

The laboratory rain gauges intercomparison: Results and operational network applications

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Introduction

Our laboratory dedicated to rain measurement in Trappes has participated in the WMO Laboratory Intercomparison of Rainfall Intensity Gauges in 2004-2005. One of the conclusions was that tipping bucket rain gauges with appropriate correction to reduce losses at high rainfall intensities, provided good measures. In Météo-France operational networks, tipping bucket rain gauges are widely used. Post-processing corrections are applied in Automatic Weather Stations. This poster sums up our activity concerning correction of tipping bucket rain gauges in operational network.



The field experiment at Trappes: various screens, masts with wind sensors, rain gauges...

Rain Gauges Studies in Trappes

Our laboratory is part of the Direction of Observation Systems at Météo-France.

Both our large field experiment and our laboratory have permitted several field and laboratory tests of rain gauges for Météo-France needs. For field studies a large pit gauge is used. Laboratory studies are carried out with our two calibration benches.

The Météo-France laboratory uses a bench composed of an electronic balance and a peristaltic pump, both connected to a standard PC with dedicated software. A water container is weighed. Water is injected through a tube into the buckets by a peristaltic pump. This pump is also controlled by the PC, both for its flow rate, start and stop. This bench allows the generation of intensity from 3 mm.h⁻¹ up to 2000 mm.h⁻¹ intensity range.



One of the two rain gauge calibration benches of Météo-France

The range may be adjusted by the selection of different tubes. The tip detector (such as a contact closure) for tipping buckets is connected to a junction signal of a RS232 line of the computer. The measure of mass for weighing gauges or the conductivity converted in rain accumulation for other rain gauges are available also on a serial line. The dedicated software controls the pump, sets a given intensity, counts a selected number of tips (or records mass or conductivity) and gets the mass variation of the water container. It outputs the rain gauge measured precipitation quantity, compared to the decrease in mass on the balance, and calculates the difference expressed in percentage. The uncertainty associated with the calibration bench is about 1%. It depends on the duration of the test and the amount of water used.

A succession of tests at various intensities can be programmed, leading to an automatic establishment of an intensity error curve.

The WMO Laboratory Intercomparison of Rainfall Intensity Gauges

During this intercomparison, 19 models of rain gauges were tested in laboratory conditions for measuring rainfall intensity. Among them, 12 were tipping-bucket rain gauges:

- 4 did not have any correction system;
- 3 had mechanical systems to limit high intensity losses;
- 5 had post-processing correction.



Four rain gauges that were tested during the intercomparison: the Waterlog, the PAAR, the Lambrecht and the Serosi

The Rain Gauge Précis-Mécanique

The Précis-Mécanique rain gauge model 3050 is equipped with a tipping bucket mechanism with deflectors in order to reduce losses at high rain intensities.

The collecting area is 1000 cm². Buckets tip for 20 grams of water, so the resolution is 0.2 mm.



Rain gauge Précis-Mécanique in Trappes field test

Each tip produces a contact closure: in older version this rain gauge was equipped with a mercury switch, as on picture. In current version, the tipping bucket mechanism with a magnet activates a sealed reed switch. Without correction, the accuracy of this rain gauge is better than 8 % depending on rain intensity. It is calibrated to give an error of 3 % at 50 mm per hour.

Précis-Mécanique rain gauges are widely used in Météo-France networks:

- about 800 in metropolitan France ;
- about 100 in France's overseas territories.

In addition to the special tipping-bucket mechanism, post-processing corrections are applied in the automatic weather station.

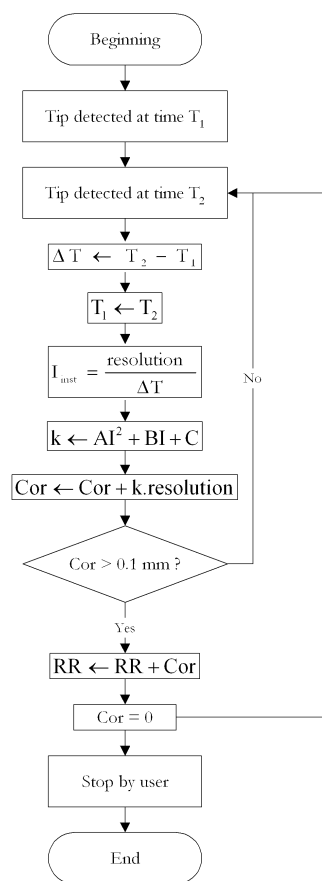


Tipping bucket system of Précis Mécanique rain gauge

Corrections Applied in Automatic Weather Stations for Rain Measurement

Several laboratory tests have enabled us to establish an average correction curve fitted with 2nd-degree-polynomial equation. Indeed this rain gauge provides repeatable measurement, essential quality to generate accurate corrections.

The corrections for rain measurement are applied in Automatic Weather Stations in the following way. At each tip, the instantaneous intensity is calculated, corresponding to the rain gauge resolution divided by the time between two tips. Then the correction factor *k* is evaluated. Eventually the corrected accumulation is calculated. When this accumulation is greater or equal to 0.1 mm, it is added to the next measurement.



Another way of calculation is also used: the average one-minute intensity is obtained from the number of tips per minute. The correction is calculated and summed up. When the accumulation of corrections is greater than 0.05 mm, 0.1 mm is added to the one-minute accumulation and 0.1 mm is subtracted from the accumulation of corrections.

References

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