A precision raindrop generator to calibrate non-catching rain gauges

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Abstract:

The need for high-resolution and low maintenance weather stations is the major factor behind the increasing adoption of Non-Catching Gauges (NCGs) by national weather services and research institutions. Data from such instruments are used for several applications and in numerous research fields, where instrumental biases can have a strong impact. For NCGs, rigorous testing and calibration are more challenging than for catching gauges. Hydrometeor characteristics like particle size, shape, fall velocity and density must be carefully reproduced to provide the reference precipitation, instead of the equivalent water flow used for the calibration of catching gauges. Instrument calibration is usually declared by the manufacturers, using internal procedures developed for the specific technology employed. No standard calibration methodology exists, that encompass all or at least most of the available NCGs (Lanza et al. 2021). The EURAMET project 18NRM03 'INCIPIT' on the 'Calibration and accuracy of non-catching instruments to measure liquid/solid atmospheric precipitation', was initiated in 2019 to address such issues.

A calibration device was developed to achieve individual drop generation on demand and in-flight measurement of the released drops. Water drops in the range from 0.5 to 6 mm in diameter are generated to mimic natural raindrops. A high-precision syringe pump is used to form the drop of the desired volume at the tip of a calibrated nozzle. A high-voltage power supply is used to apply a large potential difference between the nozzle and a metallic ring, and the resulting electric field triggers the release of the drop. A precision motorized gantry moves the generator across the horizontal plane, to cover different releasing positions within the instrument sensing area. By either varying the release height or accelerating the drop using compressed air, different fractions of the terminal velocity can be achieved, depending on the drop size. A second gantry, just above the gauge under test, aligns the plane of focus of a high-resolution camera with the fall trajectory of the drop. Three images of the same drop are captured in a single picture, using speedlights triggered at fixed time intervals. Photogrammetric techniques and a photodiode to measure the time between flashes provide the shape, size, speed, and acceleration of the drop. This characterizes each released drop before it reaches the instrument sensing area and, by comparison with the gauge measurement, the instrumental bias is obtained. Laboratory tests are presented to assess the performance of the calibration device.

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References:

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