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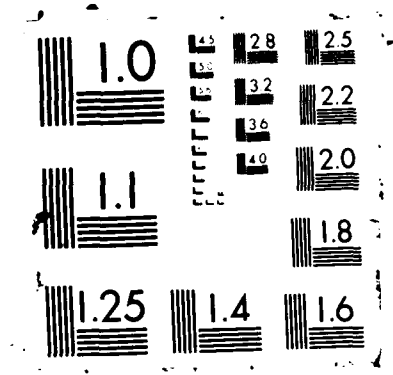
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The Effect of Meteorological Conditions on
Transmission of Radiation and Imaging Through
Natural Dusty Environments

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31 July 1986

Final Report
1 June 1985-31 May 1986

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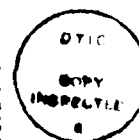
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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) The transmission of radiation is affected by dust and by turbulence. It would be desirable to be able to predict the degree of turbulence and the dust concentration. As a prelude to carrying out experiments in the Negev Desert to gather appropriate data leading to development of a prediction model, we have selected a site and prepared climatological data for that site.		

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The main aims of the one year grant from the USAF under this topic were twofold:

1. Site selection and preparation for the main experiments.
2. Climatological survey of the Sede Boqer area.

The IRGODOM group met approximately once per month to discuss requirements for siting, preparation of equipment, personnel.

There was one two-day workshop at Sede Boqer, in which the most appropriate site, with a clear line of sight path, was selected. As part of this path extends into Kibbutz Sede Boqer, which is an independent organization, we negotiated the necessary arrangements with the Head of the Kibbutz. He was most cooperative, so no problem was expected from that source. Fig. 1 shows the layout for the experiment.

The Desert Meteorology Unit had previously prepared a summary paper, "Meteorological Data for Sede Boqer," by Avraham Zangvil and Perla Druian. This summary was updated, by summarizing each year thru 1985, and then including the data for each individual year in the overall mean values 1977-1985.

We are also enclosing a report "Dust Storms at Sede Boqer," by Perla Druian and Louis Berkofsky, 1983. That report shows that the largest number of storms occurs in March, April and December, and the least number in July, August, and September. Thus we would plan to do one experiment in summer (September) and one in April.

We are still planning to go ahead with the experiments as originally proposed, and are awaiting further funding.

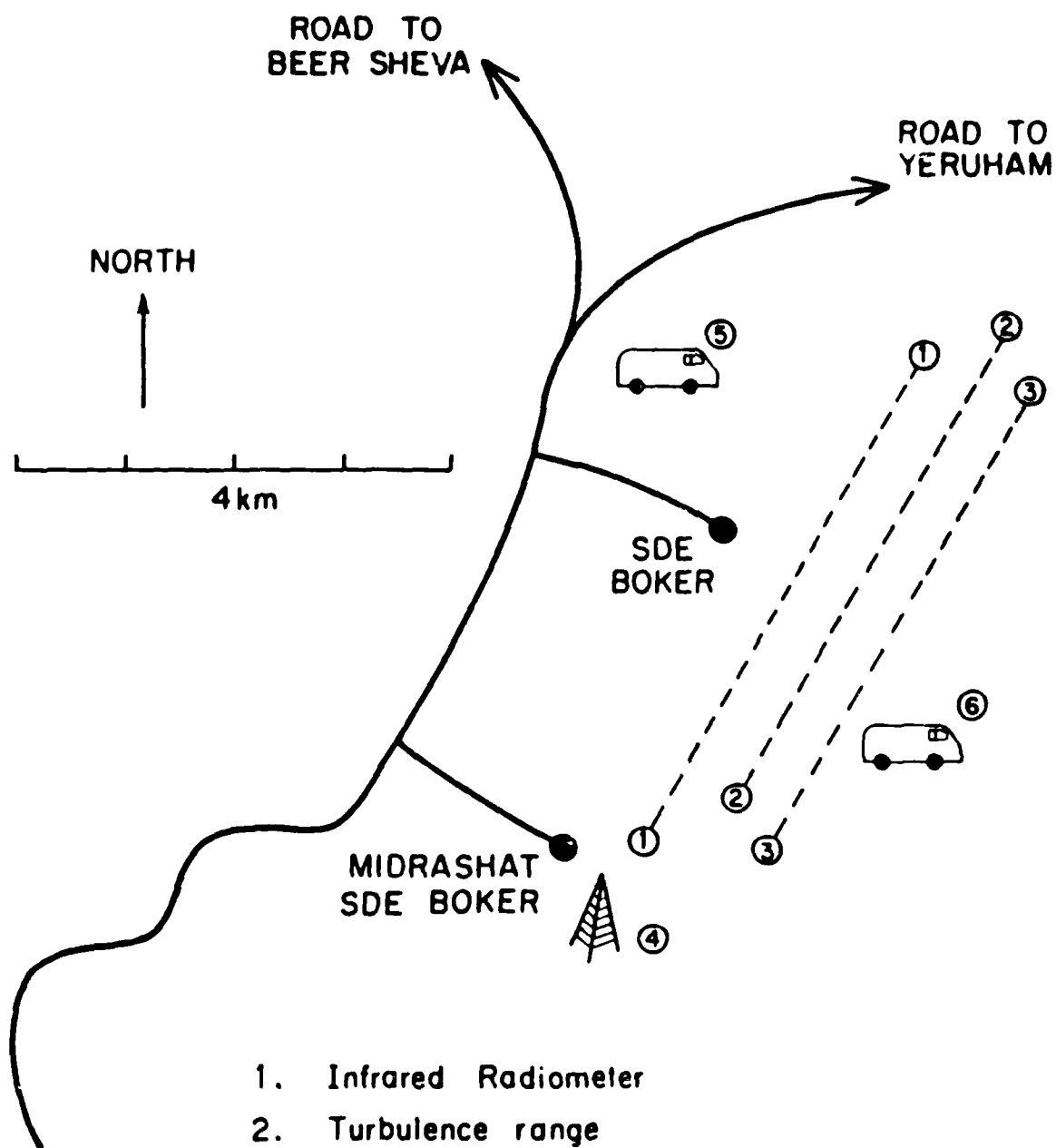


FIG. 1

Dust Storms at Sede Boqer

by

Perla Druian and Louis Berkofsky

The Jacob Blaustein Institute for Desert Research
Ben Gurion University of the Negev
Sede Boqer Campus, 84990, Israel

Desert Meteorology Papers
January, 1983

Dust Storms at Sede Boqer

1 - Abstract:

The purpose of this report is to describe the frequency of dust storms, their distribution over the months of the year and their distribution according to wind direction and velocity during the last six years (Nov. 1976 - Nov. 1982), taking into account only visibility measurements.

2 - Introduction:

The dust storm is a common phenomenon that occurs frequently in arid and semiarid areas. In general, a dust storm is defined when visibility is reduced by the presence of dust to less than 1,000 m. There are other visibility criteria, i.e., below 11 km or 700 m, as visibility limits. We use two visibility limits: 5,000 m and 1,000 m (following J. Katsnelson in his paper "Frequency of dust storms at Beer Sheva", 1970).

The necessary conditions for a dust storm are: existing areas of loose sand, dust or loess; relatively strong winds, steep lapse rate of temperature in the lower atmospheric layer and a dry spell which facilitates the existence of coarse sand or fine dust in the air (J. Katsnelson, 1970). All these conditions exist in our area.

3 - Data and Results:

Sede Boqer is located on the north of the Negev mountains, 480 m above M.S.L. The average rainfall is about 90 mm and most of it falls between November and May. Soils in this area are loess or sand or both.

Sede Boker is a climatological station. Observations have been taken three times per day (0800, 1400 and 2000) during the last six years. Because of the sparseness of measurements, accurate descriptions of the passage of dust storms were not possible. Thus it is assumed that the number of recorded cases during the entire period is not complete and smaller than its true value. We record dust storms only at the time of the observation, and the values in this report are the number of dust storm observations, not a day or a dust storm.

2-1 Distribution of dust storm observations according to month of the year:

During the last six years there were 183 cases of dust storm observations with visibility equal to or less than 5 km, and 35 of these were equal to or less than 1 km.

Table 1 gives the distribution of dust storm observations according to the month of the year.

Table 1

Distribution of dust storms at Sede Boqer according to month of the year
(period: November 1976 - October 1982)

	$V \leq 5 \text{ km}$	$V \leq 1 \text{ km}$
January	15	0
February	18	3
March	26	6
April	45	8
May	12	3
June	5	1
July	12	0
August	6	0
September	6	0
October	7	1
November	14	2
December	23	11

In this entire period April was the month with the maximum number of dust storm observations (45); next were March (26) and December (23). The explanations for these are;

Atmospheric dust penetrates into Israel in the rainy and late spring seasons when barometric cyclones cross the Eastern Mediterranean Basin (Ganor, Yaalon and E. Ganor, 1977). Most dust storms in this region are

SEDE BOQER

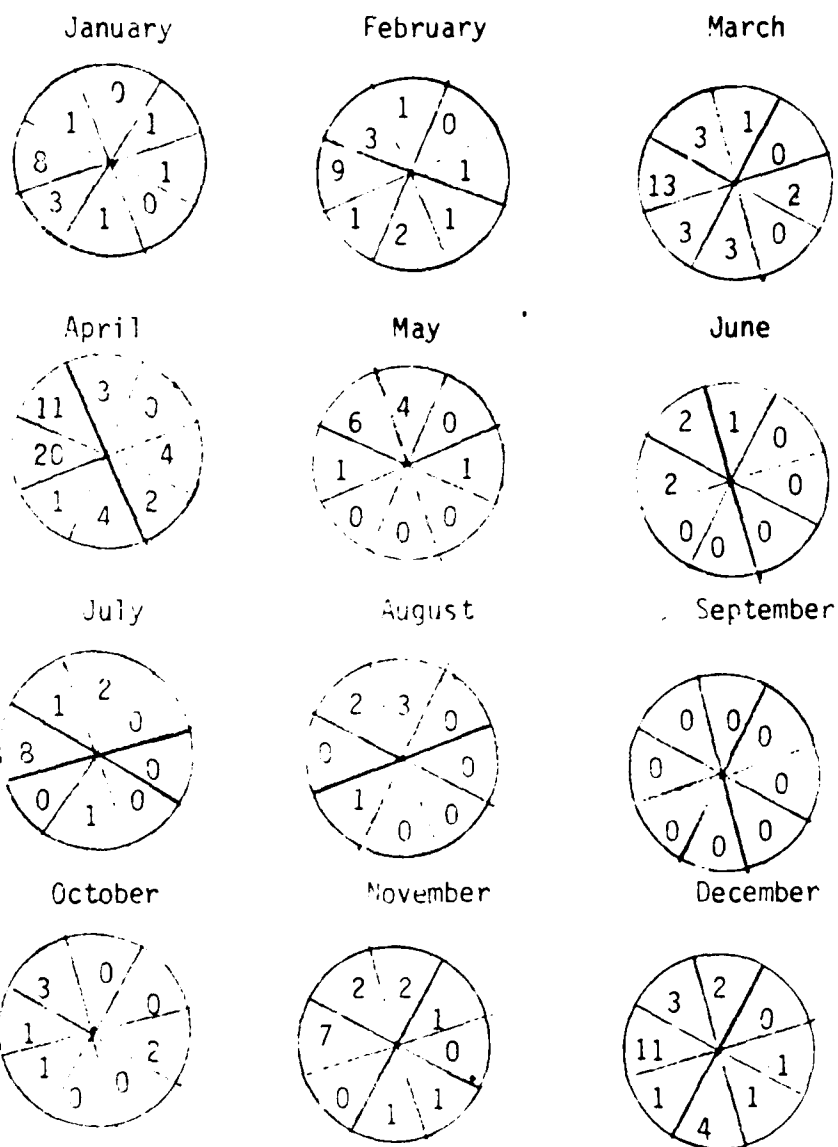


Fig 1: Frequency of wind directions during dust storm observations ($V \leq 5 \text{ km/h}$) at Sede Boqer. (Numbers are total number of observations).

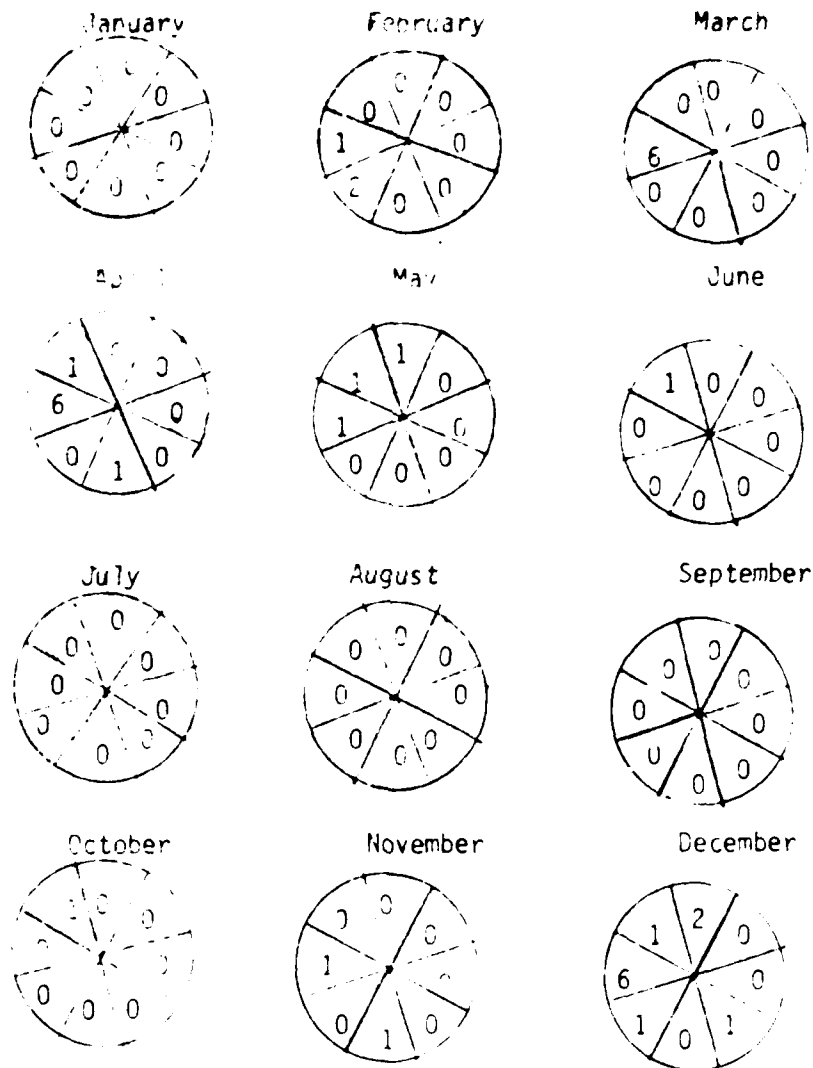
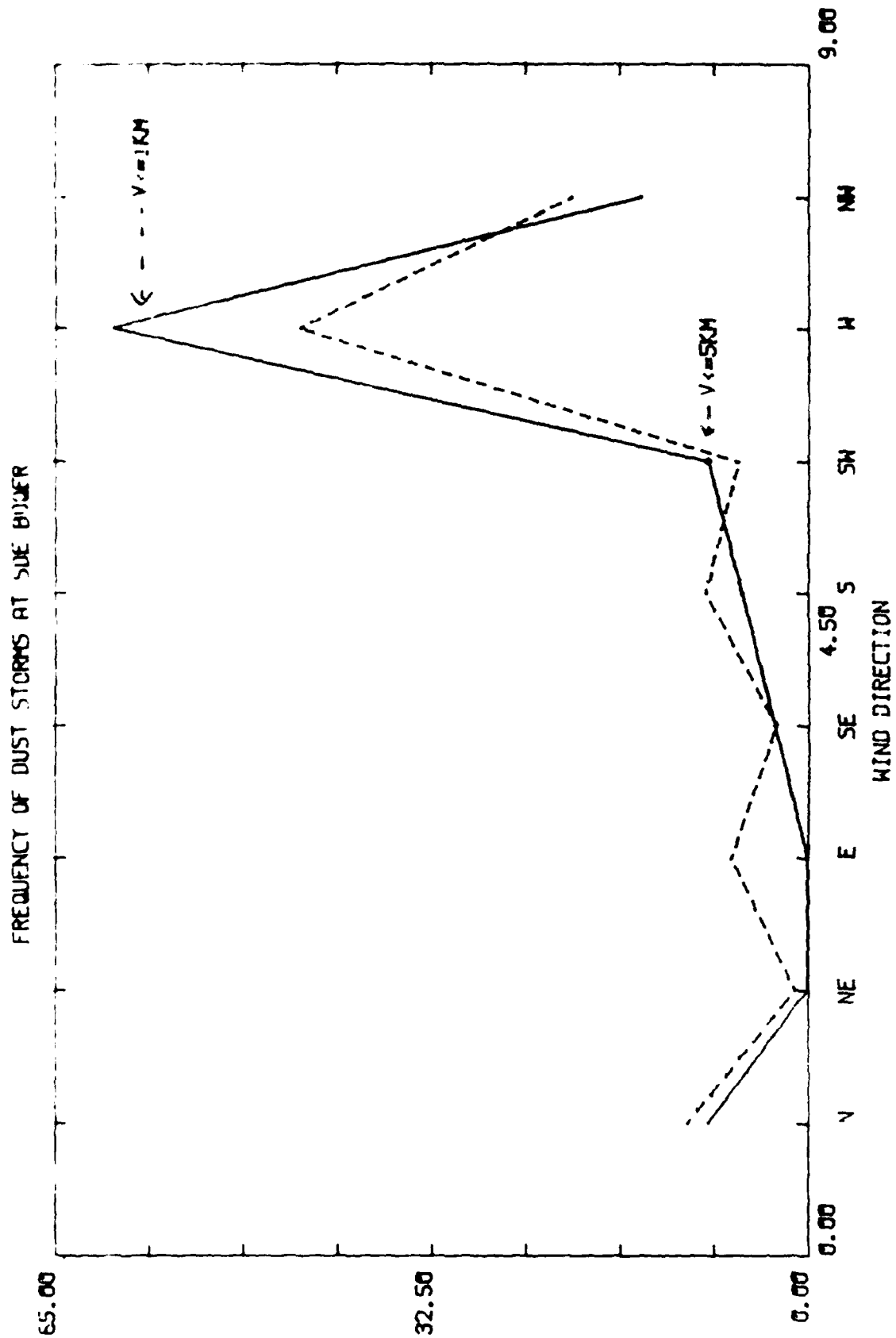


Fig 2: Frequency of wind directions during dust storms observations (V = 1 Km) at Sede Boquer.
(Numbers are total number of observations.)

FREQUENCY OF DUST STORMS

Frequency of dust storms at times of dust storms



associated with the passage of a cold front moving from W to E, which explains the 11 cases of December with visibility equal to or less than 1 km. There were no cases in September during the entire period.

3-2 Frequency of wind directions during dust storm observation according to the month of the year:

Firstly, we defined eight wind directions as follows:

N: $340^{\circ} - 20^{\circ}$	S: $160^{\circ} - 200^{\circ}$
NE: $30^{\circ} - 60^{\circ}$	SW: $210^{\circ} - 240^{\circ}$
E: $70^{\circ} - 110^{\circ}$	W: $250^{\circ} - 290^{\circ}$
SE: $120^{\circ} - 150^{\circ}$	NW: $300^{\circ} - 330^{\circ}$

Dust storm occurrences (roses) for each wind direction for each month were constructed (Figs. 1 and 2) for visibilities ≤ 5 km and ≤ 1 km. It can be seen that there are 80 cases (43%) in the sector $250^{\circ} - 290^{\circ}$ with $V \leq 5$ km and 21 cases (60%) with $V \leq 1$ km.

3-3 Percentage frequency of wind directions at times of dust storms at Sede Boqer.

Most of the dust storms at Sede Boqer are associated with winds blowing from W, the predominance in the sector in both cases (43% with visibility ≤ 5 km and 63% with visibility ≤ 1 km) can be seen in Fig. 3. The sector with the second highest frequency is NW (in both cases too). More than 60%, in the general case ($V \leq 5$ km), of dust storms come from W - NW.

4-4 Distribution of dust storms at Sede Boqer according to wind direction and velocity.

In Table 2, all 183 cases of dust storms with visibility ≤ 5 km registered during the 6 years were classified according to the eight wind directions and seven groups of wind velocity corresponding to the Beaufort Scale, given in knots. The 35 cases of dust storms with visibility ≤ 1 km were similarly classified in Table 3. The frequency data are expressed as the number of cases. The lightest winds (1 - 6 knots) are not sufficiently strong to be associated with a serious dust storm. Nevertheless, they are included because there were cases with light winds at the time of observation. But in general, winds associated with dust storms were stronger.

From Table 2 one can see the homogeneity of the distribution of dust storms with winds with velocities from 4 to 21 knots. On the other hand, Table 3 ($V \leq 1$ km) shows that there is a clear maximum with wind of 11 - 21 knots.

4 - Future plans:

In order to improve the present data set, new instrumentation will be utilized. The "Flow Controlled High Volume Air Sampling System" manufactured by Sierra Instruments Inc., is already being used to collect 24-hour data. Future plans include extended measurements of day-night differences of dust concentration, by means of this and more sophisticated equipment. This more precise data set will provide calibration for the prognostic dust model being developed and tested in the Desert Meteorology Unit (Berkofsky, 1982).

VV ≤ 5 km								
Knots	N 340°-200°	NE 300°-60°	E 70°-110°	SE 120°-150°	S 160°-200°	SW 210°-240°	W 250°-290°	NW 300°-330° Total
1-3	2	1	3	-	5	1	8	6 26
4-6	3	-	5	4	1	3	11	9 36
7-10	6	-	2	-	5	-	15	7 35
11-16	2	-	2	1	5	3	18	6 37
17-21	3	1	-	-	1	3	18	8 34
22-27	-	-	-	-	-	-	8	4 12
28-33	-	-	-	-	-	-	2	- 2

Table 2

VV ≤ 1 km								
Knots	N 340°-20°	NE 30°-60°	E 70°-110°	SE 120°-150°	S 160°-200°	SW 210°-240°	W 250°-290°	NW 300°-330° Total
1-3	1	-	-	-	-	-	-	1 2
4-6	-	-	-	-	-	-	1	- 1
7-10	1	-	-	-	-	1	2	- 4
11-16	-	-	-	1	1	1	7	- 10
17-21	1	-	-	-	1	1	7	2 12
22-27	-	-	-	-	-	-	4	1 5
28-33	-	-	-	-	-	-	1	- 1

Table 3

Distribution of Duststorms at Sede Boquer according to wind directions and velocities.
Period: November 1976 - October 1982 (three-hourly observations)

References:

- L. Berkofsky: A heuristic investigation to evaluate the feasibility of developing a desert dust prediction model. Monthly Weather Review, Vol. 110, No. 11, November 1982.
- J. Katsnelson: Frequency of dust storms at Beer Sheva. Israel Journal of Earth-Sciences, Vol. 19, 1970, pp. 69-76
- D.H. Yaalon and E. Ganor: The climatic factor of wind erodibility and dust blowing in Israel. Israel Journal of Earth-Sciences, Vol. 15, 1966, pp. 27-32.
- _____: East Mediterranean trajectories of Dust-carrying Storms from the Sahara and Sinai. Saharan Dust, Ed. Christer Morales John Wiley & Sons, Chapter 9, 1977, pp. 187-193.

Meteorological Data for
Sede Boqer

by

Abraham Zangvil and Perla Druian

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Desert Meteorology Papers, Series A, No. 8

December 1983

Introduction

Meteorological observations have been initiated towards the end of 1976 in the meteorological observation plot of the Institute for Desert Research. The plot is located on flat, bare loess soil on the north-eastern corner of the Sede Boqer Campus in Sede Zin, 45 km south of Beer Sheva, 480 m above mean sea level. (Fig. 1).

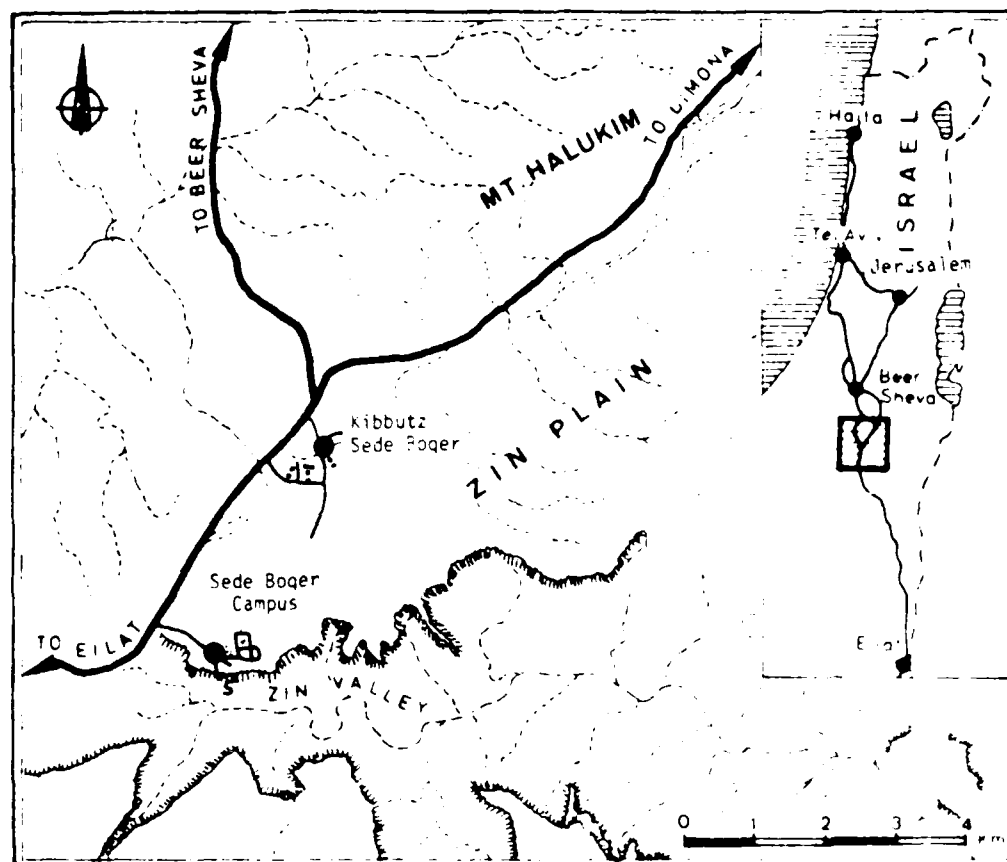


Fig.1 The Study Area

Station Instrumentation

At present the meteorological observatory includes a standard meteorological instrument shelter housing dry and wet bulb thermometers, maximum and minimum thermometers and a thermohydrograph (manufactured by Jules Richards). Rainfall is measured in a standard rain gauge, 16 cm in diameter, from October 1976 and also by a Belfort recording rain gauge. Evaporation is measured from a class A

evaporation pan since May 1978. Dew is recorded since July, 1977 by a dew balance* of the Hilther type (manufactured by Lambrecht). A grass minimum thermometer is also installed in the plot. The data used for this report are almost complete except for a few occasions. In the case of missing temperature data reference was made to the continuous chart records. In the case of missing evaporation data, the daily value was linearly interpolated. In general the percentage of missing data did not exceed 2%.

Temperature Data

Temperature data for the individual years 1977 to 1982 are presented in Tables 1 to 6. In the first five columns the average daily maximum and minimum temperatures, daily mean temperature, daily temperature range and the average daily grass minimum temperature are presented, for each month. In the next six columns extreme values of daily temperatures are presented. The standard deviation of the daily maximum, minimum, and grass minimum temperature is shown in the last three columns. Table 7 shows the average values for the 6 years of measurements and also extreme values for the period 1977-1982. The standard deviation is of the means presented in Tables 1 to 6.

Temperature and Humidity Variables at 14:00 Local Time

In Tables 8 to 13 daily mean values and standard deviations at 14:00 local time are shown for dry and wet bulb temperatures, relative humidity and dew point. Table 14 summarizes the long-term mean of the values of 6 years. The standard deviations in this table is that of the means presented in Tables 8 to 13. It is interesting to note here that the yearly maximum of the dew point occurs in September and the minimum in February.

* The original dew collecting mesh has been modified by adding on a thin (0.1 mm) plastic disc (see Candvil and Leelan, 1970).

Rainfall, Dew and Evaporation

Data for the individual years 1977-1982 are shown in Tables 15 to 20. In the first four columns information on monthly rainfall is presented. Monthly totals and extreme values of dewfall are presented in the next five columns (see also Zangvil and Druian, 1980). Monthly totals, extremes and daily means of evaporation are shown in the last six columns. Finally, Table 21 shows long-term means and extreme values of rainfall, dew fall and evaporation for the years 1977-1982. Table 22 summarizes precipitation data for the rain seasons 1976-77 to 1982-83.

Reference:

Zangvil, A. and P. Druian, 1980. Measurement of dew at a desert site in southern Israel. Geog. Res. Forum, 2, 26-34.

1977	Average daily temperature (°C)				Extreme daily values (°C)						Standard deviation (°C)		
	maximum	minimum	average	daily range	grass minimum	maximum	day	minimum	day	grass minimum	day	maximum	grass minimum
I	15.1	5.0	9.1	8.1	-	18.0	30-31	2.9	08	-	-	3.3	2.6
II	16.1	8.3	14.2	11.8	4.3	27.4	27	1.5	01	0.0	11	3.4	3.2
III	14.8	7.1	13.5	12.7	4.1	28.4	24	2.0	11	-0.5	11	4.8	2.6
IV	11.5	10.3	15.9	11.2	7.5	30.5	22	5.4	20	3.6	16	4.2	2.7
V	29.1	14.1	21.6	15.0	11.1	38.5	31	9.7	16	6.0	16	4.7	3.6
VI	31.3	17.0	24.1	14.3	14.1	37.1	06	12.7	13	10.2	11	3.1	3.2
VII	33.2	19.6	26.4	13.7	16.6	39.4	12	16.5	06	13.6	08	2.6	2.4
VIII	33.7	19.6	26.6	14.1	17.6	38.5	24	16.6	22	14.5	28	2.4	1.3
IX	29.8	17.0	23.4	12.7	14.8	33.8	25	13.7	18	10.5	19	1.6	1.6
X	35.0	13.4	19.2	11.6	10.4	32.6	15	7.0	31	4.8	27	3.3	3.4
XI	22.7	9.3	16.0	13.4	4.3	27.5	08	4.5	13-14	0.0	14	2.7	3.1
XII	14.2	5.3	10.3	9.9	1.6	21.9	03	0.7	27	-3.5	27	2.9	2.9
annual average	24.5	12.2	18.4	12.4	9.7								

Table 1: Summary of temperature data for the year 1977.

1978 month	Average daily temperature (°C)				Extreme daily values (°C)							Standard deviation (°C)		
	maximum	minimum	average	daily range	grass minimum	maximum	day	minimum	day	grass minimum	day	maximum	minimum	grass minimum
I	15.7	4.4	10.1	11.3	0.7	23.1	18	-1.0	12	-4.7	12	3.5	4.0	4.3
II	16.3	6.7	12.5	11.6	2.9	28.5	15	2.1	25	-1.9	12	3.5	3.3	4.1
III	21.3	8.7	15.0	12.6	4.5	31.8	09	3.0	15	-1.9	15	4.6	3.8	4.0
IV	25.8	10.8	18.3	15.0	6.1	34.6	04	5.5	12	0.8	29	4.9	3.1	3.1
V	30.9	15.4	23.1	15.5	12.0	37.7	27	9.6	07	5.6	08	4.1	4.0	4.4
VI	30.7	16.1	23.4	14.6	13.7	38.7	22	9.5	10	6.6	10	4.2	2.8	3.4
VII	33.2	19.2	26.2	13.9	16.6	40.3	08	15.9	02-26	12.3	02	3.3	1.7	1.9
VIII	30.9	17.2	24.0	13.7	14.3	33.5	09	14.1	22	11.4	22	1.4	1.4	1.7
IX	26.9	16.3	22.6	12.6	13.7	39.1	08	12.7	25	9.6	25	2.8	2.1	2.3
X	26.3	15.5	21.9	12.8	13.2	33.2	12	9.5	30	6.4	30	3.3	2.8	3.6
XI	19.6	8.5	14.0	11.1	4.4	23.0	02	3.0	17	-2.0	16	1.8	3.3	4.4
XII	17.2	7.0	12.1	10.2	3.6	21.4	07	2.5	10	-0.4	25	2.0	2.9	2.9
annual average	25.1	12.1	18.6	12.9	8.8									

Table 2: Summary of temperature data for the year 1978.

1979 month	Average daily temperature (°C)				grass minimum	Extreme daily values (°C)						Standard deviation (°C)		
	maximum	minimum	average	daily range		maximum	day	minimum	day	grass minimum	day	maximum	minimum	grass minimum
I	15.5	5.1	10.3	10.4	2.3	23.4	03	1.4	24	-2.4	06	3.3	2.3	2.3
II	16.9	7.5	13.2	11.4	4.7	25.7	14-18	3.8	28	0.4	04-24	3.5	2.0	2.9
III	11.2	9.3	15.2	11.9	6.4	30.0	22	4.5	04	0.6	04	4.5	3.3	3.1
IV	26.3	10.6	18.5	15.7	10.1	39.1	02	6.6	23	3.7	09	5.7	5.0	4.7
V	27.8	13.6	20.7	14.3	11.6	35.7	12	9.3	07	6.5	15	3.3	2.0	3.1
VI	32.2	17.3	24.7	14.9	14.9	39.6	24	12.1	30	10.1	01	2.8	2.2	2.3
VII	31.8	18.0	24.9	13.7	16.1	35.7	16	14.3	11	11.9	11	2.0	2.2	2.3
VIII	22.0	18.0	25.0	14.0	15.6	36.6	22	13.7	03	10.6	02	1.7	2.7	2.0
IX	29.0	17.7	23.8	12.1	15.5	37.3	28	13.7	22	10.4	22	2.2	2.0	2.9
X	27.8	15.2	21.5	12.6	12.2	33.8	01	11.2	25	7.3	25	2.2	2.2	3.1
XI	23.1	12.8	18.0	10.3	9.7	30.6	01	7.1	30	3.5	27	4.0	3.0	3.5
XII	14.8	6.2	10.5	8.5	3.7	17.5	11	1.3	19	-0.6	30	1.9	2.0	2.7
annual average	25.1	13.1	19.1	12.0	10.2									

Table 3: Summary of temperature data for the year 1979.

1980 month	Average daily temperature (°C)				Extreme daily values (°C)							Standard deviation (°C)		
	maximum	minimum	average	daily range	grass minimum	maximum	day	minimum	day	grass minimum	day	maximum	minimum	grass minimum
I	14.1	4.4	9.2	9.7	1.4	17.6	04	0.0	31	-3.5	31	2.1	2.3	2.7
II	14.6	6.2	10.5	8.6	3.9	19.6	13	1.1	02	-2.2	01	1.8	2.2	2.9
III	20.1	7.6	13.8	12.5	5.4	32.5	24	0.4	04	-0.9	06	5.6	4.6	4.4
IV	25.0	11.2	18.1	13.8	8.6	37.1	20	3.5	16	0.0	16	6.1	4.3	4.5
V	30.4	13.8	22.1	16.6	11.3	40.4	31	7.6	15	4.4	15	5.4	4.0	4.0
VI	31.6	16.1	24.0	15.6	13.8	40.2	01	12.2	06	8.7	07	3.7	2.2	2.8
VII	32.3	18.2	25.2	14.1	15.6	37.2	12	12.8	11	11.6	23	2.1	2.3	2.8
VIII	32.5	16.5	25.4	13.8	16.2	35.5	13	15.0	16-24	11.6	16	1.7	1.5	1.9
IX	29.1	16.2	22.6	12.9	13.9	33.0	22	11.6	26	8.3	26	1.4	2.1	2.7
X	27.2	14.3	20.7	12.9	11.8	31.8	15	10.0	14	6.4	14	2.3	2.3	3.0
XI	23.1	11.0	17.0	12.1	8.5	28.2	14	5.5	25	1.6	30	3.1	2.9	3.6
XII	16.7	6.9	11.8	9.3	4.6	25.8	04	2.7	02	0.5	02-03	4.0	3.0	3.4
annual average	24.7	12.0	18.4	12.7	9.6									

Table 4: Summary of temperature data for the year 1980.

1981 month	Average daily temperature (°C)				Extreme daily values (°C)						Standard deviation (°C)		
	maximum	minimum	average	daily range	grass minimum	maximum	day	minimum	day	grass minimum	day	maximum	grass minimum
I	14.0	4.2	9.1	9.8	1.3	17.0	23	0.5	25	-2.5	09	1.7	2.4
II	15.6	5.5	10.5	10.1	3.3	22.8	15	1.8	07	-1.6	06	2.8	3.8
III	17.0	6.7	14.9	12.5	6.1	34.0	19	3.7	03	1.0	03	4.6	3.1
IV	24.3	10.5	17.7	14.4	8.6	36.3	24	3.5	02-03	0.0	02	6.4	5.1
V	27.2	13.4	20.3	13.8	11.1	33.0	12	7.7	10	6.0	10	3.6	3.3
VI	31.3	15.6	23.4	15.7	13.3	36.0	29	11.0	04	9.8	04	2.7	1.9
VII	32.2	18.9	25.5	13.3	17.8	37.3	27	15.9	13	12.0	06	2.4	2.2
VIII	32.1	18.5	25.3	13.6	16.0	35.6	04	15.7	26	11.4	26	1.7	2.3
IX	31.0	18.1	24.5	12.9	15.8	36.0	02	14.3	22	11.7	12	2.3	2.0
X	28.0	14.9	21.4	13.1	12.7	31.6	17	11.6	07	9.1	21	1.9	2.0
XI	19.6	8.5	14.5	11.1	5.4	25.0	10	2.8	22	-3.0	24	2.7	3.9
XII	16.7	5.7	12.2	13.0	2.2	22.6	21	2.2	07	-1.2	07	1.8	2.1
annual average	24.6	11.9	18.3	12.8	9.5								

Table 5: Summary of temperature data for the year 1981.

1982	Average daily temperature (°C)				Extreme daily values (°C)						Standard deviation (°C)		
	extremum	minimum	average	daily range	grass minimum	maximum	day	minimum	day	grass minimum	day	maximum	grass, minimum
I	15.6	5.5	10.5	10.1	2.5	20.0	03	-0.3	17	-4.1	17-20	2.4	4.2
II	14.4	5.4	9.9	9.0	2.8	23.0	26	0.1	18	-2.0	18	3.3	3.2
III	17.6	6.4	12.0	11.2	3.4	26.5	23	2.3	29	-0.9	29	3.4	2.6
IV	26.2	12.5	19.3	13.7	10.4	34.0	21	6.8	06	3.9	01	4.1	3.6
V	22.7	13.0	19.6	13.7	10.8	35.2	16	8.5	02	4.9	02	3.3	3.0
VI	31.3	15.4	23.4	15.9	13.2	36.6	29	11.9	01	9.2	01	3.2	2.1
VII	31.3	17.8	24.6	13.5	15.7	34.6	07	15.0	21	12.6	25	1.7	3.0
VIII	22.9	18.5	20.2	13.4	16.3	35.5	12	14.2	02	11.6	02	1.6	3.0
IX	30.1	17.3	23.7	12.7	15.2	34.2	05	13.8	20	11.2	10	2.1	3.0
X	27.7	13.8	21.3	12.9	12.3	34.3	14	10.9	21	8.1	29	3.4	2.7
XI	17.6	7.7	13.2	10.9	5.0	25.1	19	3.4	30	-0.3	30	3.6	3.4
XII	13.9	5.7	10.2	8.9	2.9	17.4	20	1.3	03	-2.6	03	1.6	2.7
Annual average	23.8	11.7	17.8	12.2	9.2								

Table 6: Summary of temperature data for the year 1982.

1977- 1982	Long term average daily temperature (°C)					Extreme monthly values (°C)						Standard deviation of average daily temperature (°C)			
	maximum	minimum	average	daily range	grass minimum	maximum	day/ year	minimum	day/ year	grass minimum	day/ year	maximum	minimum	grass minimum	
I	14.7	4.8	9.8	9.9	1.6	23.4	03/1979	-1.0	12/1978	-4.7	12/1978	1.0	0.5	0.7	
II	17.0	6.6	11.8	10.4	3.7	28.5	15/1978	0.1	18/1982	-2.2	01/1980	2.2	1.0	0.7	
III	20.2	8.0	14.1	12.2	5.0	34.0	19/1981	0.4	04/1980	-1.9	15/1978	1.3	1.0	1.1	
IV	24.9	11.0	18.0	13.9	8.6	39.1	02/1979	3.5	16/1980 2-3/81	0.0	16/1980 02/1981	1.6	0.7	1.5	
V	28.7	13.9	21.3	14.8	11.3	40.4	31/1980	7.6	15/1980	4.4	15/1980	1.6	0.8	0.4	
VI	31.4	16.3	23.9	15.1	13.8	40.2	01/1980	9.5	10/1978	6.6	10/1978	0.5	0.7	0.6	
VII	32.4	18.6	25.5	13.8	16.4	40.3	08/1978	12.8	11/1980	11.6	23/1980	0.7	0.7	0.7	
VIII	32.1	18.4	25.3	13.7	16.0	38.5	24/1977	13.7	24/1977	10.6	02/1979	0.8	0.7	1.0	
IX	29.8	17.1	23.5	12.7	14.8	39.1	08/1978	11.6	26/1980	8.3	26/1980	0.7	0.7	0.8	
X	27.4	14.7	21.1	12.7	12.1	34.3	14/1982	7.0	31/1977	6.4	31/1977	1.1	0.7	0.9	
XI	21.1	9.6	15.4	11.5	6.2	30.6	01/1979	2.8	01/1979	-3.0	24/1981	1.9	1.7	2.1	
XII	16.2	6.1	11.2	10.1	3.1	25.8	04/1980	0.7	27/1977	-3.5	27/1977	1.5	0.6	1.0	
annual average	24.7	12.1	18.4	12.6	9.4										

Table 7: Summary of temperature data for the years 1977-1982.

1977 month	Temperature ($^{\circ}\text{C}$)		Wet Bulb Temperature ($^{\circ}\text{C}$)		Relative Humidity (%)		Dew Point ($^{\circ}\text{C}$)	
	daily average	standard deviation	daily average	standard deviation	daily average	standard deviation	daily average	standard deviation
I	-	-	-	-	-	-	-	-
II	-	-	-	-	-	-	-	-
III	18.8	4.7	12.1	1.9	48	17	6.5	2.7
IV	20.9	4.1	12.0	1.8	36	13	4.2	3.2
V	28.2	4.0	16.4	1.9	31	15	7.9	4.5
VI	31.0	2.2	17.4	1.5	25	9	8.0	4.3
VII	32.4	2.5	19.3	1.0	28	7	11.5	2.6
VIII	33.5	2.5	20.6	1.3	32	8	14.1	2.9
IX	26.7	1.4	19.2	1.0	41	7	13.9	2.6
X	24.1	3.2	14.8	2.5	37	11	7.8	4.7
XI	21.7	2.9	13.7	2.8	41	12	7.3	4.6
XII	14.6	2.8	9.4	1.3	52	13	4.5	2.0

Table 8: Summary of daily average (and standard deviations) of dry and wet bulb temperature, relative humidity and dew point at 14:00 local time for the year 1977.

1978 month	Temperature ($^{\circ}\text{C}$)		Wet Bulb Temperature ($^{\circ}\text{C}$)		Relative Humidity (%)		Dew Point ($^{\circ}\text{C}$)	
	daily average	standard deviation	daily average	standard deviation	daily average	standard deviation	daily average	standard deviation
I	15.2	3.2	8.7	2.2	42	13	2.0	3.2
II	17.8	3.5	9.8	1.6	38	15	1.6	4.3
III	20.5	4.8	11.1	1.9	32	13	2.1	3.2
IV	24.6	4.1	13.4	1.7	28	11	3.9	3.5
V	29.6	3.9	16.2	1.6	25	9	6.5	3.3
VI	30.5	3.8	17.5	1.8	27	9	8.8	3.5
VII	32.9	3.4	20.0	1.4	31	7	12.9	2.6
VIII	30.0	1.7	18.6	0.8	34	7	12.0	2.2
IX	28.4	2.7	18.8	1.2	41	11	13.2	3.1
X	27.6	3.4	17.2	2.2	36	10	10.6	3.6
XI	18.8	1.9	11.4	2.0	40	12	4.5	4.3
XII	16.4	2.2	11.1	1.1	53	12	6.5	2.0
annual average	24.4		14.5		36		7.1	

Table 9: Summary of daily average (and standard deviation) of dry and wet bulb temperature, relative humidity and dew point at 14:00 local time for the year 1978.

1979 month	Temperature ($^{\circ}\text{C}$)		Wet Bulb Temperature ($^{\circ}\text{C}$)		Relative Humidity (%)		Dew Point ($^{\circ}\text{C}$)	
	daily average	standard deviation	daily average	standard deviation	daily average	standard deviation	daily average	standard deviation
I	14.6	2.9	9.9	1.8	58	12	5.8	2.5
II	18.1	3.6	10.7	1.6	42	16	3.8	3.5
III	19.9	4.6	11.7	2.1	39	17	4.3	3.3
IV	25.0	5.2	13.8	1.7	31	15	4.4	4.3
V	26.6	3.2	15.7	1.4	33	13	7.8	3.7
VI	31.4	2.8	18.4	1.2	28	8	10.4	2.8
VII	31.2	2.1	19.2	1.2	32	6	12.4	2.3
VIII	31.4	1.7	19.1	1.8	32	10	11.8	4.8
IX	29.5	2.2	20.2	1.4	44	12	15.4	3.4
X	26.9	2.4	17.3	1.7	39	12	11.0	4.0
XI	22.5	4.2	14.5	2.5	44	15	8.6	3.7
XII	13.9	2.2	10.2	1.5	65	11	7.1	2.0
annual average	24.3		15.1		41		8.6	

Table 10: Summary of daily average (and standard deviation) of dry and wet bulb temperature, relative humidity and dew point at 14:00 local time for the year 1979.

Year month	Temperature ($^{\circ}\text{C}$)		Wet Bulb Temperature ($^{\circ}\text{C}$)		Relative Humidity (%)		Dew Point ($^{\circ}\text{C}$)	
	daily average	standard deviation	daily average	standard deviation	daily average	standard deviation	daily average	standard deviation
I	13.3	2.2	8.6	1.6	57	14	3.9	3.2
II	14.2	2.0	9.2	1.5	53	14	4.3	3.0
III	18.5	6.0	11.1	3.0	42	17	4.6	3.2
IV	23.2	5.3	13.0	2.3	32	12	4.3	4.1
V	29.3	5.3	16.0	1.6	26	10	6.7	2.1
VI	31.0	3.6	17.9	1.6	28	8	9.6	3.1
VII	31.5	2.1	18.5	1.3	29	8	10.5	3.8
VIII	31.9	1.7	19.6	1.1	32	7	12.7	2.6
IX	28.4	1.6	18.2	1.4	37	7	12.2	2.8
X	26.7	1.4	16.9	1.6	38	12	10.6	3.5
XI	22.5	3.0	14.7	1.9	44	9	9.3	2.5
XII	15.6	4.0	10.9	2.4	59	15	7.1	2.6
annual average	23.8		14.6		40		8.0	

Table 11: Summary of daily average (and standard deviation) of dry and wet bulb temperature, relative humidity and dew point at 14:00 local time for the year 1980.

1981 month	Temperature ($^{\circ}\text{C}$)		Wet Bulb Temperature ($^{\circ}\text{C}$)		Relative Humidity (%)		Dew Point ($^{\circ}\text{C}$)	
	daily average	standard deviation	daily average	standard deviation	daily average	standard deviation	daily average	standard deviation
I	13.1	1.7	7.9	1.6	48	13	2.1	3.5
II	14.8	2.7	9.1	1.5	48	13	3.4	2.7
III	20.9	4.5	11.9	1.9	36	15	3.8	3.9
IV	23.3	6.3	12.7	2.5	30	13	3.4	3.1
V	25.9	3.6	14.5	1.9	29	9	5.4	3.9
VI	30.7	2.7	17.6	1.5	27	6	9.2	2.6
VII	31.5	2.4	19.0	1.3	31	9	11.7	3.1
VIII	31.5	1.7	19.7	1.2	34	6	13.3	2.4
IX	30.4	2.2	19.3	1.4	35	5	13.2	2.0
X	27.2	2.2	17.6	1.5	40	12	11.7	3.4
XI	18.9	2.6	12.0	2.1	44	9	6.1	3.5
XII	18.1	1.7	10.6	1.1	39	10	3.5	3.5
annual average	23.9		14.3		37		7.2	

Table 12: Summary of daily average (and standard deviation) of dry and wet bulb temperature, relative humidity and dew point at 14:00 local time for the year 1981.

Year	Temperature ($^{\circ}\text{C}$)		Wet Bulb Temperature ($^{\circ}\text{C}$)		Relative Humidity (%)		Dew Point ($^{\circ}\text{C}$)	
	daily average	standard deviation	daily average	standard deviation	daily average	standard deviation	daily average	standard deviation
I	14.4	3.5	9.5	2.2	52	17	4.3	4.2
II	13.0	3.3	8.4	1.8	57	18	3.6	2.9
III	16.6	3.7	9.5	1.6	41	15	2.3	3.3
IV	24.7	4.2	14.1	1.9	33	14	5.4	4.7
V	25.8	3.3	15.6	1.7	35	10	8.6	3.0
VI	30.4	3.3	17.4	1.5	28	7	9.0	2.8
VII	30.7	1.7	18.9	0.8	32	7	12.0	2.2
VIII	31.3	1.6	19.5	1.2	33	6	12.8	2.8
IX	29.3	2.2	18.9	1.1	38	9	12.9	2.2
X	26.8	3.7	16.6	1.2	37	14	9.8	2.7
XI	17.8	3.8	11.8	1.8	51	15	6.8	2.3
XII	13.8	1.9	9.4	1.6	58	15	5.1	3.3
annual average	22.9		14.3		41		7.7	

Table 13: Summary of daily average (and standard deviation) of dry and wet bulb temperature, relative humidity and dew point at 14:00 local time for the year 1982.

1977 - 1982 month	Temperature ($^{\circ}\text{C}$)		Wet Bulb Temperature ($^{\circ}\text{C}$)		Relative Humidity (%)		Dew Point ($^{\circ}\text{C}$)	
	daily average	standard deviation	daily average	standard deviation	daily average	standard deviation	daily average	standard deviation
I	14.1	0.8	8.9	0.7	51	6	3.6	1.4
II	15.6	2.0	9.4	0.8	48	7	3.3	0.9
III	19.2	1.4	11.2	0.9	40	5	3.9	1.5
IV	23.6	1.4	13.2	0.7	32	2	4.3	0.6
V	27.6	1.5	15.7	0.6	30	4	7.1	1.1
VI	30.8	0.3	17.7	0.4	27	1	9.2	0.7
VII	31.7	0.7	19.2	0.5	31	2	11.8	0.8
VIII	31.6	1.0	19.5	0.6	33	1	12.8	0.8
IX	29.1	0.7	19.1	0.6	39	3	13.5	1.0
X	26.6	1.1	16.7	0.9	38	1	10.3	1.2
XI	20.4	1.9	13.0	1.4	44	3	7.1	1.6
XII	15.4	1.5	10.1	0.6	54	8	5.6	1.4
annual average	23.8		14.5		39		7.7	

Table 14: Summary of daily average (and standard deviation) of dry and wet bulb temperature, relative humidity and dew point at 14:00 local time for the years 1977-1982.

1977	Rainfall				Dew				Evaporation					
	amount (mm)	rain days	max. daily	date	amount (mm)	number of hours	max. daily	date	number of days	amount (mm)	max. daily	date	min. daily	daily average
I	31.2	10	6.6	06	-	-	-	-	-	-	-	-	-	-
II	2.1	01	2.1	07	-	-	-	-	-	-	-	-	-	-
III	3.6	03	1.4	17	-	-	-	-	-	-	-	-	-	-
IV	35.9	06	14.5	12	-	-	-	-	-	-	-	-	-	-
V	4.4	02	4.2	13	-	-	-	-	-	-	-	-	-	-
VI	0.0	-	0.0	-	-	-	-	-	-	-	-	-	-	-
VII	0.0	-	0.0	-	1.25	63	0.21	28	12	-	-	-	-	-
VIII	0.0	-	0.0	-	2.14	135	0.23	15	23	-	-	-	-	-
IX	0.0	-	0.0	-	2.08	135	0.32	22	23	-	-	-	-	-
X	0.9	02	0.6	17	1.40	129	0.18	09	20	-	-	-	-	-
XI	3.4	01	3.4	11	1.25	87	0.21	23	14	-	-	-	-	-
XII	32.4	08	16.8	22	2.28	151	0.29	26	16	-	-	-	-	-
Annual total	113.9	33												

Table 15: Summary of rainfall, dew and evaporation for the year 1977.

1978	Rainfall					Dew					Evaporation				
	amount (mm)	rain days	max. daily	date	amount (mm)	number of hours	max. daily	date	number of days	amount (mm)	max. daily	date	min. daily	date	daily average
I	2.4	03	1.4	02	1.48	161	0.17	24	16	-	-	-	-	-	-
II	2.8	02	1.8	23	0.69	66	0.15	24	08	-	-	-	-	-	-
III	7.8	03	4.3	30	0.49	36	0.18	18	06	-	-	-	-	-	-
IV	1.2	01	1.2	23	0.73	62	0.16	28	08	-	-	-	-	-	-
V	0.0	-	0.0	-	0.79	53	0.10	21	11	299.28	14.80	29	6.81	05-06	9.65
VI	0.3	01	0.3	04	1.29	104	0.19	25	16	303.89	15.50	23	6.93	05	10.13
VII	0.0	-	0.0	-	1.61	96	0.19	17	19	320.96	14.63	09	6.03	31	10.35
VIII	0.0	-	0.0	-	2.09	143	0.23	18	24	255.01	11.27	09	5.93	01	8.23
IX	0.0	-	0.0	-	2.35	174	0.19	04	26	197.35	9.68	09-10	4.30	26	6.58
X	0.9	01	0.9	14	2.00	180	0.27	11	17	170.81	9.05	03	2.77	15	5.51
XI	1.9	02	1.5	12	0.84	117	0.12	01	16	96.88	4.65	06	0.44	14	3.23
XII	23.6	06	20.1	12	2.59	169	0.27	29	16	66.95	3.91	01-02	0.83	12	2.16
Annual total	40.9	19			16.95	1,361			183						

Table 16: Summary of rainfall, dew and evaporation for the year 1978

1979	Rainfall				Dew				Evaporation						
	amount (mm)	rain days	max. daily	date	amount (mm)	number of hours	max. daily	date	number of days	amount (mm)	max. daily	date	min. daily	date	daily average
I	27.3	05	16.0	08	2.95	185	0.27	17	21	59.95	4.29	04	0.46	24	1.94
II	10.9	04	5.4	07	1.69	120	0.26	10-11	14	101.42	7.12	19	0.56	11	3.62
III	9.5	05	3.8	08	1.87	116	0.23	02	14	142.81	7.45	31	1.42	10	4.61
IV	0.0	-	0.0	-	0.38	38	0.09	08	08	237.81	17.78	29	3.73	07	7.93
V	0.8	02	0.6	04	1.31	107	0.16	24	17	249.23	13.22	02	3.11	14	8.04
VI	0.0	-	0.0	-	0.88	59	0.15	15	12	308.14	15.77	05	6.59	04	9.94
VII	0.0	-	0.0	-	1.16	111	0.16	14	19	301.18	16.47	23	7.53	14	9.72
VIII	0.0	-	0.0	-	1.35	140	0.14	09	21	273.10	11.55	04	7.19	28	8.81
IX	0.0	-	0.0	-	1.30	122	0.17	29	25	200.07	8.70	14	5.50	25	6.67
X	1.2	02	1.1	22	1.87	140	0.23	01	18	163.67	8.37	01	2.56	21	5.28
XI	20.2	03	16.0	29	1.53	114	0.24	23	15	118.43	7.04	08	2.34	06	3.95
XII	60.9	06	27.6	14	3.20	192	0.31	16	18	53.82	4.89	15	0.00	08	1.74
Annual total	130.7	27			19.49	1,444			202	2,209.63				annual daily average	6.02

Table 17: Summary of rainfall, dew and evaporation for the year 1979.

1980		Rainfall				Dew				Evaporation					
month	amount (mm)	rain days	max. daily	date	amount (mm)	number of hours	max. daily	date	number of days	amount (mm)	max. daily	date	min. daily	date	daily average
I	27.3	07	12.0	23	2.96	231	0.21	10	24	59.00	3.66	28	0.52	09	1.90
II	26.3	12	11.4	24	2.46	151	0.23	06	19	66.85	4.27	21	0.40	06	2.34
III	25.2	06	16.1	02	2.53	184	0.29	14	21	127.88	8.73	26	1.22	03	4.13
IV	4.0	02	2.8	14	0.69	74	0.10	03	12	260.47	17.93	20	4.14	25	8.68
V	0.9	01	0.9	12	0.53	50	0.12	04	09	295.76	13.49	30	2.59	14	9.54
VI	0.0	-	0.0	-	0.55	52	0.11	08	09	301.83	11.85	16	6.90	05	10.06
VII	0.0	-	0.0	-	0.89	83	0.15	02	16	289.14	17.33	12	5.70	23	9.33
VIII	0.0	-	0.0	-	1.31	117	0.12	05-14-15	21	256.07	11.29	05	5.00	28	8.26
IX	0.0	-	0.0	-	1.48	175	0.12	18-26	24	202.45	8.87	01	4.95	27	6.75
X	0.0	-	0.0	-	1.36	118	0.16	14	21	157.77	7.13	14	1.85	30	5.09
XI	0.0	-	0.0	-	1.38	114	0.19	08	15	102.46	5.19	13	1.02	28	3.42
XII	105.2	07	43.0	26	1.72	133	0.26	24	12	62.95	4.42	06	0.37	23	2.03
Annual total	170.2	37			17.86	1,482			203	2,182.63				annual daily average	5.97

Table 18: Summary of rainfall, dew and evaporation for the year 1980.

1981	Rainfall				Dew				Evaporation						
	amount (mm)	rain days	max. daily	date	amount (mm)	number of hours	max. daily	date	number of days	amount (mm)	max. daily	date	min. daily	date	daily average
I	5.4	03	3.2	12	1.25	121	0.17	01	13	73.03	4.90	04	0.06	01	2.36
II	5.3	04	3.7	24	1.49	121	0.17	12	12	76.73	6.07	23	1.13	02	2.74
III	13.3	03	11.3	26	0.83	89	0.18	07	10	137.96	8.96	20	1.11	27	4.90
IV	1.6	01	1.6	15	0.62	58	0.18	02	09	189.65	13.91	24	**	**	6.32
V	0.0	-	0.0	-	0.72	81	0.15	26	11	294.65	11.52	31	5.15	14	7.94
VI	0.0	-	0.0	-	1.00	91	0.11	17-20	14	289.62	12.46	29	7.17	05	9.65
VII	0.0	-	0.0	-	0.85	73	0.17	20	13	282.41	11.22	01	7.05	07	9.11
VIII	0.0	-	0.0	-	1.36	113	0.22	14	21	254.30	11.04	06	5.35	01	8.12
IX	0.0	-	0.0	-	1.47	141	0.23	29	24	199.93	10.02	04	5.17	23	6.61
X	0.0	-	0.0	-	2.08	161	0.22	15	22	150.88	6.08	11	3.32	23	4.87
XI	8.0	03	7.1	13	0.90	111	0.18	13	14	87.89	4.41	01	1.22	06	2.95
XII	0.0	-	0.0	-	1.31	144	0.19	13	14	73.65	3.66	25	1.34	24	2.37
Annual total	33.6	14			13.88	1,304			177	2,110.70			annual daily average		5.66

Table 19: Summary of rainfall, dew and evaporation for the year 1981.

1982	Rainfall				Dew				Evaporation						
month	amount (mm)	rain days	max. daily	date	amount (mm)	number of hours	max. daily	date	number of days	amount (mm)	max. daily	date	min. daily	date	daily average
I	15.6	10	4.1	15	1.83	159	0.27	06	16	65.78	5.52	22	0.28	05	2.12
II	23.4	11	6.9	04	0.79	88	0.19	24	13	69.75	5.62	27	0.30	05	2.43
III	12.6	05	3.9	26	1.01	104	0.18	16	14	111.57	7.94	23	0.80	02	3.60
IV	31.7	01	0.7	04	0.42	34	0.16	04	05	195.76	16.00	20	2.92	15	6.52
V	11.3	03	4.3	08	0.53	65	0.07	25	15	217.86	10.07	20	4.29	19	7.03
VI	0.7	-	0.0	-	0.55	55	0.12	18	10	273.01	12.04	13	5.76	28	9.10
VII	0.0	-	0.0	-	0.89	93	0.17	24	18	289.59	13.56	10	5.20	06	9.34
VIII	0.0	-	0.0	-	1.88	152	0.19	31	22	263.34	11.20	12	6.79	26	8.49
IX	1.7	1	1.5	28	2.57	193	0.16	30	30	197.90	11.69	05	2.50	29	6.38
X	7.1	01	7.2	23	1.85	137	0.20	11	20	169.61	10.00	14	3.34	27	5.47
XI	21.6	06	6.7	10	1.96	162	0.24	12	20	72.03	4.88	02	0.11	24	2.40
XII	16.4	08	8.4	05	1.97	144	0.27	16	17	49.56	3.12	29	0.03	14	1.60
Annual total	117.1	47			16.25	1,386			200	1,975.76				annual daily average	5.37

Table 20: Summary of rainfall, dew and evaporation for the year 1982.

1977- 1982	Rainfall				Dew				Evaporation						
	amount (mm)	rain days	max. daily	date	amount (mm)	number of hours	max. daily	date	number of days	amount (mm)	max. daily	date	min. daily	date	daily average
I	16.8	06	16.0	08/1979	2.09	171	0.27	17/1979 06/1982	18	64.44	5.52	22/1982	0.06	01/1981	2.08
II	11.8	06	11.4	24/1980	1.42	109	0.26	10-11/1979	13	78.69	7.12	19/1979	0.30	05/1982	2.81
III	12.0	05	16.1	02/1980	1.35	106	0.29	14/1980	13	130.06	8.96	20/1981	0.80	02/1982	4.20
IV	7.2	02	14.5	12/1977	0.58	53	0.18	02/1981	08	220.90	17.93	20/1980	2.92	15/1982	7.36
V	2.4	01	4.3	08/1982	0.78	71	0.16	25/1978	13	271.34	14.80	29/1978	2.59	14/1980	8.75
VI	0.05	00	0.3	04/1978	0.85	72	0.19	25/1978	12	295.30	15.77	05/1979	5.76	28/1982	9.84
VII	0.0	00	0.0	00	1.11	87	0.21	28/1977	16	296.66	17.33	12/1980	5.20	06/1982	9.57
VIII	0.0	00	0.0	00	1.69	134	0.23	15/1977 18/1978	22	260.36	11.55	04/1979	5.00	28/1980	8.40
IX	0.3	00	1.5	28/1982	1.88	157	0.32	22/1977	25	199.54	11.69	05/1982	2.50	29/1982	6.65
X	1.7	01	7.2	23/1982	1.76	144	0.27	11/1978	20	162.55	10.00	14/1982	1.85	30/1980	5.24
XI	9.2	03	16.0	29/1979	1.31	117	0.24	23/1979 12/1982	16	95.54	7.04	08/1979	0.11	24/1982	3.18
XII	39.7	06	43.0	26/1980	2.18	156	0.31	16/1979	16	61.39	4.89	15/1979	0.00	08/1979	1.98
Long term annual total	105.2	30			17.00	1,377			192	2,136.77			Long term annual daily average		5.84

Table 21: Summary of rainfall, dew and evaporation for the period 1977-1982.

rainy season	date of first rainfall	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	date of last rainfall	seasonal total	number of rainfall days	max. daily rainfall	date
1976-77	13/10	0.0	2.4	6.0	0.5	31.2	2.1	3.6	35.9	4.4	0.0	13/5	86.1	26	14.5	13/4/77
1977-78	17/11	0.0	0.9	3.4	32.4	2.4	2.8	7.8	1.2	0.0	0.3	4/6	51.2	21	16.8	22/12/77
1978-79	14/11	0.0	0.4	1.4	23.6	27.3	10.9	9.5	0.0	0.8	0.0	4/5	74.9	25	20.1	12/12/78
1979-80	1/12	0.0	1.4	20.2	6.9	27.3	26.3	25.2	4.0	0.9	0.0	12/5	166.0	40	27.6	14/12/79
1980-81	12/11	0.0	0.0	0.0	10.0	5.4	5.3	13.3	1.6	0.0	0.0	15/4	130.8	18	43.0	26/12/80
1981-82	3/11	0.0	0.0	6.0	0.0	25.6	23.4	12.6	0.7	8.3	0.0	12/5	78.6	33	10.2	26/1/82
1982-83	17/11	0.0	0.4	20.8	15.9	17.0	16.5	40.3	0.6	0.0	0.0	18/4	141.5	39	15.0	06/3/83
long term average					34.1	11.3	12.5	16.0	6.3	2.1	0.0		104.2	29	43.0	26/12/80

Table 10 Summary of rainfall data for the rain seasons 1976/77 - 1982/83 (in mm.).

month	Average daily temperature (°C)				Extreme daily values (°C)						Standard Deviation (°C)		
	maximum	minimum	average	daily range	grass minimum	maximum	day	minimum	day	grass minimum	day	maximum	grass minimum
I	12.1	3.0	7.6	9.1	0.4	16.0	22	0.0	30	-2.8	22	2.2	2.8
II	14.3	4.6	9.5	9.7	1.9	19.7	12	0.5	23	-2.2	23	3.0	3.2
III	17.7	6.3	12.0	11.4	4.1	28.9	27	0.7	15	-1.6	1	4.8	3.5
IV	22.5	9.6	16.1	12.9	7.4	29.7	29	4.9	20	2.6	20	3.9	2.8
V	28.4	13.2	20.8	15.2	10.9	35.4	31	7.8	9	5.0	6-9	3.1	2.7
VI	31.2	16.2	23.7	15.0	14.3	38.0	16	12.0	13	10.6	4	2.9	2.1
VII	32.4	18.4	25.4	14.0	16.5	40.0	11	15.3	3	13.0	4	2.2	2.0
VIII	31.9	18.7	25.3	13.2	*	37.8	3	15.5	26	*	*	2.3	*
IX	29.9	16.4	23.2	13.5	*	33.9	3	12.5	26	*	*	2.0	*
X	25.7	13.4	19.6	12.3	10.5	31.8	8	9.2	16	6.5	16-17	2.7	2.6
XI	23.3	10.2	16.8	13.1	6.4	30.7	4	6.2	30	2.0	20	3.1	3.3
XII	17.3	5.2	11.3	12.1	0.9	23.6	1	1.1	21	-3.5	21	2.9	3.1
annual average	23.9	11.3	17.6	12.6	7.3								

Table 1: Summary of temperature data for the year 1983.

* Missing data.

** Ten months' average

1984 month	Average daily temperature (°C)					Extreme daily values (°C)						Standard Deviation (°C)		
	maximum	minimum	average	daily range	grass minimum	maximum	day	minimum	day	grass minimum	day	maximum	minimum	grass minimum
I	15.3	5.1	10.2	10.2	1.3	18.7	7	1.4	9	-2.4	9-24	1.8	2.2	2.6
II	18.1	5.9	12.0	12.2	1.4	23.5	11	2.1	14	-2.0	16-18 27	2.3	2.3	3.0
III	20.3	8.8	14.6	11.5	5.7	31.7	9	3.7	16	-0.5	20	4.5	3.1	3.9
IV	24.0	10.1	17.1	13.9	6.6	34.3	18	5.2	25	1.4	26	4.4	3.0	3.6
V	30.4	13.5	22.0	16.9	10.2	39.7	25	7.5	10	3.5	10	4.4	3.7	4.1
VI	30.5	16.1	23.3	14.4	13.8	35.8	2	12.9	5-23	8.5	5	2.3	2.5	2.2
VII	31.8	16.8	24.3	15.0	14.6	35.2	5	12.2	26	9.4	26	2.0	1.9	2.5
VIII	30.9	17.2	24.1	13.7	15.3	33.7	13	13.5	5	10.1	13	1.6	1.5	2.0
IX	30.7	16.9	23.8	13.8	14.2	35.7	1	13.7	11	10.1	11	2.2	1.8	2.8
X	27.4	14.1	20.8	13.3	11.2	34.0	11	7.5	23	4.6	20	4.0	3.7	4.4
XI	20.9	8.9	14.9	12.0	6.6	24.8	4	6.9	19	2.0	30	1.9	1.9	2.4
XII	15.5	3.8	9.7	11.7	-0.5	20.0	31	-0.5	11	-5.9	11	1.8	2.9	3.3
annual average	24.7	11.4	18.1	13.7	8.4									

Table 2: Summary of temperature data for the year 1984.

1985	Average daily temperature (°C)				Extreme daily values (°C)							Standard Deviation (°C)		
	maximum	minimum	average	daily range	grass minimum	maximum	day	minimum	day	grass minimum	day	maximum	minimum	grass minimum
I	17.9	6.3	12.1	11.6	3.0	27.5	10	0.0	5	-4.6	7	2.6	3.7	4.6
II	15.6	5.6	10.6	10.0	3.3	25.5	13	2.0	8-9	-1.6	10	4.6	2.6	2.7
III	20.3	7.8	14.1	12.5	5.4	28.9	31	0.0	1	-2.9	4	4.0	4.3	5.7
IV	24.8	10.5	17.7	14.3	8.0	36.1	30	5.9	8	3.2	4	5.5	3.0	3.5
V	28.9	15.5	22.2	13.4	12.3	36.5	23	8.5	3	5.0	3	3.7	2.8	3.0
VI	31.3	16.7	24.0	14.6	13.6	39.0	3	12.5	1	9.0	8	2.6	2.0	2.4
VII	31.9	17.4	24.7	14.5	14.7	35.6	28	15.0	20	11.3	31	1.6	1.6	2.5
VIII	33.0	20.4	26.7	12.6	18.4	36.8	23	17.5	1	13.5	2	1.7	1.4	2.6
IX	30.2	17.8	24.0	12.4	15.2	37.0	22	14.3	5	11.8	16	2.2	1.5	2.1
X	25.3	13.3	19.3	12.0	9.9	32.1	6	8.0	30	4.5	30	2.7	2.8	3.2
XI	23.5	11.5	17.5	12.0	7.8	29.5	8	6.0	28	1.5	29	2.7	2.5	3.1
XII	16.8	7.4	12.1	9.4	3.9	23.5	14	1.5	24	-2.4	5	3.3	3.0	3.7
annual average	25.0	12.5	18.8	12.4	9.6									

Table 3: Summary of temperature data for the year 1985.

Long term average daily temperature ($^{\circ}\text{C}$)				Extreme monthly values ($^{\circ}\text{C}$)				Standard deviation of average daily temperature ($^{\circ}\text{C}$)			
month	maximum	minimum	average	daily range	grass minimum	maximum	day /year	minimum	day /year	grass minimum	maximum
I	14.8	4.8	9.8	10.0	1.6	27.5	10/1985	-1.0	12/1978	-4.7	1.7
II	16.7	6.2	11.5	10.5	3.2	28.5	15/1978	0.1	18/1982	-2.2	2.2
III	19.9	7.8	13.8	12.1	5.0	34.0	19/1981	0.0	01/1985	-2.9	1.4
IV	24.6	10.7	17.6	13.9	8.1	39.1	02/1979	3.5	16/1980	0.0	1.6
V	28.9	13.9	21.4	15.0	11.3	40.4	31/1980	7.5	10/1984	3.5	1.5
VI	31.3	16.3	23.8	15.0	13.8	40.2	01/1980	9.5	10/1978	6.6	0.5
VII	32.2	18.3	25.3	13.9	16.0	40.3	08/1978	12.2	26/1984	9.4	0.6
VIII	32.1	18.5	25.3	13.6	16.3	38.5	24/1977	13.5	05/1984	10.1	0.9
IX	23.9	17.1	23.5	12.8	14.8	39.1	08/1978	11.6	26/1980	8.3	0.7
X	25.3	14.3	20.6	12.6	11.6	34.3	14/1982	7.0	31/1977	4.6	1.2
XI	21.6	9.8	15.9	11.8	6.4	30.7	04/1983	2.8	01/1979	-3.0	1.9
XII	16.3	5.9	11.1	10.4	2.5	25.8	04/1980	-0.5	11/1984	-5.9	1.4
annual average	24.6	12.0	18.3	12.6	9.2						1.1
											1.9

Table 4 Summary of temperature data for the years 1977-1985

1983	Temperature (°C)			Wet Bulb Temperature (°C)		Relative humidity (%)		Dew Point (°C)	
month	daily average	standard deviation	daily average	standard deviation	daily average	standard deviation	daily average	standard deviation	
I	11.2	2.4	7.2	1.2	59	15	3.1	2.2	
II	13.2	3.2	8.1	2.1	51	15	2.6	3.4	
III	13.9	3.8	10.2	2.6	48	17	4.4	2.9	
IV	21.8	4.1	12.9	2.1	36	10	5.5	2.9	
V	27.4	3.2	15.0	1.7	26	11	4.1	8.4	
VI	30.4	3.0	17.4	1.9	28	11	8.5	5.5	
VII	31.9	2.3	18.9	0.8	29	07	11.2	3.0	
VIII	31.2	2.1	19.3	1.3	33	08	12.5	3.4	
IX	29.3	1.9	18.4	1.1	36	07	11.9	2.4	
X	25.2	2.7	15.8	1.7	38	12	9.2	4.3	
XI	22.9	3.2	14.1	1.3	40	15	7.2	4.1	
XII	16.5	2.8	10.8	1.9	50	16	5.6	3.6	
annual average	22.9		14.0		39		7.2		

Table 5: Summary of daily average (and standard deviation) of dry and wet bulb temperature, relative humidity and dew point at 14:00 local time for the year 1983.

1984 month	Temperature (°C)			Wet Bulb Temperature (°C)			Relative Humidity (%)		Dew Point (°C)	
	daily average	standard deviation		daily average	standard deviation		daily average	standard deviation	daily average	standard deviation
I	14.5	1.8		9.3	1.1		52	13	4.4	2.3
II	17.3	2.3		9.7	1.4		37	11	1.9	3.6
III	19.4	4.6		11.6	2.2		41	16	4.6	4.0
IV	22.8	4.2		12.4	2.0		29	11	2.8	4.1
V	29.2	4.3		15.4	1.7		22	10	4.5	3.7
VI	29.7	2.3		17.2	1.2		28	7	9.0	2.8
VII	31.0	2.3		17.9	1.1		28	8	9.6	3.1
VIII	30.3	1.6		18.7	2.1		32	8	11.1	3.1
IX	30.2	2.2		19.3	1.3		37	9	13.4	3.0
X	26.9	4.1		16.5	2.3		36	13	9.0	4.8
XI	20.2	1.7		13.3	1.1		46	8	8.0	2.3
XII	14.9	2.1		9.1	1.6		47	12	3.3	2.9
annual average	23.9			14.2			36		6.8	

Table 6: Summary of daily average (and standard deviation) of dry and wet bulb temperature, relative humidity and dew point at 14:00 local time for the year 1984.

1985	Temperature (°C)		Wet Bulb Temperature (°C)		Relative humidity (%)		Dew Point (°C)	
	daily average	standard deviation	daily average	standard deviation	daily average	standard deviation	daily average	standard deviation
I	17.1	2.7	10.3	2.2	43	15	3.5	4.6
II	14.7	4.8	8.3	2.0	45	19	1.4	3.7
III	19.3	4.1	10.8	3.0	36	17	2.3	6.0
IV	23.5	5.4	13.0	2.0	32	18	3.7	3.9
V	28.1	3.8	16.2	1.4	31	12	7.9	3.6
VI	30.8	2.7	17.7	1.6	28	10	9.0	4.6
VII	31.1	1.8	18.5	0.8	29	7	10.7	2.5
VIII	32.6	1.9	21.1	1.6	37	8	15.4	3.1
IX	29.6	2.3	19.2	1.0	38	8	13.3	2.7
X	24.5	2.8	15.8	1.9	41	10	9.9	3.1
XI	22.8	2.8	14.7	1.7	42	10	9.0	2.8
XII	16.0	3.4	10.8	2.1	55	20	5.9	4.2
annual average	24.2		14.7		38		7.7	

Table 7: Summary of daily average (and standard deviation) of dry and wet bulb temperature, relative humidity and dew point at 14:00 local time for the year 1985.

1977-1985 month	Temperature (°C)		Wet Bulb Temperature (°C)		Relative Humidity (%)		Dew Point (°C)	
	daily average	standard deviation	daily average	standard deviation	daily average	standard deviation	daily average	standard deviation
I	14.2	1.7	8.9	1.0	51	7	3.6	1.3
II	15.4	2.1	9.2	0.9	46	7	2.8	1.1
III	18.6	2.2	11.1	0.8	40	5	3.9	1.4
IV	23.3	1.4	13.0	0.7	32	3	4.2	0.9
V	27.8	1.5	15.7	0.6	29	4	6.6	1.6
VI	30.7	0.5	17.6	0.4	27	1	9.1	0.7
VII	31.6	0.7	18.9	0.6	30	2	11.4	1.0
VIII	31.5	1.1	19.6	0.8	33	2	12.9	1.3
IX	29.3	0.7	19.1	0.6	38	3	13.3	1.0
X	26.2	1.3	16.5	0.9	38	2	10.0	1.2
XI	20.9	2.0	13.4	1.3	44	3	7.4	1.5
XII	15.5	1.4	10.3	0.8	53	8	5.4	1.4
annual average	23.8		14.4		38		7.6	

Table 8 : Summary of daily average (and standard deviation) of dry and wet bulb temperature, relative humidity and dew point at 14:00 local time for the years 1977-1985.

1983	Rainfall				Dew				Evaporation						
	amount (mm)	rain days	max. daily	date	amount (mm)	number of hours	max. daily	date	number of days	amount (mm)	max. daily	date	min. daily	date	daily average
I	37.0	9	12.5	23	2.70	208	0.29	31	20	55.27	4.09	07	0.06	26	1.78
II	17.1	8	2.7	24	2.06	143	0.24	09	17	67.98	4.61	18	0.23	27	2.43
III	40.5	7	15.0	5	2.63	179	0.31	30	18	101.69	8.93	31	1.30	05 - 07	3.28
IV	0.6	1	0.6	18	1.25	134	0.13	08	22	163.33	8.38	29	1.96	02	5.44
V	-	-	-	-	0.54	60	0.13	28	13	240.92	10.40	31	5.00	07	7.77
VI	-	-	-	-	1.02	79	0.27	20	16	267.31	11.34	21	6.61	09	8.91
VII	-	-	-	-	1.38	99	0.15	25	20	276.40	11.87	11	7.00	06	8.92
VIII	-	-	-	-	2.07	146	0.20	25	27	247.96	11.36	04	5.70	18	8.00
IX	-	-	-	-	2.64	185	0.21	14	28	207.43	11.91	21	5.04	30	6.91
X	-	-	-	-	2.45	255	0.21	09	26	152.26	8.14	06	2.94	23	4.91
XI	-	-	-	-	1.99	155	0.27	26	15	103.17	6.36	02	1.77	24	3.44
XII	6.1	6	1.9	21	3.20	242	0.32	28	23	61.84	3.57	15	0.16	08	2.06
	101.3	31			23.93	1,885			245	1,945.56					5.32

Table 9 Summary of rainfall, dew and evaporation for the year 1983.

Rainfall				Dew				Evaporation						
year	amount mm.	days	date	amount mm.	number of hours	max. daily	date	number of days	amount (mm)	max. daily	date	min. daily	date	daily average
1934	26.0	6	12.6	15	208	0.29	20 -30	18	65.38	5.65	27	0.29	03	2.11
	1.8	1	1.8	7	162	0.26	03	19	103.00	4.75	25	1.52	01	3.55
	22.5	9	9.9	13	109	0.19	17	13	137.96	8.94	09	0.72	15	4.60
	-	-	-	-	63	0.11	29	12	195.05	8.86	06	3.88	23	6.50
	-	-	-	-	78	0.13	16	12	269.11	11.88	26	6.14	09	8.68
	-	-	-	-	121	0.24	12	21	282.36	11.17	26	7.08	06	9.41
	-	-	-	-	43	0.16	27	10	307.14	12.90	05	7.10	30	9.91
	-	-	-	-	96	0.29	27	15	266.39	12.02	18	6.29	24	8.59
	-	-	-	-	117	0.21	11	19	220.83	9.93	01	4.25	27	7.36
	5.0	1	5.0	18	164	0.17	09	23	160.88	7.97	10	2.68	29	5.19
	4.5	3	3.7	11	208	0.20	18	20	90.59	4.91	02	0.62	11	3.02
	3.6	2	2.2	9	171	0.27	26	16	72.35	4.86	18	0.08	23	2.33
	63.4	22			1,540			198	2,171.04					5.94

Table 11. Summary of rainfall, dew and evaporation for the year 1934.

1985				Rainfall				Dew				Evaporation				
month	amount (mm)	max. daily	date	amount (mm)	number of hours	max. daily	date	number of days	amount (mm)	max. daily	date	min. daily	date	daily average		
I	0.6	2	0.5	11	0.79	83	0.17	22	79.86	4.17	30	1.11	04	2.58		
II	23.5	11	0.3	15	0.71	84	0.16	18	87.94	6.99	19	1.00	21	3.14		
III	25.7	4	21.8	22	0.94	101	0.25	25	132.76	6.98	27	1.64	22	4.28		
IV	4.1	3	0.2	27	1.20	100	0.14	01	193.05	9.60	13	1.85	01	6.44		
V	0.4	1	0.4	11	0.58	68	0.11	02	281.47	10.80	27	3.14	03	9.08		
VI	-	-	-	-	0.76	72	0.17	28	286.63	12.87	03	7.27	06	9.56		
VII	-	-	-	-	1.27	98	0.26	27	288.24	11.70	22	7.27	01	9.30		
VIII	-	-	-	-	0.95	99	0.12	07	269.39	12.38	02	6.22	17	8.69		
IX	-	-	-	-	1.53	131	0.18	21	204.14	8.89	03	5.10	28	6.84		
X	0.5	1	0.5	30	1.17	94	0.17	08	160.31	8.19	18	2.14	26	5.17		
XI	-	-	-	-	0.89	71	0.17	12	99.61	5.91	25	1.49	19	3.32		
12	48.1	8	22.7	19	1.02	74	0.22	29	63.71	6.21	08	0.0	26	2.06		
	109.3	30			11.81	1,075			2,147.34					5.87		

Table 11: Summary of rainfall, dew and evaporation for the year 1985.

station	lat	lon	rainfall			dew			Evaporation					
			max. daily	date /year	number of days	max. daily	date /year	number of days	amount (mm)	max. daily	date /year	daily	date /year	daily average
1	17.5	105.0	16.0	08/1977	0.13	170	0.29	31/1983	17	65.47	5.65	27/1984	0.06	01/1981
2	17.5	105.0	11.3	24/1984	1.46	117	0.26	10-11/1979	14	81.95	7.12	19/1979	0.23	26/1983
3	17.5	105.0	21.8	22/1985	1.41	115	0.31	03/1984	14	127.52	8.94	09/1984	0.72	27/1983
4	17.5	105.0	14.5	12/1977	0.71	70	0.18	30/1983	11	205.02	17.93	20/1980	1.85	15/1984
5	17.5	105.0	4.2	18/1982	0.73	70	0.16	02/1981	13	268.54	14.80	29/1978	2.59	01/1985
6	17.5	105.0	0.2	04/1978	1.00	79	0.27	25/1978	14	289.12	15.77	05/1979	5.76	14/1980
7	17.5	105.0	0.2	04/1978	1.00	79	0.27	20/1983	16	294.38	17.33	12/1980	5.20	28/1982
8	17.5	105.0	0.2	04/1978	1.00	79	0.27	27/1985	22	260.70	12.38	02/1985	5.00	06/1982
9	17.5	105.0	0.2	04/1978	1.00	79	0.27	27/1984	24	203.76	11.91	21/1983	2.50	28/1980
10	17.5	105.0	0.2	04/1978	1.00	79	0.27	22/1977	20	160.77	10.00	14/1982	1.85	29/1982
11	17.5	105.0	0.2	04/1978	1.00	79	0.27	11/1978	15	96.38	7.04	08/1979	0.11	30/1980
12	17.5	105.0	0.2	04/1978	1.00	79	0.27	26/1983	16	63.10	6.21	08/1985	0.00	24/1982
13	17.5	105.0	0.2	04/1978	1.00	79	0.27	28/1983	196	2,116.71	Long term annual daily average			08/1979
14	17.5	105.0	0.2	04/1978	1.00	79	0.27	28/1983	196	2,116.71	Long term annual daily average			26/1985
15	17.5	105.0	0.2	04/1978	1.00	79	0.27	28/1983	196	2,116.71	Long term annual daily average			5.79

Table 1. Summary of rainfall, dew and evaporation for the period 1977-1985.

rainy season	date of first rainfall	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	date of last rainfall	seasonal total	number of rainfall days	max. daily rainfall	date
1976-77	23/10	0.0	2.4	6.0	0.5	31.2	2.1	3.6	35.9	4.4	0.0	13/05	86.1	26	14.5	13/04/77
1977-78	17/10	0.0	0.9	3.4	33.1	2.4	2.9	7.8	1.2	0.0	0.3	4/06	53.0	23	16.8	22/12/77
1978-79	14/10	0.0	0.9	1.9	23.6	27.3	10.9	9.5	0.0	0.9	0.0	4/05	74.9	25	20.1	12/12/78
1979-80	20/10	0.0	1.1	20.4	62.0	19.4	26.3	25.2	4.0	0.9	0.0	12/05	159.3	44	27.6	14/12/79
1980-81	10/12	0.0	0.0	0.0	105.2	5.4	5.3	13.3	1.6	0.0	0.0	15/04	130.8	18	43.0	26/12/80
1981-82	4/11	0.0	0.0	8.0	0.0	25.6	23.4	12.6	0.7	8.3	0.0	12/05	78.6	33	10.2	26/01/82
1982-83	28/09	1.7	8.9	20.6	16.2	37.0	17.1	40.5	0.6	0.0	0.0	18/04	142.6	42	15.0	06/03/83
1983-84	07/12	0.0	0.0	0.0	6.1	26.0	1.8	22.5	0.0	0.0	0.0	26/03	56.4	22	12.6	15/01/84
1984-85	18/10	0.0	5.0	4.5	3.6	0.8	29.5	25.7	4.3	0.4	0.0	11/05	73.8	28	21.8	22/03/85
1985-86	30/10	0.0	0.5	0.0	48.1	3.8	19.4	0.1	67.3	7.5	0.0	03/05	146.7	27	40.2	08/04/86
long term average		0.2	2.0	6.5	29.3	17.9	13.9	16.1	11.6	2.2	0.		100.2	29	43.0	26/12/80

Table 13 Summary of rainfall data for the rain seasons 1976/77 - 1985/86 (in mm.) .

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