of about 10 cm. Based on the information of echo power and Doppler shift of received signal, we can know the turbulence structure constant and back ground 3 dimensions wind velocity from a few hundred meters to about 10 km in altitude, respectively. In addition, the spectral width of received signals gives us the information of intensity of vorticity. The range resolution which is decided by the pulse width of radio wave is a few hundred meters and the temporal resolution is a few minutes. There is no other observing tool which can realize so highly resolved observation of ABL.

We analyzed LTR data obtained at Shigaraki MU observatory in Japan from 2000 to 2006. In order to investigate the averaged images of ABL under clear air condition, the daily average of wind velocity, echo power and spectral width were calculated by using the data obtained in the case of clear sky. As the results, it is clarified that the altitude of top of ABL reaches 1 km in winter and more than 2 km in the condition of summer. In daytime, the obtained averaged images show the turbulence structure constant is strongest at around the top of ABL and a region where large spectral width is observed exists under the region where the strong turbulence structure constant is observed. In addition, we found that the downward flow with the velocity of a few 10 cm/s grew up and was maintained in daytime ABL. This downward flow was observed in all seasons, however, seemed to be strongest in summer. Moreover, we also found that upward flow was almost always observed after ABL dissipated at sunset.

In order to explore the relationship between the information obtained by LTR and physical state of atmosphere, we compared the LTR data with radiosonde data which was obtained at Shigaraki MU observatory. As the results, it was shown that there are a lot of cases showing the altitude dependency of turbulence structure constant agrees roughly with that of mixing ratio. In the result obtained at about 11:45 (JST) on August 15 in 2001, the turbulence structure constant and mixing ratio had peaks at around the top of ABL (~2km), in addition, the potential temperature became high locally at this altitude. The downward and upward flows seemed to be generated at the altitude, which implies the downward flow observed in daytime ABL is generated by condensation of water vapor.

Keywords: radar, atmospheric boundary layer, troposphere

MIS29-P09 Room:Convention Hall Time:May 24 17:15-18:30

Rain Formation observed with EAR-RASS, X-band meteorological radar and other instruments over west Sumatera

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The high-temporal-resolution measurement of three dimensional wind velocities, temperature and rain intensity is very important to unveil mechanism of convective activity in the Equatorial region. Kototabang (KTB) in West Sumatera, Indonesia is one of the most ideal observational location to study these phenomena, because various atmospheric instruments to measure such parameter are installed almost over one of the most convective region. This study focuses on clarifying the behavior of convective activity statistically, and to elucidate the effect of meso-scale convective activity on the generation of localized rain at KTB.

In three EAR-RASS campaign periods (2 to 28 November 2002, 10 April to 5 May 2004 and 10 November to December 9, 2005), EAR was continuously operated in RASS mode to measure virtual temperature and three dimensional wind velocities with the temporal and height resolution of a few minutes and 150 m, respectively. From the data of precipitation echo and wind velocity, the effect of the localized circulation due to the topography of KTB on the convection is very small, and most of rainfall event are due to meso-scale convective activities. Meso-scale rain clouds were firstly formed windward from KTB, and the decaying rain cloud, which brings rainfall over ˜30 mm/hour, frequently passed over KTB. From the EAR-RASS data it is found that the passage of raincloud was well correlated with the variance of virtual temperature, although the correlation with the zonal and meridional wind velocities is not recognized. The weather radar reflectivity at 2 km did not well correspond to the rainfall data on the ground. This result suggests that the strong clouds exists below the height of 2 km.

Keywords: RASS, X-band meteorological radar, Convective activity in the Equatorial region

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

MIS29-P10 Room:Convention Hall Time:May 24 17:15-18:30

Large scale influence on precipitation propagation over Indonesia

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Mechanism of organization of cloud clusters (CCs) over Indonesian Maritime Continent (IMC) is linkage between its complex geographical variation and large-scale atmospheric structure/circulation. Super cloud cluster (SCC), which is recognized as eastward-propagating envelopes of convection, composed of westward-propagating CCs in mesoscale [1]. In this study, the relationship between statistical properties (zonal span, duration, and propagation speed) of cloud episodes/streaks in Hovmoller space and vertical shear of horizontal wind, convectively coupled Kelvin waves and Madden-Julian oscillation (MJO) is investigated.

Ten years of hourly infrared (IR) brightness temperature (T_b) are used to study the cloud episodes/streaks over the IMC. To estimate the statistics of cloud streak, a 2D-autocorrelation function is applied to the data in the Hovmoller space [2]. Daily interpolated OLR data are used to diagnose the MJO and Kelvin wave during the interest period. The MJO is diagnosed using a 30-96 days bandpass Lanczos filter on daily OLR anomalies following [3]. The Kelvin wave filtering retains eastward-propagating OLR signals within the 2.5-20 day period and wave numbers 1-14 [4].

Table 1 shows a summary of all streak characteristics in the 10ˆo S- 10ˆo N band for four classified months. In general, westward moving streaks are dominant, longer span and move faster than eastward moving streaks. Seasonal variation is also observed. The relationship between statistical properties of cloud episodes and large scale influence (e.g., MJO, Kelvin wave) will be presented in the meeting.

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Keywords: Precipitation propagation, Large scale, Indonesia

Table 1: Summary of all streak characteristics in the 10^oS-10^oN band for four classified months.

Characteristics	DJF	MAM	JJA	SON
Westwarad				
No.	2839	2576	2383	3033
Mean speed (m/s)	-16.8	-16.4	-17.1	-16.6
Mean duration (h)	9.3	9.0	9.6	10.1
Mean span (km)	507.8	482.5	538.5	546.5
Eastward				
No.	1147	1058	635	733
Mean speed (m/s)	16.0	14.8	16.1	15.3
Mean duration (h)	7.4	7.9	7.4	7.3
Mean span (km)	381.6	373.4	396.5	365.3
Ratio	2.5	2.4	3.8	4.1

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

MIS29-P11 Room:Convention Hall Time:May 24 17:15-18:30

Multiscale Features of Line-Shaped Precipitation System Generation in Central Japan during Late Baiu Season

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Multiscale structures near the line-shaped precipitation systems observed around Osaka Bay on 2 and 5 July 2006 were analyzed using observational data and a numerical model. In both cases, a cold front extending from a meso-alpha-scale cyclone in the Sea of Japan moved eastward over central Japan, and just before its passage a meso-beta-scale low (named Tokushima small low) formed over the eastern part of Shikoku Island in the warm sector of the meso-alpha-scale cyclone. On the eastern side of Tokushima small low, the southwesterly below 900-hPa level was intensified (-15 m/s) in the warm sector, and it converged with westerly on the western (cold) side of the cold front. Clockwise rotating vertical shear was produced between this southwesterly and the Baiu jet (20?30 m/s) around 700-hPa level. The stability over Osaka Bay was decreased in warm-moist air transported by the southwesterly (equivalent potential temperature $>$ 345 K at 950-hPa level and $<$ 335 K at 600-hPa level). In addition, meso-gamma-scale lee waves were generated by the westerly on the western side of the cold front flowing over the mountains (Awaji Island and Rokko Mountains) surrounding Osaka Bay, and they triggered the development of the line-shaped precipitation system around Osaka Bay. A Tokushima small low was generated in four cases among 15 cases of meso-alpha-scale cold fronts that passed in July during 2003 to 2007. An intense precipitation system related to Tokushima small low was observed only in the two cases.

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

MIS29-P12 Room:Convention Hall Time:May 24 17:15-18:30

Measurements of wind variation in surface boundary layer with tilted 1.3GHz wind profiler

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This study aims to elucidate the effects of local wind field in the surface boundary layer. In this study, tilted 1.3 GHz wind profiler and fine mesh numerical model are used to investigate behavior of wind field and large eddy in the layer. The wind and large eddy are changed in a short time, and warm or cold air is mixed near surface. These are important parameter to understand lower troposphere phenomena. Many studies depend on tower observations; therefore it is not understand widely distribution of changing wind in surface boundary layer.

In this study, to reduce the minimum height of observation, the antenna of the wind profiler is tilted from the ground surface. Three radar beams are used to observe radial wind in the boundary layer. It is appear to non-uniform system.

We also use the fine mesh numerical model called Large Eddy Simulation. The domain of this numerical model is from several meters to several kilometers, and can predict the airflow over complex terrain with high precision. Model domain used 50 m resolution topography data. This topography data was provided from Geospatial Information Authority of Japan. We compared simulation and observation result to appear the phenomena of the surface boundary layer.