

Technical Summary of Davis Wind Cup Characteristics

January 2009

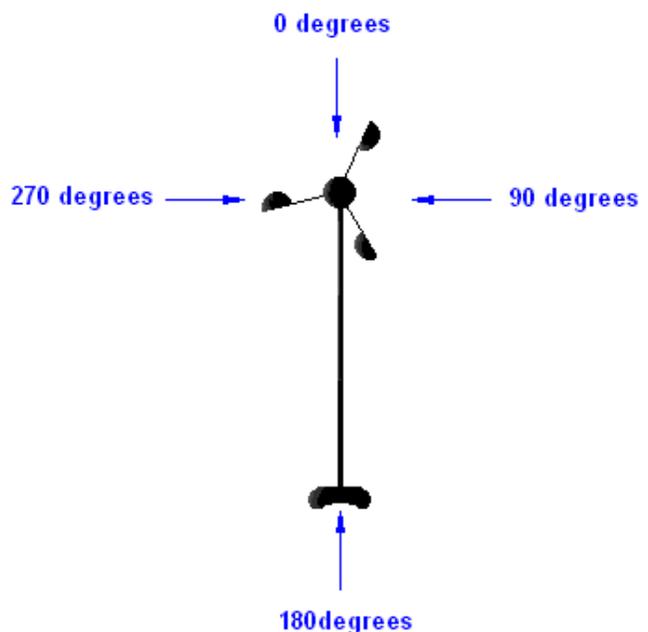
Recently Davis Instruments re-engineered its wind cups to strengthen their performance under high wind conditions. The redesign effectively thickened the wind cup arms in order keep them from breaking at high speeds. (see Weather Note dated 09/16/08)

Initially, there were some concerns that these new cups would alter the spin characteristics of the anemometer and create problems in older weather stations. This is not the case. Last month we took this concern to the Texas A&M University wind tunnel for a weeks worth of rigorous testing and our results were quite good. Not only do our new cups prove to be robust but their spin characteristics are the same or similar to the old cups. This is good news and all weather stations can take advantage of this new, robust design. Davis is proud to present to you a more accurate and durable design and feels this effort reinforces our commitment to the highest possible quality and accuracy that you have come to expect.

In addition to testing the robustness of the new wind cups we also rigorously characterized wind speed accuracy as it relates to wind direction. We have determined that the wind cups do not spin at the same velocity when the wind speed is applied at different angles to the anemometer head (wind direction). This behavior is now compensated for in the latest firmware, v1.82

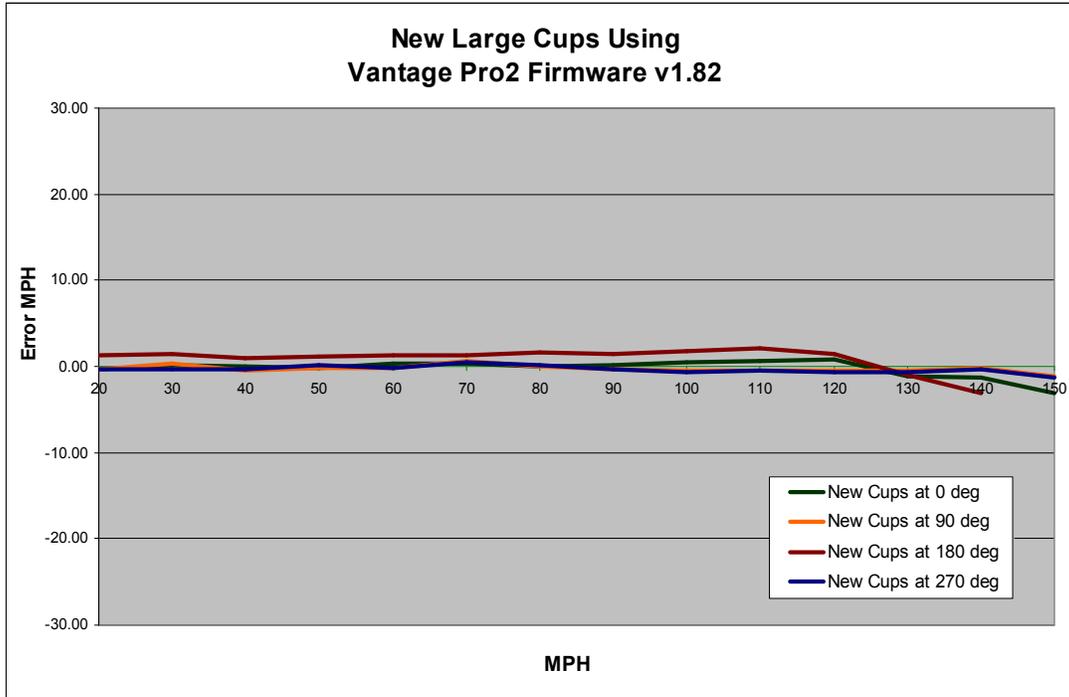
The graphs in this document plot wind speed data from different angles. These angles are the direction that the wind speed is coming from and hitting the anemometer. When viewing the anemometer from above 0 degrees means that the wind is hitting the anemometer directly on its head. 90 degrees is coming from the right of the head. 180 degrees is coming from behind the anemometer and hitting the mounting pole, anemometer base and arm first. 270 degrees is coming from the left of the anemometer head. See the figure to the right.

Top Down View of Anemometer

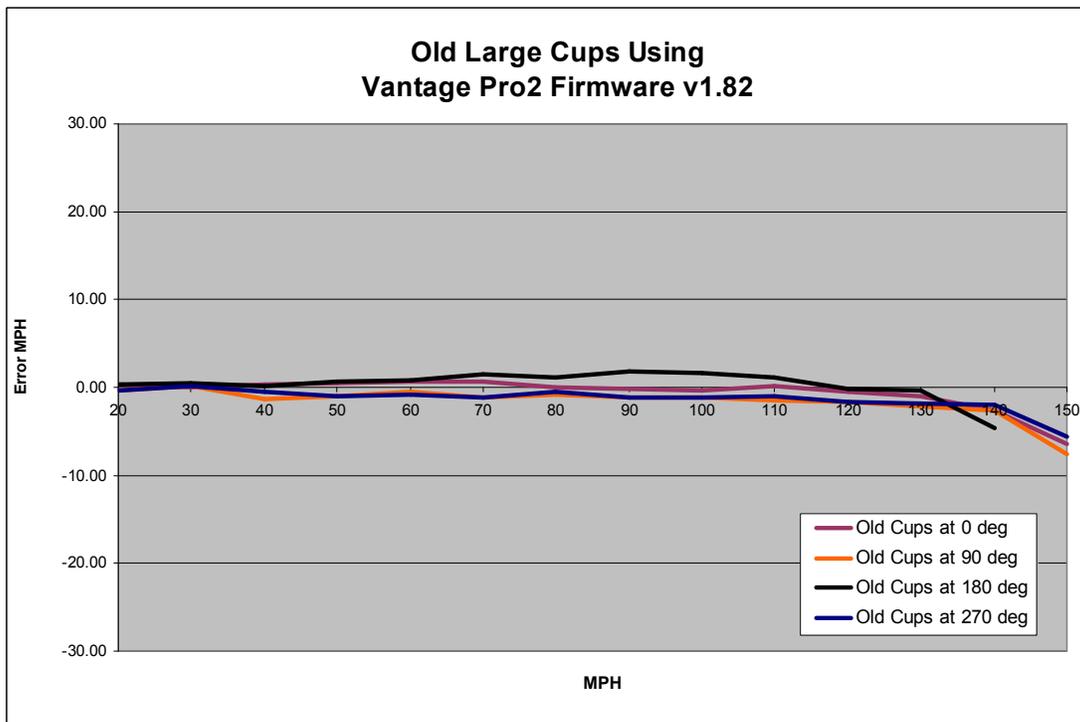


New and Old Wind Cups with a Vantage Pro2 system using firmware v1.82

With any Vantage Pro2, using old or new wind cups and new firmware (v1.82) the Davis anemometer will provide the most accurate wind speeds yet. The graph below shows that from any angle and any velocity the accuracy of this system is remarkable.



Even with the old, large cups and the latest Vantage Pro2 system you can see in the graph below that the accuracy is similar and still very good. Firmware version 1.82 is compensating for errors based on velocity and direction for both new and old cups.



Legacy Stations

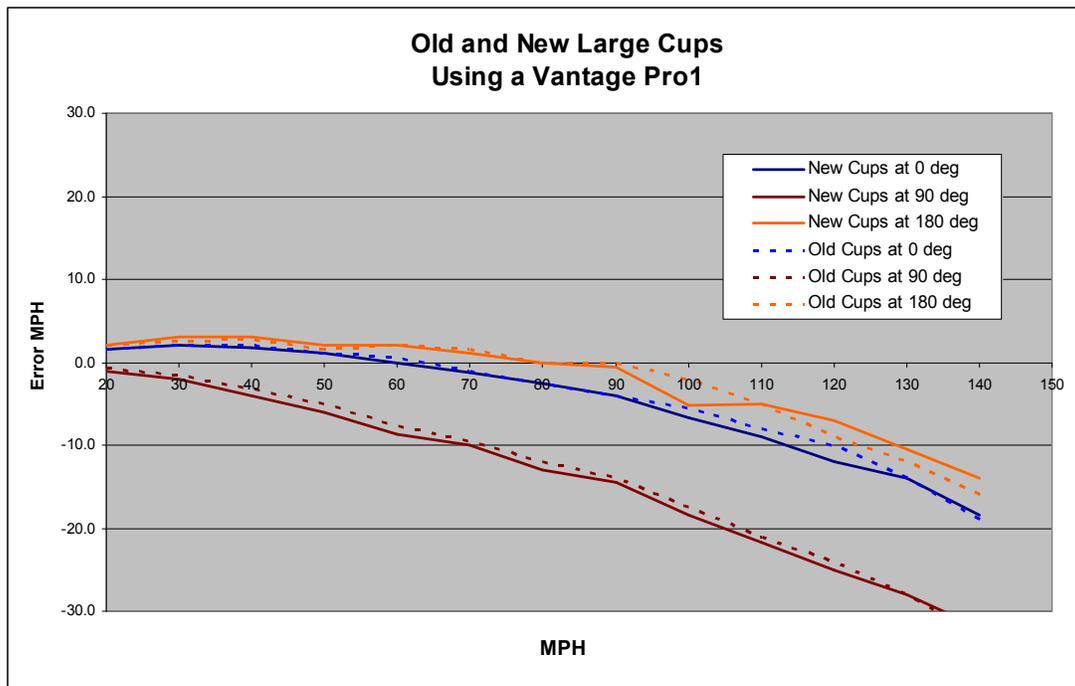
There have been some concerns that using these newer cups with legacy stations will cause undue inaccuracy. Following our extensive wind tunnel testing last month we have determined that this is not the case.

The new, large cups are well suited for Weather Wizard III's, Weather Monitor II's, and the original Vantage Pro and in fact have the same or similar errors as when the old, large cups were used.

What we have learned from our recent testing is that, for quite some time, our wind cups spin at different speeds when the wind comes from different directions. This is true with old and new cups.

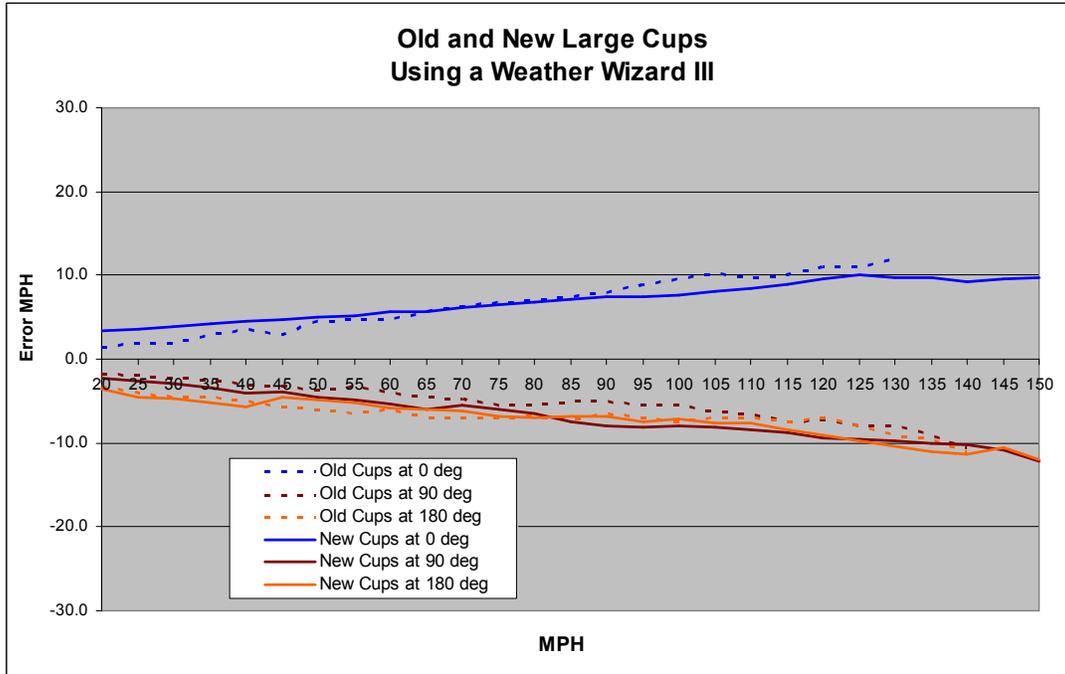
New and Old Wind Cups with a Vantage Pro1 system

You can see below that the new cups perform similar to the prior cups. Spin characteristics that have always been present are still there with the new cups. We have no plans for a firmware patch for the Vantage Pro1.



New and Old Wind Cups with a Weather Wizard III

You can see below that the new cups perform similar to the prior cups. Spin characteristics that have always been present are still there with the new cups. We have no plans for a firmware patch for the Wizard III.



Conclusion

Our new wind cups and their increased robustness are appropriate for any and all Davis weather stations. The new style of wind cups does not change accuracy when used with any station. We now understand that the rotational frequency of the cups varies when the wind comes from different angles. With a commitment to make the best weather station possible and to continually improve our product we are proud to note that the Vantage Pro2 and its latest firmware is the most accurate Davis system to date.

Addendum - 7911 OEM Applications

With the data we have gathered from our wind tunnel testing we can release the lookup table below that will assist OEM customers in using the #7911 stand alone anemometer for their custom application. This lookup table is the same whether the new or old, large cups are used. OEM developers should use the spin to speed formula of 1 closure in 2.25 seconds = 1 mph or put another way.

$$V = P (2.25 / T)$$

V= Speed in mph

T = Sample period in seconds

P = Number of pulses during the sample period

Using this formula you will be able to determine a rough wind speed based on cup rotation, or reed switch closure. The table below will assist you in offsetting the calculated value based on our wind tunnel measurements. Wind speeds not displayed in the table must be interpolated.

Wind Speed Lookup Table using a #7911 Stand Alone Anemometer						
Actual Wind Speed	Reported Wind Speed Error			Reported Wind Speed Values		
	0 deg	90 deg	180 deg	0 deg	90 deg	180 deg
20	3.3	-2.3	-3.6	23.3	17.8	16.4
25	3.5	-2.7	-4.6	28.5	22.3	20.4
30	3.8	-2.9	-4.8	33.8	27.1	25.3
35	4.2	-3.4	-5.3	39.2	31.6	29.8
40	4.5	-4.1	-5.7	44.5	35.9	34.3
45	4.7	-3.8	-4.5	49.7	41.2	40.5
50	5.0	-4.5	-4.9	55.0	45.5	45.1
55	5.3	-4.8	-5.2	60.3	50.2	49.8
60	5.7	-5.3	-5.9	65.7	54.7	54.1
65	5.8	-6.0	-6.0	70.8	59.0	59.0
70	6.2	-5.6	-6.1	76.2	64.4	63.9
75	6.4	-6.0	-6.8	81.4	69.0	68.2
80	6.8	-6.4	-6.9	86.8	73.6	73.1
85	7.1	-7.4	-6.8	92.1	77.6	78.2
90	7.4	-8.0	-6.8	97.4	82.0	83.2
95	7.5	-8.1	-7.5	102.5	86.9	87.5
100	7.7	-7.9	-7.2	107.7	92.1	92.8
105	8.2	-8.1	-7.7	113.2	96.9	97.3
110	8.5	-8.5	-7.7	118.5	101.5	102.3
115	8.9	-8.8	-8.5	123.9	106.2	106.5
120	9.5	-9.4	-9.0	129.5	110.6	111.0
125	10.0	-9.6	-9.8	135.0	115.4	115.3
130	9.8	-9.8	-10.3	139.8	120.3	119.7
135	9.8	-10.0	-11.0	144.8	125.0	124.0
140	9.3	-10.2	-11.3	149.3	129.8	128.7
145	9.5	-10.9	-10.5	154.5	134.1	134.5
150	9.8	-12.1	-12.0	159.8	137.9	138.0