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Celia Meteorological Report For 2011-2012

May 2013

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TABLE OF REVISIONS

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0	May 23, 2013	Original Issue

Executive Summary

This report summarizes the meteorological data collection at the Celia site for the period of 2011-2012. The data recovery for the period was very good with all parameters averaging greater than 90%. The joint frequency distributions showed some dramatic differences between the two years which can be attributed to some calibration changes. The peak wind direction sector for the 2-year period was from the north-northwest at the 10m level and from the northwest at the 60 and 97 m levels on the tower.

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1 Introduction

The purpose of this report is to provide a summary of the 2011 through 2012 meteorological data collection at the Celia site. The report uses several calculation programs from the MET-MIDAS[1] (Meteorological Information and Dose Assessment System) and MDVDISPLAY[2] suites of programs to generate tables and figures included in the report. All of the calculations used hourly meteorological data from the Celia meteorological tower. The hourly averaged data came from the onsite data logger with the data being transferred to SNC in Birmingham, AL.

2 Input Data

2.1 Meteorological Data

The meteorological data used in all calculations were generated by the onsite data logger located in the meteorological shelter near the Celia tower. The data are considered to be hourly averages with the exception of the rainfall data that is the total rainfall for the hour. These data were sent to ABS Consulting by SNC personnel via e-mail [3]. Once the data were received they were reviewed and edited by an ABS Consulting Meteorologist. Periods of bad or missing data were left out of all calculations.

3 Methodology

3.1 Calculations Using MIDAS Software

The calculations performed for this report used MET-MIDAS and MDVDISPLAY programs to generate tables and figures. All calculations used a final set of hourly meteorological data generated by ABS Consulting. The MIDAS programs used in the calculations have been previously validated in the Verification and Validation of MIDAS Volumes 1 and 2, December 1988 [4] and in the Met-MIDAS certification of September, 2007 [1] and MDVDISPLAY (February, 2013) [2]

The MIDAS program MDVDISPLAY with the following subprograms was run to generate this report:

- MIDMT – Meteorological Trend Plot
- MIDJF – Joint Frequency Distribution Table

- MIDBD – Data Recovery Percentage Table
- MIDRO – Wind Rose Plot
- MIDME – Means and Extremes Plot
- MIDDT – Delta Temperature Plot
- MIDMA – Meteorological Average Data Table
- METSCN – Meteorological Data Scan
- MIDEM (MDSEM) – Edit Meteorological Data

4 Results

4.1 Summary of Celia 2011-2012 Meteorological Data

The meteorological data collection at the SNC Celia site was very good during its first two years of operation from 2011-2012. All of the data were collected using the onsite Campbell Scientific data logger. The data were compared using the different levels on the tower and data from NWS sites at Pensacola, FL[5] and Mobile, AL[6].

There were no significant data collection problems that caused outages with the Celia instrumentation during the period of 2011-2012. There were however major differences in the 60-10m delta temperature readings between the two years. There was also a problem with the 97m temperature aspirator that was discovered early in 2013 that had some effect on the 97m temperature and 97-10m delta temperature during much of 2012. All of the delta temperature data is still considered valid at this time. After a few more years of data are collected it may be necessary to go back and revisit this issue.

Table 6 summarizes the data collection over the 2-year period (2011-2012). The data recovery percentages are shown for all parameters. Data recovery for all parameters was well above the 90% Nuclear Regulatory Commission (NRC) standard[7].

Table 1A and 1B summarizes the 2-year period (2011-2012) of stability class as determined by the 60-10m and 97-10m delta temperatures, respectively. Joint Frequency Distributions (JFD) were computed for wind speeds, wind directions, and stability categories. The annual JFDs at 10 meters are presented in Table 3 while the annual JFDs at 60 and 97 meters are presented in Tables 4 and 5.

Table 1A Occurrence of Stability Classes (DT60-10m) in Celia Meteorological Data

Stability Class	2011	2012	2-Year Average Percent Occurrence (2011-2012)
A	.05	25.09	12.59
B	1.43	5.98	3.71
C	5.99	6.90	6.45
D	45.67	17.50	31.56
E	26.63	17.26	21.94
F	14.24	12.71	13.47
G	5.99	14.55	10.28
Total Hours	8749	8781	17530

Table 2B Occurrence of Stability Classes (DT97-10m) in Celia Meteorological Data

Stability Class	2011	2012	2-Year Average Percent Occurrence (2011-2012)
A	0.00	1.06	0.53
B	0.00	1.63	0.82
C	0.00	1.74	0.87
D	44.67	33.83	39.24
E	36.58	32.15	34.36
F	16.37	18.79	17.58
G	2.39	10.80	6.60
Total Hours	8749	8781	17530

The stability data for the 2 year period in Table 1A and B were quite different. The year-to-year differences reflect calibration changes between the two years. For the 60-10m delta temperature most of the difference can be accounted for in the unstable (8.5 vs. 37.9) and neutral (45.7 vs. 17.5) stability classes. The percent of stable hours varied from 46.9 to 44.5 between the two years. Averaged over the two year period unstable conditions occurred about 22.8% of the time, neutral hours 31.6% and stable hours 45.6%. The 97-10m delta temperature had no unstable hours during 2011 and about 4.4% unstable hours in 2012. There is also a significant difference in the extremely stable (G stability) between the two years of 2.4 vs. 10.8%.

Figure 1 through Figure 15 show seasonal and annual wind roses from the 10, 60 and 97m levels on the tower. The predominant wind direction sector for 2011-2012 at Celia are shown in Table 2

Table 2 Predominant and Secondary Wind Direction Sectors by Season

SEASON	Tower Level (m)	10	60	97
Annual	Predominant	NNW, SSE	NNW	NNW, SSE
	Secondary	N	S, SSE	N, S
Winter	Predominant	N, SSE	NNW,SSE	N
	Secondary	NNW	N, S	S, SSE
Spring	Predominant	SSE	S	SSW
	Secondary	NNW, S	SSE, SSW	S, SSE
Summer	Predominant	S	SW	SW
	Secondary	NW	WSW, SSW	WSW
Fall	Predominant	N	NW	N, NNW
	Secondary	NNW	N, E	E

Figures 16 and 17 show wind roses from Mobile, AL and Pensacola, FL for the period of 2011 through 2012. As with most NWS sites located at airports the Pensacola, FL wind roses show predominant wind directions that line up with the runways, typically north-south and east-west. What we can see from the wind roses is the similar northwest to north winds and south-southeast to south that are predominant at the site. The Mobile, AL data that comes from a city location shows the northwest to north-northwest and southeast winds being the most predominant that lines up very well with the Celia site data, particularly at 10m.

Figure 18 and Figure 19 are plots of the daily maximum, minimum and average temperatures and dew point temperatures. The temperatures for the 2-year period averaged near normal when compared to long-term averages at the nearby NWS site in Pensacola, FL. The overall average temperature for the 2-year period was 66.73°F, which was about 1 degree below the long-term average of 67.9° F at Pensacola, FL. The maximum temperature during the 2-year period was 98.6° F on June 4, 2011 and the minimum temperature was 20.6° F on January 13, 2011. The overall average dew point temperature for the 2-year period was 56.4°F, which was about 4 degrees below the long-term average of 60.8° F at Pensacola, FL. The dew point temperature

was below the long-term normal because of the site is located further inland from the coast than Pensacola NWS, so there is less affect from the Gulf of Mexico which tends to increase the humidity (dew point). The highest dew point reading during the 2-year period was 79.0° F on August 3, 2011 and the lowest reading was 5.7° F on January 12, 2011. Figure 20 shows the delta temperature (DT) frequency for the delta temperatures (60-10 and 97-10m). During a typical year, the DT frequency is centered near zero or slightly negative. During the 2-year period the 50% level of the 60-10m primary tower delta temperature was near -0.5° F and about -0.2° F for the 97-10m delta temperature. It would be expected that the 97-10m delta temperature would be more negative than the 60-10m delta temperature because of the additional 37m in delta height. The value for the 60-10m delta temperature was near normal whereas the 97-10m delta temperature value was about a degree above normal.

Table 8 shows comparative data between the Celia site and nearby NWS sites at Mobile, AL and Pensacola, FL. The data for temperature and relative humidity agree very well. The wind speed at the 10m level at Celia is somewhat lower (5.7mph vs. 8.0 and 7.6) than the NWS sites. This deviation is caused by the difference in instrumentation. At Celia low threshold wind speed instrumentation are used so that values can be measured down to 0.5 mph. At the NWS sites they are mainly interested in high wind speed so the threshold of their instrumentation is typically about 3.0 mph.

The annual rainfall total at Celia for the 2-year period averaged 50.83 inches per year. Table 7 shows the monthly and annual rainfall totals for each year. The average annual rainfall at the Celia site is significantly less than the long-term (30 years) averages from Pensacola (65.27) and Mobile (66.15). This is probably due to the small (2 year) sample size. During the 2-year period there 34 days with one inch or more of rain (15 in 2011 and 19 in 2012). The long-term average from Pensacola and Mobile is about 20 per year. The maximum daily rainfall occurred on September 17, 2011 with 4.96 inches during severe thunderstorms.

5 References

1. Certification of Met-MIDAS (Suite of Tasks) Version 1.5.12, Revision 2, September 9, 2007, CCP-Beth-25.

2. Certification of MDVDISPLAY Version 1.5.16, Revision 0, February 9, 2013, CCP-Beth-70.

3. Meteorological data for the Celia site for the period of January 2011 through December 2012 was received by Mark Abrams via e-mail on November 14, 2012 and January 11, 2013 from Thomas Cornelius of SNC.

4. Verification and Validation of MIDAS Software Volumes 1 and 2, December 1988.

5. NOAA, NCDC, 2011-2012 Local Climatological Data, Annual summary and 2009-2012 hourly meteorological data with for Pensacola, Florida..

6. NOAA, NCDC, 2011-2012 hourly meteorological data with for Mobile, Alabama

7. Nuclear Regulatory Commission, Regulatory Guide 1.23 Revision 1, Meteorological Monitoring Programs for Nuclear Power Plants, March 2007.

Table 3 Celia JOINT FREQUENCY TABLES of Wind Speed and Wind Direction 10m Versus Delta Temperature 60-10m January 1, 2011 Through December 31, 2012

Joint Frequency Distribution

Hours at Each Wind Speed and Direction

Total Period

Period of Record = 1/1/2011 00:00 - 12/31/2012 23:00
Elevation: **Speed:** SPD10M **Direction:** WD10M **Lapse:** DT60-10M
Stability Class A Delta Temperature Extremely Unstable

Wind Speed (mph)

Wind Direction	1 - 4	4 - 8	8 - 13	13 - 19	19 - 25	≥ 25	Total
N	6	46	87	7	0	0	146
NNE	5	93	34	11	0	0	143
NE	6	102	40	7	0	0	155
ENE	3	105	33	0	0	0	141
E	5	132	19	0	0	0	156
ESE	5	75	40	0	0	0	120
SE	6	49	41	11	0	0	107
SSE	1	68	110	41	1	0	221
S	4	58	75	4	0	0	141
SSW	6	46	51	4	0	0	107
SW	3	47	43	7	0	0	100
WSW	5	43	24	0	0	0	72
W	6	51	18	1	0	0	76
WNW	4	52	36	6	0	0	98
NW	5	77	83	30	0	0	195
NNW	1	67	119	41	1	0	229
Total	71	1111	853	170	2	0	2207

Calm Hours not Included above for :	**Total Period**	0
Variable Direction Hours for:	**Total Period**	0
Invalid Hours for:	**Total Period**	14
Valid Hours for this Stability Class for:	**Total Period**	2207
Total Hours for Period		17544

Table 3 Continued

Joint Frequency Distribution

Hours at Each Wind Speed and Direction

Total Period

Period of Record = 1/1/2011 00:00 - 12/31/2012 23:00
Elevation: **Speed:** SPD10M **Direction:** WD10M **Lapse:** DT60-10M
Stability Class B Delta Temperature Moderately Unstable

Wind Speed (mph)

Wind Direction	1 - 4	4 - 8	8 - 13	13 - 19	19 - 25	≥ 25	Total
N	0	13	19	3	0	0	35
NNE	2	24	8	1	0	0	35
NE	2	20	7	0	0	0	29
ENE	2	25	7	0	0	0	34
E	2	24	7	1	0	0	34
ESE	2	24	6	1	0	0	33
SE	1	21	12	1	1	0	36
SSE	1	28	31	7	0	0	67
S	0	24	35	9	1	0	69
SSW	1	22	29	5	0	0	57
SW	3	13	18	2	0	0	36
WSW	1	14	13	1	0	0	29
W	1	21	6	0	0	0	28
WNW	1	22	4	1	0	0	28
NW	1	17	12	3	0	0	33
NNW	1	26	31	9	0	0	67
Total	21	338	245	44	2	0	650

Calm Hours not Included above for :	**Total Period**	0
Variable Direction Hours for:	**Total Period**	0
Invalid Hours for:	**Total Period**	14
Valid Hours for this Stability Class for:	**Total Period**	650
Total Hours for Period		17544

Table 3 Continued

Joint Frequency Distribution

Hours at Each Wind Speed and Direction

Total Period

Period of Record = 1/1/2011 00:00 - 12/31/2012 23:00
Elevation: **Speed:** SPD10M **Direction:** WD10M **Lapse:** DT60-10M
Stability Class C Delta Temperature Slightly Unstable

Wind Speed (mph)

Wind Direction	1 - 4	4 - 8	8 - 13	13 - 19	19 - 25	≥ 25	Total
N	2	32	33	4	0	0	71
NNE	4	46	11	3	0	0	64
NE	5	30	15	0	0	0	50
ENE	1	34	13	1	0	0	49
E	3	50	13	0	0	0	66
ESE	3	33	10	0	0	0	46
SE	1	27	20	7	1	0	56
SSE	4	55	53	13	1	0	126
S	2	39	52	13	2	0	108
SSW	0	42	44	13	0	0	99
SW	0	30	31	11	0	0	72
WSW	5	37	5	1	0	0	48
W	4	25	6	0	0	0	35
WNW	4	32	17	6	0	0	59
NW	1	27	46	8	0	0	82
NNW	1	46	44	8	0	0	99
Total	40	585	413	88	4	0	1130

Calm Hours not Included above for :	**Total Period**	0
Variable Direction Hours for:	**Total Period**	0
Invalid Hours for:	**Total Period**	14
Valid Hours for this Stability Class for:	**Total Period**	1130
Total Hours for Period		17544

Table 3 Continued

Joint Frequency Distribution

Hours at Each Wind Speed and Direction

Total Period

Period of Record = 1/1/2011 00:00 - 12/31/2012 23:00
Elevation: **Speed:** SPD10M **Direction:** WD10M **Lapse:** DT60-10M
Stability Class D Delta Temperature Neutral

Wind Speed (mph)

Wind Direction	1 - 4	4 - 8	8 - 13	13 - 19	19 - 25	> 25	Total
N	26	179	237	39	0	0	481
NNE	21	156	68	13	0	0	258
NE	34	144	69	1	0	0	248
ENE	34	138	49	3	0	0	224
E	34	173	44	7	0	0	258
ESE	29	180	77	8	0	0	294
SE	36	215	105	18	0	0	374
SSE	31	285	226	50	5	0	597
S	38	248	166	45	5	0	502
SSW	25	197	99	26	0	0	347
SW	33	137	99	20	0	0	289
WSW	27	117	39	1	0	0	184
W	27	106	46	3	0	0	182
WNW	21	141	76	19	1	0	258
NW	22	218	205	45	0	0	490
NNW	21	204	256	66	0	0	547
Total	459	2838	1861	364	11	0	5533

Calm Hours not Included above for :	**Total Period**	0
Variable Direction Hours for:	**Total Period**	0
Invalid Hours for:	**Total Period**	14
Valid Hours for this Stability Class for:	**Total Period**	5533
Total Hours for Period		17544

Table 3 Continued

Joint Frequency Distribution

Hours at Each Wind Speed and Direction

Total Period

Period of Record = 1/1/2011 00:00 - 12/31/2012 23:00
Elevation: **Speed:** SPD10M **Direction:** WD10M **Lapse:** DT60-10M
Stability Class E Delta Temperature Slightly Stable

Wind Speed (mph)

Wind Direction	1 - 4	4 - 8	8 - 13	13 - 19	19 - 25	≥ 25	Total
N	72	263	34	0	0	0	369
NNE	59	144	6	0	0	0	209
NE	59	106	6	0	0	0	171
ENE	77	102	9	0	0	0	188
E	91	120	5	0	0	0	216
ESE	71	150	18	2	0	0	241
SE	98	127	10	1	0	0	236
SSE	144	205	7	0	0	0	356
S	145	196	5	0	0	0	346
SSW	88	176	7	1	0	0	272
SW	76	143	13	0	0	0	232
WSW	81	67	5	0	0	0	153
W	75	46	6	0	0	0	127
WNW	58	88	10	0	0	0	156
NW	56	157	33	0	0	0	246
NNW	52	216	60	0	0	0	328
Total	1302	2306	234	4	0	0	3846

Calm Hours not Included above for :	**Total Period**	0
Variable Direction Hours for:	**Total Period**	0
Invalid Hours for:	**Total Period**	14
Valid Hours for this Stability Class for:	**Total Period**	3846
Total Hours for Period		17544

Table 3 Continued

Joint Frequency Distribution

Hours at Each Wind Speed and Direction

Total Period

Period of Record = 1/1/2011 00:00 - 12/31/2012 23:00
Elevation: **Speed:** SPD10M **Direction:** WD10M **Lapse:** DT60-10M
Stability Class F Delta Temperature Moderately Stable

Wind Speed (mph)

Wind Direction	1 - 4	4 - 8	8 - 13	13 - 19	19 - 25	≥ 25	Total
N	128	135	2	0	0	0	265
NNE	89	89	0	0	0	0	178
NE	94	51	0	1	0	0	146
ENE	78	43	1	0	0	0	122
E	74	29	0	0	0	0	103
ESE	64	23	0	0	0	0	87
SE	88	13	1	0	0	0	102
SSE	152	46	0	0	0	0	198
S	142	37	0	0	0	0	179
SSW	104	26	0	0	0	0	130
SW	91	29	0	0	0	0	120
WSW	107	33	0	0	0	0	140
W	100	26	0	0	0	0	126
WNW	92	41	0	0	0	0	133
NW	97	51	0	0	0	0	148
NNW	114	71	0	0	0	0	185
Total	1614	743	4	1	0	0	2362

Calm Hours not Included above for :	**Total Period**	0
Variable Direction Hours for:	**Total Period**	0
Invalid Hours for:	**Total Period**	14
Valid Hours for this Stability Class for:	**Total Period**	2362
Total Hours for Period		17544

Table 3 Continued

Joint Frequency Distribution

Hours at Each Wind Speed and Direction

Total Period

Period of Record = 1/1/2011 00:00 - 12/31/2012 23:00
Elevation: **Speed:** SPD10M **Direction:** WD10M **Lapse:** DT60-10M
Stability Class G Delta Temperature Extremely Stable

Wind Speed (mph)

Wind Direction	1 - 4	4 - 8	8 - 13	13 - 19	19 - 25	≥ 25	Total
N	262	91	0	0	0	0	353
NNE	148	67	0	0	0	0	215
NE	87	20	0	0	0	0	107
ENE	60	13	0	0	0	0	73
E	36	6	0	0	0	0	42
ESE	36	1	0	0	0	0	37
SE	41	1	0	0	0	0	42
SSE	83	12	0	0	0	0	95
S	70	9	1	0	0	0	80
SSW	44	2	0	0	0	0	46
SW	39	5	0	0	0	0	44
WSW	50	2	0	0	0	0	52
W	82	8	0	0	0	0	90
WNW	74	15	0	0	0	0	89
NW	128	9	0	0	0	0	137
NNW	262	38	0	0	0	0	300
Total	1502	299	1	0	0	0	1802

Calm Hours not Included above for :	**Total Period**	0
Variable Direction Hours for:	**Total Period**	0
Invalid Hours for:	**Total Period**	14
Valid Hours for this Stability Class for:	**Total Period**	1802
Total Hours for Period		17544

Table 3 Continued

Joint Frequency Distribution

Hours at Each Wind Speed and Direction

Summary of All Stability Classes

Total Period

Period of Record = 1/1/2011 00:00 - 12/31/2012 23:00

Elevation: **Speed:** SPD10M **Direction:** WD10M **Lapse:** DT60-10M

Delta Temperature

Wind Speed (mph)

Wind Direction	1 - 4	4 - 8	8 - 13	13 - 19	19 - 25	> 25	Total
N	496	759	412	53	0	0	1720
NNE	328	619	127	28	0	0	1102
NE	287	473	137	9	0	0	906
ENE	255	460	112	4	0	0	831
E	245	534	88	8	0	0	875
ESE	210	486	151	11	0	0	858
SE	271	453	189	38	2	0	953
SSE	416	699	427	111	7	0	1660
S	401	611	334	71	8	0	1425
SSW	268	511	230	49	0	0	1058
SW	245	404	204	40	0	0	893
WSW	276	313	86	3	0	0	678
W	295	283	82	4	0	0	664
WNW	254	391	143	32	1	0	821
NW	310	556	379	86	0	0	1331
NNW	452	668	510	124	1	0	1755
Total	5009	8220	3611	671	19	0	17530

Calm Hours not Included above for :	**Total Period**	0
Variable Direction Hours for:	**Total Period**	0
Invalid Hours for:	**Total Period**	14
Valid Hours for this Stability Class for:	**Total Period**	17530
Total Hours for Period		17544

Table 4 Celia JOINT FREQUENCY TABLES of Wind Speed and Wind Direction 60m Versus Delta Temperature 60-10m January 1, 2011 Through December 31, 2012

Joint Frequency Distribution

Hours at Each Wind Speed and Direction

Total Period

Period of Record = 1/1/2011 00:00 - 12/31/2012 23:00
Elevation: **Speed:** SPD60M **Direction:** WD60M **Lapse:** DT60-10M
Stability Class A Delta Temperature Extremely Unstable

Wind Speed (mph)

Wind Direction	1 - 4	4 - 8	8 - 13	13 - 19	19 - 25	≥ 25	Total
N	3	23	65	40	0	0	131
NNE	3	55	63	9	7	3	140
NE	2	86	69	6	3	0	166
ENE	3	75	67	3	0	0	148
E	3	77	66	1	0	0	147
ESE	0	44	59	7	0	0	110
SE	4	29	49	27	5	1	115
SSE	3	32	84	70	22	0	211
S	5	24	72	40	1	0	142
SSW	3	30	37	33	4	0	107
SW	1	29	36	32	4	0	102
WSW	7	22	34	7	0	0	70
W	3	30	40	4	1	0	78
WNW	6	40	53	15	7	0	121
NW	4	50	72	49	23	1	199
NNW	2	42	86	66	22	2	220
Total	52	688	952	409	99	7	2207

Calm Hours not Included above for :	**Total Period**	0
Variable Direction Hours for:	**Total Period**	0
Invalid Hours for:	**Total Period**	14
Valid Hours for this Stability Class for:	**Total Period**	2207
Total Hours for Period		17544

Table 4 Continued

Joint Frequency Distribution

Hours at Each Wind Speed and Direction

Total Period

Period of Record = 1/1/2011 00:00 - 12/31/2012 23:00
Elevation: **Speed:** SPD60M **Direction:** WD60M **Lapse:** DT60-10M
Stability Class B Delta Temperature Moderately Unstable

Wind Speed (mph)

Wind Direction	1 - 4	4 - 8	8 - 13	13 - 19	19 - 25	≥ 25	Total
N	0	6	11	9	0	0	26
NNE	3	14	9	10	0	0	36
NE	0	12	14	5	0	0	31
ENE	1	12	15	0	0	0	28
E	3	16	22	1	2	0	44
ESE	0	10	18	0	0	0	28
SE	0	7	24	7	1	1	40
SSE	0	7	34	17	3	0	61
S	1	8	31	26	2	1	69
SSW	1	9	23	20	4	0	57
SW	1	8	16	12	1	0	38
WSW	0	10	12	7	0	1	30
W	1	16	9	3	0	0	29
WNW	0	15	7	3	0	0	25
NW	0	11	16	10	3	0	40
NNW	1	7	27	26	7	0	68
Total	12	168	288	156	23	3	650

Calm Hours not Included above for :	**Total Period**	0
Variable Direction Hours for:	**Total Period**	0
Invalid Hours for:	**Total Period**	14
Valid Hours for this Stability Class for:	**Total Period**	650
Total Hours for Period		17544

Table 4 Continued

Joint Frequency Distribution

Hours at Each Wind Speed and Direction

Total Period

Period of Record = 1/1/2011 00:00 - 12/31/2012 23:00
Elevation: **Speed:** SPD60M **Direction:** WD60M **Lapse:** DT60-10M
Stability Class C Delta Temperature Slightly Unstable

Wind Speed (mph)

Wind Direction	1 - 4	4 - 8	8 - 13	13 - 19	19 - 25	≥ 25	Total
N	0	17	26	19	3	0	65
NNE	4	27	25	7	2	0	65
NE	3	27	17	3	1	0	51
ENE	1	20	27	4	0	0	52
E	1	26	40	6	0	0	73
ESE	2	15	22	1	0	0	40
SE	1	14	22	13	6	1	57
SSE	1	24	54	35	5	1	120
S	0	17	42	44	4	2	109
SSW	0	14	44	31	12	0	101
SW	2	13	37	17	7	2	78
WSW	1	27	14	1	0	0	43
W	0	18	16	6	0	0	40
WNW	2	20	26	8	5	0	61
NW	0	17	29	21	9	0	76
NNW	2	24	37	32	4	0	99
Total	20	320	478	248	58	6	1130

Calm Hours not Included above for :	**Total Period**	0
Variable Direction Hours for:	**Total Period**	0
Invalid Hours for:	**Total Period**	14
Valid Hours for this Stability Class for:	**Total Period**	1130
Total Hours for Period		17544

Table 4 Continued

Joint Frequency Distribution

Hours at Each Wind Speed and Direction

Total Period

Period of Record = 1/1/2011 00:00 - 12/31/2012 23:00
Elevation: **Speed:** SPD60M **Direction:** WD60M **Lapse:** DT60-10M
Stability Class D Delta Temperature Neutral

Wind Speed (mph)

Wind Direction	1 - 4	4 - 8	8 - 13	13 - 19	19 - 25	≥ 25	Total
N	10	95	164	151	11	0	431
NNE	13	84	99	39	6	0	241
NE	12	92	93	45	3	0	245
ENE	11	85	96	39	1	0	232
E	10	104	116	25	10	0	265
ESE	9	87	136	51	10	0	293
SE	10	89	209	83	18	0	409
SSE	9	89	274	148	29	5	554
S	11	74	214	128	33	9	469
SSW	8	80	176	74	24	2	364
SW	8	62	126	91	13	0	300
WSW	9	82	83	22	0	0	196
W	12	77	77	32	4	0	202
WNW	6	106	99	67	20	4	302
NW	9	143	165	156	40	3	516
NNW	10	97	171	203	31	2	514
Total	157	1446	2298	1354	253	25	5533

Calm Hours not Included above for :	**Total Period**	0
Variable Direction Hours for:	**Total Period**	0
Invalid Hours for:	**Total Period**	14
Valid Hours for this Stability Class for:	**Total Period**	5533
Total Hours for Period		17544

Table 4 Continued

Joint Frequency Distribution

Hours at Each Wind Speed and Direction

Total Period

Period of Record = 1/1/2011 00:00 - 12/31/2012 23:00
Elevation: **Speed:** SPD60M **Direction:** WD60M **Lapse:** DT60-10M
Stability Class E Delta Temperature Slightly Stable

Wind Speed (mph)

Wind Direction	1 - 4	4 - 8	8 - 13	13 - 19	19 - 25	> 25	Total
N	5	26	140	129	0	0	300
NNE	4	36	91	67	0	0	198
NE	5	30	90	34	0	0	159
ENE	2	46	99	58	0	0	205
E	4	42	116	45	0	0	207
ESE	2	60	131	65	4	0	262
SE	2	51	168	45	4	0	270
SSE	4	43	176	31	0	0	254
S	3	41	234	32	0	0	310
SSW	6	57	197	51	2	0	313
SW	7	61	175	62	1	0	306
WSW	4	45	127	38	0	0	214
W	12	41	81	21	0	0	155
WNW	7	28	61	56	0	0	152
NW	9	25	97	99	2	0	232
NNW	4	32	128	143	2	0	309
Total	80	664	2111	976	15	0	3846

Calm Hours not Included above for :	**Total Period**	0
Variable Direction Hours for:	**Total Period**	0
Invalid Hours for:	**Total Period**	14
Valid Hours for this Stability Class for:	**Total Period**	3846
Total Hours for Period		17544

Table 4 Continued

Joint Frequency Distribution

Hours at Each Wind Speed and Direction

Total Period

Period of Record = 1/1/2011 00:00 - 12/31/2012 23:00
Elevation: **Speed:** SPD60M **Direction:** WD60M **Lapse:** DT60-10M
Stability Class F Delta Temperature Moderately Stable

Wind Speed (mph)

Wind Direction	1 - 4	4 - 8	8 - 13	13 - 19	19 - 25	> 25	Total
N	4	15	59	66	0	0	144
NNE	2	15	71	58	0	0	146
NE	5	20	51	42	1	0	119
ENE	7	26	67	41	0	0	141
E	5	36	63	32	0	0	136
ESE	8	29	46	20	0	0	103
SE	4	44	55	16	0	0	119
SSE	8	25	96	19	0	0	148
S	9	41	97	27	0	0	174
SSW	5	36	98	31	0	0	170
SW	7	48	123	52	0	0	230
WSW	5	58	108	35	1	0	207
W	9	48	65	44	0	0	166
WNW	8	32	51	33	0	0	124
NW	3	22	52	35	0	0	112
NNW	4	21	61	37	0	0	123
Total	93	516	1163	588	2	0	2362

Calm Hours not Included above for :	**Total Period**	0
Variable Direction Hours for:	**Total Period**	0
Invalid Hours for:	**Total Period**	14
Valid Hours for this Stability Class for:	**Total Period**	2362
Total Hours for Period		17544

Table 4 Continued

Joint Frequency Distribution

Hours at Each Wind Speed and Direction

Total Period

Period of Record = 1/1/2011 00:00 - 12/31/2012 23:00
Elevation: **Speed:** SPD60M **Direction:** WD60M **Lapse:** DT60-10M
Stability Class G Delta Temperature Extremely Stable

Wind Speed (mph)

Wind Direction	1 - 4	4 - 8	8 - 13	13 - 19	19 - 25	≥ 25	Total
N	5	35	60	28	0	0	128
NNE	4	34	84	49	0	0	171
NE	2	40	121	37	0	0	200
ENE	10	31	103	33	0	0	177
E	2	22	70	29	0	0	123
ESE	7	20	29	10	0	0	66
SE	8	28	32	6	0	0	74
SSE	2	21	22	12	0	0	57
S	6	30	58	9	0	0	103
SSW	8	35	52	11	0	0	106
SW	3	30	47	16	1	0	97
WSW	6	31	58	23	0	0	118
W	6	39	36	29	0	0	110
WNW	8	28	36	18	0	0	90
NW	3	20	50	18	0	0	91
NNW	3	25	44	19	0	0	91
Total	83	469	902	347	1	0	1802

Calm Hours not Included above for :	**Total Period**	0
Variable Direction Hours for:	**Total Period**	0
Invalid Hours for:	**Total Period**	14
Valid Hours for this Stability Class for:	**Total Period**	1802
Total Hours for Period		17544

Table 4 Continued

Joint Frequency Distribution

Hours at Each Wind Speed and Direction

Summary of All Stability Classes

Total Period

Period of Record = 1/1/2011 00:00 - 12/31/2012 23:00

Elevation: **Speed:** SPD60M **Direction:** WD60M **Lapse:** DT60-10M

Delta Temperature

Wind Speed (mph)

Wind Direction	1 - 4	4 - 8	8 - 13	13 - 19	19 - 25	> 25	Total
N	27	217	525	442	14	0	1225
NNE	33	265	442	239	15	3	997
NE	29	307	455	172	8	0	971
ENE	35	295	474	178	1	0	983
E	28	323	493	139	12	0	995
ESE	28	265	441	154	14	0	902
SE	29	262	559	197	34	3	1084
SSE	27	241	740	332	59	6	1405
S	35	235	748	306	40	12	1376
SSW	31	261	627	251	46	2	1218
SW	29	251	560	282	27	2	1151
WSW	32	275	436	133	1	1	878
W	43	269	324	139	5	0	780
WNW	37	269	333	200	32	4	875
NW	28	288	481	388	77	4	1266
NNW	26	248	554	526	66	4	1424
Total	497	4271	8192	4078	451	41	17530

Calm Hours not Included above for :	**Total Period**	0
Variable Direction Hours for:	**Total Period**	0
Invalid Hours for:	**Total Period**	14
Valid Hours for this Stability Class for:	**Total Period**	17530
Total Hours for Period		17544

Table 5 Celia JOINT FREQUENCY TABLES of Wind Speed and Wind Direction 97m Versus Delta Temperature 97-10m January 1, 2011 Through December 31, 2012

Joint Frequency Distribution

Hours at Each Wind Speed and Direction

Total Period

Period of Record = 1/1/2011 00:00 - 12/31/2012 23:00
Elevation: **Speed:** SPD97M **Direction:** WD97M **Lapse:** DT97-10M
Stability Class A Delta Temperature Extremely Unstable

Wind Speed (mph)

Wind Direction	1 - 4	4 - 8	8 - 13	13 - 19	19 - 25	≥ 25	Total
N	0	0	0	6	0	0	6
NNE	1	1	2	0	0	0	4
NE	0	2	4	0	0	0	6
ENE	0	0	4	0	0	0	4
E	0	0	1	0	0	0	1
ESE	0	0	0	0	0	0	0
SE	0	1	3	1	0	0	5
SSE	0	0	0	8	4	1	13
S	0	0	2	2	1	0	5
SSW	0	0	1	0	0	0	1
SW	0	0	1	3	7	0	11
WSW	0	0	1	3	0	0	4
W	0	0	2	0	1	0	3
WNW	0	0	1	1	0	0	2
NW	0	2	1	4	4	0	11
NNW	0	3	3	3	3	5	17
Total	1	9	26	31	20	6	93

Calm Hours not Included above for :	**Total Period**	0
Variable Direction Hours for:	**Total Period**	0
Invalid Hours for:	**Total Period**	14
Valid Hours for this Stability Class for:	**Total Period**	93
Total Hours for Period		17544

Table 5 Continued

Joint Frequency Distribution

Hours at Each Wind Speed and Direction

Total Period

Period of Record = 1/1/2011 00:00 - 12/31/2012 23:00
Elevation: **Speed:** SPD97M **Direction:** WD97M **Lapse:** DT97-10M
Stability Class B Delta Temperature Moderately Unstable

Wind Speed (mph)

Wind Direction	1 - 4	4 - 8	8 - 13	13 - 19	19 - 25	≥ 25	Total
N	0	0	4	8	0	0	12
NNE	0	4	3	2	0	0	9
NE	0	3	3	1	0	0	7
ENE	0	1	0	0	0	0	1
E	0	1	0	0	0	0	1
ESE	0	2	2	0	0	0	4
SE	0	1	3	1	0	1	6
SSE	0	1	3	5	4	0	13
S	1	0	1	7	0	0	9
SSW	0	0	1	6	3	0	10
SW	0	0	0	8	2	0	10
WSW	0	0	4	1	0	0	5
W	0	0	1	0	0	0	1
WNW	0	0	3	1	2	0	6
NW	0	2	5	5	10	1	23
NNW	0	2	7	7	8	2	26
Total	1	17	40	52	29	4	143

Calm Hours not Included above for :	**Total Period**	0
Variable Direction Hours for:	**Total Period**	0
Invalid Hours for:	**Total Period**	14
Valid Hours for this Stability Class for:	**Total Period**	143
Total Hours for Period		17544

Table 5 Continued

Joint Frequency Distribution

Hours at Each Wind Speed and Direction

Total Period

Period of Record = 1/1/2011 00:00 - 12/31/2012 23:00
Elevation: **Speed:** SPD97M **Direction:** WD97M **Lapse:** DT97-10M
Stability Class C Delta Temperature Slightly Unstable

Wind Speed (mph)

Wind Direction	1 - 4	4 - 8	8 - 13	13 - 19	19 - 25	≥ 25	Total
N	0	1	7	9	0	0	17
NNE	0	0	5	2	0	4	11
NE	0	0	2	1	2	0	5
ENE	0	0	0	0	0	0	0
E	0	2	1	0	0	0	3
ESE	0	2	1	4	0	0	7
SE	0	1	2	4	0	0	7
SSE	1	3	3	7	7	1	22
S	0	0	3	5	1	0	9
SSW	0	0	2	5	1	0	8
SW	0	0	2	3	1	0	6
WSW	0	1	6	3	0	0	10
W	0	1	0	1	0	0	2
WNW	0	0	2	2	1	0	5
NW	0	3	8	6	6	0	23
NNW	0	1	4	3	8	2	18
Total	1	15	48	55	27	7	153

Calm Hours not Included above for :	**Total Period**	0
Variable Direction Hours for:	**Total Period**	0
Invalid Hours for:	**Total Period**	14
Valid Hours for this Stability Class for:	**Total Period**	153
Total Hours for Period		17544

Table 5 Continued

Joint Frequency Distribution

Hours at Each Wind Speed and Direction

Total Period

Period of Record = 1/1/2011 00:00 - 12/31/2012 23:00
Elevation: **Speed:** SPD97M **Direction:** WD97M **Lapse:** DT97-10M
Stability Class D Delta Temperature Neutral

Wind Speed (mph)

Wind Direction	1 - 4	4 - 8	8 - 13	13 - 19	19 - 25	≥ 25	Total
N	11	88	184	242	55	3	583
NNE	6	72	122	93	23	3	319
NE	7	120	139	63	22	0	351
ENE	8	113	129	57	16	0	323
E	2	117	150	44	8	1	322
ESE	2	104	168	58	19	5	356
SE	3	68	137	111	30	2	351
SSE	3	77	197	236	68	15	596
S	7	59	197	249	55	24	591
SSW	6	64	171	194	50	19	504
SW	6	86	122	137	74	16	441
WSW	8	74	114	60	4	3	263
W	11	106	105	36	5	1	264
WNW	6	99	124	70	31	7	337
NW	5	143	208	146	67	21	590
NNW	5	123	229	224	99	8	688
Total	96	1513	2496	2020	626	128	6879

Calm Hours not Included above for :	**Total Period**	0
Variable Direction Hours for:	**Total Period**	0
Invalid Hours for:	**Total Period**	14
Valid Hours for this Stability Class for:	**Total Period**	6879
Total Hours for Period		17544

Table 5 Continued

Joint Frequency Distribution

Hours at Each Wind Speed and Direction

Total Period

Period of Record = 1/1/2011 00:00 - 12/31/2012 23:00
Elevation: **Speed:** SPD97M **Direction:** WD97M **Lapse:** DT97-10M
Stability Class E Delta Temperature Slightly Stable

Wind Speed (mph)

Wind Direction	1 - 4	4 - 8	8 - 13	13 - 19	19 - 25	> 25	Total
N	7	44	83	250	80	0	464
NNE	15	53	77	142	42	0	329
NE	8	79	83	116	30	0	316
ENE	12	68	88	78	19	0	265
E	9	74	101	84	32	1	301
ESE	5	76	103	161	30	1	376
SE	6	46	142	184	45	2	425
SSE	10	61	203	230	40	1	545
S	11	58	165	245	14	1	494
SSW	9	64	148	228	23	1	473
SW	8	55	135	254	33	1	486
WSW	10	51	112	132	24	1	330
W	23	79	118	59	6	0	285
WNW	5	62	64	59	17	0	207
NW	11	67	65	110	55	2	310
NNW	6	66	97	154	94	0	417
Total	155	1003	1784	2486	584	11	6023

Calm Hours not Included above for :	**Total Period**	0
Variable Direction Hours for:	**Total Period**	0
Invalid Hours for:	**Total Period**	14
Valid Hours for this Stability Class for:	**Total Period**	6023
Total Hours for Period		17544

Table 5 Continued

Joint Frequency Distribution

Hours at Each Wind Speed and Direction

Total Period

Period of Record = 1/1/2011 00:00 - 12/31/2012 23:00
Elevation: **Speed:** SPD97M **Direction:** WD97M **Lapse:** DT97-10M
Stability Class F Delta Temperature Moderately Stable

Wind Speed (mph)

Wind Direction	1 - 4	4 - 8	8 - 13	13 - 19	19 - 25	> 25	Total
N	8	19	53	63	29	0	172
NNE	4	26	46	88	44	0	208
NE	8	19	55	79	30	0	191
ENE	2	18	63	63	27	0	173
E	8	35	41	81	23	0	188
ESE	6	20	35	51	27	2	141
SE	8	29	46	48	28	0	159
SSE	6	29	61	81	20	0	197
S	7	26	59	74	26	0	192
SSW	10	19	82	85	16	0	212
SW	10	39	85	99	31	1	265
WSW	6	49	89	106	32	3	285
W	13	61	95	56	21	0	246
WNW	16	34	46	40	28	1	165
NW	6	22	45	39	21	0	133
NNW	9	27	50	42	27	0	155
Total	127	472	951	1095	430	7	3082

Calm Hours not Included above for :	**Total Period**	0
Variable Direction Hours for:	**Total Period**	0
Invalid Hours for:	**Total Period**	14
Valid Hours for this Stability Class for:	**Total Period**	3082
Total Hours for Period		17544

Table 5 Continued

Joint Frequency Distribution

Hours at Each Wind Speed and Direction

Total Period

Period of Record = 1/1/2011 00:00 - 12/31/2012 23:00
Elevation: **Speed:** SPD97M **Direction:** WD97M **Lapse:** DT97-10M
Stability Class G Delta Temperature Extremely Stable

Wind Speed (mph)

Wind Direction	1 - 4	4 - 8	8 - 13	13 - 19	19 - 25	≥ 25	Total
N	1	12	18	11	0	0	42
NNE	2	18	35	33	9	0	97
NE	2	15	53	30	10	0	110
ENE	1	19	59	33	1	0	113
E	2	15	50	52	1	0	120
ESE	5	9	25	41	10	0	90
SE	2	9	29	16	4	0	60
SSE	2	14	24	11	1	0	52
S	2	9	15	15	5	0	46
SSW	1	16	24	24	1	1	67
SW	3	15	20	20	3	1	62
WSW	10	9	28	24	7	2	80
W	2	18	19	17	5	0	61
WNW	2	10	15	17	11	2	57
NW	0	6	19	13	5	0	43
NNW	1	9	24	15	8	0	57
Total	38	203	457	372	81	6	1157

Calm Hours not Included above for :	**Total Period**	0
Variable Direction Hours for:	**Total Period**	0
Invalid Hours for:	**Total Period**	14
Valid Hours for this Stability Class for:	**Total Period**	1157
Total Hours for Period		17544

Table 5 Continued

Joint Frequency Distribution

Hours at Each Wind Speed and Direction

Summary of All Stability Classes

Total Period

Period of Record = 1/1/2011 00:00 - 12/31/2012 23:00

Elevation: **Speed:** SPD97M **Direction:** WD97M **Lapse:** DT97-10M

Delta Temperature

Wind Speed (mph)

Wind Direction	1 - 4	4 - 8	8 - 13	13 - 19	19 - 25	> 25	Total
N	27	164	349	589	164	3	1296
NNE	28	174	290	360	118	7	977
NE	25	238	339	290	94	0	986
ENE	23	219	343	231	63	0	879
E	21	244	344	261	64	2	936
ESE	18	213	334	315	86	8	974
SE	19	155	362	365	107	5	1013
SSE	22	185	491	578	144	18	1438
S	28	152	442	597	102	25	1346
SSW	26	163	429	542	94	21	1275
SW	27	195	365	524	151	19	1281
WSW	34	184	354	329	67	9	977
W	49	265	340	169	38	1	862
WNW	29	205	255	190	90	10	779
NW	22	245	351	323	168	24	1133
NNW	21	231	414	448	247	17	1378
Total	419	3232	5802	6111	1797	169	17530

Calm Hours not Included above for :	**Total Period**	0
Variable Direction Hours for:	**Total Period**	0
Invalid Hours for:	**Total Period**	14
Valid Hours for this Stability Class for:	**Total Period**	17530
Total Hours for Period		17544

Table 6 Celia Meteorological Tower 2011-2012 DATA RECOVERY (Percent)

Parameter	2-Year Percent Data Recovery 2011-2012
Wind Speed 10m	99.9
Wind Speed 60m	99.9
Wind Speed 97m	99.9
Wind Direction 10m	99.9
Wind Direction 60m	99.9
Wind Direction 97m	99.9
Delta Temperature 60-10m	99.9
Delta Temperature 97-10m	99.9
Temperature 10m	99.9
Temperature 60m	99.9
Temperature 97m	99.9
Dew Point Temperature 10m	99.9
Dew Point Temperature 60m	99.9
Dew Point Temperature 97m	99.9
Precipitation	99.9
Composite	
10m Wind Speed and Direction, Delta Temperature 60-10m	99.9
60m Wind Speed and Direction, Delta Temperature 60-10m	99.9
97m Wind Speed and Direction, Delta Temperature 97-10m	99.9

Table 7 Celia PRECIPITATION January 1, 2011 through December 31, 2012

	2011	2012
January	5.41	2.72
February	3.01	6.46
March	4.07	1.87
April	2.54	3.57
May	1.39	3.93
June	2.32	8.53
July	12.41	4.66
August	1.75	7.21
September	8.31	6.27
October	0.16	2.11
November	2.29	1.18
December	3.6	5.88
Total	47.26	54.39

Table 8 Comparing Celia Site Data With Nearby NWS Sites

	Celia+	Pensacola, Florida.*	Mobile, AL*
Wind Speed (MPH)	5.7	8.0	7.6
Temperature (° F)	66.7	67.9	67.3
Dew Point (° F)	56.4	60.8	58.2
Relative Humidity (%)	72.4	75	75
Rainfall (Inches)	50.83	65.27	66.15

+ Based on 2-years of data 2011-2012
* Based on 30-years of data 1980-2010

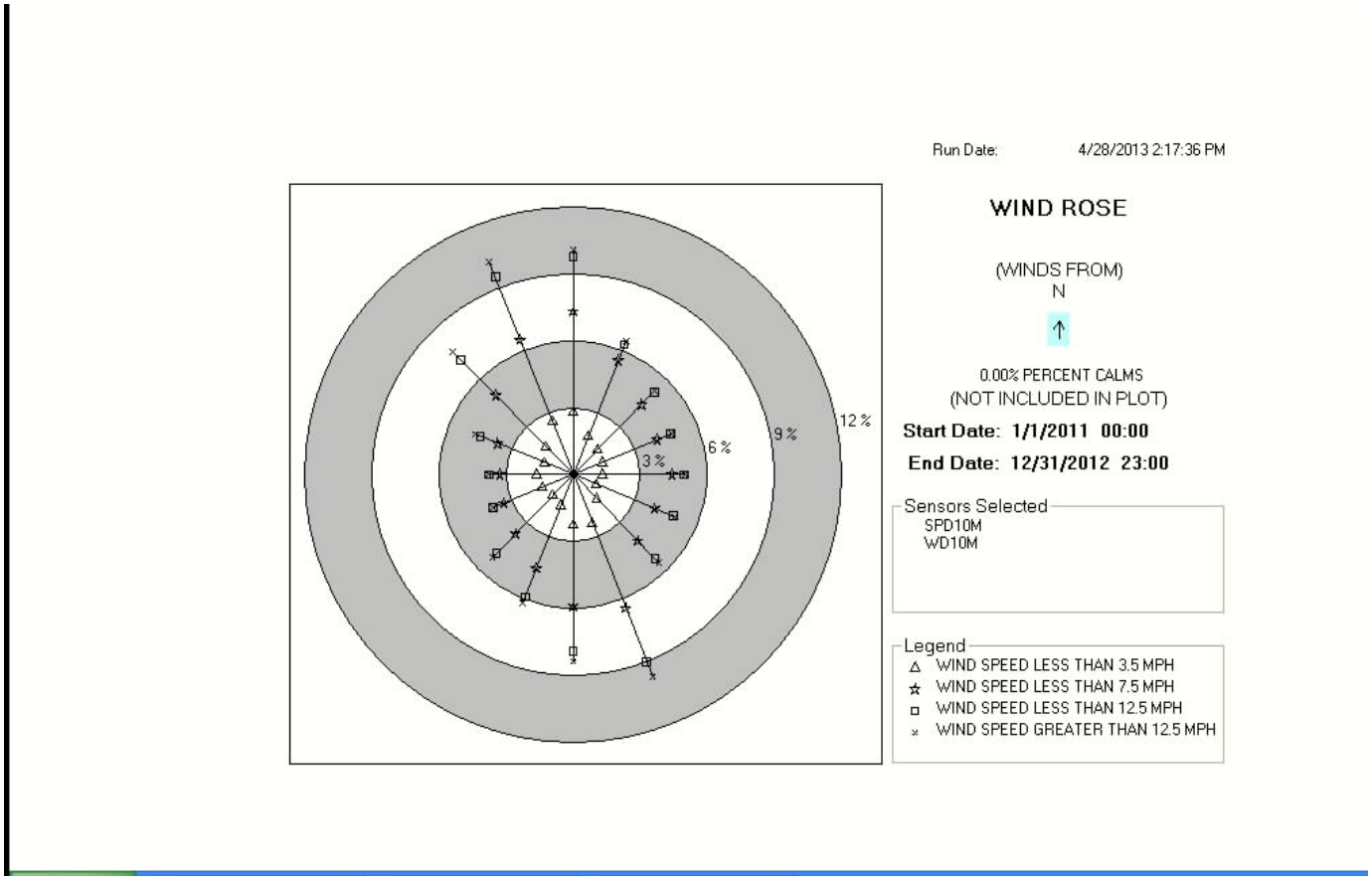

Figure 1 Celia 10m Level WIND ROSE January 1, 2011 through December 31, 2012

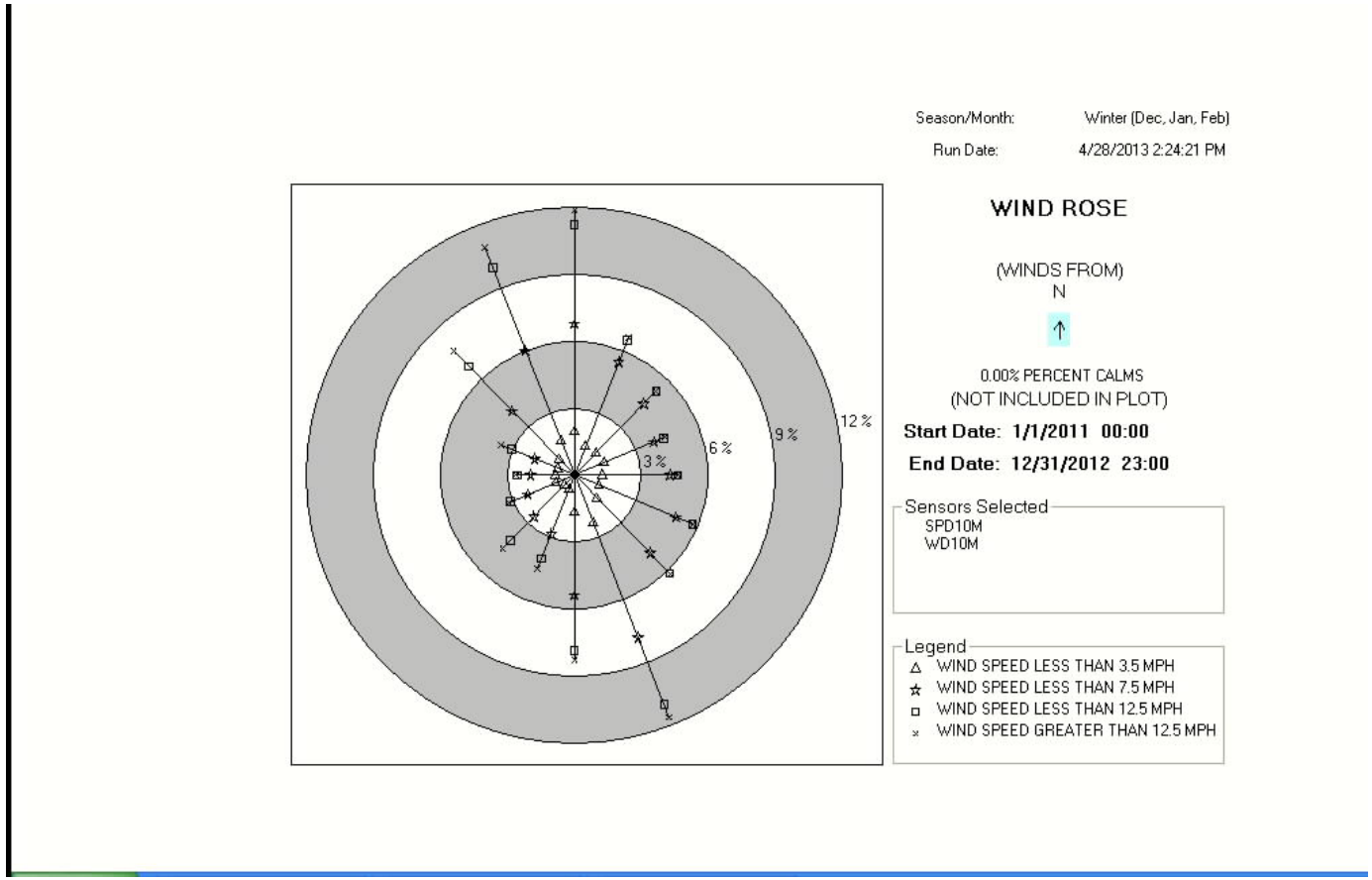

Figure 2 Celia 10m Level WIND ROSE Winter 2011-2012

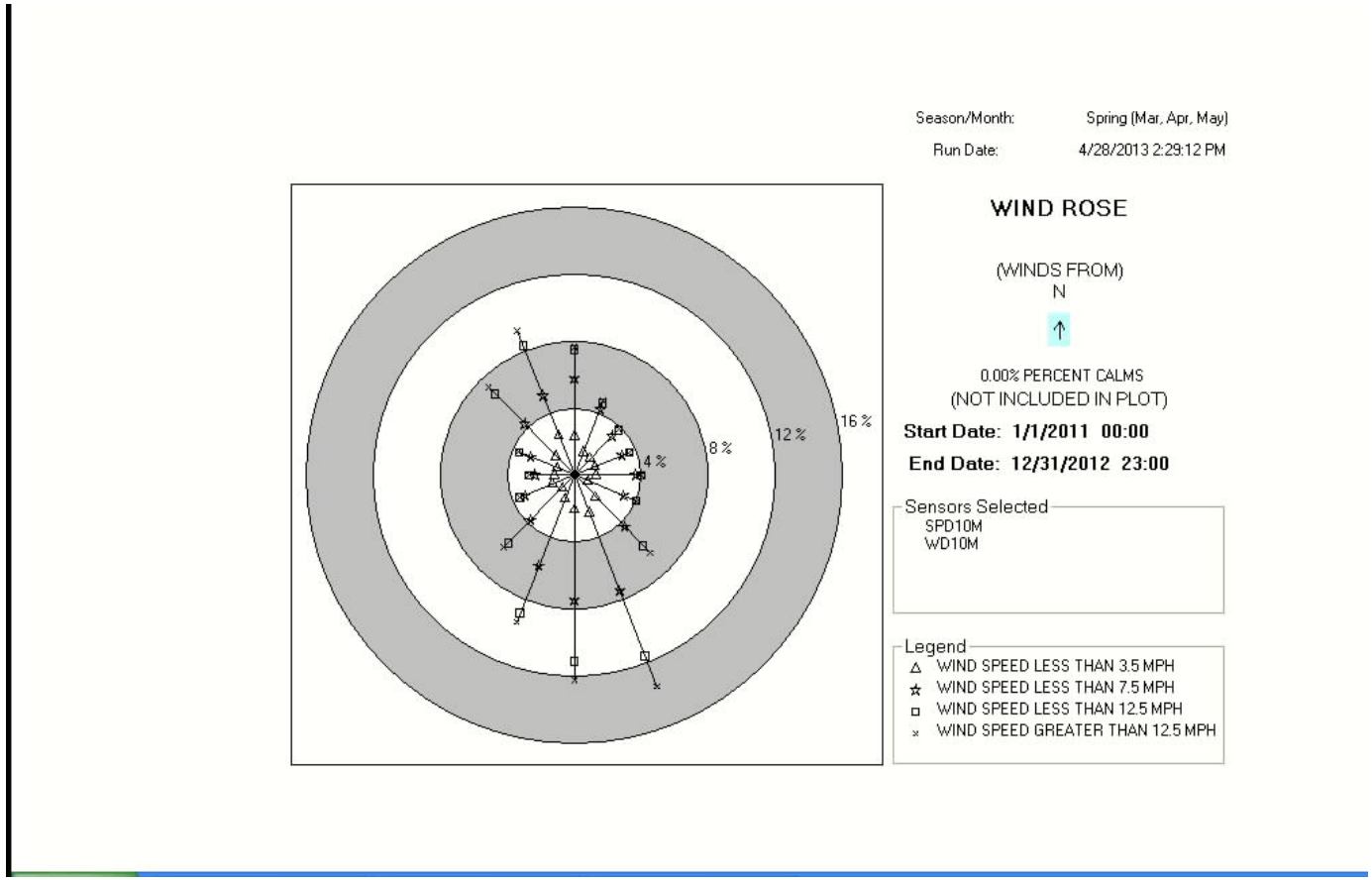

Figure 3 Celia 10m Level WIND ROSE Spring 2011-2012

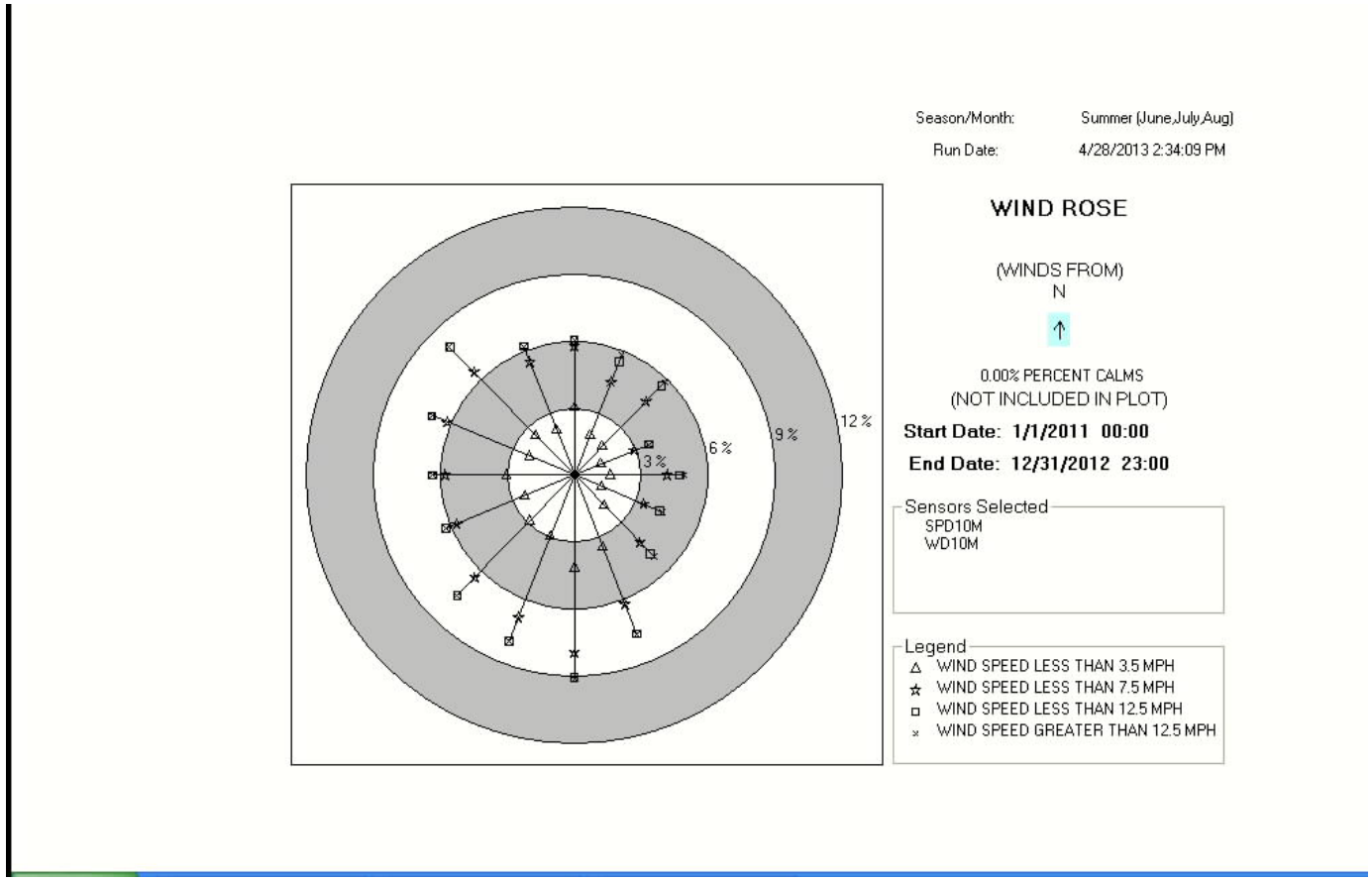

Figure 4 Celia 10m Level WIND ROSE Summer 2011-2012

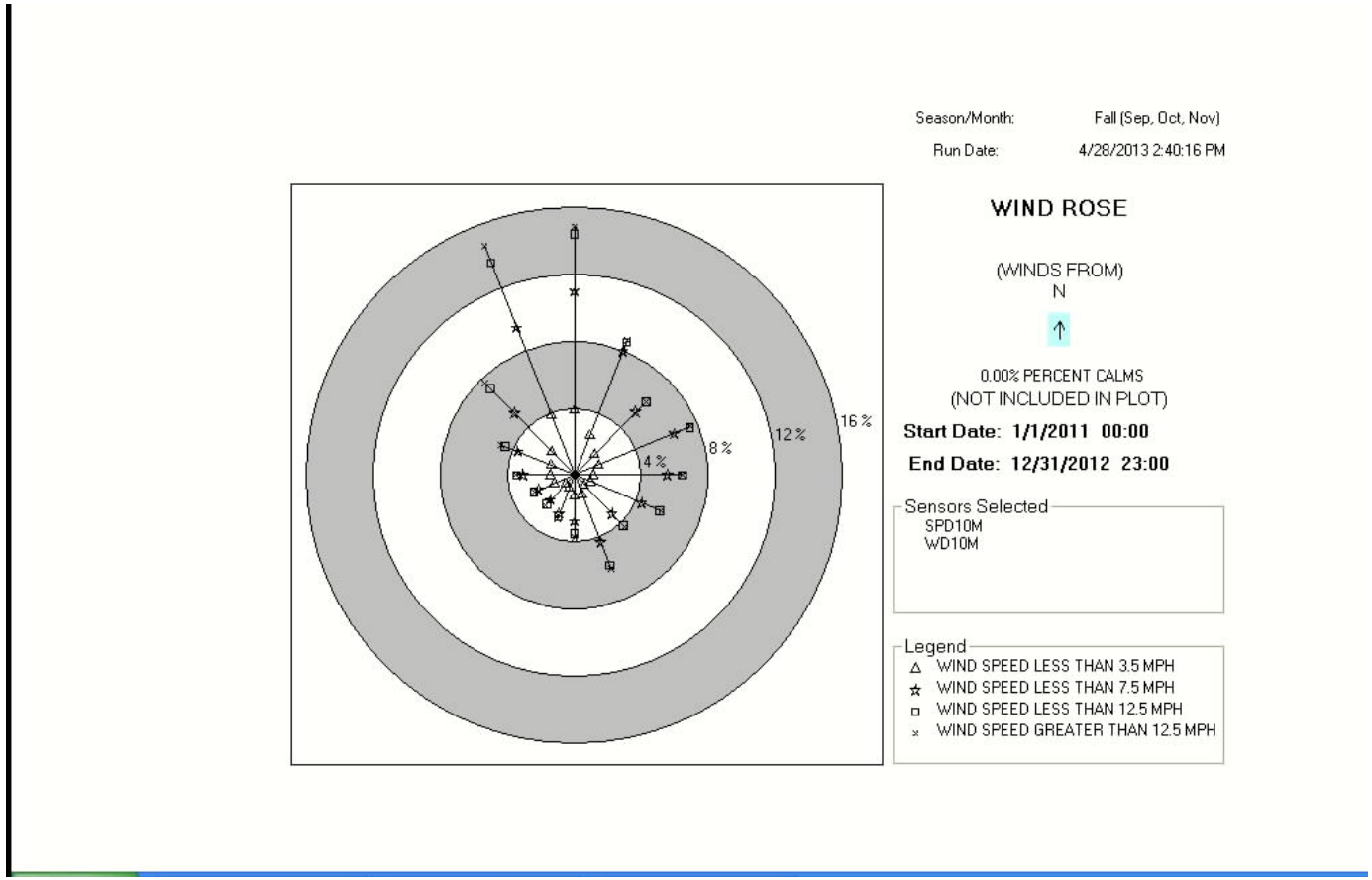

Figure 5 Celia 10m Level WIND ROSE Fall 2011-2012

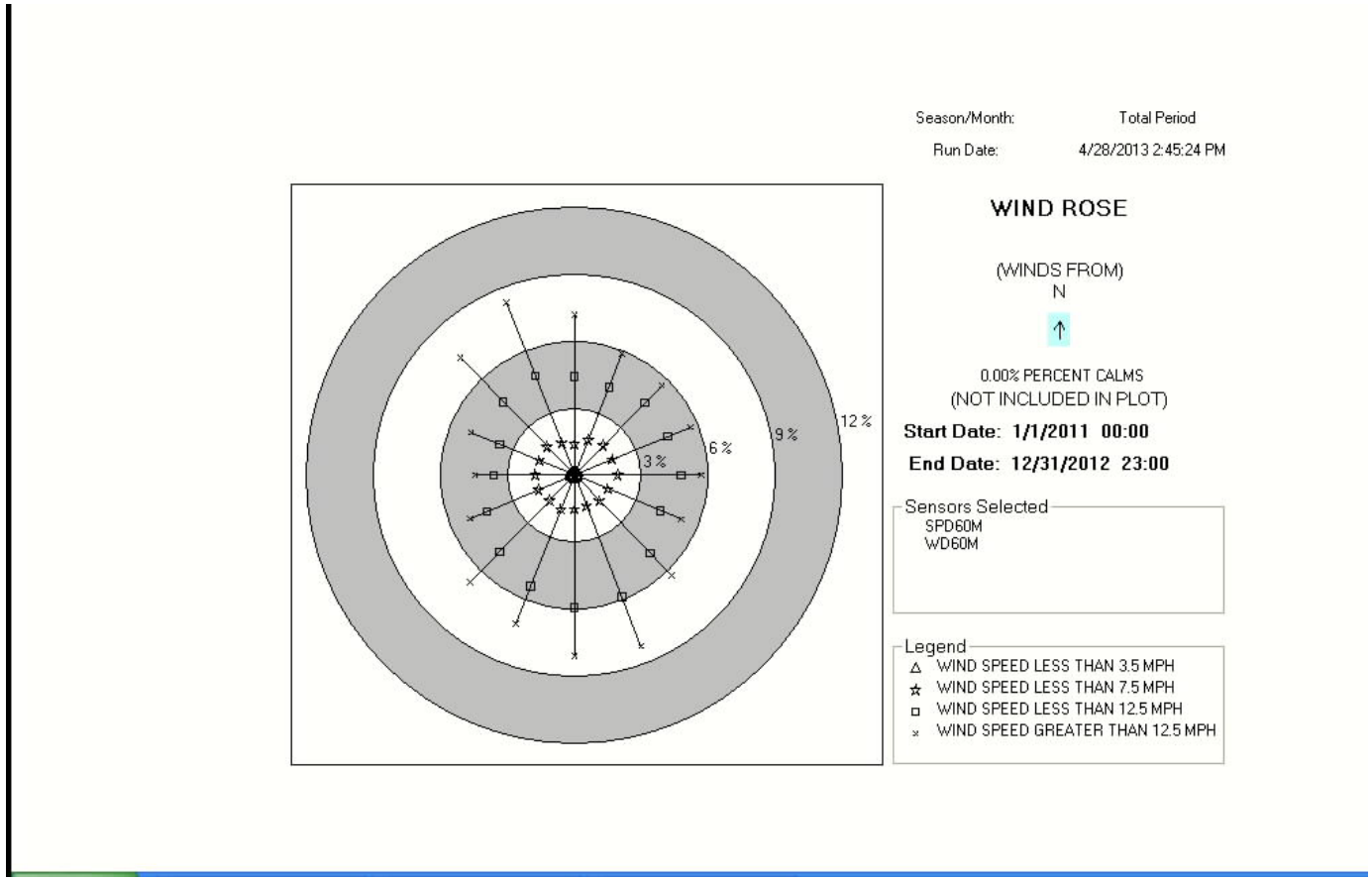

Figure 6 Celia 60m Level WIND ROSE January 1, 2011 through December 31, 2012

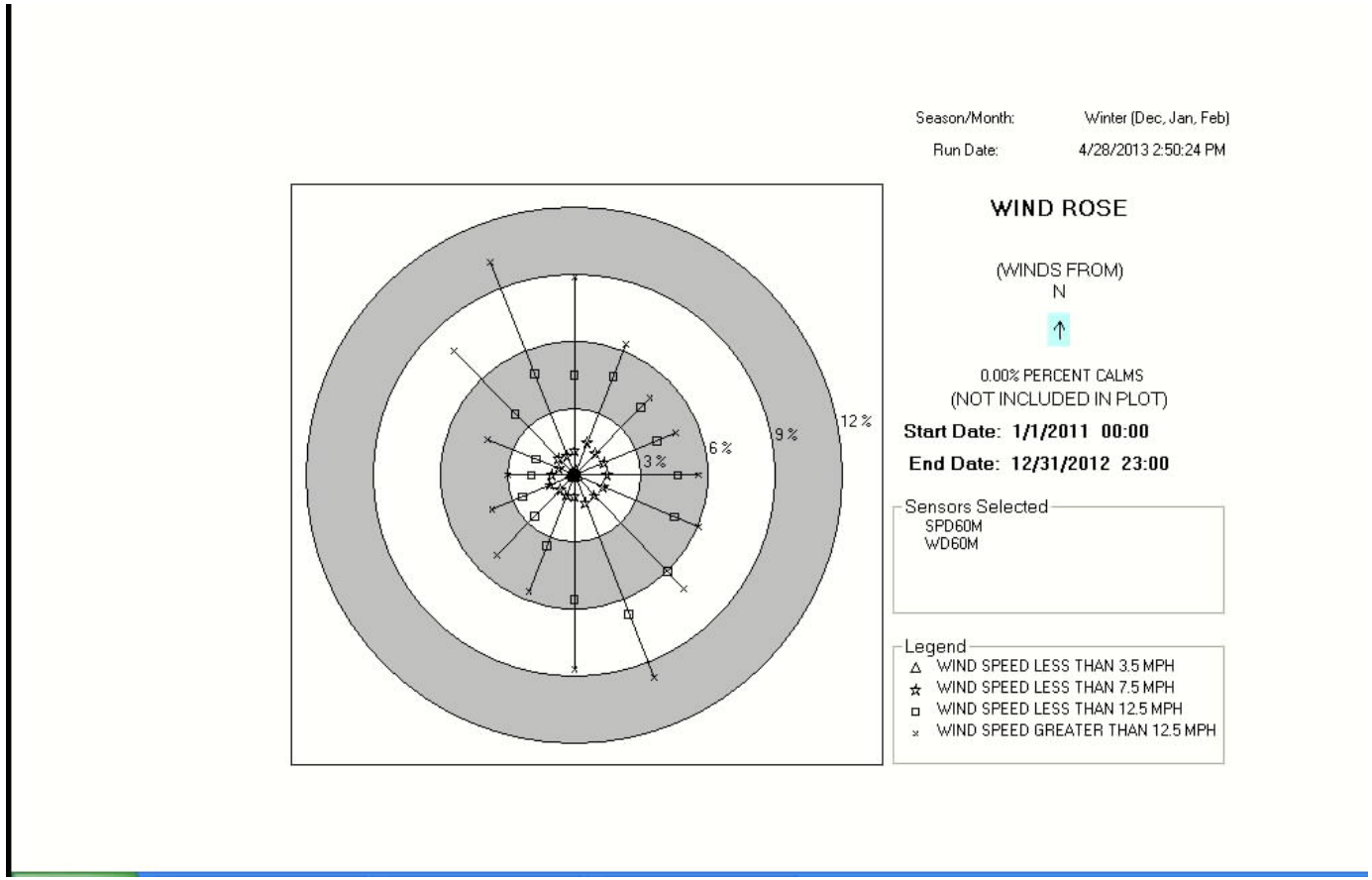

Figure 7 Celia 60m Level WIND ROSE Winter 2011-2012

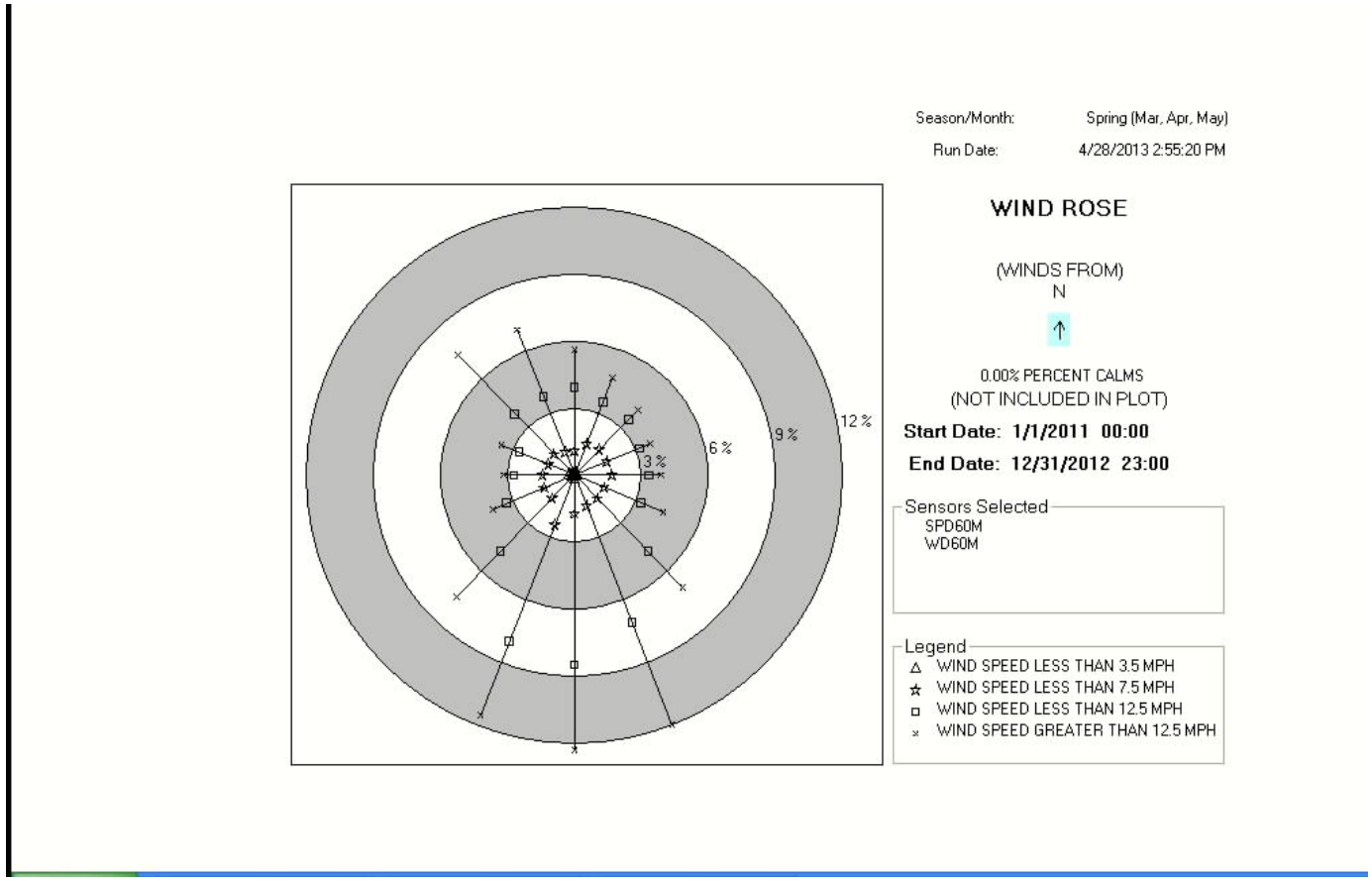

Figure 8 Celia 60m Level WIND ROSE Spring 2011-2012

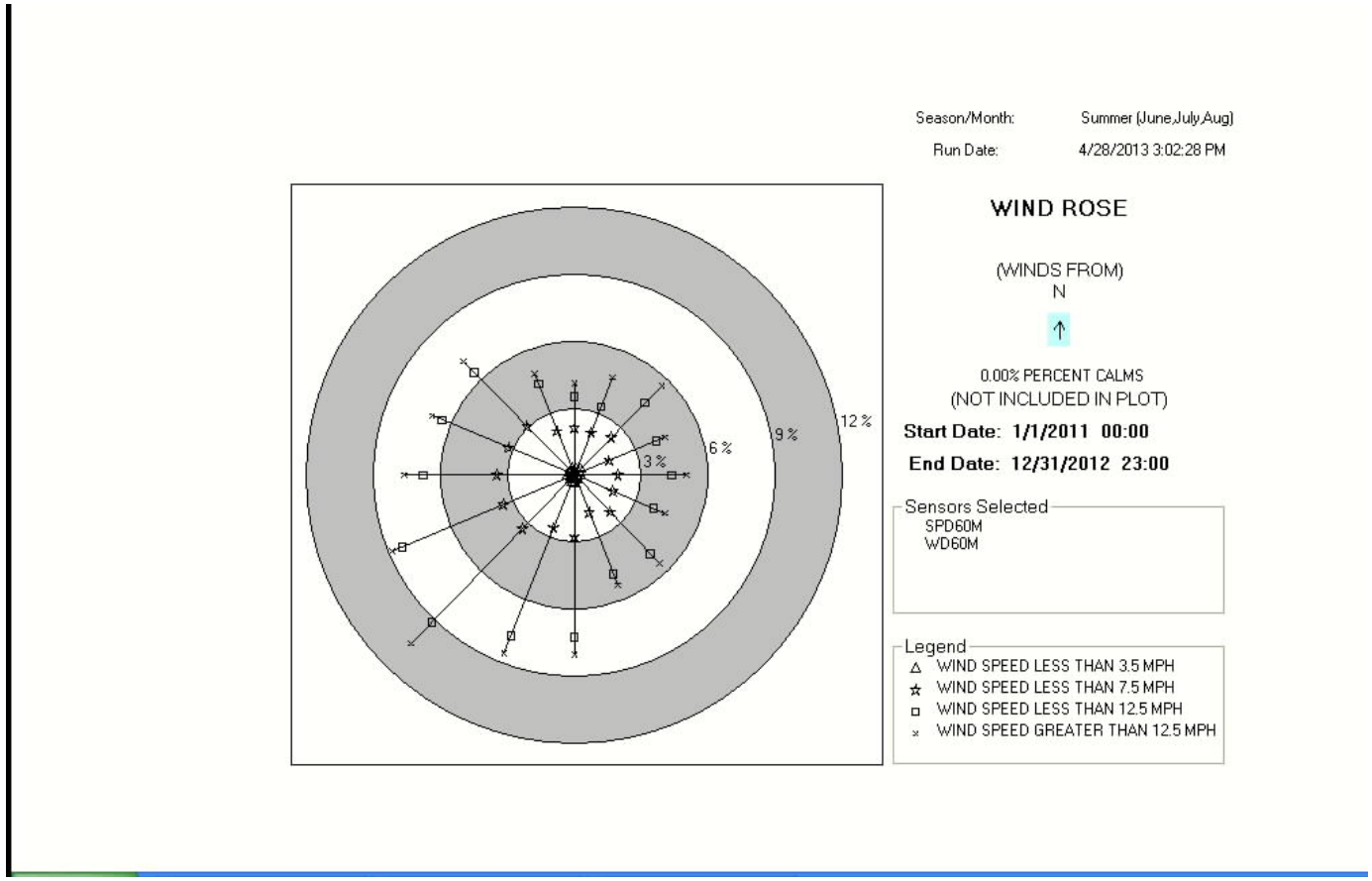

Figure 9 Celia 60m Level WIND ROSE Summer 2011-2012

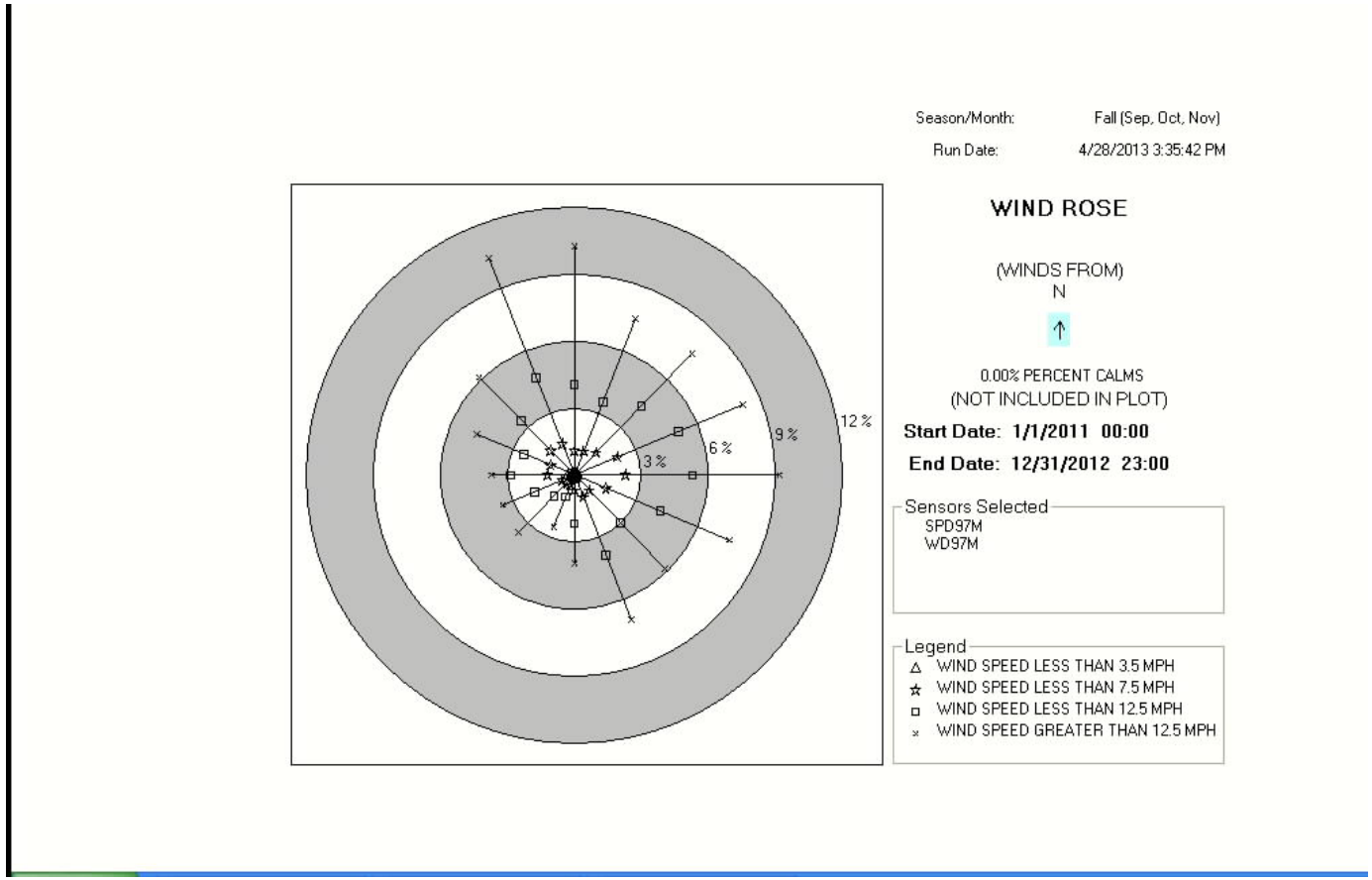

Figure 10 Celia 60m Level WIND ROSE Fall 2011-2012

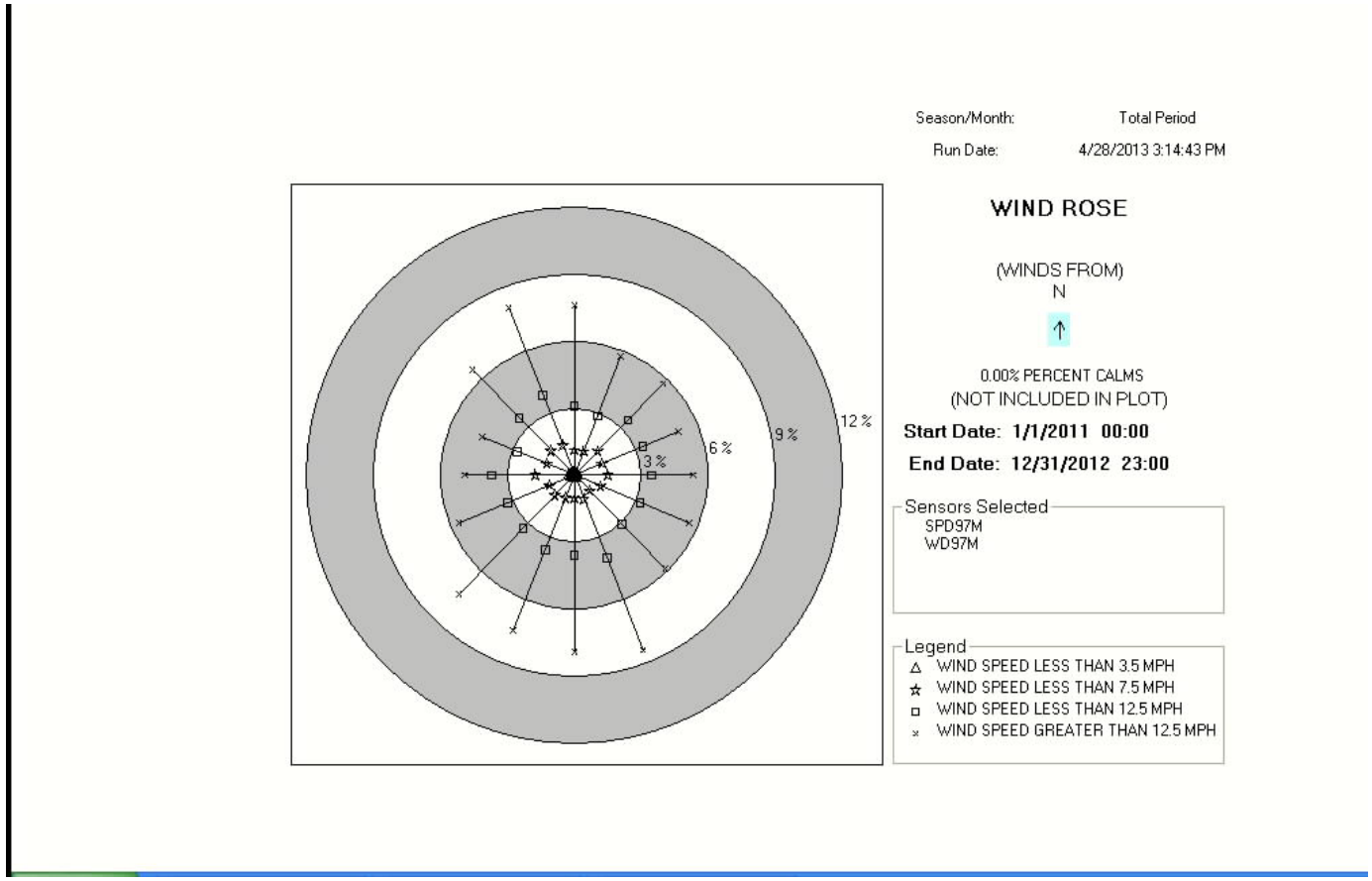

Figure 11 Celia 97m Level WIND ROSE January 1, 2011 through December 31, 2012

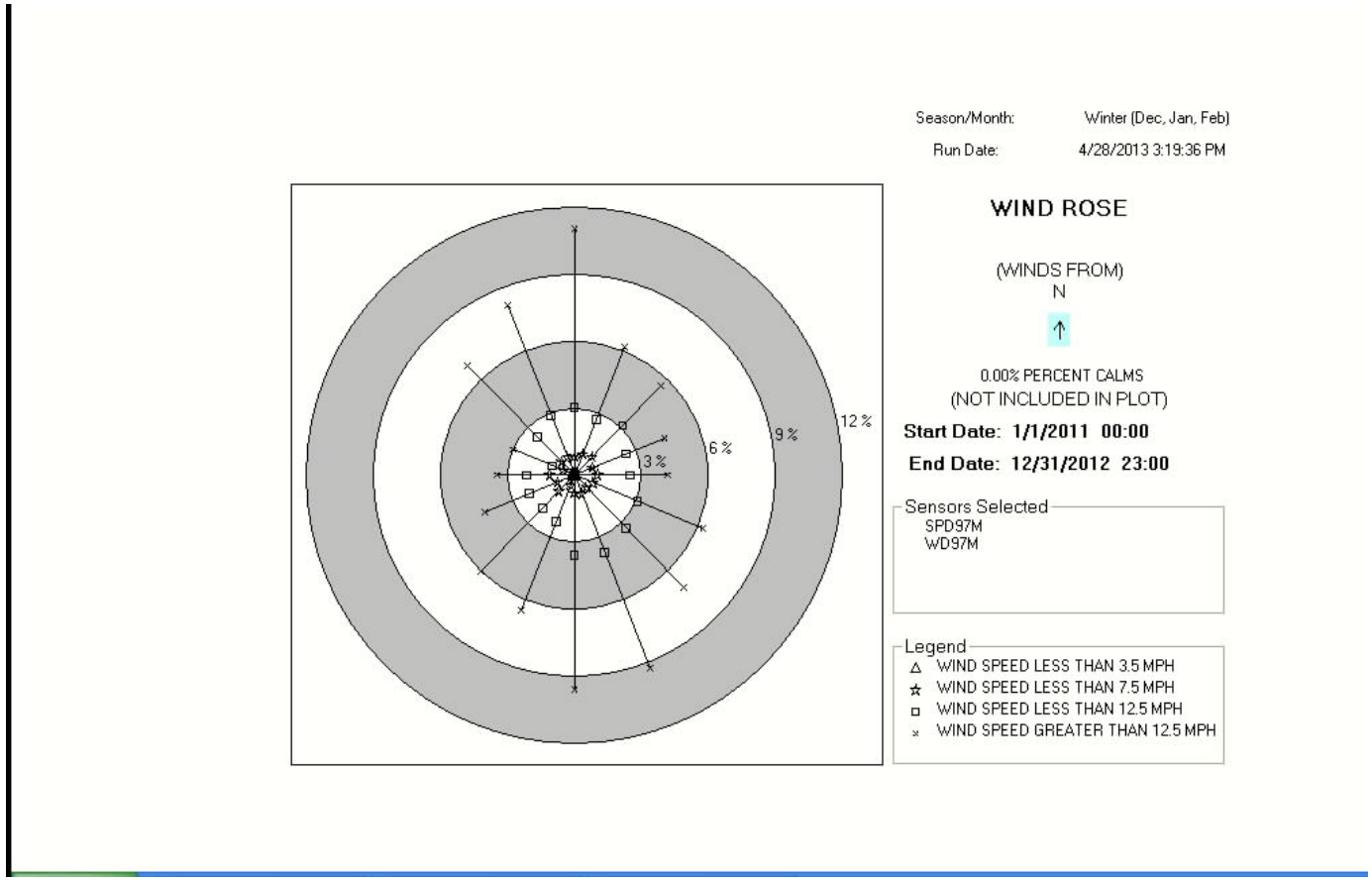

Figure 12 Celia 97m Level WIND ROSE Winter 2011-2012

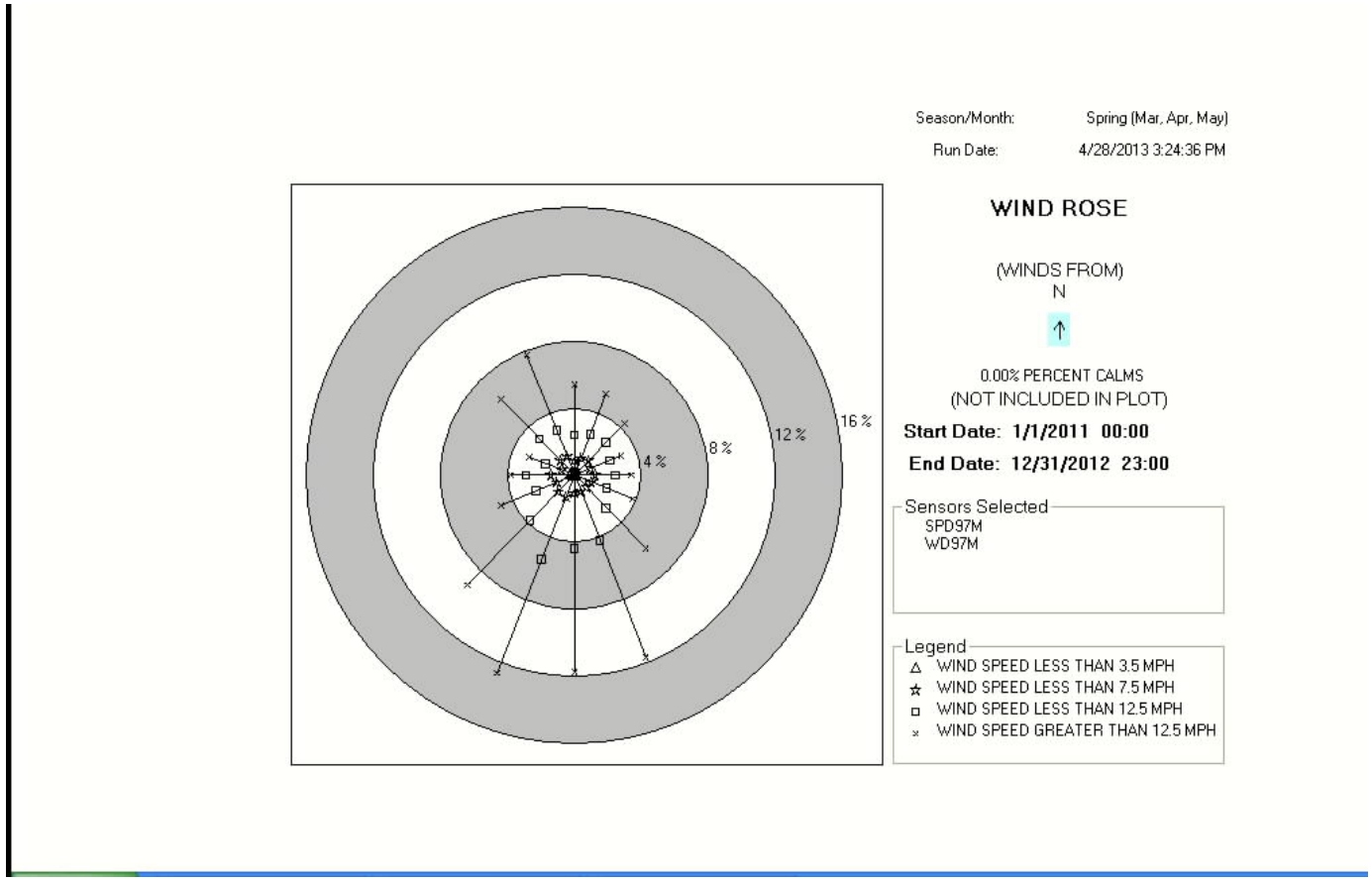

Figure 13 Celia 97m Level WIND ROSE Spring 2011-2012

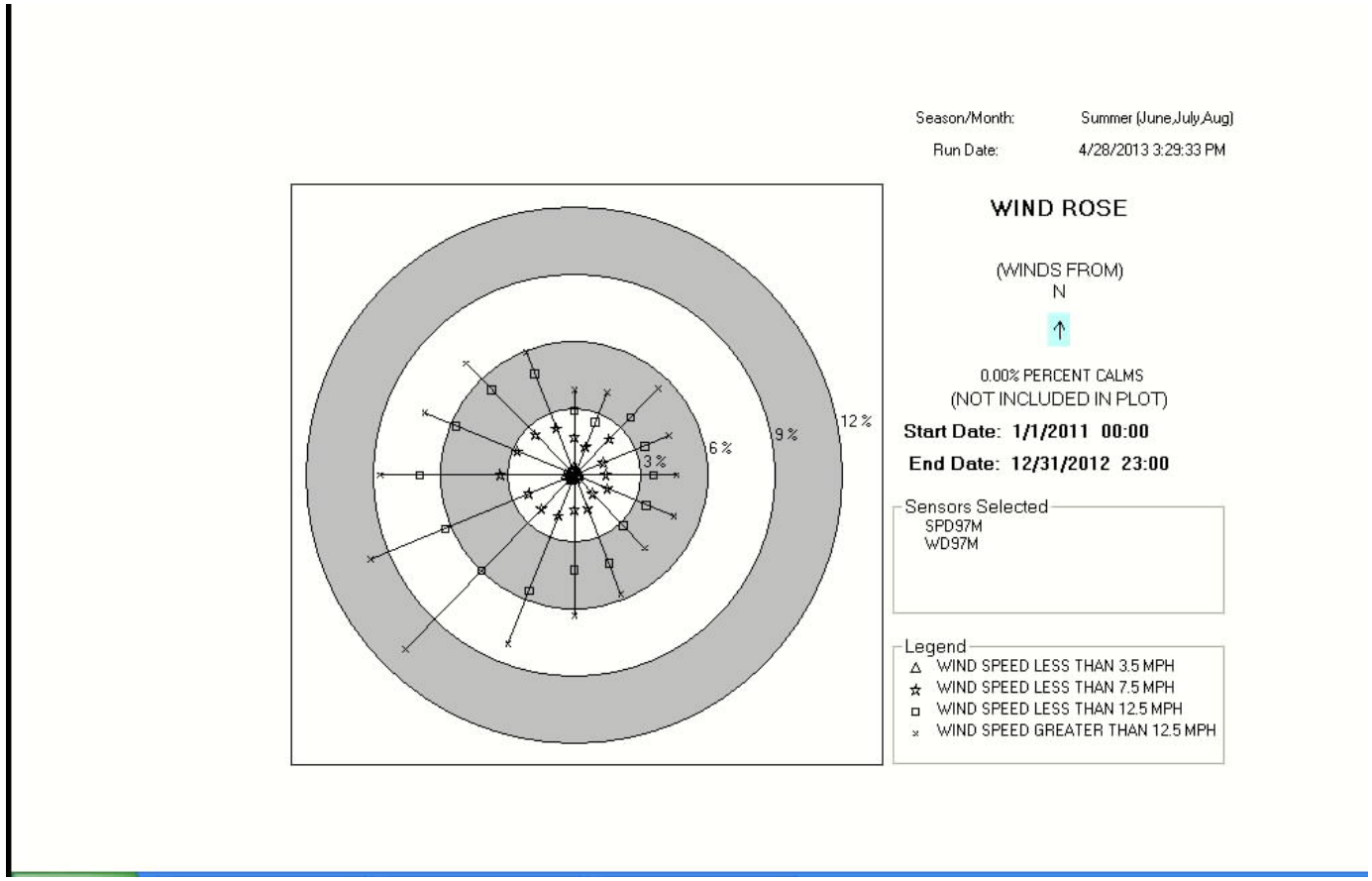

Figure 14 Celia 97m Level WIND ROSE Summer 2011-2012

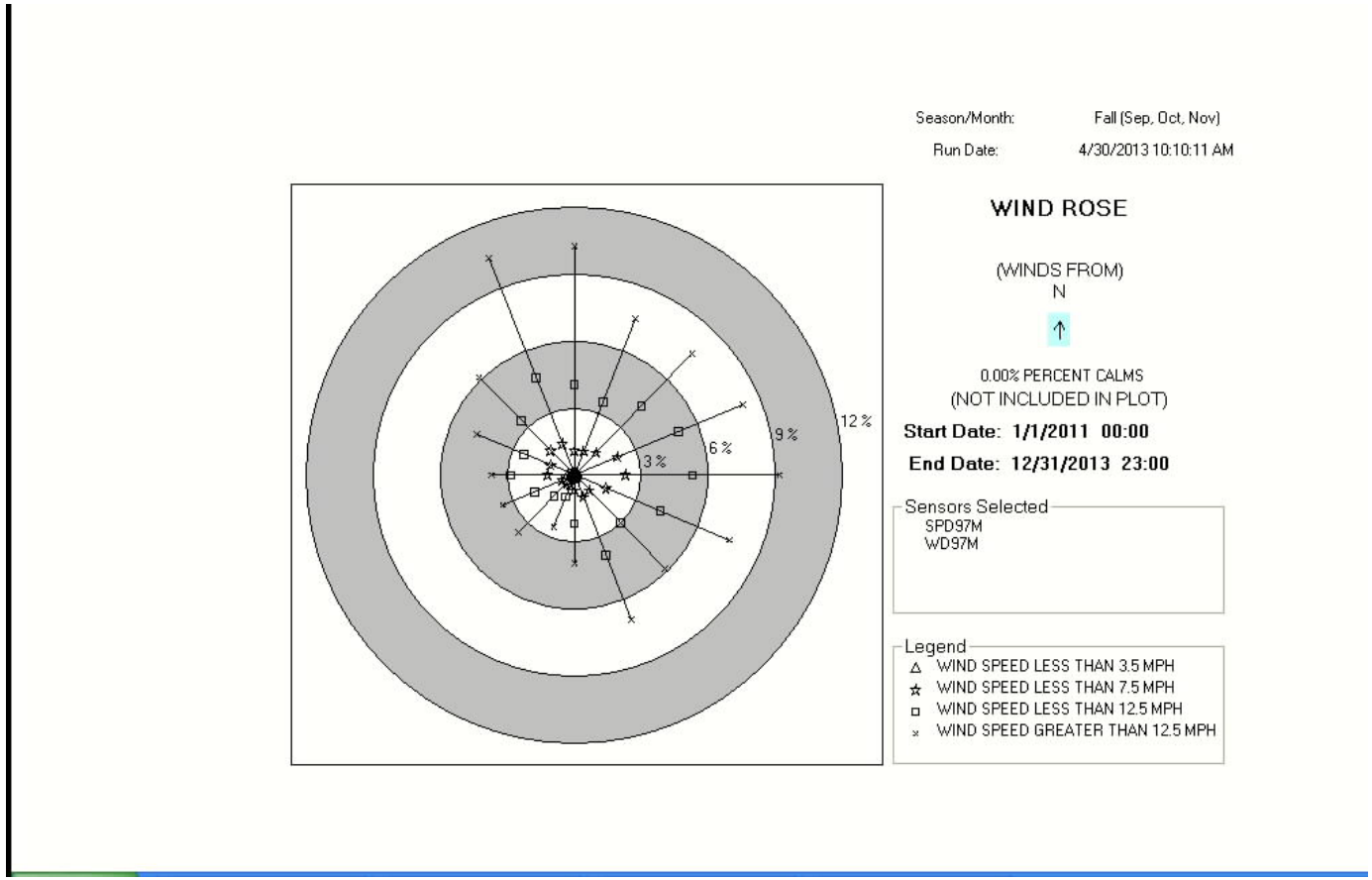

Figure 15 Celia 97m Level WIND ROSE Fall 2011-2012

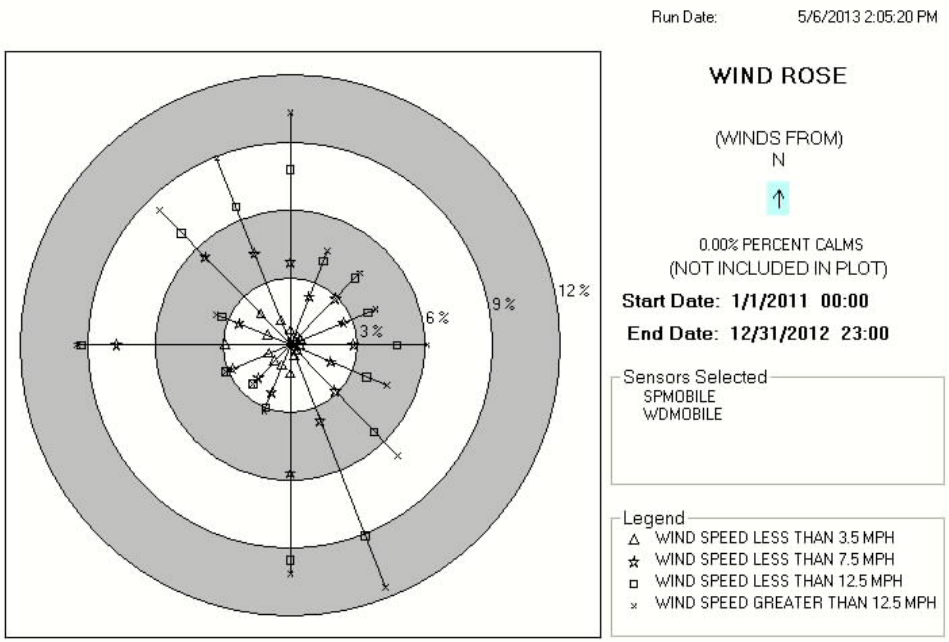

Figure 16 Mobile, AL WIND ROSE January 1, 2011 through December 31, 2012

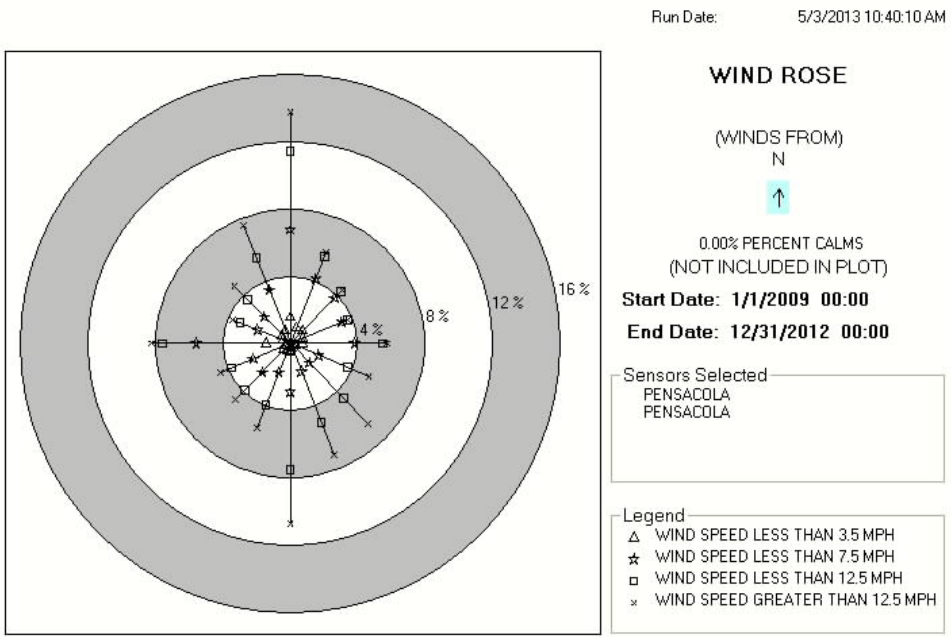

Figure 17 Pensacola, Fl WIND ROSE January 1, 2009 through December 31, 2012

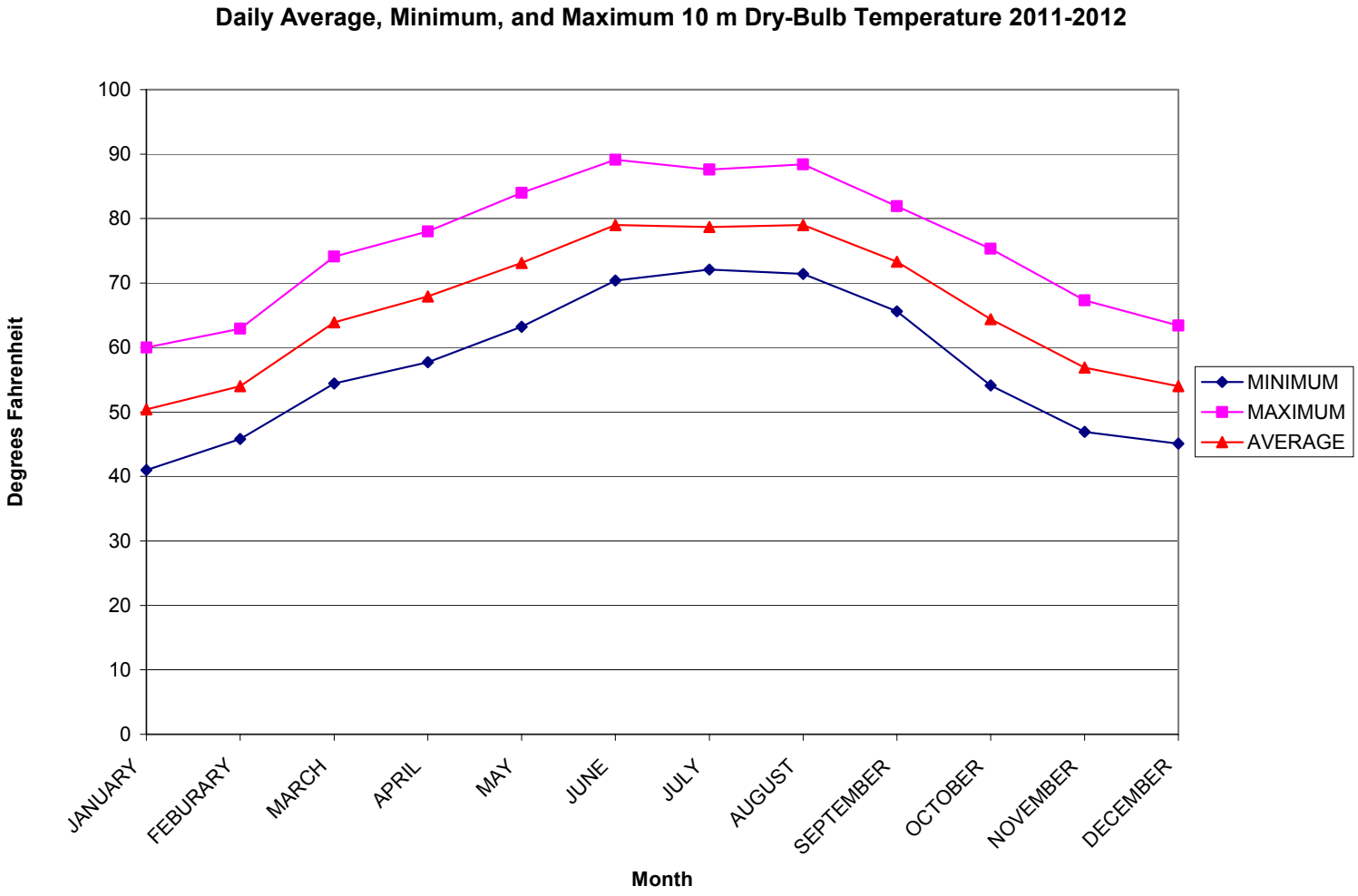

Figure 18 Daily Average, Minimum, and Maximum 10 m Dry-Bulb Temperature 2011-2012

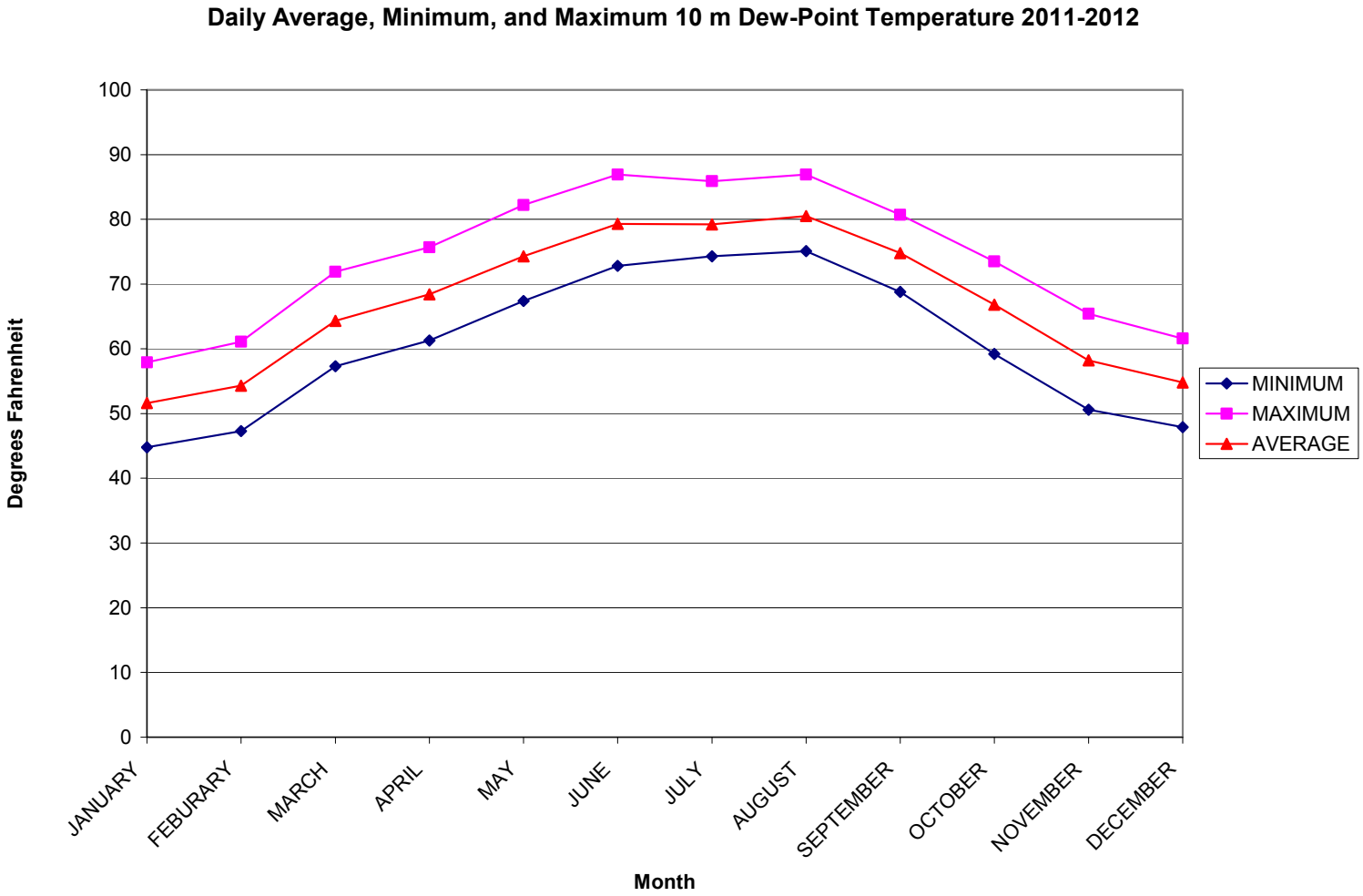

Figure 19 Daily Average, Minimum, and Maximum 10 m Dew-Point Temperature 2011-2012

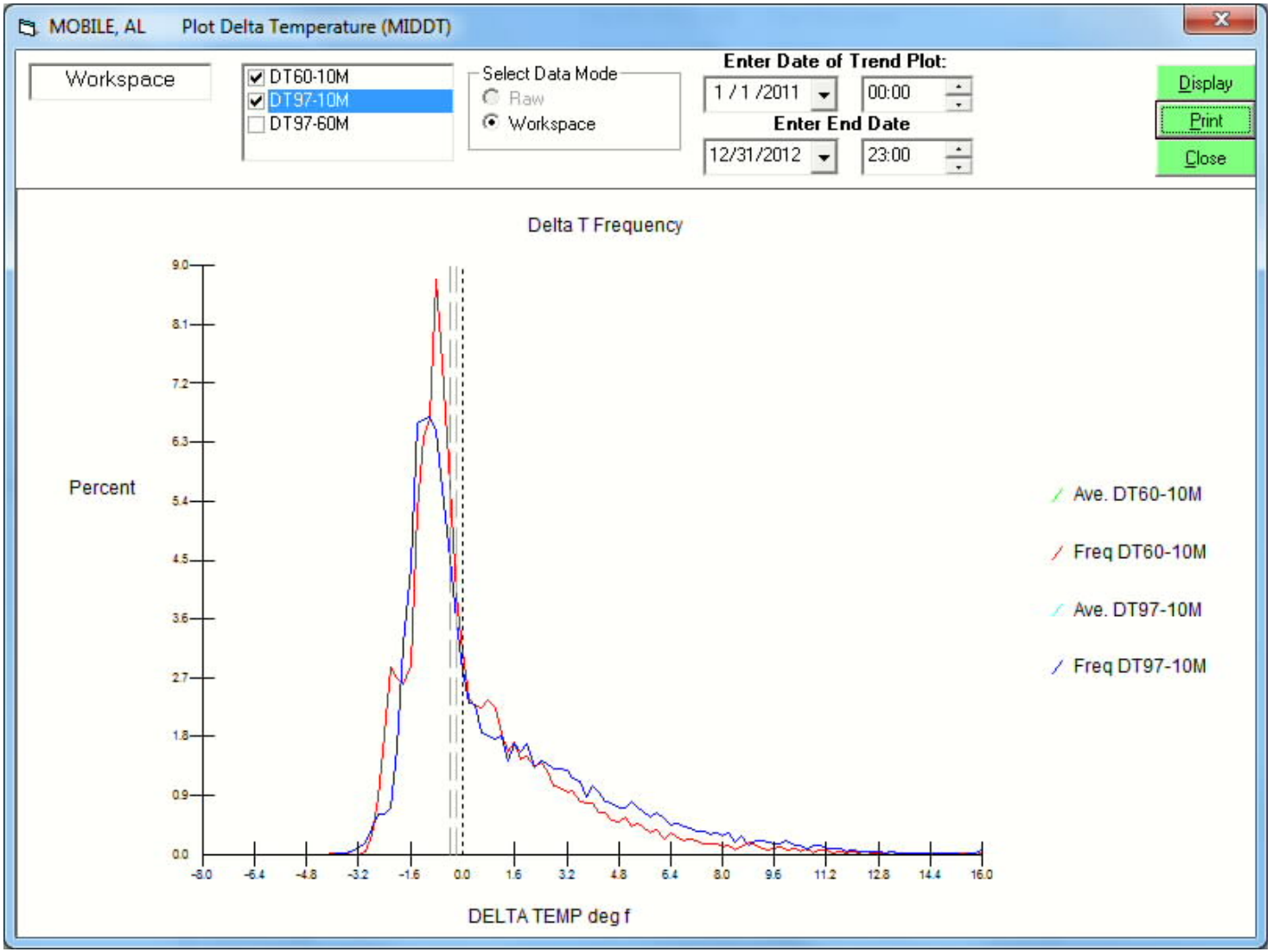

Figure 20 Delta Temperature Frequency 60-10 m and 97-10 m, 2011-2012