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A deterministic approach to define the useful integration time for in-situ precipitation observations

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The Precipitations are due to complex meteorological phenomenon and can be described as intermittent process. Theirs spatial and temporal variability is significant and covers large scales. These precipitation properties induce a very strong constraint on the measurement, which must be as continuous as possible, both in time and in space. . In particular, studies of climate change need high-resolution rainfall with resolutions much higher than 1 hour to obtain statistics of extrem rainfall and wet and dry spell duration.
For all these reasons, several instruments were used for the observation of precipitations, of which the tipping bucket rain gauge is the oldest and the most commonly used for the precipitations in-situ measurements.
Each specific device properties can induces systematical occurring errors that can lead to statistical biases. For example, for low precipitation, the tipping bucket rain gauge, records false dry periods.
So, during the past few years, other instruments more accurate than the tipping bucket rain gauge (eg disdrometer and weighting rain gauge) were placed for in-situ observation but their costs hinder the installation of large networks
The present study focuses on the impact of the rain gauge volume. The aim is to define a minimal integration time according to the bucket volume for a given climatic region
Our study focuses on Ile-de-France, this French region is a relatively dry region if we consider the annual amount of precipitation: 600 mm, a rainy region if we consider the number of days of precipitation per year: 160 days. It records Strong storm events sometimes but its precipitations are dominated by low rainfall. Eight year time series observed with a disdrometer and different rain gauges located on the French Atmospheric Research Observatory (SIRTA) , are used.
Simulated tipping bucket rain gauge series for different tipping bucket volumes and weighting rain gauge series for different weights as precision are performed. The purpose of the simulation was to ignore other effects (evaporation, spatial variability…). The simulated series are compared to the observed ones (PDF,CDF, rain peak intensity, occurrence, amount, duration, intensity …) to validate the simulation process.
Then, using the simulated series we first studied the two effects of 1-the tipping bucket volumes(resp. weights precision) and 2-the time resolution on precipitations characteristics (occurrence, standard-derivation, rain peak intensity, amount, duration, intensity, …). Secondly we proposed a method to identify the best time resolution for a used tipping bucket volumes (resp. weights precision).C) As an example, for integration time of one hour a corresponding tipping bucket of 0.15 mm is necessary while a weight precision of 0.01 mm is necessary if a 6 min time resolution is used. The relationship between the tipping bucket volumes and the minimal integration time is climatic dependent. We thus test the proposed method and criterion with other datasets for different climatic regions to study the climatic specificities.
Finally, a new criterion is also proposed to quantify the loss of variability information as a function of time resolution.