Anonymous Referee #1

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This paper deals with the estimation of vertical (fall) velocities of rain drops from Parsivel measurements, assuming that the rain drop fall speeds follow the Gunn-Kinzer (G-K) variation (using Atlas et al. 1973 equation) and some minor altitude adjustment for air density. The estimates are compared with anemometer measurements in several different locations. Disdrometer data are also used to derive Z-R relationships and the mass-weighted mean diameter. The paper contains reasonable results and is suitable for publication in AMT, but some changes need to be made, as follows:

Line 162, and Fig. 2: It might be easier to follow this flow chart if some pertinent equations are added, corresponding to each step.

- ➔ Corresponding equations at each step were added to the figure 2.

Lines 164-169, and the use of Fig. 3: Please note that although G-K formula is a good representation for the 'most probable' velocity - diameter variation (especially for > 1 mm drops), it is well known that for a given drop size, there will be a distribution of velocities associated with it (but narrow). For example see a very recent paper by Bringi et al., 2018: https://www.atmos-meas-tech.net/11/1377/2018/ in particular their Fig. 1 and 3.

- ➔ Thanks for the paper. We agree that there is a distribution of velocities for a given drop size. Also, V_p and V_f in Eq (2) that were used to calculate w are mean values for a given one minute D-V_p spectrum. Please see the equations about how to get mean V_p and V_f in Fig. 2. So their variations over a given range of drop size are minimized.

Also note that for small drops, the most suitable formula is in Foote and DuToit (1969), eq. (10), with the coefficients given in their Table 1 for N=9.

- ➔ Thanks for the paper and formula. We will consider to test the equation (10) with the coefficients in the future works.

Lines 186-189: The authors say "Also a dual-Doppler radar analysis (Liou et al., 2012) was also conducted to obtain 3-D wind components from radial velocity data of two Doppler radars as well as vertical structure of radar reflectivity in this mountain area."

However, I don't see those results in the manuscript. It would be advisable to incorporate or make use of, at least qualitatively, velocity information from the dual-Doppler analyses.

- ➔ Actually the composite reflectivity values from dual-Doppler radars were plotted in Figures 5a,c,e. They are reflectivities, not retrieved vertical velocities. We deals with very surface measurements of velocities (Parsivel and anemometer). We have not analyzed vertical velocities retrieved from dual-Doppler analyses (it starts above several hundred meters). We have examined this as well but found that there were large differences since there were large errors and uncertainties in vertical velocities retrieved from dual-Doppler radars. One other reviewer also mentioned about this issue, saying that they don't see their analysis in the manuscript.

  So we removed the sentences regarding the dual-Doppler radar analysis (also the radar composite reflectivities in blue dots were removed in Figure 5a,c,e.)

Lines 217-218: "they just pointed up or downward, depending on w signs and magnitudes".
This statement is not clear. Certainly, drop horizontal velocities will cause errors and some discussion on this needs to be included.

- ➔ We meant that the magnitudes of horizontal winds were much larger than those of vertical velocities. Thus, they are almost horizontal and just head upward or downward slightly with signs (plus/minus). We changed the sentences as follows.

  "winds are almost horizontal during the whole period and they point upward or downward slightly with the *w* signs."

  Also as shown in Fig.5, both the estimated w (w_{par}) and measured w (w_{UVW}) are very low in magnitude. As you know, these are just a vertical component of winds. Therefore, on the other hand, the low w values and stronger horizontal winds almost 5 times larger than the measured w (not shown in this manuscript) indicate that the winds just head up and down slightly with w signs. For larger rainfall (larger Z), retrieved w values were found higher, meaning that there were slightly upward-pointing large scale flow (even near the surface) around the mountain, probably producing converging-upward air and strengthening the orographic rain system. So we found that even very slightly upward motions can make favorable conditions for increasing Z and R in these mountain areas. Again, we need to test the disdrometer-based technique in other places and events. Also these w results are obtained at surface, not aloft. For the vertical extent of up/downdrafts, there is a need to examine further by using small vertically pointing radar (like micro rain radar) or profiler observations in the future.

  Plus, UVW measures airflow itself but Parsivel measures particle movements along the airflow in the sampling area. Drops in different mass (small/large) responses to the same airflow differently. These are very complex and difficult for us to discriminate even if we have Parsivel and UVW observation data. We are preparing for another manuscript in relation to factors like winds (wind shear) soon.

  We included these words and explanation in the summary and conclusion section of the revised version (page 14) as follows.

  "Eventually the newly developed technique that estimates w values from Parsivel drop size and fall velocity spectra is found physically meaningful although it needs to be further tested in other places and events. It would be applicable to w retrieval and comparison studies near the surface to investigate rain microphysics associated with up-/downward motions. The different w percentages at the different locations stressed their dependence on observed D-Vp distributions which vary largely as a result of complex factors such as rainfall intensity, up-/downdrafts, wind speed, turbulence, and so on.

  In this study, both the observed and estimated w values were very small in magnitude mostly between -0.5 and +0.5 m s^{-1}, about one fifth of the measured horizontal wind speeds. As known, the w values are just a vertical component of winds. Thus the low w values indicate almost horizontal winds that just head up and down slightly with the w signs. During the high *R* periods, the estimated w values were larger in a positive sign (windward side), suggesting that there were slightly upward flows around the mountain. Probably this produces an environment of converging-upward air in large scale and helps to intensify the orographic rain system, increasing Z and R."

Please also note Appendix A of Thurai JAOT, 2017, along with their Fig. A1, which shows drop horizontal velocities, both in terms of magnitude and direction, derived from 2D video disdrometer measurements, and the excellent comparisons with the 10m wind sensor data.

Last para in Section 4.1: Can the authors include a discussion on the role of DSDs in the calculated Z-R relationships?

- ➔ For given Z, there were relatively stronger rainfall in the leeward side (D4). We modified the sentences as follows

"Power-law *Z*-*R* relations at a form of $Z=\alpha R^{\beta}$ are compared between the observation sites in Fig. 6. There was a decrease in the coefficient α from D1 and D2 (250, 252) on the windward side to D4 (226) on the leeward side. The exponent β did not show notable change between the sides. The noticeable decrease in α suggests that for a given *Z*, *R* is larger at D4 than D1 and D2. This is consistent to histograms of DSD parameters in the later section showing the larger mean *R* and D_m at D4."

Around lines 243-245: For R>10 mm/h, Fig. 7a shows very different histograms between Parsivel-based and wind-sensor based. This should be pointed out, and explained, if possible.

- ➔ According to our analysis (for other cases) with regard to winds and reflectivities measured by Parsivel, strong winds tend to make a downward spread of drop fall velocities in Parsivel-measured drop and fall velocity spectra. Mathematically, this downward spread decreases Parsivel-measured drop fall velocities (decrease in V_p in Eqn(2) in the text) and hence w_{par} becomes more positive, making larger difference with w_{UVW}. As you know, environmental winds are very important for accurate studies of retrieving *w* from Parsivel since relatively small (tiny) drops can be blown more easily along with winds but this was not fully considered in this study as we mentioned in the manuscript. In association with winds and rain intensities, we are preparing for another manuscript for other rain cases in these areas and will submit it soon. We added the following sentences.

  "The relatively larger difference between the w_{par} and w_{UVW} histograms is found in the convective class of D1 and this is likely due to strong wind speeds that tend to make a downward spread in measured *D* vs. V_p spectra of Parsivel. Mathematically, this downward spread decreases Parsivel-measured drop fall velocities (i.e., decrease in V_p in Eq (2)) and hence w_{par} becomes more positive, making a larger difference with w_{UVW}."

Lines 255-256: "In the downward w group, the largest percentage (69%) is found at D4 (Fig. 7f)" .. So why is this? Can this be explained?

- ➔ The Parsivel measurements were made in mountain areas. D4 is located in the leeward side and the other two sites (D1, D2) are located in the windward side of the mountain. As the system moves from the south to north of the mountain, upward motions prevailed in the windward while downward motions were more dominant in the leeward side (but there were upward motions as well). By the percentage of downward w groups at the three sites, it was largest at D4. We removed the sentence and added the followings.

  "The colored areas with the percentages show readily which *w* group is far dominant. As noted, upward motions were dominant at D1 and D2 while downward motions were dominant at D4. However, they did not show large percentage differences at all the sites, suggesting that either upward or downward motions have not happened overwhelmingly in this event."