Geophysical Research Abstracts
Vol. 12, EGU2010-14863, 2010
EGU General Assembly 2010

DSD comparison between Parsivel and 2D video disdrometers

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A low profile 2D video disdrometer (2DVD_lp) was installed in northern Alabama, USA, at a well-instrumented site in June 2007. The instrument has been precisely calibrated to measure size, fall velocity, and for fully melted hydrometeors, the orientation and shape of all particles falling through its 10 cm by 10 cm sensor area. Although meant originally for drop shape studies, the 2DVD_lp measurements have also been used recently for DSD comparisons with co-located Parsivel measurements. We summarize the results of our comparisons made over a period of several months.

Twelve precipitation days were selected for our initial DSD comparisons between 2DVD_lp and one of the Parsivels. Comparisons were done in terms of the mass-weighted mean diameter, Dm, the standard deviation of the mass-spectrum, Sm, and the rainfall rate, R, all based on 1-minute DSD from the two instruments.. Time series comparisons showed close agreement in all three parameters for cases where R was less than 20 mm/h. In four cases, discrepancies in all three parameters were seen for ‘heavy’ events, with the Parsivel showing higher Dm, Sm and R, when R reached high values.

It was also noted that there were arbitrary differences in the time stamps between 2DVD and the Parsivel. A technique based on interpolation and time-shifting to determine the best cross-correlation was devised to correct for the time-lags. The resulting histogram of the differences in Dm for a 24 hour event showed a narrow and symmetric distribution, with mean equal to -0.042 and a standard deviation of 0.121.

Exceedance probability of Dm Sm and R were also compared. There was excellent agreement between the 2 instruments for Dm up to around 2 mm. Around 10% of the samples considered had Dm greater than 2 mm, and at this time percentage, the two exceedance curves started to diverge, with Parsivel showing higher number of cases for a given Dm. Similar divergences were observed for Sm at around 0.8 mm, again corresponding to 10% exceedance probability, and for R at around 25 mm/h, corresponding to 3% exceedance probability.

Possible causes for the discrepancies in Dm Sm and R were investigated. In the four cases where significant discrepancies had been observed, the Parsivel measurements had indicated ‘GR’ (or graupel) around the time of the deviation. Drop-by-drop data from the 2DVD was examined for one case. Whilst nearly 99% of the hydrometeors followed the Gunn-Kinzer curve for the fall-velocity (to within 15%), the remaining 1% had fall velocities significantly higher. Even though this event was rain dominated, when simulations were done to ‘mimic’ what Parsivel might measure, the 1% of the non-fully-melted hydrometeors (along with other factors) was shown to possibly cause an increase in Dm due to an ‘artificial’ upward shift in the assigned equivalent drop diameter, Deq.

We also present here Parsivel-to-Parsivel comparisons as well as comparisons between 2DVD_lp and the latest generation 2DVD, namely the compact unit (2DVD_c) which was installed at the same site in Nov 2009. These comparisons were made to assess the inter-instrument differences versus the intra-instrument differences.