Atmos. Meas. Tech. Discuss., 8, C5329–C5332, 2016
www.atmos-meas-tech-discuss.net/8/C5329/2016/


Atmospheric Measurement Techniques Discussions

# *Interactive comment on* "Application of bias correction methods to improve the accuracy of quantitative radar rainfall in Korea" *by* J.-K. Lee et al.

**J.-K. Lee et al.**

myroom1@daejin.ac.kr

Received and published: 5 February 2016

Manuscript information

Title: Application of bias correction methods to improve the accuracy of quantitative radar rainfall in Korea Authors: Jae-Kyoung Lee, Ji-Hyeon Kim, and Mi-Kyung Suk

Comments for the Anonymous referee#2

We thank the reviewer very much for reading our paper carefully and for the comments. Detailed responses to the comments are given below.

The paper shows how different techniques to improve the accuracy of quantitative radar



rainfall estimation (currently provided by a system called RAR) are used by the Weather Radar Center, Korea Meteorological Administration in Korea. This paper has a potential to clarify the quality of rainfall data obtainable by using single-polarization radar (calibrated with just a one reference dual-polarization radar) after adjustment with raingauges. However, the paper is not very clear, both in presenting the methods and the interpretation of results. More detail and more clear analyses should be provided in order make the results and the methods presented in the paper as understandable and make readers to appreciate their significance.

Comment#1 The introduction should be more focused on the methods adopted in the paper and should definitely clarify what is the definition of Z bias. The reflectivity measurement bias that can be fixed by applying the self-consistent calibration does not include "the temporal and spatial sampling bias, ground and sea clutter, beam-blockage and attenuation, electrical calibration, : : :.." as stated by the authors. . Basically in the paper: a) a self-consistency calibration is applied to a dual-pol weather radar; b) the absolute calibration of the dual-pol radar is "propagated" to other radar by determining the relative bias of two adjacent radars by matching reflectivities in overlapping areas; c) two raingauge-based adjustment techniques are used. The study adopts an implementation of the self-consistency calibration that is simplified from the original formulation by skipping Zdr. Did authors try to apply the version of the self-consistent calibration using Zdr, that is, at least theoretically, more accurate (unless Zdr has problems)? Moreover, authors do not specify how "b" is obtained and its value. (again, what does Fig. 4 shows ? is it an artwork to illustrate the method or represent real data ). Answer#1: In self-consistency constraint method, this paper utilized KDP instead of the Zdr because KDP and affected by only the particle size or the concentration and not the radar beam power. The concept of this method is different from the self-consistent method (Bringi et al., 2001). And b has different value for each rainfall case because of the empirical constant. Moreover, Figure 4 explains the concept of self-consistency constraint method applied in this study.

Comment#2: In general, in the paper there are many reminders to internal reports for the description of the methods used. Finally, authors, in addition to the estimated bias, should provide the accuracy of the self-consistency calibration and indicate how stable this calibration is. Moreover, it is also important to show how the error in estimating Zh bias is propagated into the estimation Zh bias of the other radars (in other words, what is the uncertainty of the figures of the Zh relative biases provided?). It is easy to note that all the radars seem to underestimate reflectivity. Have any investigations been conducted on possible mistakes in engineering calibration?. This is an important point, since using raingauge to adjust rainfall estimation whatever reflectivity bias is, let people think that having a well calibrated radar is not important, given that calibration problems can be fixed by rainguage measurements. Answer#2: In Korea, almost weather radars in work-site operations are single-polarimetric radars. So, we can use a few radar measurables, such Zh, wind velocity, and so on. To calibrate (or correct Zh bias) the single-pol weather radar, Zh bias of dual-pol radar is propagated into the single-pol radars because the dual-pol radar regularly performs self-calibration through Zh, Zdr (vertical pointing), and so on. Moreover, it is assumed that a dual-pol radar is more accurate that a single-pol radar.

Comment#3 Results of Z_calibration, once corrected Z are applied to RAR are described in sect. 3.1. However, from this section, it is not clear to me whether, apart from the case of Fig. 9 and in spite the claim at the end of the section, the application of the Z-bias had a significantly positive impact on RAR or not. Answer#3: Accepted. Authors added results of the basic RAR system in Table 4. Table 4 shows that the accuracy of the RAR system applied by Z-bias correction is better than that of none.

Comment#4: Finally, raingauge adjustment techniques are tested and the one working on local adjustments (LCG) works better. It is not clear whether LCG would work also without Zh bias adjustments, since the technique anyhow adapts the rainfall estimate to the raingauge. Authors could investigate the influence of the number of raingauge (or the spacing) utilized for LCG on the overall QPE performance. Summarizing,



although a verification of QPE technique on such a wide scale is welcome, the paper, in its present status lacks of the necessary level of detail in the description and the discussion of results. These problems results in difficulties in understanding the novelties and advancement in the state-of-the-art of weather radar precipitation estimates implied by the study described in the paper. Answer#4: Accepted. The manuscript has been revised totally to help your understanding.

Please also note the supplement to this comment:
http://www.atmos-meas-tech-discuss.net/8/C5329/2016/amtd-8-C5329-2016-supplement.zip

---

Interactive comment on Atmos. Meas. Tech. Discuss., 8, 11429, 2015.