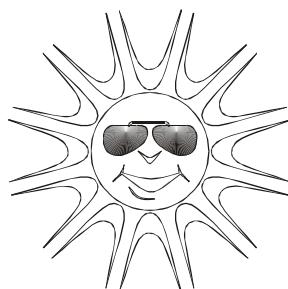


Smithsonian Tropical Research Institute

2004 Meteorological and Hydrological Summary for Barro Colorado Island

Prepared by: Steven Paton



Introduction

This is the eleventh of a series of yearly reports summarising the past year's Smithsonian Tropical Research Institute's Terrestrial-Environmental Sciences Program (T-ESP) Meteorological and Hydrological Monitoring Program on BCI. This report is not meant to be exhaustive in its coverage in that it summaries only some of the most 'important' or interesting parameters available. Any comments on how future yearly summaries could be improved would be appreciated.

Setting

The meteorology and hydrology monitoring programs on BCI are described in detail in Climate and Moisture Variability in a Tropical Forest: Long-term Records from Barro Colorado Island, Panamá. Windsor (1990). Much of the information on the next five pages has been extracted from this source.

BCI ($9^{\circ}10'N$, $79^{\circ}51'W$) is a completely forested, 1567 ha island with a 53.9 km perimeter, rising 137m above Lake Gatun. The island receives an average of 2632 mm of rain per year. The meteorological year is divided into two parts: a pronounced dry season (approximately from mid-December to the end of April), and a wet season (May to mid-December). On average, only 293 mm of rain falls during the dry season. Relative humidity, soil moisture, air pressure, solar radiation, evapotranspiration, wind speed and direction all show marked wet/dry season differences. On the other hand, temperature varies relatively little throughout the year.

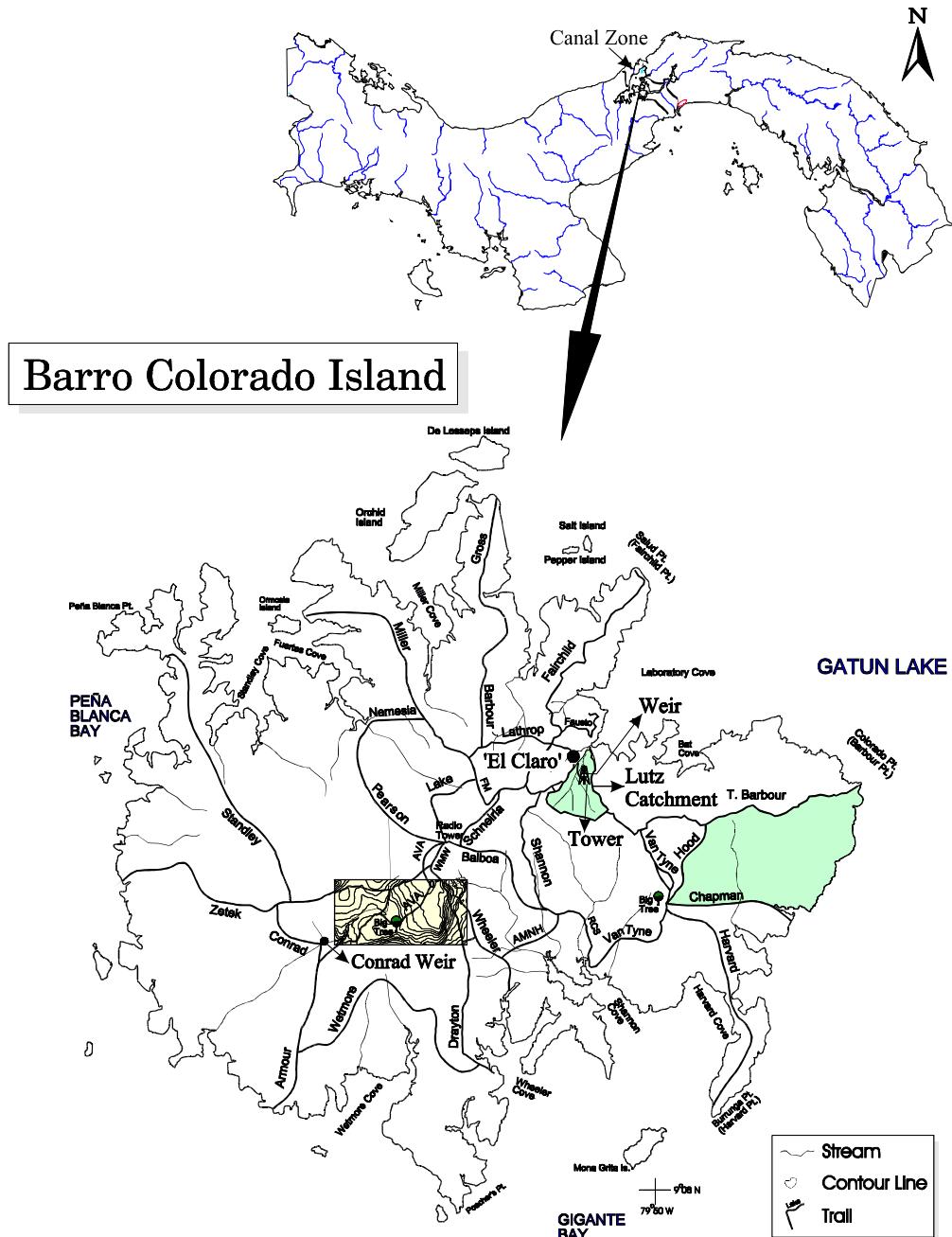
This report summarises data taken from two locations: a 48 m walk-up tower located within the Lutz catchment, and a small clearing ('El Claro') located among several laboratory buildings (see map on the following page). The tower, with sensors at 10 m intervals, provides a vertical meteorological transect through the forest canopy. The Lutz catchment, located on the Northeast slope of BCI, and is probably typical of many small catchment areas on the island. The catchment encompasses 9.73 ha. The Lutz catchment is located immediately southwest of the laboratory clearing and dormitory area. The Clearing is a grass-covered area located near several laboratory buildings.

The physical aspects of both the Clearing and the Tower have changed relatively little over time. However, cycles of vegetation removal and re-growth may have had subtle effects at both locations. The recent removal and construction of buildings near to the Clearing may also have affected the local climate. Furthermore, it is evident that the canopy surrounding the Tower has risen, perhaps by as much as 5m, since the Tower was erected – with possible measurement implications, especially at the highest levels.

In October of 2003, three new, 6-foot sections were added to the top of the tower. It was necessary to remove many banches from trees next to the tower during this operation. The new maximum height of the tower is now approximately 48m. A parallel series of meterological measurements are now being made a both the old maximum height and the

new. The exceptions to this will be: wind direction (it's now not possible to measure at the old height), and solar radiation (assumed to be unaffected by the change in height).

Data were collected using two different methods: electro-mechanically (electronic sensors, data loggers, chart recorders, etc.), and manually (rain gauges, max-min thermometers, sling psychrometers, soil samples, ETGages) by a technician - Mr. Raúl Ríos. In general, manual readings tend to provide the most accurate measurements over the long-term and, as a result, when both types of data are available, the manual readings are used in this report. Some of the disadvantages of these measurements are that they are not available for every day, and they are usually taken only once a day (once a week for soil samples).



Some summaries (temperature, relative humidity, and soil humidity) are based entirely on manual measurements. Other summaries (solar radiation, wind direction) are based entirely on electro-mechanical measurements. Finally, some summaries (rainfall and wind speed) are based on combinations of manual and electro-mechanical measurements.

The Data

This report summarises the following data:

Lutz Tower	1m	relative humidity temperature
	40m	evapotranspiration relative humidity temperature wind speed and direction
	48m	evapotranspiration solar radiation relative humidity temperature wind speed and direction
Lutz catchment		run-off soil moisture
'El Claro'		evapotranspiration rainfall relative humidity temperature

Rainfall

Rainfall was collected by rain gauges in the Clearing, and by tipping buckets in both the Clearing and near the Lutz weir. The rain gauges were read at approximately 9:00 am every day except weekends and holidays. Tipping buckets provide continuous rainfall information, but tend to underestimate total rainfall by between 2% and 12% and for that reason are not used to provide data on absolute rainfall totals. Tipping buckets generate 'events' for every 0.254 mm of rainfall recorded. The underestimation seems to be due to the instruments' inability to properly record intense periods of rainfall. In order to 'fill in' the missing rain gauge data, a computer program was written by the author that uses tipping bucket rainfall data to distribute the rain gauge data for those days when readings were not made. The program takes the total rainfall collected in the rain gauge and divides it up proportionally according to the rainfall patterns recorded by the tipping bucket. The estimated rainfall for the missing days is exactly equal to the rainfall collected by the rain gauge. The daily rainfall for the Clearing is shown on page 8.

Page 9 shows the monthly totals for this year. The graph on the same page compares this year's monthly totals with the average monthly totals ($\pm SD$) for the period 1929 to 2003.

Page 10 shows yearly rainfall totals for all year since 1925. Time series graph and frequency histograms are presented for these data.

Page 11 breaks yearly rainfall approximately into wet and dry seasons. The average beginning and end dates for the seasons as defined by the PCC (Dec. 20 and May 2) were used. The two graphs on this page are frequency histograms showing the distribution of rainfalls (1929 to 2003) for the Dry and Wet Seasons. The arrow → in each graph shows the rainfall for 2004 in relation to previous years. The small crossbar —+— above each graph represents the mean (vertical bar) and the standard deviation (horizontal bar) for the period 1929 - 2003.

Page 12 shows the beginning and end dates of the Panama Canal watershed dry season as defined by the Meteorological and Hydrological Branch of the Panama Canal Authority (PCA). The PCA defines the existence of dry season by tracking 11 variables (see list below). There are no publications justifying the use of this system and any questions should be directed to Mike Hart of the Met. & Hyd. Branch of the Panama Canal Authority. The data from Page 11 are shown graphically on Page 13.

- Westerly Component of 300 HPA Wind
- Gatun Lake Basin evaporation $> 0.13" \text{ day}^{-1}$
- Sea temperature at Amador $< 80^{\circ}\text{F}$
- $< 5 \text{ grams of water vapor kg}^{-1}$ below 12.0 ft
- Temp-Dew point difference SFC-400 HPA., $> 10^{\circ}\text{C}$
- Howard Airforce Base wind speed SFC-4000 ft., $> 15 \text{ knots}$
- Inter-Tropical Convergence Zone $> 2 \text{ deg. Lat. south of Panama}$
- Pacific Coast sea breeze $< 2 \text{ hours day}^{-1}$
- Atlantic Coast surface wind average $> 6.0 \text{ M.P.H.}$
- Gatun Lake level (corrected for water usage) falling
- Gatun Watershed daily rainfall average (of 26 stations) $< .25"$

Pages 14 and 15 show an analysis of rainfall 'events' (*storms*). For convenience, and again somewhat arbitrarily, I have defined a storm as any continuous period of rain separated by at least an hour from any other rainfall. Since this analysis required the timing of rainfall events, tipping bucket data were used. As a result, the absolute size of rainfall events should be considered as only an estimate since they will tend to disproportionately underestimate the size of storms - larger storms will be more underestimated than smaller ones. Keeping this in mind, the tables and graphs on this page compare the maximum storm size and the average storm size and duration per month for the period 1972 to 2003 and for the year 2004.

Run-off

Run-off at the Lutz catchment area was determined from the water level in a 120° V-notch weir. The height of the water was recorded by two separate instruments: continuously by a Stevens A-71 strip-chart, water level recorder and at five-minute intervals with an ISCO Bubble Flow Meter. Data from these devices are converted (either directly or through a digitizing process) into run-off (m^3) and then into rainfall equivalents.

Daily Lutz creek weir run-off totals are shown on page 16. These data are shown in terms of the equivalents of precipitation in mm. These values are calculated by taking the run-off and dividing by the total surface area of the catchment area (9.73 ha). In this way, the run-off can be more conveniently compared to the amount of rainfall.

Pages 17 show the total monthly run-off. The graph on the bottom of page 18 compares average monthly run-off for the period 1973 to 2003 with 2004. The graph on the top of page 18 compares monthly accumulated precipitation with 2004 and long-term monthly accumulated run-off (in rainfall equivalents).

Soil Moisture

Soil moisture was determined gravimetrically based on samples collected every two weeks. Samples are taken at two depths (0-10cm and 30-40cm) from ten sites in the Lutz catchment area. Samples of approximately 2.5 cm soil cores are made with an ‘Oakfield punch’. Page 19 shows the average soil moistures (% water by wet weight of soil) per month at each sample depth. The graph on the same page compares monthly averages for the period 1986 to 2003 with those for 2004.

Relative Humidity

Relative humidity was measured using the traditional method of wet and dry-bulb psychrometry. Measurements in the Clearing, at the base, middle and top of the Lutz tower (1m, 20m and 40m, respectively) were made at approximately 12:30 p.m. using a Taylor Sling Psychrometer. Data were also collected on an hourly basis by dataloggers attached to newly installed Vaisala electronic temperature/humidity sensors. These data are not reported in this yearly summary.

The average monthly relative humidities are shown in tabular and graphical form on pages 20 and 21, respectively.

Temperature

Shaded air temperature was measured in the Clearing, at the base and the top of the Lutz tower by Taylor max-min thermometers. Measurements were made by hand at approximately 930 am. Data were also collected on an hourly basis by dataloggers attached

to Vaisala electronic temperature/humidity sensors. These data are not reported in this yearly summary. The average monthly maximum and minimum temperatures for these three locations are shown in tabular and graphical form on page 22 and 23, respectively.

Solar Radiation

Global solar radiation was measured at the top of the Lutz tower using a Li-Cor LI200SB pyranometer attached to a datalogger. Hourly total (MJ m^{-2}), maximum and minimum ($\text{J m}^{-2} \text{ s}^{-1}$) were recorded. A Li-Cor 190SB sensor recorded Photosynthetically Active Radiation (PAR) similarly.

Page 24 shows the Daily Global Radiation values and Page 25 shows the Daily PAR values for 2004. Page 26 shows total monthly Global Radiation and PAR.

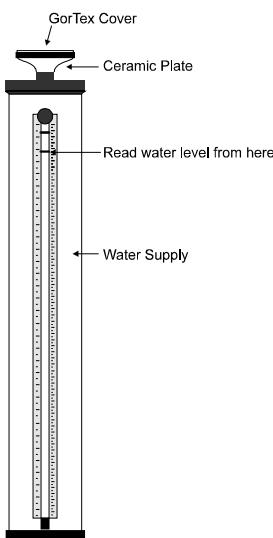
Wind Speed and Direction

Hourly average, maximum and minimum wind speed plus average wind direction was recorded at the top of the Lutz tower using a Model 05035 Young Anemometer connected to a data logger. Total wind passage was recorded on working days at approximately 9:30 am using an analogue totalizing anemometer. This device is believed to be more accurate than the Young Anemometer, especially during periods of low wind speeds due to totalizing anemometer's lower wind-speed threshold.

Page 27 shows the total daily wind passage from 40m and 48m. Page 28 shows average and maximum daily wind speeds from the Young Anemometer located at 48m. The page 29 shows daily average wind direction. The angles indicated in the table and graph on this page represent the direction into which the wind was predominately blowing on a given day. Page 30 shows the monthly average wind speed (based on the totalizing anemometer) from 40m and 48m, and monthly average directions (Young Anemometer) for the year.

Estimated Evapotranspiration and Water Balance

ETguage



Evapotranspiration was added to the meteorological program on BCI beginning on December of 1992 and is estimated using ceramic plate atmometers known as ETgages. ETgages estimate evapotranspiration by allowing water to be drawn up through a ceramic disk and out through a GorTex cover. A recent study by Fontain and Todd (Measuring Evaporation with Ceramic Bellani Plate Atmometers, 1993, Water Resources Bulletin, Vol. 29, No. 5, p. 785-795) found that such devices perform very well compared with more traditional methods of measuring evaporation.

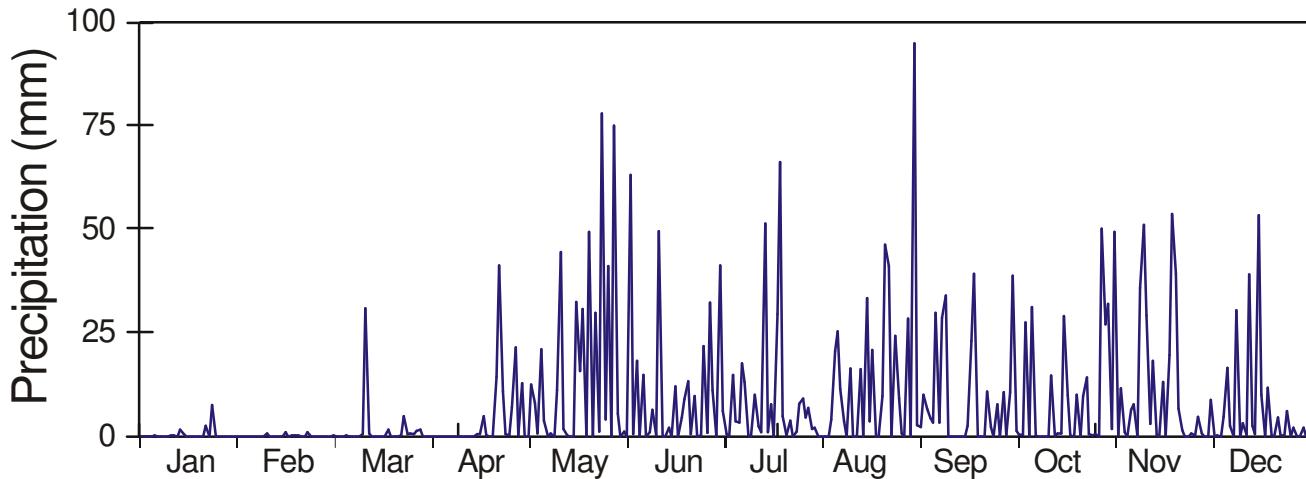
There are two ETgages currently being used on BCI: one in the Clearing located at a height of 1.5m and a second on the top of the 40m tower near the Lutz weir. ETgages are read at approximately the same time of day and with the same frequency and the rain gauges on BCI.

The data from the ETgages are used to estimate the total water balance for the Lutz catchment. Water balance is calculated as: Rainfall - Weir run-off - Evapotranspiration.

The results from the ETgages and the estimated water balance (Precipitation - (Run Off + Evapotranspiration)) for the Lutz Tower for from Nov. 1993 to the end of 2004 are given on pages 31 and 32.

Daily Rainfall (mm) on BCI recorded at ~930 hrs

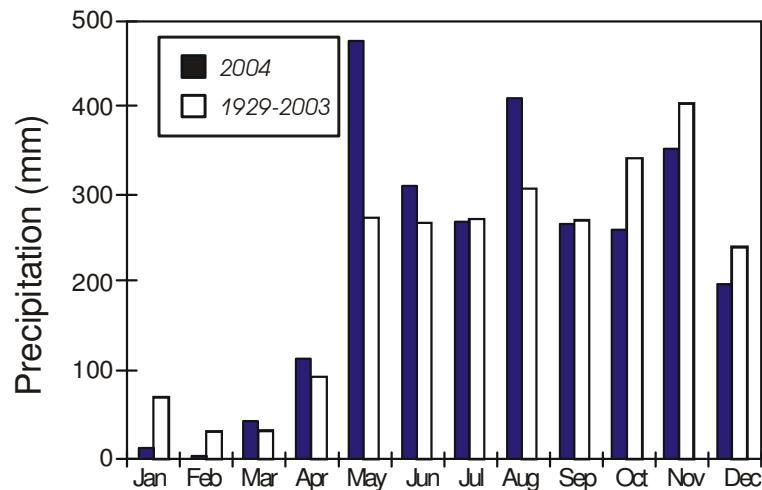
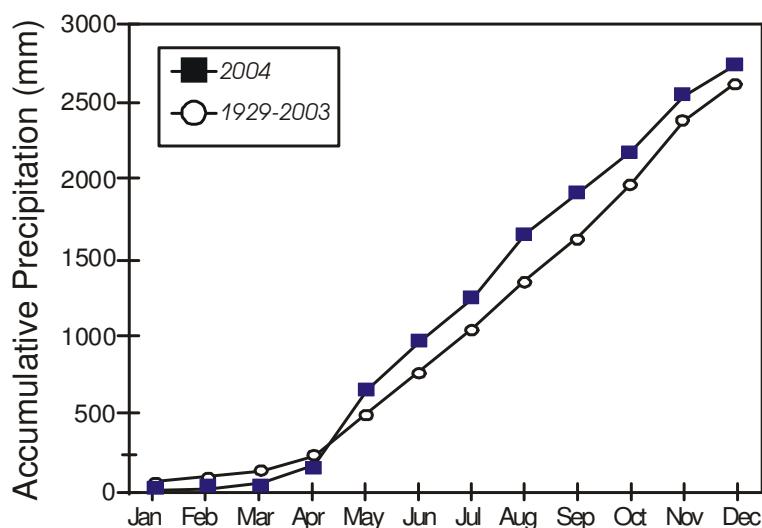
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1	0.0	0.0	0.3	0.0	0.0	0.0	6.1	0.0	2.2	1.3	49.4	8.9
2	0.0	0.0	0.0	0.0	12.5	63.2	0.6	0.0	10.0	0.3	0.3	0.0
3	0.0	0.0	0.0	0.0	8.1	0.5	0.0	0.0	6.6	0.3	11.7	0.3
4	0.0	0.0	0.0	0.0	0.8	18.3	15.0	4.1	4.4	27.6	1.0	0.0
5	0.3	0.0	0.3	0.0	21.1	0.0	3.5	20.6	3.2	0.0	0.0	4.8
6	0.0	0.0	0.0	0.0	3.8	15.0	3.3	25.4	30.0	31.2	6.4	16.6
7	0.0	0.0	0.0	0.0	0.0	0.0	17.8	11.6	3.3	0.3	7.8	2.5
8	0.0	0.0	0.0	0.0	0.6	1.0	13.2	3.7	28.7	0.0	0.0	0.0
9	0.0	0.8	0.0	0.0	0.0	6.4	0.3	0.0	34.0	0.0	35.8	30.5
10	0.3	0.0	0.5	0.0	11.3	0.3	0.0	16.5	0.0	0.0	51.3	0.0
11	0.3	0.0	31.0	0.0	44.7	49.8	10.2	0.0	0.0	0.0	29.2	3.1
12	0.0	0.0	0.8	0.0	1.8	0.0	2.5	0.0	0.0	14.7	3.0	0.3
13	1.5	0.0	0.0	0.0	0.3	0.0	1.0	16.3	0.0	0.0	18.2	39.2
14	0.5	0.0	0.0	0.0	0.0	2.0	51.6	0.0	0.0	0.8	0.3	2.5
15	0.0	1.0	0.0	0.5	0.0	0.0	1.0	33.5	0.0	0.8	0.0	0.5
16	0.0	0.0	0.0	0.5	32.5	12.2	7.9	3.6	2.5	29.1	13.2	53.6
17	0.0	0.3	0.0	4.8	15.8	0.0	0.0	20.8	23.1	10.0	0.3	10.2
18	0.0	0.3	1.5	0.3	30.7	4.6	29.5	0.0	39.4	0.3	19.8	0.0
19	0.0	0.3	0.0	0.0	0.0	9.0	66.5	0.0	0.0	0.0	53.8	11.9
20	0.0	0.0	0.0	0.0	49.5	13.3	4.8	9.9	0.0	10.2	39.4	0.3
21	2.5	0.0	0.0	14.5	0.0	0.6	0.3	46.4	0.0	0.0	6.6	0.0
22	0.0	1.0	0.3	41.4	29.9	9.9	3.8	41.2	10.9	9.9	1.5	4.6
23	7.6	0.0	4.8	10.9	1.2	0.0	0.0	0.0	2.3	14.4	0.0	0.3
24	0.0	0.0	0.5	0.5	78.1	0.3	1.2	24.4	0.0	0.6	0.0	0.3
25	0.0	0.0	0.8	0.3	4.1	21.8	8.0	9.1	7.9	0.3	0.8	6.1
26	0.0	0.0	0.5	7.1	41.1	0.9	9.1	0.8	0.0	0.5	0.3	0.0
27	0.0	0.0	1.4	21.6	0.0	32.4	4.6	0.0	10.6	0.0	4.8	2.0
28	0.0	0.0	1.7	0.3	75.2	11.2	6.9	28.5	0.3	50.3	0.8	0.0
29	0.0	0.0	0.0	13.0	5.5	0.0	1.8	0.0	10.7	27.2	0.0	0.0
30	0.0	0.0	0.0	0.0	0.0	41.4	2.0	95.2	38.9	32.1	0.0	2.0
31	0.0	0.0			1.1	0.0	2.8		1.8		0.0	
	13.0	3.6	44.2	115.6	469.6	313.9	272.3	414.3	269.0	263.7	355.8	200.4



Monthly Rainfall at 'El Claro' - Rain Guage

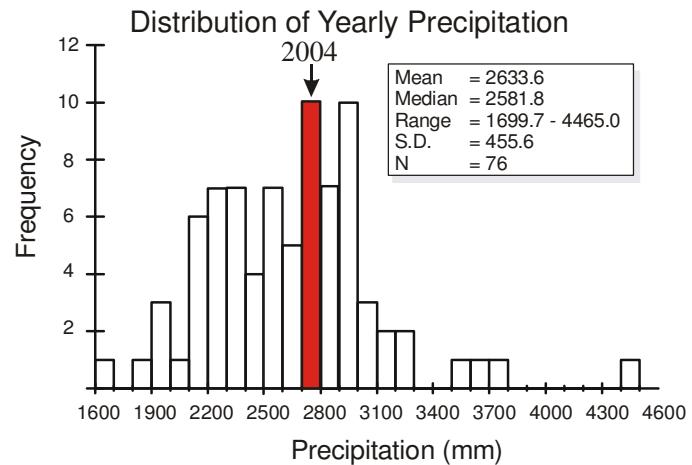
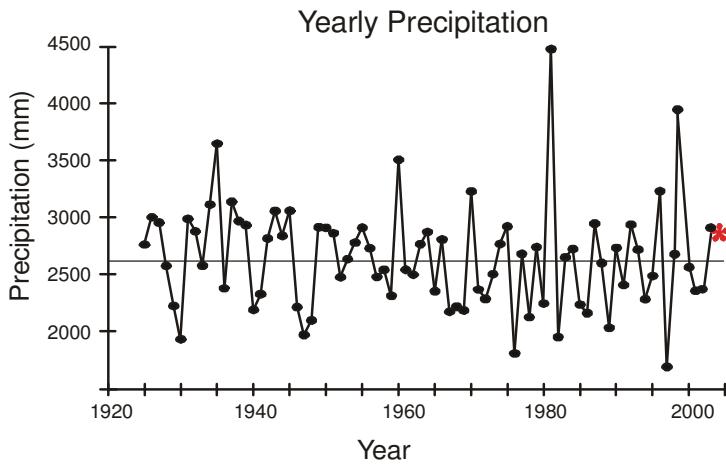
Rainfall (mm)

	Average	Min	Max	S.D.	2004	Rank (n=76)
January	70.8	0.0	374.0	76.3	13.0	64
February	31.7	0.5	186.4	34.1	3.6	68
March	33.3	0.0	173.7	36.4	44.2	22
April	93.6	0.0	463.8	87.0	115.6	25
May	276.6	78.5	622.0	100.3	479.7	4
June	271.2	66.8	541.0	87.8	313.9	22
July	274.7	92.0	725.9	96.5	272.3	37
August	309.5	149.6	586.0	91.8	414.3	9
September	273.3	130.8	507.0	86.1	269.0	39
October	344.9	153.9	544.0	94.8	263.7	57
November	408.6	110.0	1056.1	189.3	355.8	44
December	243.8	15.9	712.7	176.3	200.4	38
Total	2632.1	1699.7	4465.0	458.5	2745.5	30



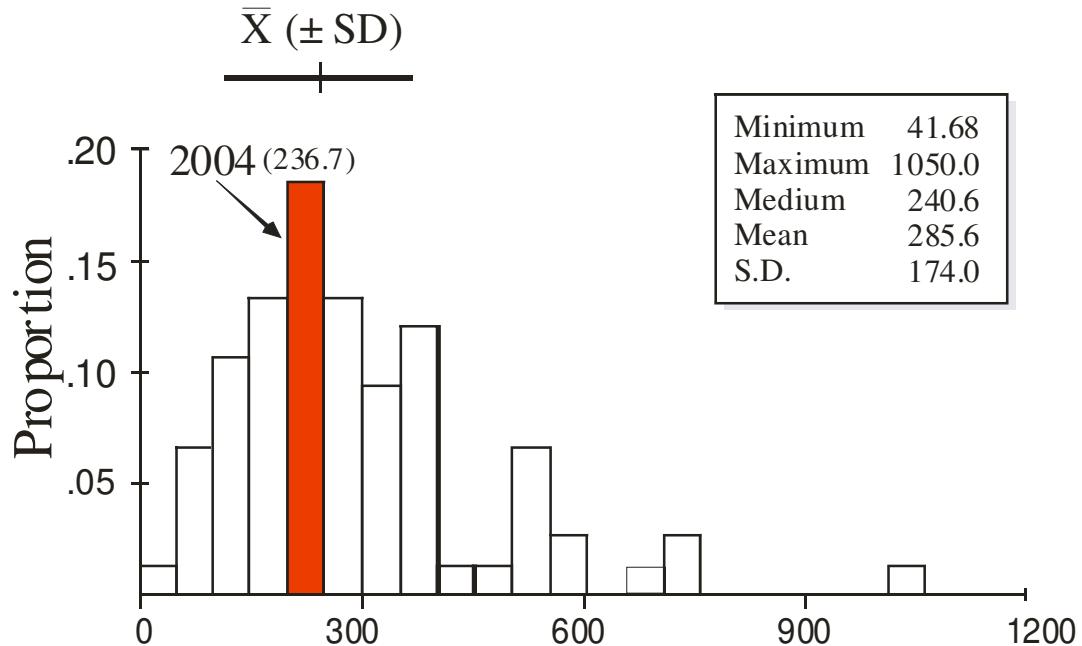
Yearly Rainfall (mm) at 'El Claro' - Rain Gauge

Year	Rain	Year	Rain	Year	Rain
1925	2764.0	1952	2481.6	1979	2742.0
1926	3003.0	1953	2637.5	1980	2252.0
1927	2956.1	1954	2684.3	1981	4465.0
1928	2579.1	1955	2910.3	1982	1960.0
1929	2228.3	1956	2729.7	1983	2654.0
1930	1940.6	1957	2482.1	1984	2726.0
1931	2981.5	1958	2545.1	1985	2242.0
1932	2878.6	1959	2317.0	1986	2167.6
1933	2581.9	1960	3500.4	1987	2955.2
1934	3109.5	1961	2545.6	1988	2602.9
1935	3642.6	1962	2373.4	1989	2176.2
1936	2384.3	1963	2767.1	1990	2767.5
1937	3117.6	1964	2875.3	1991	2642.4
1938	2969.0	1965	2357.1	1992	3047.5
1939	2932.9	1966	2807.7	1993	2729.2
1940	2195.8	1967	2181.4	1994	2285.2
1941	2332.2	1968	2223.5	1995	2531.1
1942	2816.9	1969	2192.5	1996	3227.8
1943	3055.4	1970	3141.2	1997	1699.7
1944	2838.7	1971	2373.6	1998	2683.8
1945	3058.9	1972	2292.0	1999	3726.1
1946	2221.0	1973	2506.0	2000	2550.2
1947	1978.2	1974	2770.0	2001	2331.2
1948	2105.7	1975	2923.0	2002	2300.6
1949	2916.2	1976	1818.0	2003	2891.8
1950	2908.3	1977	2685.0	2004	2745.5
1951	2863.8	1978	2132.0		

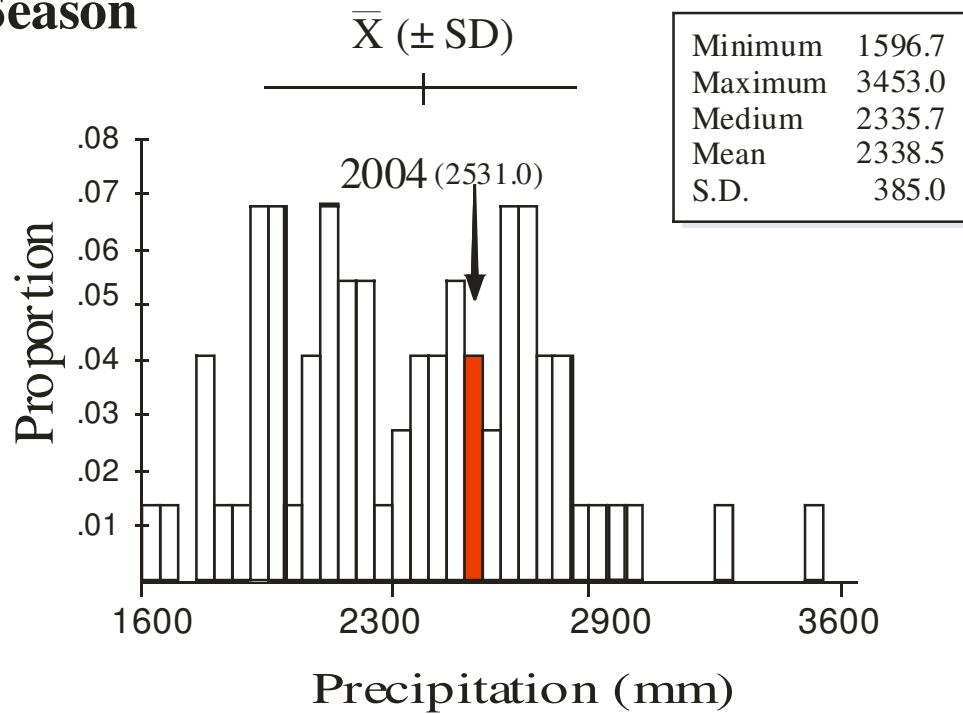


Seasonal Distribution of Precipitation

Dry Season



Wet Season



PCC Dry Season Beginning and End Dates

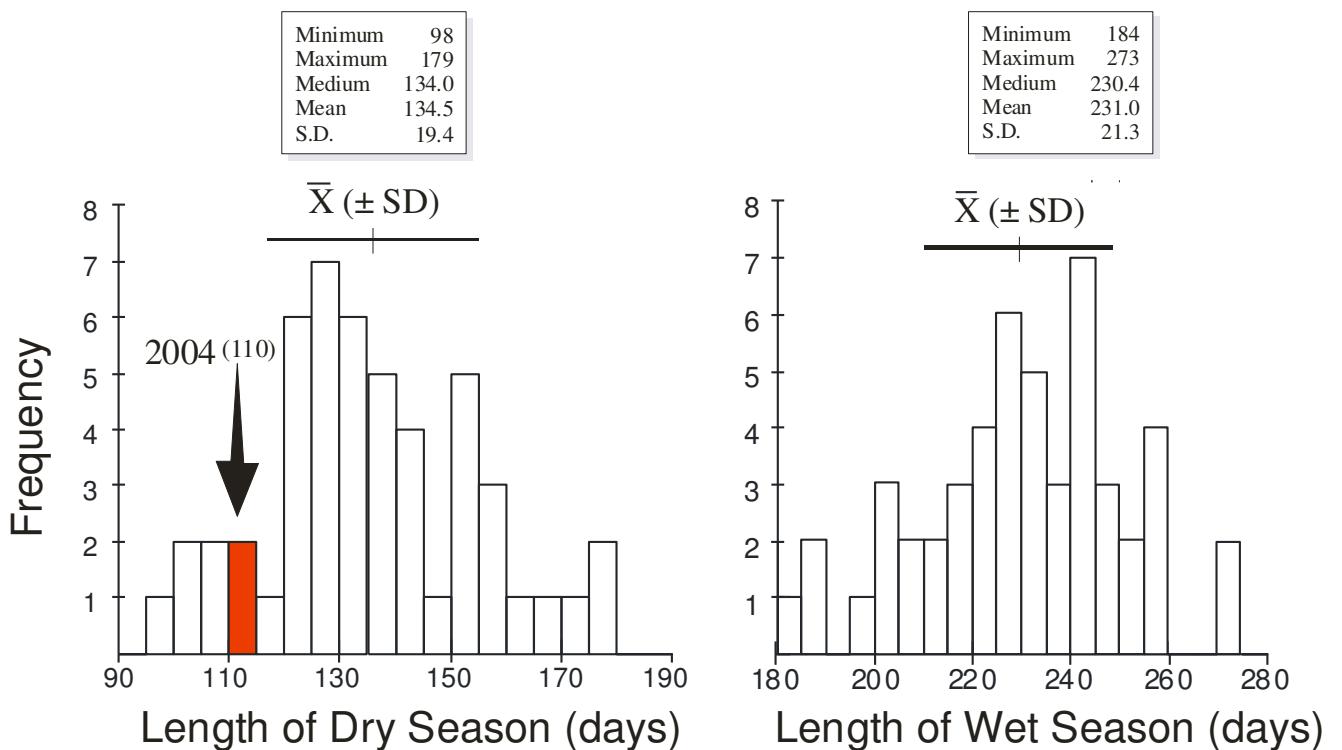
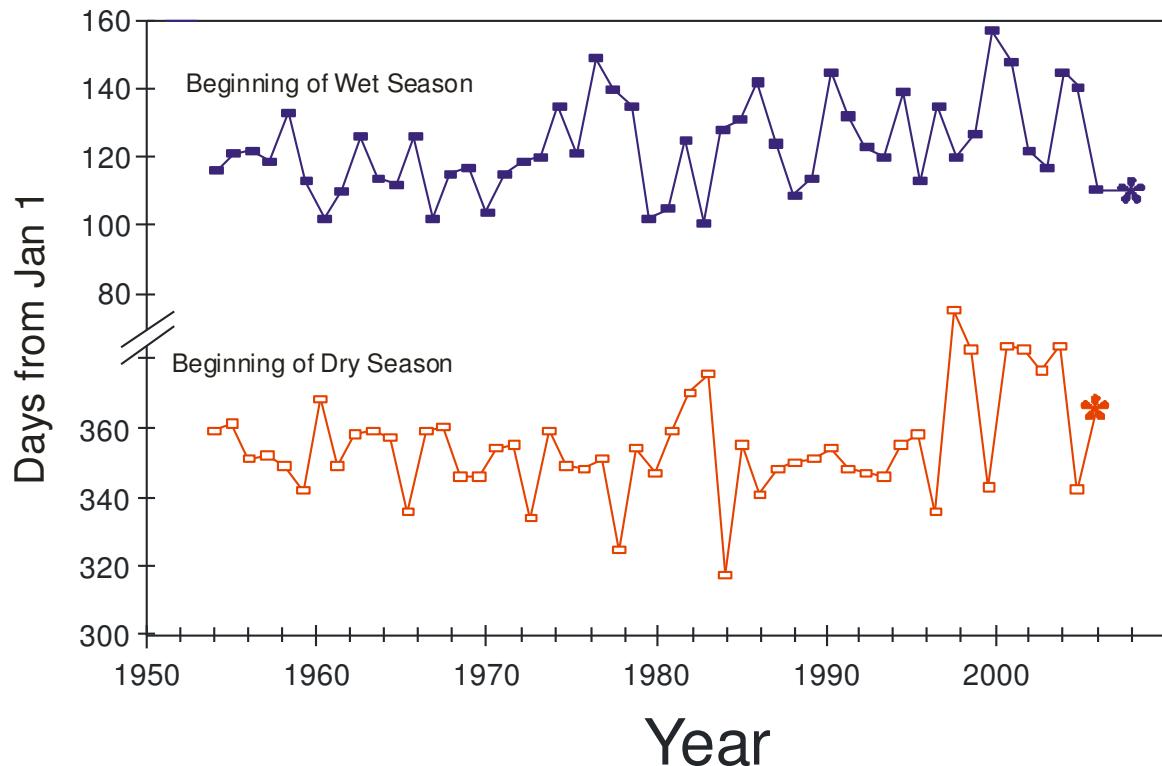
Year	Begin	End	Length		Year	Begin	End	Length		
			Dry Season	Wet Season				Dry Season	Wet Season	
1954	25-Dec-1953	27-Apr-1954	123	244		1998	09-Dec-1997	29-May-1998	171	234
1955	27-Dec-1954	02-May-1955	126	229		1999	18-Jan-1999	3-May-1999	105	259
1956	17-Dec-1955	02-May-1956	137	229		2000	17-Jan-2000	27-Apr-2000	101	258
1957	17-Dec-1956	30-Apr-1957	134	229		2001	10-Jan-2001	26-May-2001	136	237
1958	15-Dec-1957	14-May-1958	150	208		2002	18-Jan-2002	21-May-2002	123	201
1959	08-Dec-1958	24-Apr-1959	137	254		2003	08-Dec-2002	21-Apr-2003	134	253
1960	03-Jan-1960	12-Apr-1960	100	246		2004	30-dec-2004	21-Apr-2004	113	
1961	14-Dec-1960	21-Apr-1961	128	247		2005				
1962	24-Dec-1961	07-May-1962	134	232						
1963	25-Dec-1962	25-Apr-1963	121	243						
1964	24-Dec-1963	22-Apr-1964	120	223						
1965	01-Dec-1964	07-May-1965	157	232						
1966	25-Dec-1965	13-Apr-1966	109	257						
1967	26-Dec-1966	26-Apr-1967	121	230						
1968	12-Dec-1967	27-Apr-1968	137	228						
1969	11-Dec-1968	15-Apr-1969	125	249						
1970	20-Dec-1969	26-Apr-1970	127	239						
1971	21-Dec-1970	30-Apr-1972	130	214						
1972	30-Nov-1972	30-Apr-1972	152	238						
1973	24-Dec-1972	16-May-1973	143	213						
1974	15-Dec-1973	02-May-1974	138	226						
1975	14-Dec-1974	30-May-1975	167	201						
1976	17-Dec-1975	20-May-1976	155	184						
1977	20-Nov-1976	16-May-1977	177	218						
1978	20-Dec-1977	13-Apr-1978	114	244						
1979	13-Dec-1978	16-Apr-1979	124	253						
1980	25-Dec-1979	05-May-1980	132	244						
1981	04-Jan-1981	12-Apr-1981	98	273						
1982	10-Jan-1982	09-May-1982	119	189						
1983	14-Nov-1982	12-May-1983	179	223						
1984	21-Dec-1983	22-May-1984	153	198						
1985	06-Dec-1984	05-May-1985	150	223						
1986	14-Dec-1985	20-Apr-1986	127	240						
1987	16-Dec-1986	25-Apr-1987	130	236						
1988	17-Dec-1987	25-May-1988	160	208						
1989	19-Dec-1988	13-May-1989	145	215						
1990	14-Dec-1989	04-May-1990	141	223						
1991	13-Dec-1990	01-May-1991	139	225						
1992	12-Dec-1991	19-May-1992	159	215						
1993	20-Dec-1992	24-Apr-1993	125	244						
1994	24-Dec-1993	16-May-1994	143	200						
1995	02-Dec-1994	01-May-1995	150	272						
1996	27-Jan-1996	07-May-1996	101	255						
1997	17-Jan-1997	07-Jun-1997	141	185						

Avg 20-Dec
SD ±15 days

03-May
135.2 230.4

±14 days 19.4 21.3

Seasonality Distribution



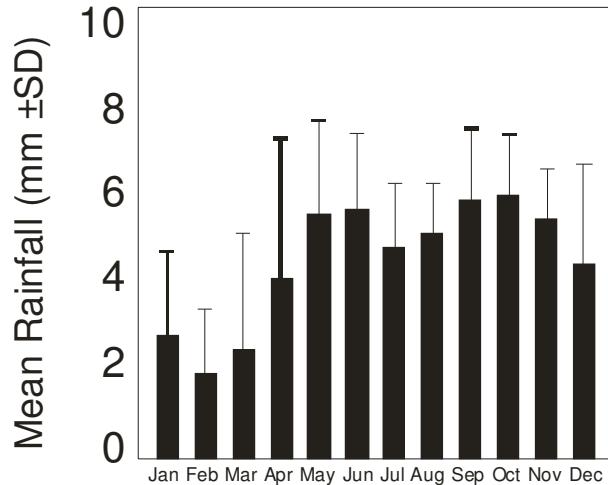
Storm Analysis

	Max. Rainfall per Storm (mm)			Storm Duration (min.)		
	1984-2003		2004	1984-2003		2004
	Mean	S.D.		Mean	S.D.	
January	23.9	26.0	5.6	32.4	17.2	13.3
February	11.9	11.8	0.8	29.2	24.4	16.3
March	13.7	15.0	17.8	39.2	40.4	62.5
April	32.7	32.5	31.8	45.8	36.0	34.3
May	54.0	27.4	63.0	55.4	14.2	55.1
June	53.7	22.4	42.7	55.2	9.6	61.2
July	47.8	18.6	58.9	47.3	9.2	46.6
August	48.0	16.3	81.5	47.4	10.0	53.2
September	51.1	19.8	33.5	55.6	11.3	60.7
October	50.3	21.1	40.6	55.7	12.4	57.0
November	47.9	15.3	30.2	54.2	14.9	70.8
December	42.7	24.3	30.0	43.3	18.9	44.6

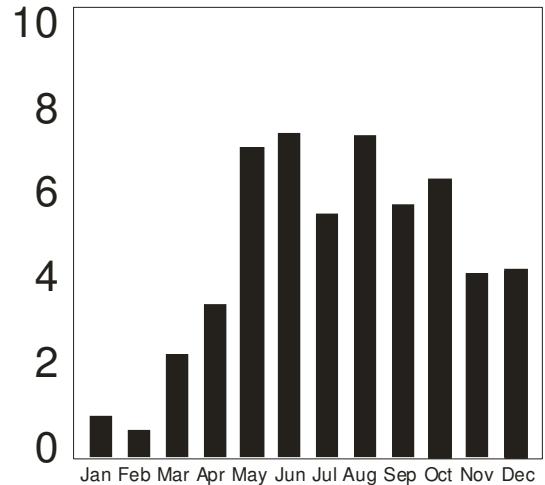
	Av. Rainfall per Storm (mm)		
	1984-2003		2004
	Mean	S.D.	
January	2.7	1.9	0.9
February	1.9	1.4	0.6
March	2.4	2.6	2.3
April	4.0	3.1	3.4
May	5.4	2.1	6.9
June	5.5	1.7	7.2
July	4.7	1.4	5.4
August	5.0	1.1	7.2
September	5.7	1.6	5.6
October	5.8	1.4	6.2
November	5.3	1.1	4.1
December	4.3	2.2	4.2

Average Monthly Storm Size

1984-2003

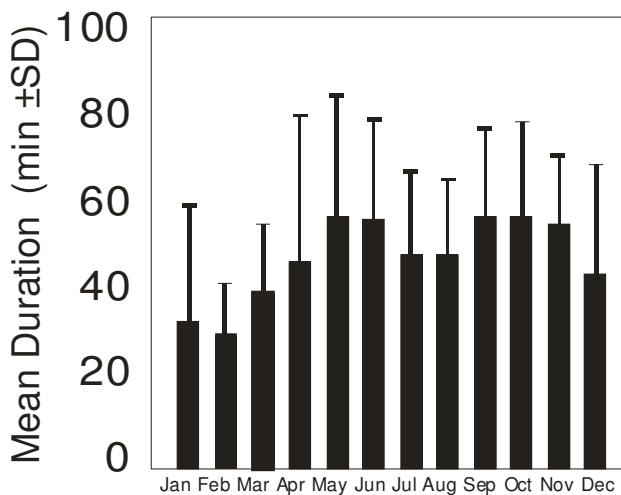


2004

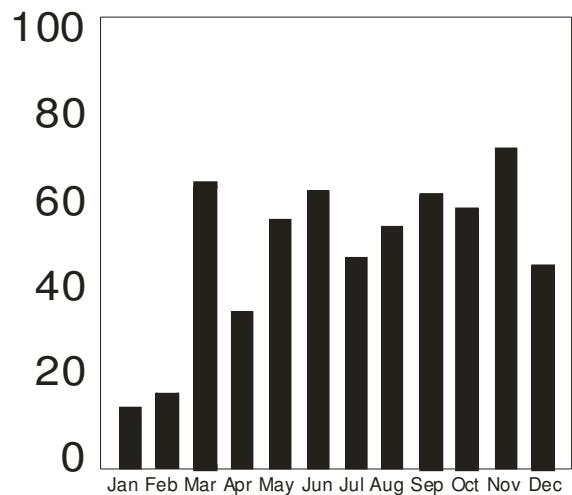


Average Monthly Storm Duration

1984-2003

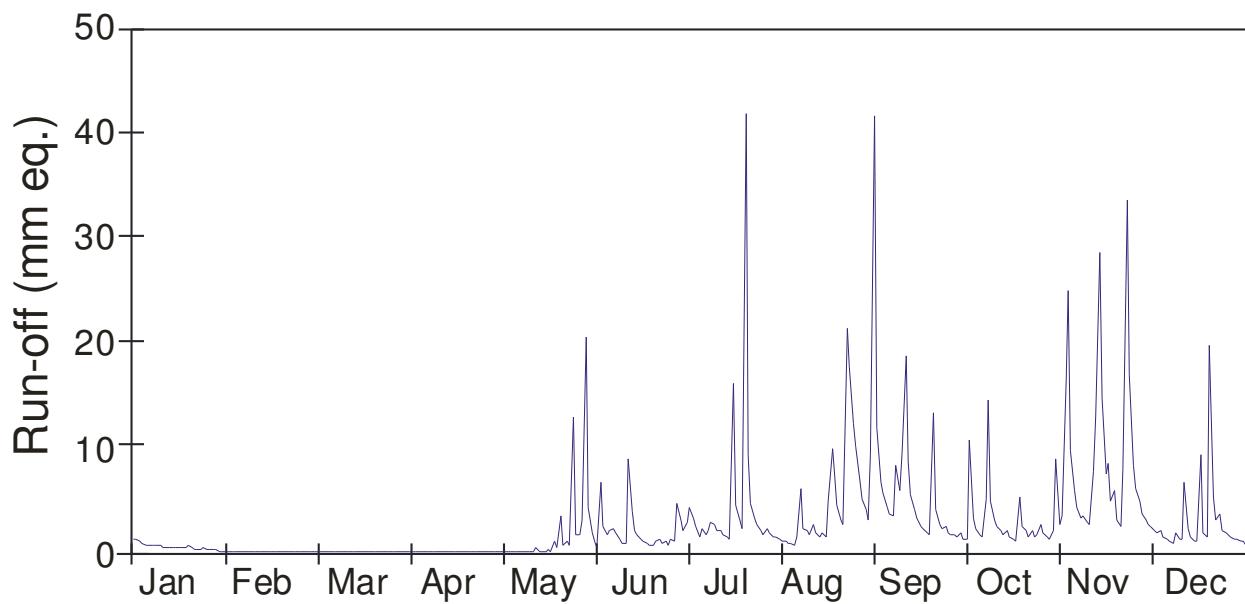


2004



Daily Lutz Weir Run-off (mm .eq.)

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1	1.3	0.2	0.0	0.0	0.0	6.7	3.2	0.9	5.8	2.2	9.8	1.5
2	1.2	0.2	0.0	0.0	0.0	2.5	2.5	0.8	4.4	1.7	6.0	1.3
3	1.1	0.1	0.0	0.0	0.0	1.8	1.5	0.8	3.7	1.4	4.4	1.1
4	0.8	0.1	0.0	0.0	0.1	2.1	2.2	1.5	3.4	5.1	3.4	1.0
5	0.7	0.1	0.0	0.0	0.0	2.2	1.7	6.2	8.4	14.5	3.5	1.8
6	0.8	0.1	0.0	0.0	0.0	2.0	2.2	2.3	5.9	4.8	3.0	1.3
7	0.7	0.1	0.0	0.0	0.0	1.2	3.0	2.2	9.5	3.1	2.6	1.2
8	0.7	0.1	0.0	0.0	0.0	0.9	2.8	1.7	18.7	2.4	7.8	6.8
9	0.6	0.1	0.0	0.0	0.0	0.9	2.1	2.7	8.7	2.0	12.9	2.2
10	0.6	0.1	0.0	0.0	0.0	9.0	2.0	1.9	5.5	1.7	28.5	1.4
11	0.5	0.1	0.1	0.0	0.5	4.0	1.8	1.5	4.1	2.2	14.7	1.1
12	0.5	0.1	0.0	0.0	0.1	2.1	1.5	1.8	3.2	1.5	7.5	1.0
13	0.5	0.1	0.0	0.0	0.0	1.7	1.3	1.4	2.6	1.3	8.6	9.4
14	0.5	0.1	0.0	0.0	0.0	1.3	16.0	4.9	2.2	1.1	4.8	2.0
15	0.5	0.1	0.0	0.0	0.2	1.1	4.5	9.9	1.9	5.4	5.8	1.5
16	0.5	0.1	0.0	0.0	0.1	0.9	3.1	7.5	1.8	2.5	3.1	19.8
17	0.5	0.1	0.0	0.0	1.1	0.7	2.3	4.6	13.4	2.1	2.4	5.3
18	0.6	0.1	0.0	0.0	0.4	0.8	41.9	3.0	4.1	1.5	8.0	3.0
19	0.6	0.1	0.0	0.0	3.5	1.1	9.3	2.7	2.8	2.2	33.6	3.7
20	0.4	0.1	0.0	0.0	0.7	1.3	4.7	21.4	2.2	1.5	17.0	2.1
21	0.3	0.1	0.0	0.0	1.0	0.9	3.3	17.8	2.6	1.8	8.3	1.8
22	0.3	0.1	0.0	0.1	0.7	1.0	2.6	12.3	1.8	2.7	6.2	1.7
23	0.4	0.1	0.0	0.0	12.9	0.8	2.1	10.1	1.6	1.9	4.8	1.5
24	0.4	0.1	0.0	0.0	1.8	1.2	1.7	6.9	1.6	1.6	3.8	1.3
25	0.3	0.1	0.0	0.0	1.7	1.1	2.2	5.2	1.4	1.3	3.2	1.4
26	0.3	0.1	0.0	0.1	3.1	4.8	1.8	4.0	1.9	2.2	2.7	1.1
27	0.3	0.1	0.0	0.0	20.6	3.1	1.6	3.2	1.3	9.0	2.5	1.0
28	0.2	0.0	0.0	0.0	4.4	2.0	1.6	9.4	1.4	2.7	2.0	0.4
29	0.2	0.1	0.0	0.0	1.8	3.0	1.3	41.7	10.7	3.5	1.8	
30	0.2	0.0	0.0	1.0	4.2	1.1	11.9	3.2	16.5	2.1		
31	0.2	0.0		0.5		1.0	6.7		24.9			

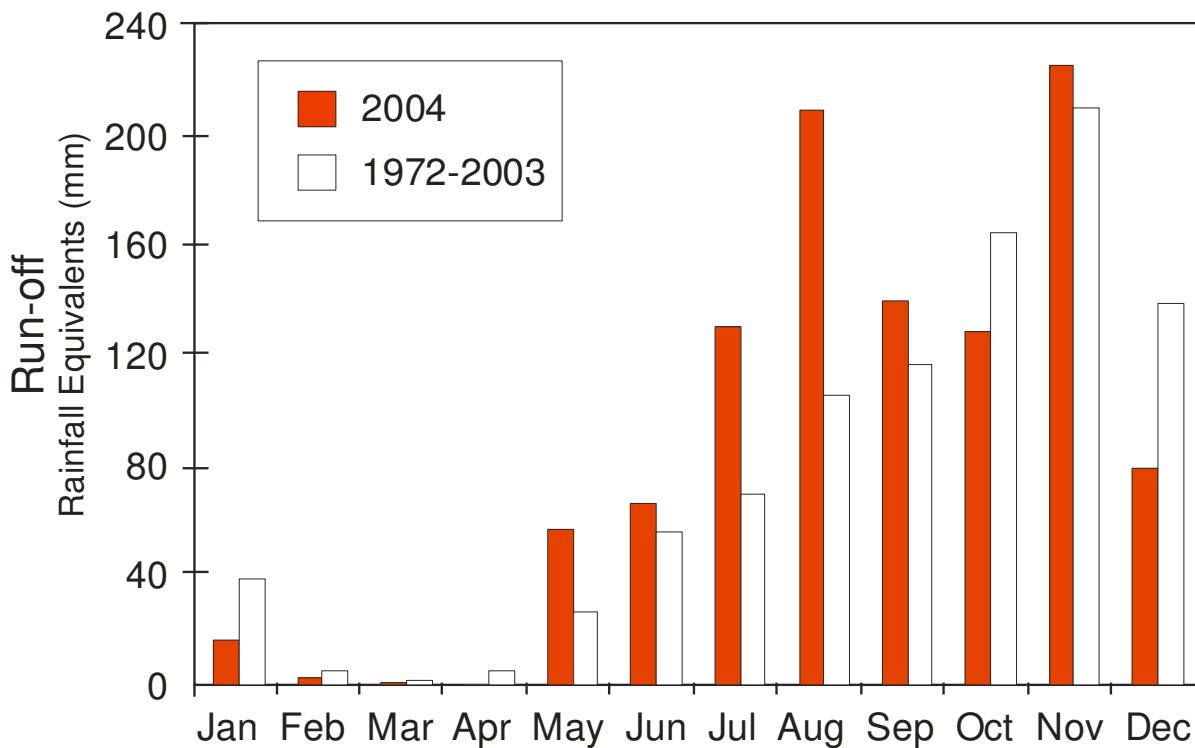
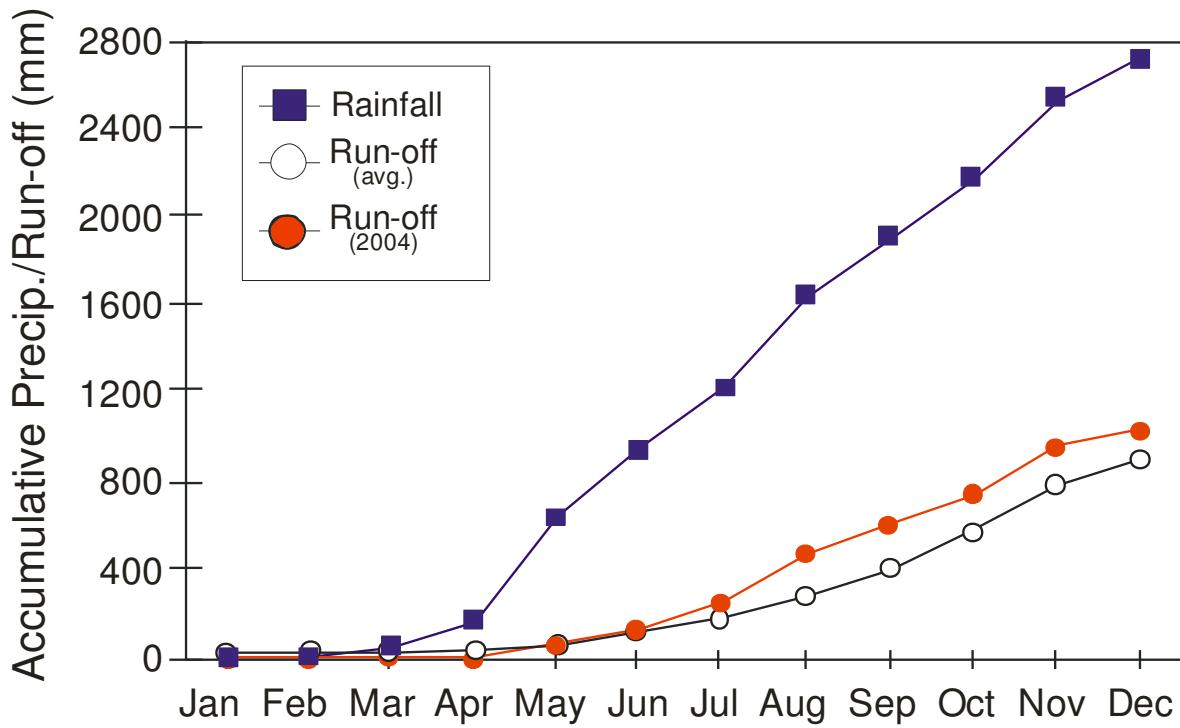


Monthly Run-off at Lutz Weir

Run-off (mm eq.)

	Long-term Averages (1972 - 2003)		2004
	Total	S.D.	Total
January	39.4	62.8	16.6
February	5.5	10.2	2.7
March	1.8	2.5	0.7
April	5.6	19.9	0.4
May	25.4	42.9	56.8
June	55.2	72.0	66.3
July	67.6	51.7	129.7
August	102.4	75.2	208.8
September	115.9	69.1	139.7
October	165.9	85.8	128.2
November	209.4	105.9	224.7
December	138.5	122.5	78.9
Total	943.6	428.4	1053.5

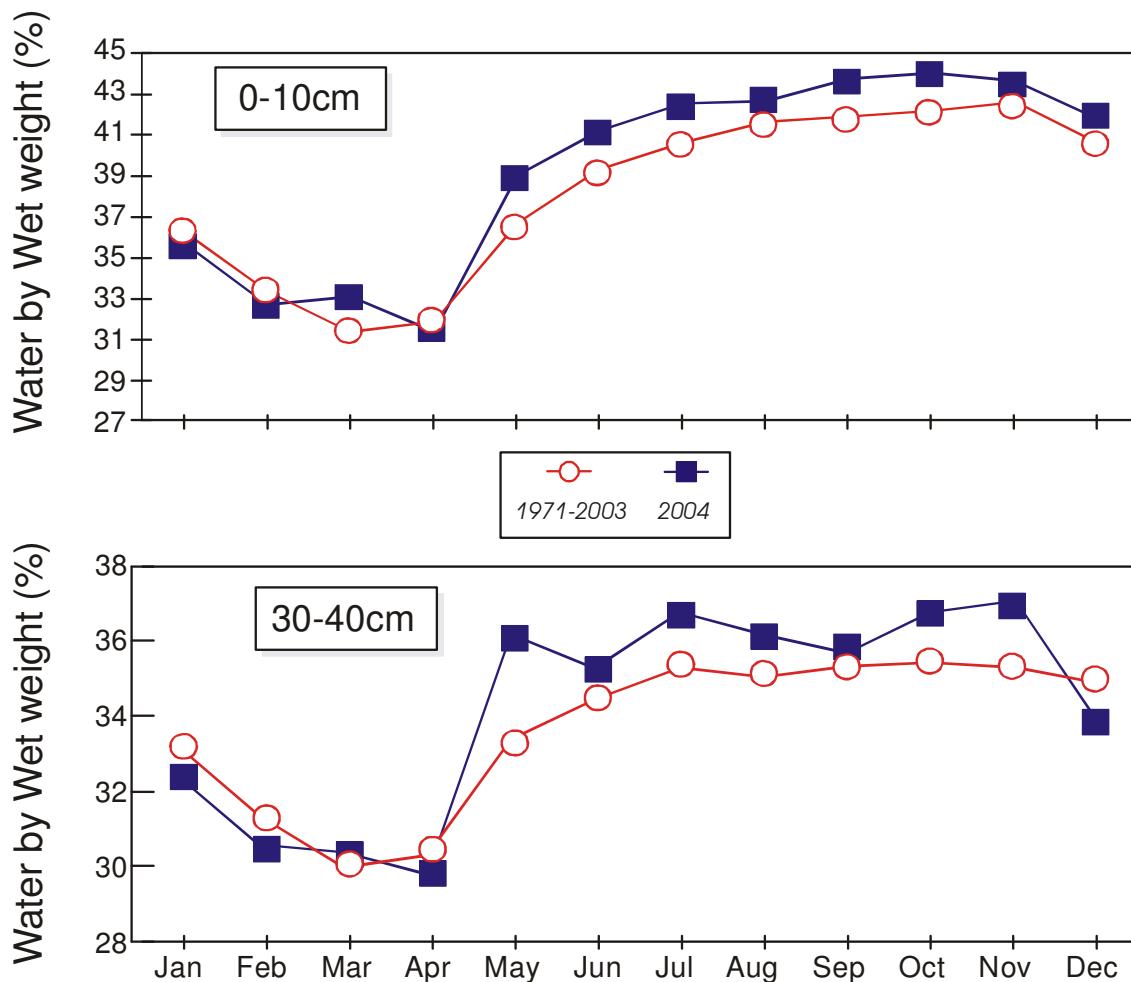
Monthly run-off at Lutz Weir



Lutz Catchment Soil Moisture

(H₂O/wet wt of soil)

	Long-term Averages (1972-2003)				2004	
	0-10 cm		30-40 cm		0-10 cm	30-40 cm
	Mean	S.D.	Mean	S.D.		
January	36.3	3.2	33.3	2.6	35.7	32.5
February	33.4	2.4	31.3	1.4	32.7	32.5
March	31.4	2.2	30.0	1.3	33.1	30.4
April	31.9	2.4	30.3	1.6	31.4	29.8
May	36.7	2.3	33.3	1.4	39.0	36.2
June	39.3	1.6	34.4	1.0	41.2	35.3
July	40.6	1.4	35.3	1.3	42.5	36.8
August	41.6	1.8	35.0	0.7	42.6	36.2
September	41.9	1.5	35.3	1.0	43.7	35.7
October	42.2	1.7	35.4	0.9	44.0	36.8
November	42.6	1.6	35.3	1.1	43.6	37.1
December	40.5	2.9	34.9	1.8	41.7	33.8



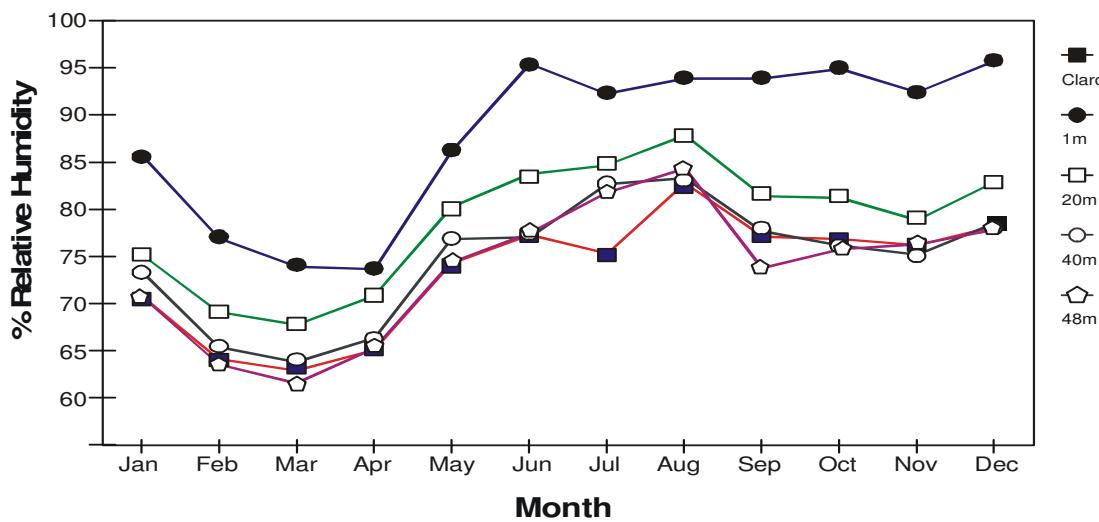
Relative Humidity (%)

Long-term Averages (1972-2003)

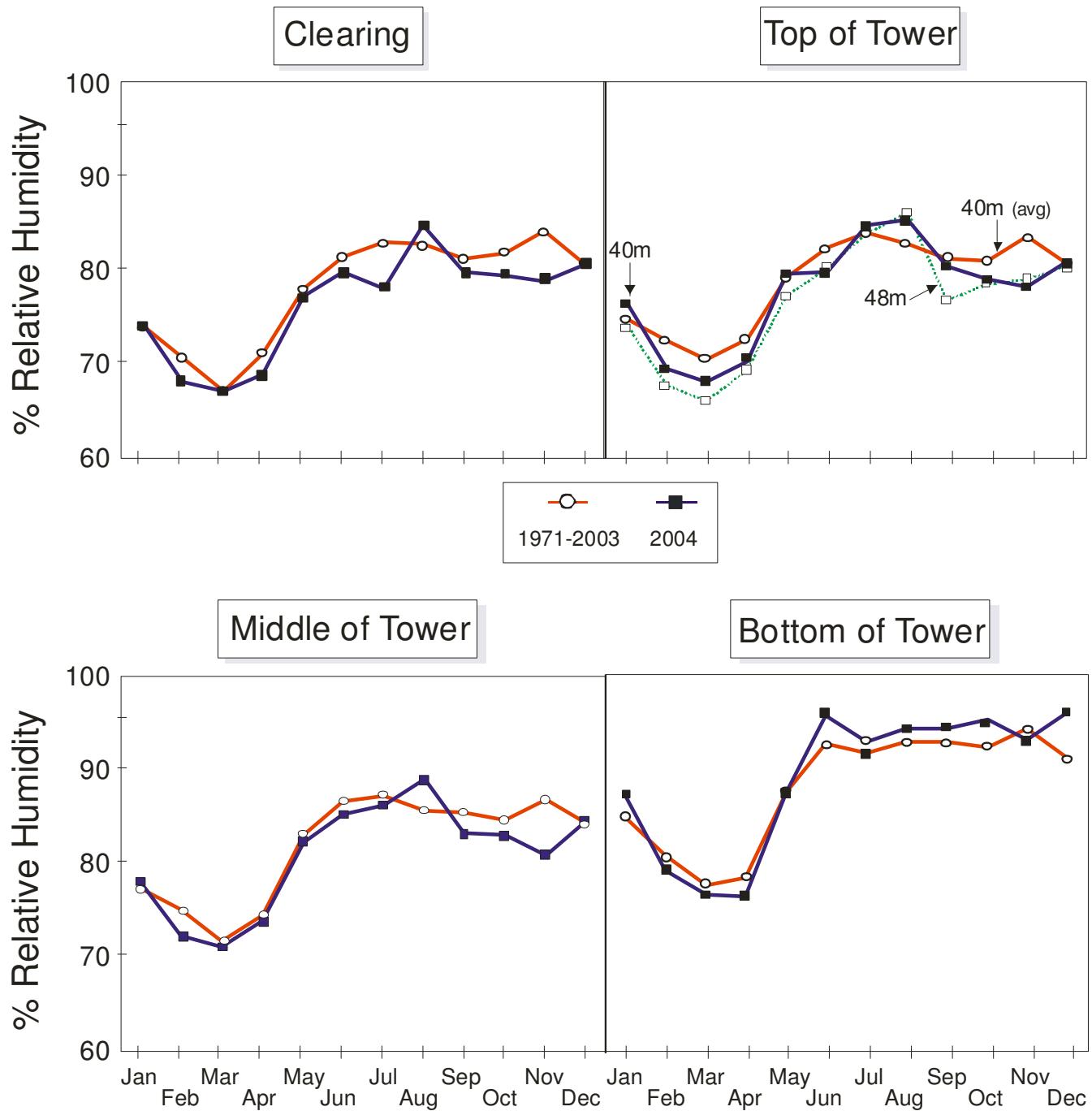
	'El Claro'		1m		20m		40m		48m	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
January	74.1	4.4	85.3	3.6	77.6	3.9	74.6	3.4	72.9	2.9
February	70.7	3.9	80.9	3.7	75.3	3.7	72.3	3.9	69.7	0.3
March	67.1	4.1	77.8	4.2	72.0	3.7	70.4	3.1	67.4	6.2
April	71.1	4.8	78.6	4.8	74.8	3.2	72.5	2.7	71.2	2.5
May	77.9	4.8	87.9	4.0	83.3	3.3	79.0	3.8	78.0	6.1
June	81.4	4.1	93.0	2.8	86.9	3.2	82.3	3.3	76.4	3.1
July	82.9	4.3	92.0	6.2	87.6	2.9	83.8	3.2	81.1	4.2
August	82.7	4.4	93.2	3.0	86.0	2.6	82.7	2.4	80.9	0.5
September	81.1	4.6	93.2	2.2	85.6	2.1	81.1	3.1	76.7	0.1
October	81.8	3.9	92.6	5.2	84.8	3.2	80.8	3.2	79.5	1.1
November	84.1	3.9	94.6	2.6	87.1	3.7	83.4	4.0	84.6	1.2
December	80.5	5.2	91.3	3.7	84.4	7.1	80.6	5.0	81.9	6.4

2004

	'El Claro'	1m	20m	40m	48m
January	74.2	87.5	78.1	76.5	74.3
February	68.2	79.5	72.6	69.3	67.7
March	67.1	76.9	71.4	67.9	65.9
April	69.0	76.7	74.1	70.2	69.2
May	77.2	87.7	82.5	79.5	77.3
June	79.9	96.0	85.6	79.7	80.1
July	78.1	93.1	86.5	84.6	83.8
August	84.8	94.6	89.3	85.2	86.1
September	79.7	94.6	83.5	80.2	76.7
October	79.5	95.4	83.3	78.8	78.5
November	78.9	93.3	81.3	78.0	79.0
December	80.7	96.3	84.9	81.0	80.4



Relative Humidity (%)

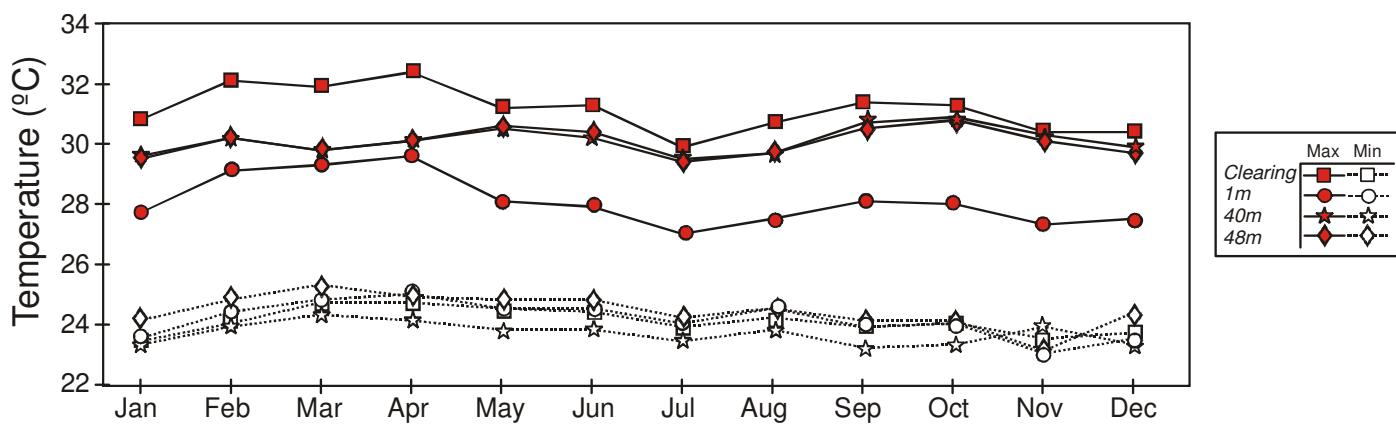


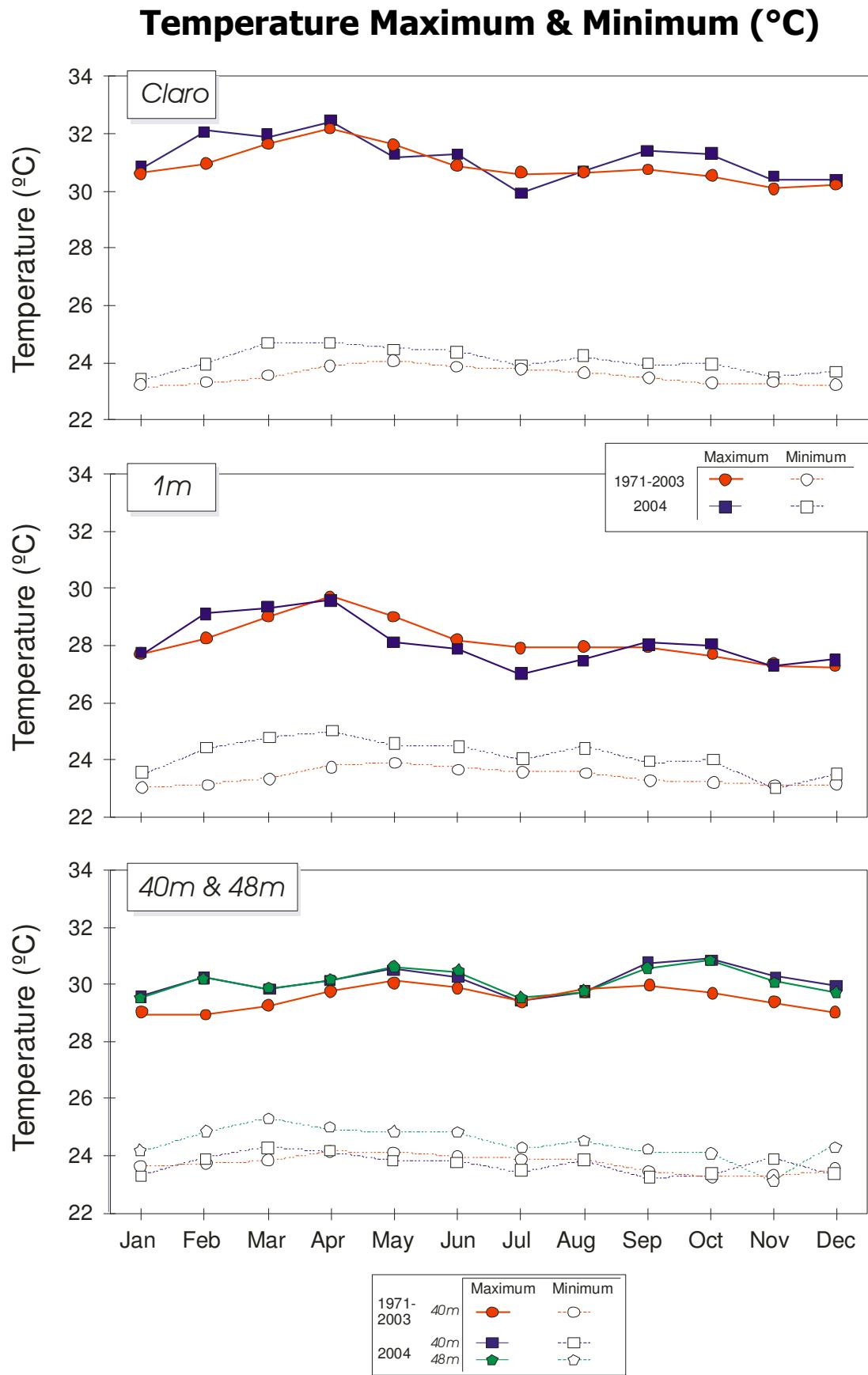
Avg. Monthly Maximum & Minimum (°C) Temperatures

Long-term Averages (1972-2003)

'El Claro'			1m		40m		48m	
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
January	30.6	23.2	27.7	23.1	28.9	23.6	29.4	25.2
February	30.9	23.3	28.3	23.2	29.0	23.8	29.8	25.2
March	31.6	23.5	29.1	23.4	29.3	23.8	31.0	24.4
April	32.2	23.9	29.7	23.9	29.8	24.2	30.8	25.3
May	31.6	24.1	29.0	24.0	30.1	24.1	30.7	24.8
June	30.8	23.8	28.1	23.8	29.9	24.0	30.7	24.2
July	30.5	23.8	27.9	23.6	29.4	23.9	29.9	24.5
August	30.6	23.7	27.9	23.6	29.8	23.9	30.0	24.6
September	30.7	23.5	27.9	23.3	30.0	23.5	30.8	24.4
October	30.5	23.3	27.6	23.3	29.8	23.3	30.6	24.2
November	30.0	23.3	27.3	23.2	29.4	23.3	30.0	24.5
December	30.2	23.2	27.2	23.2	29.4	23.5	29.8	24.6

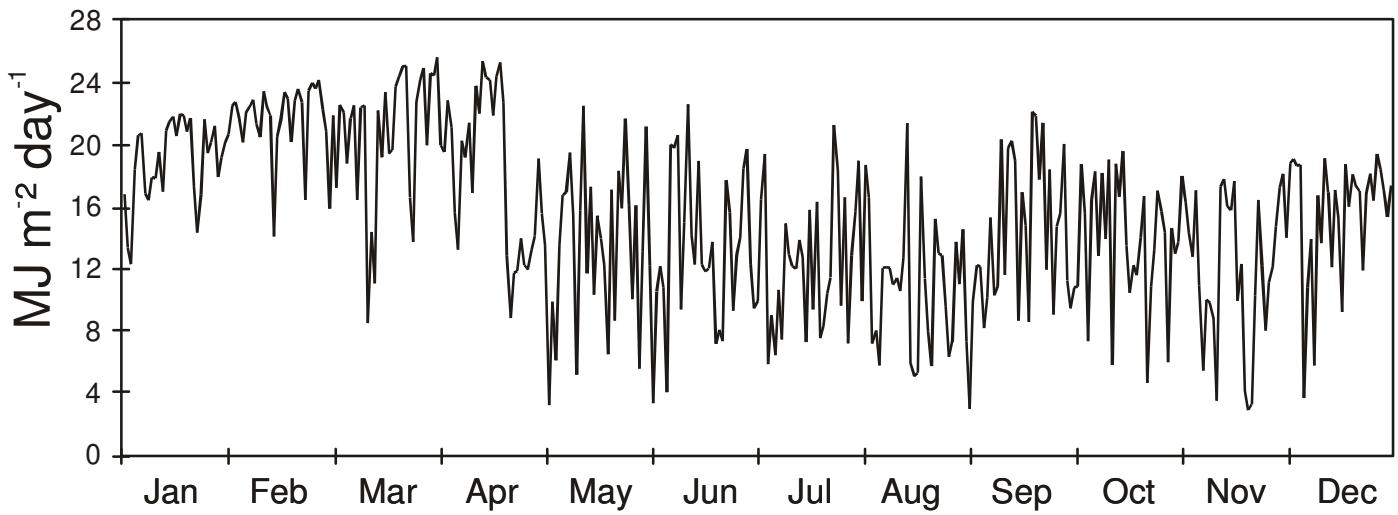
<u>2004</u>	'El Claro'	1m		40m		48m	
		Max.	Min.	Max.	Min.	Max.	Min.
January	30.8 23.4	27.7	23.5	29.6	23.3	29.5	24.1
February	32.1 24.0	29.1	24.4	30.2	23.9	30.2	24.8
March	31.9 24.7	29.3	24.8	29.8	24.3	29.8	25.3
April	32.4 24.7	29.6	25.0	30.1	24.1	30.1	24.9
May	31.2 24.5	28.1	24.5	30.5	23.8	30.6	24.8
June	31.3 24.4	27.9	24.5	30.2	23.8	30.4	24.8
July	29.9 23.9	27.0	24.0	29.4	23.4	29.5	24.2
August	30.7 24.2	27.5	24.5	29.7	23.8	29.7	24.5
September	31.4 23.9	28.1	23.9	30.7	23.2	30.5	24.1
October	31.3 24.0	28.0	24.0	30.9	23.3	30.8	24.1
November	30.4 23.5	27.3	23.0	30.3	23.9	30.1	23.1
December	30.4 23.7	28.1	23.5	29.9	23.3	29.7	24.4





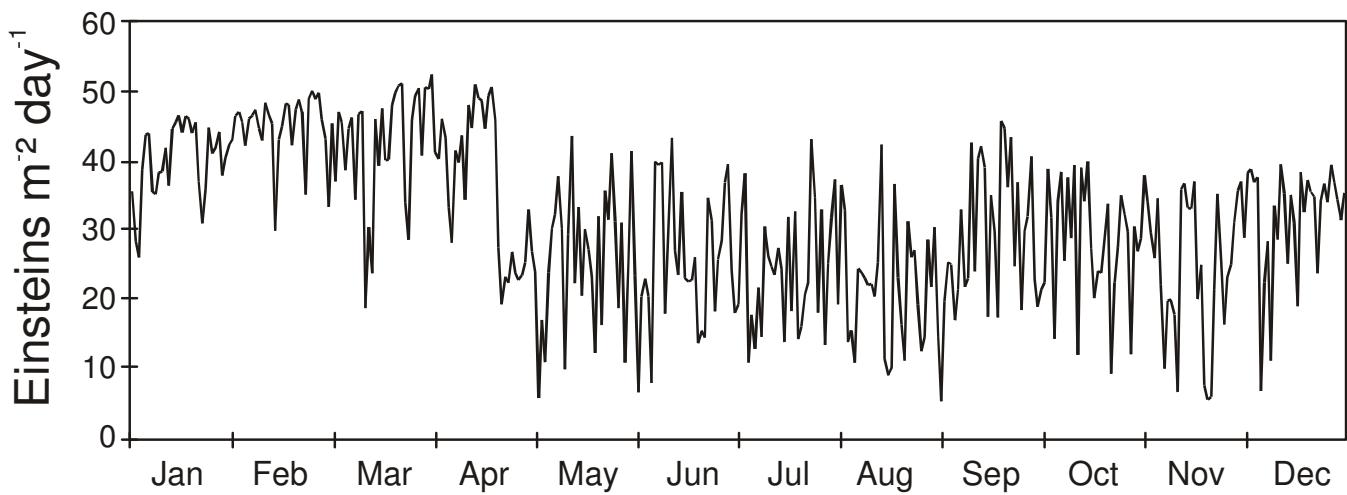
Daily Total Radiation ($\text{MJ m}^{-2} \text{day}^{-1}$)

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1	16.8	22.5	21.9	19.9	13.6	3.4	10.0	18.7	9.9	10.9	16.3	18.8
2	13.4	22.7	17.2	19.6	3.3	10.6	16.5	16.6	12.3	18.7	14.3	19.1
3	12.3	21.8	22.5	22.8	9.9	12.2	19.4	7.2	12.2	15.6	12.8	18.6
4	18.4	20.1	22.1	21.1	6.2	10.8	5.9	8.1	8.2	7.4	17.1	18.7
5	20.6	22.1	18.8	15.6	13.6	4.1	9.0	5.8	10.2	16.4	11.0	3.7
6	20.7	22.4	21.7	13.3	16.8	20.0	6.5	12.1	15.3	18.3	5.5	10.8
7	16.9	22.9	22.5	20.2	17.0	19.8	10.7	12.1	10.3	12.9	10.1	13.9
8	16.4	21.3	16.4	19.2	19.5	20.6	7.5	12.1	10.9	18.2	9.9	5.8
9	17.9	20.5	22.4	21.4	15.5	9.4	14.9	11.0	20.3	13.9	8.9	16.7
10	17.8	23.4	22.5	16.9	5.2	15.0	13.0	11.4	11.6	19.0	3.6	13.7
11	19.5	22.4	8.6	23.8	15.8	22.6	12.2	10.6	19.8	5.9	17.3	19.1
12	17.0	21.9	14.4	22.0	22.5	14.2	12.0	12.7	20.2	18.8	17.8	16.9
13	20.9	14.1	11.1	25.4	11.7	12.3	13.9	21.4	19.0	16.7	16.0	12.1
14	21.5	20.5	22.2	24.3	17.3	18.9	12.8	6.0	8.7	19.6	15.8	17.1
15	21.8	21.6	19.2	24.2	10.4	12.3	7.3	5.1	16.9	13.5	17.7	15.3
16	20.6	23.4	23.4	21.9	15.4	11.8	15.8	5.4	14.8	10.5	10.0	9.3
17	22.0	22.9	19.4	24.4	13.9	12.0	9.4	17.9	8.6	12.3	12.3	18.7
18	21.9	20.2	19.7	25.3	12.3	13.8	16.3	11.4	22.1	11.6	4.2	16.0
19	20.8	22.8	23.7	22.7	6.6	7.2	7.6	8.0	21.9	14.0	3.0	18.1
20	21.7	23.6	24.4	12.9	17.1	8.1	8.4	5.8	17.8	16.7	3.3	17.4
21	17.3	22.7	25.0	8.9	8.7	7.4	10.4	15.2	21.4	4.7	10.3	17.0
22	14.4	16.4	25.0	11.8	18.3	17.7	11.5	13.0	12.0	10.9	16.4	11.9
23	16.8	23.5	16.6	11.9	15.9	15.7	21.3	12.9	18.4	13.3	12.2	16.9
24	21.6	24.0	13.8	14.0	21.7	9.3	18.4	9.6	9.1	17.0	8.1	18.1
25	19.5	23.6	22.7	12.3	16.1	12.9	9.7	6.4	14.7	15.7	11.2	16.4
26	20.1	24.1	24.1	12.0	10.1	14.0	16.6	7.3	15.6	14.4	12.2	19.4
27	21.2	22.3	24.9	13.2	16.1	18.5	7.2	13.8	20.0	6.1	14.7	18.4
28	17.9	20.9	19.9	14.1	5.6	19.7	12.9	11.1	11.3	14.6	17.3	17.1
29	19.2	15.9	24.6	19.1	13.1	12.3	15.7	14.6	9.5	13.0	18.1	15.3
30	20.2		24.4	15.6	21.1	9.5	19.0	7.4	10.8	13.8	14.0	17.4
31	20.7		25.6		12.3		10.0	3.0		18.0		16.8



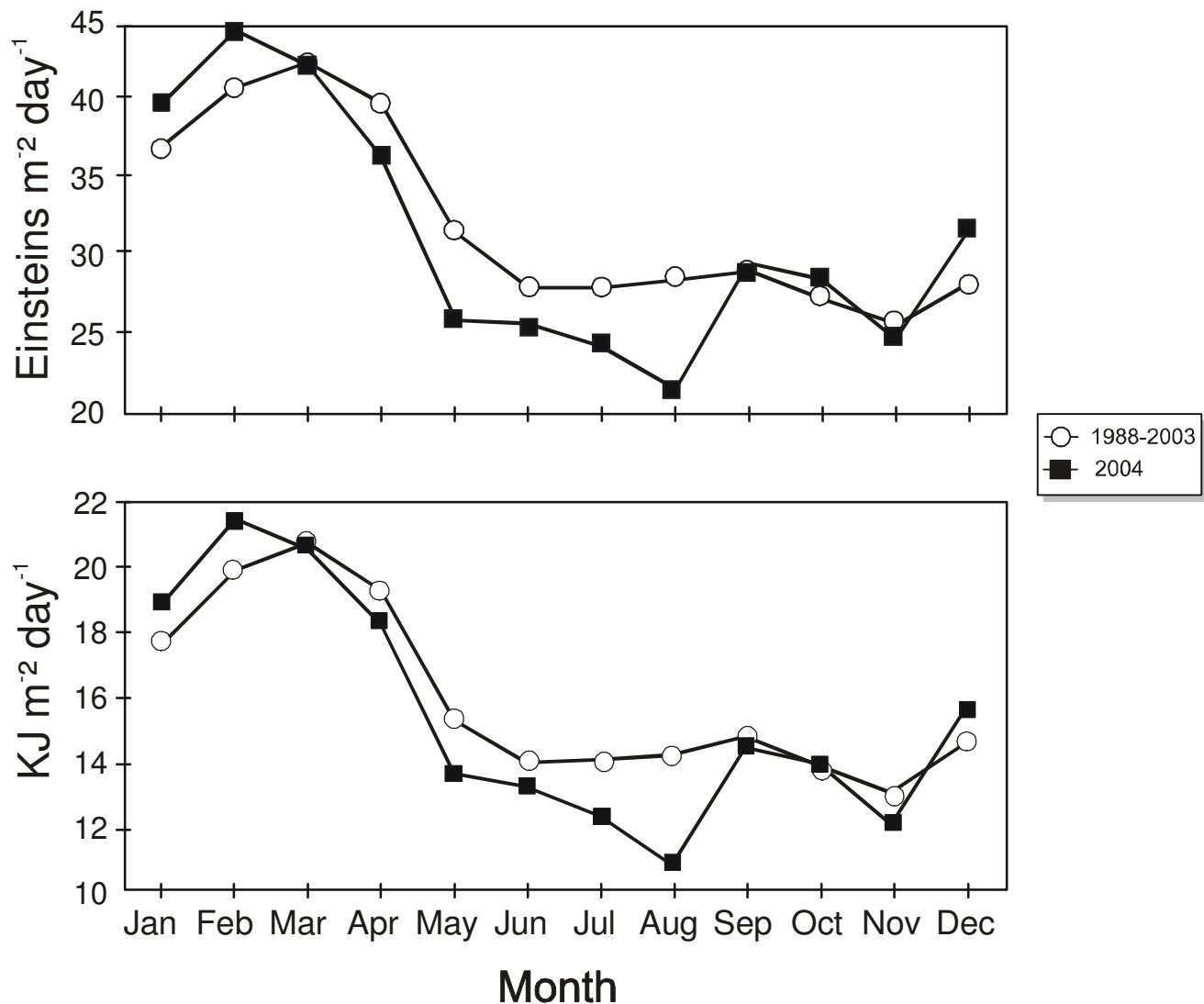
Daily Total PAR (Einstiens m⁻² day⁻¹)

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1	35.6	46.4	45.4	41.2	24.1	6.9	19.4	36.5	19.9	22.6	34.1	38.2
2	28.5	47.0	37.0	40.3	6.0	20.5	32.4	32.9	25.5	38.8	29.7	38.8
3	26.2	45.5	47.0	46.0	17.2	23.1	38.2	14.0	25.2	31.9	26.1	36.9
4	38.7	42.2	45.5	43.4	11.2	20.6	11.1	15.7	17.2	14.6	34.7	37.7
5	43.7	46.0	38.7	33.4	24.0	8.2	17.9	11.1	21.6	34.2	22.3	7.0
6	44.0	46.5	44.6	28.3	30.3	39.9	13.1	24.5	33.0	38.4	10.2	22.6
7	35.6	47.3	46.2	41.5	32.4	39.4	21.8	24.1	22.0	25.7	20.0	28.5
8	35.2	44.6	34.5	39.8	37.8	39.8	14.8	23.2	23.2	37.6	20.2	11.4
9	38.3	42.9	46.7	43.6	30.3	18.2	30.6	22.2	42.6	29.0	18.0	33.6
10	38.5	48.3	47.1	34.4	10.2	29.8	26.3	22.4	24.2	39.4	6.9	28.8
11	41.9	46.6	18.9	48.0	29.5	43.3	24.9	20.6	40.3	12.2	35.9	39.5
12	36.5	45.4	30.5	44.7	43.6	27.1	23.7	25.4	42.1	39.0	36.8	35.3
13	44.5	30.0	23.9	50.9	22.5	23.7	27.5	42.3	39.0	34.2	33.3	25.3
14	45.5	43.0	46.0	49.0	33.4	35.5	24.5	11.6	17.7	39.9	33.2	35.1
15	46.5	44.9	39.3	48.6	20.7	23.2	14.1	9.3	35.1	27.5	37.0	31.1
16	44.1	48.2	47.5	44.6	30.2	22.7	32.0	10.4	29.8	20.4	20.2	19.2
17	46.4	48.0	40.1	49.3	27.3	22.9	18.5	36.7	17.6	24.2	25.1	38.4
18	46.0	42.2	40.1	50.6	23.5	26.2	32.7	23.3	45.7	24.0	7.9	32.7
19	44.0	47.4	48.0	45.9	12.4	13.9	14.4	16.6	44.6	29.1	5.8	37.2
20	45.5	48.8	49.7	27.6	32.0	15.7	16.3	11.4	36.3	33.8	6.2	35.5
21	37.0	47.0	50.8	19.4	16.6	14.7	21.0	31.3	43.4	9.5	21.5	34.9
22	31.1	35.1	51.1	23.4	35.7	34.7	22.5	26.2	24.9	22.6	35.3	23.9
23	35.9	48.9	34.1	22.5	31.6	31.4	43.1	27.2	36.9	27.6	25.5	34.3
24	44.7	50.0	28.7	27.0	41.0	18.5	34.8	19.5	18.6	35.1	16.6	36.7
25	41.0	48.8	45.9	24.0	31.3	25.9	18.3	12.8	29.9	32.3	23.4	34.1
26	41.8	49.7	49.3	22.9	18.9	28.5	33.0	14.7	32.0	29.9	25.2	39.4
27	44.1	45.9	50.4	23.6	31.1	36.9	13.6	28.7	40.6	12.3	31.1	36.9
28	37.9	43.2	40.8	25.5	11.1	39.6	25.3	22.0	23.0	30.6	35.7	34.5
29	40.4	33.4	50.5	33.0	25.6	24.4	31.8	30.5	19.1	27.0	37.0	31.5
30	42.3		50.3	27.0	41.4	18.2	37.3	14.8	21.6	28.9	29.0	35.4
31	43.0		52.4		23.6		19.5	5.6		38.0		34.6



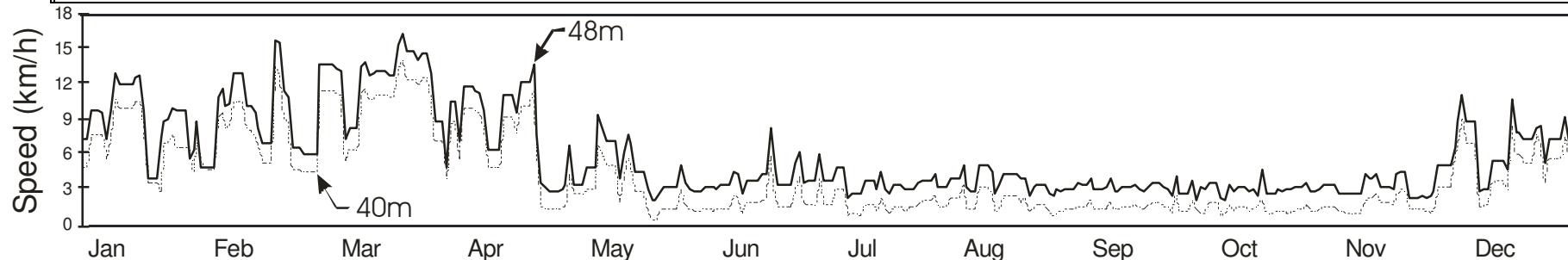
Total Monthly Solar Radiation

	Long-term Average (1988-2003)				2004	
	PAR (Einstiens m ⁻² day ⁻¹)		Pyranometer (MJ m ⁻² day ⁻¹)		PA R	Pyran.
	Mean	S.D.	Mean	S.D.		
January	37.1	4.8	17.6	1.0	40.1	19.0
February	41.0	4.6	19.9	1.1	44.9	21.6
March	42.7	3.3	20.9	1.2	42.6	20.7
April	40.1	3.2	19.4	1.1	36.7	18.3
May	31.7	3.6	15.4	1.4	26.0	13.6
June	28.1	3.4	14.0	1.1	25.8	13.2
July	28.1	3.3	14.2	1.2	24.3	12.3
August	28.6	3.6	14.5	1.5	21.5	10.8
September	29.2	3.1	14.8	1.1	29.8	14.5
October	27.3	4.5	13.9	1.5	28.7	13.9
November	25.7	4.1	13.1	1.1	24.8	12.0
December	28.5	5.8	14.6	2.5	31.9	15.6



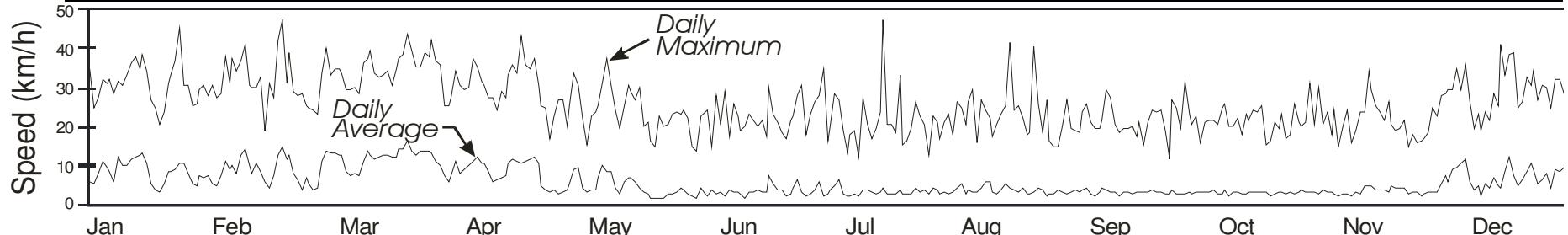
Daily Average Wind Speed – Totalizing Anemometer (km/h)

	Jan.		Feb.		Mar.		Apr.		May		June		July		Aug.		Sep.		Oct.		Nov.		Dec.	
	40m	48m	40m	48m	40m	48m	40m	48m	40m	48m	40m	48m	40m	48m	40m	48m	40m	48m	40m	48m	40m	48m	40m	48m
1	5.0	7.3	4.8	4.9	11.4	13.6	8.8	10.5	2.7	3.5	1.5	3.3	1.8	3.7	2.4	4.0	1.6	3.4	1.1	3.0	1.6	3.4	5.5	6.6
2	5.0	7.3	4.8	4.9	11.4	13.6	5.7	7.2	2.7	3.5	1.5	3.3	1.8	3.7	2.4	4.0	1.6	3.4	2.0	3.6	1.6	3.4	7.2	8.8
3	7.7	9.7	9.0	10.8	11.2	13.3	10.0	11.9	3.0	4.8	1.3	3.3	3.1	5.0	3.5	5.2	2.2	4.0	2.0	3.6	1.1	2.7	9.1	11.1
4	7.7	9.7	9.7	11.6	11.0	13.2	10.0	11.9	3.0	4.8	1.5	3.0	3.1	5.0	1.5	3.2	1.3	3.0	2.0	3.6	1.1	2.7	6.9	8.8
5	7.7	9.7	8.2	10.2	5.4	7.3	10.0	11.9	3.0	4.8	1.5	3.4	3.1	5.0	1.3	2.9	1.3	3.0	0.8	2.4	1.1	2.7	6.9	8.8
6	7.7	9.5	8.5	10.4	6.4	8.3	9.6	11.4	6.8	9.4	1.5	3.4	0.9	2.3	1.3	2.9	1.3	3.0	1.1	2.2	1.1	2.7	6.9	8.8
7	5.7	7.3	10.5	12.8	6.4	8.3	9.4	11.2	5.9	8.2	1.5	3.4	1.0	2.7	3.2	5.2	1.5	3.3	1.7	3.4	1.1	2.7	1.5	2.9
8	7.6	9.7	10.5	12.8	6.4	8.3	8.1	9.8	5.1	7.1	2.6	4.6	1.0	2.7	3.2	5.2	2.0	4.0	1.3	2.9	1.1	2.7	1.7	3.1
9	10.8	13.0	10.5	12.8	11.3	13.5	4.9	6.4	5.1	7.1	2.3	4.3	0.8	2.6	3.2	5.2	1.3	2.9	1.5	3.2	2.1	4.3	1.7	3.1
10	9.9	12.0	8.2	10.1	11.6	13.8	4.9	6.4	5.1	7.1	1.0	2.6	1.8	3.8	2.7	4.5	1.3	2.9	1.5	3.2	2.3	3.9	3.6	5.4
11	9.9	12.0	8.1	10.0	10.8	12.8	4.9	6.4	2.0	4.0	2.0	3.8	1.8	3.8	1.1	2.7	1.6	3.2	1.5	3.2	2.3	3.9	3.8	5.5
12	9.9	12.0	7.6	9.5	10.6	12.9	4.9	6.4	3.9	6.2	2.0	3.8	1.8	3.8	1.6	3.4	1.6	3.2	1.2	2.8	2.8	4.4	3.8	5.5
13	9.9	12.0	6.6	8.4	11.1	13.1	9.2	11.1	5.7	7.8	2.0	3.8	1.3	3.1	2.5	4.4	1.6	3.2	1.4	3.1	1.9	3.2	3.8	5.5
14	10.4	12.5	5.3	7.0	11.1	13.1	9.2	11.1	5.0	7.0	2.0	3.8	2.3	4.5	2.5	4.4	1.7	3.4	1.7	2.4	1.9	3.2	3.0	4.8
15	10.5	12.7	5.3	7.0	11.1	13.1	9.2	11.1	2.8	4.6	2.2	4.3	1.4	3.1	2.5	4.4	1.6	3.1	2.2	4.8	1.9	3.2	8.5	10.8
16	7.8	9.7	5.3	7.0	10.9	12.8	7.8	9.7	2.8	4.6	2.2	4.3	1.0	2.6	2.5	4.4	1.3	2.8	1.1	2.7	1.8	3.2	6.1	8.0
17	3.7	3.9	13.4	15.8	11.0	12.7	10.1	12.1	2.8	4.6	5.8	8.3	1.6	3.4	2.0	4.1	1.7	3.2	1.1	2.7	2.7	4.3	6.1	8.0
18	3.7	3.9	12.8	15.5	13.3	15.4	10.1	12.1	1.4	3.1	2.7	4.8	1.6	3.4	2.4	4.1	1.9	3.5	1.1	2.7	3.0	4.6	5.4	7.3
19	3.7	3.9	9.1	11.5	14.1	16.2	10.1	12.1	0.5	2.2	1.6	3.4	1.6	3.4	1.2	2.6	1.9	3.5	1.2	3.0	2.9	4.5	5.4	7.3
20	2.7	7.6	8.9	10.9	12.4	14.8	11.4	13.6	0.5	2.2	1.6	3.4	1.2	3.2	1.4	3.3	1.9	3.5	1.2	2.9	1.3	2.4	5.4	7.3
21	6.9	8.8	4.8	6.5	12.4	14.8	5.6	7.8	1.3	2.7	1.6	3.4	1.5	3.2	1.7	3.4	1.7	3.3	1.1	3.0	1.3	2.4	7.8	8.2
22	7.0	9.0	4.8	6.5	12.4	14.8	1.6	3.6	1.5	3.3	1.7	3.4	1.5	3.2	1.7	3.4	1.6	3.1	1.1	3.0	1.3	2.4	6.9	8.4
23	7.7	10.0	4.8	6.5	11.9	14.0	1.4	3.3	1.5	3.3	3.0	5.2	1.8	3.6	1.7	3.4	1.1	2.5	1.3	3.3	1.5	2.4	3.6	5.2
24	6.5	9.8	4.5	6.1	12.5	14.7	1.4	2.9	1.5	3.3	4.2	6.3	2.1	3.8	1.2	2.6	2.6	4.2	1.3	3.3	1.2	2.3	5.7	7.3
25	6.5	9.8	4.5	6.1	12.5	14.6	1.4	2.9	1.5	3.3	1.9	3.7	2.1	3.8	0.8	2.6	1.2	2.7	1.3	3.3	1.1	2.4	5.7	7.3
26	6.5	9.8	4.5	6.1	10.9	13.0	1.4	2.9	3.1	5.1	1.8	3.9	2.1	3.8	1.1	3.1	1.2	2.7	1.9	3.7	1.4	2.9	5.7	7.3
27	6.5	5.6	4.5	6.1	7.1	8.8	1.5	3.2	1.8	3.6	1.8	3.9	2.6	4.5	1.1	2.9	1.2	2.7	1.2	2.9	3.2	5.1	5.7	7.3
28	4.6	6.3	11.4	13.6	7.1	8.8	1.6	3.4	1.4	3.1	1.8	3.9	1.6	3.3	1.4	3.1	2.2	3.7	1.2	2.9	3.2	5.1	7.5	9.2
29	7.0	8.8	11.4	13.6	7.1	8.8	4.3	6.7	1.3	3.0	3.9	6.0	1.6	3.3	1.4	3.1	1.4	2.2	1.4	3.0	3.2	5.1	5.5	6.9
30	5.4	4.9	0.0	0.0	3.9	5.0	2.7	3.5	1.3	3.0	1.8	3.7	1.6	3.2	1.4	3.1	1.0	3.3	1.6	3.4	3.2	5.1	5.5	6.9
31	4.8	4.9			8.7	10.5			1.3	3.0			2.4	4.0	1.7	3.6			1.6	3.4			0.0	0.0



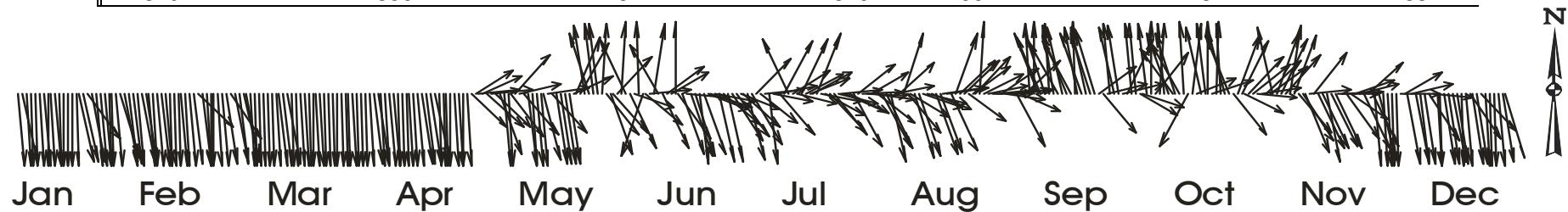
Daily Average Wind Speed (km/h)

	Jan.		Feb.		Mar.		Apr.		May		June		July		Aug.		Sep.		Oct.		Nov.		Dec.	
	Avg	Max	Avg	Max	Avg	Max	Avg	Max	Avg	Max	Avg	Max	Avg	Max	Avg	Max	Avg	Max	Avg	Max	Avg	Max	Avg	Max
1	6.0	34.5	4.9	27.3	12.9	34.4	7.9	30.2	4.0	21.8	2.2	24.1	3.7	19.7	4.4	26.4	3.7	23.6	3.0	20.9	3.1	17.9	9.2	29.1
2	5.5	24.6	7.5	28.3	12.6	34.4	8.9	29.5	3.4	15.3	3.5	15.0	4.8	28.2	5.1	24.5	4.3	25.6	3.4	21.3	2.7	24.4	9.6	34.4
3	7.9	27.5	11.1	37.8	12.8	33.5	10.0	29.9	3.7	22.3	2.7	27.7	6.4	26.7	2.6	20.4	2.8	21.2	3.8	21.6	2.3	14.6	10.6	29.4
4	11.1	31.9	8.9	30.8	8.4	29.5	11.1	37.1	3.7	23.7	3.0	20.7	2.8	18.8	3.6	26.3	2.3	19.5	2.6	20.3	2.9	20.0	11.6	35.7
5	9.5	30.7	10.1	37.2	7.3	29.4	12.2	35.2	6.9	25.4	2.0	28.8	2.3	13.0	3.0	29.6	3.4	19.5	2.7	24.7	2.7	24.1	6.1	26.2
6	8.4	32.1	8.1	33.8	7.9	30.1	10.4	31.4	9.8	30.8	3.5	17.4	2.4	17.9	3.0	15.9	4.1	21.5	3.5	25.8	2.2	15.6	4.0	19.4
7	6.1	28.5	12.8	36.5	7.2	28.1	10.7	30.4	8.6	37.0	3.5	25.5	2.7	19.0	4.2	26.5	3.8	29.3	2.3	20.1	3.1	18.7	4.6	23.0
8	12.3	31.4	13.9	40.7	10.9	36.1	8.5	27.3	8.7	30.4	3.0	22.7	2.3	12.2	5.7	24.4	3.1	27.3	3.1	19.7	2.8	23.5	2.4	18.7
9	10.1	30.4	10.0	30.2	13.7	37.3	6.0	27.1	4.1	24.3	2.6	18.7	4.0	27.3	5.9	22.0	3.0	20.5	3.1	21.9	4.8	23.5	5.5	23.5
10	9.8	32.8	7.9	29.9	12.8	39.1	6.4	24.2	2.9	19.2	1.6	20.0	3.6	20.6	3.2	17.5	2.0	18.5	2.5	17.7	4.6	34.0	4.2	21.5
11	11.8	36.4	10.3	29.6	11.6	33.4	6.7	28.9	6.0	25.1	3.0	22.8	3.3	16.8	2.8	20.5	3.2	19.6	2.8	23.1	4.8	29.4	7.1	28.5
12	12.3	37.7	8.4	32.6	12.1	32.4	7.6	27.4	6.8	30.6	3.3	21.5	2.8	19.3	4.0	23.3	3.3	19.6	3.2	21.3	4.0	25.0	5.0	25.2
13	12.6	34.7	6.0	18.8	12.5	33.1	10.4	33.1	6.6	28.7	3.6	19.9	3.2	23.9	5.3	25.2	2.9	19.9	3.0	24.0	3.7	23.4	4.5	41.0
14	13.2	38.1	4.3	31.1	12.8	34.2	11.7	35.5	5.7	26.6	3.3	21.7	4.0	47.1	4.3	41.3	3.0	17.2	3.2	23.7	3.7	21.6	8.3	33.1
15	10.4	34.0	7.3	27.2	12.2	30.4	11.3	33.4	4.1	29.7	3.2	17.3	2.9	20.7	3.5	24.2	3.2	21.2	3.1	25.0	3.2	26.0	11.9	38.1
16	5.3	26.5	12.7	42.1	12.2	34.7	10.7	43.2	3.3	19.8	7.4	29.9	2.7	20.3	3.3	25.0	3.0	15.3	3.0	15.4	4.6	20.5	7.5	38.7
17	3.6	24.6	14.5	47.3	14.0	37.3	11.2	35.6	2.7	21.0	5.2	22.9	2.5	18.3	4.5	22.2	3.0	21.2	2.1	16.1	4.3	19.1	4.9	24.9
18	3.3	20.3	11.6	31.2	14.0	38.1	11.5	34.3	1.7	16.2	3.9	21.1	3.7	33.1	2.9	18.1	3.8	24.3	2.7	21.1	4.3	19.3	6.1	26.0
19	5.1	23.8	12.5	38.9	16.5	43.7	12.1	37.0	1.7	14.5	3.8	18.6	2.9	15.2	2.6	18.4	3.3	23.5	3.1	19.5	4.3	21.6	8.3	32.4
20	8.3	31.1	7.7	29.0	13.7	39.5	10.4	30.2	1.8	22.3	2.3	16.7	2.8	16.3	3.0	40.3	3.3	23.9	3.3	23.0	2.9	14.7	10.6	30.6
21	8.5	33.1	6.5	27.8	12.8	35.4	4.6	25.1	1.4	19.8	2.8	21.5	2.8	19.6	4.3	25.9	2.5	19.0	2.5	17.1	2.9	17.9	9.2	33.8
22	8.8	36.9	3.9	28.5	13.8	34.9	3.9	24.8	2.7	20.3	4.2	22.4	4.1	26.2	3.8	18.3	2.7	11.7	3.0	17.9	3.1	16.0	5.5	26.8
23	10.4	44.8	6.9	25.4	13.8	39.0	3.5	17.1	2.6	23.3	6.4	27.7	3.5	22.5	2.4	26.8	3.6	26.5	2.9	25.9	2.4	16.5	6.6	30.4
24	10.4	30.3	5.2	24.6	13.4	37.6	4.0	22.5	3.3	23.5	3.1	30.2	3.9	20.3	2.8	16.1	2.7	24.9	3.4	20.9	2.7	17.0	7.9	29.7
25	8.0	30.3	3.8	24.3	13.4	41.8	2.7	26.6	4.4	23.1	2.2	18.0	2.5	12.7	2.7	15.0	2.7	19.3	3.7	19.8	3.3	18.3	4.2	24.5
26	5.4	25.1	4.5	23.0	11.1	36.9	3.0	26.8	3.8	24.0	2.8	23.2	4.0	22.7	3.5	14.9	2.7	31.6	3.0	20.9	3.3	24.7	9.1	32.2
27	4.6	25.5	10.8	33.6	10.1	35.5	3.5	20.1	2.8	21.8	3.5	26.2	3.8	21.0	3.3	20.0	3.2	22.8	3.3	31.2	3.4	22.5	8.6	32.0
28	7.4	29.6	13.4	40.0	7.2	25.2	5.3	25.1	2.1	14.6	5.9	27.8	2.5	17.1	2.8	26.7	2.8	20.4	3.1	20.2	5.4	27.6	9.8	28.4
29	6.9	30.2	13.3	33.0	5.6	25.2	8.8	33.4	1.6	13.8	2.3	34.5	3.1	20.9	3.2	19.6	3.1	22.3	2.9	30.1	7.6	28.5	7.1	32.6
30	7.2	27.6			7.5	27.2	9.6	30.2	4.4	22.7	2.7	16.3	2.7	23.2	3.7	19.0	3.1	15.8	3.8	20.6	5.6	29.4	5.4	27.9
31	5.2	30.6			11.2	33.8			2.5	23.5			3.4	18.0	3.3	18.2			3.4	23.7			4.4	21.2



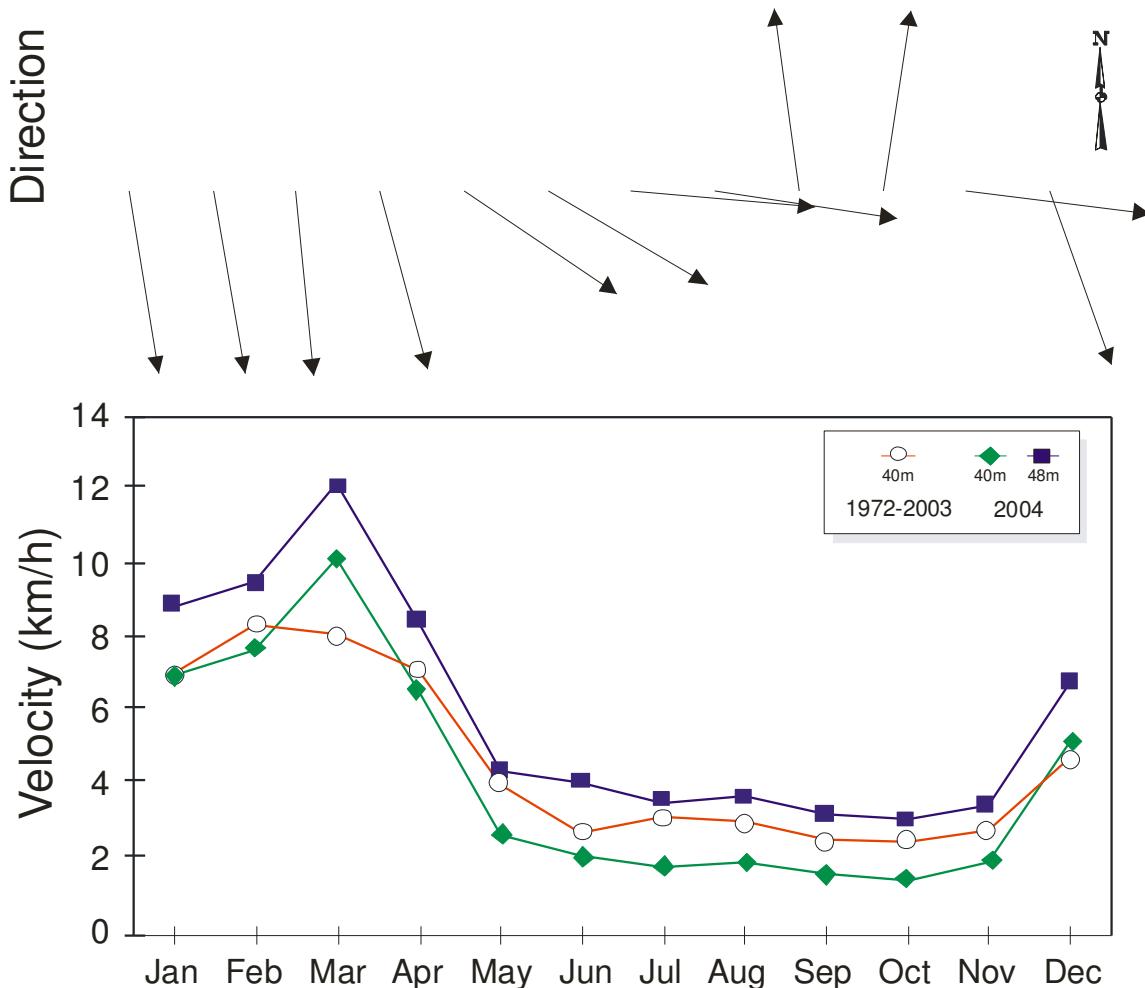
Average Daily Wind Direction

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1	351	343	358	349	307	177	294	320	266	170	264	353
2	340	351	357	350	236	31	266	340	316	286	243	355
3	355	354	355	356	261	295	347	263	284	280	248	356
4	357	350	352	356	304	267	276	244	242	168	156	356
5	356	349	349	356	347	194	263	211	173	179	211	269
6	351	349	348	354	355	134	305	302	181	236	219	253
7	350	357	342	355	350	319	222	288	147	187	237	343
8	358	357	357	351	349	247	139	331	143	171	195	262
9	354	355	357	346	337	252	251	328	148	148	214	341
10	352	351	354	348	265	180	278	281	172	130	303	347
11	356	356	353	344	302	307	221	277	164	149	310	343
12	358	350	357	339	345	327	254	281	135	136	325	310
13	359	347	358	356	346	272	258	327	159	174	266	272
14	359	297	356	355	345	329	252	325	145	43	235	354
15	357	347	356	357	343	330	214	264	137	194	319	358
16	341	354	356	0	256	345	275	264	178	258	319	346
17	340	359	358	356	217	327	287	322	159	158	342	345
18	308	1	357	355	224	283	301	214	148	170	317	340
19	342	356	360	359	164	280	304	242	157	180	319	345
20	351	350	356	354	149	275	277	242	149	259	270	356
21	350	346	354	297	168	339	266	292	153	183	269	351
22	351	309	358	251	169	295	284	247	247	173	307	308
23	356	341	356	267	188	338	285	239	303	153	291	346
24	358	345	357	255	304	310	317	184	261	145	258	345
25	351	335	356	297	326	306	245	254	170	304	262	300
26	333	342	356	266	302	282	268	263	158	215	319	355
27	342	356	353	297	238	297	271	270	163	222	244	358
28	349	358	348	326	185	336	253	266	261	285	317	356
29	347	358	343	349	140	314	274	249	221	239	352	350
30	350		355	352	318	241	294	273	172	246	335	342
31	340		356		281	316	316	266		273		332



Average Monthly Wind Speed and Direction

	Long-term Av.			2004		
	Avg. Speed		Direction	Speed		Direction
	40m	48m		40m	48m	
January	7.1	9.8	356.6	7.0	8.9	350.6
February	8.5	10.5	3.4	7.7	9.5	349.6
March	8.1	10.2	1.1	10.2	12.2	354.7
April	7.1	8.6	352.2	6.6	8.4	345.1
May	4.0	5.4	305.0	2.6	4.4	303.4
June	2.7	3.3	269.2	2.1	4.0	300.2
July	3.2	4.2	307.0	1.8	3.6	274.7
August	3.0	4.1	264.6	1.9	3.7	278.5
September	2.5	3.2	219.1	1.6	3.2	172.1
October	2.5	4.1	217.0	1.4	3.1	189.0
November	2.8	4.0	260.2	1.9	3.5	276.9
December	4.8	5.9	332.9	5.2	6.8	340.7



Estimated Evapotranspiration and Water Balance

Average (1993-2003)	'El Claro'			'40m'			'48m'		
	Month ⁻¹	Day ⁻¹	S.D.	Month ⁻¹	Day ⁻¹	S.D.	Month ⁻¹	Day ⁻¹	S.D.
January	94.9	3.1	0.8	146.8	4.7	0.7	185.0	6.0	0.1
February	114.1	4.1	0.7	156.6	5.6	0.5	180.3	6.4	0.3
March	135.2	4.4	0.6	178.4	5.8	0.7	181.3	5.8	0.1
April	117.7	3.9	0.5	159.7	5.3	0.4	163.3	5.4	0.4
May	81.5	2.6	0.8	107.1	3.5	0.7	112.3	3.7	1.2
June	56.1	1.9	0.5	80.4	2.7	0.6	83.8	2.8	0.4
July	61.2	2.0	0.3	82.8	2.7	0.6	89.3	3.0	0.5
August	60.8	2.0	0.3	86.2	2.8	0.5	83.0	2.7	0.2
September	65.8	2.2	0.4	87.3	2.9	0.3	102.0	3.4	0.1
October	64.3	2.1	0.3	87.3	2.8	0.3	87.3	2.8	0.2
November	47.0	1.6	0.4	70.8	2.4	0.7	70.3	2.3	0.2
December	60.6	2.0	0.8	96.4	3.1	1.1	111.3	3.6	1.4

2004	Evapotranspiration (mm eq. day ⁻¹)			Net Water Balance (mm eq. day ⁻¹)		
	'El Claro'	40 m	48 m	'El Claro'	40 m	48 m
January	4.1	4.8	5.5	-4.3	-16.9	-17.6
February	5.1	5.3	6.1	-4.7	-5.4	-6.1
March	5.3	5.8	6.4	-4.1	-4.6	-5.2
April	4.2	4.5	4.8	-0.3	-0.6	-1.0
May	2.1	2.6	3.0	11.9	13.3	12.9
June	2.3	2.6	2.8	6.0	6.0	5.8
July	1.8	2.3	2.5	2.9	4.5	4.3
August	1.9	2.4	2.6	4.9	7.0	6.8
September	2.5	2.8	3.4	1.8	-0.8	-1.3
October	2.3	2.5	2.9	2.1	1.5	1.1
November	2.0	2.8	3.1	2.3	4.8	4.5
December	2.7	4.0	4.5	1.2	-4.9	-5.4

Estimated Evapotranspiration and Water Balance

