

On the wind-induced undercatch in rainfall measurement using CFD-based simulations

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The reliability of liquid atmospheric precipitation measurements is a basic requirement since rainfall data represent the fundamental input variables of many scientific applications (hydrologic models, weather forecasting data assimilation, climate change studies, calibration of weather radar, etc.). The scientific community and the National Meteorological Services worldwide are facing the issue of improving the accuracy of precipitation measurements, with an increased focus on retrieving the information at a high temporal resolution. The rainfall intensity is indeed fundamental information for the precise quantification of the markedly time-varying behavior of precipitation events.

Environmental conditions have a relevant impact on the rain collection/sensing efficiency. Among other effects, wind is recognized as a major source of underestimation since it reduces the collection efficiency of the catching-type gauges (Nespor and Sevruk, 1999), the most common type of instruments used worldwide in the national observation networks.

The collection efficiency is usually obtained by comparing the rainfall amounts measured by the gauge with the reference, which was defined by EN-13798 standard (CEN, 2002) as a gauge placed below the ground level inside a pit. A lot of scatter can be observed for a given wind speed, which is mainly caused by comparability issues among the tested gauges. An additional source of uncertainty is the drops size distribution (DSD) of the rain, which varies on an event-by-event basis.

The goal of this study is to understand the role of the physical characteristics of precipitation particles on the wind-induced rainfall underestimation observed for catching-type gauges. To address this issue, a detailed analysis of the flow field in the vicinity of the gauge is conducted using time-averaged computational fluid dynamics (CFD) simulations (Colli et al., 2015). Using a Lagrangian model, which accounts for the hydrodynamic behavior of liquid particles in the atmosphere, droplets trajectories are calculated to obtain the collection efficiency associated with different drop size distribution and varying the wind speed. The main benefit of investigating this error by means of CFD simulations is the possibility to single out the prevailing environmental factors from the instrumental performance of the gauges under analysis. The preliminary analysis shows the variations in the catch efficiency due to the horizontal wind speeds and the DSD. Overall, this study contributes to a better understanding of the environmental sources of uncertainty in rainfall measurements.

References:

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