Rainfall Estimation from Radar in different seasons over Northern Thailand

P Aumjira And P Trivej

Department of Earth Science, Faculty of Science, Kasetsart University, Bangkok, Thailand

Email: fscipntr@ku.ac.th

Abstract. Thailand was located on the path of the tropical cyclones which were formed in the South China Sea and the Pacific ocean. The storms in Thailand are often downgraded to tropical depression. Northern Thailand has a tropical climate which can be divided into three seasons: rainy (May–October), winter (October–February) and summer (March-May). The averages rainfall is around 1,200–1,600 mm/year influenced by the two types of the monsoon winds. Northeast monsoon brings the cold and dry air mass from China to cover the major part of Thailand. Southwest monsoon brings the warm and moist air mass from the Indian Ocean toward Thailand causing abundant rain over the country. The objective of the research is to evaluate Z-R relationship ($Z = AR^b$) for rainfall estimation in different seasons. This study uses reflectivity data from Omkoi radar station in Chiang Mai Thailand and rainfall data in the radius of 240 kilometers from the Omkoi weather radar station from the Thai Meteorological Department. The method for matching reflectivity data (Z) and rainfall rate (R) relationship is PMM (Probability Matching Method). The result show that the Z-R relationship in the rainy season is $Z = 103.83R^{1.51}$ and the Z-R relationship in summer and winter is $Z = 102.18R^{1.46}$. For the same rainfall intensity, reflectivity value in summer and winter season is higher than in the rainy season. This research shows that each type of monsoon wind causes different characteristics of rainfall. Thus rainfall estimation for different seasons should be based on the different Z-R relationship for more accuracy.

1. Introduction

Thailand climate is influenced by monsoon winds that have a seasonal character as represented in figure 1. The rainfall amounts vary according to the cause and type of cloud. The most rain occurs in Thailand from the cumulus, cumulonimbus and nimbostratus. Cloud types have a physical difference in rainfall intensity, raining area, raindrop size distributions. Stratiform cloud in family of nimbostratus, rainfall product the highest raining area and lead to heavy rainfall. Most will be influenced by the air front and cumuliform cloud in family cumulonimbus cloud, product heavy rainfall around the centers of rain cell and few rainfall at the area far away center.[1]

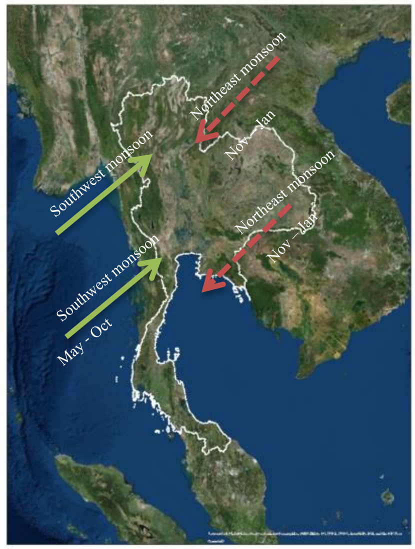


Figure 1. Monsoon in Thailand

2. Used Data

The study area is Omkoi weather radar station range around 240 kilometers cover 10 provinces in the northern Thailand as figure 2.

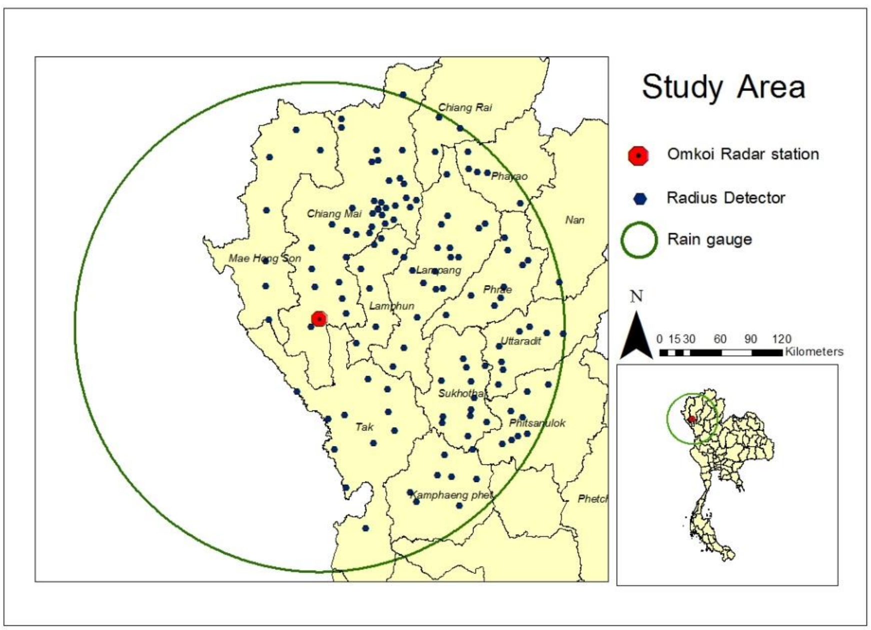


Figure 2. Location of Omkoi weather radar station in Chiang Mai and rain gauge in the study area.

2.1 Includes data collection

Rainfall data: collection data amount of rainfall related in 2015 from rainfall station of Thai Meteorological Department in the radius of 240 km (42 stations) from Omkoi weather radar station.

Reflectivity data (Z): collection data in volume file (Gematronik volume file format) related in 2015 from Omkoi weather radar station and transformation data from volume file by TITAN (computer software for transformation radar data) to Meteorological data volume (MDV).

3. Method

3.1 Probability Matching Method (PMM)

Matching the reflectivity data with rainfall data for evaluate the Z-R Relationship. In this study, classified data into rainy (May-October) and non-rainy (November to December, January-April) and matching the reflectivity data (Z) with rainfall rate (R) relationship by PMM (Probability Matching Method) as represented in figure 3. Z-R relationship [2] is a relationship between the rain intensity R (mm/h) and the factor of reflectivity radar Z (mm^6/m^3), which is defined as follows [3] .The Z-R relationship can be described by the empirical power law relationship which can be expressed as followed by equation (1):

$$Z = AR^b \tag{1}$$

Probability Matching Method (PMM) is the process that the sampling volume, timing and location problems are not taken into account. The matching is done between the Cumulative Distribution Functions (CDFs) of Z values and R from rain gauge measurement can be found [4]. Pearson correlation coefficient is measured as a correlation coefficient-indicates the strength and direction of a linear relationship between two variables. A number of different coefficients are used for different situations. The result showed in figure 3-4.

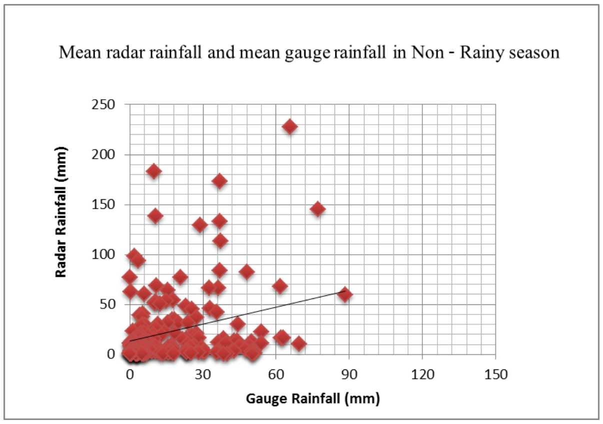


Figure 3. Mean radar rainfall in non–rainy season.

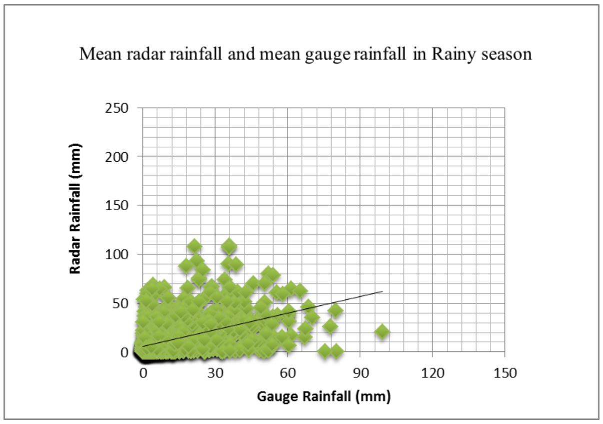
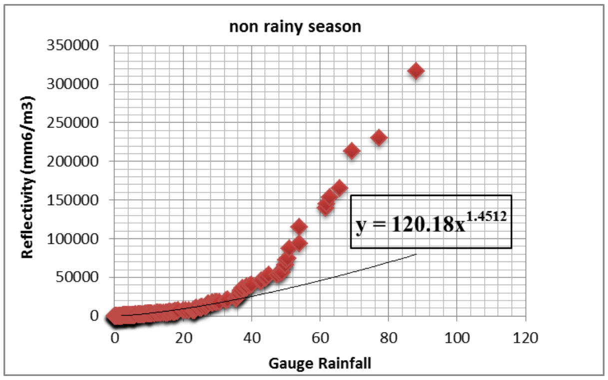


Figure 4. Mean radar rainfall and mean gauge rainfall in rainy season.

4. Result

The same Z-R relationship cannot be used in different seasons. This is because the parameters A and b in Z-R relationship usually change from one area to the other depended on the variations of raindrop size distribution in both space and time. Thus Z-R relationship should be appropriate for in different season. The Z-R relationship in rainy season is $Z = 103.83R^{1.5082}$ and the Z-R relationship in summer and winter is $Z = 120.18R^{1.4512}$. The scatter plot of R-G which is shown in Figure 3 in rainy season has a correlation coefficient of data higher than in the non-rainy season. For the same rainfall intensity, reflectivity value in non–rainy season is higher than in the rainy season. Cumulonimbus rain cloud in rainy season yields the highest rainfall and rain area while Cumulus rain cloud in rainy season yields the small rain area [5]. This research shows that each monsoon causes a different type of rain.



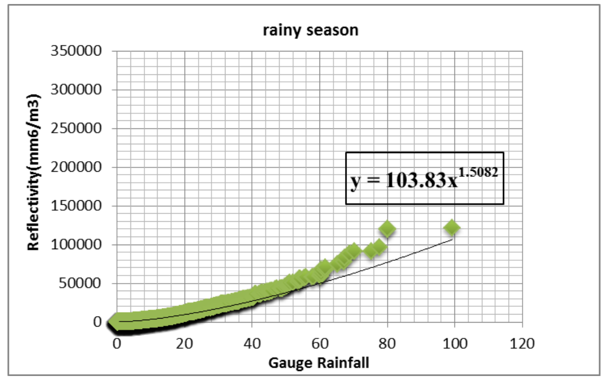


Figure 5. Z-R relationship in rainy season. **Figure 6.** Z-R relationship in non-rainy season.

5. Conclusion

The objective of this research is to evaluate Z-R relationship ($Z = AR^b$) for rainfall estimation in different monsoons. Matched daily gauge rainfall from Thai Meteorological Department in mm/day with reflectivity data from Omkoi radar station in mm^6/hour. The reflectivity values from radar CAPPI data can provide information of raincloud (shape, size of rain cell and spatial variation of rainfall intensity). For the same rainfall, the non - rainy season raincloud has a higher reflectivity than the rainy season raincloud. Our interpretation is that the non-rainy season raincloud is cumulonimbus, while the rainy season raincloud is nimbostratus. Cumulonimbus cover large raining area. It can lead to high rainfall intensity but in a short period. The raindrops are large and the reflectivity is large too. It grows when the air is vertically unstable. On the other hand, nimbostratus is resulted from the movement of air front during monsoon. It is composed of small drop and thus has low reflectivity. However, it can yield a large amount of rainfall because the rain can fall for a long period of time.

Acknowledgements

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