The 2022 WMO Technical Conference on Meteorological and Environmental Instruments and Methods of Observation (TECO-2022)

10-13 October 2022, Paris (France)

The INCIPIT project: calibration and accuracy of non-catching instruments to measure liquid/solid atmospheric precipitation

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Abstract:

"INCIPIT – Calibration and accuracy of non-catching instruments to measure liquid/solid atmospheric precipitation" is a joint research project funded by the European Metrology Programme for Research and Innovation (EMPIR) of EURAMET, the European Association of National Institutes of Metrology. The World Meteorological Organization is partner of this project, acting as "Chief Stakeholder" since the project is addressed to deliver normative proposal and recommendations for calibration of meteorological instruments. The project has two main overall aims, namely (i) to develop calibration procedures for non-catching instruments measuring liquid/solid atmospheric precipitation and (ii) to understand and evaluate the uncertainty components and influence parameters for non-catching precipitation instruments. Among the specific objectives, the project includes the development of traceable methods and dedicated facilities for the calibration of non-catching precipitation instruments and the assessment of model functions, including the relevant input and influence parameters. This contribution reports a summary of the results of the project.

1. Introduction

An initial investigation was performed to review the state-of-the-art of the various non-catching precipitation measuring instruments manufactured by the industry of hydrometeorological sensors, including their working principles, technical characteristics, and calibration practices. This review was not yet available in the literature, was essential as the starting point of this project and constitutes an original result. Indeed, further to the project deliverable, a scientific paper was published in an international peer-reviewed journal containing a synthesis of the results (Lanza et al., 2021). The work allowed to identify the main working principles used, and to categorize them into optical, acoustic, and radar -based sensors. The most used instruments employ contactless sensors, based on optical principles, including infrared laser beam occlusion and light scatter as induced by the falling hydrometeors moving through the field-of-view of the instrument. Sensors for detecting the impact of hydrometeors on a solid surface are also used, although interacting with the measurand in this case, while radar-based instruments are less common. The review revealed that calibration is generally performed by the instrument manufacturer, occasionally from researchers in dedicated studies, but a commonly agreed procedure is still lacking, and traceability seldom addressed. The currently adopted calibration techniques were reviewed and criticized in view of the development of a new traceable calibration procedure. Suitable concepts and components were identified, together with the missing or inconsistent aspects that were included into the project focus points.

2. Drop generator devices

To enable testing of non-catching instruments to measure liquid atmospheric precipitation, a system that can mimic real precipitation is required. The reason is that such instruments measure the total precipitation in the form of the sum of the individual drops, in contrast to the case for more traditional instrument types (e.g., tipping bucket or gravimetric), which are focussed on the total amount of precipitation. Thus motivated, two different drop generators for calibration purposes (DG1 and DG2) were developed during the project as well as a third generator (DG3) for testing purposes.

The first raindrop generator (DG1, Figure 1) is composed of 1) a nozzle/needle, 2) a volumetric pump and 3) a piezo-electric membrane (a "buzzer"). This raindrop generator was designed for drop diameters ranging from 0.2 mm to about 7 mm. The corresponding volume range covers more than four orders of magnitude, and hence several different physical principles for drop formation are required to cover this range. The largest drops (> 4 mm) are produced as free-falling drops using a special nozzle. Drops in the diameter range of 1 – 4 mm are produced from flat-tipped needles. These drops are not free falling, and instead the release of the drops is initiated by a pulse from the piezo-electric membrane. Drops with a diameter smaller than 1 mm are ejected from within the inside of a small nozzle. In the latter case, the piezo-electric membrane (the "buzzer") makes a pulse, causing a small amount of water to be ejected rapidly.

Figure 1: Left: The raindrop generator DG1 with the pump and the buzzers and nozzles; nine different nozzles are employed for different drop sizes. Generation of a large drop (centre, left), a medium-sized drop (centre, right) and a small drop (right) with four steps in the formation process being visualised.

A second raindrop generator (DG2) to calibrate non-catching precipitation measuring instruments is described in a companion paper (Chinchella et al., 2022). The reader is referred to that paper for additional details.

Two high-precision syringe pumps, with a capacity of 20 and 1 ml (and piston diameters of 20 and 4.5 mm, respectively), are used to produce water drops of the required volume (see Figure 2). An electric field, generated by a high voltage trigger, allows releasing each single drop on demand. Each drop is generated at the tip of a suitable nozzle by dispensing the necessary volume to achieve the desired drop size and then detached by exploiting a 5 kV potential difference, where the water is negatively charged and attracted by a metal ring (positively charged), positioned just below the tip of the nozzle. By using different nozzles/needles and the proper syringe pump, drops of various size are produced.

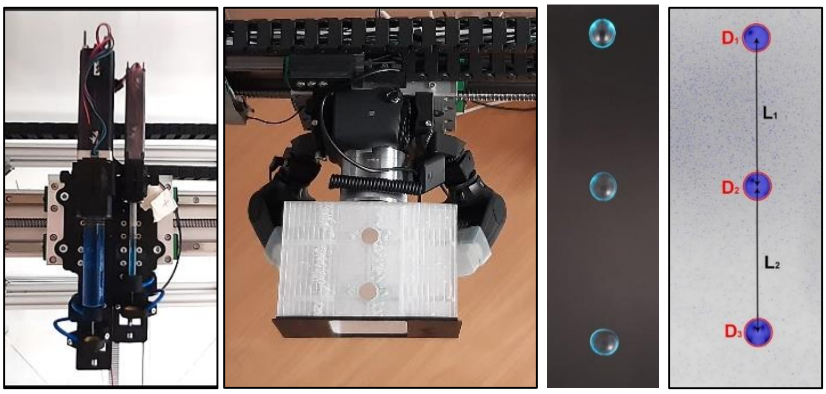


Figure 2: From left to right: DG2 – double-syringe pump for drop formation and detachment, photogrammetric device for the verification of the generated drop size and velocity, and sample image of a single water drop in flight as captured three times in the same picture by the photogrammetric device with the same image reported, after software processing elaboration, to show the detected equivolumetric circular shape of the drop (D1 to D3, in red) and travelled distances (L1 and L2).

To verify the size and fall velocity of the generated drops just above the sensing area of the instrument under test, a photogrammetric device is included in the drop generator assembly (see Figure 2). The system uses a high-resolution camera (Sony a6100) equipped with two flashes, which are triggered three times in a very short sequence (at 4.2 ms intervals) to capture three images of each drop in flight within a single picture (see Figure 2, third image). The timing for the activation of the speedlights and the opening of the camera shutter are defined based on a numerical model of the drop vertical acceleration in still air. Each image is processed by a dedicated software to derive the drop size (equivolumetric diameter) and fall velocity. An example of the processed images is reported in the right-hand side of Figure 2, where a single drop in three different positions is shown with the automatically detected drop circular contour (in red).

The third drop generator (DG3) was designed with the specific purpose to be used in lab to investigate the errors of different types of non-catching rain gauges (disdrometers) due to multiple simultaneous drops being detected as a single large drop or drops falling at the edge of the detection area and the influence of environmental conditions (temperature, humidity) on instrument responses. DG3 fulfilled the following specific requirements: controlled drops of uniform sizes, possibility to control drop fall position inside the measurement area, possibility to change the falling frequency and the possibility to test for 2 or 3 drops falling in the measurement volume in different positions. The treatment of information in non-catching instruments assumes that only one drop is present in the measurement volume. To test the instrument response when this is not the case the drop generator must be able to release simultaneously 2 drops that will cross at the same time the measurement area. DG3 uses three peristaltic pumps and different nozzles geometries to generate drops. The nozzle is mounted on a moving metallic structure to allow easy change of the droplet position inside the measurement area. The displacement of the nozzle is controlled by two motors (stepper motor and servo motor). Both nozzle displacement and pumps parameters are controlled through a computer interface. The system is mounted on a metallic structure. Top and lateral photographs showing the constructive elements of the DG3 are shown in Figure 3.

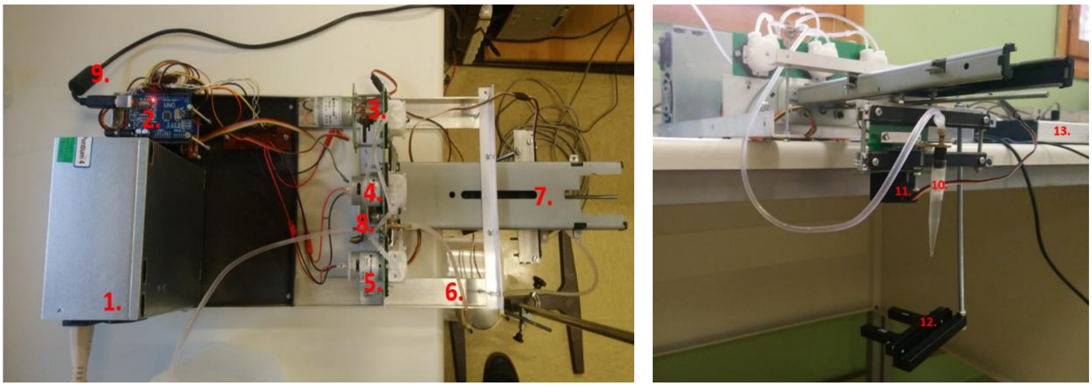


Figure 3: Top and front views of the DG3: 1- power supply; 2 - Arduino control board; 3,4 and 5 - the 3 peristaltic pumps; 6 - output tube of the pump going to the nozzle; 7 - rails for the movable part; 8 (under the pump 4) - stepper motor; 9 - USB connection to the computer; 10 - nozzle (can be changed); 11 - servo motor for lateral movement; 12- photodiode detector linked to 13 - StopShot trigger system.

One of the pumps (#3 on Figure 3) was decoupled to obtain slower speed and the 3 pumps are connected to the same tube, itself connected directly to the nozzle. This nozzle is attached to a servo motor (#11 on Figure 3) and the servo motor itself is fixed on a moving part, linked to the stepper motor by a linear screw, allowing a slide movement along the screw. At the side of the nozzle, a long screw allows to suspend a photodetector (#12 on Figure 3). This is the sensor of a commercial system, StopShot, that can fire 3 different triggers at different temporal intervals after a detection by the photodetector. One of the trigger outputs is redirected to a counter, allowing to keep track of the count of drops that passed through the photodetector.

The drop generator designed and constructed at SMD generates spherical unperturbed drops at a frequency between 2 and 17 drops/s. The 5 nozzles already available and characterized generate drops with sizes ranging from 2.2 to 4.9 mm. Other sizes may be generated with different nozzles, but small drops might be difficult to produce. One of the nozzles releases 2 identical drops simultaneously. The moveable frame allows to change the position of the droplet falling inside the measurement volume in order to test possible detection errors related to the position.

3. Calibration uncertainty model

A model for the calibration uncertainty of non-catching precipitation gauges was proposed and detailed. The approach is based on separating uncertainty components into blocks. This gives a flexibility on designing a calibration procedure by combining different blocks (i.e., changing the drop generator or the type of instrument). The model is detailed in Baire et al. (2022).

The first block element for this model is grouping the sources of uncertainties related to the reference droplet diameter. The second block is related to the disdrometer itself and to its physical principles of operation. Impact, radar or optical disdrometers will show specific uncertainties that can be further explored starting from the specific model equations. One common component is related to the discretization, this latter being not only principle dependent but also manufacturer dependent. The block related to instruments will also include the influence of environmental parameters. The third block in the model groups the effects related to the signal treatment. The information on filtering and calculation algorithms is not publicly available but we observed significant differences in rain intensity values indicated by the instrument and those computed using raw data when available. The main filtering component is related to final velocity of the falling drops, and this might be a major concern when developing an easy to implement calibration procedure. The drop generator needs to either eject drops with an initial velocity or be placed at a height that will ensure reaching the final velocity by free fall, this latter option being not easily obtained in normal laboratory buildings.

The modelling approach proposed in this work depicts the cause-and-effect relationships of the measurements to be analysed and modelled as a block diagram. The block diagram uses three types of standard blocks:

- Parameter sources (SRC): providing measurable quantity.
- Transmission units (TRANS): any kind of signal processing and influencing.
- Indicating units (IND): indicate input quantities.

The two-staged model proposed for the calibration uncertainty of non-catching precipitation gauges is presented in Figure 4. The instruments studied here use drops as measurable quantities, transformed into either Particle Size Distribution (PSD) or Particle Velocity and Size Distribution (PVSD)—depending on the working principle of the instrument. Some instruments provide values for those distributions, others do not. Either way, values of sizes (and velocities) are then used by the instrument to compute the Rainfall Intensity. Therefore, the first IND block, IND1 in Figure 4, is also a parameter source for the indication of rain intensity given by the instrument.

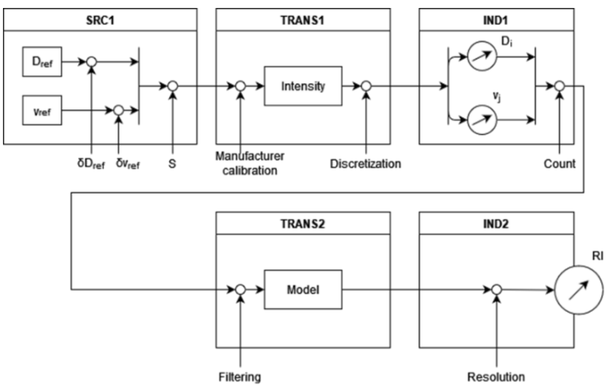
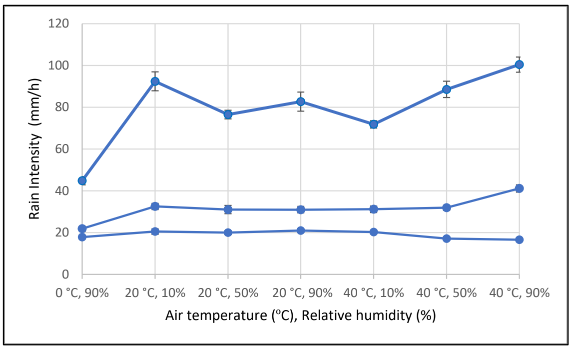


Figure 4: Uncertainty model for non-catching precipitation gauges.

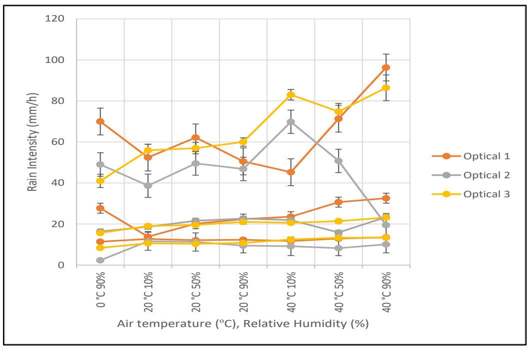
Furthermore, the study of the impact of wind as a major environmental influencing factor on the sensor area for a sample non catching gauge (NCG) was performed. Indeed, according to the measuring principle exploited, NCGs have complex, often non-axisymmetric outer designs because of the geometric constraints imposed by the sensor used. The work demonstrated that such components are significant in the case of the Thies LPM precipitation gauge and quantified their magnitude using CFD simulation, suitably validated against dedicated WT flow velocity measurements. The wind direction is found to be the most relevant influencing factor in determining the magnitude of the airflow perturbation, due to the non-axisymmetric geometry of the gauge. This must be considered when interpreting measurements obtained in windy conditions, since the positioning of the instrument in the field is constrained by the sensor specifications and cannot be aligned with the predominant wind at the installation site to minimize this effect. Results are summarised in Chinchella et al. (2021).

In addition, the evaluation of the influence of air temperature and humidity on different models of non-catching precipitation instruments were performed. This study was performed under controlled environmental conditions in a 2-m-high climate chamber. The drop generator, designed and manufactured by SMD and previously characterized in terms of its sensitivity to air temperature and humidity variations was used as stable standard. The previous characterization of the drop generator demonstrates that its sensitivity to air temperature variations is low enough to be used for the characterization of the non-catching rain instruments. In addition to the drop generator, the following instrumentation was involved: Calibrated thermometers (Pt-100), an anemometer, hygrometer and a calibrated scale ($U(k = 2)$ =0.10 mg).

A special configuration of the position of the drop generator and the instrument under study was defined to minimize the measurements dependence on the air currents, generated inside the climate chamber with the purpose of reaching isothermal conditions. Despite this fact, special attention was paid to fit each generated drop into the sensing area of the rain instrument in each measurement. Figure 5a shows the variation of one impact disdrometer readings under different air temperature and humidity conditions and for different stable reference rain intensities. The vertical bars are the standard deviation of all measurements taken during a specific time interval (10 min) and this time interval was the same for all the environmental conditions points. Figure 5a suggests that the dependence of impact disdrometers with air temperature and humidity is stronger for high rain intensities and at low temperature.



a)



b)

Figure 5: a) Dependence of one impact disdrometer on the air temperature and humidity conditions, for different constant reference rain intensities; **b)** Dependence of three different models of Optical disdrometers with air temperature and humidity conditions and for different stable reference rain intensities.

Three different models of optical disdrometers were also studied and the results are summarized in Figure 5b, where the vertical bars are the standard deviation of the measurements performed at each environmental condition. As in the case of impact disdrometer, 10 minutes was defined as the measurements' interval in all cases. As in the case of impact disdrometers, the influence of air temperature and humidity is more evident for high intensity rates and for extreme conditions of air temperature and humidity.

4. Calibration and uncertainty budget

In the case of DG1, the metrological traceability of the volume of the generated drops was achieved through time (i.e., drop frequency), density, and flow. The total uncertainty on the drop size was 0.5 % (k=2). The dominating contribution to the uncertainty of the drop volume originated mainly from the flowrate calibration of the pump. This calibration was performed in the DTI microflow laboratory: The reference flowrate measurement was based on the gravimetric technique using a calibrated precision scale with 0.000001 g resolution placed on a granite table in a temperature-stabilized environment, and the flowrate determination included relevant corrections such as the effects of displacement, buoyancy, and evaporation. Evaporative loses during the fall of the drops have been estimated by model calculations and measurements; the results by the two methods exhibit good agreement and shows that such loses are about 0.03 % and thus negligible. The acceleration of the drops is due to the gravity only. As consequence the drop velocity can be adjusted by change their fall height. The resulting drop velocity can be estimated based on calculations assuming spherical geometry of the drops. Furthermore, to measure the drop velocity photographic technique is employed.

For the DG2, validation of drop size measurements was obtained by weighing the total volume of samples of about 20 to 45 drops with a precision balance with having a resolution of 0.001 g. Drops were released at 1.20 m above the centre of the measurement plane of the camera. Results are summarized in the companion paper (Chinchella et al., 2022) in terms of the average drop diameter obtained from the software and the balance, and their relative percentage error difference (assuming the balance as the reference). This percentage error difference increases with the drop size, since the photogrammetric detection overestimates the drop diameter when drops present an oblate section due to significant oscillations in their shape. This is due to those drops failing to approach the aerodynamic equilibrium during the flight i.e., their terminal fall velocity. A second set of tests was conducted using the photogrammetric system alone, without weighing the overall water volume.

The repeatability of the drop size is quite good, and the deviations of the maxi-mum and minimum generated drop size from the average diameter are about equal to 110 % and 90 %, respectively. Also good is the consistency of the measured fall velocities and their repeatability. It is evident that the fraction of the terminal velocity that can be achieved with the fall height adopted in the tests (1.20 m) is about 90 % for the smallest drops (D = 0.85 mm), while it only reaches about 50 % for the largest drops (D = 3.42 mm). The rain generator DG3 uses different nozzle geometries to generate drops of different sizes. The nozzle is mounted on a moving metallic structure to allow easy change of the drop position inside the measurement area. Each nozzle was tested using a precise weighing instrument to have information on the drop sizes. Assuming all drops are equal, by weighting 100 drops 10 times for each nozzle, we estimated the uncertainty on the drop weight, see Table 1. This is propagated to the drop size by taking also into account the uncertainty contribution to the density of water at the room temperature.

Table 1: Characterization of the different nozzles available for the DG3. The drop frequency was measured, and the drop weight is the mean weight of at least three different measurements. Drop size is calculated from drop weight assuming spherical shape.

Nozzle	Drop frequency (drops/s)	Drop weight (mg)	Drop size (mm)
A	3.4	9.5 ± 0.09	2.6 ± 0.02
B	2.1	23.5 ± 0.21	3.6 ± 0.02
D	2.8	44.5 ± 0.13	4.4 ± 0.01
E	2.4	61.7 ± 1.56	4.9 ± 0.08
F	5.0	8.1 ± 0.08	2.5 ± 0.02

The repeatability of the measurement is quite good but tends to be better for the smaller sizes. The characterization of the different nozzles shows that the probability density function (pdf) used here must be a normal distribution since the effects not modelled coming from the nozzle shape will affect the repeatability of the measurement. Since this drop generator was built for test purposes, there were no velocity measurements or control. It can thus be used only with estimation for drop velocity through calculation or be used at heights where the drop terminal velocity can be reached.

In addition, a numerical model for free-falling water droplets was developed using COMSOL Multiphysics software. The simulation of drops fall allowed to estimate the velocity at a given distance from the nozzle but also the drop shape to investigate the non-sphericity that can be an uncertainty source for non-catching instruments.

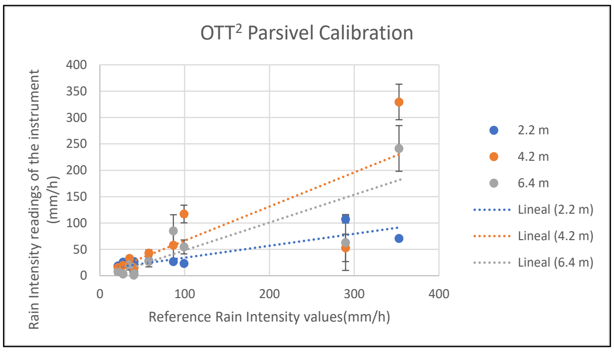
Further to the laboratory validation, field testing of some available NCGs was performed at the experimental field test sites of Payerne – Switzerland, and Vigna di Valle – Italy, thanks to the availability and support of Metèo Swisse and the Italian Meteorological Service, respectively. In Payerne, at the end of March 2022, two rain generators (DG1 and DG2) were mounted used for the verification of the installed Thies laser disdrometer, while in Vigna di Valle, in June 2022, only the DG2 was used for the verification of the Biral light scatter disdrometer.

Lessons learned from the experiments performed in Payerne and Vigna di Valle are that calibration procedures for NCGs should be limited to the controlled laboratory environment. Indeed, the experienced wind and atmospheric humidity conditions proved to be challenging for both rain generators developed within the project. Ambient characteristics especially impact on the production (detachment) of the smallest drops and their fall trajectory (deviation from the vertical) towards the instrument sensing area. Also, for the largest drops, the relevant release height that is necessary to reach a significant portion of the terminal velocity would require tall temporary support structures, whose installation and management is tough in field conditions. It is therefore recommended that calibration is only performed in the laboratory, while limited verification tests to check that the instrument does not deviate significantly from the original calibration, must be limited in the field to few intermediate drop sizes (in the order of 2-3 mm in diameter) and in low wind and humidity conditions.

Some non-catching rain gauges were calibrated using the DG3 designed and assembled as described above. The non-catching gauge under study is an optical gauge (OTT Parsivel2). This instrument was calibrated at laboratory conditions, 20 ºC ± 1 ºC and < 50 % RH, and three different distances between the drop generator and the sensitive area of the instruments (2.2 m, 4.2 m and 6.4 m). Figure 6 shows different views of the calibration performed with the drop generator at a 6.4 and 4.2 m height. Special attention was paid to fit each generated drop into the sensing area of the rain gauges. Before performing the measurements, the optimal relative position between the drop generator and the rain gauge was determined by reaching the maximum rain intensity reading in the rain gauge. To increase the measurements comparison reliability, a constant measuring time interval of 10 min was defined for all the measurements.


a)


b)



c)

Figure 6: Laboratory configuration for the calibration performed with the drop generator (a) at a height of 6.4 m, (b) at a height of 6.4 m with a view from the platform where the drop generator is placed and (c) calibration of the OTT2 Parsivel at different distances between the drop generator and the sensitive area of the instrument.

The OTT2 Parsivel was calibrated following the procedure already described in previous paragraphs. For this calibration, disdrometer data every 10 s were considered. Figure 6 shows the average of all disdrometer rain intensity readings for different reference rain intensities generated by the SMD drop generator and for several distances between the drop generator and the sensitive area of the non-catching instruments. The bars represent the standard deviation of the non-catching instrument readings at each calibration point. The calculated reference values of the rain intensity generated by the drop generator depends on the sensitive area of the non-catching instruments. These reference values are derived from the drop size, drop generation rate (determined in the calibration of the drop generator at 20 ºC) and considering the collecting area is 180 mm x 30 mm for the OTT2 Parsivel, as it is indicated in its technical manual.

Figure 6 shows that 2.2 m between the drop generator and the non-catching instrument is not high enough to perform a correct calibration, this is due the drops are unable to reach the appropriate terminal velocity and these drops are not correctly detected by the OTT2 Parsivel. An increase of the quality of the calibration with the distance is expected, but this is in contradiction with Figure 6, where the calibration at 4.2 m seems better than the calibration at 6.4 m. Two reasons explain this behaviour. On one side, the drops generated at 4.2 m reach a velocity value very close to the appropriate terminal velocity, needed for correct readings and calculations performed by the OTT2 Parsivel. On the other side, the drops generated at 6.4 m are more disperse when they reach the level of the sensitive area of the instruments, and some of them don’t cross the sensitive area. This means that some drops are not detected by the instrument and, as a consequence, the readings of the instrument are lower than the rain intensity generated at the drop generator. This is confirmed by Figure 7, which shows the rain intensity as given by the device, in red, computed with the DSD after filtering particles detected at a ± 50 % of the terminal velocity, in blue, and from the theorical drop size using the number of detected particles, in green.

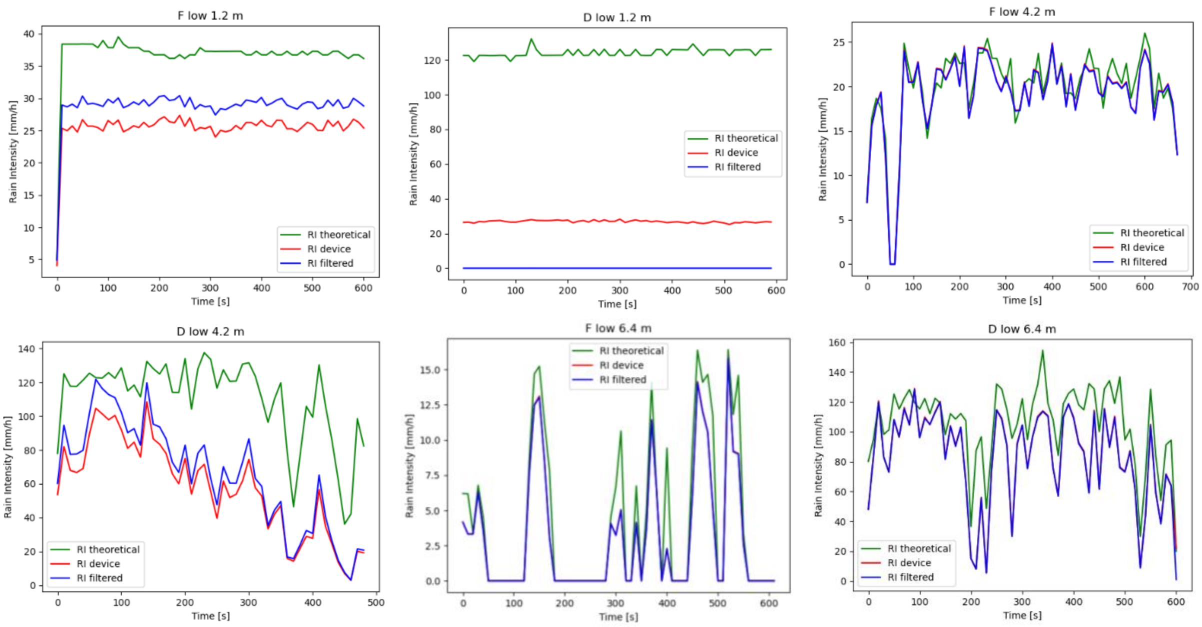


Figure 7: Rain intensity from the device (in red), from the DSD filtered (in blue) and from the theorical drop size (in green) for the 10 minutes of measurements, for nozzle F at low speed (5 drops/s, 2.5 mm) on the left, and for nozzle D at low speed (2.8 drops/s, 4.5 mm) on the right. The first line is in the climatic chamber (1.2 m), the second one for the gas laboratory (4.2 m) and the last one for the force laboratory (6.4 m).

We can see that at 6.4 m, the device rain intensity curve and the filtered one are superposed at this scale. For the F nozzle (2.5 mm drops), the differences between the theorical curve and the two other ones can be explained by a non-negligible number of particles detected at a size lower than the characterized size (a peak of more than 60 particles at 2.125 mm for a characterized size of 2.5 mm). The higher number of particles detected, and the larger diameter of drops might explain larger differences for the D nozzle (4.5 mm drops). The differences between the device rain intensity and the computed rain intensity from the DSD for the D nozzle at 4.2 m can be explained by filtering/algorithm. Since we are using the raw data from the device, we might have used, for the computation of rain intensity, some drops that have been discarded by the device for its computation of this value.

5. Normative aspects and conclusions

A technical report, including a draft procedure for the traceable calibration of non-catching precipitation measuring instruments, was prepared by the consortium, and delivered to CEN/TC 318 (Hydrometry)/WG12 (Rainfall intensity). The document contains the description of a recommended traceable calibration method for consideration in the development of future standards.

The proposed traceable calibration procedure summarises the results of the work performed in various steps of the project, including the analysis of the state-of-the-art about the calibration of non-catching precipitation gauges, the design, construction and testing of rain generators, the assessment of the model uncertainty for precipitation measurements using non-catching instruments, and the laboratory and field testing of the procedure using different sample gauges. All the issues encountered, and the obtained results, contributed to raise the confidence that the proposed procedure is suitable for the traceable calibration of non-catching precipitation measuring instruments in the laboratory. Field verification using the proposed procedure is only recommended for those specific and limited cases, where instruments cannot be removed from the field installation. The first step in the procedure is the definition of the characteristics of a suitable drop generator, able to release drops of the desired size (diameter) at a sufficient release height above the instrument sensing area, to ensure enough vertical fall distance of the released drops and a sufficient (possibly close to terminal) fall velocity. Essential elements of the drop generator are:

- a drop formation and detachment device able to produce, on demand, drops of a predetermined size, with equivolumetric diameters between 0.5 and 6 mm;

- a verification device, using and independent measurement principle, able to detect the released drops in flight along their fall trajectory and determine their actual size and fall velocity before they reach the sensing area (or volume) of the instrument under test;

- in case the instrument under test does not interfere with the drop trajectory (e.g., employs an optical principle), a gravimetric device (usually a weighing system) able to check the total mass delivered through a given sequence of drops.

The drop generator used for calibration shall have an expanded uncertainty of less than 1%, calculated with a coverage factor equal to 1.28. This number shall be certified with explicit traceability to the international standards by means of extensive characterisation that shall be demonstrated and documented.

The proposed calibration procedure is as follows:

- Calibration of non-catching precipitation measuring instruments shall be performed by generating a controlled set of water drops and letting them fall from a sufficient height over the sensing area (or volume) of the instrument under test. The drop size and fall velocity shall be determined by means of an extensive characterisation of the drop generator and their uncertainty assessed and traced back to the international system of units (Baire et al., 2022). When triggered by the generated drops, the reading of the instrument shall be recorded and compared with the known drop characteristics.

- Water drops of at least three different diameters in the range 0.5 mm – 6 mm shall be generated (it is advisable to generate five different diameters, including those at the limits of the above range)

- The release height above the sensing area of the instrument under test shall be such that at least 50% of the terminal velocity is achieved when the drop reaches the sensing area (or volume) of the instrument (this means that at least 0.063 m are used for a drop with diameter 0.5 mm and at least 2.1 m for a drop with diameter 6 mm).

- It is recommended that the size and fall velocity of each generated drop are measured immediately before or after they reach the instrument under test by means of an independent measurement method (gravimetric, photogrammetric, etc.)

- Drops should be released in different positions over the sensing area (or volume) of the instrument under test, to cover both the central and peripheral measurement regions (a minimum of 5-6 different positions is recommended, depending on the instrument geometry)

- Enough drops should be released to allow statistical significance of the results (at least 30 drops per each position) and the mean and coefficient of variation of each set of drops shall be used to assess the performance of the instrument under test.

Collaboration with the CEN/TC 318 materialised with the approval within the same TC of a new work item (NWI) for a European norm entitled "Hydrometry - Measurement of precipitation intensity - Metrological requirements and test methods for non-catching type rain gauges". This new work item was approved last February 2022, and it was activated based on the proposal submitted by the Italian national normative body (UNI) after suggestion from the INCIPIT partners and approved by 15 countries in a balloting process. A second document was prepared and submitted to the same TC, to support the proposal of a new work item (NWI) for a Technical Report entitled "Calibration and accuracy on non-catching precipitation measurement instruments", approved in February 2022.

The preparation of the two documents concludes the pre-normative activities of the INCIPIT project and both are submitted to CEN in response to the specific testing and measurement needs for non-catching instruments that were expressed in October 2017 by CEN TC318 to EURAMET, through the cooperation programme between STAIR (the joint CEN CENELEC strategic Working Group supporting standardization in research and innovation) and EMPIR.

6. References

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