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Comparison of three types of disdrometers under natural rainfall conditions

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Accurate and comparable rainfall measurements are important in many fields of research in order to assure detailed knowledge of rainfall characteristics. The use of ground-based rainfall measurement devices such as disdrometers has allowed for more detailed information on rainfall characteristics. The disdrometers use a laser beam to measure drop size and velocity. However, due to drop deformation, differences in instrument design, resolution, sample area and data handling of each device the direct comparison of rainfall data from different types of disdrometers is hindered. Thus, there is a need for further knowledge on the types of disdrometers and their intercomparability. In this study, a comparison of three types of disdrometers placed at the same site under natural rainfall conditions was carried out.

The following disdrometers were investigated in the study: The Present Weather Sensor PWS100 by Campbell Scientific (PWS), the Laser Precipitation Monitor by Thies Clima (Thies) and the Present Weather Sensor OTT Parsivel by OTT Hydromet (Parsivel). Two disdrometers of the type PWS were used in this study and they will be referred to as PWS 1 and PWS 2 hereafter. The precipitation gauge OTT Pluvio2 (RG) from OTT Hydromet was used as a reference for the rainfall measurement. Measurements were carried out from August to October 2018 in Petzenkirchen, Lower Austria, Austria.

The results from five analysed events show that all disdrometers underestimated the accumulated rainfall amount compared to the rain gauge. The best agreement with the rain gauge was by the PWS 1 with a mean absolute error (MAE) of 0.5, thereafter PWS 2 (MAE=1.6), then Thies (MAE=2.6) and Parsivel had the lowest overall agreement with the RG (MAE=2.9). The two PWS disdrometers had equal mean drop size and similar mean drop fall velocity. Thies had both lower mean drop size and mean velocity, whereas Parsivel had similar mean drop size to PWS 1 and 2, but a higher mean velocity. The drop size-velocity distribution revealed that Parsivel measured drops < 1 mm in diameter to have higher velocities. Thies measured much more drops and smaller drops than the other disdrometers. This could be a result of break-up of drops after splashing on the instrument, which would also explain the smaller mean drop size and lower mean velocity. Kinetic energy (KE) per mm rainfall was nearly identical for PWS 1 and 2. Parsivel measured 12 % less KE/mm than the PWS disdrometers, while Thies measured 31 % less, which can also be explained from the drop size-velocity distributions.

The two PWS disdrometers also showed deviating accumulated rainfall amount measurements. However, the drop size distribution and velocity measurements as well as KE/mm rainfall showed similar values. This shows the need for calibration even within disdrometers of the same type.

This study revealed the difficulty in using data from different rainfall measurement devices. A rain gauge and three types of disdrometers showed considerable variability between them, even though they were all placed at the same site.