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Wind effect on rain gauge measurement: A new approach to an old problem

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The authors discuss development of a Large Eddy Simulation (LES) based Computational Fluid Dynamics (CFD) model of rain gauge measurement of rain and its experimental validation. Wind-induced underestimation of rainfall measurements by rain gauges has been long recognized. Correction procedures have been developed based on experimental studies, but their effectiveness has been questioned because the wind effects are still not fully understood. As a result, the hydrologic community uses rainfall data of unknown systematic and random errors, and is unable to separate the effects of natural variability from observational uncertainties. The errors propagate further into the remote sensing rainfall estimates that are calibrated and validated using rain gauge data. This pathological situation has negative consequences for all areas of hydrometeorological research and practice.

The authors propose a comprehensive approach to study this problem using the best currently available techniques. They discuss use of a combination of computational and empirical experiments to model and quantify the effects of wind on in-situ measurements of rainfall. The empirically-driven computational experiments use Large Eddy Simulation method for two-phase flows taking into account both the geometry of the measurement devices and the microphysical structure of rainfall. The numerical simulations of the rain drop behavior in turbulent wind field includes two-way coupling between the particles and the flow field. The empirical experiments use redundant setups with multiple devices of the same kind to account for the instrumental errors and to reduce uncertainties in the experiment itself. The wind field and its turbulence characteristics are monitored by high-resolution ultrasonic probes. Laser precipitation monitors are used to monitor drop size distribution and high-speed digital

video cameras record the drop trajectories. Wind tunnel is used to study the effect of debris screens used inside of the rain gauges and fences often deployed around them to mitigate the wind effects. Following international standards, the accurate reference is provided by three carefully calibrated pit-gauges. The authors present the results obtained up to date.