P8.19 A STUDY OF TYPHOON RAINFALLS USING TRMM/ PR AND GROUND GAUGE OBSERVATIONS

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1. Introduction

The island of Taiwan is located in the one of the main paths of the Northwest Pacific Tropical cyclone. On average, annually there are 3~4 typhoons hitting Taiwan during the summer seasons. Heavy rainfalls brought by typhoons usually lead to flash floods, mountainous landslides and debris flows and cause a severe economic loss and life safety. Therefore it becomes an absolutely important issue to improve the understanding of the characteristics of typhoon rainfall and to prevent or lessen the heavy rainfall disaster. Though radar observations can provide more detail reflected signal from heavy rainfall associated with typhoons, usually it is limited in mountainous areas owing the blocking of terrain. There are two of third areas in Taiwan covered by mountain, especially the Central Mountain Range, with the average elevation of more than 2000m. Therefore we need more observations to reach the current important issue. Satellite remote sensing is one of the best ways to do it. Precipitation Radar (PR) on board the Tropical Rainfall Measuring Mission (TRMM) satellite is the first radar on satellite. It can provide very high vertical and horizontal resolution measurements to retrieve rainfall products.

In this paper, the TRMM standard PR-2A25 products generated and provided by NASA and NASDA were used to analyze the characteristics of typhoon's rainfall on ground surface. And the rain gauge data were used to validate the rainfall rate (RR) retrieved by PR. Also the relationship between rain gauge (RG)_RR and PR_RR was

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established in this study and a rain-gauge-corrected PR ground surface rain map was provided.

2. Data processing

The study domain ranges from 15^{o}N to 30^{o}N in latitude and from 110^{o}E to140^{o}E in longitude.

There are two kinds of data sets used in this paper (1) TRMM/PR standard level 2 data (PR-2A25), and (2) ground rain gauges, described as follows.

TRMM/PR data

In this study, we collected standard products of TRMM/PR 2A25data set of version 5(Iguchi 1994; Iguchi 2000) on Sep. 16, 2001 while Typhoon NARI hit Taiwan, and the retrieval near-surface rainfall rate, defined as the rainfall rate observed at a range bin just above the surface clutter (Ikai 2003) was used to compare with that of rain gauge (see detail from Fig. 1).

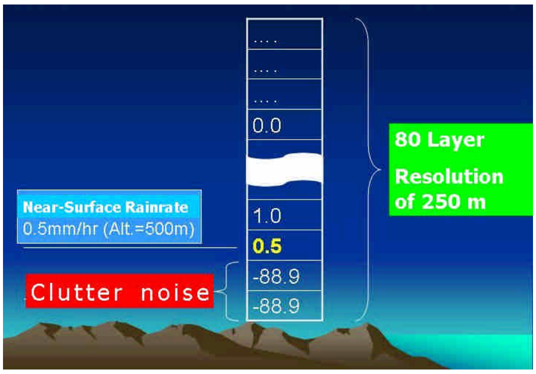

Fig. 1 The near surface rainfall rate retrieved by PR was used to compare with that of rain gauge.

Ground rain gauge data

Considering the different physical parameters measured by PR and ground rain gauge, we used RG_RR with 4 kinds of time-interval (10 minutes, 20 minutes, 30minutes, and 60minutes) to compare with PR_RR. In Taiwan we have high density of rain gauge distribution for rainfall measurements, which is shown in Fig. 2.

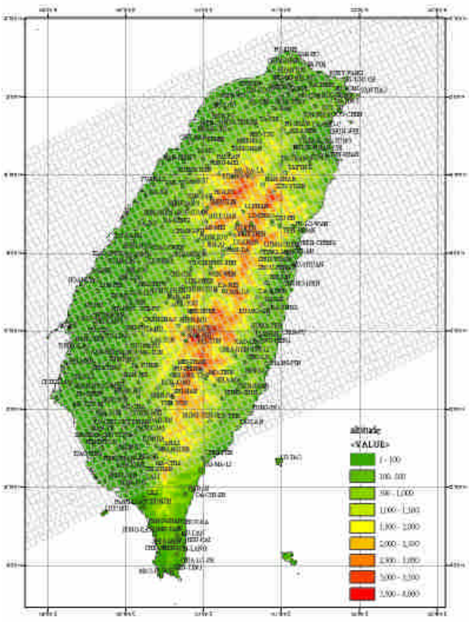

Fig. 2 The illustration is a scatter of ground rain gauge in Taiwan. There are 362 automatic ground rain gauges on the island.

3. Comparisons between PR_RR and RG_RR

From the scatter-plot of PR_RR verse RG_RR in Fig. 3, we can find a linear relationship between them. RG_RRs are greater than PR_RRs by 33%, 29%, 32%, and 30% for 60-minute (60min_RR), 30-minute (30min_RR), 20-minute (20min_RR), and 10-minute rainfall accumulations (10min_RR), respectively. The correlation coefficients between PR-RR and RG_RR are 0.517, 0.518, 0.501, and 0.455 respectively

(Shown in Tab. 1).

For Typhoon NARI case it was shown that the PR-RR is underestimated approximately by 31% compared with RG_RR and that the RG_RR with 30-minute rainfall accumulation gets better relationship with PR_RR than the other time-interval rainfall accumulation. But from Table 1 we can find there is little difference between 60-minute and 30-minute rainfall accumulation, so we choose 60-minute accumulation rainfall as the candidate to compare with PR_RR for the following case.

Fig. 4 shows the rain maps of PR_RR（in the right） and RG_RR（in the middle） for Typhoon RAMMASUN at 1450 UTC on 3 July 2002. The GMS-5 infrared image（in the left） is also shown for comparison. Because of only few ground rain gauges employed on mountainous areas, there are some rainy areas without rainfall measurement. On the other hand, PR can easily conquer this problem by the advantage of top-down measurement. It is evident from the comparison of the rain maps of PR_RR and RG_RR. Fig. 5 is the scatter-plot of the PR_RR verse RG_RR with 60-minute for Typhoon RAMMASUN case at 1450 UTC on 3 July 2002. The result of comparison shows that the RG_RR is greater than PR_RR by about 85%. Fig. 6 and 7 are the same as Fig. 4 and 5, but at 2145 UTC. Fig. 7 shows that the RG_RR is greater than PR_RR by about 49%. From the above results we can't find a consistent relationship between PR_RR and RG_RR. Evidently, there exist some factors needed to consider. In the future we will put more attention in the variation of rainfall associated with the slope of topography and the elevation of terrain.

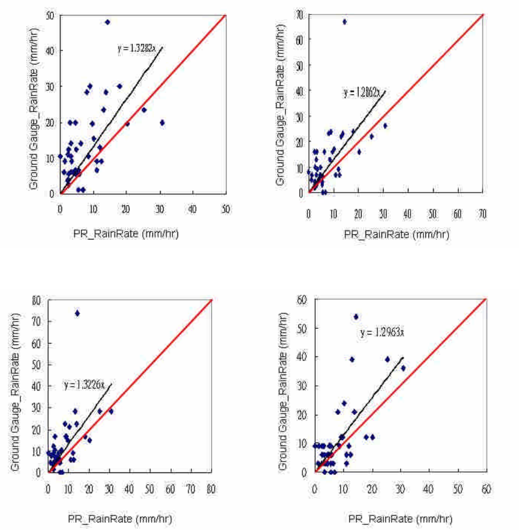

Fig. 3 Scatter-plots of the PR_RR verse RG_RR with 60-minute (left top), 30-minute (right top), 20-minute (left down), and 10-minute (right down) time-interval accumulation rainfall for Typhoon NARI case at 1740UTC on 16 September 2001. The black solid lines are the linear regression lines derived from PR_RR and RG_RR data set, and the red solid lines represent PR_RR equal to RG_RR.

Table 1 The correlation coefficients between PR-RR and RG_RR for the Typhoon NARI case.

	60min_RR	30min_RR	20min_RR	10min_RR
PR_RR	0.517	0.518	0.501	0.455

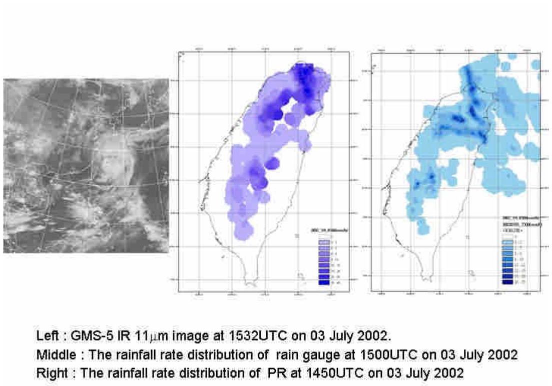

Fig. 4 The rain maps of PR_RR (right) and RG_RRs (middle) at 1450 UTC on 3 July 2002 for Typhoon RAMMASUN case. GMS-5 infrared image (left) shows the coverage of Typhoon RAMMASUN.

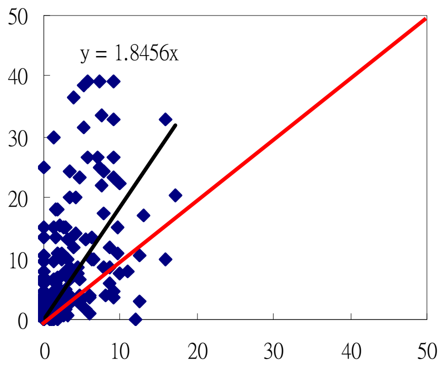

Fig. 5 Scatter-plots of the PR_RR verse RG_RR with 60-minute for Typhoon RAMMASUN case at 1450 UTC on 3 July 2002. The horizontal axis is PR_RR （mm/h） and the vertical axis is RG_RR(mm/h).

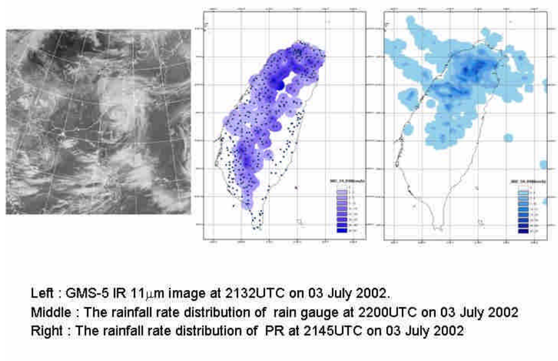

Fig. 6 The same as Fig. 4 but at 2145 UTC.

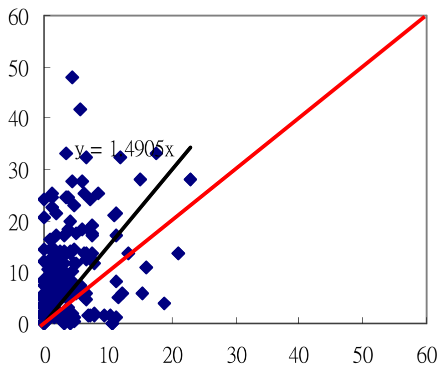

Fig. 7 The same as Fig. 5 but at 2145 UTC.

4. Summaries

From our preliminary study some summaries were made as follows:

(1) The PR-RR is underestimated approximately by 31% compared with RG_RR for Typhoon NARI case, and 62% for Typhoon RAMMASUN case.

(2) The RG_RR with 30-minute rainfall accumulation gets better relationship with PR_RR than the other time-interval rainfall accumulation.

References

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