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Influence of disdrometer type on rainfall kinetic energy measurement

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Rainfall kinetic energy (KE) is an important indicator for the potential soil loss due to rainfall in erosion risk assessment. Kinetic energy-intensity (I) relationships have been developed as a means to calculate the KE of rainfall, when only the rainfall intensity is known. The direct measurement of KE has been enabled due to the use of disdrometers, which measure the size and velocity of raindrops. Previous measurements have shown that rainfall measurements for the same site differed among disdrometer types. Therefore, the best fitting KE-I relationship is likely dependent on the type of disdrometer. In this study, the influence of the disdrometer-specific drop size and velocity measurements on the formulation of new KE-I relationships as well as the fit of existing equations from literature was investigated. Disdrometer rainfall data was collected in 1-minute intervals from six laser-based disdrometers. Two disdrometers of each of the following three types were compared: the PWS100 Present Weather Sensor from Campbell Scientific, the Laser Precipitation Monitor from Thies Clima and the first generation Parsivel from OTT Hydromet. The disdrometers were set up individually at sites in Austria, Czech Republic and New Zealand. Rainfall was measured between 2014 and 2019 with varying amounts of collected data for each site. The results revealed the inherent differences in drop size and velocity distribution estimation between different types of devices. The same pattern of rainfall drop size and velocity distribution could be seen for disdrometers of the same type despite spatial separation. This indicates that actual spatial differences in rainfall characteristics may be difficult to discern when comparing data from different types of disdrometers. New exponential KE-I relationships based on disdrometer data were formulated for each site and device. To confirm the use of the new KE-I equations, one of the equations was validated using rain gauge data from the same site. The best fit of literature KE-I equation varied among sites and devices. The relationship employed in the Revised Universal Soil Loss Equation (RUSLE) always underestimated KE with a percent bias ranging from -2 to -30 %. This study highlights the differences in disdrometer rainfall kinetic energy measurements and how these influence the formulation and evaluation of KE-I relationships, which are important in rainfall erosivity studies.