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Interactive Comment

Interactive comment on "Improving the rainfall rate estimation in the midstream of the Heihe River Basin using rain drop size distribution" *by* G. Zhao et al.

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This manuscript describes a study in which measured raindrop size distributions on the Quinghai-Tibet Plateau are used to answer three research questions, namely (1) What is the relation between the diameter and terminal fall speed of a raindrop? (2) Why are $Z-R$ relations not unique? and (3) What are optimal polarimetric radar rainfall retrieval relations? All of these research questions have been studied extensively in the past, and in this sense, this manuscript does not present anything new. A new contribution of this manuscript could be the comparison of these site-specific relations to those given in the literature, along with an explanation of the similarities or differences. However, in its current form, this manuscript is not a significant contribution to the field. Furthermore, there are several discrepancies and errors in the figures in this manuscript. Specific comments on the manuscript are given below.

The motivation for this work as described in the abstract is improving rainfall estimates for hydrology. For this purpose, the authors evaluate site-specific X-band polarimetric radar rainfall retrieval algorithms. This will only improve rainfall estimates in the area if there is an X-band polarimetric radar available, either currently or in the near future. It should be made explicit in the manuscript if this is indeed the case, and if not, the title and abstract should be modified.

The OTT Parsivel has been described extensively by Yuter et al. (2006), so the detailed description of the signal processing could be left out of the manuscript (this is less relevant to hydrologists). There are some issues with the PARSIVEL when used in snow (see Battaglia et al., 2010), which may also have a minor influence on retrieved drop sizes and velocities.

The authors note that they use the gamma DSD. However, it is not clear from the rest of the paper how this parameterization of the DSD is used. Are gamma DSDs fitted to measured DSDs, after which N_0, Λ, and μ are used to compute the bulk rainfall variables R, Z, Z_{DR}, and K_{DP}?

The authors fit a power-law relation between raindrop fall velocity and diameter based on measured raindrop properties, and argue that the difference between their relation and that of Atlas and Ulbrich (1977; the reference is missing in the reference list) is caused by differences in atmospheric conditions due to the high altitude of the measurements. It would have been very relevant to compare these results to relations that take these atmospheric conditions into account (such as the relations given by Beard, 1976). Furthermore, it should be made clear how the authors obtained the raindrop diameter and terminal velocity pairs presented in Table 1 and Figure 1. Are these av-

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erages of diameters or terminal velocities returned by the PARSIVEL, or something entirely different? This will probably affect the interpretation of the results.

There seems to be an error in Figure 2a, which shows three DSDs measured by the PARSIVEL. All three DSDs are claimed to yield the same value of Z (namely 35.5 dBZ). However, this cannot be the case, as the line corresponding to $R = 8.0$ mm h^{-1} (dotted line) is always above the line corresponding to $R = 4.3$ mm h^{-1} (solid line). Any conclusions that are drawn based on this figure should hence be reconsidered (the conclusion that the relation between Z and R is not unique is true, but should not be based on the analyses presented here).

The authors make a distinction between stratiform and convective rainfall. However, it is not clear how this distinction is made, and on what it is based. This should at least be described. It could also be argued that this distinction should not be made, because it is very difficult to operationally identify stratiform and convective rain.

The conclusion that the retrieval relation involving Z, Z_{DR}, and K_{DP} is the most accurate is trivial, as the retrieval relations it is compared to involve a subset of Z, Z_{DR}, and K_{DP}. The optimized retrieval relation using all of these variables should hence be the most accurate by definition. Any true assessment of these retrieval relations should take other sources of error into account as well. For example, it is well-known that K_{DP} cannot be reliably measured by radar at low rainfall intensities (see e.g. Ryzhkov and Zrnić, 1995), and one of the reasons to use Z_{DR}, and K_{DP} is that these variables do not suffer from the calibration issues that affect Z.

Both quantities used to describe errors in R (NE and PRMSE) are measures of the scatter. Using a bias error and a measure of the scatter such as NE or PRMSE would yield more insight. As defined in Eq. (10), the PRMSE is not the intended percentage root-mean-squared error, but rather the relative absolute error (Eq. (10) can be rewritten as PRMSE $= \langle |R_{\mathrm{est}} - R_{\mathrm{dis}}| / R_{\mathrm{dis}} \rangle$). I assume that this is a typing mistake, and that the values of PRMSE presented in this manuscript have been computed using the

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correct form (something like PRMSE $= \sqrt{\langle (R_{\mathrm{est}} - R_{\mathrm{dis}})^2 \rangle} / R_{\mathrm{dis}}$).

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