Anonymous Referee #3

Review of AMT-2018-63
By Dong-Kyun Kim and Chang-Keun Song
Manuscript title: Characteristics of vertical velocities estimated from drop size and fall velocity spectra of a Parsivel disdrometer.

This manuscript reports about the estimation of vertical air velocity by disdrometer (Parsivel) measurements. The estimation is based on the comparison between measured (by Parsivel) and theoretical vertical drop velocity. In particular, the mean measured drop velocity is calculated from Parsivel data. The estimated vertical air velocity is compared and validated with the vertical motion measured by a collocated ultrasonic anemometer. One case study, during the monsoon rainy season in South Korea, is analyzed at three different measurement sites. The characteristics of DSD parameters (i.e. radar reflectivity, rain rate, mean mass diameter, etc.) are analyzed with respect to the upward or downward estimated air motion.

The structure of the paper is linear, but at the same time many inaccuracies both scientific/descriptive and language (the paper should be checked by a native English) can be found within the paper. My main concern is related to the unsuitableness of the analyzed case study to validate the vertical air motion estimate from Parsivel measurements. The vertical air velocity mainly ranges between -0.5 and +0.5 ms-1, but nothing is reported about the measurement uncertainty of the ultrasonic anemometer as well as the correction of the theoretical drop fall velocity due to the air density. Because of the very low values of vertical air motion, even during convective precipitation, the analysis carried out by the authors does not clarify the doubt that the vertical velocity estimates are within the measurement and process uncertainty. Due to these general considerations, I do not retain that the manuscript is ready to be published on the Atmospheric Measurement Techniques journal. I encourage the authors to deepen investigate the methodology by considering other case studies (involving higher values of vertical air velocity). In the following, I report more specific comments.

- Line 108: the citations “Niu et al. (201)” and “Ulbrich (1992)” are not present in the reference list. Please, check all the reference list.

  ➔ All the references were carefully checked.

- Lines 116-118: referring to Tokay et al. (2009, 2014), how the Parsivel underestimation and overestimation of small and large drops, respectively, affects the calculation of the mean fall speed?

  ➔ Our Parsivels are the old version ones. We did not investigate the underestimation and overestimation of small and large drops quantitatively and their effects on the mean fall velocities. In our measurements, we found that the mean drop fall velocities measured by Parsivel are much more sensitive to fall velocities of smaller drops ranged from 0.25 mm (almost the minimum size detected by Parsivel) to about 2.0 mm than those of large drops (> 2.0 mm). More works need to be done for this issue.

- Lines 142-146: what is the uncertainty of the ultrasonic anemometer measurements? This is a fundamental information needed to validate the air motion estimated from Parsivel data.

  ➔ The accuracies of the instrument for wind speed and direction were added as follows.

  “The accuracies are ±0.05 m s^{-1} for wind speed (0 to 30 m s^{-1}) and ±2 degrees for wind direction (0 to 30 m s^{-1}), respectively.”

- Equation 2: is there a meteorological site (able to measure air pressure and temperature) collocated with the Parsivel and ultrasonic anemometer? This can be useful in a better quantification of the deviation from the drop fall velocity at sea level and in quantifying the difference between using the standard atmosphere equation and the measured temperature and pressure.

- ➔ There are meteorological sites around the mountains but no sensors to measure pressure and temperature in the collocated instrument sites. One other reviewer suggested to remove the atmospheric density correction term (Beard, 1985) since the site altitudes are very low and related errors in drop fall velocity are negligible.

  So we removed that part in the equation and modified the text as follows.

  "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."

- Lines 159-160: there is no correspondence between what the authors say in the abstract (and within the text), that is the field observational site is on the Mt. Jiri at 1915 m above the sea level, and what reported here, that is the three measurement sites are at very lower altitudes. Please, uniform the information about the field observational sites.

- ➔ All the site altitudes are above sea level. AGL was changed to ASL.

- Lines 186-191: the authors cite about the analysis of 3D wind components as well as the vertical structure of the precipitation from dual-Doppler radar measurements, but data are not shown neither discussed. Please add an analysis on this or remove the statement.

- ➔ We removed the sentences as other reviewers also commented similarly on this.

They also refer to "..a daily accumulated accumulated rainfall distribution.." but they refer to the case study (as correctly reported in the caption of Figure 4). Please, uniform the text to avoid misunderstandings in the reader.

- ➔ We changed the text to avoid confusion as follows.

  "Figure 4 shows a distribution of accumulated rainfall on 1 July"

- Figure 5 and relative discussion: I agree with the authors that the trend and Parsivel w and UVW w is similar but, as already reported in the introductive part, the very low values along the whole period cannot be useful the validate the procedure, in my opinion.

- ➔ 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."

- Why Figure 6 for D4 shows three different fit lines? Do they refer to UP, DOWN and UP/DOWN together data? If it is the case, this should be mentioned in the next. Do they overlap at D1 and D2 site?

➔ Thanks for pointing this out. Yes the three fit lines are given for up, down, and up/down all data. For consistency with Figs 6a and 6b, we modified Figure 6c only with one fit line for all w data. (other two lines were removed) Each coefficient α and exponent β in the text were obtained from these lines.

- Lines 240-242: there are several more recent paper (Tokay and Short, 196, Bringi et al., 2003, niu et al., 2010 just to make a few examples) reporting different methodologies to discriminate stratiform and convective precipitation rather than a simple rain rate threshold.

➔ Yes, there have been many methods regarding discriminating stratiform and convective rainfall. The simple R threshold used in this study is just the simplest one of them. But which method that classifies rain type is used is not really important here because similar w patterns (showing the w similarity) would be expected from any method although percentages in each w group will be changed a little bit, though.

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)."

- Lines 324-330: in my opinion this is a too strong speculation. The technique is surely promising but has to be tested in different conditions (i.e. more intense vertical winds) or the authors have to more discuss about the sensitivity of the ultrasonic anemometer used to validate the technique.

"notably different characteristics in magnitude and signs and signs between the windward and leeward side…" are not so evident and in contradiction with what the authors report just below this sentence where they state the vertical wind range between -0.5 and +0.5 ms-1 for the case study.

- ➔ Yes, we agree with your point and we need to test the technique in different places and conditions. We modified the sentences 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 than 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."