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

1. Fujiwara, M. et al., JGR, 103, D15, 19,173-19,182, 1998.

Keywords: coupling process, tropical tropopause region, lidar