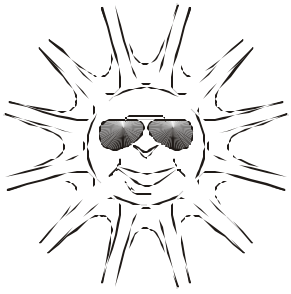
Smithsonian Tropical Research Institute

2001 Meteorological and Hydrological Summary for Barro Colorado Island

Prepared by: Steven Paton



Introduction

This is the eighth 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°10'N, 79°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 2634 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.

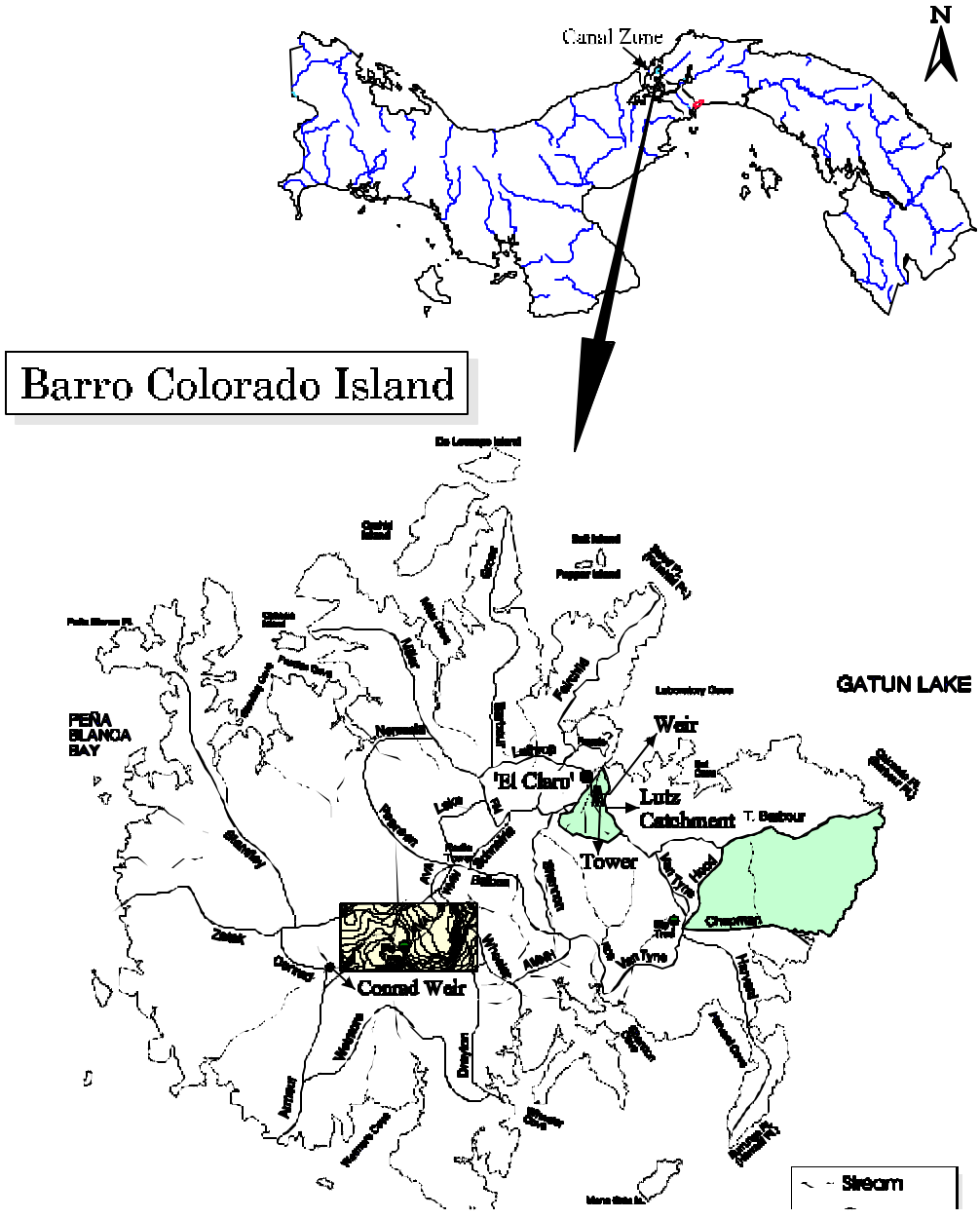
This report summarises data taken from two locations: a 48 m walk-up tower located within the Lutz catchment, and a small clearing ('El Claro') located among several laboratory buildings (see map on the following page). The tower, with sensors at 10 m intervals, provides a vertical meteorological transect 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 2001, 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 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
	42m	**evapotranspiration**
		relative humidity
		solar radiation
		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 (±SD) for the period 1929 to 2000.

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 2000) for the Dry and Wet Seasons. The arrow ⟹ in each graph shows the rainfall for 2001 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 - 2000.

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" day^{-1}
Sea temperature at Amador < 80 °F
< 5 grams of water vapor kg^{-1} below 12,00 ft
Temp-Dew point difference SFC-400 HPA., > 10°C
Howard Airforce Base wind speed SFC-4000 ft., > 15 knots
Inter-Tropical Convergence Zone > 2 deg. Lat. south of Panama
Pacific Coast sea breeze < 2 hours day^{-1}
Atlantic Coast surface wind average > 6.0 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 2000 and for the year 2001.

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 2000 with 2001. The graph on the top of page 18 compares monthly accumulated precipitation with 2001 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 2000 with those for 2001.

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 830 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 pyrranometer attached to a datalogger. Hourly total (KJ m^{-2}), maximum and minimum (J m^{-2} s^{-1}) were recorded. A Li-Cor 190SB sensor recorded Photosynthetically Active Radiation (PAR) similarly.

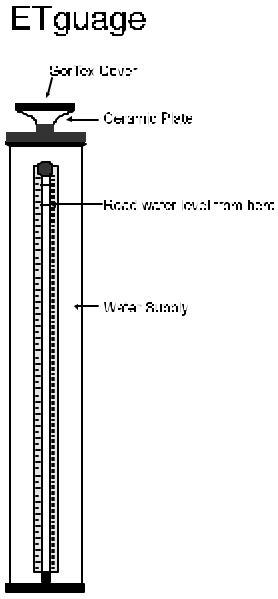
Page 24 shows the Daily Global Radiation values and Page 25 shows the Daily PAR values for 2001. Page 26 shows total monthly Global Radiation and PAR.

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 average and maximum daily wind speeds from the Young Anemometer. The page 28 shows average wind direction. The angles indicated in the table and graph on this page represent the direction from which the wind was predominately blowing on a given day. Page 29 shows the monthly average wind speeds (based on the totalizing anemometer) and directions for the year.

Estimated Evapotranspiration and Water Balance



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.

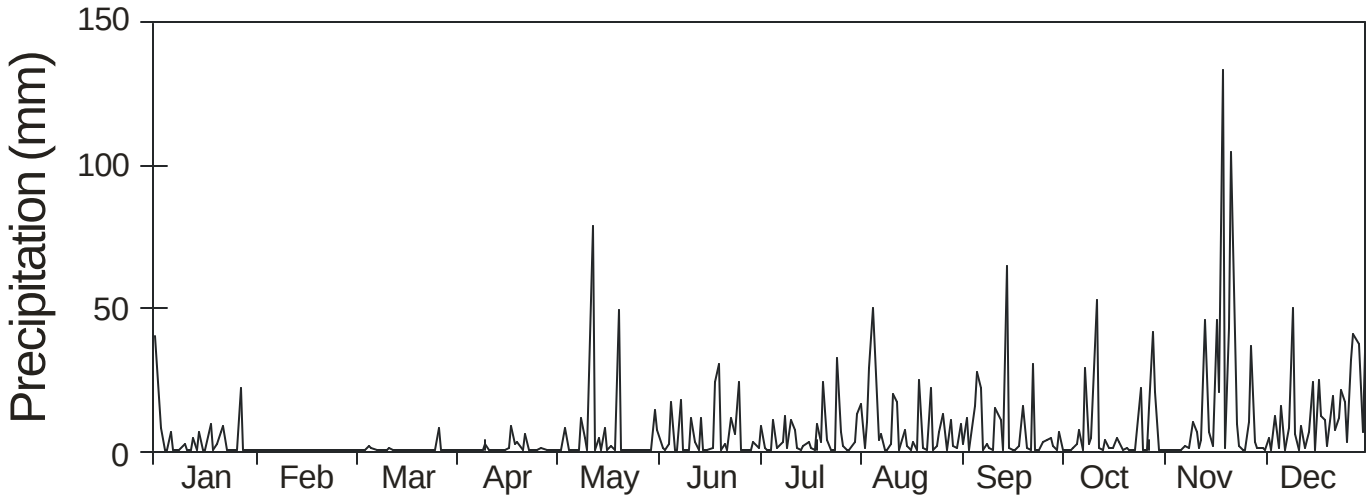
There are two ETgages currently being used on BCI: one in the Clearing located at a height of 1.5m and a second on the top of the 40m tower near the Lutz weir. ETgages are read at approximately the same time of day and with the same frequency and the rain gauges on BCI.

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 2001 are given on pages 30 and 31.

Daily Rainfall (mm) on BCI recorded at 900 hrs

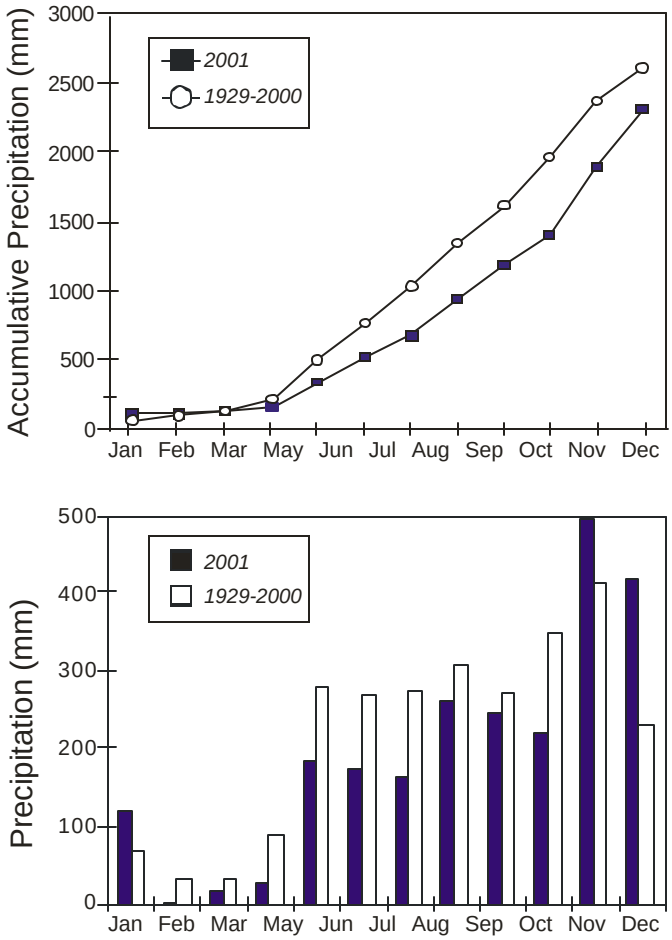
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1	39.7	0.0	0.0	0.3	0.7	7.1	1.5	16.3	2.8	0.0	0.5	0.0
2	8.2	0.0	0.0	0.0	0.0	1.0	8.8	1.0	11.6	0.5	0.0	4.6
3	0.0	0.0	0.0	0.0	0.0	0.3	0.8	10.4	0.0	0.3	0.0	0.0
4	0.0	0.0	0.0	0.0	8.1	2.5	0.0	29.3	15.7	1.0	0.0	12.7
5	6.6	0.0	0.0	0.0	0.0	16.8	0.0	49.8	27.9	2.8	0.0	1.0
6	0.3	0.0	2.0	0.0	0.5	0.0	10.7	4.3	22.4	7.1	0.0	15.5
7	0.5	0.0	0.8	0.0	0.0	0.0	1.2	5.3	0.3	0.0	2.0	0.0
8	0.0	0.0	0.0	0.3	0.0	17.5	3.1	0.0	2.4	29.7	0.8	8.0
9	3.0	0.0	0.0	0.0	11.4	0.0	12.7	0.3	0.9	2.8	10.2	50.0
10	0.3	0.0	0.0	2.3	4.6	0.6	0.8	2.3	0.0	5.1	6.7	6.0
11	0.0	0.0	0.0	0.0	0.0	11.8	10.9	19.8	15.0	53.3	1.3	0.3
12	4.6	0.3	0.8	0.0	78.7	3.0	7.5	17.0	11.1	1.3	4.5	8.4
13	0.0	0.0	0.0	0.0	0.0	0.3	0.9	0.0	0.5	0.0	46.5	0.8
14	6.1	0.0	0.0	0.0	5.1	11.4	0.3	7.4	65.5	4.1	6.1	6.4
15	0.0	0.0	0.0	0.0	0.0	0.0	1.8	2.0	1.0	1.5	1.8	24.2
16	0.0	0.0	0.0	0.5	7.6	0.0	3.7	0.3	0.3	0.8	46.5	0.3
17	9.7	0.0	0.0	0.8	0.0	1.5	1.3	3.3	0.0	4.8	21.1	25.0
18	0.3	0.0	0.0	8.6	1.8	23.7	0.0	0.0	1.8	3.6	133.9	12.2
19	2.8	0.0	0.0	2.8	0.3	31.2	9.4	24.8	15.7	0.0	0.9	10.9
20	6.5	0.5	0.0	3.3	49.2	0.0	3.6	0.9	1.3	0.8	42.9	1.8
21	8.7	0.3	0.0	0.0	0.0	2.3	24.3	0.0	0.0	0.0	104.6	19.3
22	0.3	0.0	0.5	5.8	0.0	0.3	3.9	22.9	30.7	0.0	9.7	7.1
23	0.0	0.0	0.0	0.0	0.0	11.5	0.3	0.0	0.3	0.3	1.8	12.2
24	0.0	0.0	0.7	0.3	0.0	5.6	0.0	1.8	0.3	22.9	0.6	21.4
25	0.0	0.0	0.7	0.0	0.0	23.8	32.5	6.6	3.6	0.0	0.0	17.2
26	22.9	0.0	0.7	0.0	0.0	0.0	6.1	13.7	4.1	0.0	10.1	3.6
27	0.0	0.5	7.9	1.3	0.0	0.0	1.5	0.3	4.6	14.7	36.8	32.0
28	0.0	0.0	0.3	0.3	0.3	0.0	0.3	10.9	1.5	41.6	3.7	41.1
29	0.0		0.0	0.0	0.3	0.0	0.0	1.5	0.0	21.0	1.1	19.8
30	0.0		0.0	0.0	0.3	3.2	3.3	0.8	6.6	0.0	1.0	3.5
31	0.0		0.3		14.0		13.2	9.4		0.0		18.0
	120.3	**1.5**	**14.5**	**26.5**	**182.8**	**175.4**	**164.2**	**262.1**	**247.9**	**219.7**	**495.0**	**383.1**



Monthly Rainfall at 'El Claro' - Rain Guage

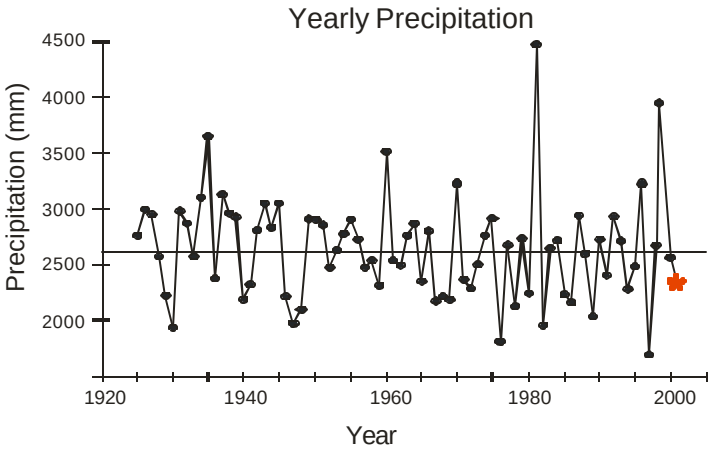
Rainfall (mm)

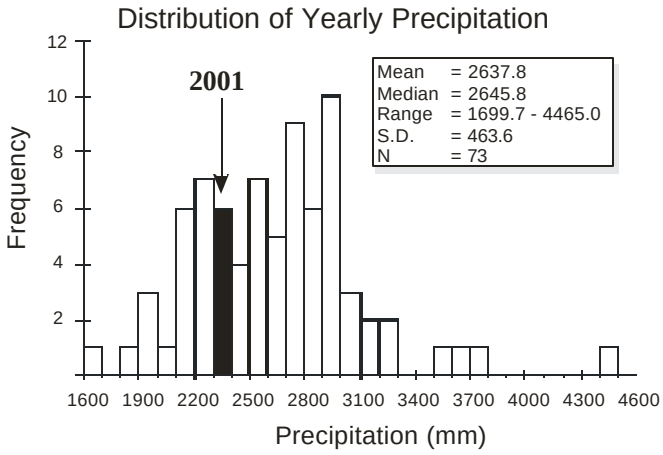
	Average	Min	Max	S.D.	2001	Rank (n=73)
January	69.6	0.0	374.0	76.8	**120.3**	**12**
February	32.7	0.5	186.4	34.5	**1.5**	**71**
March	33.8	0.0	173.7	36.9	**14.5**	**40**
April	93.9	0.0	463.8	88.2	**26.5**	**54**
May	278.5	78.5	622.0	101.5	**182.8**	**61**
June	272.2	66.8	541.0	88.4	**175.4**	**64**
July	274.6	92.0	725.9	96.6	**164.2**	**66**
August	309.5	149.6	586.0	92.9	**262.1**	**50**
September	273.4	130.8	507.0	85.9	**247.9**	**43**
October	350.4	153.9	544.0	92.3	**219.7**	**68**
November	408.2	110.0	1056.1	192.7	**495.0**	**20**
December	241.1	15.9	712.7	175.4	**383.1**	**15**
Total	**2637.8**	**1699.7**	**4465.0**	**463.6**	**2293.1**	**52**


Accumulative Precipitation (mm)
3000
2500
2000
1500
1000
500
0
2001
1929-2000
Jan Feb Mar May Jun Jul Aug Sep Oct Nov Dec
Precipitation (mm)
500
400
300
200
100
0
2001
1929-2000
Jan Feb Mar May Jun Jul Aug Sep Oct Nov Dec

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

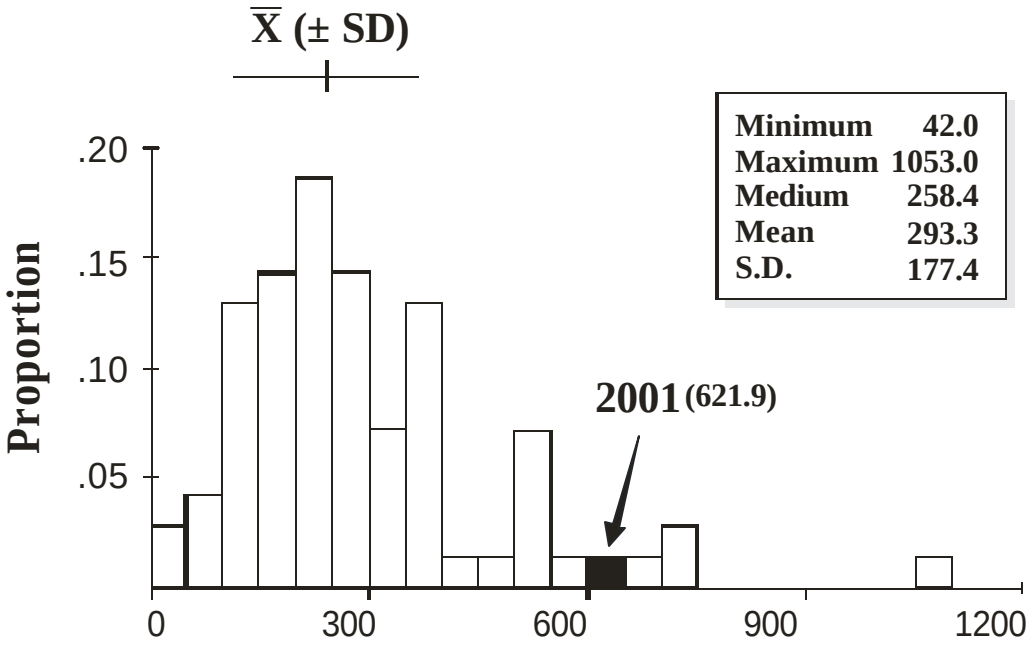
Year	Rain	Year	Rain	Year	Rain
1925	2764.0	1951	2863.8	1977	2685.0
1926	3003.0	1952	2481.6	1978	2132.0
1927	2956.1	1953	2637.5	1979	2742.0
1928	2579.1	1954	2684.3	1980	2252.0
1929	2228.3	1955	2910.3	1981	4465.0
1930	1940.6	1956	2729.7	1982	1960.0
1931	2981.5	1957	2482.1	1983	2654.0
1932	2878.6	1958	2545.1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



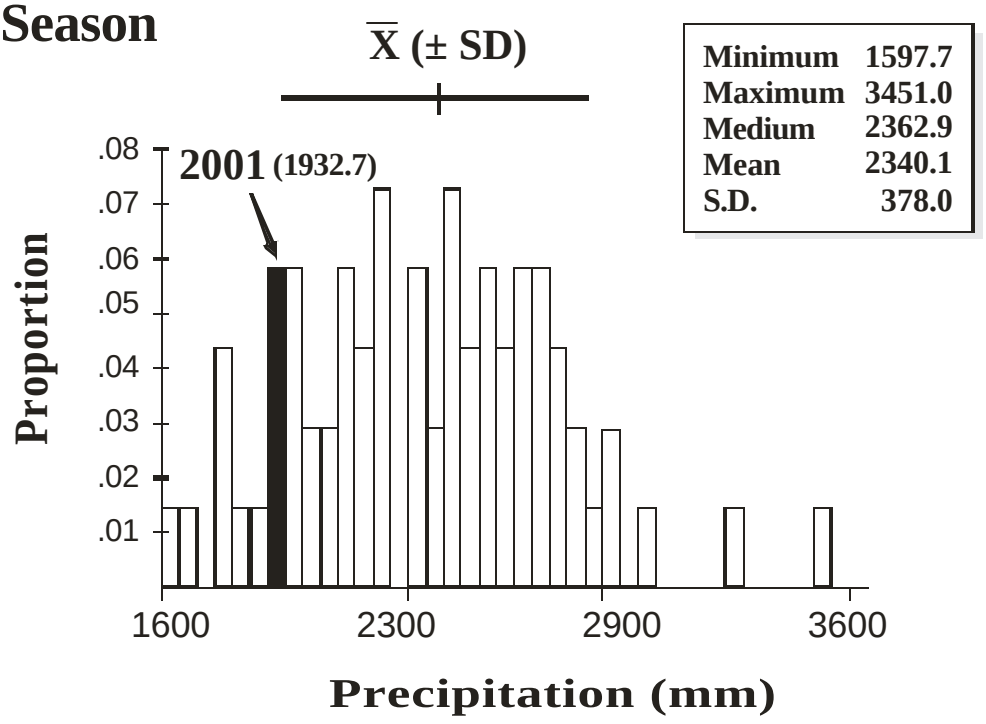


Seasonal Distribution of Precipitation

Dry Season

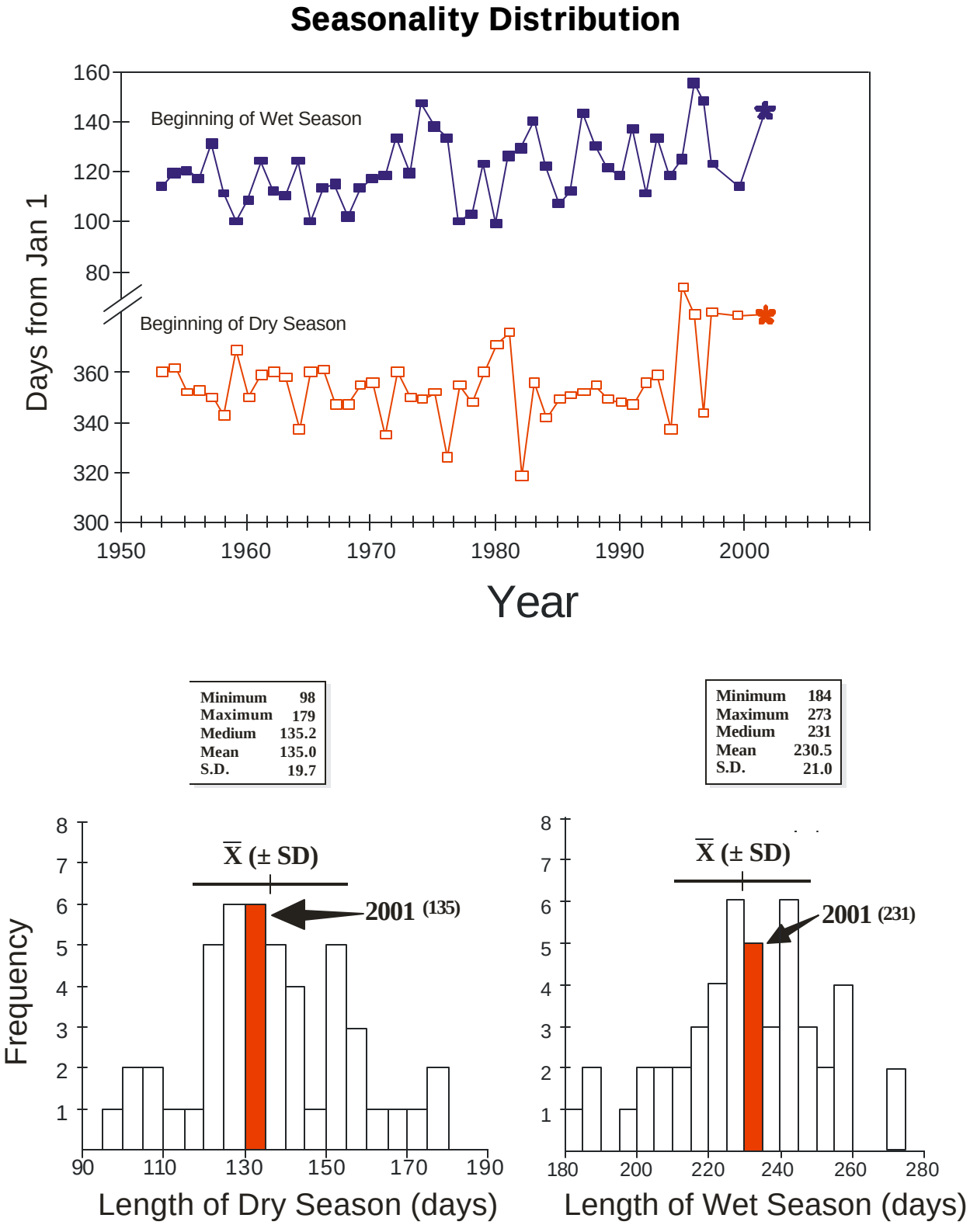


Wet Season



PCC Dry Season Beginning and End Dates

Year	Begin	End	Length	
			Dry Season	Wet Season
1954	25-Dec-1953	27-Apr-1954	123	244
1955	27-Dec-1954	02-May-1955	126	229
1956	17-Dec-1955	02-May-1956	137	229
1957	17-Dec-1956	30-Apr-1957	134	229
1958	15-Dec-1957	14-May-1958	150	208
1959	08-Dec-1958	24-Apr-1959	137	254
1960	03-Jan-1960	12-Apr-1960	100	246
1961	14-Dec-1960	21-Apr-1961	128	247
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
1998	09-Dec-1997	29-May-1998	171	234
1999	18-Jan-1999	3-May-1999	105	259
2000	17-Jan-2001	27-Apr-2000	101	258
2001	**10-Jan-2002**	**26-May-2001**	**136**	**237**
Avg	**20-Dec**	**02-May**	**135.2**	**229.8**
SD	**±14 days**	**±14 days**	**19.9**	**21.0**

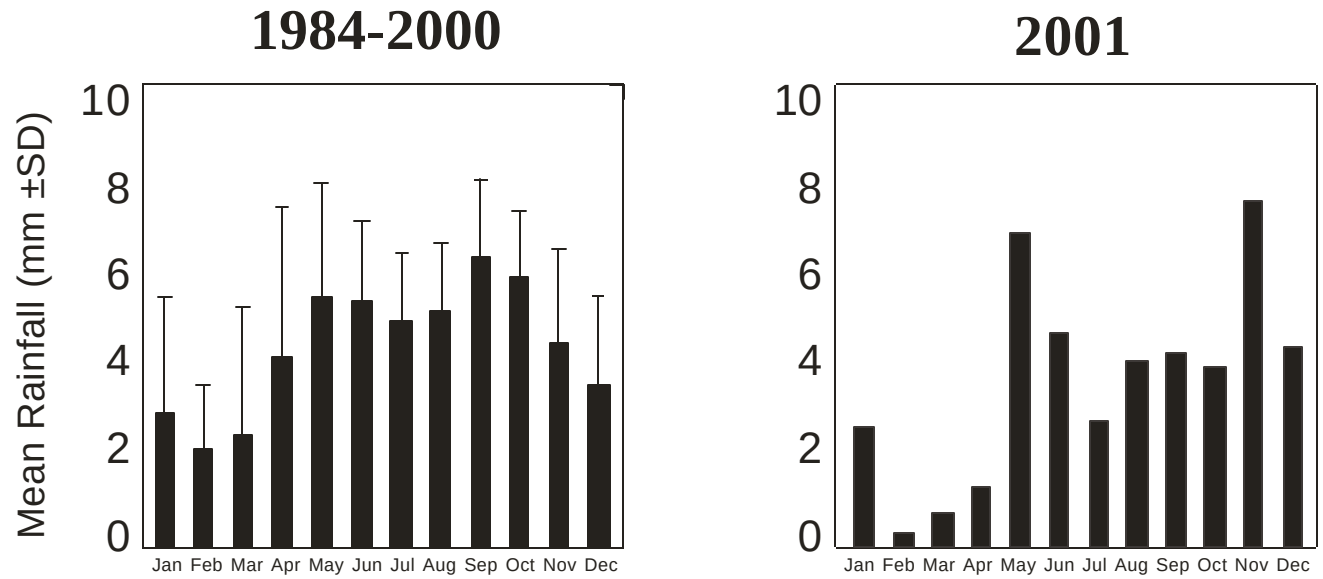

Seasonality Distribution
Beginning of Wet Season
Beginning of Dry Season
Days from Jan 1
Year
160
140
120
100
80
360
340
320
300
1950
1960
1970
1980
1990
2000
Minimum 98
Maximum 179
Medium 135.2
Mean 135.0
S.D. 19.7
Minimum 184
Maximum 273
Medium 231
Mean 230.5
S.D. 21.0
X̄ (± SD)
2001 (135)
Frequency
Length of Dry Season (days)
X̄ (± SD)
2001 (231)
Length of Wet Season (days)

Storm Analysis

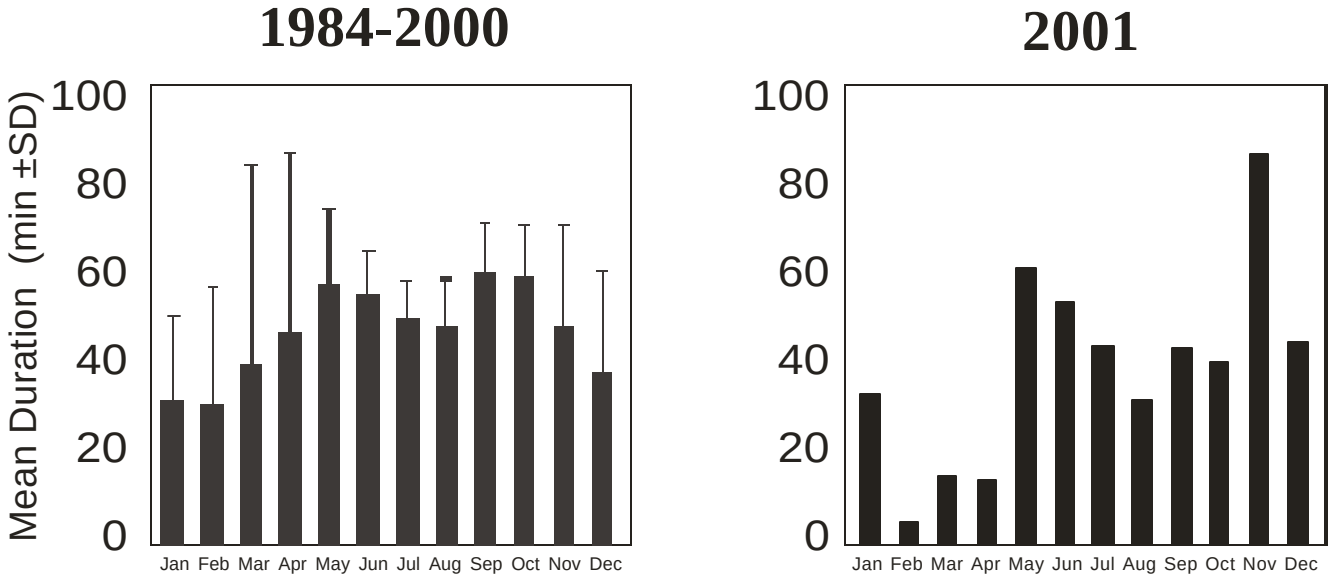
	Max. Rainfall per Storm			Storm Duration (min.)		
	1984-2000		2001	1984-2000		2001
	Mean	S.D.		Mean	S.D.	
January	24.4	28.1	**18.5**	31.3	18.5	**32.8**
February	13.4	12.2	**0.3**	30.5	25.8	**5.0**
March	14.9	15.8	**4.1**	41.7	43.3	**15.0**
April	35.3	34.7	**7.9**	47.8	38.3	**14.2**
May	53.8	29.7	**65.8**	55.2	15.4	**60.2**
June	54.3	22.1	**26.4**	56.2	8.8	**52.5**
July	47.2	16.8	**26.7**	48.6	9.2	**42.8**
August	47.1	16.8	**44.5**	48.0	10.0	**31.3**
September	51.7	20.8	**56.4**	57.8	10.8	**42.4**
October	51.9	22.1	**38.4**	59.0	11.3	**39.6**
November	41.4	13.7	**89.7**	51.2	17.6	**84.3**
December	39.2	26.7	**42.7**	40.6	22.4	**44.1**

	Av. Rainfall per Storm (mm)		
	1984-2000		2001
	Mean	S.D.	
January	2.6	2.1	**2.6**
February	2.1	1.4	**0.3**
March	2.6	2.8	**0.7**
April	4.3	3.3	**1.3**
May	5.4	2.3	**6.8**
June	5.5	1.7	**4.6**
July	4.9	1.4	**2.7**
August	5.0	1.2	**4.0**
September	5.8	1.7	**4.2**
October	6.1	1.3	**3.9**
November	4.8	1.6	**7.5**
December	3.7	1.9	**4.3**

Average Monthly Storm Size

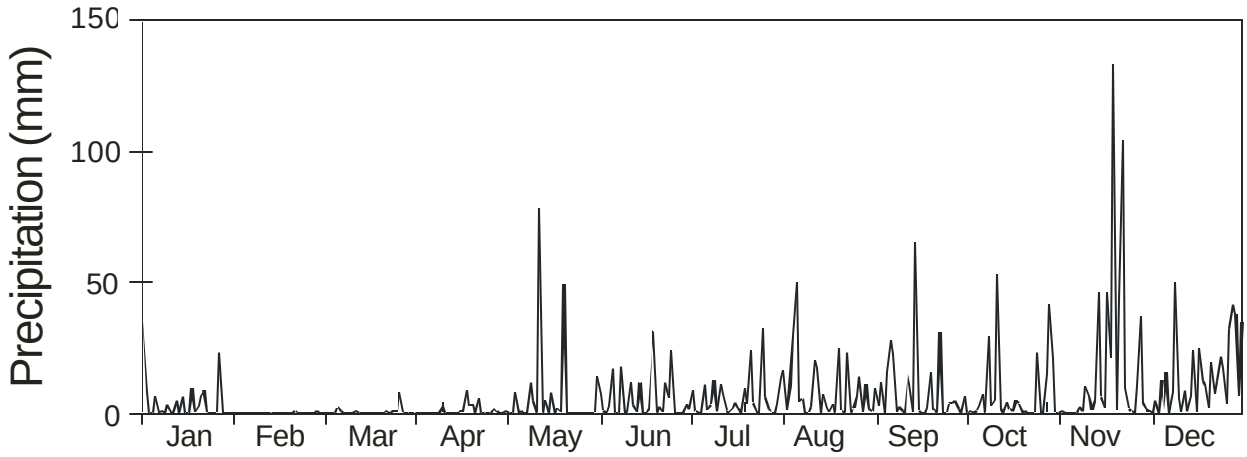


Average Monthly Storm Duration



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

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1	15.2	0.3	0.1	0.0	0.0	0.0	0.1	0.5	0.7	0.4	1.1	2.3
2	8.1	0.3	0.1	0.0	0.0	0.1	0.1	0.3	0.5	0.4	0.9	2.2
3	5.2	0.3	0.1	0.0	0.0	0.0	0.1	1.2	0.8	0.3	0.9	1.7
4	3.6	0.3	0.1	0.0	0.0	0.1	0.1	11.0	0.8	0.3	0.9	2.5
5	3.2	0.3	0.1	0.0	0.0	0.1	0.1	1.2	8.3	0.3	0.8	3.0
6	2.5	0.2	0.1	0.0	0.0	0.0	0.1	0.7	2.0	0.3	0.6	1.9
7	2.1	0.2	0.1	0.0	0.0	0.1	0.1	0.7	1.1	2.2	0.5	1.6
8	1.9	0.2	0.1	0.0	0.0	0.0	0.1	0.4	0.8	0.7	0.7	12.4
9	1.6	0.2	0.1	0.0	0.0	0.0	0.1	0.3	0.6	0.7	0.7	5.2
10	1.4	0.2	0.1	0.0	0.1	0.0	0.1	0.6	0.6	13.6	0.5	3.4
11	1.4	0.2	0.1	0.0	0.0	0.1	0.1	0.9	0.8	3.6	0.6	3.0
12	1.3	0.2	0.1	0.0	0.3	0.1	0.1	1.3	1.1	1.9	0.6	2.4
13	1.2	0.2	0.1	0.0	0.0	0.1	0.1	0.5	13.2	1.3	5.2	2.2
14	1.2	0.2	0.1	0.0	0.1	0.1	0.1	0.5	2.9	1.1	1.6	4.5
15	1.0	0.2	0.1	0.0	0.0	0.0	0.1	0.4	1.4	1.0	10.7	2.9
16	0.9	0.2	0.1	0.0	0.0	0.0	0.1	0.3	0.9	0.9	7.4	4.0
17	1.0	0.2	0.0	0.0	0.0	0.1	0.1	0.3	0.7	0.8	8.5	4.4
18	0.8	0.2	0.0	0.0	0.0	0.9	0.1	0.2	1.2	0.7	76.2	4.3
19	0.8	0.2	0.0	0.0	0.6	0.2	0.1	0.6	0.7	0.6	11.3	4.1
20	1.0	0.2	0.0	0.0	0.1	0.1	0.1	0.4	0.6	0.5	15.5	6.3
21	0.9	0.2	0.0	0.0	0.1	0.1	0.3	2.2	0.6	0.5	70.1	5.0
22	0.8	0.2	0.0	0.0	0.0	0.1	0.2	1.1	2.7	0.4	12.3	4.1
23	0.6	0.2	0.0	0.0	0.0	0.1	0.1	0.6	1.3	0.9	6.3	10.2
24	0.6	0.2	0.0	0.0	0.0	0.5	0.1	0.5	0.9	0.7	4.4	13.1
25	1.4	0.2	0.0	0.0	0.0	0.3	0.9	0.5	0.8	0.5	3.7	10.6
26	0.9	0.2	0.1	0.0	0.0	0.1	0.4	0.6	0.6	0.7	13.0	5.8
27	0.7	0.1	0.1	0.0	0.0	0.1	0.2	0.4	0.6	8.0	6.2	32.8
28	0.7	0.1	0.1	0.0	0.0	0.1	0.2	0.4	0.5	5.0	4.3	19.5
29	0.5		0.1	0.0	0.0	0.1	0.2	0.4	0.6	3.0	3.4	10.0
30	0.4		0.0	0.0	0.1	0.1	0.2	0.5	0.5	1.7	2.7	9.1
31	0.4		0.0		0.1		0.2	0.4		1.3		8.8



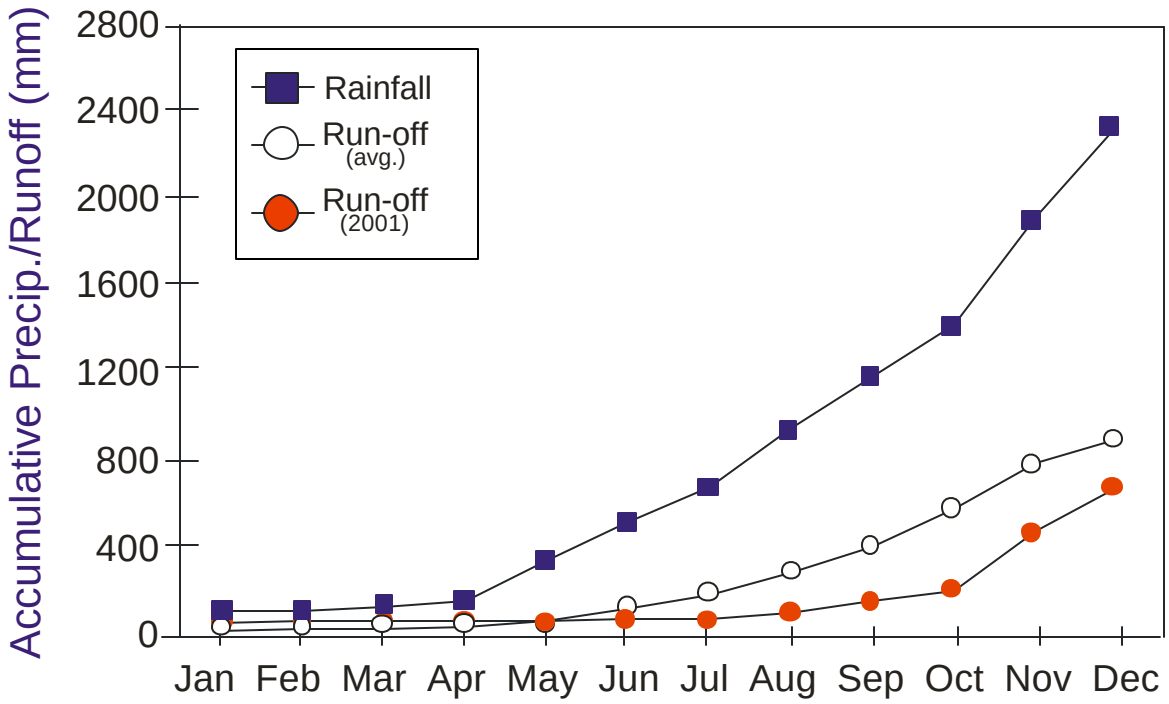
Monthly Run-off at Lutz Weir

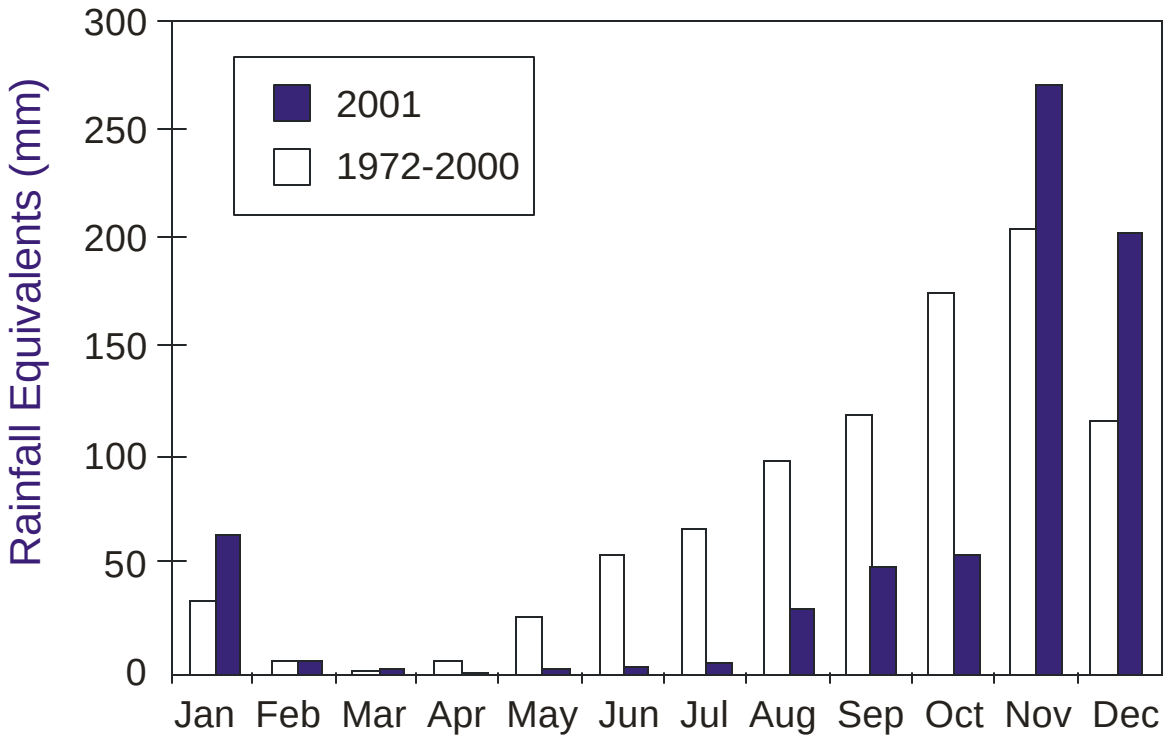
Run-off (mm eq.)

	Long-term Averages (1972 - 2000)				
	Peak	**Delayed**	**Base**	**Total**	**S.D.**
January	13.8	2.1	21.3	**37.2**	64.0
February	0.2	0.3	5.1	**5.5**	10.7
March	0.1	0.2	1.5	**1.8**	2.6
April	3.6	0.6	2.0	**6.1**	20.9
May	13.0	3.8	10.7	**27.5**	44.6
June	27.4	5.8	25.3	**58.5**	74.7
July	23.4	6.7	38.1	**68.2**	52.6
August	41.3	8.2	54.0	**103.5**	77.5
September	45.9	9.0	63.4	**118.3**	69.9
October	70.9	10.5	93.8	**175.2**	83.8
November	79.4	11.3	117.1	**207.8**	110.2
December	48.4	6.3	79.6	**134.3**	119.9
Total	**368.7**	**63.2**	**516.6**	**950.6**	**450.9**

	2001			
	Peak	**Delayed**	**Base**	**Total**
January	1.4	1.0	60.7	**63.1**
February	0.0	0.0	5.9	**6.0**
March	0.0	0.0	1.8	**1.8**
April	0.0	0.0	0.6	**0.6**
May	0.5	0.4	0.9	**1.8**
June	0.4	0.7	2.6	**3.7**
July	0.3	0.7	3.5	**4.5**
August	10.7	4.6	13.9	**29.2**
September	17.3	8.3	23.3	**48.9**
October	20.8	6.1	27.4	**54.4**
November	146.7	15.8	109.3	**271.9**
December	53.8	16.5	132.9	**203.2**
Total	**252.0**	**54.3**	**382.8**	**689.1**

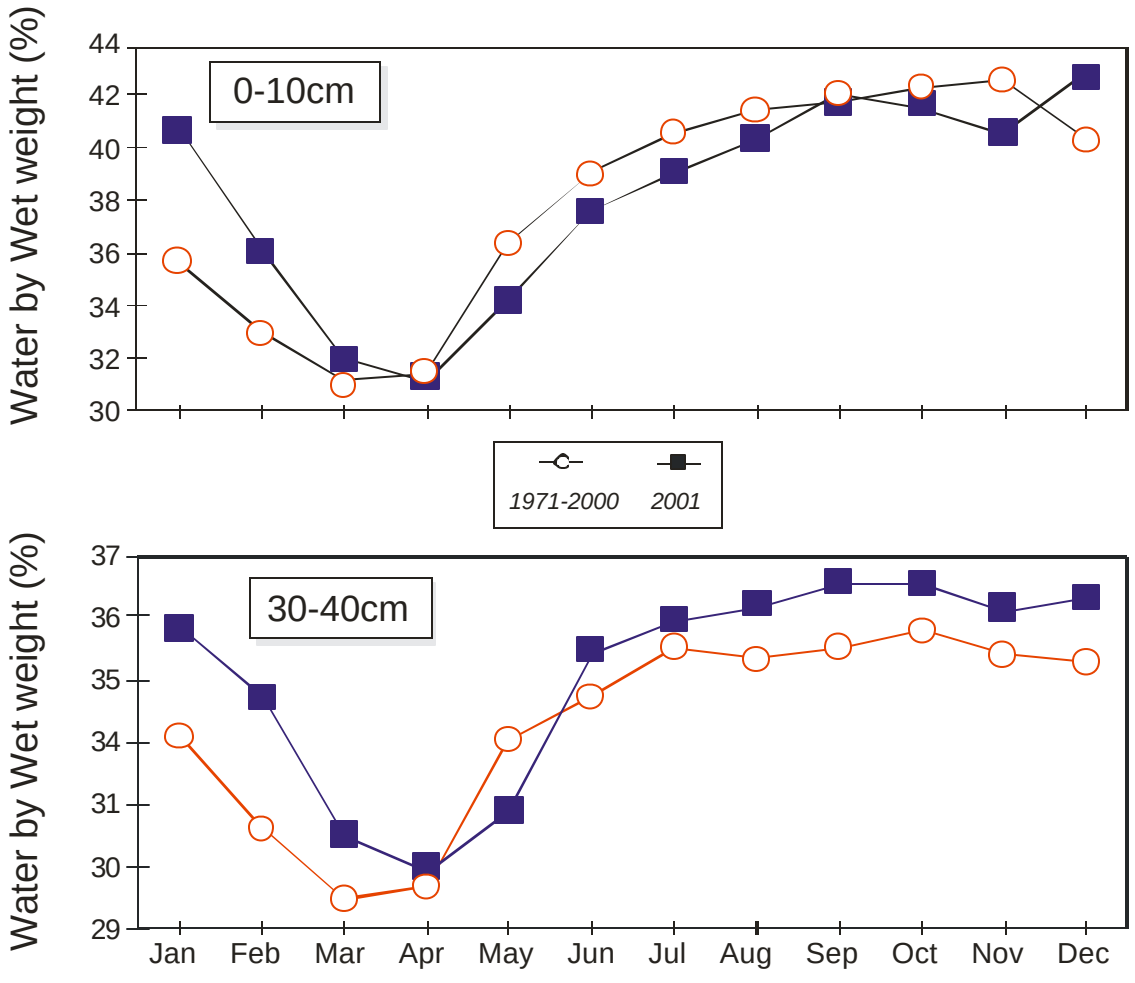
Monthly run-off at Lutz Weir





Lutz Catchment Soil Moisture
(H_2O/wet wt of soil)

	Long-term Averages (1972-2000)				2001	
	0-10 cm		30-40 cm		0-10 cm	30-40 cm
	Mean	S.D.	Mean	S.D.		
January	36.0	3.1	33.2	2.7	**40.9**	**35.5**
February	33.3	2.4	31.3	1.3	**36.2**	**34.0**
March	31.5	2.3	30.0	1.4	**31.1**	**30.2**
April	31.9	2.5	30.3	1.7	**32.0**	**31.0**
May	36.7	2.3	33.4	1.4	**34.3**	**31.5**
June	39.4	1.7	34.4	1.1	**37.7**	**34.9**
July	40.7	1.4	35.3	1.3	**39.2**	**35.6**
August	41.5	1.8	35.0	0.7	**40.5**	**35.9**
September	41.8	1.5	35.3	1.0	**42.2**	**36.4**
October	42.2	1.8	35.5	0.8	**41.7**	**36.4**
November	42.6	1.6	35.3	1.2	**40.7**	**35.8**
December	40.5	2.9	34.9	1.9	**43.0**	**36.1**



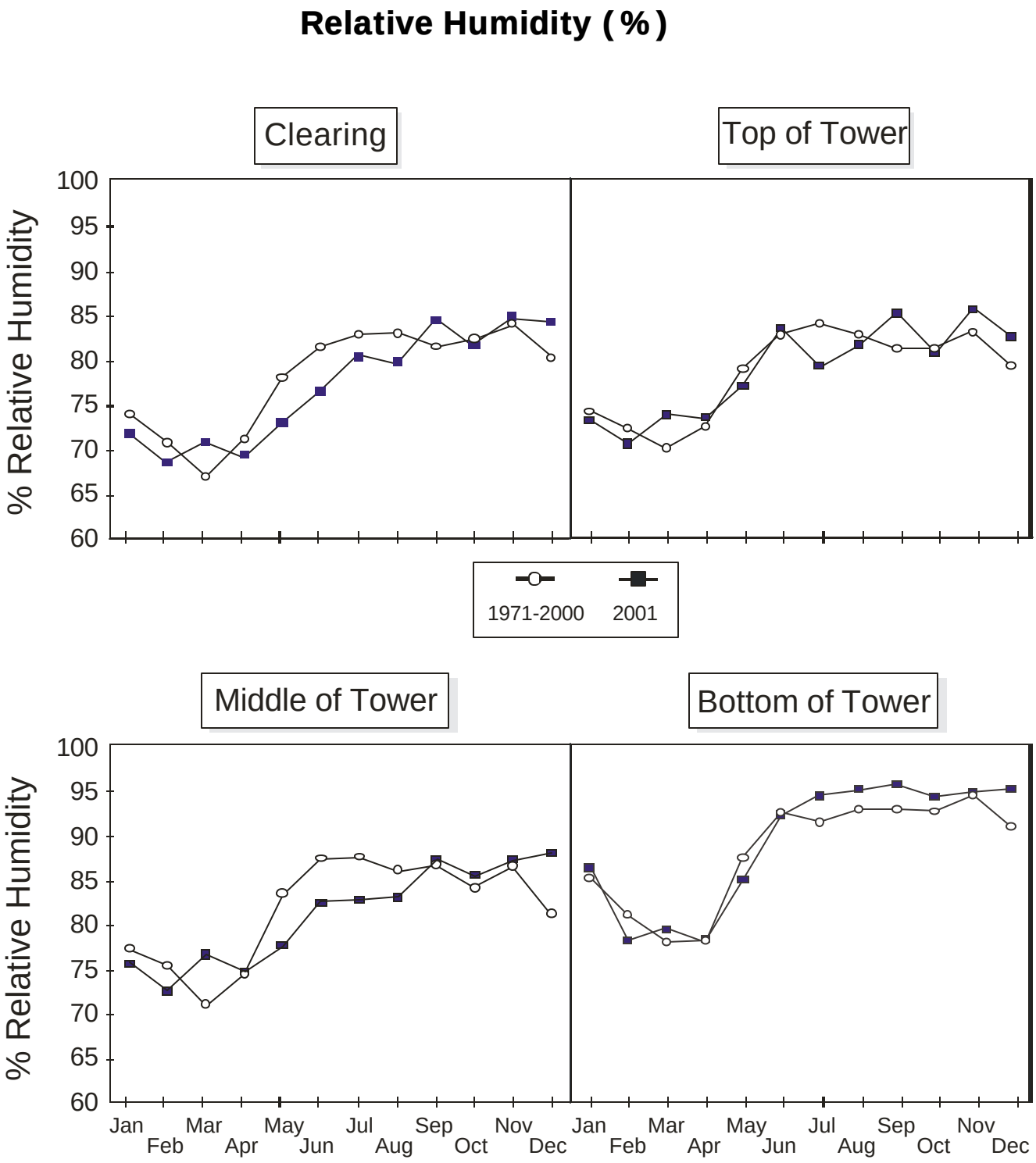
Relative Humidity (%)

Long-term Averages (1972-2000)

	'El Claro'		1m		20m		40m	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
January	73.8	4.4	85.0	3.5	77.1	3.9	74.1	3.4
February	70.8	4.2	81.0	4.0	75.4	4.1	72.2	4.3
March	67.0	3.6	77.9	3.8	70.9	3.2	70.1	2.9
April	71.2	5.2	78.1	4.9	74.3	3.8	72.4	3.0
May	78.0	5.1	87.3	4.0	83.3	2.3	78.9	3.8
June	81.5	4.3	92.4	2.5	87.2	2.6	82.6	3.4
July	82.7	4.7	91.2	6.8	87.4	2.8	83.9	3.1
August	82.8	4.9	92.8	2.9	86.0	2.9	82.7	2.7
September	81.4	5.1	92.8	1.8	86.5	2.5	81.1	3.2
October	82.3	4.1	92.5	6.0	84.0	3.7	81.1	3.6
November	83.9	3.8	94.3	2.7	86.4	4.2	82.9	4.2
December	80.1	4.0	90.8	2.8	81.1	7.1	79.2	5.1

2001

	'El	1m	20m	40m
January	82.1	90.9	84.1	80.9
February	71.8	83.2	76.1	73.6
March	66.9	75.6	72.6	70.7
April	69.4	79.6	73.2	71.8
May	81.2	89.2	85.7	82.7
June	85.3	97.3	89.2	83.2
July	82.3	95.9	84.8	81.3
August	83.4	95.0	86.5	84.7
September	77.1	93.8	83.8	77.9
October	82.9	94.4	85.6	79.2
November	77.8	93.9	82.8	78.8
December	80.1	95.1	84.9	80.5


Relative Humidity (%)
Clearing
Top of Tower
Middle of Tower
Bottom of Tower
% Relative Humidity
100
95
90
85
80
75
70
65
60
1971-2000
2001
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

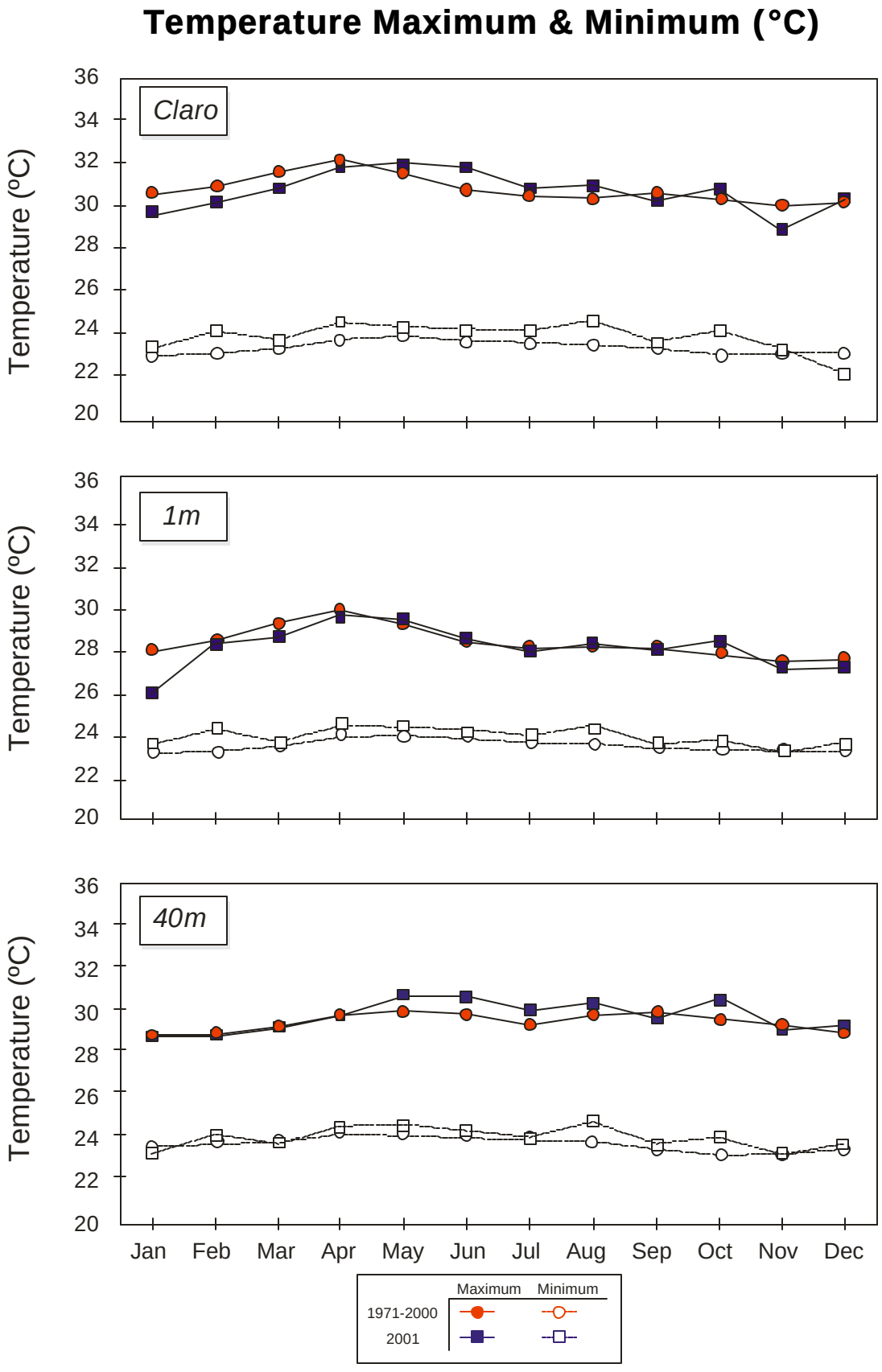
Avg. Monthly Maximum & Minimum (°C) Temperatures

Long-term Average (1972-2000)

	'El Claro'		1m		40m	
	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum
January	30.6	23.1	27.8	23.0	28.7	23.6
February	31.0	23.2	28.2	23.1	28.7	23.7
March	31.6	23.4	29.1	23.4	29.0	23.8
April	32.2	23.9	29.7	23.8	29.7	24.2
May	31.6	24.0	29.0	23.8	29.8	24.1
June	30.8	23.8	28.2	23.7	29.5	24.0
July	30.5	23.7	27.9	23.5	29.1	23.9
August	30.5	23.6	27.9	23.5	29.4	23.8
September	30.7	23.4	27.9	23.2	29.6	23.5
October	30.4	23.2	27.6	23.2	29.3	23.2
November	30.0	23.2	27.3	23.1	29.0	23.3
December	30.2	23.2	27.3	23.1	28.7	23.5

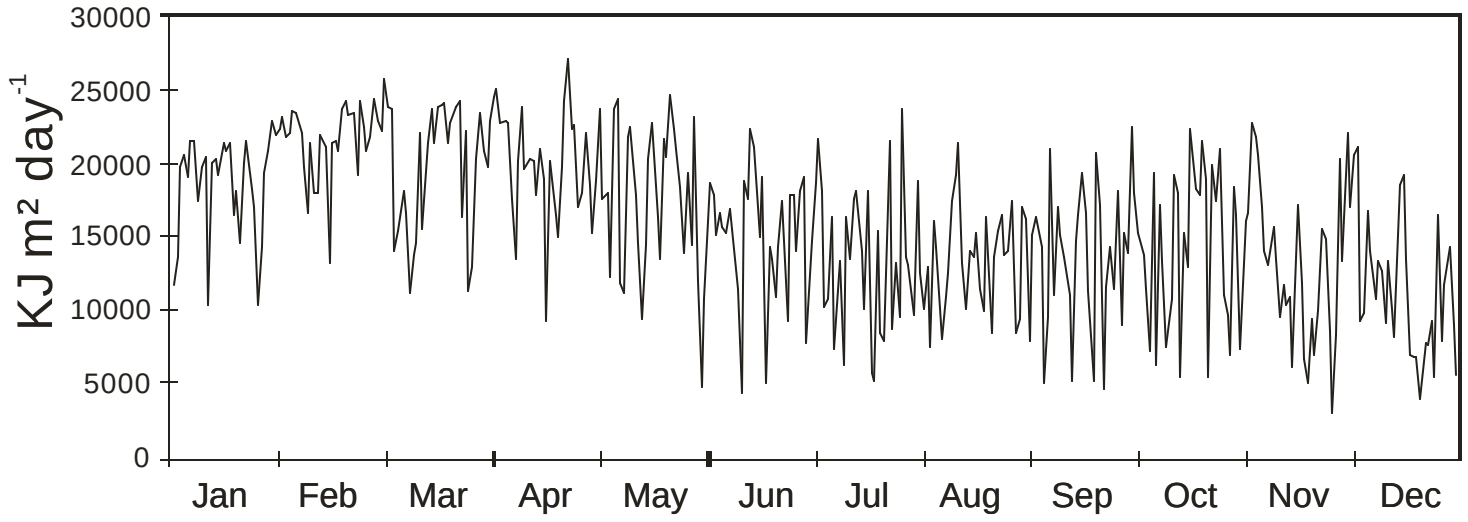
2001

	'El Claro'		1m		40m	
	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum
January	30.4	23.9	27.2	23.9	29.7	23.7
February	30.8	24.0	27.5	24.2	29.8	23.9
March	31.0	24.1	27.8	24.2	30.0	24.0
April	31.1	23.8	27.6	23.9	29.9	23.5
May	30.4	23.7	27.0	23.7	29.6	23.4
June	30.2	23.4	27.0	23.5	29.8	23.3
July	29.1	23.3	26.6	23.5	29.0	23.4
August	29.6	23.4	25.8	23.3	28.7	23.5
September	30.2	24.2	28.1	24.1	28.7	24.2
October	30.8	23.8	28.4	23.7	29.1	23.6
November	31.8	24.6	29.4	24.5	29.7	24.4
December	32.0	24.4	29.2	24.6	30.6	24.3


Temperature Maximum & Minimum (°C)
Claro
1m
40m
Temperature (ºC)
36
34
32
30
28
26
24
22
20
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Maximum
Minimum
1971-2000
2001

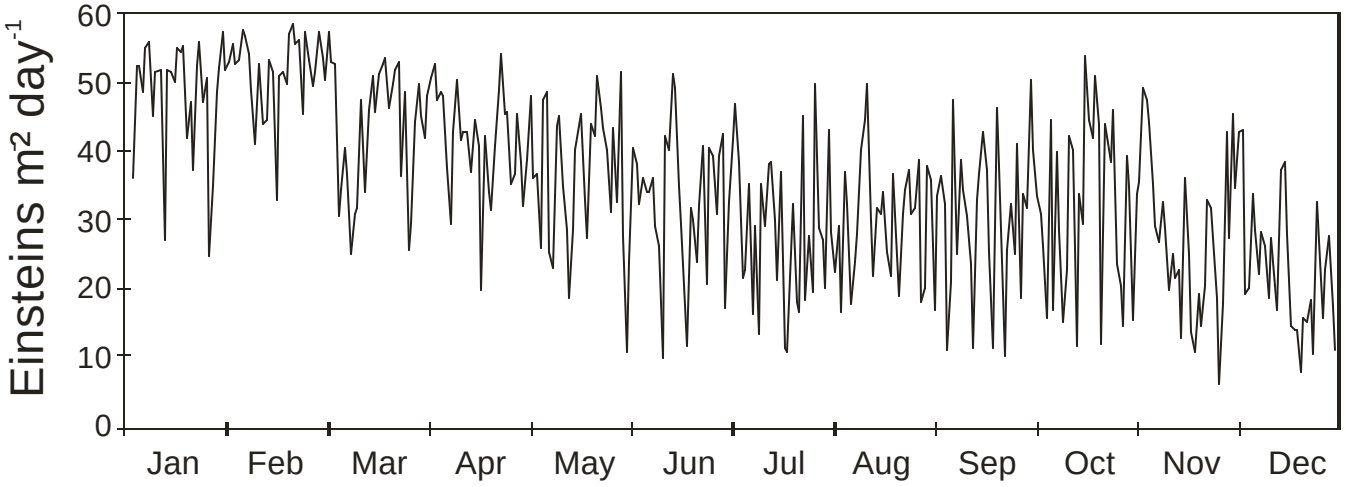
Daily Total Radiation (KJ m^{-2} day^{-1})

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1	11800	23016	22087	22908	18798	10706	14694	12452	7856	17930	15929	17066
2	13580	21667	25598	24409	23602	18651	18671	10116	15084	15267	16611	20574
3	19699	22014	23694	24931	17661	17744	21567	12894	16279	13836	22718	21040
4	20583	23512	23669	22717	17931	15075	18010	7438	14223	11381	21664	9303
5	19072	23301	14051	22838	12290	16606	10243	16006	5068	7134	20592	9847
6	21460	21980	15339	22669	23536	15705	10762	14207	9563	19356	17027	16647
7	21432	19612	17960	17587	24319	15203	16305	8117	20977	6350	14040	14064
8	17386	16502	16592	13475	11806	16873	7371	10823	11005	17079	13011	10718
9	19705	21270	11079	20110	11147	15587	13390	12490	17010	13296	15657	13317
10	20406	17936	13807	23755	21693	11474	6243	17478	15145	7525	13459	12546
11	10410	17869	14493	19569	22436	4335	16288	19157	13603	10772	9579	9065
12	19983	21815	22031	20261	17678	18707	13495	21252	11012	19164	11761	13329
13	20207	21159	15502	20075	14533	17575	17653	13253	5229	17949	10407	10181
14	19254	13250	21268	17734	9394	22260	17975	10129	14706	5399	10831	8216
15	21215	21243	23653	20949	14375	21044	14094	14095	16485	15212	6118	18542
16	20766	21360	21277	18922	20196	14913	10090	13691	19354	12935	17151	19162
17	21244	20836	23763	9219	22660	19127	18051	15193	16621	22352	11829	13554
18	16396	23618	23911	20049	16322	5070	5655	11416	11259	18173	6712	7113
19	18045	24178	23995	16488	13496	14182	5309	9985	5217	17740	5141	6895
20	14501	23165	21198	15006	21480	13489	15467	16287	20656	21420	9346	6884
21	19998	23313	22760	19614	20367	10842	8533	8544	17202	18871	7043	3968
22	21342	19169	23755	24142	24648	14155	7940	13619	4705	5465	10035	7829
23	18217	24147	24152	26962	22297	17497	21448	15335	11648	19787	15483	7565
24	17066	22371	16246	22277	21035	9184	8795	16468	14276	17478	14810	9282
25	10410	20780	22186	22525	18344	17769	13240	13759	11398	20974	8686	5356
26	14262	21645	11254	17007	13863	17710	9537	14027	18093	11049	3032	16433
27	19311	24363	12885	17886	19276	14090	23669	17422	8938	9664	8410	7976
28	20775	22848	20291	22036	14387	18058	13617	8505	15239	7061	20159	11784
29	22909		23245	18402	23004	19013	13001	9376	13981	18320	13292	14194
30	21786		20791	15282	12082	7782	9738	17068	22451	16365	21980	8915
31	22269		19593		4778		18726	16184		7393		5562



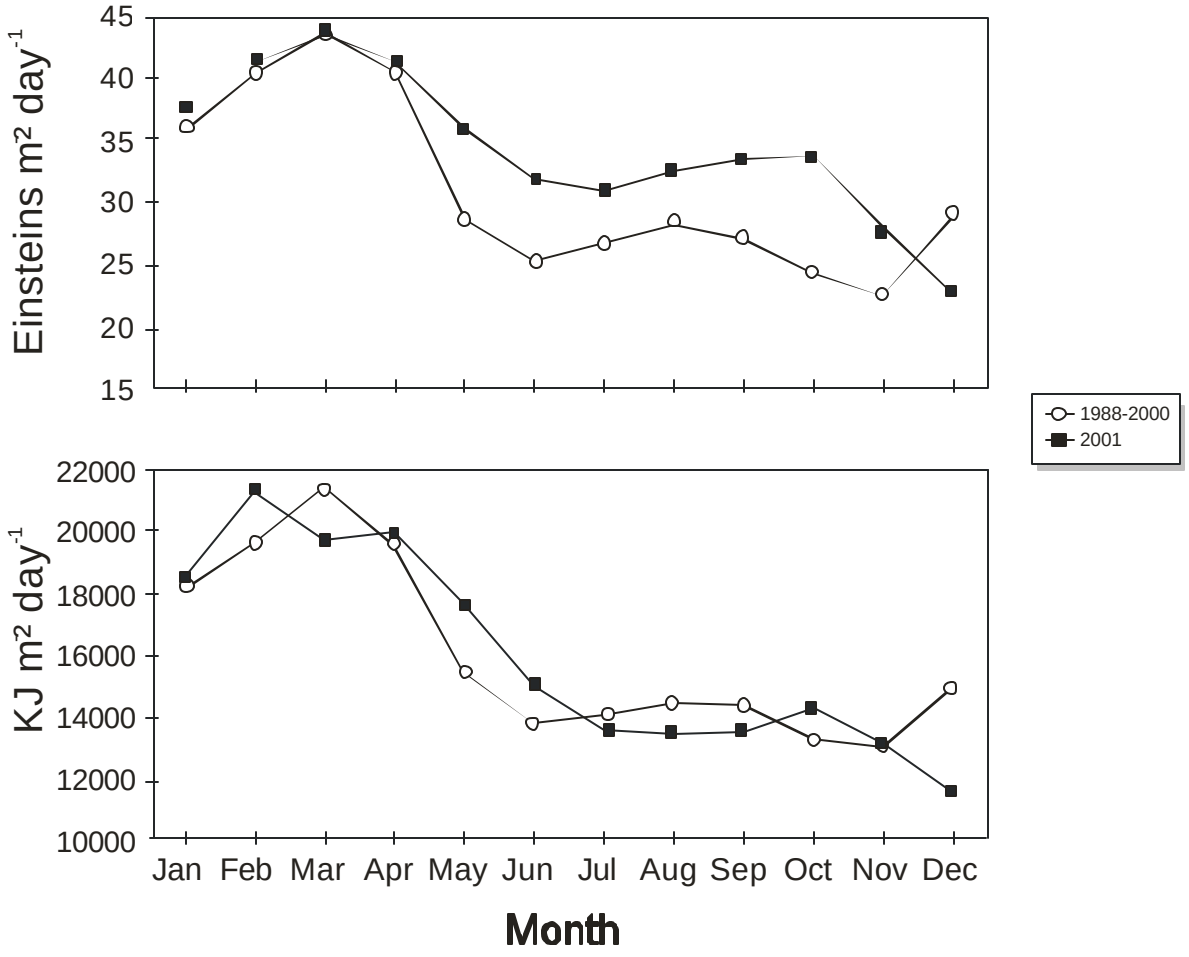
Daily Total PAR (Einsteins m^{-2} day^{-1})

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1	32.3	55.7	50.5	48.1	39.0	24.2	32.9	28.5	17.4	40.2	34.1	34.9
2	36.4	52.8	57.4	50.9	48.2	40.5	41.6	22.8	33.9	33.7	35.9	42.9
3	52.6	53.6	53.3	52.9	36.5	38.4	47.0	29.3	36.8	31.0	49.3	43.2
4	52.5	57.6	52.9	47.7	37.0	32.6	38.8	17.0	32.6	26.2	47.6	19.6
5	48.8	56.6	30.9	48.8	25.9	36.3	21.9	37.3	11.3	16.1	44.4	20.5
6	55.1	54.5	34.7	48.3	47.7	34.4	23.1	32.6	21.4	44.8	35.5	34.1
7	55.7	48.9	40.4	37.9	48.8	34.2	35.6	18.1	47.6	17.3	29.2	28.8
8	45.4	41.2	37.1	29.6	25.4	36.2	16.5	24.2	25.1	39.8	26.8	22.5
9	51.7	52.8	25.1	43.0	23.3	29.4	29.4	28.2	38.9	28.6	32.9	28.3
10	52.1	44.1	31.2	50.5	43.8	26.2	13.8	40.2	34.6	15.4	28.9	26.5
11	27.3	44.7	31.9	41.7	45.2	10.2	35.5	44.5	30.8	23.1	20.3	19.1
12	52.2	53.5	47.5	42.8	35.3	42.3	29.4	50.0	24.1	42.4	25.2	27.4
13	51.8	51.8	34.3	42.9	28.9	40.1	38.3	30.3	11.6	40.1	21.8	20.8
14	50.3	33.0	46.1	37.4	18.9	51.3	38.6	22.3	33.2	11.8	23.0	17.1
15	55.0	51.2	51.1	44.5	28.8	49.4	30.3	32.0	37.0	34.0	13.0	37.4
16	54.8	51.8	45.7	40.8	40.4	35.3	21.7	31.1	43.0	29.5	36.3	38.9
17	55.3	50.0	51.5	20.3	45.6	29.8	37.2	34.3	37.5	54.1	25.1	28.1
18	42.0	57.0	52.9	42.3	33.0	11.9	11.6	25.6	25.5	44.6	14.1	14.9
19	47.2	58.4	53.8	34.4	27.6	32.0	11.1	22.3	11.5	42.1	11.1	14.2
20	37.5	55.7	46.3	31.7	44.0	30.2	32.6	36.9	46.3	51.1	19.5	14.2
21	52.7	56.1	49.9	40.8	42.4	24.3	18.5	19.4	38.3	44.0	14.9	8.4
22	55.9	45.7	52.0	49.1	51.2	32.3	16.9	31.0	10.3	12.3	20.9	16.1
23	47.5	57.4	53.3	54.5	46.4	40.7	45.2	34.7	25.8	43.9	33.1	15.5
24	50.9	53.6	36.7	45.6	43.6	21.2	18.8	37.7	32.4	38.8	31.9	18.6
25	24.9	49.5	48.8	45.9	40.3	40.6	27.9	31.2	25.3	46.0	18.9	10.8
26	35.3	51.9	25.8	35.4	31.3	39.7	20.0	31.9	41.1	23.9	6.6	32.8
27	48.7	57.4	29.5	36.9	43.6	31.1	50.1	39.0	19.1	20.9	18.0	16.0
28	52.4	53.9	44.4	45.5	32.9	39.6	28.9	18.4	34.1	14.9	42.9	23.2
29	57.2		49.8	38.6	51.6	42.5	27.4	20.6	31.9	39.7	27.5	27.8
30	51.9		45.1	32.1	27.9	17.4	20.6	38.3	50.6	35.1	45.6	17.8
31	53.1		42.0		11.2		43.2	36.2		15.8		11.3



Total Monthly Solar Radiation

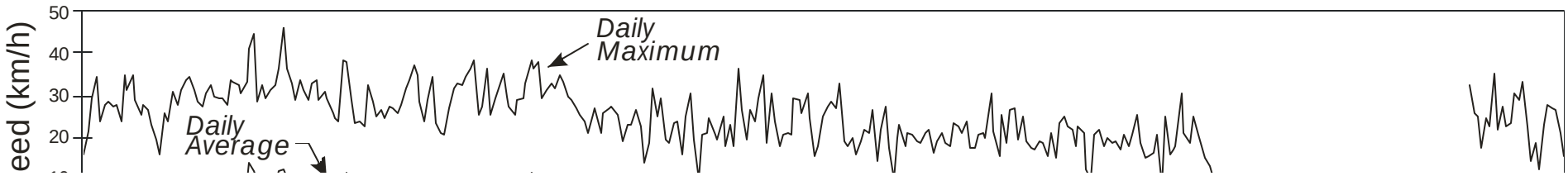
	Long-term Average (1988-2000)				2001	
	PAR (Einsteins m^{-2} day^{-1})		Pyranometer (KJ m^{-2} day^{-1})		PA R	Pyran.
	Mean	S.D.	Mean	S.D.		
January	36.5	4.3	18095.1	1400.8	**47.9**	**18564.2**
February	40.1	4.0	19578.4	1252.4	**51.8**	**21355.0**
March	42.5	3.8	21819.5	2069.8	**43.6**	**19745.9**
April	40.3	3.6	19518.2	1335.3	**42.0**	**19993.4**
May	31.3	3.6	15364.3	1611.2	**37.0**	**17723.7**
June	27.9	3.5	13688.1	1234.0	**33.1**	**15014.2**
July	28.5	3.7	14004.7	1317.6	**29.2**	**13534.8**
August	28.9	3.9	14388.7	1502.5	**30.5**	**13444.7**
September	28.9	3.5	14226.7	1811.7	**30.3**	**13476.2**
October	26.8	4.8	13268.8	1607.0	**32.3**	**14280.6**
November	22.8	8.0	12289.0	3328.1	**27.8**	**13083.8**
December	28.4	6.8	14763.8	2157.1	**23.6**	**11513.7**


Einsteins m² day-1
45
40
35
30
25
20
15
KJ m² day-1
22000
20000
18000
16000
14000
12000
10000
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Month
1988-2000
2001

Daily Average and Maximum Wind Speed (km/h)

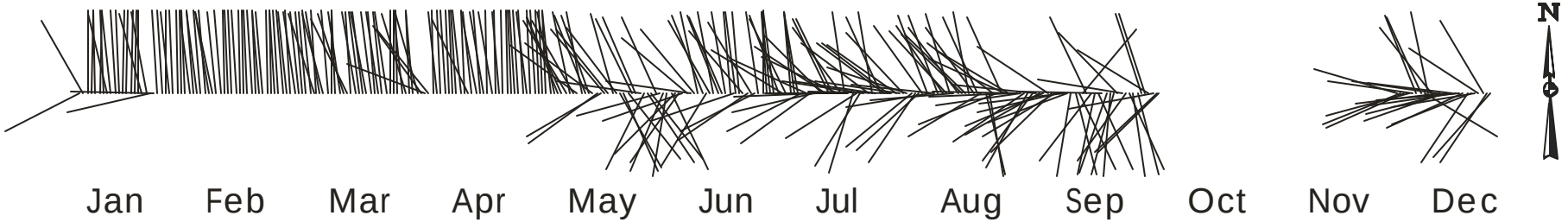
	Jan.		Feb.		Mar.		Apr.		May		June		July		Aug.		Sep.		Oct.		Nov.		Dec.	
1	3.0	16.2	8.9	32.6	8.2	30.8	4.1	27.0	8.1	29.3	1.9	10.2	2.4	18.4	2.8	18.8	2.0	22.3	4.3	25.2	**2.7**		**4.4**	
2	3.8	21.9	8.3	30.1	6.0	29.4	9.6	32.0	7.7	26.9	2.7	20.5	4.8	25.2	2.3	18.1	2.6	18.5	4.6	20.7	**2.7**		**4.4**	
3	8.1	29.7	6.3	29.7	6.7	26.3	8.2	32.9	5.9	25.4	2.9	21.2	6.9	27.7	2.1	23.8	2.5	22.6	2.6	18.4	**2.7**		**4.0**	
4	9.1	34.5	6.6	29.4	5.1	24.8	9.0	32.7	4.0	24.1	2.0	24.7	7.3	28.6	1.5	22.5	2.4	21.4	2.3	15.1	**2.7**		**3.2**	
5	5.7	24.1	7.0	28.3	4.6	24.1	10.3	34.6	3.7	21.3	2.5	20.5	5.4	27.2	1.6	21.3	2.3	12.6	2.2	13.3	**2.7**		**2.0**	
6	6.4	28.1	10.7	33.9	9.8	38.4	10.6	36.7	4.2	25.5	3.5	19.5	3.7	32.8	2.8	24.4	1.3	10.6	2.2	11.0	**3.6**		**3.8**	
7	6.8	28.7	10.8	33.5	11.8	37.9	11.0	38.4	5.0	26.9	2.8	24.9	2.6	19.2	3.7	17.6	2.2	20.5			**2.6**		**2.9**	
8	3.8	27.7	9.7	32.6	9.8	29.3	8.6	25.6	3.6	21.2	3.2	18.3	2.9	18.4	3.0	17.9	2.5	22.4	**3.5**		**3.2**		4.2	32.7
9	6.0	28.1	10.8	30.4	6.5	23.7	7.4	27.7	2.5	26.0	3.4	23.0	2.3	20.2	3.0	20.8	2.1	18.5	**4.0**		**2.7**		4.0	26.2
10	7.0	24.1	10.5	33.7	3.2	24.0	9.5	36.4	4.6	26.9	3.3	18.4	2.4	16.5	3.6	21.4	2.7	20.1	**1.8**		**2.7**		3.4	24.9
11	7.6	34.8	14.5	41.3	3.6	22.9	6.0	25.4	5.6	27.7	1.9	36.6	3.0	19.4	3.9	20.3	3.0	19.0	**1.5**		**2.7**		3.5	17.7
12	8.9	31.8	12.5	44.9	8.2	32.4	8.2	29.7	5.6	25.4	3.2	26.7	3.0	22.4	3.8	30.7	2.4	19.1	**1.9**		**3.8**		4.9	24.4
13	8.9	34.8	10.5	28.4	7.1	28.6	6.7	31.9	4.1	23.6	3.6	19.6	4.1	21.2	5.1	21.6	2.2	17.1	**1.8**		**2.9**		5.1	22.9
14	7.5	29.0	10.6	32.5	6.5	25.3	7.7	35.2	2.4	19.2	3.8	26.8	4.5	26.5	3.0	15.7	2.6	20.7	**2.0**		**2.2**		2.2	35.4
15	8.6	25.7	9.7	29.4	6.6	26.7	6.8	29.9	2.9	23.4	4.1	24.0	3.1	14.9	4.8	25.4	2.5	18.1	**2.2**		**1.2**		4.7	22.2
16	8.2	28.2	9.2	31.8	5.1	24.7	8.7	27.4	3.2	23.3	6.0	29.4	2.3	22.1	3.0	18.8	3.6	20.7	**1.6**		**2.9**		6.5	27.4
17	5.5	26.8	9.0	32.5	6.8	27.4	6.3	25.4	3.7	26.5	8.4	34.8	4.8	27.8	3.7	26.5	3.1	25.4	**2.8**		**2.9**		4.6	22.8
18	5.3	23.0	12.3	36.7	6.4	27.3	9.3	29.1	4.1	22.7	3.7	18.6	2.8	18.0	3.6	27.2	2.1	18.8	**2.6**		**2.9**		3.7	23.5
19	3.2	20.0	13.1	46.5	6.0	26.0	8.5	29.4	2.8	14.5	5.7	30.5	1.8	10.2	1.1	19.9	2.3	15.5	**2.7**		**2.2**		3.1	30.4
20	2.9	16.1	10.9	36.3	5.7	28.3	10.3	33.0	2.8	18.7	6.2	24.1	2.5	20.0	2.0	25.2	2.2	15.6	**2.7**		**2.6**		4.3	29.2
21	6.7	26.3	9.7	33.0	7.7	32.2	12.0	38.5	3.2	31.9	3.3	18.1	2.2	23.2	1.7	19.5	2.4	16.7	**2.7**		**2.6**		4.8	33.6
22	6.8	24.4	8.8	29.3	11.1	34.1	9.9	36.5	3.9	25.0	2.3	20.6	2.1	18.4	2.9	17.7	2.4	20.6	**1.4**		**2.2**		3.3	22.8
23	7.3	31.3	8.1	34.2	10.8	37.5	9.3	37.7	3.1	29.6	3.1	21.1	2.6	21.0	1.7	17.1	1.9	8.7	**2.5**		**1.9**		3.4	14.8
24	6.6	28.3	9.4	31.6	9.3	34.7	8.3	29.4	3.2	19.8	3.4	20.8	4.0	20.7	2.6	19.0	2.0	25.3	**2.0**		**1.9**		4.3	18.6
25	9.2	31.7	7.4	29.3	8.1	28.8	8.6	31.8	2.6	18.9	5.1	29.7	3.0	19.2	2.5	19.0	2.5	16.5	**2.6**		**1.9**		2.9	12.7
26	9.6	33.9	8.3	32.9	6.1	24.4	8.0	33.1	2.5	23.7	8.6	29.0	2.7	18.6	2.5	16.0	2.5	17.4	**2.1**		**1.5**		3.3	23.0
27	10.5	34.4	9.6	34.2	9.6	28.9	10.4	32.0	2.6	24.3	7.2	25.9	3.8	21.2	3.4	21.0	3.0	18.2	**2.1**		**2.3**		3.6	27.9
28	9.1	31.6	8.4	29.1	8.7	34.6	10.9	34.7	2.0	16.5	6.1	30.5	2.4	22.1	2.5	15.4	3.6	30.6	**2.1**		**2.3**		5.3	27.1
29	7.9	28.7			5.5	23.7	10.8	33.5	3.4	25.3	5.2	24.5	2.7	16.6	3.2	23.5	3.4	21.1	**3.5**		**1.8**		6.8	26.6
30	7.1	27.8			3.4	21.1	9.4	29.8	2.6	30.4	2.9	15.7	2.6	19.3	3.5	25.3	2.7	19.0	**3.3**		**4.6**		4.4	21.0
31	7.1	30.3			2.7	20.6			2.4	19.6			3.0	21.2	3.3	22.7			**2.9**				2.3	15.7

(Bolded data taken from totalizing anemometer)



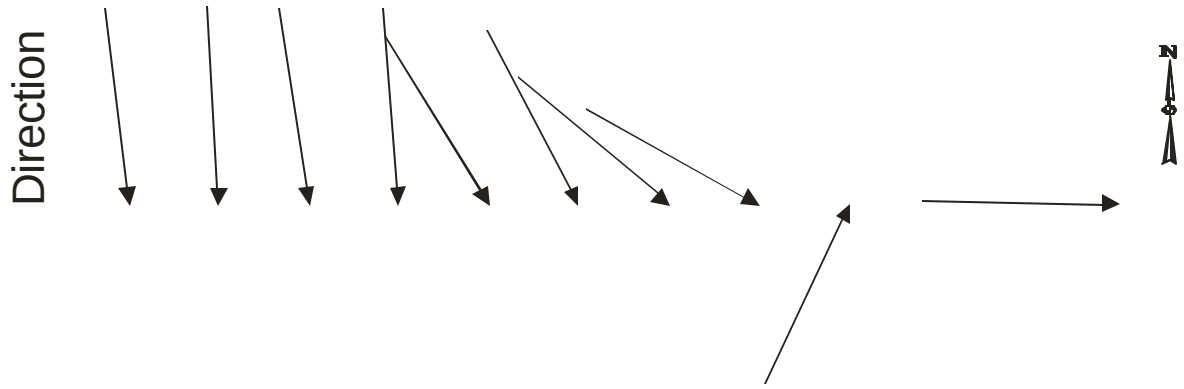
Average Daily Wind Direction

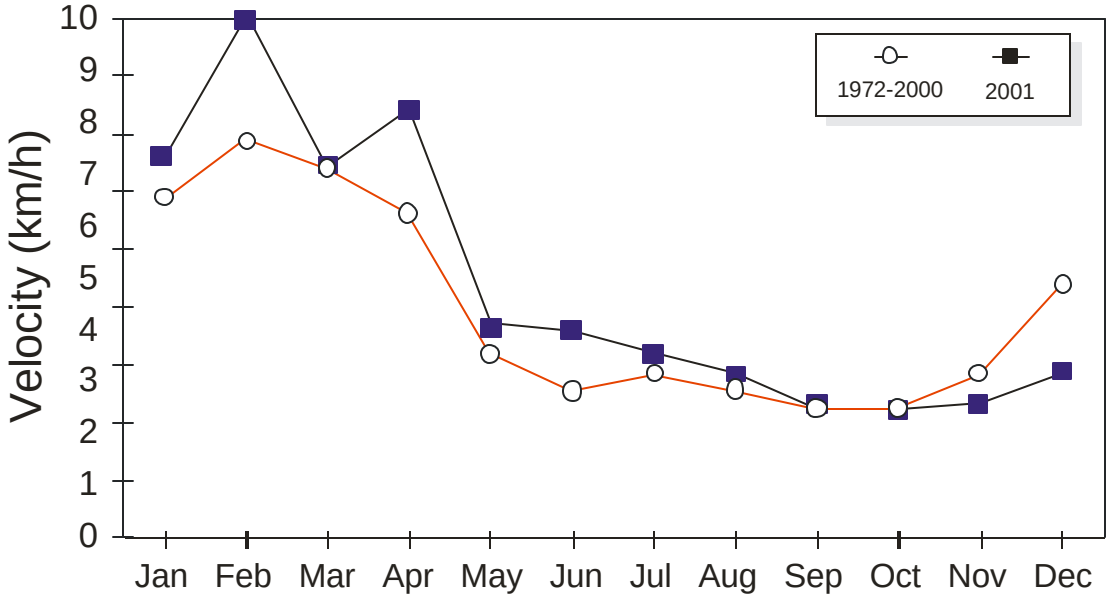
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1	243	355	356	321	357	189	302	317	235	343		
2	330	357	343	358	355	153	333	288	210	343		
3	0	351	355	354	349	225	355	230	213	302		
4	1	349	350	357	338	214	353	214	276	260		
5	358	354	345	357	335	251	350	228	241	226		
6	1	357	356	357	330	311	242	325	247	226		
7	358	359	359	357	348	279	295	340	305			286
8	346	358	357	356	331	321	234	261	227			248
9	354	358	351	355	307	348	257	276	239			246
10	358	358	342	357	350	339	268	339	257			254
11	357	359	333	333	339	211	315	327	264			279
12	2	359	355	353	342	331	304	318	250			339
13	2	358	350	349	307	350	333	343	189			337
14	1	358	353	356	234	339	334	265	165			121
15	2	358	353	351	240	338	296	324	153			348
16	0	355	349	358	320	351	324	315	39			322
17	344	355	353	351	322	356	353	315	335			279
18	350	359	355	358	346	252	271	349	217			264
19	257	359	352	355	323	353	197	324	191			252
20	272	356	353	358	151	354	238	335	155			256
21	356	356	352	359	157	318	212	239	272			277
22	358	357	359	357	141	236	279	166	198			263
23	0	355	359	356	334	328	307	170	184			265
24	354	357	358	356	337	243	351	308	196			245
25	358	353	354	357	279	350	278	248	316			214
26	359	355	344	354	206	359	337	337	280			249
27	359	355	357	358	146	355	307	295	215			261
28	358	355	354	358	143	353	308	301	155			303
29	353		345	357	337	352	272	268	172			330
30	356		325	357	254	339	306	272	164			214
31	354		292		202		278	263				221



Average Monthly Wind Speed and Direction

	Long-term Av. (1972-2000)			2001	
	Speed	S.D.	Direction	Speed	Direction
January	6.6	2.1	358.2	**7.4**	**352.8**
February	7.6	2.3	4.7	**10.2**	**356.3**
March	7.3	2.3	1.5	**7.2**	**350.9**
April	6.2	1.6	352.1	**8.4**	**355.0**
May	3.6	1.1	306.5	**4.1**	**328.1**
June	2.8	1.2	269.7	**4.0**	**332.1**
July	3.0	1.1	310.8	**3.5**	**310.2**
August	2.8	0.9	260.4	**3.1**	**298.5**
September	2.4	1.0	223.8	**2.4**	**205.6**
October	2.4	0.9	221.5	**2.4**	
November	3.1	1.2	258.4	**2.5**	
December	4.7	1.7	335.4	**3.1**	**271.5**





Estimated Evapotranspiration and Water Balance

Average	'El Claro'			40 m		
(1993-2000)	Month^{-1}	S.D.	Day^{-1}	Month^{-1}	S.D.	Day^{-1}
January	85.1	18.6	2.7	140.0	19.4	4.5
February	104.4	16.0	3.7	151.6	12.5	5.4
March	132.7	22.2	4.3	187.8	17.9	6.1
April	111.4	11.7	3.7	161.1	15.7	5.4
May	70.8	14.6	2.3	102.5	10.4	3.3
June	49.6	11.0	1.7	78.5	18.0	2.6
July	59.2	7.9	1.9	83.6	19.1	2.7
August	60.4	9.3	1.9	89.5	16.5	2.9
September	63.9	5.7	2.1	88.1	9.7	2.9
October	61.4	8.6	2.0	86.8	9.2	2.8
November	45.1	15.9	1.5	71.7	24.6	2.4
December	54.4	17.3	1.8	93.6	28.9	3.0

2001	Evapotranspiration (mm eq.)		Net Water Balance (mm eq.)	
	'El Claro'	40 m	'El Claro'	40 m
January	111.5	159.5	-54.3	-102.3
February	142.5	179.0	-146.8	-183.3
March	122.0	151.7	-109.3	-139.0
April	134.0	158.5	-108.1	-132.6
May	129.5	149.5	51.5	31.5
June	78.0	106.0	99.8	71.8
July	61.5	89.0	92.1	64.6
August	58.0	92.5	174.9	140.4
September	43.5	69.5	155.4	129.4
October	67.0	102.5	105.0	69.5
November	47.0	68.0	176.1	155.1
December	38.5	64.5	179.4	153.4

Estimated Evapotranspiration and Water Balance