Rainfall Inter-comparison of TE525 and Pluvio Precipitation Gauges at Wisconet Hancock Station

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USDA United States Department of Agriculture
WARF Wisconsin Alumni Research Foundation

Introduction

The Wisconsin Environmental Mesonet (Wisconet) provides timely soil and weather monitoring data and is funded by the United States Department of Agriculture (USDA) Rural Partnerships Institute and the Wisconsin Alumni Research Foundation (WARF). Wisconet uses the TE525, a tipping bucket precipitation gauge, to accurately measure liquid precipitation. However, uncertainty regarding the validity of measurements required investigation into the reliability of the TE525. While we trust the data reported by the TE525, we aim to eliminate any doubts about its performance.

Background

Hancock Agricultural Research Station has one of the oldest deployed weather stations in the Wisconet network. As such, data collected at this location (and at any Wisconet station) is constantly being reviewed to ensure the most accurate values are being reported. It was decided Hancock would be an ideal location to compare the current precipitation gauge used by the Wisconet, the TE525, to a different model, the Precipitation Gauge OTT Pluvio2 L (Pluvio). The main goal of this study was to establish trust in the TE525 precipitation gauge and find any limitations that would hinder accurate measurements.

The TE525 is a tipping bucket precipitation gauge that reports data on the five-minute interval. There are add-ons that can be used to limit the impact of wind and other environmental factors.

The Pluvio is a weighing precipitation gauge with a built-in filter that limits the impact of wind, temperature, and evaporation on measurements. Data is reported on the one-minute interval and values such as intensity (mm/hr) are recorded in addition to total precipitation.

Rainfall events beginning in early June 2024 through the end of 2024 were analyzed to compare the performance of the two precipitation gauges.





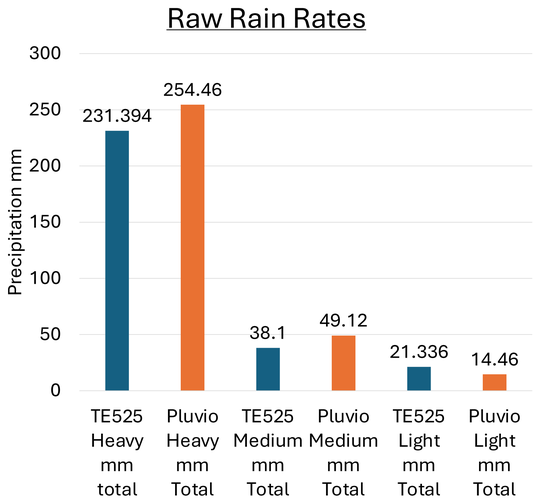
Methodology

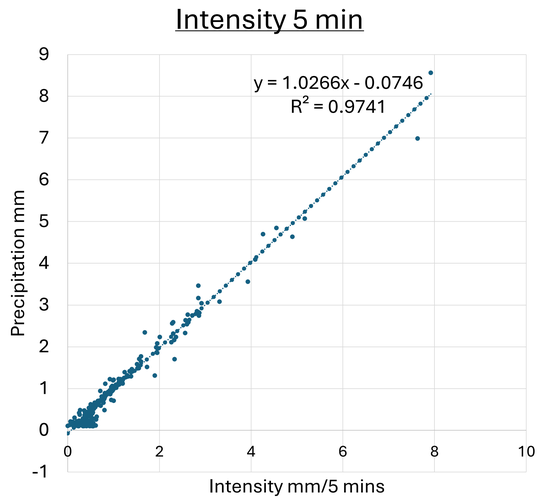
Precipitation accumulation as a function of rain rate was the primary tool used to compare the performance of the TE525 and Pluvio. (Note: rainfall was the dominant precipitation type during the months data was collected).

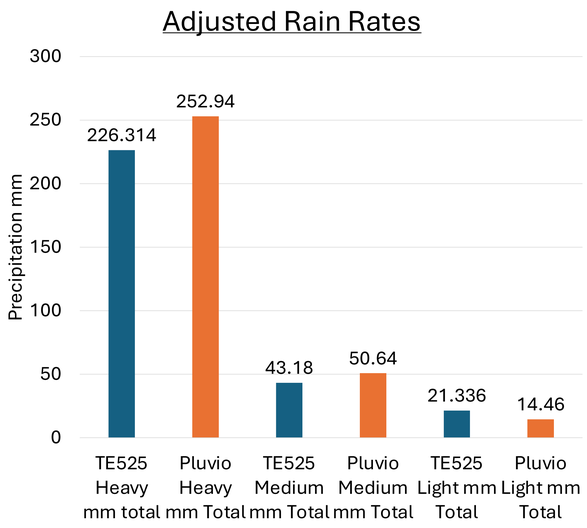
Using data gathered from the Pluvio, a relationship between the amount and intensity of rainfall was derived. This equation was then used to find the intensity of rain events recorded by the TE525.

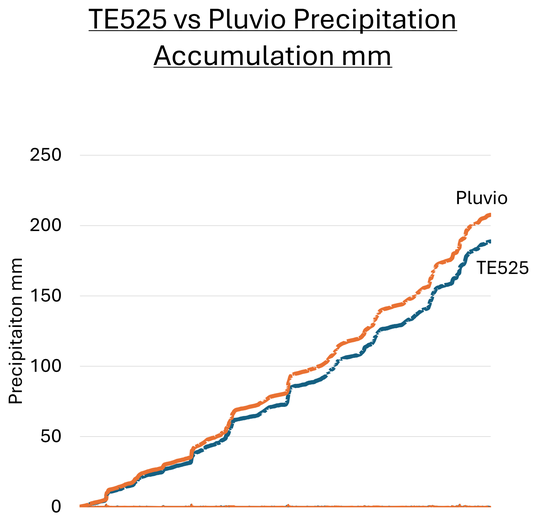
From here, rain events were broken into light (0mm/hr-0.213mm/hr), medium (0.214mm/hr-2.417mm/hr), and heavy (2.418mm/hr-102. 8mm/hr) rain rates. From there, the precision of the TE525 and Pluvio with respect to these three categorizations was evaluated.

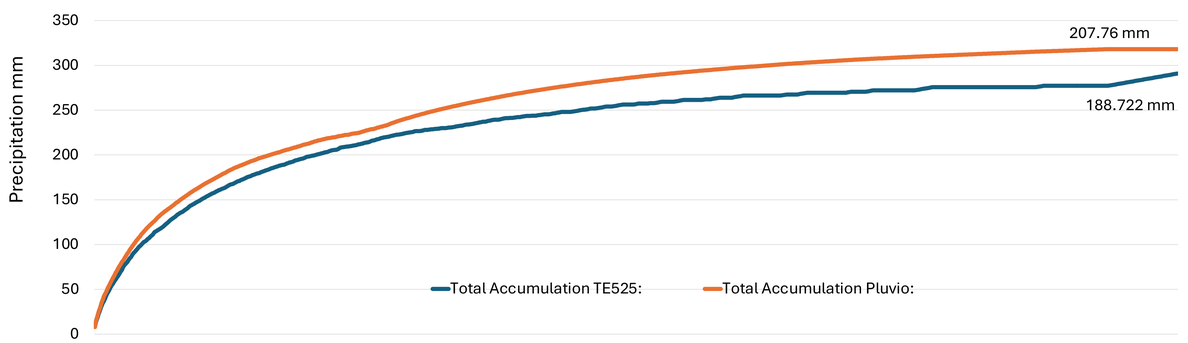
Data and Analysis











To better compare how the TE525 and Pluvio were reporting precipitation, Pluvio measurements were summed every five minutes so data between the two devices would be on the same time interval. The disparity in the one-minute and five-minute interval can be seen in the "TE525 vs Pluvio Precipitation Accumulation mm" plot; while the TE525 follows the same overall trend as the Pluvio, the two lines appear to be slightly "off".

Findings

Across all data points, TE525 measurements were within 10% of reported Pluvio measurements. This number is consistent with limitations of the TE525 listed in the manual.

When looking at raw rain rates, the heavy precipitation rate was the most precise of measurements between TE525 and Pluvio values, with the TE525 reporting within 9% of reported Pluvio values.

This trend is also present in adjusted rain rate data; heavy precipitation was the most precise rate, with the TE525 reporting values within 11% of reported Pluvio values. Adjusted medium precipitation events had increased precision between the two precipitation gauges as compared to the raw medium rain rate, while light precipitation events saw no change in precision. Interestingly enough, in both raw and adjusted rain rates for light precipitation, the TE525 reported higher values than the Pluvio.

Based on these observations, it can be observed that precipitation intensity does play a role in how much precipitation is measured. When comparing both devices across all plots, it can also be noted that the TE525 generally follows the same trends as the Pluvio. When there were dips in precipitation in Pluvio data, there was also a mirrored dip in TE525 reported data. In addition, values reported by the TE525 were consistently smaller than values reported by the Pluvio.





Conclusion

When considering the limitations of traditional precipitation gauges, such as wind influence and funnel clogging, values reported by the TE525 are of the expected accuracy as described in the user manual.

It is important to note that rain is a point measurement, and varies significantly across short distances (even a few feet!). Keeping this in mind, data reported by the TE525 follows trends reported by the Pluvio. Once again, these data points are predominantly rain measurements. It would be interesting to see how data changes as snow and other forms of precipitation are introduced to the data set.

In addition, the use of wind shields on the TE525 gauges could impact measurements and this could be an interesting thing to compare to data without wind shields. Overall, the TE525 is a reliable precipitation gauge and provides accurate data.

Resources

- Operating Instructions: Precipitation Gauge OTT Pluvio2 L
- TE525-Series: Tipping Bucket Rain Gauge Product Manual

Acknowledgments

Funding from USDA Rural Partnerships Institute (RPI) and the Wisconsin Alumni Research Foundation (WARF)