THE USE OF COMPARISON CALIBRATION OF REFLECTIVITY FROM THE TRMM PRECIPITATION RADAR AND GROUND-BASED OPERATIONAL RADARS

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1. INTRODUCTION

Precipitation is the major factor effecting weather and climate. Weather radar is one of multi-sensors for detecting the precipitation. Space-borne and ground-borne weather radars are common platforms, and both of them have advantages and disadvantages respectively. For example, in the flat area ground-based radars could cover more, and the space-bond radars could give the global distribution especially in those area that the ground radars couldn't do. Given the decade-long and highly successful Tropical Rainfall Measuring Mission (TRMM), it's now possible to provide quantitative comparison between ground and spaced radars for detailed precipitation structure(add references). In China, there are total five types of ground-based radars with different hardware parameters and wavelengths (see Table 1, s-band includes three types as SA, SB, and SC, c-band includes two types as CC and CD). During past research, we found that there are often differences between ground radars(see Figure 1), and the maximum value of their difference could arrive at 4-5dBZ (Zhou, 2013; Xiao et al., 2007). In another way, the precipitation radar (PR) on TRMM has an acute calibration within about 1dBZ,and it can detect the minimum rainfall intensity of 0.7mm/h. (Wang, 2009; Kawanishi et al., 2000; Kozu et al., 2001; Takahashi et al., 2003;) Some comparison between PR and ground radars (GR) has been done, and some research reveals that when the difference of reflectivity arrives 2dBZ, the average rainfall of month precipitation error could arrive above 30%. (Anagnostou et. al., 2000; Houze et al., 2004; Wang et. al., 2009; Wen et. al., 2011) In this research, reflectivity of three types of GR and PR are compared and An example of calibration between PR and GR is given.

2. DATA AND MATCHING METHOD

Three kinds of GRs(SA/SB/SC) are used in this research by detecting the precipitation progress during 2011-2012 in JJA(June, July, and August). Corrected reflectivity of TRMM 2A25 products are also applied. For the resolution of GRs and PR are not the same, we use linear Interpolation in vertical Direction method(NVI), 3D digital mosaic system and Area Matching Method (AMM) to make both of the two data with 10km×10km horizontal and 500m vertical resolution. (Xiao and Liu, 2006; Wang et al., 2009; Bolen and Chandrasekar, 2000; Heymsfield et al., 2000; Anagnostou et al., 2001)

3. RESULTS

Figure 1 gives the matched cases of echo reflectivity comparison between PR and GR at the same height, and the dashed lines are the track of PR. We can find out that： although the average intensity of reflectivity of SA radar is weaker than PR, their coverage of echo are quite agreement with each other. The echo coverage of SB and SC radars less than PR. The reason results in differences between GRs and PR maybe as follows:(1) the temple and special matching errors (2) the influence of "detecting blind zone " for GRs (3) the effect of attenuation in far away distance from radar beam (5) ground cluster influence Figure 2 and 3 gives the

distribution of the scatter plots for all the matching pairs as well as those under 5km height. It's obviously that The distribution of the pairs matched within 5km have good correlation, and the scatters distributed symmetrically with the 1:1 line. While above 5km height, it's showed that the scatter number between 20-30dBZ is more in GR than PR, and the results show that there is a certain systematic error between PR and GR. Figure 4 shows the vertical profile reflectivity feature of convective and stratiform cloud according to the cloud type products in PR-2A25. PR can describe detailed structure of "bright-band" level of stratiform cloud due to its higher vertical resolution. In addition, within 2km near the ground, the profile of PR exists an obvious peak. This may due to the ground clutter and other factors near the surface.

4. CASE OF CALIBRATION GR BY PR

In this research, linear regression method is used to calibrate GR radar in August, 2011. An equation of y=ax+b could be got from observation in July. Then the x= (y-b) /a to the overall correction of the radar's observation in August July.(Figure 5)

5. CONCLUSIONS

In this study, three weather radar (SA/SB/SC) and PR were compared and analyzed, and the difference between ground radar and space borne radar (PR) is obtained. Compares suggest that both SA and SB radars have much better agreement to PR than SC radar. The mean correlation coefficient of SA, SB, and SC radars are 0.82, 0.80 and 0.56 respectively. Vertical profiles of radar reflectivity of different rain types detected by the three kind radars also showed the same characteristic that SC radar had much difference with PR. Although PR is used to calibrate the GR for a primary test, and it shows that the PR can make sense in correcting the systematic errors of ground-based radars, the space borne radar and ground radar have the advantages and disadvantage of each other. In the next work, we hope to further study the method of calibration GR and PR for each other.

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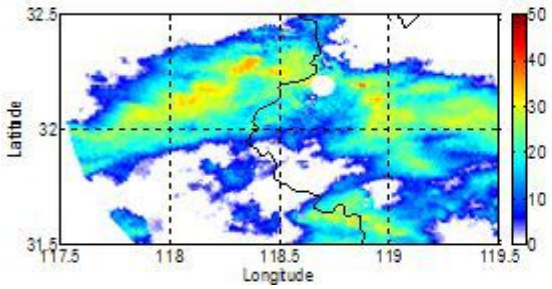
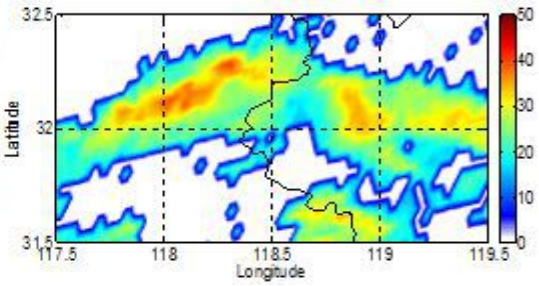
Table 1. Main parameters of operational weather radars in China

Radar Type	SA	SB	SC	CC	CD
Frequency(GHz)	2.7-3.0	2.7-3.0	2.7-3.0	5.3-5.5	5.3-5.5
Beam width(°)	1	1	1	1	1
Antenna diameter(m)	11.8	11.9	11.8	4.5	4.5
Pulse width(μm)	1.57	1.57	1.0	0.8/1.0	2/2.5
Antenna gain(dB)	≥44	≥44	≥44	≥43	≥43
Peak power(KW)	≥650	≥650	≥650	≥250	≥250

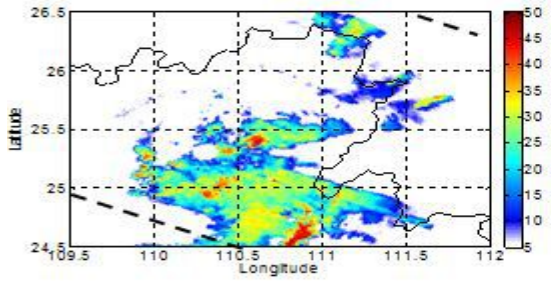
(a) (b)



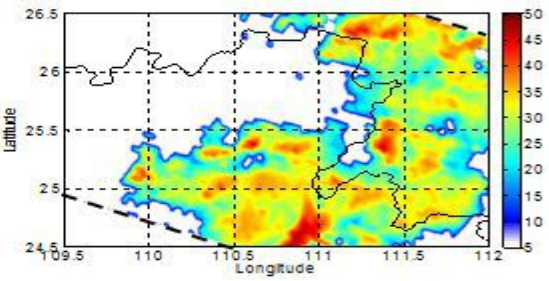
(c)



(d)



(e)



(f)

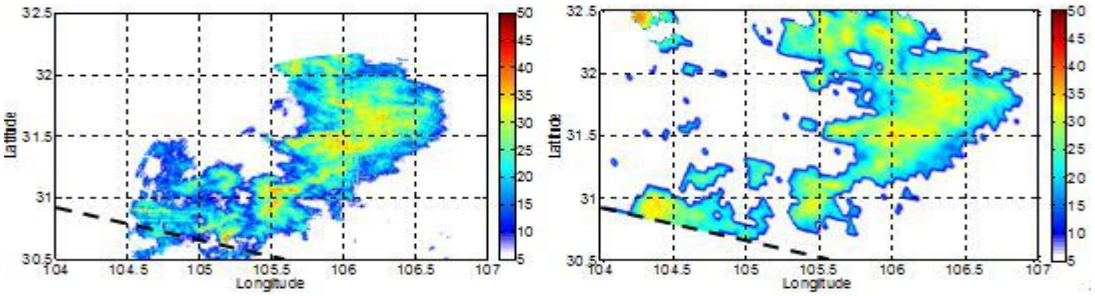


Figure 1 Echo reflectivity compared from PR(right) and GRs(left), (a) and (b) are for SA, (c) and (d) are for SB, and (e) and (f) are for SC， the dashed line show the PR tracks.

(a) (b)

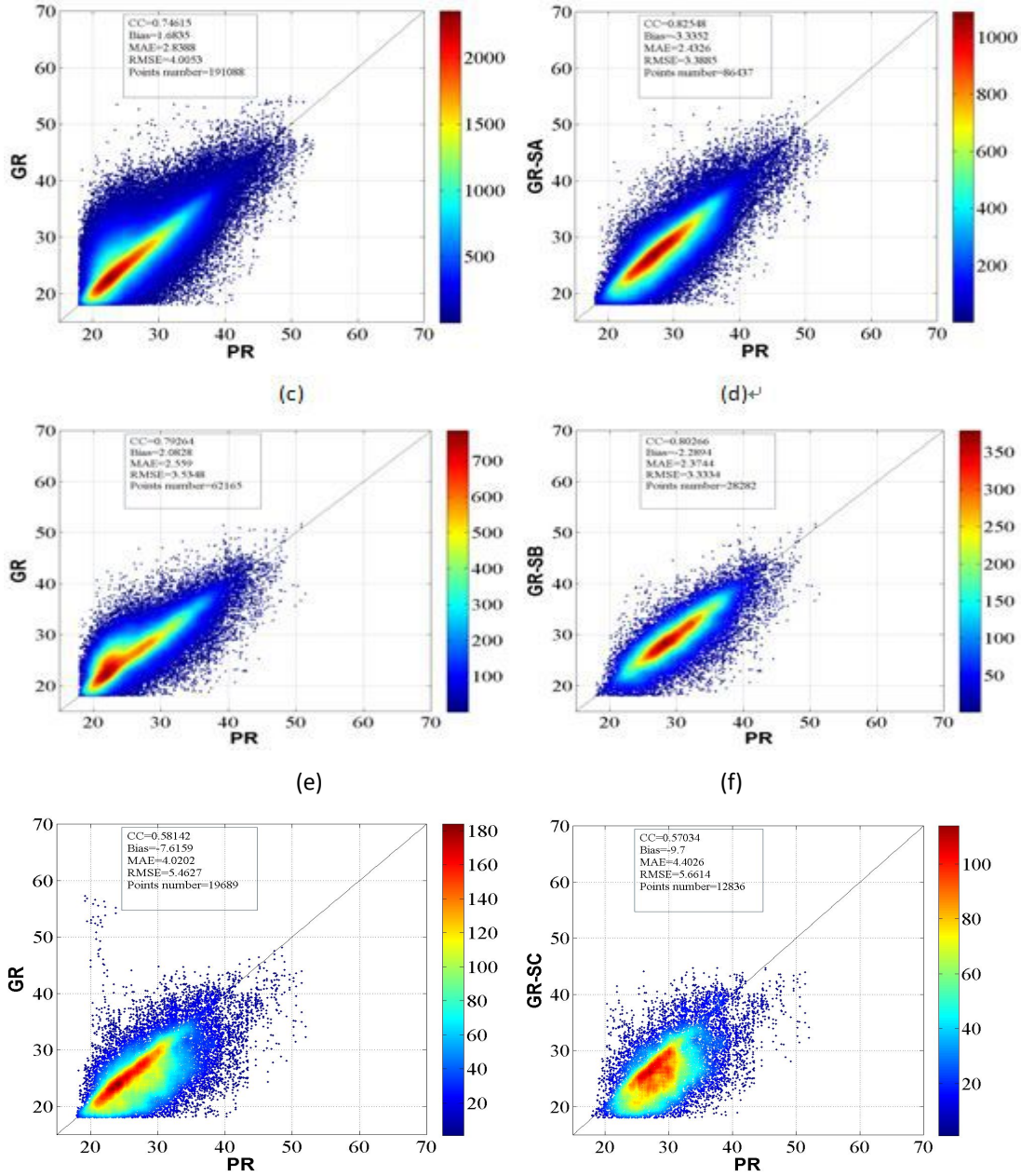


Figure 2 Scatter plot density compared by PR and GRs with all height levels(left) and under 5km levels(right), (a) and (b) are for SA, (c) and (d) are for SB, and (e) and (f) are for SC

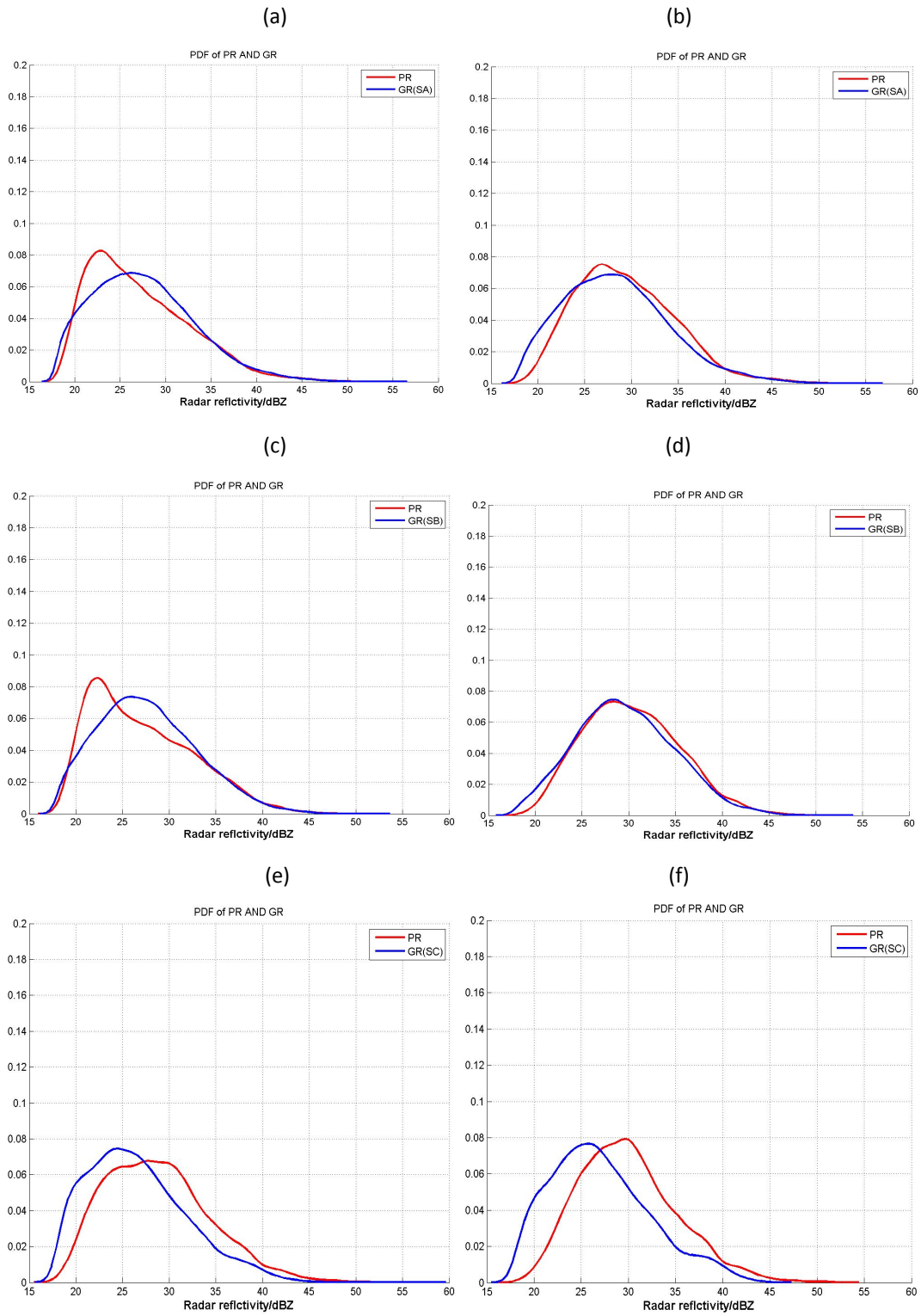


Figure 3 Property Density Frequency(PDF) compared from PR and GRs with all height levels(left) and under 5km levels(right), (a) and (b) are for SA, (c) and (d) are for SB, and (e) and (f) are for SC, red and blue lines stands for PR and GR respectively

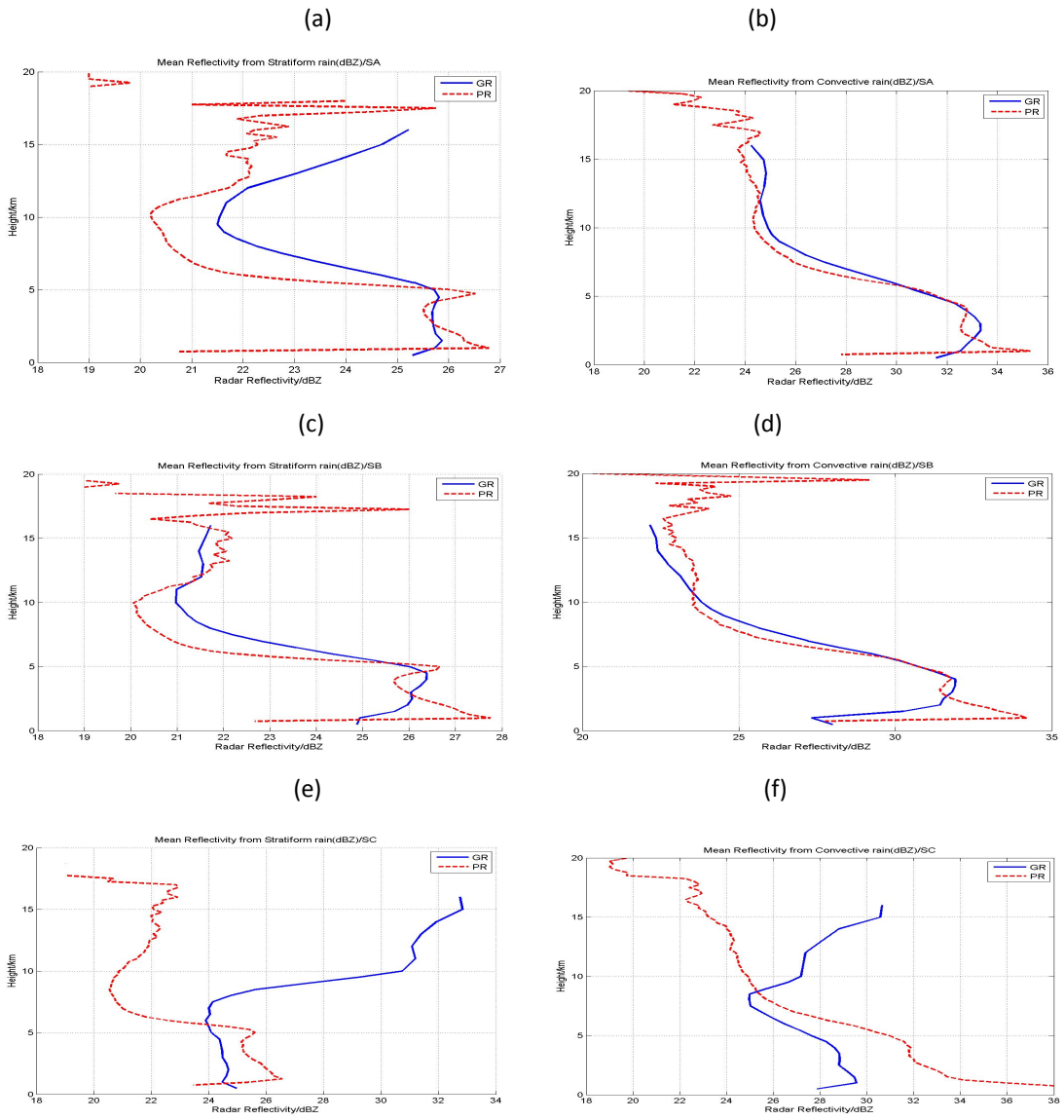


Figure 4 Comparisons of vertical profile reflectivity from PR and GRs of stratiform (left) and convective (right) cloud, (a) and (b) are for SA, (c) and (d) are for SB, and (e) and (f) are for SC, red and blue lines stands for PR and GR respectively.

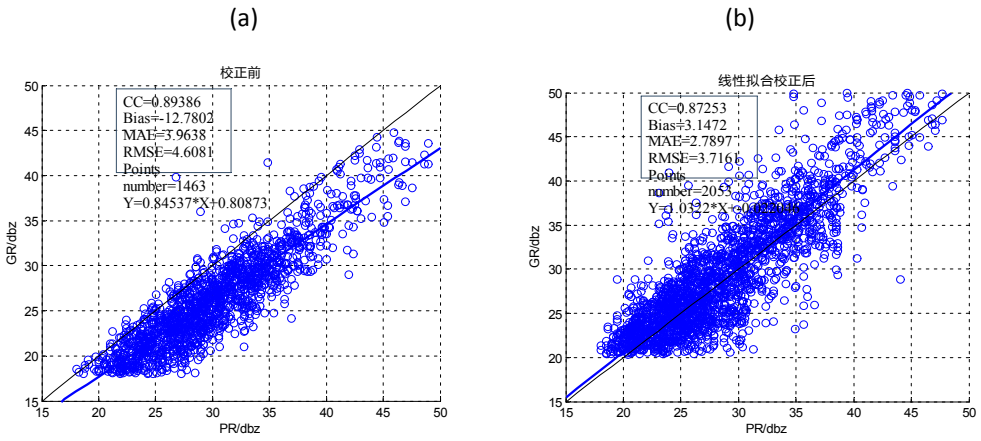


Figure 5. (left) scatter plots on 3km height before calibration of GR radar in July, 2011, (right) scatter plots on 3km height after calibration in August, 2011 by using linear regression equation of July,2011