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Vertical Wind Profiles in Precipitating Cloud System observed with Equatorial Atmosphere Radar (EAR)

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1. INTRODUCTION

Several algorithms to retrieve latent heat profiles using TRMM PR have been developed in these years. Precipitation Radar Heating (PRH) algorithm proposed by Sato (2004) has unique characteristics; utilizes only the PR data, no need any assistance from model outputs, and can apply for all the area observed with TRMM satellite. In order to study intraseasonal variation of Asian monsoon system, we have established TRMM PR dataset including latent heating profiles retrieved by the PRH, with resolutions of 2.5 x 2.5 degrees and every 10-day interval (Mori et al. 2002). The PRH, however, needs to estimate vertical wind profile in precipitating clouds implicitly and it is an essential factor to retrieve the latent heating profile. It is important, therefore, to validate vertical wind profiles estimated by the PRH with those observed by another independent method. Currently, we have started to make a comprehensive and independent dataset of vertical wind profiles observed with Equatorial Atmospheric Radar (EAR) to validate those estimated by the PRH.

2. DATA AND METHOD

The EAR, installed in June 2001 at Kototabang (0.20S, 100.32E, 865 m MSL) over Sumatera Island, Indonesia, is a VHF atmospheric radar system that can observe vertical wind profiles directly up to a height of approximately 20 km with high time and vertical resolutions (1.5 minutes and 150 m, respectively) in both clear air and precipitating clouds. We made statistics of vertical wind profiles observed with the EAR for four years (June 2001 - May 2004) which were sorted out by local time, month, year, and reflectivity profile patterns observed with a boundary layer radar (BLR).

The BLR installed at Kototabang is an UHF atmospheric radar and can observe rainfall reflectivity up to 6.5 km with a similar resolutions of the EAR. The BLR reflectivity profiles are partitioned into four categories; stratiform, combination of stratiform and convective, deep convective, and shallow convective rainfalls based on Renggono et al. (2001) technique. Because the EAR spectrums have already smoothed over every 10 minutes, we chose the BLR reflectivity profiles for analysis when they show one category up to 10 minutes continuously. Period of analysis in this study is a later part of the first CPEA (Coupled Process of Equatorial Atmosphere) campaign observational period (April 10 – May 09 in 2004).

3. RESULTS

Contoured frequency by altitude diagrams (CFADs) of vertical wind derived from the EAR are depicted for stratiform and convective rainfalls classified by the BLR reflectivity profiles. The vertical wind profile in stratiform rainfall shows upward (downward) current centered at 8 km (4 km) in the upper (lower) troposphere with a maximum frequency at approximately 0.1 m/s (-0.1 m/s). This general property is consistent with that in the typical stratiform rainfalls in tropics (Houze 1982). On the other hand, that in convective rainfall shows weak upward current centered at around 10 km, however, also shows weak downward in the lower troposphere. This property of the vertical wind profile is somewhat inconsistent with that in the typical convective rainfalls as shown by Houze (1982). The CFAD for convective rainfall shows low distribution frequency in general In comparison with that for stratiform rainfall, this suggests the vertical wind profiles for convective rainfall vary much widely in each case.

Vertical wind profiles averaged for each convective rainfall event are depicted to confirm their variability. The profiles differ each other much in comparison with those for stratiform rainfall. This suggests we need classify the profiles for convective rainfall in detail, e.g., for each precipitating event, for each developing stage of precipitating cloud system.

4. SUMMARY

Vertical wind profiles in precipitating cloud system observed with the EAR are analyzed in terms of rainfall types classified by the BLR over Sumatera Island, Indonesia. The CFADs of vertical wind profiles for stratiform rainfall show a distinct property similar to those in the foregoing studies. That for convective rainfall, however, varies much and does not show a typical property consistent with those in preceding studies as an averaged result. The vertical wind profiles, in particular, in convective rainfalls vary significantly among case by case. We, therefore, will present vertical wind profiles in each precipitating event for each rainfall type, those in each developing stage of precipitating cloud systems, and comparison with those of TRMM PRH products on the session.

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