Anonymous Referee #2

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The paper "Characteristics of vertical velocities estimated from drop size and fall velocity spectra of a Parsivel disdrometer" by Kim and Song presents the results of an experimental study aimed to develop a technique to estimate the vertical velocity of raindrops in natural rain, and to apply the technique to convective precipitation around mount Jiri, in South Korea. The data from three measuring sites, equipped with a Parsival disdrometer and an ultrasonic anemometer, are used to study the relation between the velocities measured by the two instruments in leeward and windward side of the mt. Jiri for convective and stratiform rain.

The paper is interesting, fairly well written and the topic is comprised among the subject areas of AMT. I therefore suggest the publication of the paper, after a few modifications I suggest below.

Lines 154-160. The correction proposed by Authors to take into account the reduction of air density with altitude is around 1% for D4, and this error is largely negligible if compared to other experimental errors, so I suggest to cancel this discussion and to use the Atlas et al. (1973) relation. For example, ultrasonic anemometers show that the air velocity varies greatly (much more than 1%) at sub-minute scale, while the Authors assume the speed of air is constant (Vf) during one minute and different drops fall with different instantaneous velocity.

- ➔ Yes, we removed the correction term in Eq (2), just using the original relation of Atlas et al.(1973) and modified the sentences as below. 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 (1 min interval). Please see the equations about how to get mean V_p and V_f in Fig. 2.

  "Altitudes of D1, D2, and D4 are 105, 280 and 313 m ASL, respectively. Due to the very low altitudes of these observation sites, change in atmospheric density with height is negligible and thus the atmospheric density correction (Beard, 1985) on V_f is ignored."

Figure 4. This is a 2-panel figure. On the left there is accumulated precipitation (color shades) but also isolines of altitude, I guess. Altitude is also reported on the right figure, enlarged, but the meaning of the color is not given. I suggest to simplify this figure, avoiding to repeat the same information twice, and better describing in the caption what is shown in the figure.

- ➔ Yes we understand what you pointed out here. To be exact, the contours are not the same in both the panels. On the left panel, they are contours of altitude at 300 m interval with accumulation rainfall amounts in color, just giving broad information on where more rainfall has occurred around the mountain (i.e., there was relatively more rainfall south of the mountain) in a much larger domain. On the right panel, contours of altitude are plotted at 200 m interval. This time, we added a color bar to the next that shows altitudes and modified the figure caption as follows.

  "Figure 4. (a) Distribution of an acumulated rainfall (mm) on 1 July over contours of altitude at 300 m interval and (b) the enlarged topography of Mt. Jiri with contours of altitude at 200 m interval, showing nine observation sites. Three sites in red are where the Parsivel and UVW measurements were analyzed in this study. R1 and R2 show sites with a rain gauge only"

Figure 5 (a, b, c). The "composite reflectivity (dBZ) from the dual radar: : :" is never mentioned in the text and these data never used in the discussion: I suggest to remove the blue dots, and the sentence on lines 186-188.

- ➔ The blue dots and related sentences were removed.

Figure 5 (d, e, f). I suggest to expand the y-axis scale, say between -0.5 to 1 m s-1, in order to better appreciate the differences between the two vertical velocities.

- ➔ The plots were modified as you suggested.

Figure 5. Since it is discussed the coincidence of rainshowers and differences between the two w, it would probably better to put R/Z/Dm and w plots one above the other.

- ➔ The plots were modified as you suggested. (We were concerned about the figure setting a little bit, though.)

Lines 220-223. This sentence is not convincing and too speculative. The causes of increase or decrease of rainrate are very complex and cannot be understood by simply measure the point-like vertical velocity few tens of centimeters above the ground. What is measured here is not the updraft/downdraft of convective development (that cannot last for many hours), but probably the weak component of the wind speed due to the uphill/downhill flux.

- ➔ Here, our analysis depends entirely on surface measurements of Parsivel and UVW and estimated w values from Parsivel data. With these surface measurements, it may be difficult to relate them to up/downdrafts aloft. However, certainly, there was an increase of R within downward motions (negative w_{UVW}) around 1300 and 1630 LST in Fig. 5. Due to the very low w magnitude, I do not call this pronounced downdraft (maybe related to downdrafts aloft but we can't tell with surface measurements only). As I wrote below, I think they are slightly downward-pointing airflow in large scale (induced by the rainfall system and mountain) (please read the paragraph below). Also if you look at Figs. 8 and 9 (with Fig. 5), the histograms of parameters make sense with our knowledge in regard to convective and stratiform rainfall. In this study, they were obtained with additional w information, which is very meaningful and promising. As you pointed out, reasons for the R increase and decrease may be complex in mountainous areas. There is a need to test the disdrometer-based technique in other places and events to generalize.

  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."

Lines 233-235. It is true that higher b indicates steeper relation between R and Z, bus does not tell anything about the "strength" of rainfall occurred, it is a measure of the relative occurrence of smaller and larger drops.

- ➔ Yes I agree. This is about the comparison of Z-R relations between two different places. For a given reference value of Z, we can tell larger R or small R. Often times, Z-R comparisons are used to see a relative strength between convective and stratiform rain for a given Z (please see Yuter and Houze (1997) and Atlas et al. (2000)). 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."

Line 242. It should be noted here that there are a plenty of algorithms based on DSD to discriminate convective and stratiform precipitation based on DSD and not only on rainrate (Tokay and Short, 1996, Caracciolo et al., 2006, Thomson et al., 2015, Thurai et al., 2016).

- ➔ Yes we added more references as follows.

  "In this study, a simple *R* threshold, $R < 10$ mm h^{-1} and $R > 10$ mm h^{-1} (Leary and Houze 1979; Testud et al., 2001), to discriminate stratiform and convective rain was used although there have been a plenty of other methods based on DSDs and vertical profiles to discriminate stratiform and convective rain (Bringi et al., 2003; Caracciolo et al., 2006; Thompson et al., 2015; Thurai et al., 2016; Tokay and Short 1996; Tokay et al., 1999; Ulbrich and Atlas 2002; Williams et al., 1995)."

Figure 7. Please keep wpar and wUVW names as in the text and other figures. How are the histograms normalized? They are percent of what?

- ➔ We keep them to be consistent in the text and figures. They were not normalized. They are percent of frequency of occurrences. These are histograms with a bin size of 0.05 m s^{-1}.

Occurrences in each w group were changed to percent values as they are divided by the total occurrence during the analysis period. So if we add them up, it amounts to 100%. So they are percent values of frequency of occurrence. We added sentences to be clarified as follows.

"Occurrences of upward and downward motions were changed to percentage values as they are divided by a total count of upward and downward *w* during the entire period. A bin size for these histograms is 0.05 m s^{-1}. "