

SRNL-RP-2010-00149

Savannah River Site Annual Meteorology Report for 2009 (U)

Report Date 5/14/2010

Savannah River National Laboratory
Savannah River Nuclear Solutions
Aiken, SC 29808

**Prepared for the U.S. Department of Energy Under
Contract Number DE-AC09-08SR22470**



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Printed in the United States of America

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E. D. Kabela

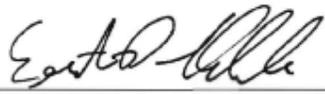
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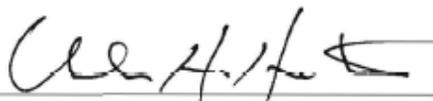
REVIEWS AND APPROVALS



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Overview

Summaries of meteorological observations collected at the Savannah River Site in 2009 depict a year that overall saw below normal temperatures and near-normal precipitation. Annual rainfall for 2009 was 0.26 inches less than the most recent 30-year average (1979-2008), and ranks as the twenty-sixth wettest year since 1952. January and February's total rainfall of 1.98 and 1.68 inches, respectively, was the eighth lowest for those months and July's total rainfall of 2.56 inches was the tenth lowest in the 56 years of record; conversely, the monthly rainfall in December, 10.24 inches, was the highest on record. The largest daily rainfall of 3.55 inches on December 25th was due to a strong low pressure system that moved across the Ohio River Valley. Rainfall of 0.01 inches or more occurred on 121 days during the year.

The annual average temperature for 2009, 62.8°F, was the 5th *coldest* of any year in a record that dates to 1968. Conditions were cooler than average in 11 of the 12 months of the year. Above average temperatures only occurred in June, however, it ranked outside of the top ten (17th warmest) respectively in terms of warmth ranking. July (78.6°F, 4th coolest) and August (78.2°F, 10rd coolest) each ranked in the top ten coldest in their respective months. The coldest temperature of the year was 12.9°F on the morning of February 5; the warmest temperature was 98.5°F on the afternoon of July 1.

Several significant wind events occurred during the winter and early spring of the year. The highest measured ground-level wind speed (gust), 58.3 miles per hour (mph), was associated with a severe thunderstorm which passed over the SRS on May 4th. A tight pressure gradient from

a strong low pressure area over the Tennessee River Valley on April 7th produced the highest daily average wind speed of 11.0 mph.

The most notable weather 'event' of 2009 was a tornado which touched down north of Fort Gordon, tracked through South Augusta, and continued into South Carolina where it produced Enhanced Fujita Scale 3 (EF3) damage in Silver Bluff and New Ellenton. The tornado passed within one mile of the WJBF-TV tower in Beech Island, SC where the SRNL Atmospheric Technologies Group has instrumentation placed at heights of 100 feet, 200 feet, and 1000 feet above ground. Wind measurements at the 1000 foot level measured a peak instantaneous wind speed of over 100 miles per hour!

Background

The General SRS Climate

The Savannah River Site region has a humid subtropical climate characterized by relatively short, mild winters and long, warm, and humid summers (Oliver and Fairbridge, 1987).

Summer-like conditions typically last from May through September, when the area is frequently under the influence of a western extension in the semi-permanent Atlantic subtropical anticyclone (i.e. the 'Bermuda' high). Winds in summer are light and cold fronts generally remain well north of the area. Daily high temperatures during the summer months exceed 90°F on more than half of all days on the average. Scattered afternoon and evening thunderstorms are common.

The influence of the Bermuda high begins to diminish during the fall as continental air masses become more prevalent, resulting in lower humidity and more moderate temperatures. Average rainfall during the fall is usually the least of the four seasons.

In the winter months, mid-latitude low pressure systems and associated fronts often migrate through the region. As a result, conditions frequently alternate between warm, moist, subtropical air from the Gulf of Mexico region and cool, dry polar air. The Appalachian Mountains to the north and northwest of the SRS help to moderate the extremely cold temperatures that are associated with occasional outbreaks of Arctic air. Consequently, less than one-third of winter days have minimum temperatures below freezing on average, and days with temperatures below 20°F are infrequent. Measurable snowfall occurs an average of once every 2 years.

Tornadoes occur more frequently in spring than the other seasons of the year. Although spring weather is somewhat windy, temperatures are usually mild and humidity is relatively low.

Overview of the Savannah River Site Meteorological Monitoring Program

Meteorological data are collected at SRS from a network of nine primary monitoring stations (Fig. 1). Towers located adjacent to each of eight operations areas (A, C, D, F, H, K, L, and P areas) are equipped to measure wind direction, wind speed, temperature, and dew point at a height of 61 meters (m) above ground. Temperature and dew point are also measured at 2m. A ninth tower near N-Area, known as the Central Climatology site (CLM), is instrumented with wind, temperature, and dew point sensors at four levels: 2m (4m for wind), 18m, 36m, and 61m. The CLM site is also equipped with an automated tipping bucket rain gauge, a barometric pressure sensor, and a solar radiometer near the tower at ground level. Data acquisition units at each station record a measurement from each instrument at 1-second intervals. Every 15 minutes, 900 data points are processed to generate statistical summaries for each variable, including averages and instantaneous maxima, and the results are uploaded to a relational database for permanent archival. All aspects of the meteorological data collection program meet or exceed applicable regulatory criteria. Parker and Addis (1993) provide a complete description of the meteorological monitoring program at SRS.

Quality assurance of the data is conducted in two phases: an initial screening of recent data, followed by an in-depth review and final quality classification. The initial

screening, performed twice daily by qualified instrument technicians, consists of a thorough examination of 15-minute data retrieved from the database, in conjunction with a summary of instrument diagnostics obtained from the local data acquisition units. Potential problems are noted in a daily checksheet and, as needed, data acquisition unit software is configured to assign a quality control tag to data collected from the questionable instruments. Quality flags are also set during periods of calibration and maintenance.

The second phase of the quality assurance process is conducted according to formal procedure (SRNL, 2004). Daily checksheets generated during the initial screening, tower-specific logbook entries, initial quality flags, and time series plots of related data are reviewed to determine a final quality status for each record. All records permanently archived in the data base are identified as good, fatal, intermittent, biased, or uncalibrated.

Tall Tower Monitoring System

ATG's Tall Tower facility near Beech Island, SC provides a set of high-quality meteorological measurements that is unique to the southeast U.S. This facility utilizes fast-response sonic anemometers, water vapor sensors, and barometric pressure sensors, and slow-response temperature sensors and relative humidity sensors. Data are collected at 30m (100 ft), 61m (200 ft), and 304m (1000 ft) above ground level. Spread-spectrum modems at each measurement level transmit raw data to a redundant set of PCs at the Savannah River National Laboratory (SRNL). Data processing software on the PCs determine mean values and other statistical quantities every 15 minutes and uploads the results to the relational database.

Additional Measurements

Additional precipitation measurements are collected from a network of 12 plastic wedge rain gauges across the SRS (See Fig. 1). These gauges are read manually by security or operations personnel once per day, usually around 6 am. The daily data are reported to the SRNL Atmospheric Technologies Center, reviewed to correct obvious flaws, and manually entered into a permanent electronic data base.

Additional measurements of temperature and relative humidity are recorded from a weather station located in A-Area, adjacent to SRNL. This station consists of a standard National Weather Service 'cotton region' instrument shelter. Data collected from this station are manually tabulated for archival as daily high and low values of temperature and relative humidity. Tabulated values are then entered into a permanent electronic data base.

Data Sources for the 2009 Report

Summaries provided with this report are based on the following sources of data:

- Ground level (surface) measurements of *temperature (2m)*, *dew point temperature (2m)*, *wind speed (4m)*, *precipitation*, *barometric pressure*, and *solar radiation* from CLM, as well as meteorological quantities derived from these primary data, such as *relative humidity* (temperature and dew point), *wet bulb temperature* (temperature and dew point), *wet bulb globe temperature* (temperature, dew point, wind speed, and solar radiation), and *cooling/heating degree days* (temperature).
- Wind speed and direction from measurements collected at each of the

four levels of the CLM tower and the 61m level of the eight area towers.

- Precipitation from the network of manually-read rain gauges

A series of SAS System® software routines were used to extract the desired data sets from the data base and perform initial statistical processing on all records with a QA status of 'good'. More than 99% of the data used in this report met this QA classification in 2009.

Output from the initial processing was then imported into an Excel® spreadsheet to generate the final summaries that are presented in the report.

Long-term climatological records are available for temperature, precipitation, and relative humidity. Statistics generated from these data are used for comparisons with the 2009 summaries.

Available records of SRS temperature and relative humidity begin in 1968. From 1968 through 1995, the climatological statistics used in this report are based on the daily maxima and minima recorded at the SRNL instrument shelter. After 1995, these statistics are based on measurements from the 2m level of CLM.

Precipitation data are available from 1952. For the period 1952 through 1995, statistics presented in the report are based on daily observations from the SRNL rain gauge. Summaries after 1995 are based on data collected from the CLM rain gauge.

Climatology of the SRS for 2009

Highlights

Meteorological data summaries for 2009 depict a year that saw below normal temperatures and near-normal precipitation. The annual average temperature of 62.8°F was the 6th coldest of any year in the available record. Each month experienced below normal temperatures with the exception of June which was 1.0°F above normal for the month. Annual rainfall for 2009 was 0.26 inches less than the most recent 30-year average (1979-2008), which made it the 26th wettest year on record; however rainfall amounts across the site varied, as only two of the 12 manual rain gauges fell below the 30-year average. Rainfall was well above average in April, May, November, and December; conversely, January, February, June, and July 2009 ranked within the top ten driest of any April, May, November and December on record, respectively. A summary plot of daily observations of temperature, precipitation, relative humidity, and wind speed is given in Figure 2.

A 500mb composite anomaly plot from NOAA's Climatic Diagnostic Center, suggest that the relatively cool weather observed through much of the eastern U.S. for July through November was due to the persistent presence of a low pressure trough over the Mid-Atlantic Coast. The persistent trough is mainly attributed to a moderate El Nino which formed in the equatorial Pacific Ocean in late Spring 2009. In June, the Bermuda high extended west into the Southeast U.S. as well as the Ohio River Valley contributing to the only month with above normal temperatures during 2009. This was due to a shift in the North Atlantic Oscillation (NAO) from neutral and positive phase, to a negative

phase which results in warmer temperature and less precipitation than normal for the Southeast U.S.

Impacts of El Nino events are typically felt during the late fall and into the winter which would include below normal temperatures and above normal precipitation. These characteristics are evident in November and December 2009 with temperatures at least 1.5°F below normal and precipitation totals which were the 6th (November) and 1st (December) wettest for their respective months.

The most notable weather 'event' of 2009 was a tornado which touched down north of Fort Gordon, tracked through South Augusta, and continued into South Carolina where it produced EF3 damage in Silver Bluff and New Ellenton. The tornado passed within one mile of the WJBF-TV tower in Beech Island, SC where the SRNL Atmospheric Technologies Group has instrumentation placed at heights of 100 feet, 200 feet, and 1000 feet above the ground. Wind measurements at the 1000 foot level measured a peak wind speed of over 100 miles per hour!

Temperature

Monthly average, annual average and daily extreme temperatures for 2009 are summarized in Table 1(a). Similar statistics for a 30-year climatological reference period (1979-2008) are given in Table 2. A plot of observed daily high and low temperatures for 2009 is shown in Fig. 3. Plots of annual average temperature, monthly average daily high and low temperature, and days exceeding significant temperature thresholds (<32°F, >90°F) for 2009 and the 30-year reference period are shown in Figures 4, 5, and 6, respectively.

The annual average temperature for 2009, 62.8°F, was 1.5 degrees below the 30-year climatological average. Monthly average temperatures were below climatological averages for all months of the year except June. Furthermore, average temperatures for July and August ranked among the ten coldest on record for those months. Temperatures above 90°F were observed on 59 days during the year and around 70% of total days in June. Temperature extremes ranged from 12.9°F on February 5th to 98.5°F on July 1st. Daily low temperature records were set on February 21, March 4, July 1, September 4, and October 19. The only daily high temperature record was set on December 9th.

Monthly and annual total heating and cooling degree days (based on a reference temperature of 65°F) are summarized in Table 1(c).

The last spring killing freeze (temperature <28°F) date was March 5, while the first fall killing freeze was December 21. March 5 was the last frost date (temperature <32°F) of the spring, and December 6 was the first frost date of the fall.

Precipitation

Annual, monthly, and daily rainfall statistics for 2009 are summarized in Table 1(a). Monthly and annual totals for the previous 30-years (1979-2008) are given in Table 3. Monthly and annual rainfall totals for the 12 manually read gauges across the SRS are summarized in Table 4. A plot of daily totals (midnight to midnight) for the CLM site for 2009 is shown as Figure 7. A comparison of annual and monthly rainfall for 2009 and the 30-year climatological reference period are shown in Figures 8 and 9, respectively.

Total precipitation at the CLM site, 47.95 inches, was only 0.26 inches less than the 30-year average, making it the 26th wettest year on record (since 1952). The monthly total of 1.98 inches and 1.68 inches for January and February, respectively, was the eighth lowest on record for those months. Conversely, November's total of 5.45 inches was the sixth highest and December's total of 10.24 inches was the highest on record. The heavy rain that occurred on December 25 (3.55 in) was due to a strong low pressure system moving slowly over the Southeast United States.

Measurable precipitation (>0.01 inch) occurred on 121 days and rainfall greater than 0.5 inch occurred on 30 days.

Atmospheric Moisture

Monthly average, annual average, and daily extreme dew point temperature, wet bulb temperature, and relative humidity for 2009 are summarized in Table 1(b). This table also presents monthly and annual averages of the daily maximum and minimum humidity. A plot of daily observed values of maximum and minimum humidity for 2009 is shown in Figure 10. Plots of annual and monthly averages of humidity for 2009 and the 30-year climatological reference period (1979-2008) are shown in Figures 11 and 12, respectively.

Average relative humidity for 2009 was 69% with an average daily minimum of 47% and an average daily maximum of 87%. Days with relative humidity of 20% or less occurred in February, March, June, and July. The lowest relative humidity recorded during the year was 18% on February 13. Average daily minimum relative humidity was less than long-term values for each month during the year

except March, April, May, October, November, and December.

Observed dew point temperatures ranged from a maximum of 76.1°F on August 19 to a minimum of 5.0°F on January 16. Wet bulb temperature ranged from a maximum of 79.4°F on June 26 to a minimum of 12.6°F on February 5.

Heat Stress

Restrictions on outdoor work due to excessive heat are based on values of the wet bulb globe temperature (WBGT) (WSRC, 1995). Hunter and Minyard (2000) provide a description of WBGT and the method used at SRS to calculate WBGT from standard meteorological measurements at CLM.

Monthly and annual maximum WBGT and statistics on heat stress category days for 2009 is summarized in Table 1(b). The highest WBGT for 2009 was 91.1°F on August 10. Heat stress Category 5 (WBGT >90.0°F) occurred on 7 days during the summer period. A total of 161 days reached at least Category 1 (WBGT > 77.0 °F) from March through October (with one day in December).

Wind

Monthly average and extreme wind speed at the CLM 4 meter level for 2009 is summarized in Table 1(c). Daily averaged wind speed for the year is plotted in Figure 13. Figures 14(a) and 14(b) show wind rose plots depicting joint occurrence frequencies of wind speed category by wind direction sector at the 61 meter level of the eight area towers. Figure 15 provides wind rose plots for the 4 levels of measurement at CLM. Seasonal wind rose plots for 2009 for data from the 61m level of CLM are shown in Figure 16. Tables of

the joint frequency data used to create the wind rose plots are given in Appendix A.

Monthly average wind speeds were highest in February, April, and November, with monthly averages exceeding 4.5 mph. The highest instantaneous wind speed recorded at the 4m level, 58.3 mph, was associated with a severe thunderstorm which passed over the SRS during the day on May 4th. A tight pressure gradient from a strong low pressure area over the Tennessee River Valley produced the highest daily average wind speed of 11.0 mph on April 7. Average wind speeds were generally the lowest during June, July, August, September, and October.

Wind rose plots for the area towers show typical annual patterns for the 61 meter level. This pattern consists of higher frequencies of wind from the northeasterly sectors and the southwesterly to west sectors. Due to the location of the D area tower in the shallow valley formed by the Savannah River, winds are somewhat more frequently from the southeasterly and northwesterly sectors than for the other area towers. Wind speeds at D-Area are also less than other 61-meter level towers as is seen in the frequency of 2-4 mph (>50%), which is significantly greater than other towers with approximately 40% for both 2-4 and 4-6 mph. Wind roses for CLM also show typical variations in the frequency patterns by level, with progressively higher frequencies of southeasterly winds and lower frequencies of northeasterly and southwesterly winds nearer the ground. Weber (2003) provides a complete description of the wind climatology at the CLM site.

The seasonal wind roses show that higher frequencies of westerly wind occur in the winter and spring and a much higher frequency of northeasterly wind during the

late summer and fall. 2009 exhibited a slight decrease in the frequency of northeast winds and a slight increase in the frequency of westerly winds, especially in the winter, compared with wind rose plots from the previous 2 or 3 years. This is due to the increased frequency of frontal passages through the Savannah River Site during the year, with the winter season pattern being more pronounced.

Barometric Pressure

Annual and monthly average and extreme barometric pressure is summarized in Table 1(c). Daily average barometric pressure is plotted in Figure 17. The occurrence of lowest daily average and 15-minute minimum barometric pressure, 990.6 and 986.5 mb, respectively, were associated with the passage of a strong low pressure system through the area on April 3. The highest daily average and 15-minute maximum barometric pressure, 1022.9 and 1026.9 mb, respectively, were associated with a strong high pressure system that built over the mid-Atlantic region of the U. S. on January 16.

Solar Radiation

Annual and monthly averages and extremes of daily total solar radiation are summarized in Table 1(c). This table also provides monthly and annual values of the fraction of observed solar radiation relative to theoretical clear sky maxima. The monthly theoretical values were estimated from tables published by Budyko (1974). Daily total solar radiation for 2009 is plotted in Figure 18. The average daily values ranged from 182 langley per day (ly/day) in December to 565 ly/day in June. The months of February, April, and June were relatively sunny with observed solar radiation greater than 70% of clear sky maximum. January, May, August, October, November, and December were relatively cloudy with monthly average observed solar radiation less than 65% of the clear sky maximum, respectively. Individual daily extremes ranged from 28 ly on December 18 to 702 ly on June 30.

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Table 1(a) - Means and Extremes of SRS Meteorological Data for 2009

Month	Temperatures (°F)													Precipitation (in)							
	Average					Extremes				Number of Days				Total	Departure from 30yr avg	Rank (1952-2009)	Greatest in 24 Hrs	Date of 24hr max	No. of Days		
	Avg. Daily High	Avg. Daily Low	Month Avg.	Departure from 30yr avg	Rank (1968-2009)	Highest	High Date	Lowest	Low Date	Maximum Above 90 °F	Maximum Above 100 °F	Minimum Below 32 °F	Minimum Below 20 °F						Greater Than 0.01 in.	Greater Than 0.1 in.	Greater Than 0.5 in.
Jan	56.0	36.1	44.9	-1.3	20	72.2	5th	16.4	17th	0	0	16	3	1.98	-2.01	8	0.45	18th	12	6	0
Feb	60.2	36.6	47.4	-2.4	14	74.8	11th	12.9	5th	0	0	10	1	1.68	-1.97	8	0.88	28th	8	3	1
Mar	67.6	44.5	55.2	-1.5	12	84.2	11th	23.6	4th	0	0	3	0	3.65	-0.89	22	1.20	28th	11	3	2
Apr	74.0	50.6	62.3	-1.5	11	88.7	24th	31.9	8th	0	0	1	0	4.60	+1.38	16	2.35	2nd	7	6	3
May	80.6	63.0	70.7	-1.0	17	90.8	31st	49.1	18th	1	0	0	0	5.20	+1.99	10	1.06	5th	13	9	5
Jun	90.7	69.4	79.2	+1.0	17	98.1	27th	63.4	1st	21	0	0	0	2.73	-2.18	10	1.17	18th	9	5	2
Jul	90.1	69.0	78.6	-2.5	4	98.5	1st	59.4	19th	19	0	0	0	2.56	-2.94	9	0.50	6th	10	9	0
Aug	89.3	70.0	78.2	-1.8	10	95.4	5th	61.0	24th	15	0	0	0	3.13	-1.56	16	1.55	5th	11	6	2
Sep	85.0	65.2	74.1	-0.8	16	90.2	6th	47.1	30th	3	0	0	0	3.73	+0.01	27	1.65	18th	10	6	3
Oct	72.9	55.1	62.7	-2.5	12	88.2	9th	35.2	19th	0	0	0	0	3.00	-0.17	22	1.12	12th	10	5	4
Nov	66.4	45.9	54.6	-1.5	17	75.8	15th	32.1	28th	0	0	0	0	5.45	+2.41	6	2.77	11th	7	4	3
Dec	55.4	37.3	45.6	-2.8	12	77.9	9th	25.7	29th	0	0	8	0	10.24	+6.44	1	3.55	25th	13	9	5
Year	74.1	53.6	62.8	-1.5	5	98.5	1-Jul	12.9	5-Feb	59	0	38	4	47.95	-0.26	26	3.55	25-Dec	121	71	30

Rank by coolest
 Rank by warmest
 Rank by wettest
 Rank by dryest

Table 1(b) - Means and Extremes of SRS Meteorological Data for 2009

Month	Dew Point Temperature (°F)					Wet Bulb Temperature (°F)					Relative Humidity (%)					Wet Bulb Globe Temperature (°F)						
	Average	Highest	High Date	Lowest	Low Date	Average	Highest	High Date	Lowest	Low Date	Avg. Daily Maximum	Avg. Daily Minimum	Monthly Avg.	Lowest	Low Date	Highest	High Date	Number of Days				
																		Cat 1 and Above	Cat 2 and Above	Cat 3 and Above	Cat 4 and Above	Cat 5
Jan	34.5	60.7	4th	5.0	16th	40.7	64.2	5th	15.1	17th	91	46	70	23	17th	72.5	5th	0	0	0	0	0
Feb	33.7	59.4	19th	5.6	4th	41.5	62.9	12th	12.6	5th	87	37	63	18	13th	70.1	11th	0	0	0	0	0
Mar	43.4	62.7	28th	12.6	3rd	49.3	68.1	10th	21.2	3rd	91	43	69	19	20th	79.9	10th	2	0	0	0	0
Apr	48.3	63.8	14th	25.1	8th	54.8	67.7	24th	30.4	8th	88	40	64	23	22nd	81.8	24th	6	0	0	0	0
May	60.8	71.0	16th	38.3	19th	64.7	74.5	29th	44.9	19th	88	52	73	28	3rd	86.1	29th	24	12	1	0	0
Jun	67.1	75.6	14th	47.5	29th	71.1	79.4	26th	58.6	30th	87	44	69	19	29th	90.8	26th	30	27	24	13	4
Jul	64.4	74.7	16th	50.0	1st	69.4	79.0	16th	56.0	19th	81	43	64	20	1st	89.6	28th	31	30	21	4	0
Aug	67.6	76.1	19th	56.3	24th	71.1	79.2	11th	58.3	24th	88	49	72	33	24th	91.1	10th	31	30	23	12	3
Sep	62.3	73.7	24th	43.0	29th	66.7	76.4	23rd	45.4	30th	86	48	69	29	6th	87.6	25th	27	20	4	0	0
Oct	55.0	73.7	9th	32.3	19th	58.3	77.0	9th	34.1	19th	90	58	78	31	4th	85.5	9th	9	3	1	0	0
Nov	47.5	68.9	1st	26.6	27th	51.3	70.0	1st	30.7	28th	93	56	78	31	28th	75.1	15th	0	0	0	0	0
Dec	34.1	64.0	9th	12.5	11th	40.9	67.6	9th	22.8	29th	78	50	65	24	10th	77.3	3rd	1	0	0	0	0
Year	51.6	76.1	19-Aug	5.0	16-Jan	56.7	79.4	26-Jun	12.6	5-Feb	87	47	69	18	13-Feb	91.1	10-Aug	161	122	74	29	7

Table 1(c) - Means and Extremes of SRS Meteorological Data for 2009 (cont'd)

Month	Wind Speed (mph)				Barometric Pressure (mb)					Solar Radiation (ly/day)						Degree Days					
	Monthly Average	Max 15-min Average	Max Instantaneous	Date Max Inst.	Average	Lowest	Low Date	Highest	High Date	Average Daily Total	% of Theoretical Max	Minimum Daily Total	Date	Maximum Daily Total	Date	Heating Degree Days	Daily maximum	Date	Cooling Degree Days	Daily Maximum	Date
Jan	4.3	17.9	44.6	7th	1008.0	987.1	7th	1026.9	16th	235	0.65	29	24th	384	31st	621	37	21st	0	0	
Feb	4.5	18.6	38.5	19th	1010.9	991.3	19th	1024.5	5th	334	0.74	44	28th	471	21st	493	38	5th	0	0	
Mar	4.2	17.1	34.0	29th	1009.5	991.6	29th	1022.0	5th	381	0.67	36	28th	566	29th	317	32	3rd	12	4	11th
Apr	4.9	20.5	43.0	6th	1005.8	986.5	3rd	1019.5	27th	505	0.74	43	2nd	662	17th	122	20	7th	40	8	25th
May	4.4	12.5	58.3	4th	1004.8	996.6	29th	1014.2	19th	471	0.63	127	4th	693	31st	22	11	19th	196	14	29th
Jun	3.8	14.1	35.3	18th	1000.5	990.7	29th	1008.8	2nd	565	0.71	273	4th	702	30th	0	0		425	20	27th
Jul	4.0	17.1	43.9	29th	1004.1	992.9	1st	1013.9	11th	531	0.69	316	7th	678	1st	0	0		421	20	2nd
Aug	3.3	20.5	43.9	5th	1006.1	996.9	22nd	1013.7	9th	459	0.65	161	27th	628	24th	0	0		408	17	11th
Sep	3.5	11.7	26.8	2nd	1005.9	995.5	28th	1011.1	20th	400	0.66	184	26th	575	4th	4	4	30th	277	13	25th
Oct	3.7	13.0	22.8	7th	1005.7	993.9	16th	1015.9	20th	272	0.54	33	27th	497	1st	134	18	19th	63	12	10th
Nov	4.6	17.5	30.3	27th	1006.8	996.1	13th	1016.7	6th	236	0.59	41	22nd	382	5th	311	19	28th	0	0	
Dec	4.4	14.1	33.6	9th	1007.8	987.8	19th	1022.5	12th	182	0.55	28	18th	318	29th	599	28	12th	0	0	
Year	4.1	20.5	58.3	4-May	1006.3	986.5	7-Jan	1026.9	16-Jan	381	0.65	28	18-Dec	702	30-Jun	2623	38	5-Feb	1842	20	2-Jul

Table 2. Monthly and Annual Average and Extreme Temperatures, 1979-2009

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1979	42.1	44.6	57.5	64.5	71.3	75.1	79.6	80.5	73.4	64.8	57.4	47.4	63.2
1980	45.9	44.3	52.6	63.5	71.2	78.3	83.8	82.5	79.2	62.7	52.8	46.0	63.6
1981	40.4	48.5	53.0	67.0	68.6	81.3	81.3	76.3	74.0	62.1	54.4	43.2	62.5
1982	43.0	50.0	58.9	62.4	75.7	78.8	80.9	80.1	75.0	66.2	58.7	54.8	65.4
1983	43.3	48.0	55.3	59.4	66.8	76.7	84.3	83.9	74.8	67.2	56.4	45.8	63.5
1984	45.0	51.7	56.5	62.6	71.9	80.1	80.1	80.8	74.0	73.4	53.4	56.9	65.5
1985	42.9	49.5	60.2	67.5	74.5	80.8	81.1	79.7	75.7	70.8	65.5	45.4	66.1
1986	45.4	54.6	57.9	66.4	74.4	82.7	86.9	80.1	78.4	67.1	61.3	49.3	67.0
1987	46.2	48.6	56.5	62.3	74.5	79.9	82.8	83.8	76.6	60.7	59.1	52.9	65.3
1988	42.3	47.8	56.8	64.2	70.4	76.8	81.6	81.4	75.4	61.2	58.0	49.1	63.8
1989	52.2	52.0	58.3	64.2	70.6	79.8	81.4	80.9	75.3	67.3	52.4	44.2	64.9
1990	54.9	57.5	60.0	64.0	72.9	80.5	83.7	83.8	79.0	69.4	59.9	54.6	68.4
1991	47.9	54.1	60.3	69.2	76.9	79.5	83.6	81.2	77.4	68.1	55.4	54.0	67.3
1992	49.5	54.1	57.2	65.0	71.2	78.9	83.7	80.7	76.9	65.0	57.1	48.0	65.6
1993	51.7	47.8	53.2	58.9	69.7	78.2	83.6	80.0	75.2	62.8	55.2	43.6	63.3
1994	41.5	50.1	60.2	68.0	71.2	82.3	81.8	81.2	77.4	67.2	62.3	53.3	66.4
1995	45.5	49.9	58.6	65.9	73.5	75.0	79.9	79.0	71.8	65.9	50.8	43.8	63.3
1996	44.6	50.1	50.6	61.6	72.9	76.5	79.3	76.0	72.7	62.1	51.6	48.8	62.2
1997	48.2	52.9	63.3	61.2	68.5	74.0	80.2	79.0	75.0	64.1	51.6	47.0	63.8
1998	49.7	51.1	53.6	62.7	74.6	82.1	82.6	80.3	75.8	66.9	60.5	53.6	66.1
1999	51.9	51.6	53.4	67.2	69.7	76.6	80.7	82.9	73.8	64.3	58.1	48.6	64.9
2000	44.4	50.2	58.5	60.7	75.1	78.0	79.9	77.6	71.7	62.5	53.1	38.2	62.5
2001	43.8	52.4	53.0	63.9	71.3	75.3	77.7	78.8	71.2	62.2	60.0	52.4	63.5
2002	47.3	48.0	57.6	68.1	70.2	77.5	80.5	78.4	75.4	66.7	51.7	44.5	63.8
2003	42.0	47.5	57.6	61.6	70.6	75.2	77.3	77.7	71.9	63.7	58.2	42.9	62.2
2004	43.7	45.2	58.5	63.4	74.0	77.7	80.1	77.3	73.2	66.2	56.1	45.8	63.4
2005	47.9	49.0	53.1	60.9	68.0	75.4	79.4	78.8	77.0	64.7	56.1	44.3	62.9
2006	50.8	47.3	55.3	66.3	70.1	76.2	80.3	80.5	72.9	62.4	53.6	50.6	63.8
2007	48.6	46.4	58.4	61.8	70.2	76.5	77.4	81.9	75.2	68.7	54.0	52.3	64.3
2008	43.8	51.1	55.3	61.8	70.2	80.1	78.7	77.9	73.7	61.1	50.0	52.1	63.0
2009	44.9	47.4	55.2	62.3	70.7	79.2	78.6	78.2	74.1	62.7	54.6	45.5	62.8

Avg	46.2	49.8	56.7	63.8	71.7	78.2	81.1	80.0	74.9	65.2	56.1	48.4	64.3
Lowest Mon	35.3	41.3	49.5	58.9	66.8	74.0	77.3	74.5	70.5	60.1	48.7	38.2	62.2
Yr Lowest	1977	1978	1971	1993	1983	1997	2003	1973	1973	1976	1976	2000	2003
Rec Low	-3	10	11	26	38	48	56	56	41	28	18	5	-3
Yr Rec	1985	1996	1980	2007	1989	1984	1963	1986	1967	1976	1970	1962	1985
Highest Mon	59.6	57.5	63.3	69.2	76.9	82.7	86.9	83.9	79.2	73.4	65.5	56.9	68.4
Yr Highest	1974	1990	1997	1991	1991	1986	1986	1983	1980	1984	1985	1971	1990
Rec High	86	86	90	99	102	105	107	107	104	96	89	82	107
Yr Rec	1975	1989	1974	1986	1963	1985	1986	1983	1990	1986	1974	1984	1986

Table 3. Monthly and Annual Rainfall, 1979-2009

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1979	3.59	7.74	3.09	6.49	8.94	1.54	7.85	2.12	6.13	1.35	3.95	2.17	54.96
1980	5.12	3.48	10.96	1.69	3.49	2.99	0.90	2.03	5.86	2.14	2.50	1.91	43.07
1981	0.89	5.02	4.72	2.07	6.90	4.29	3.96	5.79	0.54	2.81	1.00	9.55	47.54
1982	3.94	4.46	2.51	5.68	2.73	4.28	11.49	5.02	4.62	3.87	2.41	4.85	55.86
1983	3.75	7.22	6.62	5.77	1.67	6.57	4.85	6.32	3.56	1.92	5.39	4.15	57.79
1984	3.51	7.09	6.05	8.00	9.79	2.54	7.28	5.52	0.60	0.31	0.90	1.38	52.97
1985	3.01	6.92	1.31	0.84	1.70	4.62	8.10	4.38	0.49	6.34	6.36	2.48	46.55
1986	1.46	3.58	4.08	1.45	3.84	3.03	2.96	10.90	1.54	4.19	5.82	5.83	48.68
1987	7.39	7.55	4.97	0.70	3.57	5.64	4.87	4.93	3.56	0.29	2.74	1.42	47.63
1988	4.15	3.19	2.91	4.78	2.85	7.12	1.78	6.80	4.40	3.39	2.17	2.91	46.45
1989	1.42	3.59	5.52	4.89	2.60	6.67	11.46	3.27	4.87	3.36	3.00	4.41	55.06
1990	3.07	2.38	2.37	1.21	2.95	0.89	7.31	8.07	0.62	19.62	1.41	1.57	51.47
1991	7.03	1.84	7.89	4.73	3.06	2.17	7.89	9.26	4.40	0.99	1.55	3.32	54.13
1992	4.45	3.89	2.98	2.40	1.34	6.27	3.69	4.83	6.38	3.11	7.78	2.86	49.98
1993	7.45	3.62	8.37	1.74	1.43	3.27	3.12	2.23	7.29	0.99	1.87	1.81	43.19
1994	4.80	3.91	6.42	1.05	1.45	5.08	7.47	3.47	0.99	10.01	3.05	4.62	52.32
1995	6.96	7.97	0.92	1.28	1.77	8.15	5.71	6.92	5.75	2.64	2.38	4.47	54.92
1996	3.65	2.43	6.64	2.40	2.96	3.04	5.57	6.91	3.67	2.16	2.32	3.20	44.95
1997	4.20	5.45	2.69	4.38	2.38	6.90	7.09	2.01	4.89	4.08	5.51	9.09	58.67
1998	7.73	8.90	6.69	7.35	4.05	4.65	5.27	2.88	4.81	0.78	0.82	1.80	55.73
1999	5.31	2.29	3.44	1.95	1.26	7.52	4.91	3.14	4.46	2.57	1.50	1.21	39.56
2000	5.77	0.73	3.95	1.34	1.36	4.74	2.47	4.49	7.70	0.02	3.50	1.53	37.60
2001	3.11	2.68	7.21	1.28	3.85	6.49	4.79	3.55	3.33	0.50	1.03	0.54	38.36
2002	2.85	2.13	3.86	2.58	1.69	2.30	5.95	5.47	3.45	3.19	4.00	3.58	41.05
2003	1.73	5.00	7.09	8.43	5.57	10.99	8.91	4.59	2.70	3.03	1.21	1.93	61.18
2004	2.85	6.71	0.81	1.34	3.45	6.41	1.23	2.96	10.26	1.02	3.17	2.69	42.90
2005	2.14	3.89	6.09	1.69	2.87	8.23	5.81	4.08	0.19	3.60	2.67	6.16	47.42
2006	3.38	2.90	1.76	2.41	1.83	6.89	5.22	2.19	2.50	1.66	2.98	4.56	47.42
2007	3.27	3.60	1.98	2.95	1.23	4.83	4.57	2.66	0.97	1.35	0.55	8.79	36.75
2008	3.72	5.36	3.04	2.39	1.82	1.37	5.44	5.40	0.94	4.12	5.14	2.87	41.61
2009	1.98	1.68	3.65	4.60	5.20	2.73	2.56	3.13	3.73	3.00	5.45	10.24	47.95

Avg	3.99	4.43	4.54	3.22	3.21	4.91	5.50	4.69	3.72	3.17	3.04	3.80	48.21
Min	0.89	0.73	0.81	0.60	1.23	0.89	0.90	1.04	0.19	0.00	0.21	0.46	28.82
Yr Min	1981	2000	2004	1972	2007	1990	1980	1963	2005	1963	1958	1955	1954
Max	10.02	8.90	10.96	8.43	10.90	12.97	13.71	12.34	10.26	19.62	7.78	10.24	73.47
Yr Max	1978	1998	1980	2003	1976	1973	1971	1964	2004	1990	1992	2009	1964

Table 4 - SRS Rainfall (in inches) for 2009, Manual Gauges

Month	700-A	Barricade 2	Barricade 3	Barricade 5	100-C	400-D	200-F	200-H	100-K	100-L	100-P	SRNL
Jan	2.14	2.57	2.00	1.62	2.18	2.03	2.38	2.02	1.63	1.66	1.96	2.19
Feb	1.38	2.25	1.90	1.19	0.87	0.80	1.27	1.25	0.97	0.73	0.70	1.94
Mar	4.46	5.31	5.21	4.43	4.54	4.25	4.75	4.74	4.30	3.88	4.33	4.58
Apr	3.76	4.75	3.58	4.33	4.01	5.86	4.34	4.04	5.52	5.32	5.48	4.17
May	4.22	4.43	4.99	6.49	5.07	8.21	5.94	6.37	9.48	6.64	4.25	4.90
Jun	3.73	3.91	4.98	3.74	4.29	1.72	4.28	5.19	4.54	2.45	4.57	4.11
Jul	3.56	6.29	7.75	3.63	7.00	4.47	5.75	5.77	5.22	5.28	5.78	4.16
Aug	2.44	2.87	5.03	1.74	4.18	7.67	3.51	2.85	5.19	3.51	2.77	2.73
Sep	4.51	3.42	4.60	3.13	4.02	5.74	3.17	3.53	4.61	3.93	4.45	5.18
Oct	3.32	7.85	7.22	2.65	3.07	2.89	3.53	3.34	5.67	2.48	2.55	3.66
Nov	5.58	6.01	6.28	4.24	6.08	4.56	5.38	6.12	5.67	4.55	5.55	6.59
Dec	8.36	11.15	9.49	8.35	9.84	9.75	9.74	10.39	9.44	8.84	9.11	10.30
Annual	47.46	60.81	63.03	45.54	55.15	57.95	54.04	55.61	62.24	49.27	51.50	54.51

Fig. 1 SRS Meteorological Monitoring Network

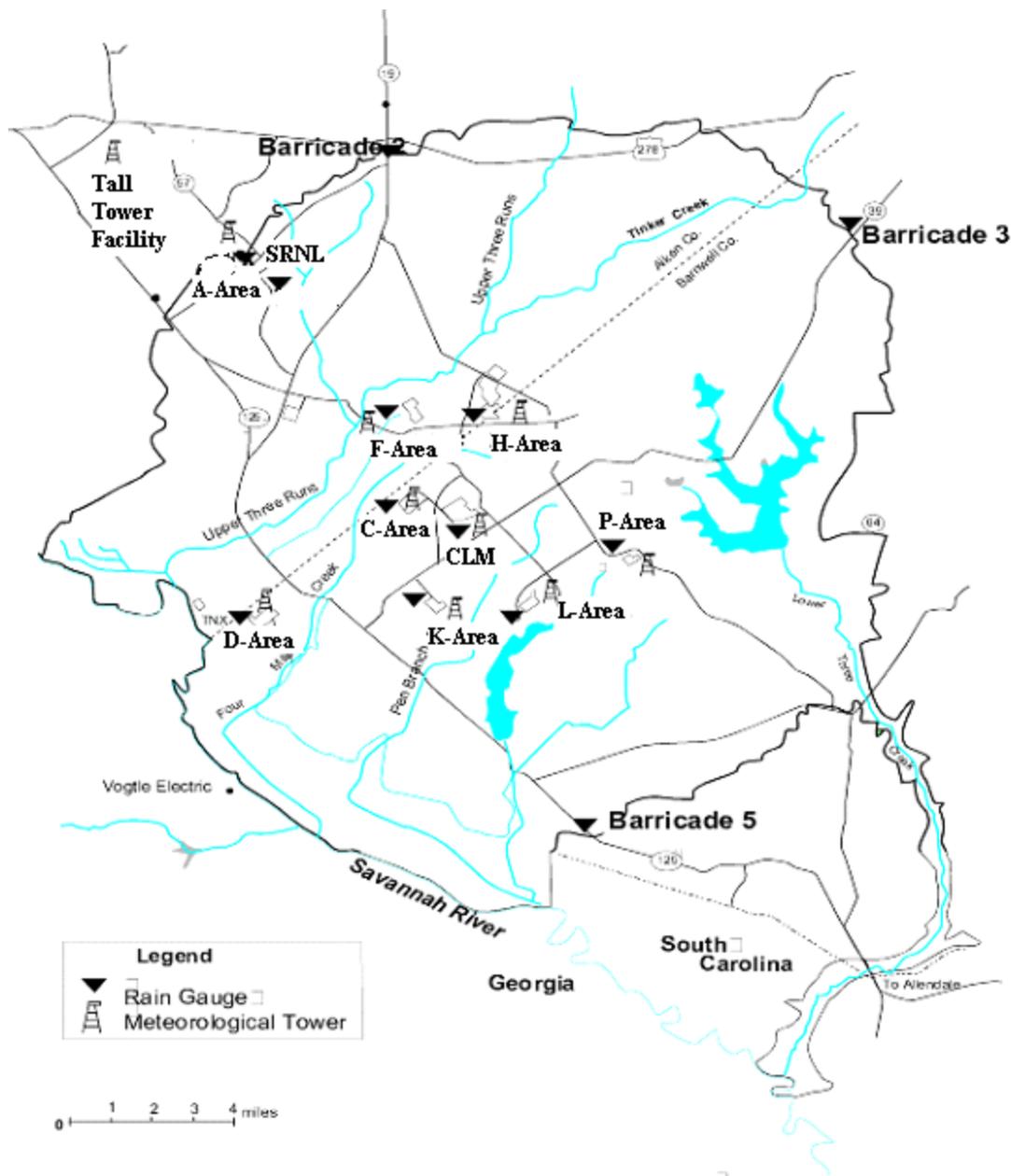


Fig. 2 - Summary of Daily Data for 2009

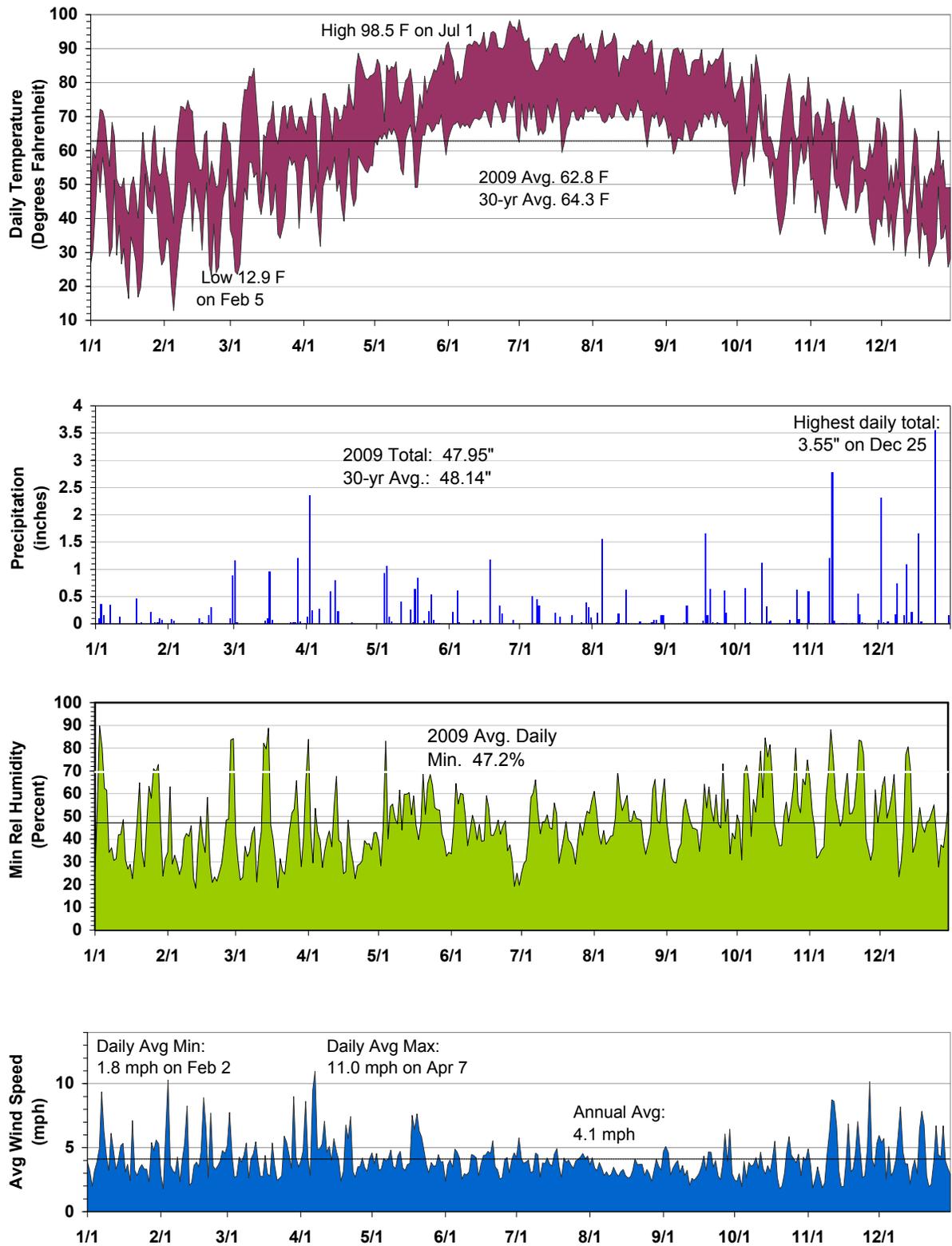


Fig. 3 - Daily High and Low Temperatures for 2009

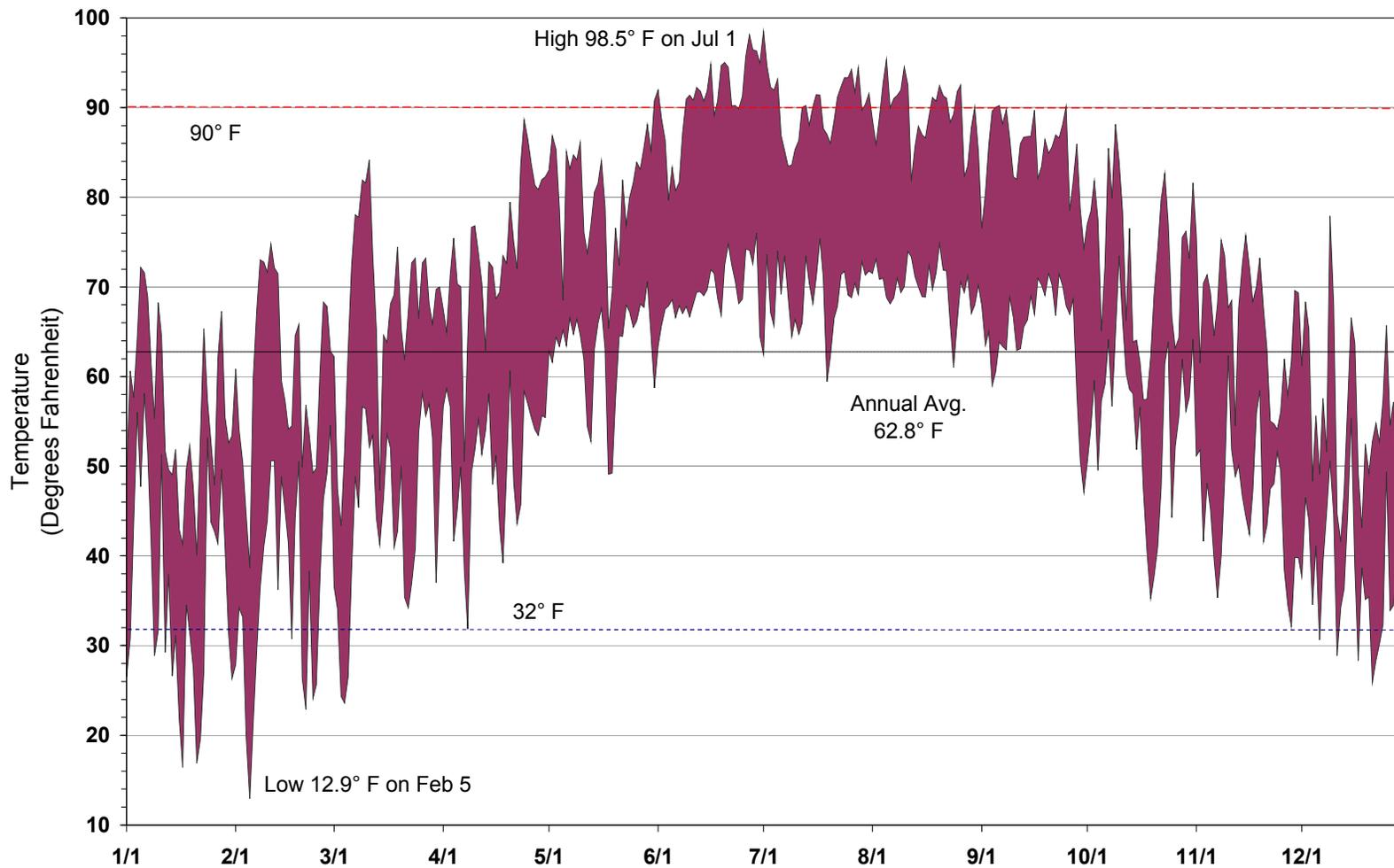


Fig. 4 - SRS Annual Average Temperature 1979-2009

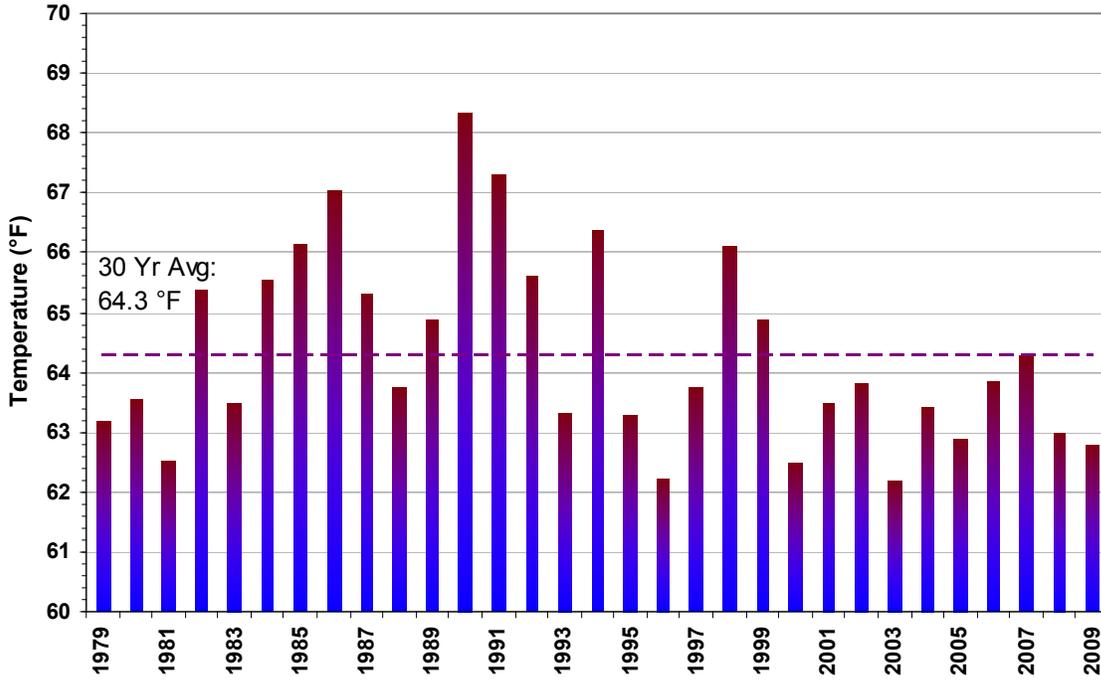


Fig. 5 - SRS Monthly Average Temperature

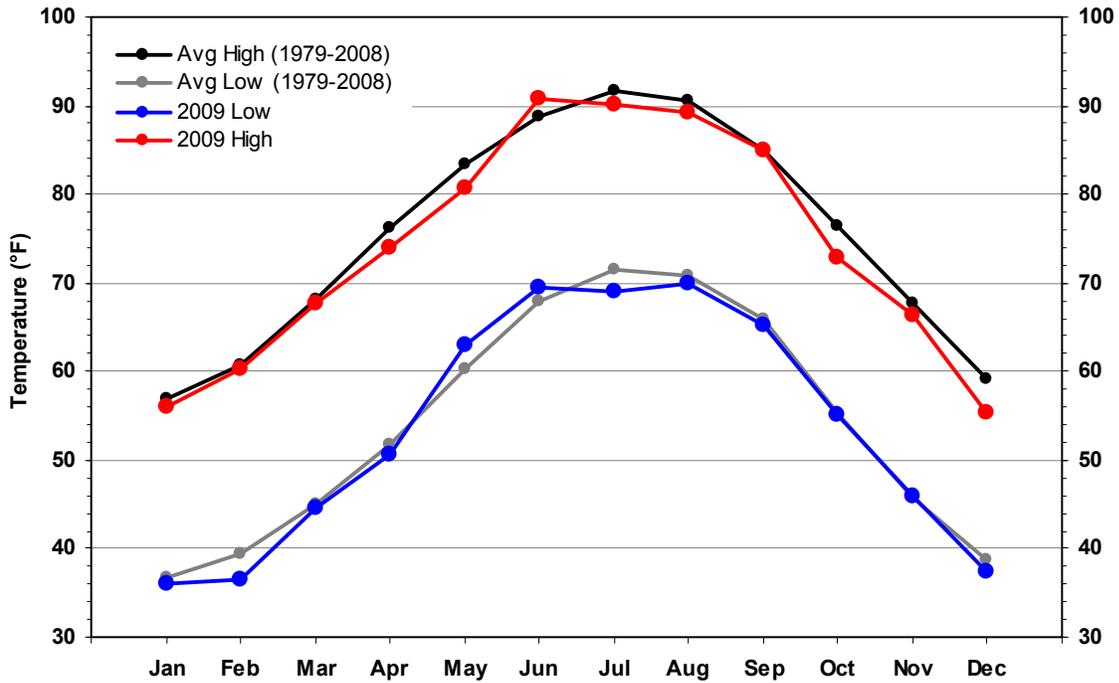


Fig. 6 - Number of Freezing (<32 F) and Sweltering (>90 F) Days

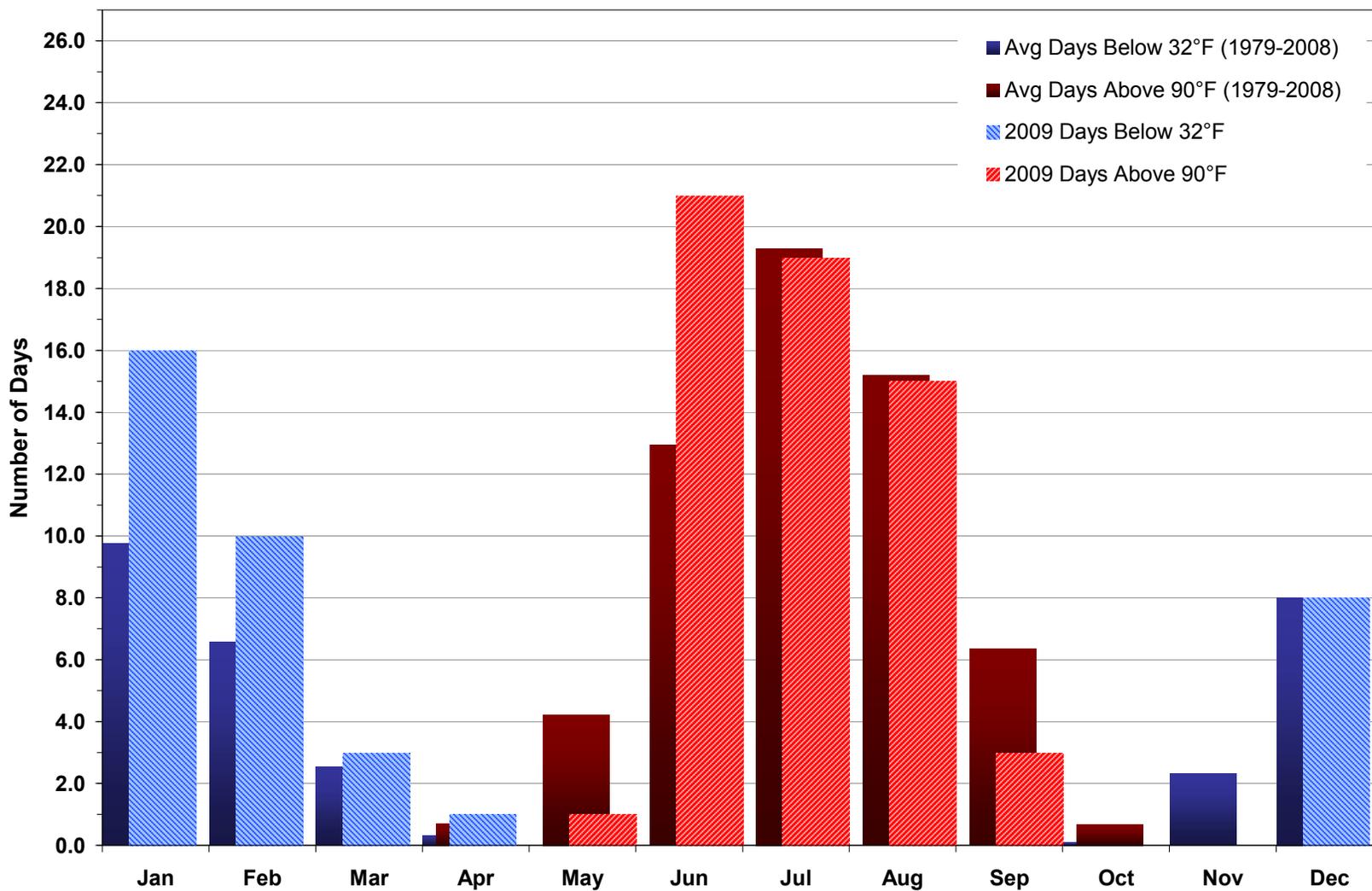


Fig. 8 - SRS Annual Precipitation 1979-2009

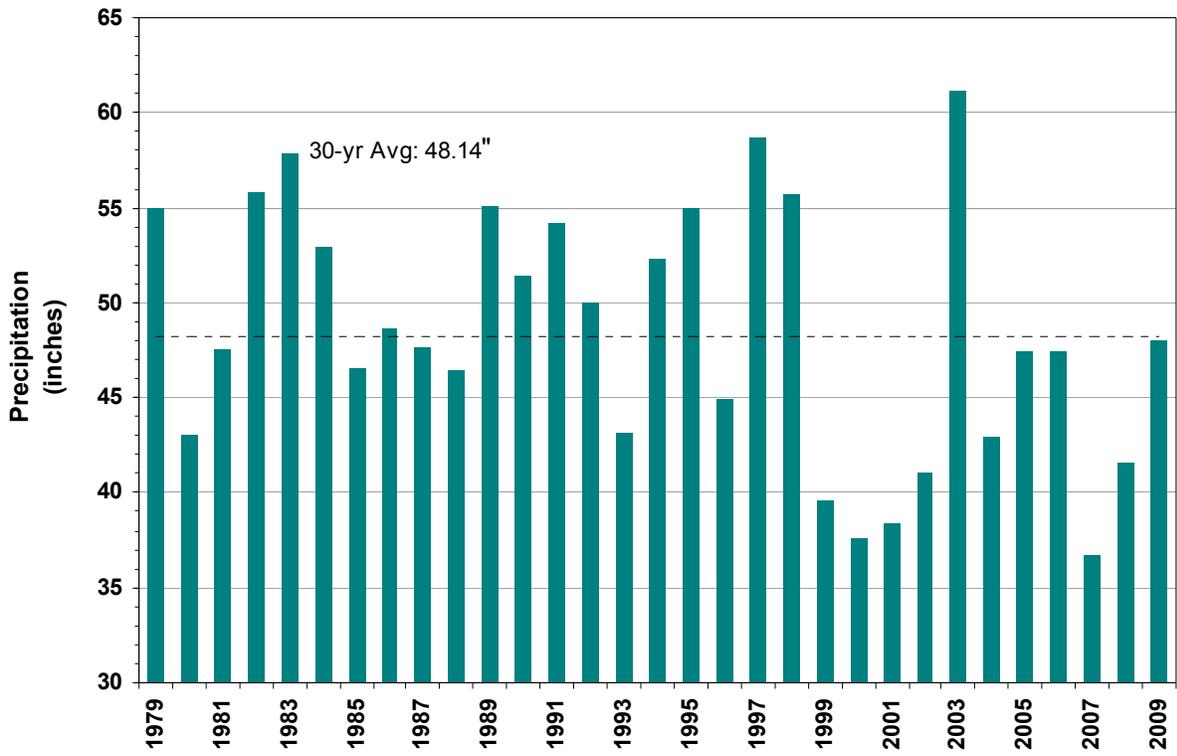


Fig. 9 - SRS Monthly Precipitation

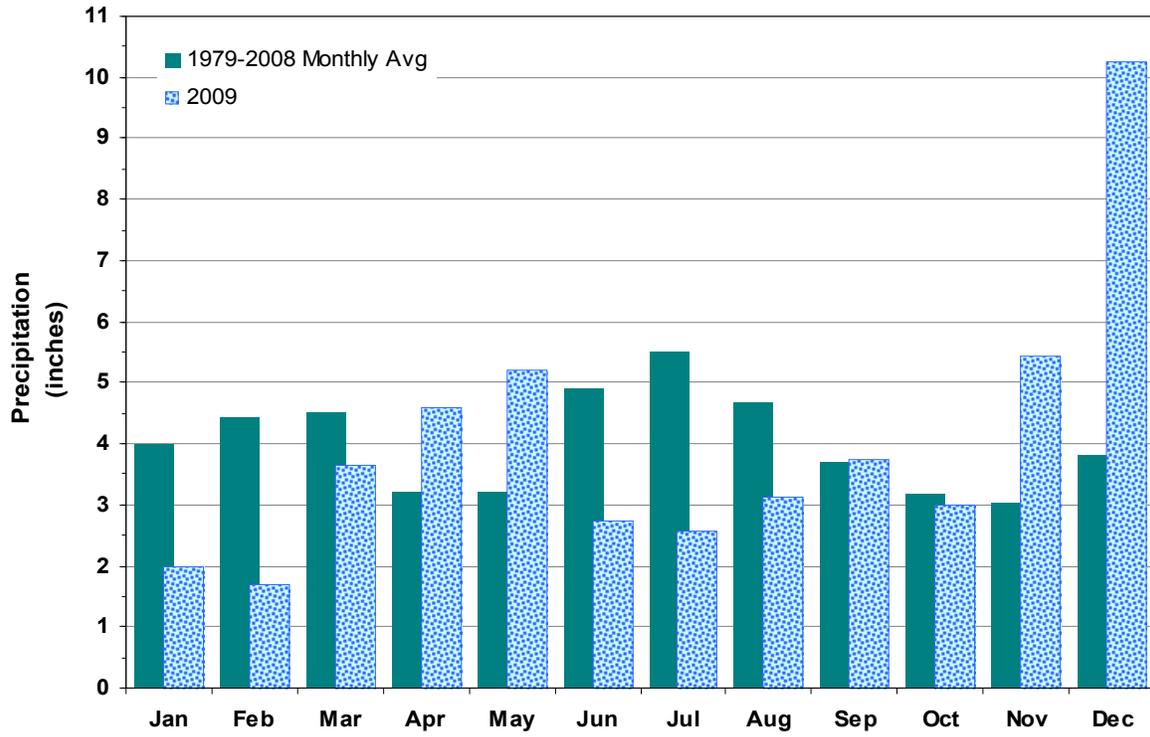


Fig. 10 - Daily High and Low Humidity for 2009

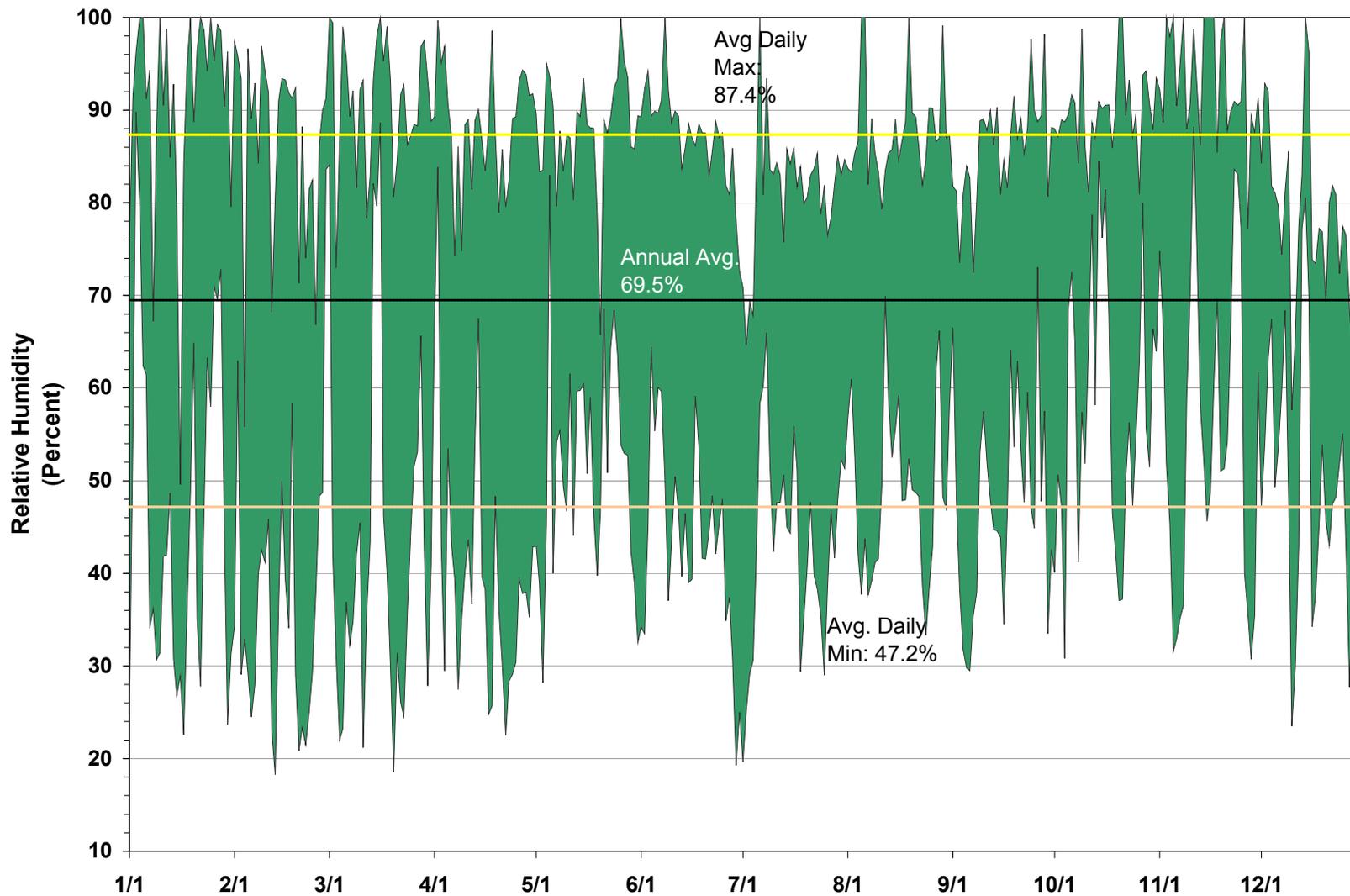


Fig. 11 - SRS Annual Average Humidity 1979-2009

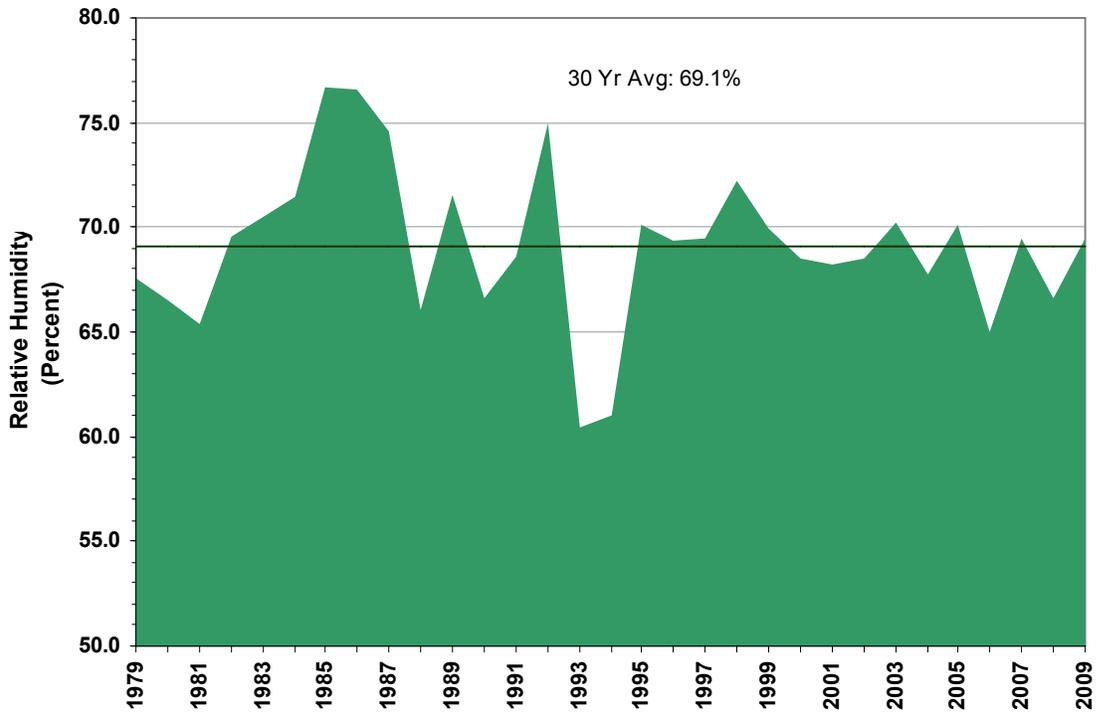


Fig. 12 - SRS Monthly Average Minimum Humidity

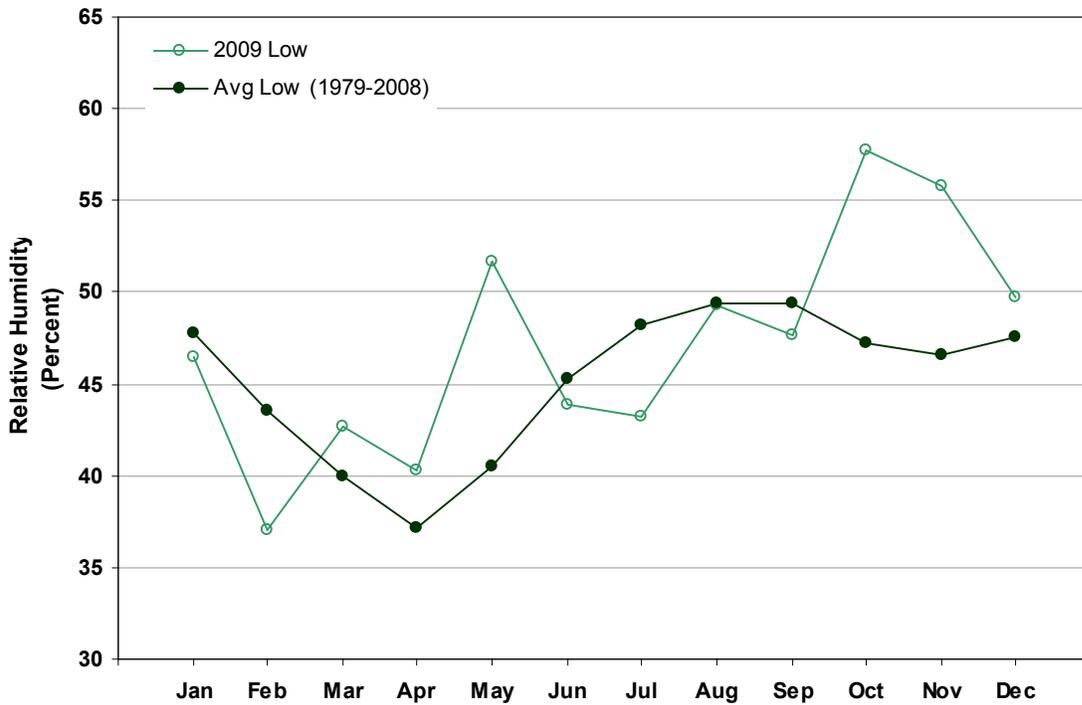


Fig. 13 - Daily Average Wind Speed for 2009

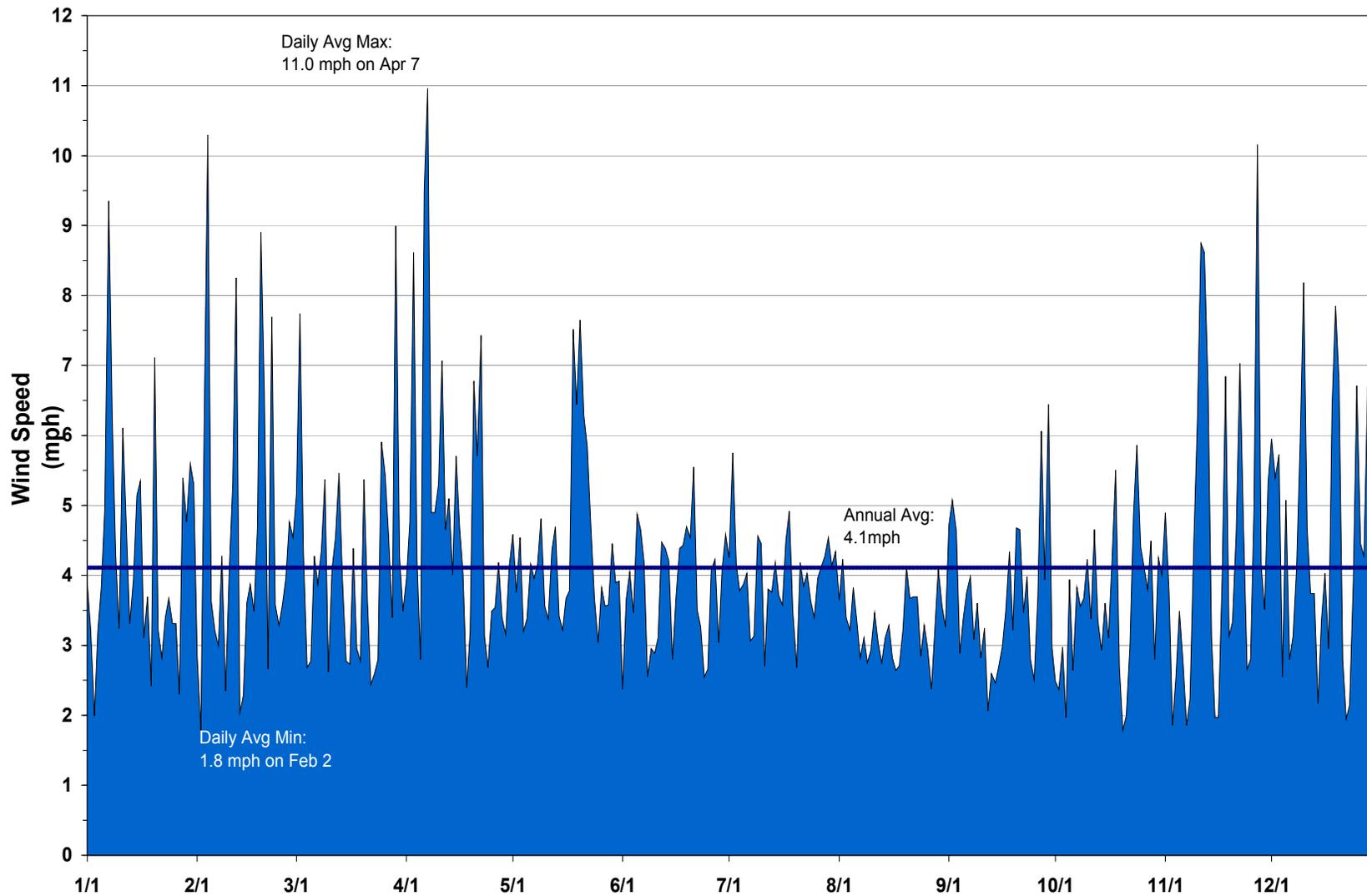
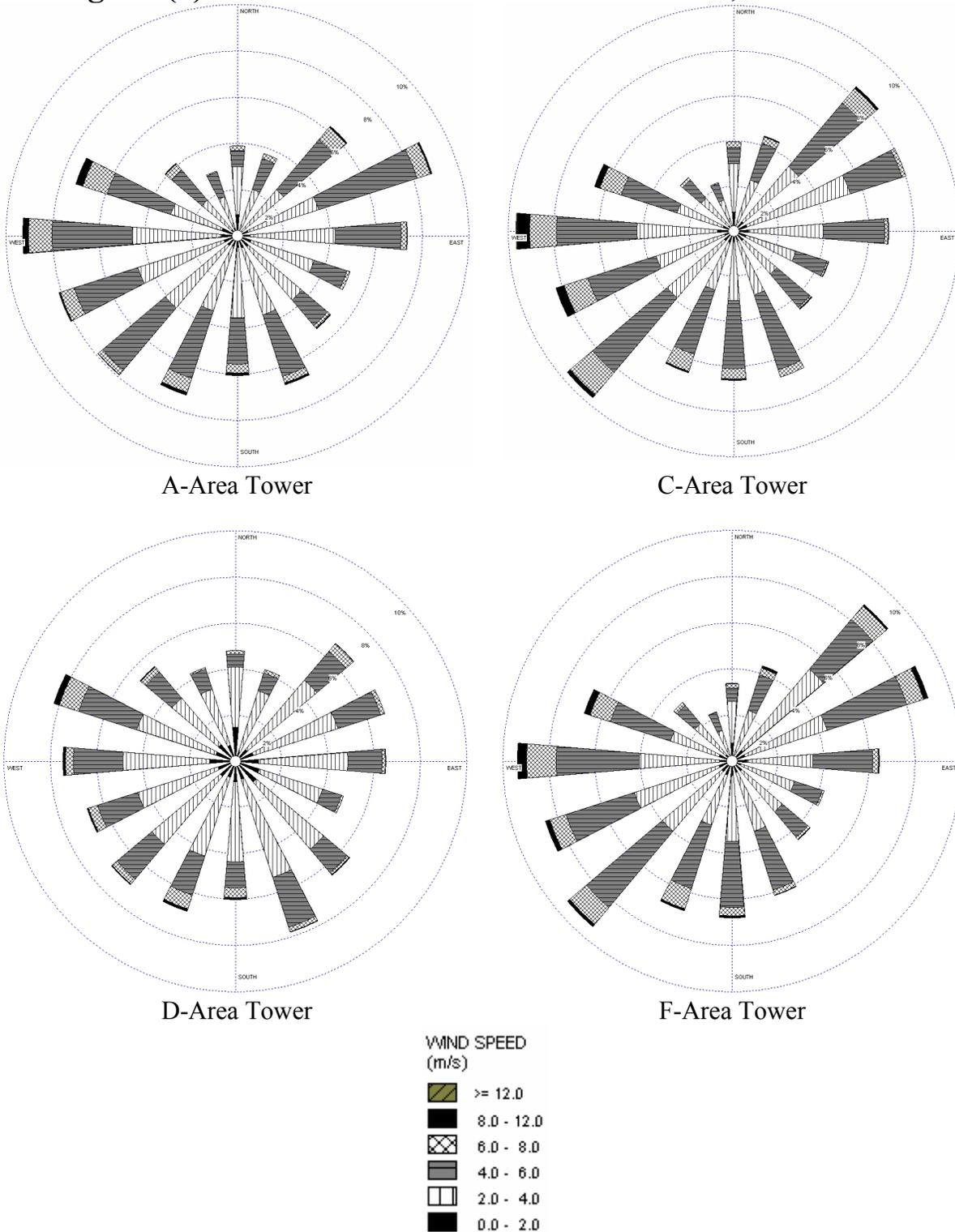
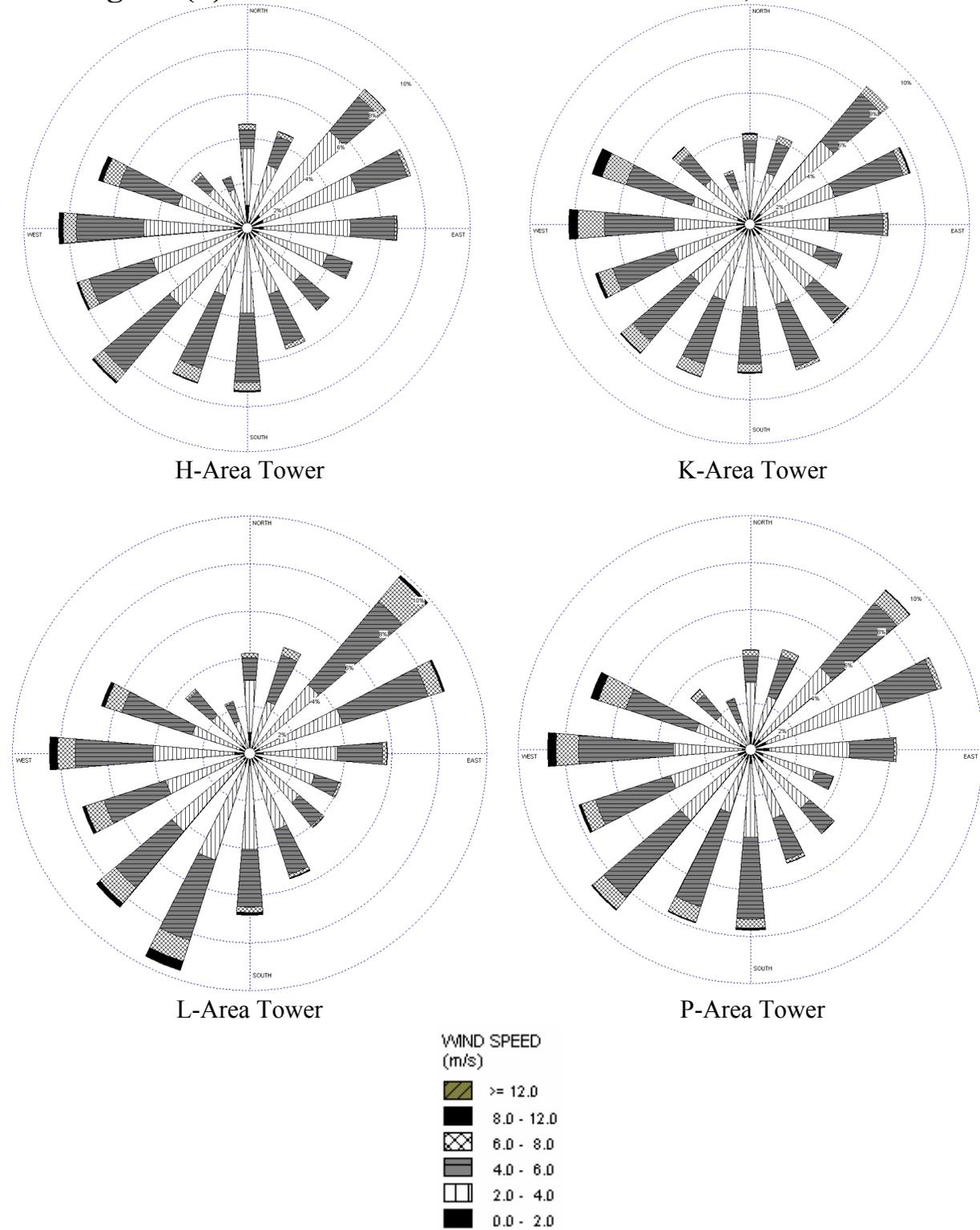


Fig. 14 (a) – Annual Wind Rose Plots for 2009, 61-m Level



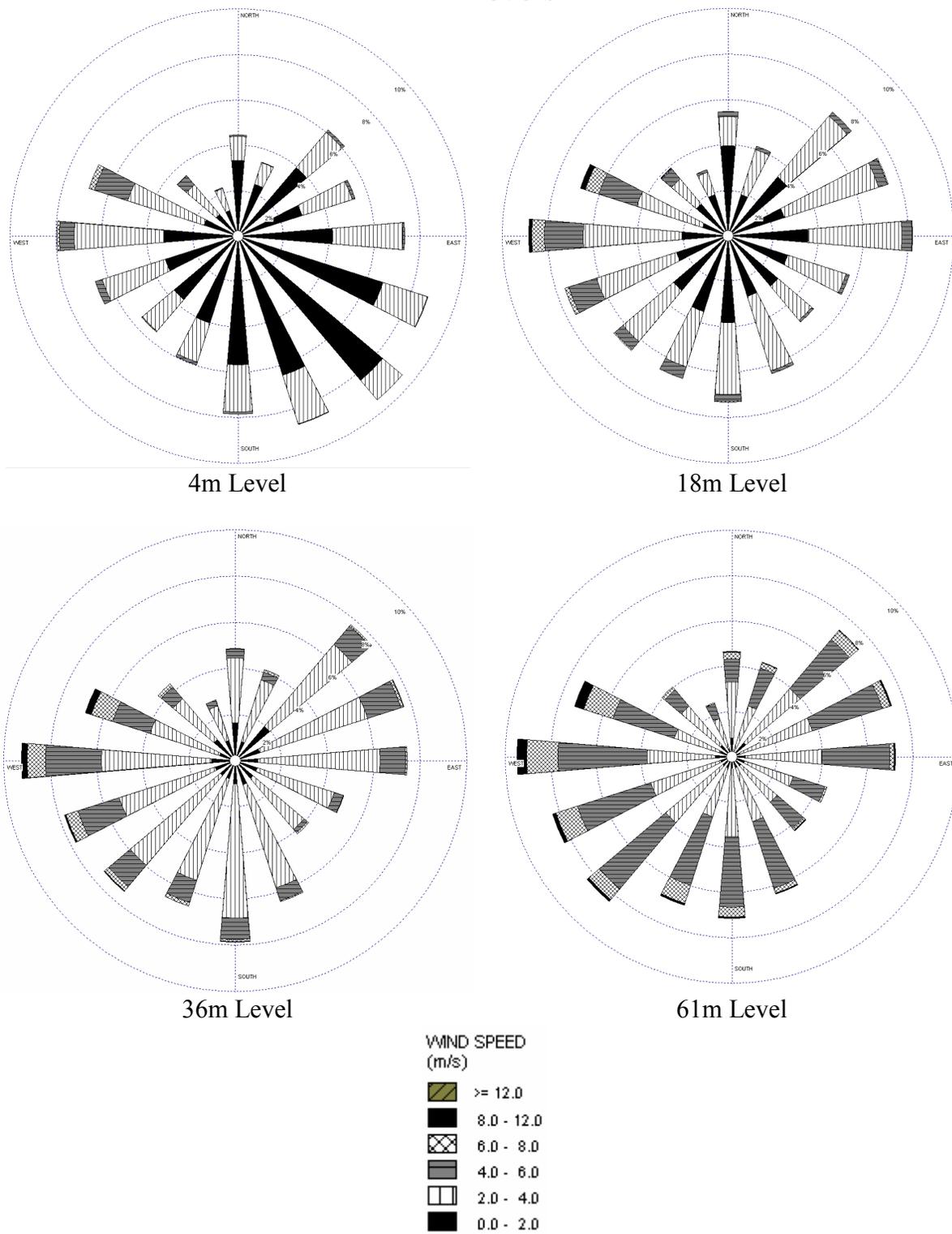
Windrose plot depicts the frequency of occurrence of wind direction sector (direction from which the wind blows) by wind speed category.

Fig. 14 (b) – Annual Wind Rose Plots for 2009, 61-m Level



Windrose plot depicts the frequency of occurrence of wind direction sector (direction from which the wind blows) by wind speed category.

Fig. 15 – Annual Wind Rose Plots for 2009, Central Climatology, All Levels



Windrose plot depicts the frequency of occurrence of wind direction sector (direction from which the wind blows) by wind speed category.

Fig. 16 – Seasonal Wind Rose Plots for 2009, Central Climatology, 61-m Level



Windrose plot depicts the frequency of occurrence of wind direction sector (direction from which the wind blows) by wind speed category.

Fig. 17 - Daily Average Barometric Pressure for 2009

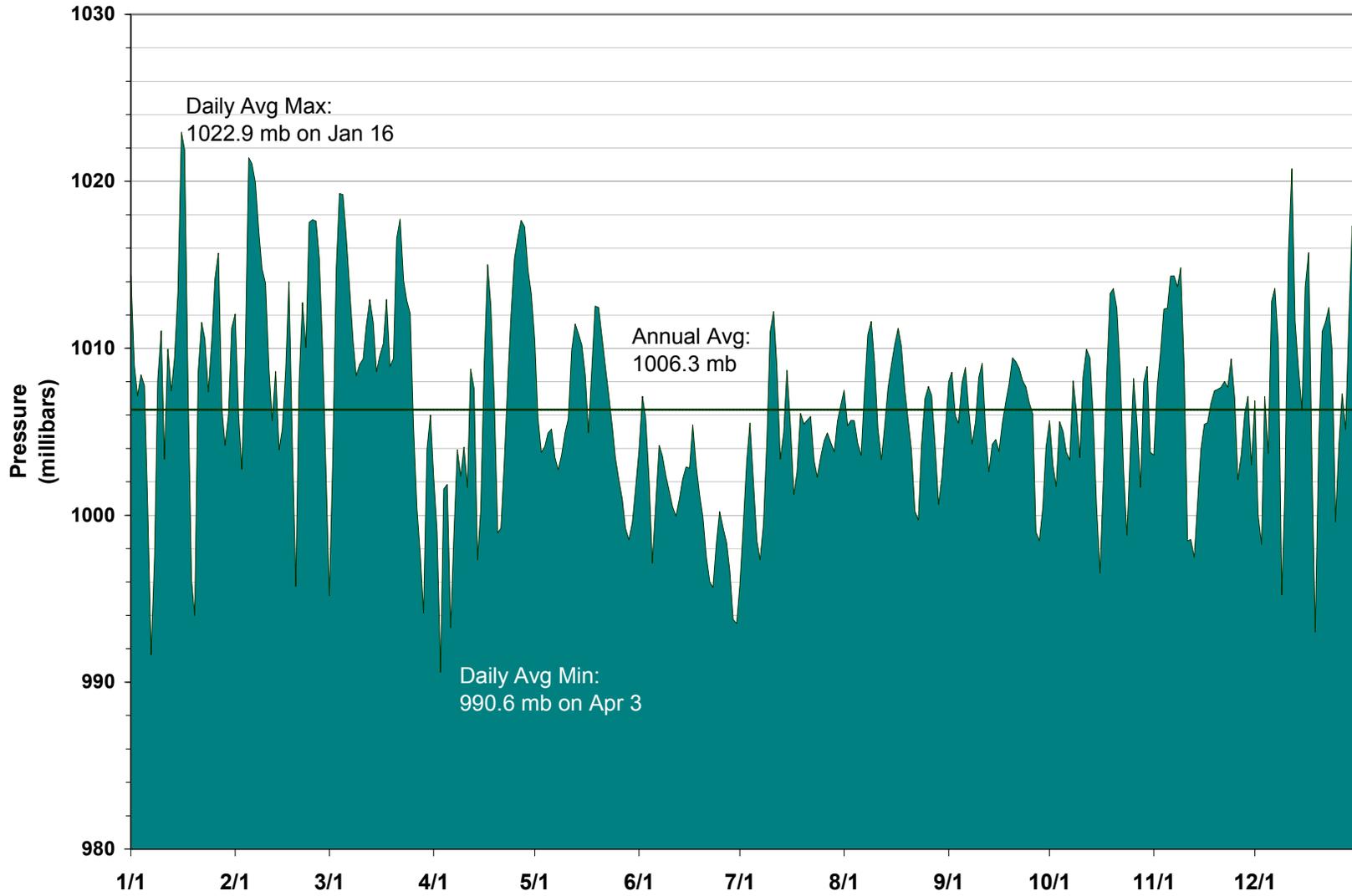


Fig. 18 - Daily Solar Radiation for 2009

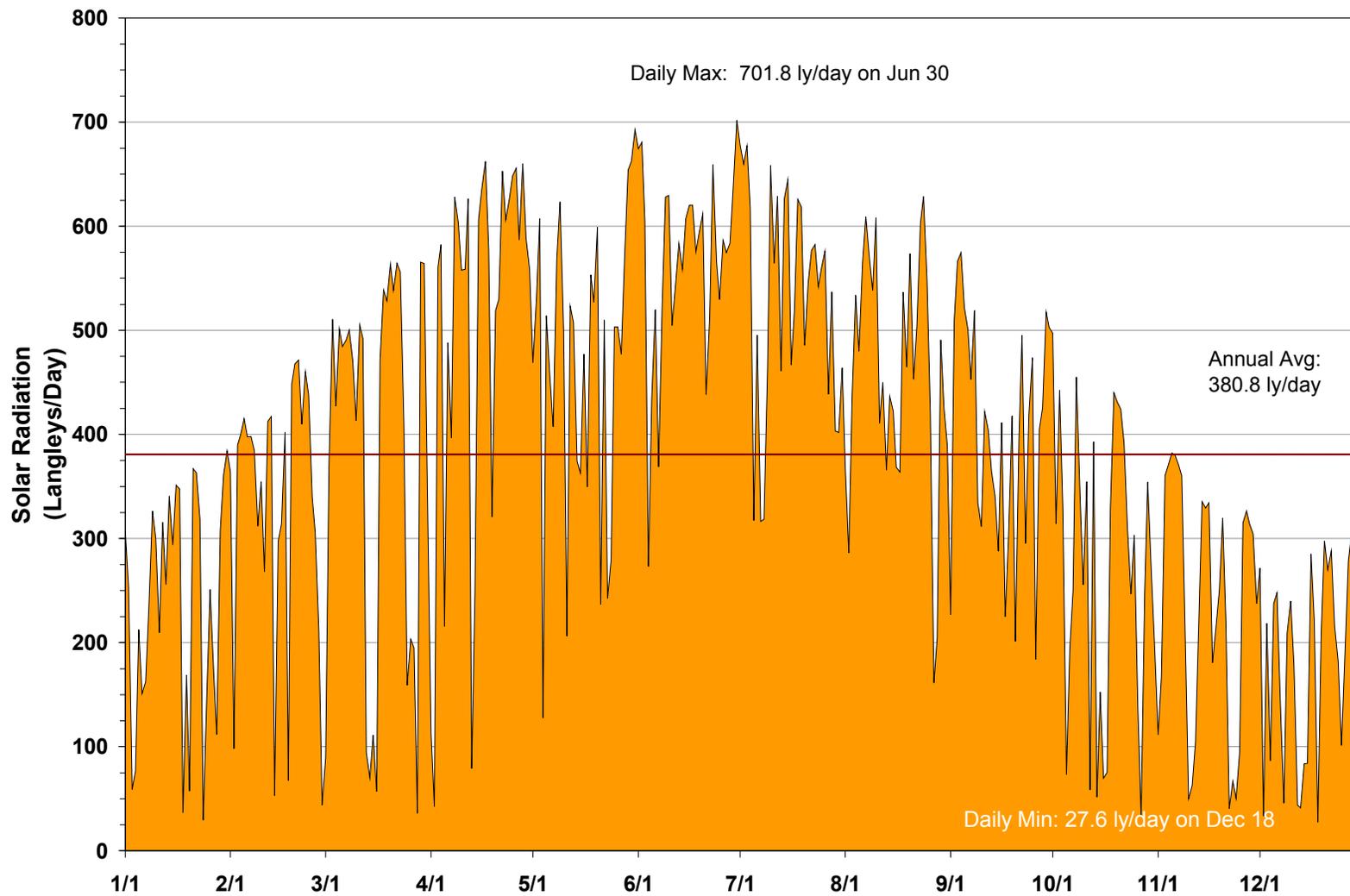


Table A.1 - Joint Occurrence Frequencies of Wind Direction Sector by Wind Speed Category for the A Area Tower, 2009

Sector	Wind Speed Category, meters/sec						Total
	0-2	2-4	4-6	6-8	8-12	>12	
N	0.009130	0.020660	0.007080	0.002060	0.000000	0.000000	0.038930
NNE	0.002170	0.018950	0.013930	0.002170	0.000000	0.000000	0.037220
NE	0.002740	0.023400	0.028310	0.006850	0.000800	0.000000	0.062110
ENE	0.004910	0.031970	0.044530	0.006050	0.000570	0.000000	0.088020
E	0.005710	0.036530	0.028310	0.002400	0.000340	0.000000	0.073300
ESE	0.006170	0.028770	0.014730	0.001260	0.000110	0.000000	0.051030
SE	0.006280	0.030030	0.014610	0.001480	0.000460	0.000000	0.052860
SSE	0.005590	0.030370	0.027860	0.002970	0.000800	0.000000	0.067590
S	0.005250	0.030140	0.020090	0.003880	0.001140	0.000000	0.060510
SSW	0.005020	0.029110	0.030480	0.006390	0.001370	0.000000	0.072380
SW	0.005590	0.035390	0.035280	0.002400	0.000110	0.000000	0.078780
WSW	0.006280	0.038930	0.028770	0.006280	0.000570	0.000000	0.080830
W	0.007080	0.038470	0.034480	0.010160	0.002280	0.000110	0.092590
WNW	0.007310	0.023060	0.028770	0.011070	0.003080	0.000000	0.073300
NW	0.003650	0.016550	0.017010	0.003540	0.000460	0.000000	0.041210
NNW	0.003650	0.014040	0.011300	0.000340	0.000000	0.000000	0.029340
Total	0.086540	0.446400	0.385550	0.069300	0.012100	0.000110	0.999890

Table A.2 - Joint Occurrence Frequencies of Wind Direction Sector by Wind Speed Category for the C Area Tower, 2009

Sector	Wind Speed Category, meters/sec						Total
	0-2	2-4	4-6	6-8	8-12	>12	
N	0.008450	0.021350	0.007310	0.002400	0.000000	0.000000	0.039500
NNE	0.002510	0.021240	0.017240	0.002850	0.000460	0.000000	0.044300
NE	0.005590	0.031970	0.036880	0.008330	0.001140	0.000000	0.083910
ENE	0.006170	0.048060	0.023860	0.001830	0.000110	0.000000	0.080030
E	0.006620	0.032880	0.027170	0.001600	0.000340	0.000000	0.068620
ESE	0.005710	0.023180	0.014390	0.000800	0.000110	0.000000	0.044180
SE	0.005590	0.019290	0.019070	0.001030	0.000340	0.000000	0.045320
SSE	0.004000	0.025570	0.034940	0.003310	0.000000	0.000000	0.067820
S	0.004800	0.025920	0.030250	0.004450	0.000690	0.000000	0.066100
SSW	0.005370	0.022030	0.029800	0.007990	0.000570	0.000000	0.065760
SW	0.005590	0.033220	0.043270	0.012670	0.001940	0.000000	0.096700
WSW	0.004570	0.031510	0.031740	0.011070	0.003540	0.000340	0.082770
W	0.007420	0.035390	0.035620	0.011990	0.005480	0.000460	0.096360
WNW	0.005250	0.021350	0.025690	0.010050	0.002400	0.000000	0.064730
NW	0.003430	0.015640	0.010730	0.001480	0.000000	0.000000	0.031280
NNW	0.002630	0.012100	0.007540	0.000340	0.000000	0.000000	0.022610
Total	0.083690	0.420710	0.395480	0.082200	0.017130	0.000800	0.999890

Table A.3 - Joint Occurrence Frequencies of Wind Direction Sector by Wind Speed Category for the D Area Tower, 2009

Sector	Wind Speed Category, meters/sec						Total
	0-2	2-4	4-6	6-8	8-12	>12	
N	0.014960	0.026030	0.005590	0.001480	0.000000	0.000000	0.048070
NNE	0.004220	0.027860	0.008110	0.001600	0.000000	0.000000	0.041790
NE	0.006850	0.039280	0.016440	0.004220	0.000230	0.000000	0.067020
ENE	0.008340	0.038140	0.019410	0.001830	0.000000	0.000000	0.067710
E	0.010050	0.038360	0.015070	0.001260	0.000110	0.000000	0.064850
ESE	0.010960	0.028660	0.008560	0.000690	0.000000	0.000000	0.048870
SE	0.011870	0.037910	0.013470	0.001030	0.000460	0.000000	0.064740
SSE	0.008340	0.044530	0.022720	0.001830	0.000230	0.000000	0.077640
S	0.008910	0.034710	0.011190	0.004220	0.001030	0.000000	0.060060
SSW	0.007310	0.035740	0.017930	0.006170	0.001260	0.000000	0.068390
SW	0.008790	0.038360	0.019750	0.002740	0.000460	0.000000	0.070110
WSW	0.007760	0.036420	0.018270	0.004110	0.000690	0.000000	0.067250
W	0.011300	0.037220	0.021350	0.003430	0.001140	0.000000	0.074450
WNW	0.008910	0.035850	0.026380	0.008680	0.002510	0.000000	0.082320
NW	0.009590	0.026260	0.014840	0.002740	0.000570	0.000000	0.054010
NNW	0.007540	0.025350	0.009130	0.000690	0.000000	0.000000	0.042700
Total	0.145700	0.550700	0.248230	0.046700	0.008680	0.000000	0.999890

Table A.4 - Joint Occurrence Frequencies of Wind Direction Sector by Wind Speed Category for the F Area Tower, 2009

Sector	Wind Speed Category, meters/sec						Total
	0-2	2-4	4-6	6-8	8-12	>12	
N	0.007880	0.017940	0.005830	0.001940	0.000110	0.000000	0.033700
NNE	0.002510	0.020560	0.016340	0.002860	0.001030	0.000000	0.043300
NE	0.006400	0.045810	0.028330	0.007430	0.000910	0.000000	0.088880
ENE	0.006060	0.037590	0.036440	0.007540	0.001940	0.000000	0.089570
E	0.006630	0.028680	0.026050	0.002400	0.000460	0.000000	0.064210
ESE	0.004340	0.024450	0.012450	0.000910	0.000000	0.000000	0.042160
SE	0.005830	0.022960	0.014510	0.001140	0.000230	0.000000	0.044670
SSE	0.005480	0.026390	0.026850	0.002170	0.000230	0.000000	0.061120
S	0.006280	0.028450	0.028560	0.003660	0.000800	0.000000	0.067750
SSW	0.006510	0.022620	0.028900	0.009140	0.000910	0.000000	0.068090
SW	0.005940	0.033930	0.043190	0.009600	0.001260	0.000000	0.093910
WSW	0.006060	0.038730	0.031080	0.007540	0.001710	0.000230	0.085340
W	0.005710	0.034730	0.036100	0.012910	0.004110	0.000000	0.093570
WNW	0.006060	0.022280	0.027300	0.009250	0.002740	0.000000	0.067630
NW	0.003880	0.017370	0.010510	0.001710	0.000110	0.000000	0.033590
NNW	0.002280	0.011650	0.008230	0.000340	0.000000	0.000000	0.022510
Total	0.087860	0.434140	0.380670	0.080540	0.016570	0.000230	0.999890

Table A.5 - Joint Occurrence Frequencies of Wind Direction Sector by Wind Speed Category for the H Area Tower, 2009

Sector	Wind Speed Category, meters/sec					Total	
	0-2	2-4	4-6	6-8	8-12		>12
N	0.010390	0.025230	0.008450	0.002280	0.000110	0.000000	0.046470
NNE	0.003650	0.026030	0.013360	0.002170	0.000110	0.000000	0.045320
NE	0.007650	0.049090	0.020440	0.004000	0.000110	0.000000	0.081290
ENE	0.007650	0.044070	0.023520	0.001710	0.000000	0.000000	0.076950
E	0.007420	0.038820	0.019870	0.000910	0.000110	0.000000	0.067130
ESE	0.005480	0.032200	0.011420	0.000460	0.000000	0.000000	0.049550
SE	0.005480	0.026490	0.015640	0.000460	0.000230	0.000000	0.048290
SSE	0.005370	0.025920	0.023630	0.001830	0.000110	0.000000	0.056860
S	0.004570	0.033340	0.031170	0.003540	0.000690	0.000000	0.073300
SSW	0.005140	0.026490	0.034360	0.006280	0.000570	0.000000	0.072840
SW	0.005820	0.039730	0.038700	0.005710	0.000800	0.000000	0.090760
WSW	0.004570	0.040070	0.029460	0.005020	0.000910	0.000000	0.080030
W	0.006170	0.040070	0.030250	0.005820	0.002060	0.000000	0.084370
WNW	0.005590	0.027060	0.027510	0.007760	0.001940	0.000000	0.069870
NW	0.004110	0.018950	0.007880	0.001830	0.000000	0.000000	0.032770
NNW	0.002740	0.015410	0.005710	0.000340	0.000000	0.000000	0.024200
Total	0.091790	0.508960	0.341360	0.050120	0.007760	0.000000	0.999890

Table A.6 - Joint Occurrence Frequencies of Wind Direction Sector by Wind Speed Category for the K Area Tower, 2009

Sector	Wind Speed Category, meters/sec					Total	
	0-2	2-4	4-6	6-8	8-12		>12
N	0.006510	0.021580	0.010160	0.002740	0.000570	0.000000	0.041560
NNE	0.003200	0.021460	0.014500	0.003080	0.000000	0.000000	0.042240
NE	0.006620	0.043160	0.028310	0.004220	0.000000	0.000000	0.082320
ENE	0.005940	0.034820	0.032420	0.002850	0.000690	0.000000	0.076720
E	0.005140	0.031050	0.024430	0.002060	0.000230	0.000000	0.062910
ESE	0.006050	0.026260	0.010850	0.000690	0.000110	0.000000	0.043950
SE	0.006510	0.031850	0.019070	0.001260	0.000460	0.000000	0.059140
SSE	0.005940	0.032420	0.029800	0.001480	0.000110	0.000000	0.069760
S	0.004800	0.032770	0.026030	0.003540	0.000800	0.000000	0.067930
SSW	0.005140	0.031170	0.030600	0.005940	0.000110	0.000000	0.072950
SW	0.005020	0.030140	0.034590	0.006740	0.000570	0.000000	0.077060
WSW	0.006740	0.029680	0.028880	0.007080	0.001260	0.000110	0.073750
W	0.006050	0.028880	0.031050	0.012100	0.004110	0.000000	0.082200
WNW	0.006170	0.021810	0.031170	0.011420	0.004680	0.000110	0.075350
NW	0.004110	0.022830	0.015180	0.003650	0.000570	0.000000	0.046350
NNW	0.003650	0.013360	0.007540	0.001260	0.000000	0.000000	0.025800
Total	0.087570	0.453250	0.374590	0.070100	0.014270	0.000230	0.999890

Table A.7 - Joint Occurrence Frequencies of Wind Direction Sector by Wind Speed Category for the L Area Tower, 2009

Sector	Wind Speed Category, meters/sec						Total
	0-2	2-4	4-6	6-8	8-12	>12	
N	0.008910	0.021810	0.009710	0.001830	0.000000	0.000000	0.042250
NNE	0.003650	0.019530	0.020320	0.003430	0.000000	0.000000	0.046930
NE	0.003650	0.034250	0.046020	0.012900	0.001370	0.000000	0.098200
ENE	0.004450	0.036650	0.037790	0.006170	0.000910	0.000000	0.085980
E	0.005820	0.030940	0.019180	0.001830	0.000110	0.000000	0.057890
ESE	0.005820	0.023180	0.010390	0.001140	0.000000	0.000000	0.040530
SE	0.004800	0.022610	0.012670	0.000800	0.000230	0.000000	0.041110
SSE	0.004220	0.029690	0.019750	0.001480	0.000460	0.000000	0.055610
S	0.005250	0.035280	0.024210	0.002280	0.001140	0.000000	0.068170
SSW	0.004800	0.042480	0.035510	0.009130	0.004000	0.000000	0.095910
SW	0.003770	0.039050	0.031290	0.008560	0.002170	0.000000	0.084840
WSW	0.003770	0.033460	0.027290	0.008110	0.001140	0.000110	0.073880
W	0.006620	0.034030	0.032770	0.007540	0.003310	0.000000	0.084270
WNW	0.004800	0.020780	0.031060	0.007310	0.001600	0.000000	0.065540
NW	0.004570	0.016560	0.013250	0.001370	0.000000	0.000000	0.035740
NNW	0.001710	0.012790	0.007990	0.000690	0.000000	0.000000	0.023180
Total	0.076620	0.453070	0.379200	0.074560	0.016440	0.000110	0.999770

Table A.8 - Joint Occurrence Frequencies of Wind Direction Sector by Wind Speed Category for the P Area Tower, 2009

Sector	Wind Speed Category, meters/sec						Total
	0-2	2-4	4-6	6-8	8-12	>12	
N	0.007660	0.021160	0.011210	0.002400	0.000340	0.000000	0.042770
NNE	0.004800	0.019210	0.018180	0.002740	0.000110	0.000000	0.045060
NE	0.005600	0.040370	0.036250	0.006860	0.000460	0.000000	0.089550
ENE	0.007090	0.052380	0.024470	0.002060	0.000000	0.000000	0.086000
E	0.008120	0.034310	0.019100	0.001140	0.000000	0.000000	0.062670
ESE	0.005830	0.023790	0.007660	0.000340	0.000000	0.000000	0.037630
SE	0.007430	0.025500	0.013610	0.000340	0.000230	0.000000	0.047120
SSE	0.003770	0.027220	0.018530	0.001260	0.000110	0.000000	0.050890
S	0.005950	0.031680	0.034770	0.003890	0.000800	0.000000	0.077080
SSW	0.004570	0.024020	0.041860	0.006860	0.000460	0.000000	0.077770
SW	0.004230	0.035570	0.042890	0.006400	0.000690	0.000000	0.089780
WSW	0.005720	0.030420	0.033970	0.006400	0.000910	0.000110	0.077540
W	0.003890	0.029390	0.040710	0.009610	0.003430	0.000110	0.087150
WNW	0.005150	0.019900	0.031340	0.012350	0.003320	0.000000	0.072050
NW	0.002290	0.016930	0.011780	0.002630	0.000230	0.000000	0.033850
NNW	0.002520	0.009950	0.010290	0.000340	0.000000	0.000000	0.023100
Total	0.084630	0.441790	0.396610	0.065650	0.011090	0.000230	0.999890

**Table A.9 - Joint Occurrence Frequencies of Wind Direction Sector
by Wind Speed Category for the 4m Level Central Climatology Tower, 2009**

Sector	Wind Speed Category, meters/sec						Total
	0-2	2-4	4-6	6-8	8-12	>12	
N	0.033340	0.010500	0.000690	0.000000	0.000000	0.000000	0.044530
NNE	0.024090	0.009930	0.000230	0.000000	0.000000	0.000000	0.034250
NE	0.039500	0.020320	0.001370	0.000000	0.000000	0.000000	0.061190
ENE	0.029680	0.022830	0.001370	0.000000	0.000000	0.000000	0.053890
E	0.041670	0.030370	0.000910	0.000000	0.000000	0.000000	0.072950
ESE	0.066790	0.020320	0.000340	0.000000	0.000000	0.000000	0.087450
SE	0.083110	0.011300	0.000000	0.000000	0.000000	0.000000	0.094420
SSE	0.064160	0.022610	0.000230	0.000000	0.000000	0.000000	0.087000
S	0.056510	0.020780	0.000910	0.000000	0.000000	0.000000	0.078210
SSW	0.040190	0.018040	0.001370	0.000000	0.000000	0.000000	0.059600
SW	0.036760	0.018040	0.000460	0.000110	0.000000	0.000000	0.055370
WSW	0.033450	0.029000	0.003200	0.000000	0.000000	0.000000	0.065650
W	0.032540	0.039270	0.006390	0.001140	0.000000	0.000000	0.079350
WNW	0.015640	0.035160	0.015300	0.002510	0.000000	0.000000	0.068620
NW	0.012560	0.017130	0.005140	0.000340	0.000000	0.000000	0.035160
NNW	0.011870	0.010160	0.000340	0.000000	0.000000	0.000000	0.022380
Total	0.621870	0.335770	0.038250	0.004110	0.000000	0.000000	0.999890

**Table A.10 - Joint Occurrence Frequencies of Wind Direction Sector
by Wind Speed Category for the 18m Level Central Climatology Tower, 2009**

Sector	Wind Speed Category, meters/sec						Total
	0-2	2-4	4-6	6-8	8-12	>12	
N	0.03950	0.01290	0.00217	0.00000	0.00000	0.00000	0.05457
NNE	0.01918	0.02055	0.00171	0.00000	0.00000	0.00000	0.04144
NE	0.03414	0.03494	0.00228	0.00000	0.00000	0.00000	0.07136
ENE	0.02626	0.04361	0.00411	0.00046	0.00000	0.00000	0.07444
E	0.03551	0.04133	0.00457	0.00023	0.00000	0.00000	0.08163
ESE	0.02786	0.02694	0.00160	0.00000	0.00000	0.00000	0.05640
SE	0.02911	0.01952	0.00103	0.00000	0.00000	0.00000	0.04966
SSE	0.02809	0.03414	0.00137	0.00000	0.00000	0.00000	0.06359
S	0.03813	0.03151	0.00297	0.00046	0.00000	0.00000	0.07307
SSW	0.03505	0.02546	0.00525	0.00000	0.00000	0.00000	0.06576
SW	0.03162	0.02923	0.00480	0.00034	0.00000	0.00000	0.06599
WSW	0.02409	0.03699	0.01279	0.00183	0.00011	0.00000	0.07581
W	0.02055	0.04350	0.01701	0.00571	0.00137	0.00000	0.08814
WNW	0.01187	0.03071	0.01735	0.00639	0.00228	0.00000	0.06862
NW	0.01838	0.01439	0.00559	0.00057	0.00011	0.00000	0.03905
NNW	0.01918	0.01028	0.00103	0.00000	0.00000	0.00000	0.03048
Total	0.43852	0.45599	0.08563	0.01598	0.00388	0.00000	0.99989

**Table A.11 - Joint Occurrence Frequencies of Wind Direction Sector
by Wind Speed Category for the 36m Level Central Climatology Tower, 2009**

Sector	Wind Speed Category, meters/sec						Total
	0-2	2-4	4-6	6-8	8-12	>12	
N	0.016440	0.028090	0.003770	0.000340	0.000000	0.000000	0.048640
NNE	0.008680	0.027860	0.003770	0.001140	0.000000	0.000000	0.041440
NE	0.019640	0.046120	0.010500	0.000910	0.000000	0.000000	0.077180
ENE	0.011190	0.048750	0.015180	0.001140	0.000230	0.000000	0.076490
E	0.009820	0.052750	0.010850	0.000800	0.000000	0.000000	0.074210
ESE	0.010050	0.034820	0.004000	0.000230	0.000000	0.000000	0.049090
SE	0.010050	0.029000	0.001940	0.000570	0.000000	0.000000	0.041560
SSE	0.010960	0.046690	0.006050	0.000340	0.000000	0.000000	0.064050
S	0.010160	0.058000	0.009250	0.000800	0.000110	0.000000	0.078320
SSW	0.008220	0.046120	0.010050	0.001710	0.000000	0.000000	0.066100
SW	0.008560	0.050690	0.012220	0.002170	0.000340	0.000110	0.074100
WSW	0.009130	0.043500	0.018610	0.005370	0.000690	0.000000	0.077290
W	0.010390	0.047270	0.024090	0.007880	0.002630	0.000000	0.092250
WNW	0.007310	0.031400	0.016900	0.009590	0.002740	0.000000	0.067930
NW	0.012100	0.023290	0.006390	0.001710	0.000110	0.000000	0.043610
NNW	0.009130	0.015760	0.002740	0.000110	0.000000	0.000000	0.027740
Total	0.171820	0.630090	0.156300	0.034820	0.006850	0.000110	0.999890

**Table A.12 - Joint Occurrence Frequencies of Wind Direction Sector
by Wind Speed Category for the 61m Level Central Climatology Tower, 2009**

Sector	Wind Speed Category, meters/sec						Total
	0-2	2-4	4-6	6-8	8-12	>12	
N	0.005020	0.030250	0.031050	0.004220	0.000690	0.000000	0.071240
NNE	0.005250	0.022610	0.031620	0.008450	0.000910	0.000000	0.068840
NE	0.005250	0.032880	0.038360	0.005940	0.001140	0.000000	0.083570
ENE	0.005370	0.032080	0.034020	0.009930	0.001480	0.000110	0.083000
E	0.007190	0.030030	0.039500	0.013590	0.004110	0.000230	0.094650
ESE	0.005710	0.021010	0.028430	0.013360	0.004220	0.000000	0.072730
SE	0.006740	0.022490	0.009700	0.001480	0.000110	0.000000	0.040530
SSE	0.003770	0.013930	0.006960	0.000570	0.000000	0.000000	0.025230
S	0.008220	0.024890	0.010050	0.002970	0.000460	0.000000	0.046580
SSW	0.002510	0.021010	0.017580	0.002510	0.000110	0.000000	0.043730
SW	0.008330	0.031170	0.028430	0.005020	0.000340	0.000000	0.073300
WSW	0.003770	0.033450	0.032540	0.003430	0.000800	0.000000	0.073980
W	0.006050	0.033680	0.029910	0.001830	0.000570	0.000000	0.072040
WNW	0.006050	0.022380	0.014730	0.000800	0.000110	0.000000	0.044070
NW	0.005370	0.021010	0.015070	0.001140	0.000340	0.000000	0.042930
NNW	0.005140	0.025000	0.030710	0.002280	0.000460	0.000000	0.063590
Total	0.089740	0.417860	0.398680	0.077520	0.015870	0.000340	0.999890

Table A.13 - Joint Occurrence Frequencies of Wind Direction Sector by Wind Speed Category for the 61m Level Central Climatology Tower, Winter 2009

Sector	Wind Speed Category, meters/sec						Total
	0-2	2-4	4-6	6-8	8-12	>12	
N	0.004170	0.020380	0.036130	0.004170	0.001850	0.000000	0.066700
NNE	0.002780	0.014360	0.038910	0.014820	0.000930	0.000000	0.071790
NE	0.004170	0.021770	0.038910	0.008800	0.002320	0.000000	0.075960
ENE	0.003710	0.026400	0.037050	0.012510	0.002320	0.000460	0.082450
E	0.010190	0.035660	0.048170	0.025940	0.004630	0.000000	0.124590
ESE	0.006020	0.028720	0.056040	0.037050	0.010650	0.000000	0.138490
SE	0.006020	0.025940	0.016670	0.003710	0.000460	0.000000	0.052800
SSE	0.002320	0.017600	0.007870	0.000460	0.000000	0.000000	0.028250
S	0.007410	0.016670	0.010190	0.000930	0.000000	0.000000	0.035200
SSW	0.001390	0.012040	0.018530	0.000460	0.000000	0.000000	0.032420
SW	0.004630	0.027330	0.018060	0.003710	0.000000	0.000000	0.053730
WSW	0.003710	0.032420	0.039830	0.006020	0.003240	0.000000	0.085220
W	0.007870	0.025470	0.029640	0.001390	0.002320	0.000000	0.066700
WNW	0.003710	0.014360	0.004630	0.000930	0.000000	0.000000	0.023620
NW	0.004170	0.010650	0.006020	0.000930	0.000000	0.000000	0.021770
NNW	0.003710	0.009730	0.025470	0.000930	0.000460	0.000000	0.040300
Total	0.075960	0.339510	0.432140	0.122740	0.029180	0.000460	0.999540

Table A.14 - Joint Occurrence Frequencies of Wind Direction Sector by Wind Speed Category for the 61m Level Central Climatology Tower, Spring 2009

Sector	Wind Speed Category, meters/sec						Total
	0-2	2-4	4-6	6-8	8-12	>12	
N	0.003797	0.013346	0.014956	0.003336	0.000000	0.000000	0.035435
NNE	0.003336	0.012425	0.019213	0.003106	0.000000	0.000000	0.038080
NE	0.003682	0.018063	0.024850	0.003221	0.000000	0.000000	0.049816
ENE	0.004027	0.013346	0.015186	0.001841	0.000000	0.000000	0.034400
E	0.004602	0.015301	0.008283	0.001381	0.000115	0.000000	0.029682
ESE	0.003797	0.016797	0.011850	0.001381	0.000230	0.000000	0.034055
SE	0.006328	0.020709	0.013576	0.001035	0.000000	0.000000	0.041648
SSE	0.004947	0.032789	0.055913	0.005752	0.000000	0.000000	0.099401
S	0.004372	0.047975	0.083525	0.004142	0.000000	0.000000	0.140014
SSW	0.004602	0.040382	0.040382	0.006558	0.000115	0.000000	0.092039
SW	0.004832	0.040037	0.034514	0.007478	0.000690	0.000000	0.087551
WSW	0.004487	0.034169	0.048205	0.015301	0.006903	0.000115	0.109180
W	0.003797	0.025886	0.031408	0.018178	0.007248	0.000230	0.086747
WNW	0.005062	0.020479	0.015762	0.011620	0.004947	0.000460	0.058330
NW	0.006673	0.018983	0.010699	0.002071	0.000000	0.000000	0.038426
NNW	0.004487	0.014956	0.005292	0.000460	0.000000	0.000000	0.025195
Total	0.072828	0.385643	0.433614	0.086861	0.020248	0.000805	0.999999

Table A.15 - Joint Occurrence Frequencies of Wind Direction Sector by Wind Speed Category for the 61m Level Central Climatology Tower, Summer 2009

Sector	Wind Speed Category, meters/sec						Total
	0-2	2-4	4-6	6-8	8-12	>12	
N	0.009510	0.022640	0.004530	0.000450	0.000000	0.000000	0.037140
NNE	0.001810	0.012680	0.006340	0.000000	0.000000	0.000000	0.020830
NE	0.005890	0.024000	0.010420	0.000450	0.000000	0.000000	0.040760
ENE	0.004980	0.028990	0.016760	0.000000	0.000000	0.000000	0.050720
E	0.005890	0.033970	0.013590	0.000000	0.000000	0.000000	0.053440
ESE	0.008610	0.023550	0.011780	0.000910	0.000450	0.000000	0.045290
SE	0.006790	0.020830	0.014040	0.000000	0.000000	0.000000	0.041670
SSE	0.003620	0.039860	0.037590	0.000450	0.000000	0.000000	0.081520
S	0.005430	0.050720	0.038950	0.000450	0.000450	0.000000	0.096010
SSW	0.009060	0.038040	0.042120	0.004080	0.000000	0.000000	0.093300
SW	0.004980	0.064760	0.043930	0.003620	0.000450	0.000000	0.117750
WSW	0.007700	0.057070	0.043030	0.003620	0.000450	0.000000	0.111870
W	0.007700	0.042120	0.044840	0.006340	0.000910	0.000000	0.101900
WNW	0.002720	0.024460	0.019470	0.001810	0.000450	0.000000	0.048910
NW	0.005890	0.026720	0.008610	0.000910	0.000000	0.000000	0.042120
NNW	0.004080	0.009510	0.002720	0.000450	0.000000	0.000000	0.016760
Total	0.094660	0.519930	0.358700	0.023550	0.003170	0.000000	0.999550

Table A.16 - Joint Occurrence Frequencies of Wind Direction Sector by Wind Speed Category for the 61m Level Central Climatology Tower, Fall 2009

Sector	Wind Speed Category, meters/sec						Total
	0-2	2-4	4-6	6-8	8-12	>12	
N	0.006410	0.009620	0.012820	0.002290	0.000000	0.000000	0.031140
NNE	0.005040	0.011900	0.007330	0.000000	0.000000	0.000000	0.024270
NE	0.005950	0.016480	0.019230	0.002750	0.000460	0.000000	0.044870
ENE	0.006870	0.018320	0.017860	0.005040	0.000460	0.000000	0.048530
E	0.008700	0.026100	0.028390	0.009620	0.000000	0.000000	0.072800
ESE	0.008700	0.017860	0.021520	0.007780	0.000920	0.000000	0.056780
SE	0.012360	0.030220	0.005490	0.000000	0.000000	0.000000	0.048080
SSE	0.007330	0.020600	0.014190	0.000920	0.000000	0.000000	0.043040
S	0.013740	0.040290	0.020150	0.008700	0.001830	0.000000	0.084710
SSW	0.005490	0.039840	0.034340	0.006410	0.000460	0.000000	0.086540
SW	0.010070	0.049450	0.062730	0.005490	0.000000	0.000000	0.127750
WSW	0.003660	0.046250	0.048530	0.004580	0.000000	0.000000	0.103020
W	0.006870	0.049910	0.041210	0.000920	0.000000	0.000000	0.098900
WNW	0.007780	0.024730	0.016030	0.000460	0.000000	0.000000	0.048990
NW	0.004580	0.018770	0.016030	0.000000	0.000000	0.000000	0.039380
NNW	0.009160	0.016940	0.013280	0.001830	0.000000	0.000000	0.041210
Total	0.122710	0.437270	0.379120	0.056780	0.004120	0.000000	0.999540