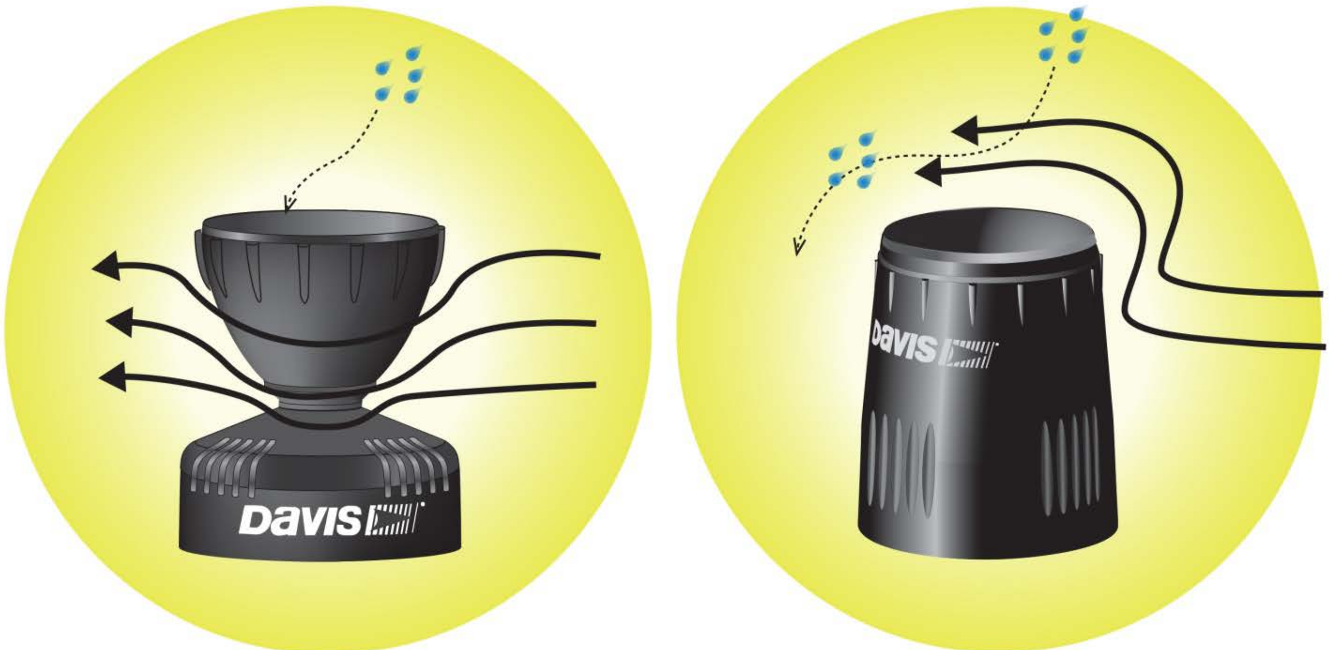
Davis AeroCone Reduces Rainfall

Error Caused by Wind

Application Note **38**



SUMMARY

In high wind events, tests have shown that an aerodynamically shaped cone will reduce undercatchment caused by the aerodynamic blockage by the rain collector. The amount of improvement is dependent on a large array of variables including, but not limited to, wind speed at the orifice, precipitation drop size and distribution, and rainfall intensity. The largest reduction of error will occur in high wind conditions with light rain, but any time wind is a factor the AeroCone will report more accurate rainfall amounts.

The goal of rainfall measurement is to measure the amount of precipitation that would hit the ground if the collector were not there. That is not easily done because the rain collector IS, in fact, there.

In 1953, John C. Kurtyka documented and quantified the causes of errors in precipitation measurement. He concluded that evaporation, adhesion, the collector's color and inclination, and splash, all combined, create a -1.5 % error. But exposure (wind) caused a -5.0 to -80.0 % error. This has been supported by studies in the 60s, 80s, and 90s that show the main sources of rain gauge errors to be wetting losses, splash in (when the rain collector is very low to the ground) or splash out, and the effects of wind. (This assumes that the rain collector has been sited correctly so that, for example, the anemometer does not block the rain collector, and buildings or trees are not too close. As anyone who has sited a weather station knows, perfect siting is often impossible.)

While we can say that wind does cause undercatchment in any rain collector with an orifice that is not at ground level, it is not easy to say exactly how much undercatchment because there are so many variables that affect it. In a heavy rain storm with low winds, heavy rain drops fall straight down into the mouth of the collector in the same way they would hit the circle of earth below it. But add wind to the mix, and the shape of the cylinder becomes a big factor in adding errors to precipitation collection. The extent of the undercatchment is a function of wind speed at the orifice, precipitation drop size and distribution, rainfall intensity, and the aerodynamics of the gauge itself. Wind direction, season, latitude, temperature, geography, atmospheric conditions, and local climatology can add further variability. But it is safe to say that the most extreme undercatchment would occur in conditions where there is light rain and heavy winds.

This is because wind is diverted from the side of the typical, cylindrical collector up and over the mouth. The wind that is diverted is accelerated over the mouth and carries rain drops with it, causing some of them to miss the mouth altogether. Eddies of wind are created inside the mouth of the collector, which may create lift and affect both catch and outsplash.

There are two ways to avoid or minimize this issue. One is to get the collector out of the wind. You can do this with a wind screen around the collector. Wind screens are large and expensive, so are generally not practical. They are usually deployed in environments that experience a lot of blowing and drifting snow. Another way to get out of the wind is to use what is called a “turf and pit collector.” In a turf and pit collector, the rain collector is mounted in a pit so that the mouth of the collector is even with the surface of the earth. It has to be in turf to prevent splash in, and sited so that no ground water is introduced. It is not very practical except as a comparison tool.

The other way is to minimize the wind diversion by creating a more aerodynamic shape that allows more of the wind to go around rather than over the collector.

Researchers at Newcastle University, department of Civil Engineering and Geosciences in the UK, compared aerodynamic rain collectors with a similar profile to Davis’s AeroCone and straight-sided cylinder collectors to a turf and pit collector standard. The results indicated that in a high wind event, the aerodynamically shaped rain collector mounted at ground level came closer than the straight-sided cylindrical collector to catching as much rain as the turf and pit collector. In fact it, it caught 19% more than the cylindrical rain collector at ground level. In a low wind event, the aerodynamic collector did 11% better.

While this improved accuracy is a good starting point, determining precisely how much accuracy is improved is difficult. The conditions around a rain collector in a storm are chaotic and variable. Wind is not always laminar. Every rain storm has in its own set of dynamic effects. Our testing has shown that rain collectors that are just a few feet apart can vary considerably, especially when wind is a factor.

We have, and will continue to field test our new rain collector in high wind and rain environments. So far our tests indicate an overall improvement, in all the weather conditions of the test period -- not just high wind ones -- with the AeroCone catching about 8% more rain than our old style rain collector.

This improvement does not change our published specification of rainfall accuracy (based on an annual average), because the improvement is seen under specific conditions, while specifications are based on laboratory testing mitigated by year-round field testing.

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