

# The New Premium CoCoRaHS Precipitation Gauge and Why Manual Precipitation Gauges are so Important

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## Abstract

Even in our technologically advanced world with an abundance of automated weather stations, the CoCoRaHS standard precipitation gauge remains the tried and true 4” manual gauge. There is no perfect precipitation gauge, at any cost, and even the most expensive electronic rain gauges have deficiencies and biases. The standard 4” precipitation gauge used by CoCoRaHS has been shown to report to within 4% of official NWS standard rain gauges, thus making it comparable to NOAA's official instrumentation. The accuracy, simplicity, and low cost of the manual gauge used by CoCoRaHS instills consistency and high degrees of participation.

Moreover, the fact a manual gauge does not self-empty is a valuable attribute since it provides unequivocal evidence of precipitation without loss of given electronic or transmission issues associated with automatic gauges. Manual gauges also require frequent human interaction which provides invaluable maintenance and inspection of the gauge that an automated gauge may rarely get. Manual gauges also enable us to measure precipitation virtually anywhere, even when electricity or the internet are not available. These are the practical advantages to manual gauges, but perhaps more important than anything is proper siting, operation, and maintenance of the precipitation gauge.

## Manual Precipitation Gauge

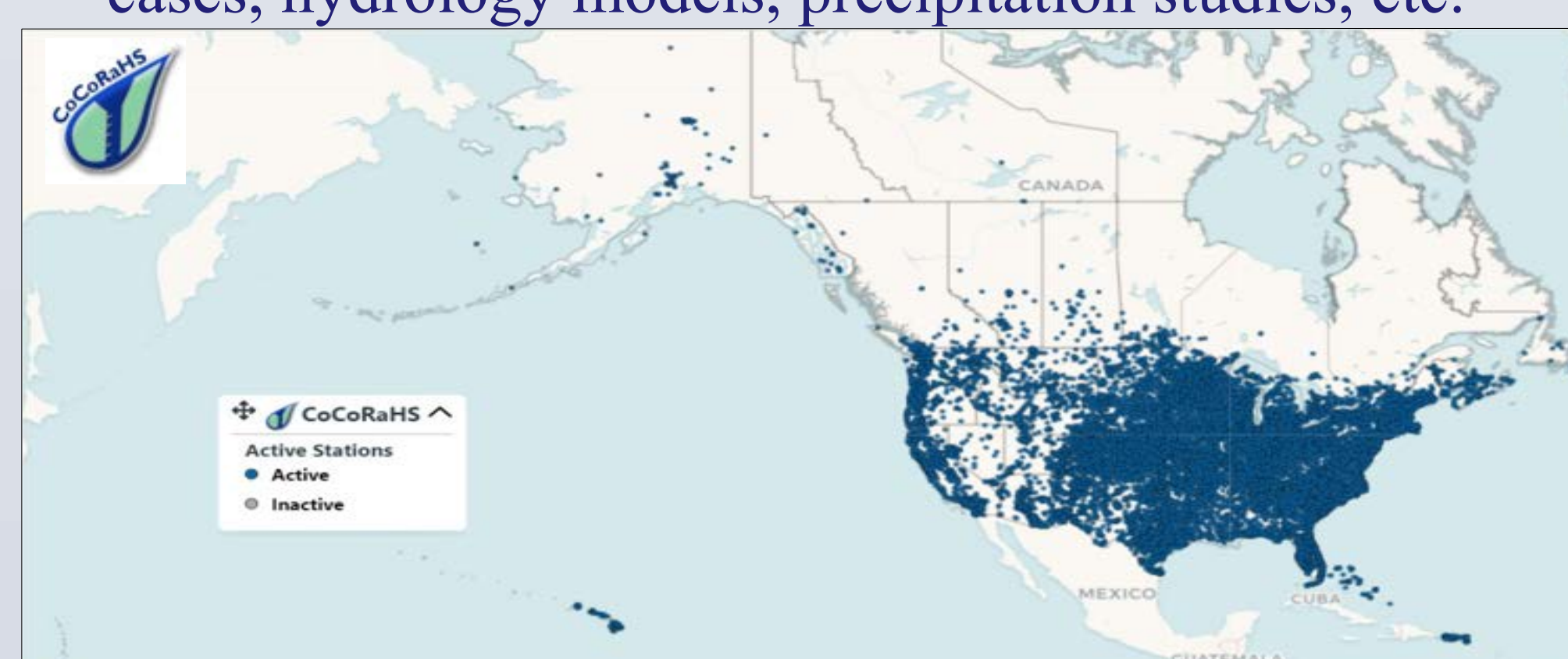
A manual precipitation gauge is simply an instrument that captures precipitation and stores it in a cylinder that is then measured and emptied manually by a human versus an automated gauge that measures and self-empty's the precipitation. The National Weather Service 8-inch standard rain gauge exists at virtually every official climatological station. Although the 8-inch (diameter) standard rain gauge is preferred, a 4 inch diameter plastic gauge is an acceptable substitute at some locations. The 8” standard rain gauge has a capacity of 20 inches whereas the smaller, traditional 4” plastic gauge capacity is 11 inches. **The new 4” TROPO precipitation gauge is the new premium gauge option for CoCoRaHS volunteers, but has a capacity of 13 inches!**



4” TROPO Precipitation Gauge in a summer and winter setting.

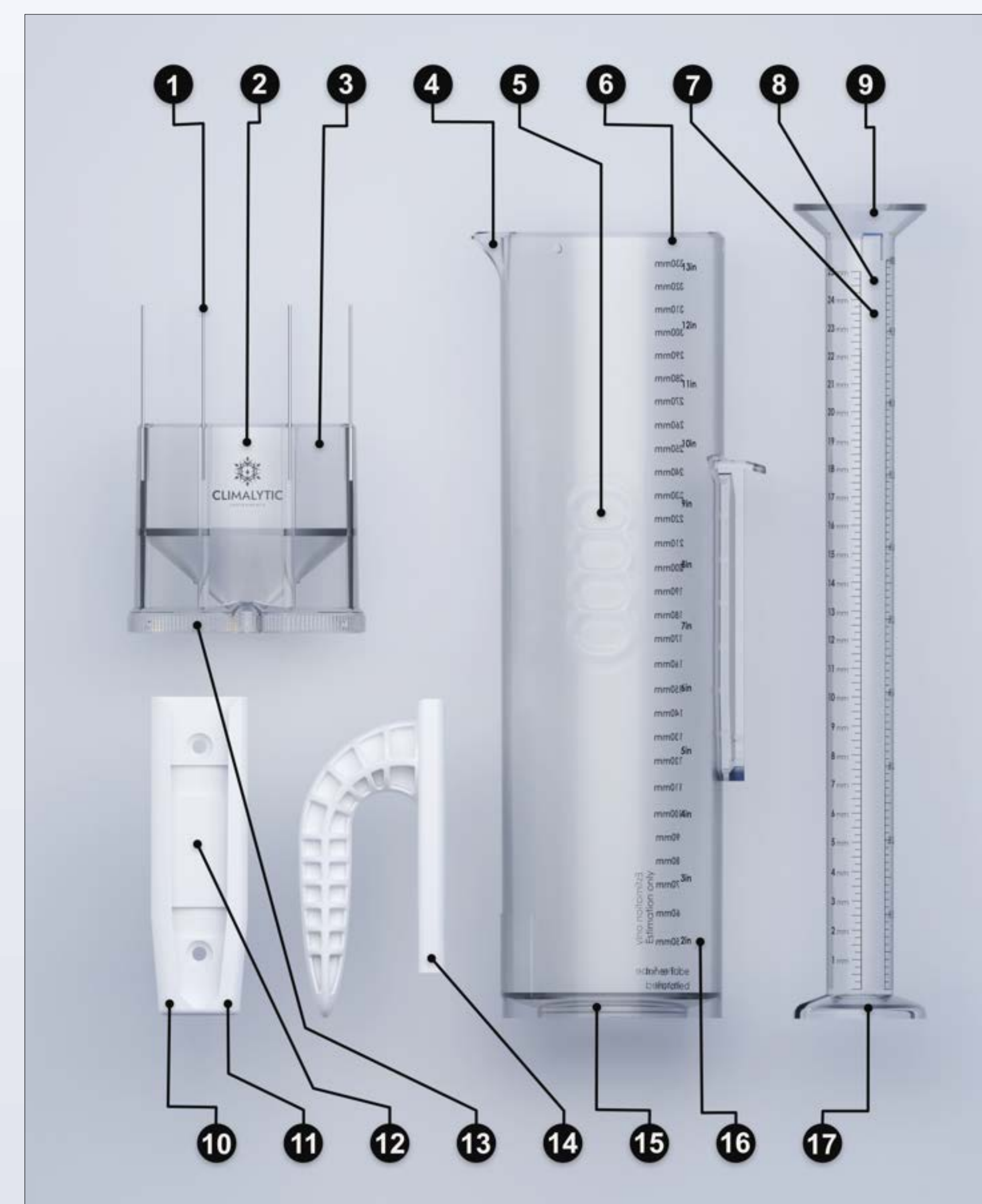
## Top 10 Reasons Manual Precipitation Gauges are Important

- 1) Manual gauges often provide the **official precipitation measurements at NOAA observation sites**. For this reason, precipitation records from sources such as the Global Historical Climatological Network (GHCN) provide the most accurate historical record for analyzing climate trends.
- 2) Manual gauges **do not require power or internet**, thus making rural/remote measurement easy, possible.
- 3) Manual gauges are not self-emptying, therefore offering **visible, satisfying, and unequivocal truth of the accumulated precipitation** without any derivation estimation schemes applied (e.g. counting tips)
- 4) **Measuring fresh snowfall and the snow water equivalent (SWE) with automated instrumentation is rarely as accurate** as that from a skilled weather observer using a manual precipitation gauge.
- 5) For some use cases, the **cost and complexity** of installing an automated gauge is not necessary.
- 6) Manual gauges, by nature require frequent human interaction, and therefore are generally **maintained, cleaned and operated with more care and attention**.
- 7) Anyone can own and operate a manual precipitation gauge since they are **economical and easy to deploy**. This promotes vast observer networks (e.g CoCoRaHS) for assessing storms & **aiding hydro-meteorologists in reconstructing storms** for purposes of design, forensic cases, hydrology models, precipitation studies, etc.



- 8) Manual gauges can be **easily and quickly deployed to monitor and confirm precipitation** characteristics at special events, festivals, filming productions, golf tournaments, fundraisers, outdoor concerts, and parades for purposes of “rain insurance” policies/claims.
- 9) Manual precipitation gauges **last longer, are more reliable and are more accurate** given they don't have moving parts, electronics, batteries, or required periodic calibrations. Manual gauges are more reliable and accurate in measuring extreme precipitation because they don't suffer from transmission issues or under-catch associated mechanisms (e.g. tipping buckets).
- 10) Manual rain gauges are more fun, engaging, and offer a great way for anyone to participate in measuring precipitation!

## The TROPO Precipitation Gauge



## Features

- 1) Bird deterrent rods
- 2) Removable cap for capturing & measuring water equivalent of snow, hail, sleet or ice
- 3) Tall cap for more accurate catchment of precipitation
- 4) Pour spout on outer cylinder made of UV stabilized Poly-carbonate, the same material of greenhouses
- 5) Textured grips on outer cylinder for secure handling of the gauge
- 6) 13.5” (342.9 mm) maximum capacity
- 7) Accuracy to the nearest .01” (.25 mm)
- 8) Units in both metric and imperial
- 9) Funnel opening atop inner cylinder
- 10) Easy, no-tool installation to pole
- 11) Weather-protected bracket design for easy mounting & unmounting
- 12) Flexible mounting bracket for pole or post installation
- 13) Locking funnel cap to avoid blow-offs
- 14) Removable handle for easy handling of the unmounted gauge
- 15) Beveled guide ensures easy placement of inner cylinder
- 16) Outer cylinder graduations for quick, estimated readings
- 17) Inner cylinder equipped with stabilizing base for easy filling

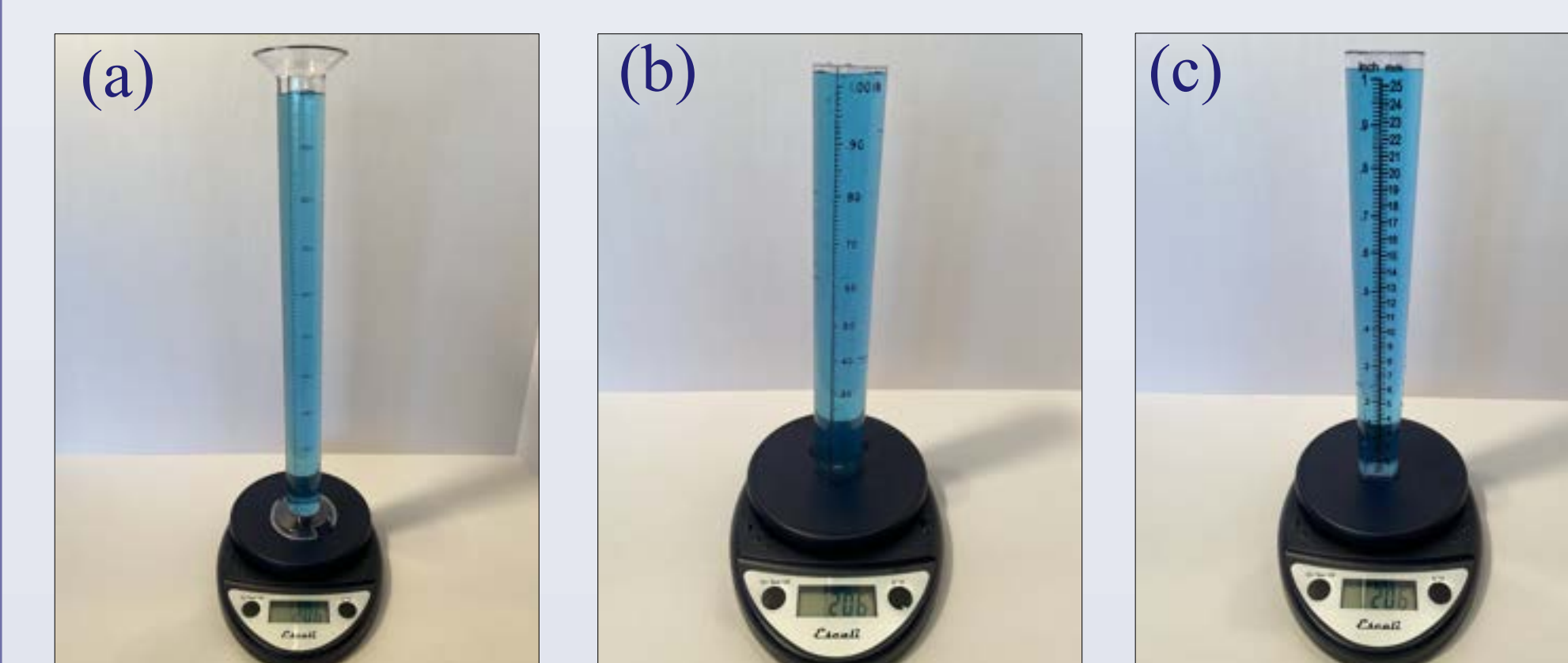
## Calibration and Field Testing

Knowing one inch of water equals 206 grams within a 4-inch diameter cylinder, we used a CoCoRaHS-approved scale, and tared the scale (to 0) with the gauge on the scale, then poured water into the TROPO until it reached 206 grams and then checked to make sure the meniscus was at the 1.00” marking on the inner cylinder. And sure enough, it was perfect – see picture below! We did the same for two other popular gauges and found them to be slightly off.

$$\text{Volume} = \pi r^2 h = \pi 2^2 1 = 12.57 \text{ in}^3$$

$$\text{Density of Water} = 16.387 \text{ g/in}^3$$

$$\text{Weight of 1” of water} = \text{Volume} * \text{Density} = \mathbf{206 \text{ g}}$$



206 g of water shown in (a) TROPO, (b) “Stratus” and (c) “Outback Blue” 4-inch rain gauge.

## Field Testing and Evaluation

Ten carefully-selected field testers across the United States critically evaluated the features, measurements, and accuracy of the TROPO gauge. The 2-month long field testing and evaluation campaign addressed the following:

- Installation
- Measurement & accuracy
- Handling
- Users Guide

The field testing informed a White Paper and some final design tweaks to the TROPO gauge and users manual.

## Gauge Specs

- Size, without bird deterrent rods (L x W x H): 4 in x 4 in x 18.19 in (102 mm x 102 mm x 462 mm)
- Weight: 1.68 lbs (762 g)
- Maximum Capacity: ~13.5” (~342.9 mm)
- Accuracy: +/- .01” (.25 mm)
- Materials: Poly-carbonate/acrylonitrile butadiene styrene (PC/ABS) and UV stabilized Poly-carbonate

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