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)

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

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

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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

Japan Geoscience Union Meeting 2012
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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

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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

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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.

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Keywords: radar, turbulence

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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

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

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

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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

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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

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

HIGASHI, Kuniaki[1*], YASUTOMO, Kiyohara[2], MANABU, Yamanaka D.[2], YOSHIAKI, Shibagaki[3], MASANORI, Kusuda[4], TAKESHI, Fujii[5]

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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.

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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.