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Quantifying and Mitigating Wind-Induced Undercatch in Rainfall Measurements

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Despite the apparent simplicity, it is notoriously difficult to measure rainfall accurately because of the challenging environment within which it is measured. Systematic bias caused by wind is inherent in rainfall measurement and introduces an inconvenient unknown into hydrological science that is generally ignored. This paper examines the role of rain gauge shape and mounting height on catch efficiency (CE), where CE is defined as the ratio between non-reference and reference rainfall measurements. Using a pit gauge as a reference, we have demonstrated that rainfall measurements from an exposed upland site, recorded by an adjacent conventional cylinder rain gauge mounted at 0.5m, were underestimated by more than 23% on average. At an exposed lowland site, with lower wind speeds on average, the equivalent mean undercatch was 9.4% for an equivalent gauge pairing. An improved-aerodynamic gauge shape enhanced CE when compared to a conventional cylinder gauge shape. For an improved-aerodynamic gauge mounted at 0.5m above the ground, the mean undercatch was 11.2% at the upland site and 3.4% at the lowland site. The mounting height of a rain gauge above the ground also affected CE due to the vertical wind gradient near to the ground. Identical rain gauges mounted at 0.5m and 1.5m were compared at an upland site, resulting in a mean undercatch of 11.2% and 17.5%, respectively. By selecting three large rainfall events and splitting them into shorter duration intervals, a relationship explaining 81% of the variance was established between CE and wind speed.