Radar rainfall analysis in the middle of Indochina peninsular

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Abstract. The method of measurement a radar rainfall is studied using both a standard Z-R, B=200 and β=1.6, and a calculated Z-R. A temporal average of radar rainfall shows a good statistics between the radar rainfall (RR) and the gauge rainfall (RG). The calculated Z-R parameters in September 2009 are 18.51 and 1.96 for B and β respectively. Using a calculated conversion factor (C.F) from the calculated Z-R shows a good result of validation of RR and RG. Rainfall pattern shows a high rain rate and high standard deviation of daily mean of rainfall near the Annam range.

Keywords: Weather radar, Rainfall, Indochina peninsular

1. INTRODUCTION

A lack of high frequency for both spatial and temporal rainfall observation in Indochina peninsular is the one of the main reasons of the slow development in the advanced knowledge of climatological rainfall. Besides, this region has always suffered from the rainfall variation in which flood is the main problem during the monsoon season. This study is intended to implement the method of using radar reflectivity with gauge rainfall to measure an accurate radar rainfall. The Z-R parameters, is studied of both standard Z-R, and calculated Z-R. Some aspect of spatial rainfall pattern is also investigated.

2. DATA AND METHOD

The weather radar is located in Vientiane, Laos, (102°34'14.2", 17º58'15.9") at 168 meters above mean sea level using C-band belonged to Department of Meteorology and Hydrology (DMH) Lao PDR. There are two observation distances, which are at 120 km as short observation and 400km as long observation as shown in Fig 1a. A volume scan of radar observation consists of these two observations, which are used to create a CAPPI (Constant Altitude Plan Position Indicator) at 3 km. There are four of volume scans in an hour. The rain gauge is delivered from Thai Meteorological Department (TMD), which has 259 gauges within 250 km of radar observation radius as shown in Fig.1b. The period of study is September 2009.

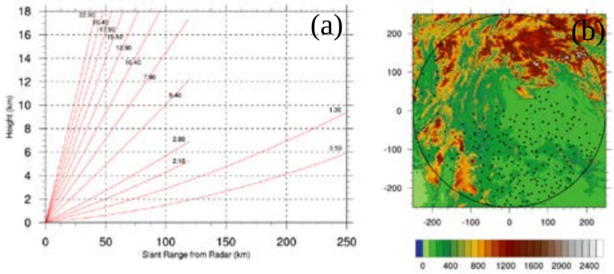

Fig. 1. (a) range-height diagram (b) topography, radar radius and gauge rainfall distribution

3. RESULTS AND DISCUSSION

3.1 Z-R variations

The Z-R parameters may change by temporal variation due to a drop size distribution (DSD) depending on a cloud type. Therefore, The Z-R parameters are computed based on a method mentioned in Yokoi et.al (2012). The parameters are iteratively computed for each pentad and for September 2009 until it converged to a threshold. The derived Z-R parameters are used to convert radar reflectivity into RR. The Z-R parameters of each pentad are ranged from 10 to 25 for B except for the pentad54 which had a storm during the observational period. The β values are averagely 2.0 of each pentad. The calculated B and β of September 2009 are 18.51 and 1.96.Since, we do not consider the DSD from different cloud types, the calculated B value is much relatively smaller than observed by Fujiwara (1965).

3.2 Conversion Factor

The derivation of an accurate radar rainfall is our main purpose for this study. Therefore, the slope and y-intercepted axis between RR and RG are calculated as the conversion factor. The RR converted by standard Z-R and the calculated Z-R of September 2009 are calculated with a corresponding RG to find C.F as shown in Fig.2a and 2c. The RMSE and bias of before applying C.F. of using the calculated Z-R is much smaller than using the standard Z-R. The new RR of both calculations is calculated by using the calculated C.F. The bias value after applying the standard Z-R is nearly zero but the R value is higher than using the calculated Z-R. We consider that using

C.F. of the calculated Z-R shows an acceptable radar rainfall even the bias still exists and some of new RR becomes a negative value because of negative y-intercepted axis.

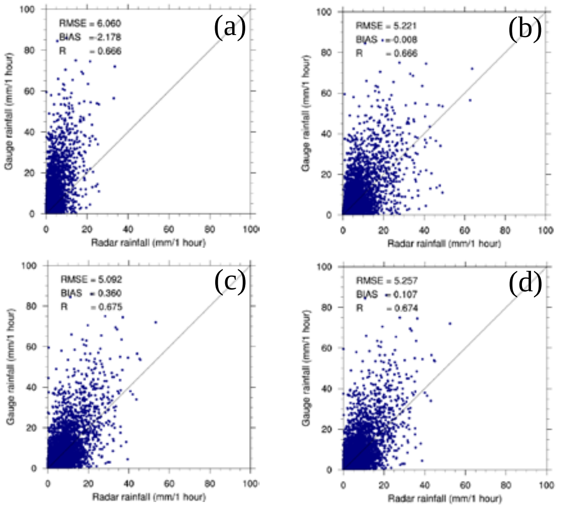

Fig. 2. (a) and (b) before and after applying C.F of the standard Z-R (c) and (d) before and after applying C.F of the calculated Z-R

3.3 Radar rainfall of a different Z-R

We attempt to find an optimal Z-R, which is best suited for our purpose. Therefore, we investigate by choosing the pentad50. Some of the existing Z-R parameters are selected including the calculated Z-R of pentad50 to calculate RR. The results (not shown here) of using the calculated Z-R is as good as using B=230 and β=1.1. The result of using standard Z-R shows the underestimate of radar rainfall. We conclude that our calculated Z-R is suitable and practical for estimating RR after validating with RG.

3.4 Temporal average

The results of C.F based on hourly rainfall as shown in Fig.2b and 2d are still not satisfied for the purpose because of its wide scattered points on the scatter diagrams. Therefore, the temporal average of both RR and RG has been applied to decrease the characteristics of scattering points from hourly-based rainfall. The RR converted by the standard Z-R and the calculated Z-R are accumulated as a temporal average of 1, 3, 6, 12 and 24 hours of September as well as RR. The R value of using a longer accumulation time of both Z-R parameters shows a strongly positive correlation between RR and RG as shown in Fig.3.Nevertheless, the scattered points of using the standard Z-R show an underestimate of radar rainfall to gauge rainfall. The RMSE and bias of using the calculated Z-R are smaller than using the standard Z-R. The daily-based result is satisfied for the purpose to use for studying rainfall pattern in the region.

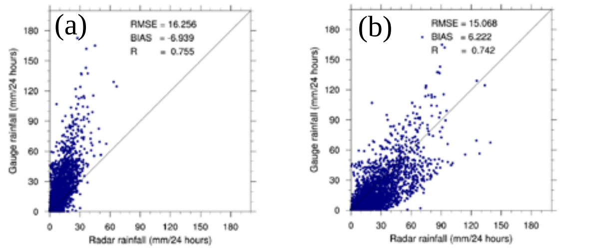

Fig. 3. The temporal average **(**a) the standard Z-R of 24 hours (b) the calculated Z-R of 24 hours

3.5 Spatiotemporal rainfall

An assumption needed to be proved is whether the rainfall pattern of this region is induced by the geographical terrain. Thus, the accumulated daily radar rainfall is calculated for September 2009 to find a daily mean of RR as shown in Fig. 4a.The RR is converted by using C.F of the calculated Z-R. Compared with geographical terrain, there is a high rainfall rate shown in the northeast of radar site where the Annam range is located. The standard deviation of the mean daily radar rainfall shows the existence of a high fluctuation of rainfall rate near the foot of Annam range to the easternmost of radar site (not seen here) as well as the southernmost part of radar site as shown in Fig. 4b. We are doing a meteorological study to explain the results.

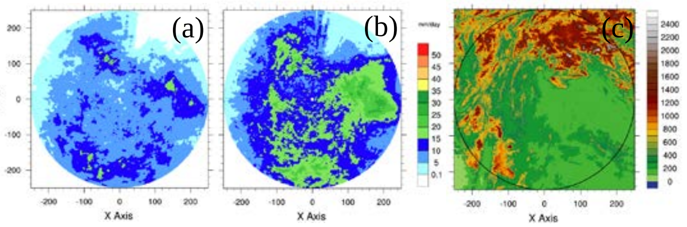

Fig. 4 (a) Daily mean of radar rainfall (b) standard deviation radar rainfall by using the calculated Z-R (c) Geographical terrain and radar radius

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