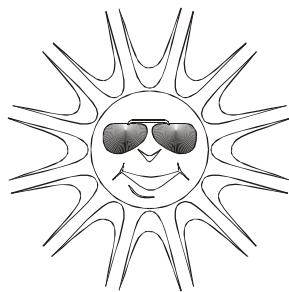


**Smithsonian Tropical Research Institute**

**1999 Meteorological and Hydrological  
Summary for  
Barro Colorado Island**

**Prepared by: Steven Paton**



## Introduction

This is the seventh 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

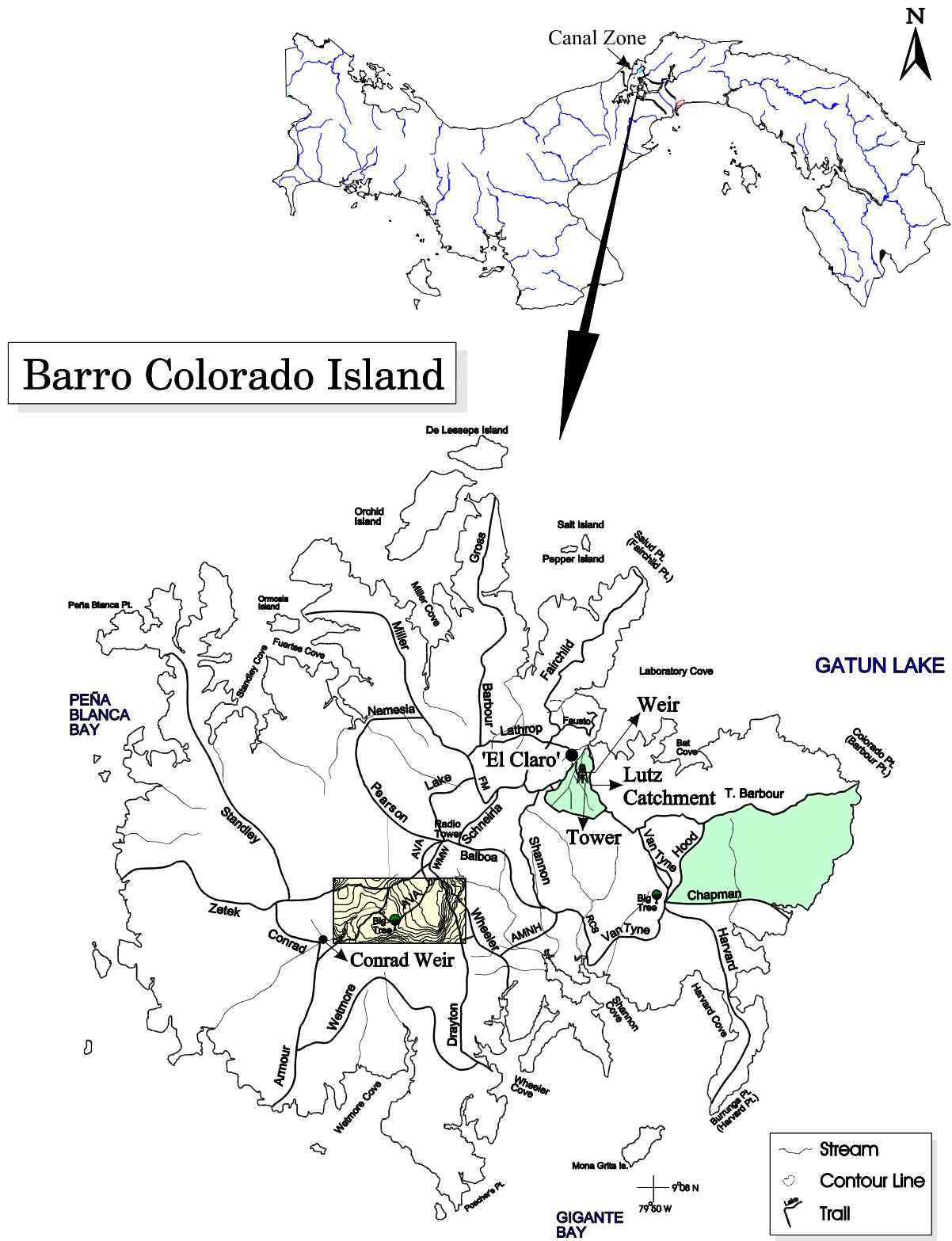
The meteorology and hydrology monitoring programs on BCI are described in detail in Climate and Moisture Variability in a Tropical Forest: Long-term Records from Barro Colorado Island, Panamá. Windsor (1990). Much of the information on the next five pages has been extracted from this source.

BCI ( $9^{\circ}10'N$ ,  $79^{\circ}51'W$ ) is a completely forested, 1500 ha island, rising 137m above Lake Gatun. The island receives an average of 2623 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 285 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 42 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 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 little over time. However, cycles of vegetation removal and re-growth, plus the recent removal and construction of nearby buildings, have very likely affected the local climate around the Clearing. 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.

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  | temperature<br>relative humidity  |
|                | 40m | temperature<br>relative humidity<br>wind speed and direction<br>solar radiation<br>evapotranspiration |
| Lutz catchment |     | run-off<br>soil moisture  |
| 'El Claro'     |     | temperature<br>relative humidity<br>rainfall<br>evapotranspiration                                    |

### 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 1999.

Page 10 shows yearly rainfall totals for all years 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. 19 and May 2) were used. The two graphs on this page are frequency histograms showing the distribution of rainfalls (1929 to 1999) for the Dry and Wet Seasons. The arrow → in each graph shows the rainfall for 1999 in relation to previous years. The small cross bar —+ above each graph represents the mean (vertical bar) and the standard deviation (horizontal bar) for the period 1929 - 1999.

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 Commission. The PCC 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 PCC. 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 12,00 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 1998 and for the year 1999.

### 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 ( $\text{m}^3$ ) and then into rainfall equivalents.

Daily Lutz creek weir run-off totals is 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 1998 with 1999. The graph on the top of page 18 compares monthly accumulated precipitation with 1999 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 1998 with those for 1999.

### **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 pyranometer attached to a datalogger. Hourly total (KJ/m<sup>2</sup>), maximum and minimum (J/m<sup>2</sup>/s) 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 1999. Page 26 shows total monthly Global Radiation and PAR.

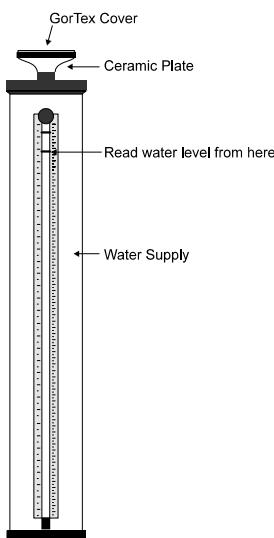
## Wind Speed and Direction

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

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.

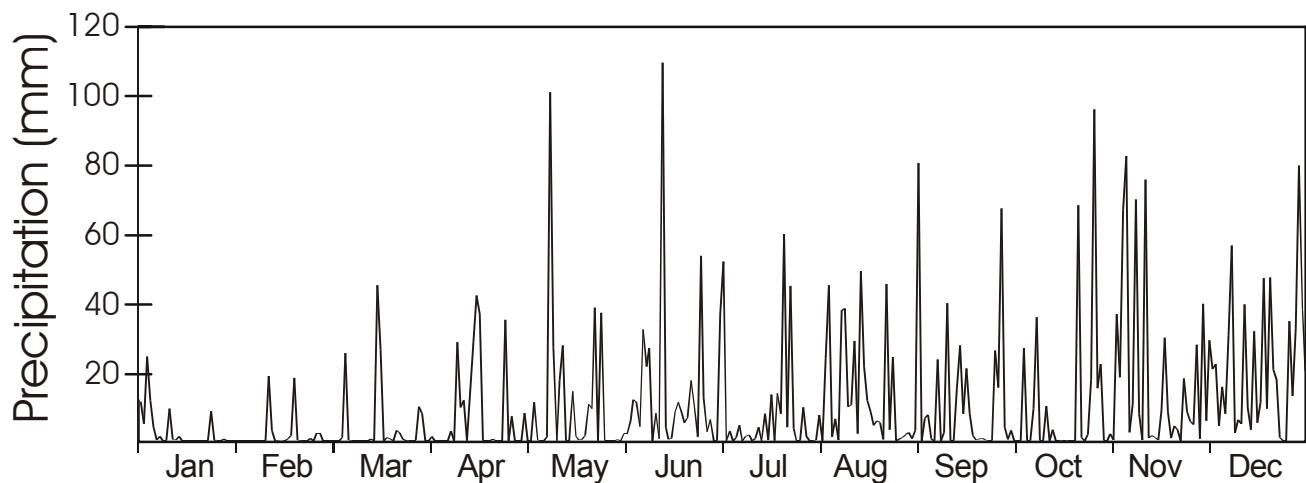
There are two ETgages currently being used on BCI: one in the Clearing located at a height of 1.5m and a second on the top of the 40m tower near the Lutz weir. ETgages are read at approximately the same time of day and with the same frequency and the rain gauges on BCI.

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 1999 are given on pages 30 and 31.

## Daily Rainfall (mm) on BCI recorded at 900 hrs

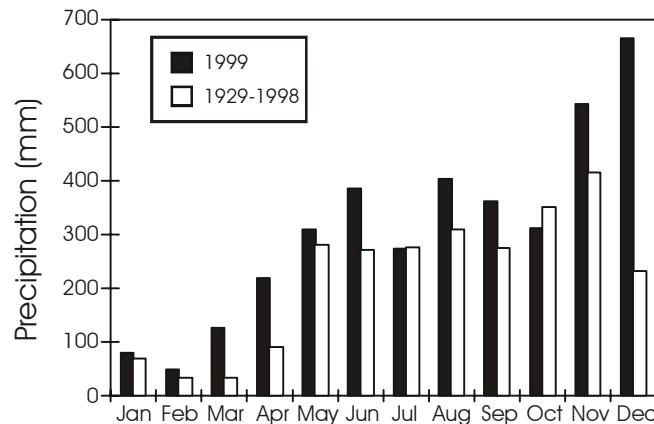
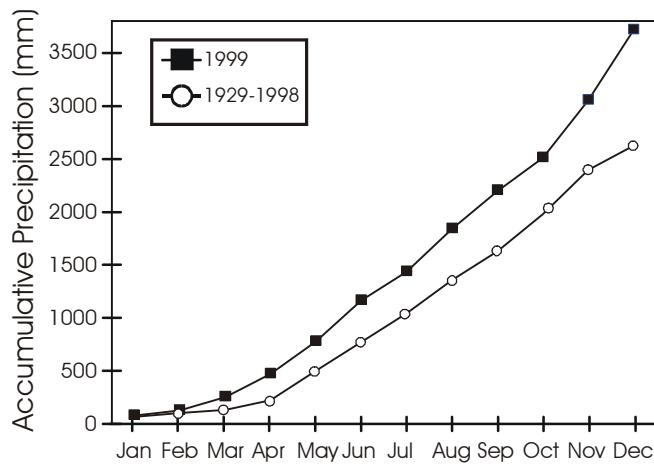
|    | Jan. | Feb. | Mar.  | Apr.  | May   | June  | July  | Aug.  | Sep.  | Oct.  | Nov.  | Dec.  |
|----|------|------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1  | 11.3 | 0.0  | 0.0   | 0.0   | 8.1   | 2.1   | 36.8  | 7.5   | 80.5  | 0.0   | 0.3   | 29.2  |
| 2  | 5.0  | 0.0  | 0.0   | 1.3   | 0.0   | 2.0   | 52.1  | 0.0   | 0.0   | 0.0   | 36.8  | 20.8  |
| 3  | 24.4 | 0.0  | 0.0   | 0.0   | 0.0   | 5.8   | 0.0   | 24.0  | 6.6   | 0.0   | 18.4  | 22.4  |
| 4  | 11.8 | 0.0  | 0.0   | 0.0   | 11.2  | 11.9  | 2.8   | 45.2  | 7.6   | 26.9  | 67.0  | 4.4   |
| 5  | 4.1  | 0.0  | 1.0   | 0.0   | 0.3   | 11.1  | 0.0   | 1.3   | 0.6   | 0.0   | 82.6  | 15.7  |
| 6  | 0.3  | 0.0  | 25.4  | 0.0   | 0.0   | 4.1   | 1.1   | 6.4   | 0.0   | 0.0   | 2.5   | 7.9   |
| 7  | 1.3  | 0.0  | 0.3   | 0.0   | 0.0   | 32.3  | 4.5   | 0.3   | 23.6  | 9.4   | 10.7  | 30.7  |
| 8  | 0.0  | 0.0  | 0.0   | 2.8   | 1.1   | 21.6  | 0.0   | 37.8  | 0.0   | 35.8  | 69.9  | 56.6  |
| 9  | 0.0  | 0.0  | 0.0   | 0.0   | 101.1 | 26.9  | 1.3   | 38.4  | 2.5   | 0.0   | 7.9   | 2.4   |
| 10 | 9.4  | 18.8 | 0.0   | 28.6  | 27.1  | 0.0   | 1.8   | 9.9   | 39.9  | 0.0   | 0.3   | 6.1   |
| 11 | 0.5  | 3.0  | 0.0   | 9.7   | 0.0   | 8.1   | 0.0   | 10.4  | 0.0   | 10.2  | 75.6  | 4.9   |
| 12 | 0.3  | 0.0  | 0.0   | 11.7  | 17.5  | 0.6   | 0.8   | 29.0  | 0.0   | 0.0   | 0.8   | 39.6  |
| 13 | 1.3  | 0.1  | 0.0   | 0.0   | 27.7  | 109.6 | 4.1   | 2.0   | 15.2  | 3.3   | 1.5   | 9.5   |
| 14 | 0.0  | 0.3  | 0.5   | 14.2  | 0.0   | 4.0   | 0.0   | 49.3  | 27.7  | 0.0   | 1.0   | 3.3   |
| 15 | 0.0  | 0.0  | 0.0   | 28.4  | 0.0   | 0.5   | 7.9   | 21.5  | 7.9   | 0.0   | 0.3   | 31.8  |
| 16 | 0.0  | 0.6  | 45.2  | 42.2  | 14.4  | 0.8   | 0.3   | 11.8  | 21.1  | 0.3   | 8.9   | 5.3   |
| 17 | 0.0  | 1.5  | 26.7  | 36.8  | 1.4   | 8.4   | 13.5  | 8.6   | 7.9   | 0.3   | 30.0  | 11.2  |
| 18 | 0.0  | 18.3 | 0.0   | 0.0   | 0.3   | 11.2  | 0.0   | 4.6   | 1.5   | 0.0   | 8.4   | 47.1  |
| 19 | 0.0  | 0.3  | 1.0   | 0.0   | 0.5   | 8.0   | 13.7  | 5.8   | 0.3   | 0.0   | 0.8   | 9.4   |
| 20 | 0.0  | 0.0  | 0.5   | 0.0   | 1.8   | 5.2   | 7.9   | 5.3   | 0.5   | 0.0   | 4.4   | 47.4  |
| 21 | 0.0  | 0.0  | 0.0   | 0.5   | 10.7  | 6.9   | 60.0  | 0.5   | 0.8   | 68.3  | 3.3   | 20.6  |
| 22 | 0.0  | 0.0  | 3.0   | 0.0   | 9.3   | 17.5  | 4.0   | 45.5  | 0.3   | 1.0   | 0.0   | 17.8  |
| 23 | 8.6  | 0.8  | 2.3   | 0.0   | 38.7  | 10.2  | 45.0  | 3.2   | 0.0   | 0.0   | 18.0  | 1.0   |
| 24 | 0.2  | 0.0  | 0.5   | 0.0   | 0.0   | 1.3   | 3.6   | 24.4  | 0.0   | 1.9   | 8.4   | 0.0   |
| 25 | 0.0  | 2.3  | 0.0   | 35.1  | 37.1  | 53.6  | 0.0   | 0.0   | 26.2  | 17.9  | 5.6   | 0.0   |
| 26 | 0.0  | 2.3  | 0.3   | 0.0   | 0.0   | 12.4  | 0.0   | 0.5   | 15.4  | 96.0  | 4.8   | 34.8  |
| 27 | 0.5  | 0.0  | 0.3   | 7.1   | 0.0   | 2.7   | 9.7   | 1.0   | 67.3  | 15.3  | 27.9  | 13.0  |
| 28 | 0.0  | 0.0  | 0.3   | 0.0   | 0.0   | 6.2   | 1.3   | 1.8   | 4.1   | 22.4  | 0.6   | 32.8  |
| 29 | 0.0  | 9.9  | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | 2.4   | 0.5   | 0.0   | 39.8  | 79.8  |
| 30 | 0.0  | 7.9  | 0.0   | 0.5   | 0.0   | 0.0   | 0.0   | 0.6   | 3.0   | 0.0   | 5.8   | 38.1  |
| 31 | 0.0  | 0.0  | 0.0   | 0.0   | 0.3   | 0.3   | 3.0   | 0.0   | 2.0   | 0.0   | 20.3  |       |
|    | 79.0 | 48.3 | 125.0 | 218.4 | 308.6 | 385.1 | 272.1 | 402.1 | 360.9 | 310.9 | 542.0 | 663.7 |



## Monthly Rainfall at 'El Claro' - Rain Guage

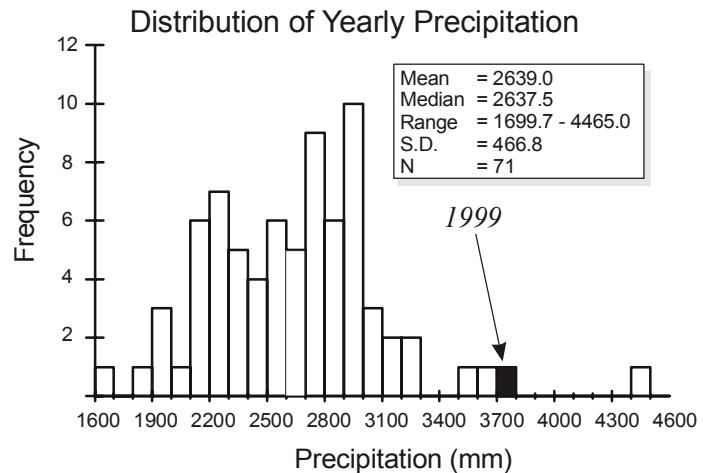
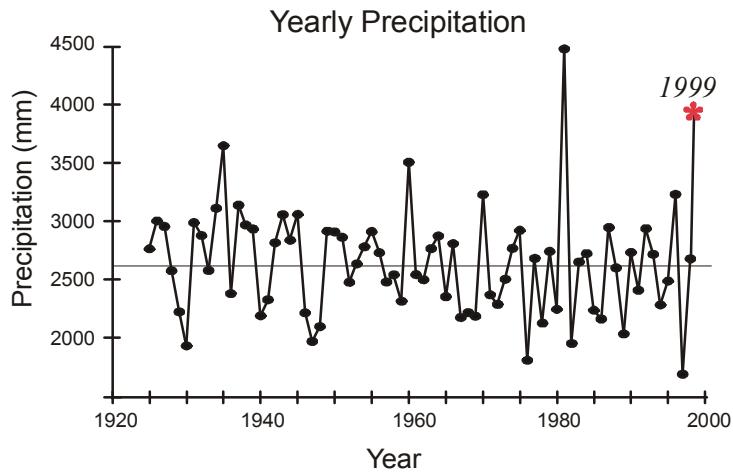
Rainfall (mm)

|           | Average | Min    | Max    | S.D.  | 1999   | Rank<br>(n=71) |
|-----------|---------|--------|--------|-------|--------|----------------|
| January   | 67.9    | 0.0    | 374.0  | 76.7  | 79.0   | 19             |
| February  | 32.7    | 0.5    | 186.4  | 34.9  | 48.3   | 17             |
| March     | 32.9    | 0.0    | 173.7  | 35.6  | 125.0  | 4              |
| April     | 91.2    | 0.0    | 463.8  | 87.9  | 218.4  | 7              |
| May       | 279.5   | 78.5   | 622.0  | 102.1 | 308.6  | 25             |
| June      | 270.2   | 66.8   | 541.0  | 88.5  | 385.1  | 8              |
| July      | 275.7   | 92.0   | 725.9  | 97.6  | 272.1  | 36             |
| August    | 309.1   | 149.6  | 586.0  | 93.2  | 402.1  | 10             |
| September | 273.8   | 130.8  | 507.0  | 85.4  | 360.9  | 10             |
| October   | 349.8   | 153.9  | 544.0  | 93.1  | 310.9  | 47             |
| November  | 408.5   | 110.0  | 1056.1 | 193.9 | 542.0  | 15             |
| December  | 232.3   | 15.9   | 712.7  | 168.6 | 663.7  | 2              |
| Total     | 2623.6  | 1699.7 | 4465.0 | 451.6 | 3716.1 | 2              |



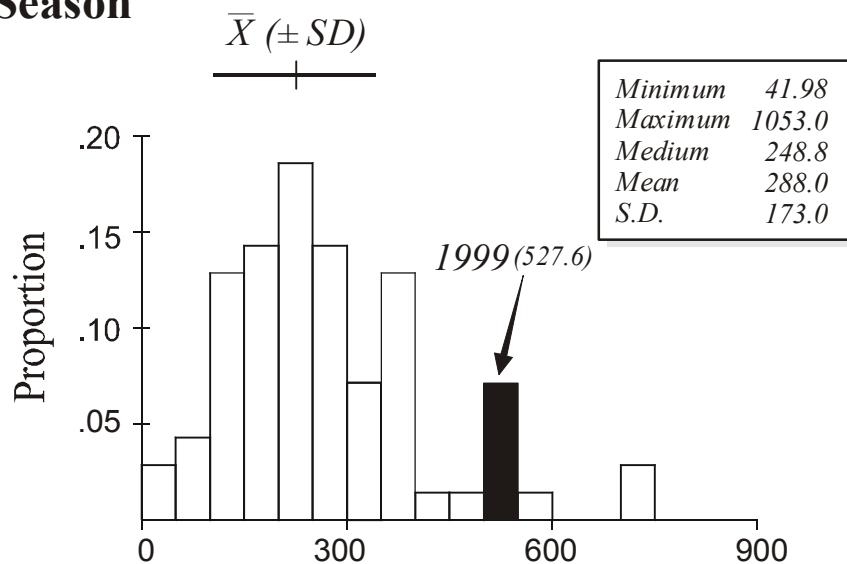
## Yearly Rainfall (mm) at 'El Claro' - Rain Gauge

| Year | Rain   | Year | Rain   | Year | Rain   |
|------|--------|------|--------|------|--------|
| 1925 | 2764.0 | 1950 | 2908.3 | 1975 | 2923.0 |
| 1926 | 3003.0 | 1951 | 2863.8 | 1976 | 1818.0 |
| 1927 | 2956.1 | 1952 | 2481.6 | 1977 | 2685.0 |
| 1928 | 2579.1 | 1953 | 2637.5 | 1978 | 2132.0 |
| 1929 | 2228.3 | 1954 | 2684.3 | 1979 | 2742.0 |
| 1930 | 1940.6 | 1955 | 2910.3 | 1980 | 2252.0 |
| 1931 | 2981.5 | 1956 | 2729.7 | 1981 | 4465.0 |
| 1932 | 2878.6 | 1957 | 2482.1 | 1982 | 1960.0 |
| 1933 | 2581.9 | 1958 | 2545.1 | 1983 | 2654.0 |
| 1934 | 3109.5 | 1959 | 2317.0 | 1984 | 2726.0 |
| 1935 | 3642.6 | 1960 | 3500.4 | 1985 | 2242.0 |
| 1936 | 2384.3 | 1961 | 2545.6 | 1986 | 2167.6 |
| 1937 | 3117.6 | 1962 | 2373.4 | 1987 | 2955.2 |
| 1938 | 2969.0 | 1963 | 2767.1 | 1988 | 2602.9 |
| 1939 | 2932.9 | 1964 | 2875.3 | 1989 | 2176.2 |
| 1940 | 2195.8 | 1965 | 2357.1 | 1990 | 2767.5 |
| 1941 | 2332.2 | 1966 | 2807.7 | 1991 | 2642.4 |
| 1942 | 2816.9 | 1967 | 2181.4 | 1992 | 3047.5 |
| 1943 | 3055.4 | 1968 | 2223.5 | 1993 | 2719.2 |
| 1944 | 2838.7 | 1969 | 2192.5 | 1994 | 2285.2 |
| 1945 | 3058.9 | 1970 | 3141.2 | 1995 | 2531.1 |
| 1946 | 2221.0 | 1971 | 2373.6 | 1996 | 3227.8 |
| 1947 | 1978.2 | 1972 | 2292.0 | 1997 | 1699.7 |
| 1948 | 2105.7 | 1973 | 2506.0 | 1998 | 2683.8 |
| 1949 | 2916.2 | 1974 | 2770.0 | 1999 | 3716.1 |

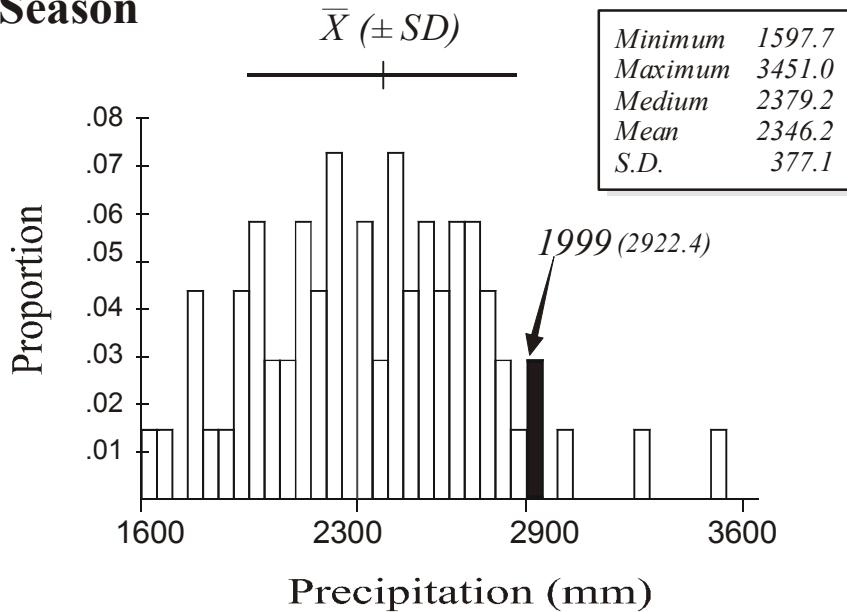


## Seasonal Distribution of Precipitation

### Dry Season



### Wet Season

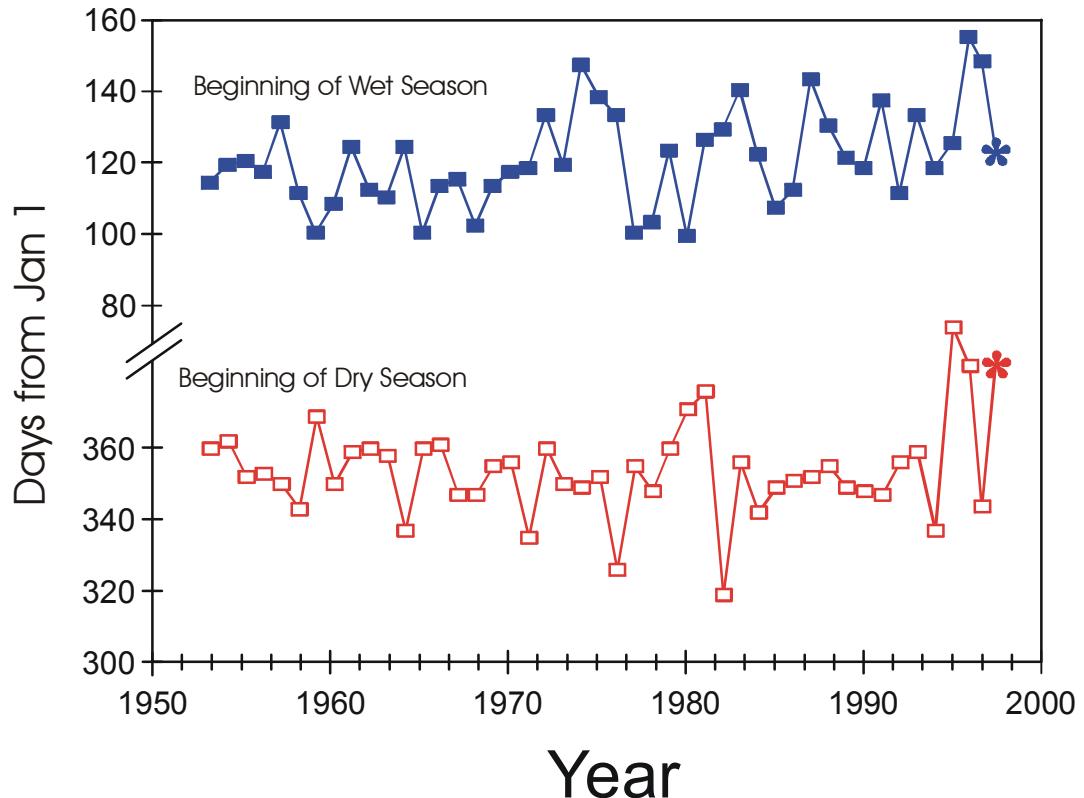


## PCC Dry Season Beginning and End Dates

| 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-1971       | 130        | 214        |
| 1972        | 30-Nov-1971        | 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        | 271        |
| 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        |
| <b>1999</b> | <b>18-Jan-1999</b> | <b>3-May-1999</b> | <b>105</b> | <b>259</b> |
| <b>2000</b> | <b>17-Jan-2000</b> |                   |            |            |
| Avg         | 19-Dec             | 02-May            | 136.6      | 229.8      |

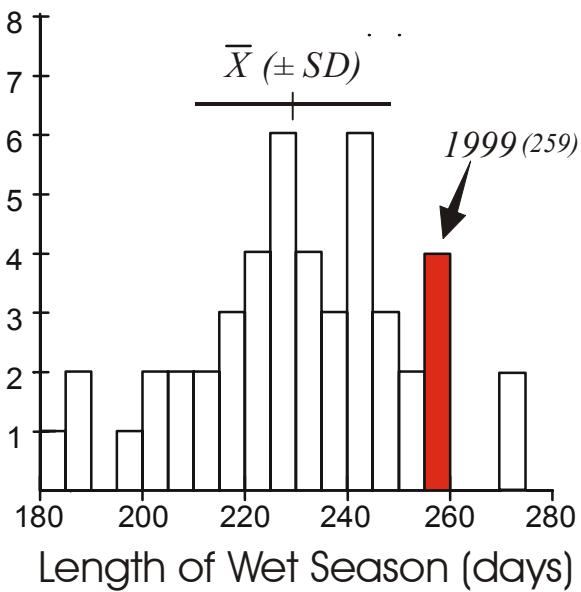
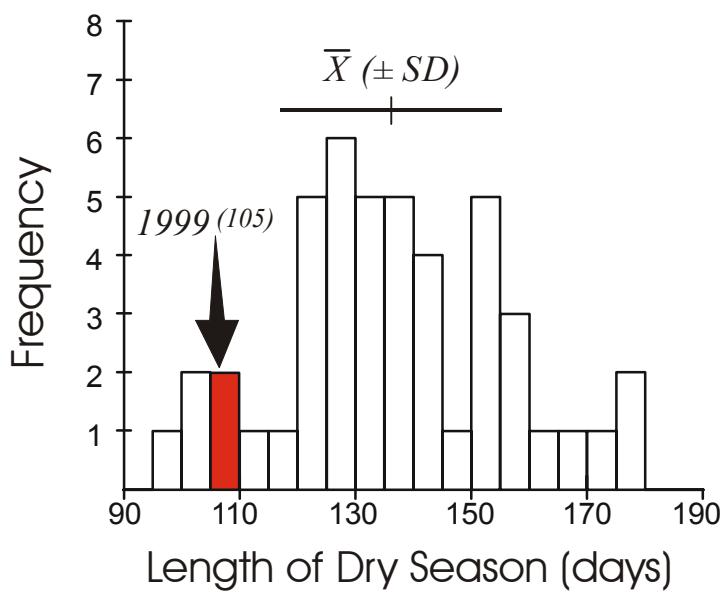
|           |  |                 |  |                 |  |             |  |             |
|-----------|--|-----------------|--|-----------------|--|-------------|--|-------------|
| <b>SD</b> |  | <b>±14 days</b> |  | <b>±14 days</b> |  | <b>20.8</b> |  | <b>21.0</b> |
|-----------|--|-----------------|--|-----------------|--|-------------|--|-------------|

## Seasonality Distribution



|         |       |
|---------|-------|
| Minimum | 98    |
| Maximum | 179   |
| Medium  | 135.0 |
| Mean    | 136.0 |
| S.D.    | 19.5  |

|         |       |
|---------|-------|
| Minimum | 184   |
| Maximum | 273   |
| Medium  | 229   |
| Mean    | 229.7 |
| S.D.    | 21.0  |



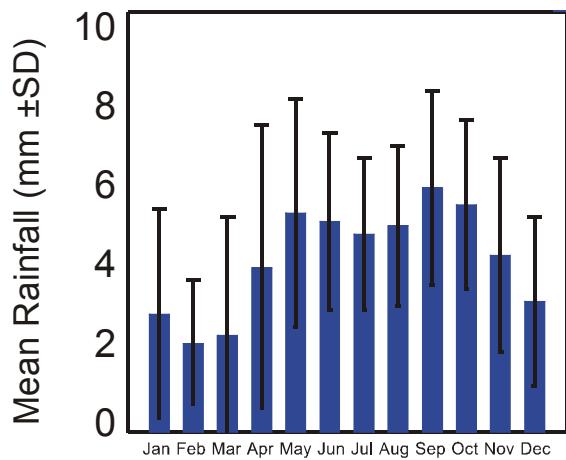
## Storm Analysis

|           | Max. Rainfall per Storm |      |              | Storm Duration (min.) |      |             |
|-----------|-------------------------|------|--------------|-----------------------|------|-------------|
|           | 1984-98                 |      | 1999         | 1984-98               |      | 1999        |
|           | Mean                    | S.D. |              | Mean                  | S.D. |             |
| January   | 20.9                    | 25.4 | <b>19.6</b>  | 31.0                  | 18.4 | <b>35.7</b> |
| February  | 12.8                    | 12.3 | <b>16.0</b>  | 29.5                  | 26.6 | <b>26.4</b> |
| March     | 12.2                    | 14.1 | <b>43.9</b>  | 38.3                  | 43.8 | <b>55.2</b> |
| April     | 30.9                    | 36.0 | <b>37.8</b>  | 43.0                  | 40.4 | <b>49.5</b> |
| May       | 50.3                    | 30.1 | <b>104.4</b> | 53.7                  | 21.7 | <b>68.2</b> |
| June      | 48.3                    | 23.8 | <b>89.1</b>  | 50.6                  | 16.5 | <b>65.6</b> |
| July      | 43.9                    | 19.9 | <b>61.2</b>  | 45.7                  | 15.0 | <b>39.6</b> |
| August    | 45.4                    | 19.7 | <b>73.4</b>  | 43.5                  | 15.3 | <b>47.6</b> |
| September | 48.5                    | 24.4 | <b>62.0</b>  | 54.8                  | 17.9 | <b>50.4</b> |
| October   | 45.5                    | 27.1 | <b>62.7</b>  | 53.9                  | 18.3 | <b>67.8</b> |
| November  | 34.6                    | 18.4 | <b>61.5</b>  | 44.9                  | 24.7 | <b>56.8</b> |
| December  | 33.4                    | 28.0 | <b>40.9</b>  | 33.0                  | 22.1 | <b>65.2</b> |

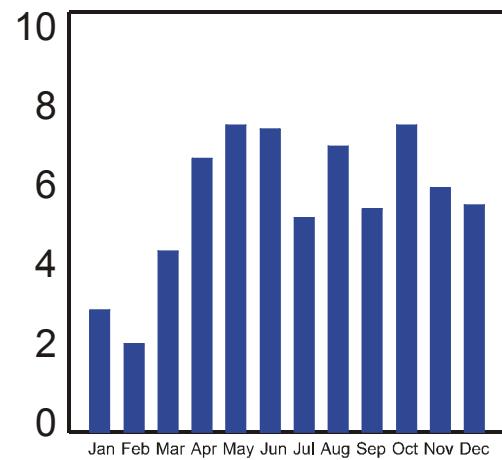
|           | Av. Rainfall per Storm (mm) |      |            |
|-----------|-----------------------------|------|------------|
|           | 1984-98                     |      | 1999       |
|           | Mea                         | S.D. |            |
| January   | 2.8                         | 2.5  | <b>2.9</b> |
| February  | 2.1                         | 1.5  | <b>2.1</b> |
| March     | 2.3                         | 2.8  | <b>4.3</b> |
| April     | 3.9                         | 3.4  | <b>6.5</b> |
| May       | 5.2                         | 2.7  | <b>7.3</b> |
| June      | 5.0                         | 2.1  | <b>7.2</b> |
| July      | 4.7                         | 1.8  | <b>5.1</b> |
| August    | 4.9                         | 1.9  | <b>6.8</b> |
| September | 5.8                         | 2.3  | <b>5.3</b> |
| October   | 5.4                         | 2.0  | <b>7.3</b> |
| November  | 4.2                         | 2.3  | <b>5.8</b> |
| December  | 3.1                         | 2.0  | <b>5.4</b> |

## Average Monthly Storm Size

1984-1998

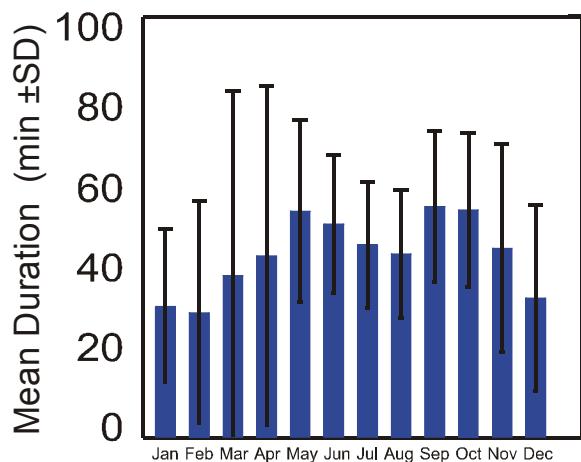


1999

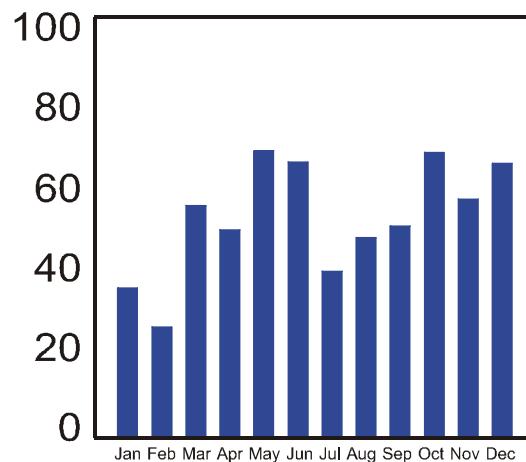


## Average Monthly Storm Duration

1984-1998

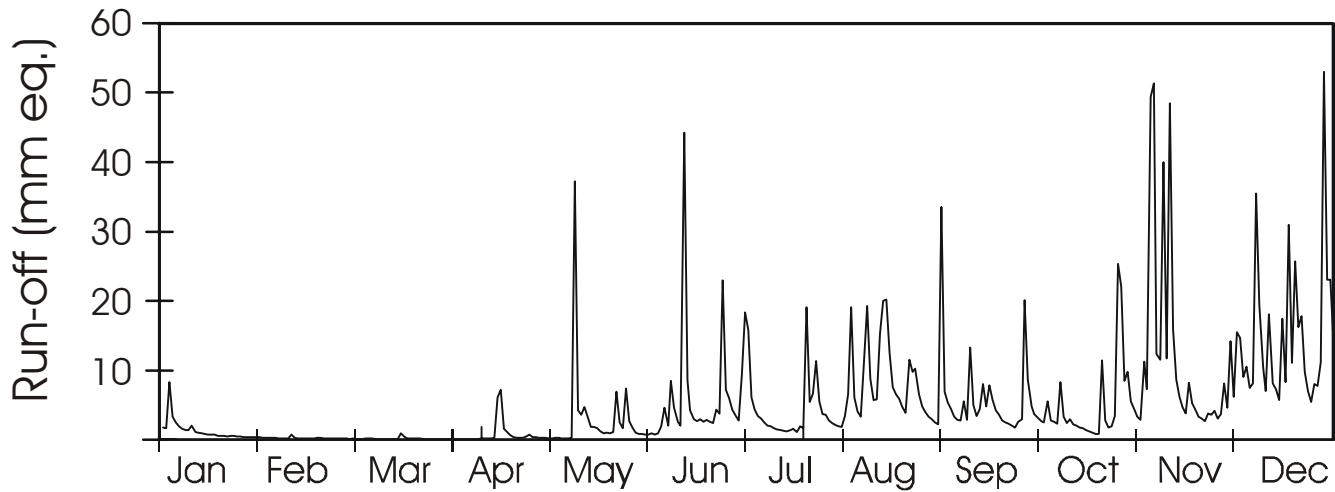


1999



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

|    | Jan. | Feb. | Mar | Apr. | May  | June | July | Aug. | Sep. | Oct. | Nov. | Dec. |
|----|------|------|-----|------|------|------|------|------|------|------|------|------|
| 1  | 1.7  | 0.3  | 0.1 | 0.1  | 0.2  | 0.7  | 18.3 | 3.4  | 6.9  | 2.7  | 2.9  | 15.4 |
| 2  | 1.7  | 0.3  | 0.1 | 0.1  | 0.2  | 0.9  | 15.8 | 6.5  | 5.3  | 2.4  | 11.2 | 14.6 |
| 3  | 8.3  | 0.2  | 0.1 | 0.1  | 0.2  | 0.7  | 6.0  | 19.0 | 4.4  | 5.5  | 7.2  | 9.0  |
| 4  | 3.3  | 0.2  | 0.1 | 0.1  | 0.2  | 0.9  | 4.3  | 6.1  | 3.3  | 2.7  | 49.3 | 10.4 |
| 5  | 2.4  | 0.2  | 0.2 | 0.1  | 0.2  | 1.9  | 3.4  | 4.0  | 2.8  | 2.5  | 51.2 | 7.4  |
| 6  | 1.9  | 0.2  | 0.1 | 0.1  | 0.2  | 4.6  | 3.0  | 3.3  | 2.8  | 2.3  | 12.3 | 8.1  |
| 7  | 1.6  | 0.2  | 0.1 | 0.1  | 0.2  | 2.0  | 2.5  | 11.1 | 5.5  | 8.2  | 11.5 | 35.4 |
| 8  | 1.4  | 0.2  | 0.1 | 0.1  | 0.3  | 8.4  | 2.0  | 19.2 | 2.8  | 3.2  | 39.9 | 19.4 |
| 9  | 1.3  | 0.2  | 0.1 | 0.1  | 37.2 | 4.6  | 1.9  | 8.7  | 13.2 | 2.4  | 11.7 | 10.4 |
| 10 | 2.0  | 0.7  | 0.1 | 0.2  | 4.2  | 2.6  | 1.6  | 5.7  | 5.0  | 2.9  | 48.3 | 7.0  |
| 11 | 1.1  | 0.3  | 0.1 | 0.2  | 3.6  | 2.0  | 1.5  | 5.8  | 3.3  | 2.2  | 15.8 | 18.0 |
| 12 | 1.0  | 0.2  | 0.1 | 0.2  | 4.7  | 44.2 | 1.4  | 15.1 | 4.4  | 2.0  | 8.6  | 8.0  |
| 13 | 0.9  | 0.2  | 0.1 | 0.2  | 3.3  | 8.6  | 1.2  | 20.0 | 8.0  | 1.8  | 6.2  | 7.3  |
| 14 | 0.8  | 0.2  | 0.1 | 0.2  | 1.9  | 4.2  | 1.2  | 20.2 | 4.8  | 1.6  | 4.7  | 5.7  |
| 15 | 0.7  | 0.1  | 0.1 | 6.1  | 1.8  | 2.9  | 1.4  | 12.4 | 7.8  | 1.4  | 3.7  | 17.4 |
| 16 | 0.7  | 0.2  | 0.9 | 7.2  | 1.7  | 2.6  | 1.5  | 7.5  | 5.7  | 1.2  | 8.2  | 8.3  |
| 17 | 0.7  | 0.2  | 0.4 | 1.5  | 1.2  | 2.9  | 1.1  | 6.5  | 4.2  | 1.0  | 5.3  | 30.9 |
| 18 | 0.5  | 0.3  | 0.2 | 1.0  | 1.0  | 2.6  | 1.9  | 5.8  | 3.6  | 0.8  | 4.3  | 11.0 |
| 19 | 0.5  | 0.2  | 0.2 | 0.6  | 1.0  | 2.8  | 1.6  | 4.7  | 2.8  | 0.8  | 3.3  | 25.6 |
| 20 | 0.5  | 0.2  | 0.1 | 0.3  | 0.9  | 2.5  | 19.1 | 3.8  | 2.5  | 11.4 | 3.0  | 16.1 |
| 21 | 0.5  | 0.2  | 0.1 | 0.3  | 1.1  | 2.3  | 5.4  | 11.5 | 2.3  | 2.7  | 2.6  | 17.8 |
| 22 | 0.5  | 0.1  | 0.1 | 0.2  | 6.9  | 4.3  | 6.6  | 9.7  | 2.0  | 1.7  | 3.7  | 9.7  |
| 23 | 0.5  | 0.1  | 0.1 | 0.2  | 2.5  | 3.8  | 11.3 | 10.2 | 1.7  | 1.9  | 3.6  | 6.9  |
| 24 | 0.5  | 0.1  | 0.1 | 0.4  | 1.6  | 22.9 | 5.5  | 6.5  | 2.6  | 3.4  | 4.1  | 5.4  |
| 25 | 0.4  | 0.1  | 0.1 | 0.7  | 7.3  | 7.2  | 3.7  | 4.8  | 3.0  | 25.3 | 3.0  | 8.0  |
| 26 | 0.4  | 0.1  | 0.1 | 0.4  | 2.6  | 6.0  | 3.5  | 3.9  | 20.1 | 22.0 | 3.6  | 7.7  |
| 27 | 0.4  | 0.1  | 0.1 | 0.3  | 1.7  | 4.3  | 2.7  | 3.3  | 8.6  | 8.5  | 8.1  | 11.1 |
| 28 | 0.3  | 0.1  | 0.1 | 0.3  | 1.0  | 3.5  | 2.4  | 2.9  | 4.8  | 9.7  | 4.5  | 52.9 |
| 29 | 0.3  | 0.1  | 0.2 | 0.8  | 2.8  | 2.1  | 2.4  | 3.7  | 5.5  | 14.2 | 23.0 |      |
| 30 | 0.3  | 0.1  | 0.2 | 0.8  | 9.3  | 1.9  | 2.2  | 3.1  | 4.2  | 6.2  | 23.0 |      |
| 31 | 0.3  | 0.1  | 0.8 |      | 1.8  | 33.4 |      |      | 3.3  |      | 18.1 |      |



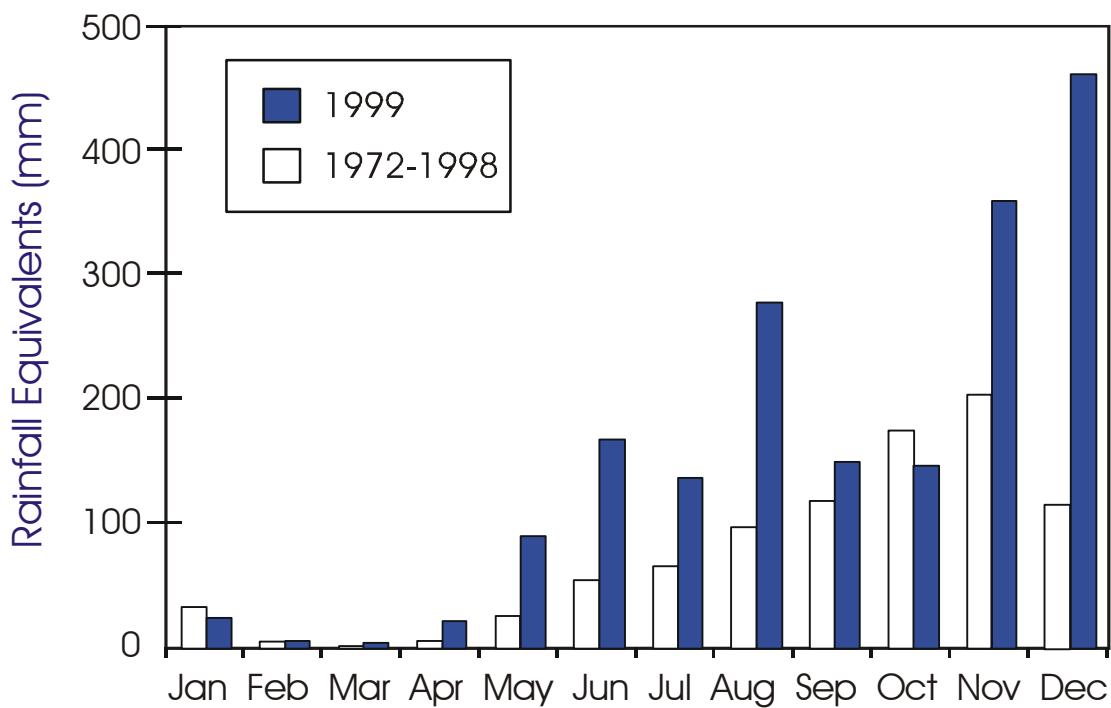
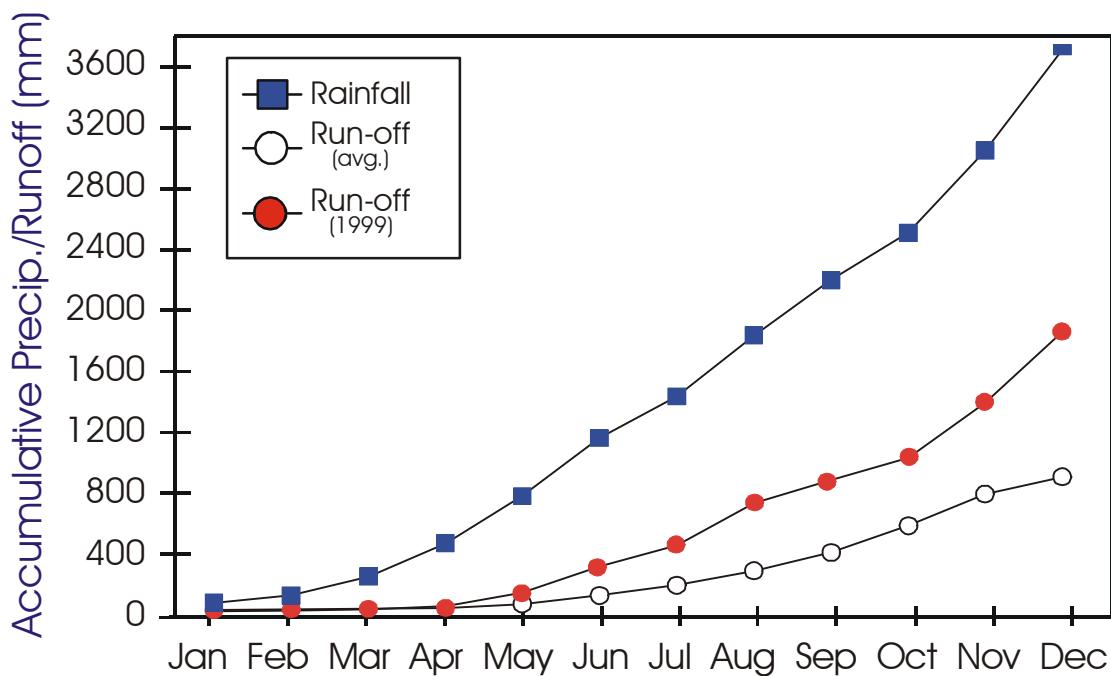
## Monthly Run-off at Lutz Weir

### Run-off (mm eq.)

|                  | Long-term Averages (1972 - 1998) |             |              |              |              |
|------------------|----------------------------------|-------------|--------------|--------------|--------------|
|                  | Peak                             | Delayed     | Base         | Total        | S.D.         |
| <b>January</b>   | 12.7                             | 1.9         | 18.5         | <b>33.1</b>  | 62.7         |
| <b>February</b>  | 0.2                              | 0.3         | 4.9          | <b>5.4</b>   | 11.0         |
| <b>March</b>     | 0.1                              | 0.2         | 1.4          | <b>1.7</b>   | 2.6          |
| <b>April</b>     | 3.4                              | 0.5         | 1.7          | <b>5.7</b>   | 21.5         |
| <b>May</b>       | 12.4                             | 3.7         | 9.9          | <b>26.0</b>  | 44.3         |
| <b>June</b>      | 25.9                             | 5.5         | 23.5         | <b>54.9</b>  | 74.2         |
| <b>July</b>      | 23.1                             | 6.5         | 36.8         | <b>66.4</b>  | 52.7         |
| <b>August</b>    | 39.6                             | 7.8         | 50.8         | <b>98.2</b>  | 72.1         |
| <b>September</b> | 47.2                             | 9.1         | 63.4         | <b>119.6</b> | 71.1         |
| <b>October</b>   | 71.3                             | 10.2        | 94.5         | <b>176.0</b> | 86.8         |
| <b>November</b>  | 77.9                             | 11.0        | 116.5        | <b>205.4</b> | 108.7        |
| <b>December</b>  | 40.3                             | 5.3         | 70.9         | <b>116.5</b> | 100.3        |
| <b>Total</b>     | <b>355.2</b>                     | <b>60.4</b> | <b>497.5</b> | <b>915.5</b> | <b>429.0</b> |

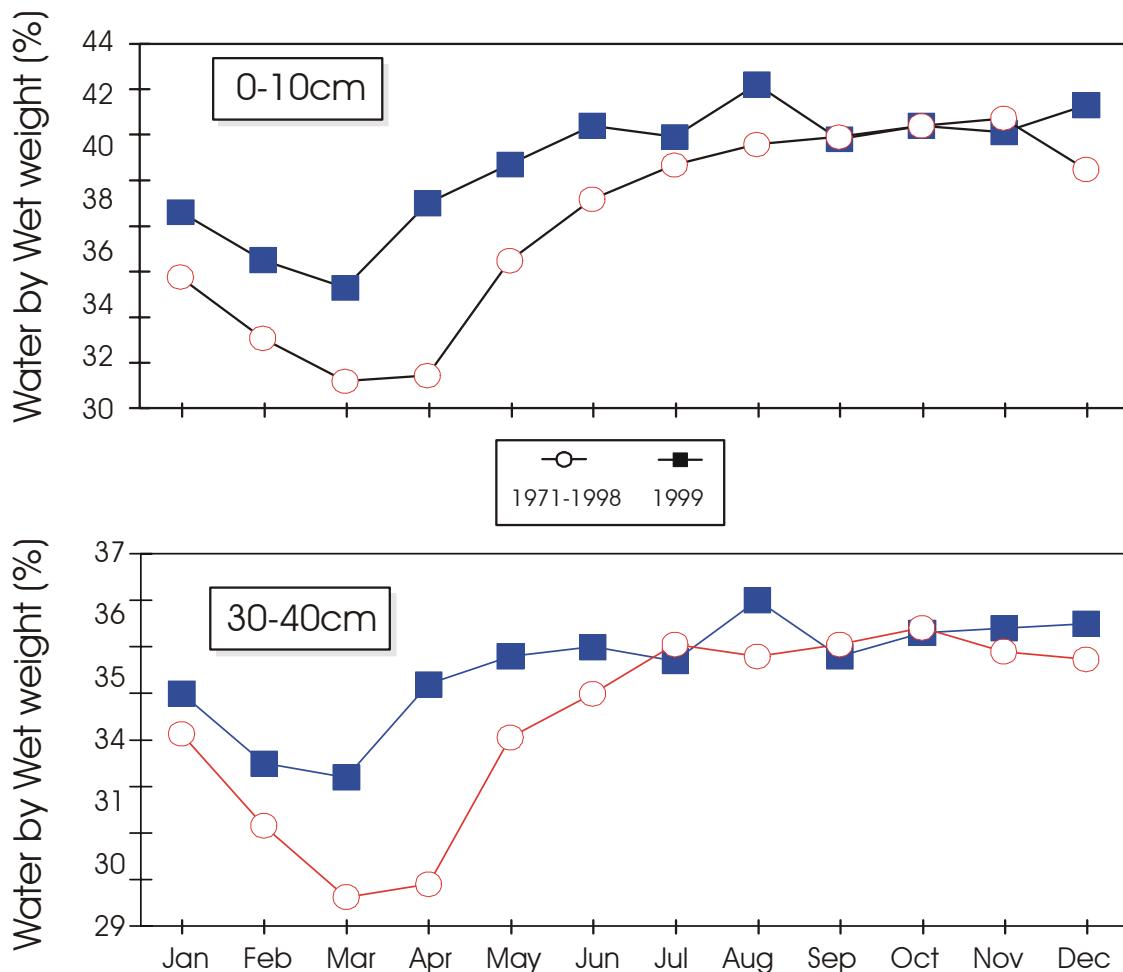
|                  | 1999         |              |               |               |
|------------------|--------------|--------------|---------------|---------------|
|                  | Peak         | Delayed      | Base          | Total         |
| <b>January</b>   | 4.2          | 3.8          | 29.5          | <b>37.5</b>   |
| <b>February</b>  | 0.2          | 0.3          | 5.3           | <b>5.8</b>    |
| <b>March</b>     | 0.2          | 0.6          | 3.6           | <b>4.4</b>    |
| <b>April</b>     | 10.3         | 2.6          | 8.9           | <b>21.7</b>   |
| <b>May</b>       | 41.8         | 10.3         | 38.9          | <b>91.0</b>   |
| <b>June</b>      | 74.7         | 12.0         | 82.5          | <b>169.1</b>  |
| <b>July</b>      | 45.3         | 10.2         | 82.1          | <b>137.7</b>  |
| <b>August</b>    | 114.9        | 17.1         | 147.7         | <b>279.6</b>  |
| <b>September</b> | 43.4         | 12.0         | 95.5          | <b>150.8</b>  |
| <b>October</b>   | 54.7         | 7.1          | 85.4          | <b>147.2</b>  |
| <b>November</b>  | 166.7        | 22.6         | 172.9         | <b>362.3</b>  |
| <b>December</b>  | 181.0        | 20.6         | 263.3         | <b>469.1</b>  |
| <b>Total</b>     | <b>737.4</b> | <b>119.3</b> | <b>1015.5</b> | <b>1876.6</b> |

### Monthly run-off at Lutz Weir



## Lutz Catchment Soil Moisture (H<sub>2</sub>O/wet wt of soil)

|           | Long-term Averages (1972-1998) |      |          |      | 1999    |          |
|-----------|--------------------------------|------|----------|------|---------|----------|
|           | 0-10 cm                        |      | 30-40 cm |      | 0-10 cm | 30-40 cm |
|           | Mean                           | S.D. | Mean     | S.D. |         |          |
| January   | 35.8                           | 3.1  | 33.1     | 1.1  | 38.6    | 34.0     |
| February  | 33.1                           | 2.4  | 31.2     | 1.3  | 36.5    | 32.5     |
| March     | 31.2                           | 2.2  | 29.6     | 1.4  | 35.3    | 32.2     |
| April     | 31.4                           | 2.1  | 29.9     | 1.6  | 39.0    | 34.2     |
| May       | 36.5                           | 2.2  | 33.1     | 1.4  | 40.7    | 34.8     |
| June      | 39.2                           | 1.6  | 34.0     | 0.9  | 42.4    | 35.0     |
| July      | 40.7                           | 1.4  | 35.1     | 0.7  | 41.9    | 34.7     |
| August    | 41.6                           | 1.8  | 34.8     | 0.5  | 44.2    | 36.0     |
| September | 41.9                           | 1.6  | 35.1     | 1.0  | 41.8    | 34.8     |
| October   | 42.4                           | 1.8  | 35.4     | 0.9  | 42.4    | 35.3     |
| November  | 42.7                           | 1.7  | 34.9     | 1.2  | 42.1    | 35.4     |
| December  | 40.5                           | 2.9  | 34.7     | 0.8  | 43.3    | 35.5     |



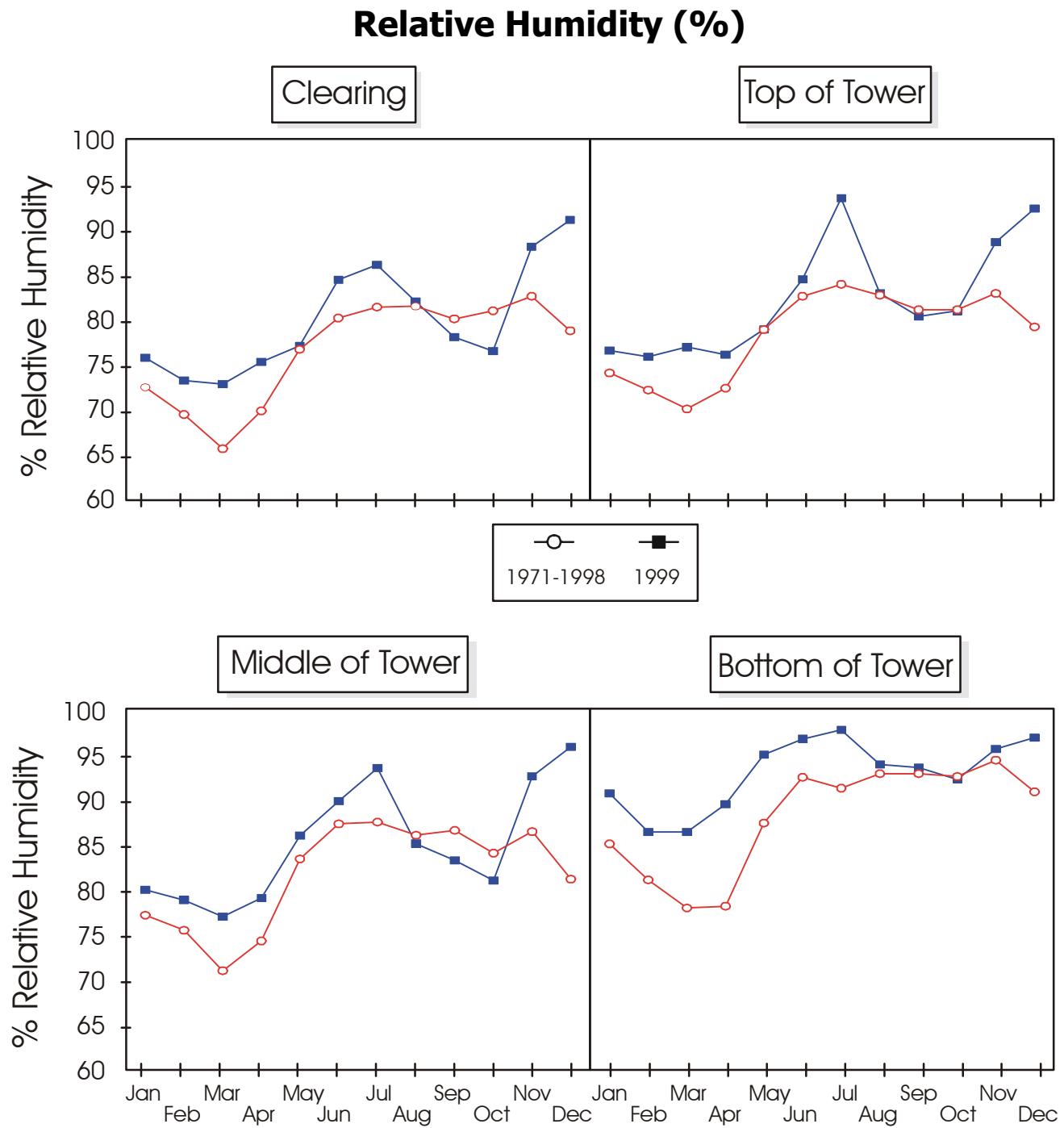
## Relative Humidity (%)

Long-term Averages (1972-1998)

|           | ‘El Claro’ |      | 1m   |      | 20m  |      | 40m  |      |
|-----------|------------|------|------|------|------|------|------|------|
|           | Mean       | S.D. | Mean | S.D. | Mean | S.D. | Mean | S.D. |
| January   | 73.8       | 4.4  | 85.0 | 3.4  | 77.1 | 4.1  | 74.1 | 3.5  |
| February  | 70.8       | 4.2  | 81.0 | 3.9  | 75.4 | 4.2  | 72.2 | 4.3  |
| March     | 67.0       | 3.7  | 77.9 | 3.7  | 70.9 | 2.8  | 70.1 | 2.7  |
| April     | 71.2       | 5.1  | 78.1 | 4.8  | 74.3 | 3.8  | 72.4 | 3.0  |
| May       | 78.0       | 5.0  | 87.3 | 3.9  | 83.3 | 2.3  | 78.9 | 3.9  |
| June      | 81.5       | 4.2  | 92.4 | 2.5  | 87.2 | 2.7  | 82.6 | 3.5  |
| July      | 82.7       | 4.6  | 91.2 | 6.7  | 87.4 | 2.1  | 83.9 | 2.0  |
| August    | 82.8       | 4.8  | 92.8 | 2.8  | 86.0 | 3.1  | 82.7 | 2.7  |
| September | 81.4       | 5.0  | 92.8 | 1.8  | 86.5 | 2.5  | 81.1 | 3.3  |
| October   | 82.3       | 4.0  | 92.5 | 5.8  | 84.0 | 3.8  | 81.1 | 3.6  |
| November  | 83.9       | 3.8  | 94.3 | 2.7  | 86.4 | 3.9  | 82.9 | 4.1  |
| December  | 80.1       | 4.5  | 90.8 | 3.0  | 81.1 | 5.7  | 79.2 | 4.2  |

1999

|           | ‘El Claro’ | 1m   | 20m  | 40m  |
|-----------|------------|------|------|------|
| January   | 73.7       | 85.1 | 79.9 | 74.0 |
| February  | 70.9       | 81.1 | 78.8 | 72.4 |
| March     | 66.8       | 77.9 | 77.0 | 69.9 |
| April     | 71.1       | 78.2 | 79.0 | 72.2 |
| May       | 77.8       | 87.3 | 85.9 | 78.6 |
| June      | 81.4       | 92.3 | 89.8 | 82.7 |
| July      | 82.5       | 91.1 | 93.4 | 83.8 |
| August    | 82.6       | 92.7 | 85.1 | 82.6 |
| September | 81.5       | 92.8 | 83.2 | 81.3 |
| October   | 82.3       | 92.5 | 80.9 | 81.2 |
| November  | 84.0       | 94.2 | 92.5 | 83.2 |
| December  | 79.7       | 90.5 | 95.8 | 78.6 |



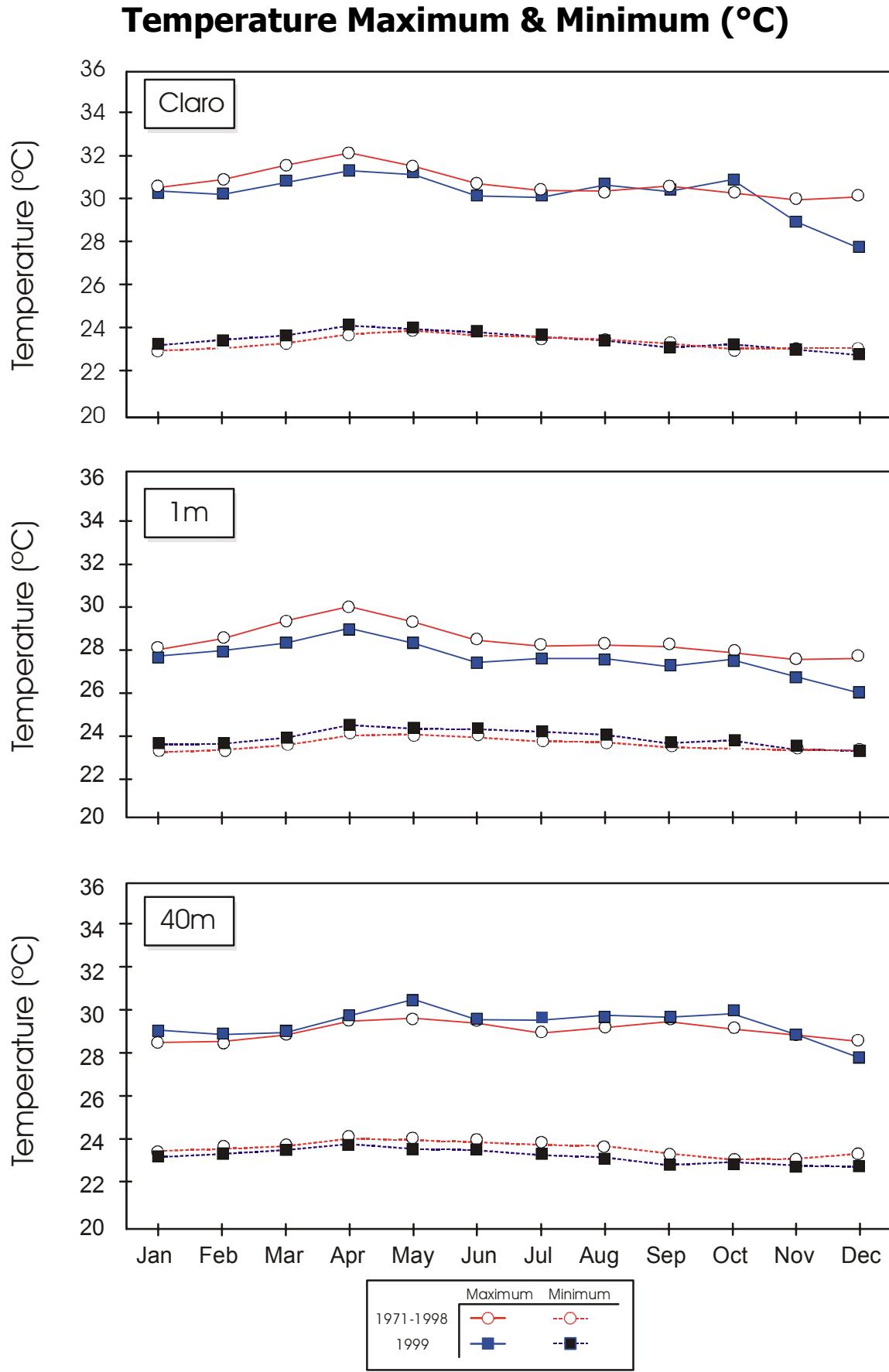
## Avg. Monthly Maximum & Minimum (°C) Temperatures

Long-term Average (1972-1998)

|           | 'El Claro' |         | 1m      |         | 40m     |         |
|-----------|------------|---------|---------|---------|---------|---------|
|           | Maximum    | Minimum | Maximum | Minimum | Maximum | Minimum |
| January   | 30.6       | 23.1    | 27.8    | 23.0    | 28.6    | 23.6    |
| February  | 31.0       | 23.2    | 28.3    | 23.1    | 28.7    | 23.7    |
| March     | 31.6       | 23.4    | 29.1    | 23.3    | 29.0    | 23.9    |
| April     | 32.2       | 23.8    | 29.8    | 23.8    | 29.6    | 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    | 28.0    | 23.5    | 29.3    | 23.9    |
| 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  | 30.1       | 23.2    | 27.3    | 23.1    | 29.0    | 23.3    |
| December  | 30.2       | 23.2    | 27.4    | 23.1    | 28.7    | 23.5    |

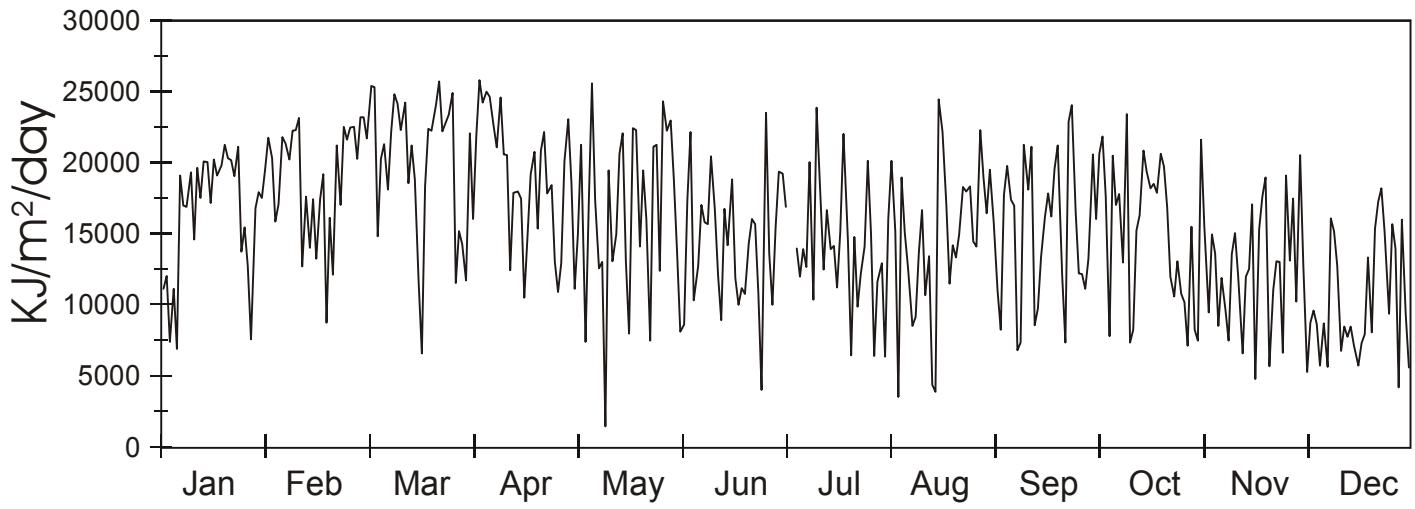
1999

|           | 'El Claro' |         | 1m      |         | 40m     |         |
|-----------|------------|---------|---------|---------|---------|---------|
|           | Maximum    | Minimum | Maximum | Minimum | Maximum | Minimum |
| January   | 30.5       | 23.3    | 27.5    | 23.4    | 29.2    | 23.4    |
| February  | 30.3       | 23.6    | 27.7    | 23.4    | 29.0    | 23.5    |
| March     | 30.8       | 23.8    | 28.1    | 23.7    | 29.1    | 23.7    |
| April     | 31.4       | 24.2    | 28.7    | 24.3    | 29.9    | 24.0    |
| May       | 31.2       | 24.1    | 28.1    | 24.1    | 30.6    | 23.7    |
| June      | 30.2       | 23.9    | 27.2    | 24.1    | 29.7    | 23.7    |
| July      | 30.2       | 23.7    | 27.3    | 24.0    | 29.7    | 23.4    |
| August    | 30.7       | 23.5    | 27.3    | 23.8    | 29.9    | 23.3    |
| September | 30.4       | 23.2    | 27.0    | 23.4    | 29.8    | 23.0    |
| October   | 31.0       | 23.4    | 27.3    | 23.6    | 30.0    | 23.1    |
| November  | 29.1       | 23.1    | 26.5    | 23.1    | 29.0    | 23.0    |
| December  | 27.8       | 22.9    | 25.8    | 23.1    | 27.9    | 22.9    |



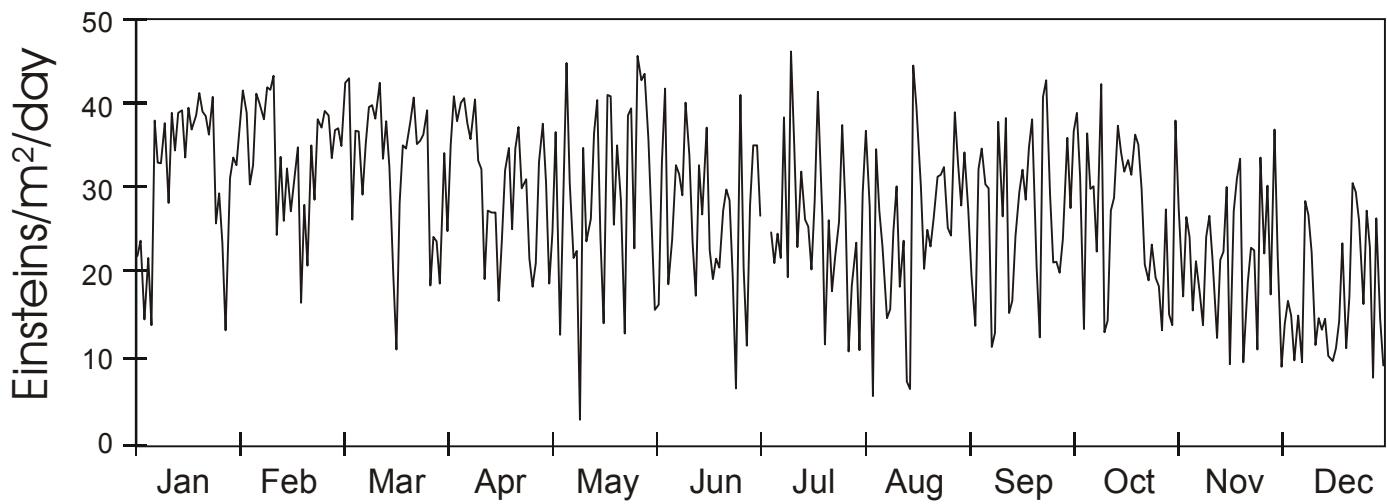
## Daily Total Radiation (KJ/m<sup>2</sup>/day)

|    | <b>Jan.</b> | <b>Feb.</b> | <b>Mar.</b> | <b>Apr.</b> | <b>May</b> | <b>June</b> | <b>July</b> | <b>Aug.</b> | <b>Sep.</b> | <b>Oct.</b> | <b>Nov.</b> | <b>Dec.</b> |
|----|-------------|-------------|-------------|-------------|------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| 1  | 7421        | 15900       | 25400       | 21858       | 14990      | 8653        | 16938       | 20172       | 11041       | 20634       | 15616       | 5340        |
| 2  | 11179       | 17075       | 25351       | 25801       | 21292      | 17330       |             | 15160       | 8309        | 21853       | 9504        | 8801        |
| 3  | 6947        | 21840       | 14843       | 24244       | 7430       | 22175       |             | 3558        | 17781       | 17683       | 14984       | 9653        |
| 4  | 19137       | 21376       | 20295       | 25013       | 17104      | 10366       | 13996       | 18990       | 19794       | 7842        | 13639       | 8706        |
| 5  | 16997       | 20247       | 21345       | 24645       | 25589      | 12795       | 11995       | 15120       | 17404       | 20512       | 8562        | 5782        |
| 6  | 16892       | 22277       | 18139       | 22642       | 17386      | 17049       | 13968       | 12675       | 17001       | 17056       | 11948       | 8712        |
| 7  | 19354       | 22287       | 22196       | 21094       | 12596      | 15838       | 12672       | 8587        | 6878        | 17798       | 9726        | 5666        |
| 8  | 14622       | 23152       | 24823       | 24584       | 13034      | 15690       | 20044       | 9172        | 7397        | 13025       | 7544        | 16116       |
| 9  | 19656       | 12733       | 24139       | 20591       | 1509       | 20467       | 10408       | 13702       | 21297       | 23450       | 13617       | 15196       |
| 10 | 17552       | 17634       | 22323       | 20546       | 19463      | 16729       | 23900       | 16704       | 18163       | 7378        | 15062       | 12798       |
| 11 | 20102       | 14061       | 24231       | 12481       | 13096      | 12147       | 18676       | 10731       | 21146       | 8305        | 12010       | 6790        |
| 12 | 20090       | 17472       | 18601       | 17892       | 15000      | 8963        | 12526       | 13485       | 8594        | 15252       | 6628        | 8523        |
| 13 | 17199       | 13301       | 21220       | 17998       | 20666      | 16809       | 16707       | 4412        | 9774        | 16336       | 12036       | 7803        |
| 14 | 20259       | 17460       | 18876       | 17495       | 22076      | 14241       | 13979       | 3941        | 13430       | 20879       | 12589       | 8507        |
| 15 | 19132       | 19220       | 11565       | 10527       | 13113      | 18854       | 14174       | 24489       | 16222       | 19397       | 17079       | 7229        |
| 16 | 19843       | 8781        | 6634        | 14807       | 8005       | 11930       | 11243       | 22155       | 17853       | 18235       | 4833        | 5787        |
| 17 | 21305       | 16137       | 18357       | 19220       | 22453      | 10041       | 15157       | 17035       | 16274       | 18537       | 15367       | 7357        |
| 18 | 20352       | 12163       | 22424       | 20762       | 22322      | 11211       | 22056       | 11512       | 19568       | 17918       | 17637       | 7985        |
| 19 | 20189       | 21238       | 22252       | 15392       | 14108      | 10781       | 14513       | 14204       | 21216       | 20663       | 18977       | 13380       |
| 20 | 19070       | 17035       | 24055       | 20878       | 19482      | 14377       | 6494        | 13373       | 12075       | 19759       | 5725        | 8113        |
| 21 | 21159       | 22559       | 25720       | 22193       | 16055      | 16050       | 14836       | 15016       | 7381        | 16940       | 11095       | 15417       |
| 22 | 13804       | 21626       | 22220       | 17867       | 7528       | 15692       | 9888        | 18307       | 22893       | 12017       | 13102       | 17284       |
| 23 | 15464       | 22477       | 22796       | 18448       | 21150      | 10862       | 12220       | 18008       | 24084       | 10639       | 13049       | 18209       |
| 24 | 12724       | 22531       | 23372       | 13046       | 21281      | 4060        | 14163       | 18375       | 16632       | 13096       | 6679        | 15170       |
| 25 | 7626        | 20283       | 24911       | 10947       | 12436      | 23513       | 20175       | 14476       | 12259       | 10789       | 19132       | 9430        |
| 26 | 16839       | 23199       | 11590       | 12972       | 24323      | 13641       | 15083       | 14112       | 12208       | 10213       | 13140       | 15710       |
| 27 | 17959       | 23214       | 15226       | 20097       | 22274      | 10031       | 6443        | 22311       | 11171       | 7186        | 17518       | 14017       |
| 28 | 17547       | 21742       | 14314       | 23066       | 22991      | 15522       | 11646       | 18984       | 13284       | 15499       | 10281       | 4259        |
| 29 | 19545       |             | 11750       | 18543       | 18794      | 19362       | 12983       | 16463       | 20630       | 8278        | 20560       | 16001       |
| 30 | 21772       |             | 22094       | 11160       | 13723      | 19263       | 6393        | 19501       | 16069       | 7539        | 12832       | 9360        |
| 31 | 20333       |             | 16062       |             | 8138       |             | 16044       | 15822       |             | 21614       |             | 5651        |



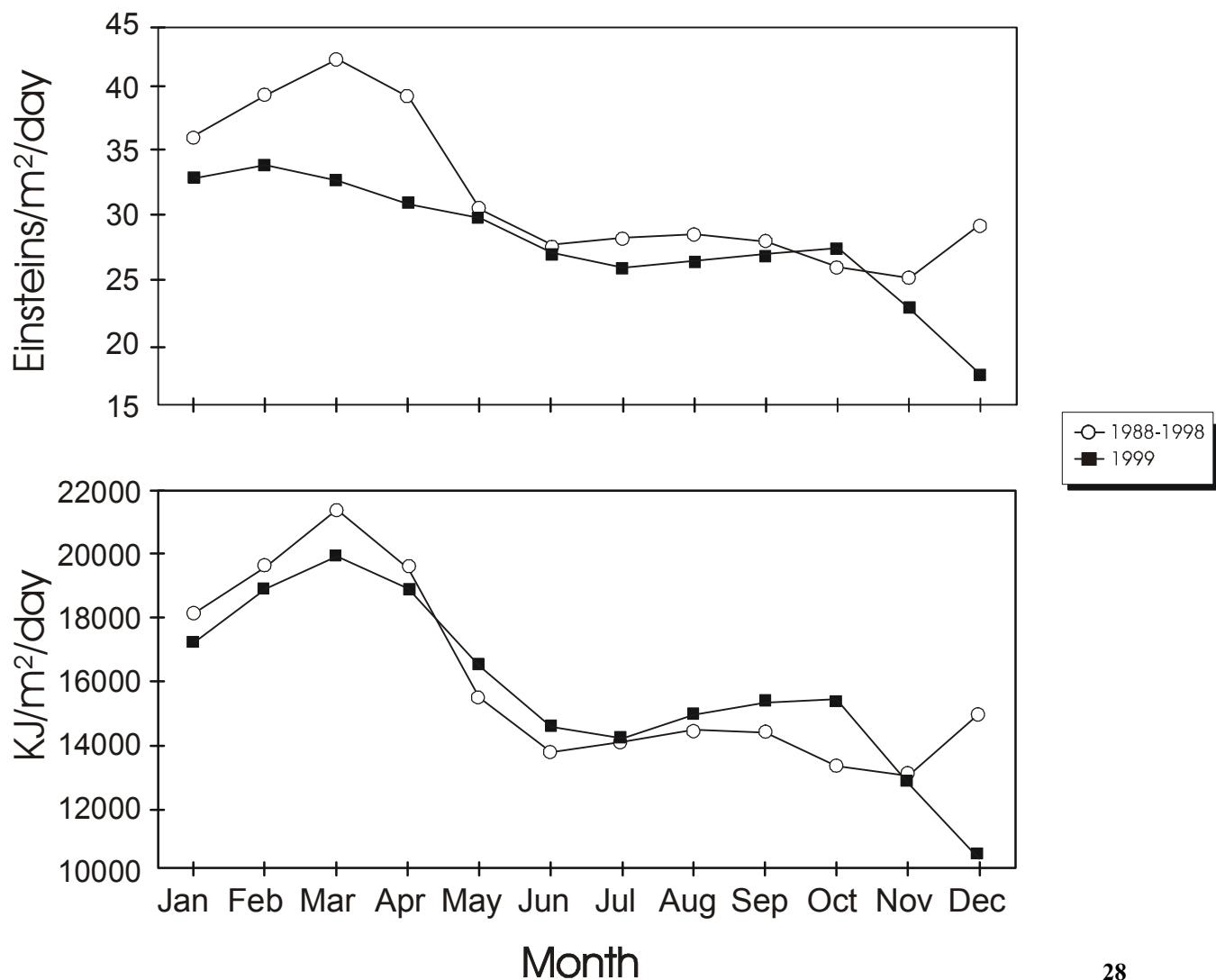
## Daily Total PAR (Einstiens/m<sup>2</sup>/day)

|    | Jan. | Feb. | Mar. | Apr. | May  | June | July | Aug. | Sep. | Oct. | Nov. | Dec. |
|----|------|------|------|------|------|------|------|------|------|------|------|------|
| 1  | 16.3 | 34.9 | 55.8 | 48.0 | 32.9 | 19.0 | 37.2 | 44.3 | 24.3 | 45.4 | 34.3 | 11.7 |
| 2  | 24.6 | 37.5 | 55.7 | 56.7 | 46.8 | 38.1 |      | 33.3 | 18.3 | 48.0 | 20.9 | 19.3 |
| 3  | 15.3 | 48.0 | 32.6 | 53.3 | 16.3 | 48.7 |      | 7.8  | 39.1 | 38.9 | 32.9 | 21.2 |
| 4  | 42.1 | 47.0 | 44.6 | 55.0 | 37.6 | 22.8 | 30.8 | 41.7 | 43.5 | 17.2 | 30.0 | 19.1 |
| 5  | 37.4 | 44.5 | 46.9 | 54.2 | 56.2 | 28.1 | 26.4 | 33.2 | 38.3 | 45.1 | 18.8 | 12.7 |
| 6  | 37.1 | 49.0 | 39.9 | 49.8 | 38.2 | 37.5 | 30.7 | 27.9 | 37.4 | 37.5 | 26.3 | 19.1 |
| 7  | 42.5 | 49.0 | 48.8 | 46.4 | 27.7 | 34.8 | 27.9 | 18.9 | 15.1 | 39.1 | 21.4 | 12.5 |
| 8  | 32.1 | 50.9 | 54.6 | 54.0 | 28.6 | 34.5 | 44.1 | 20.2 | 16.3 | 28.6 | 16.6 | 35.4 |
| 9  | 43.2 | 28.0 | 53.1 | 45.3 | 3.3  | 45.0 | 22.9 | 30.1 | 46.8 | 51.5 | 29.9 | 33.4 |
| 10 | 38.6 | 38.8 | 49.1 | 45.2 | 42.8 | 36.8 | 52.5 | 36.7 | 39.9 | 16.2 | 33.1 | 28.1 |
| 11 | 44.2 | 30.9 | 53.3 | 27.4 | 28.8 | 26.7 | 41.0 | 23.6 | 46.5 | 18.3 | 26.4 | 14.9 |
| 12 | 44.2 | 38.4 | 40.9 | 39.3 | 33.0 | 19.7 | 27.5 | 29.6 | 18.9 | 33.5 | 14.6 | 18.7 |
| 13 | 37.8 | 29.2 | 46.6 | 39.6 | 45.4 | 36.9 | 36.7 | 9.7  | 21.5 | 35.9 | 26.5 | 17.2 |
| 14 | 44.5 | 38.4 | 41.5 | 38.5 | 48.5 | 31.3 | 30.7 | 8.7  | 29.5 | 45.9 | 27.7 | 18.7 |
| 15 | 42.0 | 42.2 | 25.4 | 23.1 | 28.8 | 41.4 | 31.2 | 53.8 | 35.7 | 42.6 | 37.5 | 15.9 |
| 16 | 43.6 | 19.3 | 14.6 | 32.5 | 17.6 | 26.2 | 24.7 | 48.7 | 39.2 | 40.1 | 10.6 | 12.7 |
| 17 | 46.8 | 35.5 | 40.3 | 42.2 | 49.3 | 22.1 | 33.3 | 37.4 | 35.8 | 40.7 | 33.8 | 16.2 |
| 18 | 44.7 | 26.7 | 49.3 | 45.6 | 49.1 | 24.6 | 48.5 | 25.3 | 43.0 | 39.4 | 38.8 | 17.5 |
| 19 | 44.4 | 46.7 | 48.9 | 33.8 | 31.0 | 23.7 | 31.9 | 31.2 | 46.6 | 45.4 | 41.7 | 29.4 |
| 20 | 41.9 | 37.4 | 52.9 | 45.9 | 42.8 | 31.6 | 14.3 | 29.4 | 26.5 | 43.4 | 12.6 | 17.8 |
| 21 | 46.5 | 49.6 | 56.5 | 48.8 | 35.3 | 35.3 | 32.6 | 33.0 | 16.2 | 37.2 | 24.4 | 33.9 |
| 22 | 30.3 | 47.5 | 48.8 | 39.3 | 16.5 | 34.5 | 21.7 | 40.2 | 50.3 | 26.4 | 28.8 | 38.0 |
| 23 | 34.0 | 49.4 | 50.1 | 40.5 | 46.5 | 23.9 | 26.9 | 39.6 | 52.9 | 23.4 | 28.7 | 40.0 |
| 24 | 28.0 | 49.5 | 51.4 | 28.7 | 46.8 | 8.9  | 31.1 | 40.4 | 36.6 | 28.8 | 14.7 | 33.3 |
| 25 | 16.8 | 44.6 | 54.8 | 24.1 | 27.3 | 51.7 | 44.3 | 31.8 | 26.9 | 23.7 | 42.0 | 20.7 |
| 26 | 37.0 | 51.0 | 25.5 | 28.5 | 53.5 | 30.0 | 33.1 | 31.0 | 26.8 | 22.4 | 28.9 | 34.5 |
| 27 | 39.5 | 51.0 | 33.5 | 44.2 | 49.0 | 22.0 | 14.2 | 49.0 | 24.6 | 15.8 | 38.5 | 30.8 |
| 28 | 38.6 | 47.8 | 31.5 | 50.7 | 50.5 | 34.1 | 25.6 | 41.7 | 29.2 | 34.1 | 22.6 | 9.4  |
| 29 | 43.0 |      | 25.8 | 40.8 | 41.3 | 42.6 | 28.5 | 36.2 | 45.3 | 18.2 | 45.2 | 35.2 |
| 30 | 47.8 |      | 48.6 | 24.5 | 30.2 | 42.3 | 14.1 | 42.9 | 35.3 | 16.6 | 28.2 | 20.6 |
| 31 | 44.7 |      | 35.3 |      | 17.9 |      | 35.3 | 34.8 |      | 47.5 |      | 12.4 |



## Total Monthly Solar Radiation

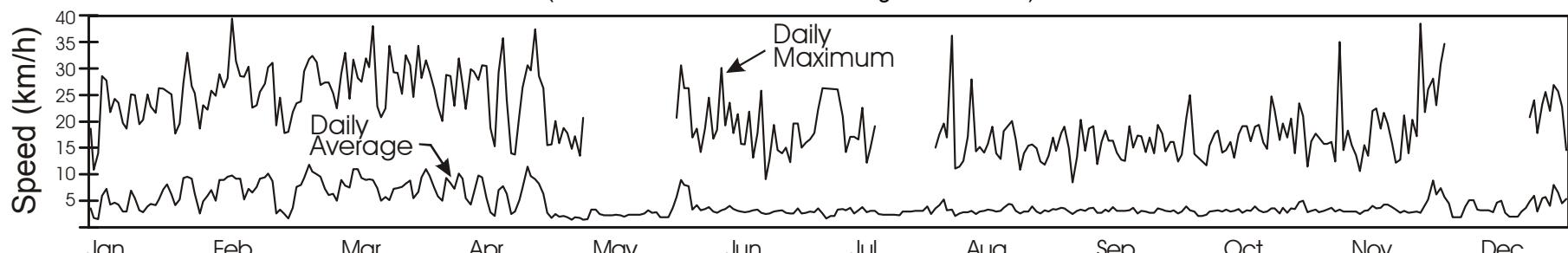
|           | Long-term Average (1988-1998)          |      |   |        | 1999 |         |
|-----------|--|------|---|--------|------|---------|
|           | PAR<br>(Einsteins/m <sup>2</sup> /day) |      | Pyranometer<br>(KJ/m <sup>2</sup> /day) |        | PA R | Pyran.  |
|           | Mean                                   | S.D. | Mean                                    | S.D.   |      |         |
| January   | 36.4                                   | 4.1  | 18095.1                                 | 1400.8 | 37.7 | 17163.5 |
| February  | 39.6                                   | 4.3  | 19578.4                                 | 1252.4 | 41.5 | 18893.6 |
| March     | 42.5                                   | 3.6  | 21391.7                                 | 1070.9 | 43.8 | 19907.2 |
| April     | 39.4                                   | 4.4  | 19528.1                                 | 1381.6 | 41.5 | 18893.7 |
| May       | 30.5                                   | 3.5  | 15423.3                                 | 1649.8 | 36.1 | 16432.5 |
| June      | 27.7                                   | 3.4  | 13688.1                                 | 1234.0 | 31.8 | 14481.4 |
| July      | 28.3                                   | 3.5  | 14004.7                                 | 1317.6 | 31.0 | 14114.5 |
| August    | 28.6                                   | 3.8  | 14388.7                                 | 1502.5 | 32.7 | 14856.5 |
| September | 28.0                                   | 3.8  | 14300.1                                 | 1850.5 | 33.5 | 15260.8 |
| October   | 25.9                                   | 4.4  | 13232.7                                 | 1656.7 | 33.8 | 15365.3 |
| November  | 25.1                                   | 4.3  | 12930.6                                 | 960.7  | 27.9 | 12682.4 |
| December  | 29.3                                   | 5.9  | 14903.6                                 | 2156.3 | 22.6 | 10282.3 |



## Daily Average and Maximum Wind Speed (km/h)

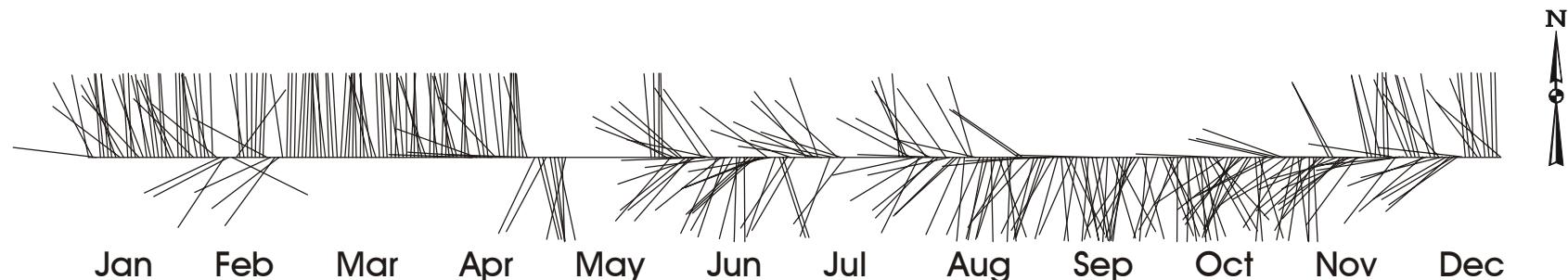
|    | Jan. | Feb. | Mar. | Apr. | May  | June | July | Aug. | Sep. | Oct. | Nov. | Dec. |
|----|------|------|------|------|------|------|------|------|------|------|------|------|
| 1  | 3.5  | 18.6 | 4.9  | 24.8 | 6.0  | 27.4 | 7.2  | 22.9 | 1.8  | 17.1 | 3.1  | 14.2 |
| 2  | 1.7  | 10.8 | 8.9  | 28.9 | 6.2  | 25.3 | 10.1 | 31.9 | 1.7  | 13.4 | 3.3  | 18.6 |
| 3  | 1.5  | 13.9 | 8.9  | 26.4 | 4.9  | 22.5 | 9.1  | 27.0 | 1.3  | 20.6 | 3.7  | 24.5 |
| 4  | 5.9  | 28.5 | 9.4  | 28.2 | 8.8  | 29.0 | 5.4  | 22.2 | 1.5  |      | 2.9  | 16.7 |
| 5  | 7.2  | 27.7 | 9.7  | 39.4 | 7.7  | 33.0 | 4.3  | 29.8 | 3.2  |      | 2.6  | 18.3 |
| 6  | 4.2  | 21.8 | 9.1  | 31.4 | 7.4  | 24.2 | 6.5  | 29.4 | 3.2  |      | 3.1  | 30.1 |
| 7  | 4.6  | 24.2 | 9.1  | 28.6 | 10.9 | 31.6 | 9.8  | 27.9 | 2.4  |      | 3.4  | 19.2 |
| 8  | 4.2  | 23.5 | 5.2  | 28.4 | 10.9 | 28.2 | 9.3  | 30.6 | 2.1  |      | 3.9  | 23.5 |
| 9  | 2.9  | 19.7 | 7.1  | 30.4 | 9.2  | 27.5 | 5.5  | 30.5 | 2.1  |      | 3.4  | 17.7 |
| 10 | 2.9  | 18.6 | 6.4  | 22.6 | 8.8  | 31.9 | 2.7  | 18.7 | 2.1  |      | 3.1  | 21.4 |
| 11 | 6.9  | 25.1 | 7.6  | 23.0 | 8.9  | 30.3 | 2.0  | 15.3 | 2.3  |      | 2.9  | 15.7 |
| 12 | 5.4  | 24.9 | 9.1  | 25.6 | 8.9  | 38.1 | 7.0  | 29.3 | 2.1  |      | 2.7  | 15.5 |
| 13 | 3.1  | 19.4 | 9.4  | 27.0 | 7.3  | 22.8 | 7.7  | 35.8 | 1.9  |      | 2.8  | 21.8 |
| 14 | 2.7  | 20.2 | 10.1 | 30.3 | 4.9  | 20.7 | 6.2  | 24.0 | 2.3  |      | 3.1  | 13.1 |
| 15 | 3.8  | 25.1 | 8.6  | 31.1 | 5.6  | 22.5 | 2.4  | 13.9 | 2.3  |      | 3.2  | 17.8 |
| 16 | 4.3  | 22.8 | 2.6  | 19.1 | 5.1  | 34.3 | 2.9  | 13.7 | 2.3  |      | 2.6  | 25.8 |
| 17 | 4.1  | 21.6 | 3.2  | 24.4 | 7.2  | 29.2 | 5.1  | 21.2 | 2.3  |      | 2.4  | 9.1  |
| 18 | 5.2  | 26.2 | 2.4  | 17.8 | 7.3  | 29.1 | 7.5  | 26.4 | 2.5  |      | 2.6  | 12.8 |
| 19 | 7.1  | 26.1 | 1.6  | 18.0 | 7.6  | 25.2 | 11.4 | 30.6 | 3.1  |      | 2.9  | 19.3 |
| 20 | 8.1  | 25.6 | 3.6  | 21.8 | 8.1  | 32.4 | 9.5  | 29.6 | 2.7  |      | 3.0  | 14.5 |
| 21 | 6.1  | 25.1 | 7.6  | 23.4 | 8.8  | 30.6 | 8.9  | 37.4 | 2.7  |      | 3.1  | 13.9 |
| 22 | 4.1  | 17.6 | 7.9  | 23.7 | 5.4  | 24.5 | 8.2  | 28.5 | 1.9  |      | 2.7  | 15.0 |
| 23 | 5.1  | 19.5 | 9.2  | 29.4 | 6.6  | 34.3 | 6.3  | 26.2 | 1.9  |      | 2.6  | 12.2 |
| 24 | 9.2  | 27.2 | 11.7 | 31.8 | 9.3  | 28.2 | 2.6  | 15.5 | 1.9  |      | 2.6  | 19.5 |
| 25 | 9.5  | 33.0 | 10.4 | 32.3 | 10.9 | 31.5 | 1.7  | 15.6 | 3.6  |      | 3.5  | 19.5 |
| 26 | 9.2  | 26.6 | 10.0 | 31.2 | 9.6  | 29.2 | 2.3  | 20.1 | 5.7  | 20.7 | 2.5  | 15.0 |
| 27 | 6.2  | 25.3 | 9.5  | 26.8 | 7.5  | 26.1 | 1.9  | 15.9 | 8.8  | 30.5 | 2.6  | 15.9 |
| 28 | 2.5  | 18.6 | 7.2  | 27.4 | 5.8  | 22.8 | 2.0  | 18.7 | 8.0  | 26.3 | 2.9  | 16.6 |
| 29 | 4.7  | 23.0 |      | 4.9  | 20.1 | 1.8  | 17.8 | 7.6  | 26.3 | 2.8  | 17.8 | 3.5  |
| 30 | 5.9  | 22.2 |      | 9.3  | 28.8 | 1.3  | 14.8 | 3.2  | 17.0 | 3.5  | 22.2 | 4.1  |
| 31 | 7.0  | 25.8 |      |      | 8.3  | 28.6 |      | 4.1  | 18.6 |      | 5.2  | 19.5 |
|    |      |      |      |      |      |      |      |      |      |      |      | 2.9  |
|    |      |      |      |      |      |      |      |      |      |      |      | 14.9 |
|    |      |      |      |      |      |      |      |      |      |      |      | 3.2  |
|    |      |      |      |      |      |      |      |      |      |      |      | 17.6 |
|    |      |      |      |      |      |      |      |      |      |      |      | 4.5  |
|    |      |      |      |      |      |      |      |      |      |      |      | 22.8 |

(Bolded data taken from totalizing anemometer)



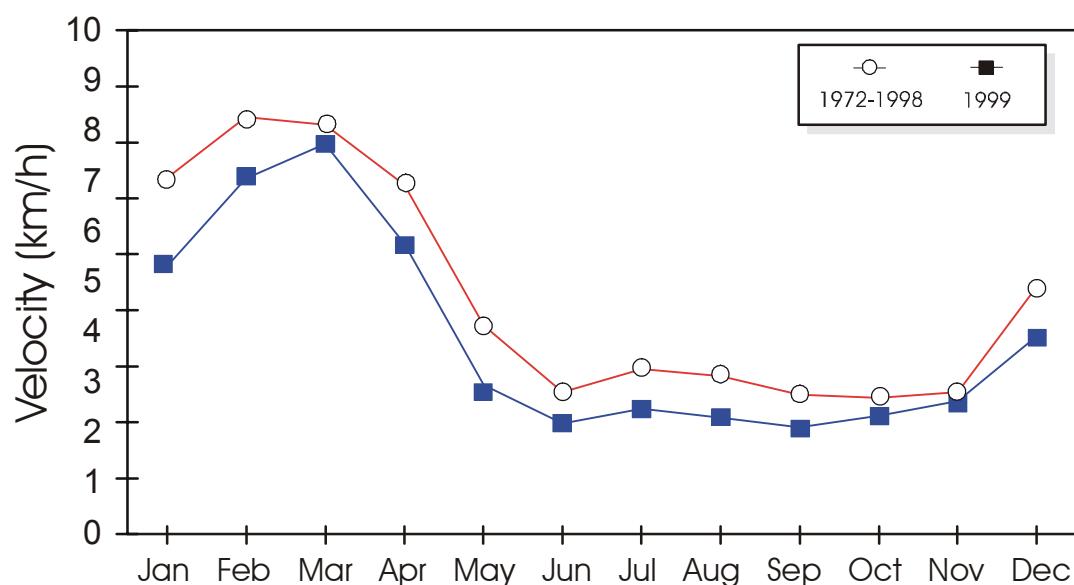
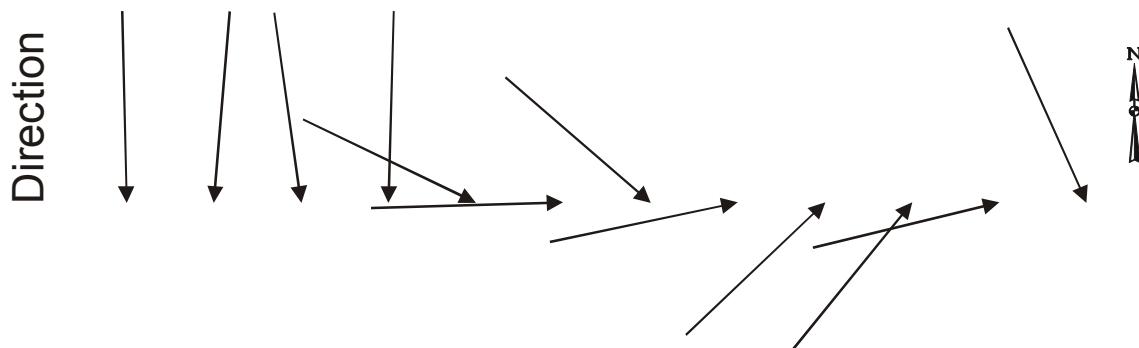
## Average Daily Wind Direction

|    | Jan.  | Feb.  | Mar.  | Apr.  | May   | June  | July  | Aug.  | Sep.  | Oct.  | Nov.  | Dec.  |
|----|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1  | 348.6 | 343.5 | 356.0 | 352.9 | 172.4 | 291.3 | 288.9 | 298.0 | 222.5 | 184.6 | 241.4 | 358.7 |
| 2  | 332.5 | 358.4 | 357.4 | 1.9   | 168.1 | 307.5 | 210.2 | 258.0 | 194.1 |       | 282.8 | 358.6 |
| 3  | 277.0 | 309.5 | 353.1 | 1.3   | 178.1 | 311.4 |       | 206.2 | 205.9 |       | 243.7 | 278.9 |
| 4  | 356.2 | 244.9 | 357.8 | 353.7 | 192.9 | 231.1 |       | 238.9 | 197.8 | 196.9 | 282.9 | 217.5 |
| 5  | 354.0 | 213.6 | 356.4 | 345.7 |       | 221.2 | 321.8 | 322.2 | 200.9 | 158.0 | 289.8 | 260.4 |
| 6  | 355.0 | 242.4 | 356.8 | 344.8 |       | 231.1 | 295.0 | 297.8 | 267.5 | 151.1 | 234.4 | 264.4 |
| 7  | 352.4 | 116.6 | 3.7   | 2.6   |       | 251.4 | 311.9 | 224.1 | 209.9 | 159.5 | 213.7 | 336.5 |
| 8  | 340.5 | 36.2  | 4.5   | 0.5   |       | 325.8 | 340.6 | 231.0 | 195.5 | 199.7 | 192.0 | 341.0 |
| 9  | 307.4 | 357.4 | 2.2   | 353.4 |       | 268.0 | 277.9 | 272.0 | 175.3 | 180.6 | 173.1 | 346.3 |
| 10 | 329.7 | 350.6 | 0.9   | 271.8 |       | 282.2 | 179.3 | 324.8 | 162.6 | 210.4 | 189.0 | 345.0 |
| 11 | 356.8 | 358.7 | 358.9 | 289.8 |       | 324.1 | 200.6 | 257.8 | 155.2 | 172.2 | 240.2 | 229.5 |
| 12 | 358.0 | 0.0   | 0.4   | 349.4 |       | 205.3 | 282.0 | 226.0 | 203.7 | 181.7 | 180.6 | 249.5 |
| 13 | 349.2 | 0.9   | 357.4 | 352.3 |       | 231.1 | 312.5 | 227.6 | 188.8 | 168.1 | 177.1 | 341.1 |
| 14 | 317.3 | 2.4   | 347.2 | 354.5 |       | 198.7 | 287.6 | 204.1 | 167.5 | 160.1 | 210.3 | 350.7 |
| 15 | 338.7 | 2.0   | 351.8 | 273.8 |       | 263.0 | 217.6 | 185.2 | 170.5 | 176.6 | 230.5 | 318.8 |
| 16 | 352.0 | 298.0 | 342.3 | 316.8 |       | 209.8 |       | 330.8 | 184.5 | 171.2 | 226.1 | 255.6 |
| 17 | 346.6 | 245.4 | 357.6 | 353.0 |       | 181.3 |       | 343.8 | 169.3 | 150.4 | 334.1 | 239.8 |
| 18 | 352.8 | 216.1 | 357.9 | 356.5 |       | 194.5 |       | 282.6 | 169.8 | 137.9 | 331.5 | 229.6 |
| 19 | 352.4 | 232.8 | 356.6 | 2.6   |       | 179.3 |       | 203.4 | 271.8 | 150.8 | 247.8 | 239.4 |
| 20 | 357.3 | 351.8 | 359.2 | 359.3 |       | 227.6 |       | 190.9 | 193.4 | 272.3 | 223.5 | 235.2 |
| 21 | 355.9 | 1.3   | 1.2   | 358.7 |       | 228.0 |       | 194.6 | 183.4 | 236.1 | 230.9 | 276.5 |
| 22 | 336.9 | 1.3   | 351.3 | 357.1 |       | 228.7 |       | 178.8 | 163.7 | 197.5 | 236.0 | 354.5 |
| 23 | 336.8 | 1.5   | 355.9 | 355.5 |       | 248.1 |       | 193.4 | 151.4 | 198.8 | 255.4 | 354.4 |
| 24 | 358.5 | 3.7   | 359.4 | 344.0 |       | 249.2 |       | 161.2 | 187.1 | 216.9 | 216.4 | 358.7 |
| 25 | 358.4 | 2.6   | 3.2   | 271.9 |       | 306.9 |       | 197.9 | 187.1 | 222.2 | 248.1 | 323.1 |
| 26 | 357.6 | 2.2   | 359.9 | 205.5 | 355.1 | 260.3 |       | 173.6 | 191.2 | 231.5 | 270.4 | 338.2 |
| 27 | 355.8 | 1.6   | 357.4 | 166.3 | 359.2 | 199.7 |       | 182.3 | 197.4 | 211.3 | 349.0 | 354.7 |
| 28 | 314.5 | 359.3 | 345.0 | 166.9 | 0.0   | 161.7 |       | 213.8 | 214.2 | 213.1 | 346.3 | 354.3 |
| 29 | 349.5 |       | 340.6 | 208.5 | 358.4 | 161.9 | 355.2 | 305.1 | 210.0 | 175.2 | 1.5   | 358.8 |
| 30 | 355.3 |       | 0.5   | 170.4 | 299.1 | 213.3 | 342.7 | 304.3 | 165.6 | 163.4 | 345.7 | 359.0 |
| 31 | 356.4 |       | 0.5   |       | 220.8 |       | 335.4 | 263.8 |       | 184.8 |       | 310.4 |



## Average Monthly Wind Speed and Direction

|                  | Long-term Av. (1972-1998) |      |           | 1999       |              |
|------------------|---------------------------|------|-----------|------------|--------------|
|                  | Speed                     | S.D. | Direction | Speed      | Direction    |
| <b>January</b>   | 7.1                       | 1.1  | 358.7     | <b>5.3</b> | <b>347.0</b> |
| <b>February</b>  | 8.4                       | 1.3  | 4.7       | <b>7.1</b> | <b>349.3</b> |
| <b>March</b>     | 8.2                       | 1.1  | 1.6       | <b>7.8</b> | <b>356.8</b> |
| <b>April</b>     | 7.0                       | 1.6  | 351.9     | <b>5.8</b> | <b>345.8</b> |
| <b>May</b>       | 4.1                       | 1.3  | 305.3     | <b>2.9</b> | <b>286.1</b> |
| <b>June</b>      | 2.8                       | 0.5  | 268.4     | <b>2.1</b> | <b>227.6</b> |
| <b>July</b>      | 3.2                       | 0.9  | 310.9     | <b>2.4</b> | <b>298.5</b> |
| <b>August</b>    | 3.1                       | 0.7  | 258.2     | <b>2.2</b> | <b>228.3</b> |
| <b>September</b> | 2.7                       | 0.3  | 226.4     | <b>2.0</b> | <b>186.2</b> |
| <b>October</b>   | 2.6                       | 0.3  | 219.0     | <b>2.3</b> | <b>183.7</b> |
| <b>November</b>  | 2.8                       | 0.3  | 256.4     | <b>2.6</b> | <b>245.7</b> |
| <b>December</b>  | 4.9                       | 1.1  | 335.8     | <b>3.9</b> | <b>322.3</b> |



## Estimated Evapotranspiration and Water Balance

| Average<br>(1993-1998) | 'El Claro'          |      |                   | 40 m                |      |                   |
|------------------------|---------------------|------|-------------------|---------------------|------|-------------------|
|                        | Month <sup>-1</sup> | S.D. | Day <sup>-1</sup> | Month <sup>-1</sup> | S.D. | Day <sup>-1</sup> |
| January                | 84.7                | 22.2 | 2.7               | 143.9               | 21.9 | 4.6               |
| February               | 101.0               | 15.4 | 3.6               | 151.0               | 14.1 | 5.4               |
| March                  | 126.1               | 18.2 | 4.1               | 187.3               | 18.5 | 6.0               |
| April                  | 114.2               | 12.3 | 3.8               | 165.1               | 15.0 | 5.5               |
| May                    | 66.8                | 13.9 | 2.2               | 100.8               | 11.6 | 3.3               |
| June                   | 47.2                | 12.5 | 1.6               | 76.0                | 21.0 | 2.5               |
| July                   | 57.0                | 8.0  | 1.8               | 80.2                | 22.2 | 2.6               |
| August                 | 57.5                | 9.6  | 1.9               | 88.8                | 20.1 | 2.9               |
| September              | 61.9                | 5.5  | 2.1               | 89.4                | 11.5 | 3.0               |
| October                | 57.1                | 2.8  | 1.8               | 84.0                | 8.8  | 2.7               |
| November               | 36.7                | 5.1  | 1.2               | 64.2                | 24.5 | 2.1               |
| December               | 57.0                | 18.6 | 1.8               | 99.9                | 29.5 | 3.2               |

| 1999      | Evapotranspiration<br>(mm eq.) |       | Net Water Balance<br>(mm eq.) |        |
|-----------|--------------------------------|-------|-------------------------------|--------|
|           | 'El Claro'                     | 40 m  | 'El                           | 40 m   |
| January   | 78.5                           | 137.0 | -37.0                         | -82.4  |
| February  | 99.0                           | 161.0 | -56.5                         | -118.4 |
| March     | 128.5                          | 172.5 | -7.9                          | -51.9  |
| April     | 98.0                           | 139.0 | 98.7                          | 57.7   |
| May       | 70.0                           | 101.0 | 147.6                         | 116.6  |
| June      | 57.0                           | 90.5  | 159.0                         | 125.5  |
| July      | 60.5                           | 90.0  | 73.9                          | 44.4   |
| August    | 66.5                           | 92.5  | 56.0                          | 30.0   |
| September | 70.5                           | 85.0  | 139.6                         | 125.1  |
| October   | 79.0                           | 99.0  | 84.7                          | 63.9   |
| November  | 56.5                           | 79.0  | 123.2                         | 100.7  |
| December  | 36.0                           | 57.5  | 158.4                         | 136.9  |

## Estimated Evapotranspiration and Water Balance

