EGU24-11487, updated on 26 Jun 2024
https://doi.org/10.5194/egusphere-egu24-11487
EGU General Assembly 2024

Laboratory calibration of non-catching rain gauges using a precision raindrop generator

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Non-Catching Gauges (NCGs) are instruments used to measure precipitation without the need to collect the equivalent water volume in a reservoir. They sense each hydrometeor individually, often using a contactless approach, providing measurements of the relevant microphysical properties of precipitation. These gauges offer several advantages over traditional catching gauges, making them an invaluable source of data for numerous research applications. However, NCGs, like catching-type gauges, are susceptible to measurement biases from both instrumental and environmental sources. To assess instrumental biases, rigorous testing and calibration are required, which can be more challenging than for catching gauges. In fact, to provide reference precipitation, it is necessary to carefully reproduce hydrometeor characteristics such as particle size, shape, fall velocity, and density. Calibration is therefore typically delegated to manufacturers, who may use undisclosed procedures that cannot be traced to the international standards (see Lanza et al. 2021 for a review).

In this work, we use an existing precision raindrop generator, as detailed in the work of Baire et al. (2022), to verify the performance of optical NCGs that employ two different measuring principles. During laboratory tests, drops ranging from 0.6 to 5 mm in diameter were released from a height of 1.2 m over the instrument sensing area. At least 50 drops were generated for each combination of drop diameter and gauge tested. The generator independently measured the diameter and fall velocity of each released drop using a photogrammetric approach, providing a traceable reference for the calibration. The percentage errors for both the measured drop size and fall velocity were computed by comparing gauge measurements against the reference drop, either drop by drop (when the gauge provides the raw data) or in terms of Particle Size and Velocity Distribution (PSVD) matrix (for all gauges). Additionally, by assuming a literature Drop Size Distribution (DSD) and integrating measured and reference microphysical properties over the range of drop diameters tested, the percentage error for rainfall intensity measurements was also computed. The gauges tested show significant biases in both microphysical and integral properties, with the latter being larger than what is generally expected from traditional catching gauges.

The development of the precision raindrop generator was funded as part of the activities of the EURAMET project 18NRM03 "INCIPIT Calibration and Accuracy of Non-Catching Instruments to measure liquid/solid atmospheric precipitation". The project INCIPIT has received funding from the EMPIR programme co-financed by the Participating States and from the European Union's Horizon 2020 research and innovation programme. Laboratory testing of NCGs was carried out in the framework of the Italian national project PRIN2022MYTKP4 "Fostering innovation in precipitation measurements: from drop size to hydrological and climatic scales".

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