Setup for calibration of non-catching disdrometers

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Introduction

Precipitation is an ECV: Essential climate variable
Product: Estimates of liquid and solid precipitation

Climate studies and everyday hydrological, meteorological, and agricultural applications rely on instruments which measure liquid/solid atmospheric precipitation, however meaningful comparison and interpretation of data is only possible when a common ground for evaluating the measurement uncertainty is provided.

Calibration

Traditional rain gauges: (Tipping bucked + Gravimetric): Measure accumulated amount of precipitation
Non-catching disdrometers: Precipitation = sum of individual rain drops

Key parts of calibration
1. Procedure (INCIPT project)
2. Generation of artificial rain
3. Traceability scheme

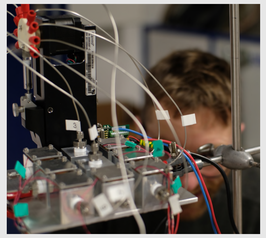
Calibration procedure: INCIPIT Project

EURAMET project 18NMR03
- Title: Calibration and accuracy of non-catching instruments to measure liquid/solid atmospheric precipitation
- Project period: 2019 – 2022 (June)
- Coordinator: INRIM (Andrea Merlone)
- Participants: INRIM (Italy), CEM (Spain), DTI (Denmark), SMD (Belgium), UNIGE (Italy) and EDI (Switzerland)

18NRM03 INCIPIT

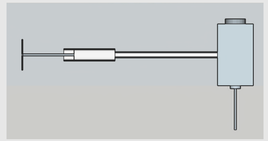
Publishable Summary for 18NRM03 INCIPIT
Calibration and accuracy of non-catching instruments to measure liquid/solid atmospheric precipitation

Generation of rain drops



The goal is to simulate real rain
- Volumetric pump
- Water chamber
- Buzzer: Piezo-electric membrane
- Nozzle or tube

Physical principles

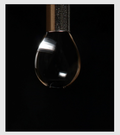


Large drops, > 4 mm: Free falling drops
- Pump + very large nozzle because $r \propto \sqrt[3]{d}$
- Difficult to determine physical drop parameters

Medium-sized drops, 1 – 4 mm: Free falling with a kick

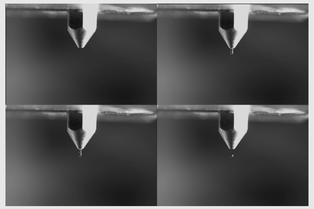
- Pump + tube + buzzer
- Buzzer controls drop release (before free fall)
- Physical parameters from flow and drop frequency

Small drops, < 1 mm: Nozzle + buzzer



- Buzzer ejects water from within the nozzle
- For appropriate parameters → each pulse = one drop
- Physical parameters from flow and drop frequency

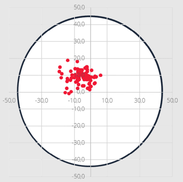
Acceleration



Gravity used for acceleration
- Velocity must be close to terminal velocity
  - → correct detection by gauges
- … or extrapolated to terminal velocity

Graph showing height required as a function of drop size:

Drop diameter	Height: 1 m	Height: 3 m	Height: 8 m	Height: 15 m
0.3 mm	97%	100%	100%	100%
1 mm	76%	96%	100%	100%
3 mm	50%	76%	95%	99%
5 mm	40%	63%	86%	96%



Traceability

Traceability in measurements
- Metrological Traceability or Measurement Traceability is a “property of a measurement result whereby the result can be related to a reference through a documented unbroken chain of calibrations, each contributing to the measurement uncertainty.”
- Traceability ensures that measurement is taking into account all uncertainties and is an accurate representation of an object being measure

Possible traceability routes
- Measuring falling drops using photographic techniques
- Deducing volume of formed drops from flow and time → selected
- $r = \sqrt[3]{\frac{Q}{f}} \cdot \frac{3}{4\pi}$
- Uncertainty: Dominated by flow
  - Evaporation of falling drops < 0.05 %
- Flow calibration in DTI MicroFlow laboratory using gravimetric method
  - Pumped water is accumulated in beaker
  - Correction for buoyancy, displacement, evaporation, temperature variations, …
  - Accuracy = 0.5 %

Status

- Drop generation 0.2 – 7 mm
- Test calibrations conducted
- Currently upgrading setup
- Increase drop velocity: High Platform or Drop Acceleration Device

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