EGU22-7871
EGU General Assembly 2022

Influence of the drop size distribution on the collection efficiency of catching gauges as a function of rainfall intensity

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Adjustments of the wind-induced bias of conventional catching type rain gauges derive from collection efficiency (CE) curves that can be obtained either from field experiments or from numerical simulation (Lanza and Cauteruccio, 2021). The use of numerical simulation allows to overcome the limitations of the experimental installations and monitoring campaigns (e.g., the many influencing variables involved and the variability of the rainfall process) to cover a wide range of wind speed and rainfall intensity (RI) conditions. Also, the accuracy of the measurements taken as a reference is still an issue in field experiments.

A Lagrangian particle tracking (LPT) model, suitably validated in the wind tunnel (see Cauteruccio et al., 2021), is applied to the results of computational fluid dynamic (CFD) simulations of the airflow field surrounding a rain gauge to derive a simple formulation of the collection efficiency curves as a function of wind speed (Cauteruccio and Lanza, 2020). A new parameterization is proposed to highlight the influence of rainfall intensity, based on the typical form of the drop size distribution (DSD) of rainfall events (data from the Italian territory). The methodology is applied to a cylindrical gauge, which has the typical outer shape of most tipping-bucket rain gauges, as a representative specimen of operational measurement instruments.

Using rainfall intensity as a controlling factor for the collection efficiency has solid physical bases in the relationship between RI and the DSD (Colli et al., 2020), and the role of RI can only be quantified using numerical simulations of both the airflow field (using CFD) and the particle motion (via the LPT).

A simple formulation of the adjustment curves is obtained, which can be easily applied in an operational context, since wind velocity is the only ancillary variable required to perform the adjustment. Wind is often measured by operational weather stations together with the precipitation intensity, so the correction adds no relevant burden to the cost of meteo-hydrological networks.

References

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