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A METEOROLOGICAL REPORT FOR THE MT. HOPKINS OBSERVATORY: 1968 - 1969

M. R. PEARLMAN, D. HOGAN, W. KIRCHHOFF,
K. GOODWIN, D. KURTENBACH, S. ROCKETTO,
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20

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October 26, 1970

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ABSTRACT

This document is a compilation of the weather data collected at the Mt. Hopkins Observatory in southern Arizona during 1968 and 1969. It is the first in a series of periodic meteorological and atmospheric "seeing" reports aimed at assisting scientists in the scheduling of experiments at the Observatory site. Conclusions from these data must be drawn in relation to the interest of the individual investigator.

RÉSUMÉ

Ce document est une compilation des données météorologiques relevées au Mt. Hopkins Observatory en Arizona du Sud, en 1968 et 1969. C'est le premier d'une série de rapports "voyants" météorologiques et atmosphériques périodiques dont le dessein est d'aider les hommes de science à programmer les expériences à l'observatoire même. Nous devons tirer les conclusions de ces données par rapport à l'interêt de l'investigateur particulier.

КОНСПЕКТ

Эта статья является компиляцией погодных данных полученных в Маунт Гопкинс обсерватории, в южной Аризоне, в течение 1968 и 1969 годов. Она является первой из группы периодических метеорологических и атмосферных "наглядных" сообщений имеющих целью помочь ученым в составлении расписаний опытов в обсерватории. Выводы из этих данных должны быть сделаны учитывая интересы различных исследователей.

A METEOROLOGICAL REPORT FOR THE MT. HOPKINS OBSERVATORY: 1968-1969

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1. METEOROLOGICAL MEASUREMENTS

During 1968 and 1969, weather data were collected at SAO's Mt. Hopkins Observatory in southern Arizona. Figure 1 shows a topographic map of the area.

Temperature and humidity measurements (see Figures 2 to 4) were taken hourly on knoll #2 with a continuous-reading Bendix Freiz Instrument Hygrothermograph Model 594. Calibrations were taken at least once a week with a Taylor mercury thermometer and a U.S. Weather Bureau thermometer. The estimated measurement accuracy was ±1°F. The humidity system was calibrated at least once a week with a Taylor sling psychrometer. The accuracy of relative-humidity measurements was estimated to be about 5%.

Values for dew point (see Figures 5 and 6) and absolute humidity (see Figures 7 and 8) were determined from the hourly temperature and relative-humidity data. Saturation vapor pressures were calculated from an analytic expression, based on the Smithsonian Meteorological Tables,[*] supplied by Dr. Gordon D. Thayer of ESSA. Water-vapor densities were calculated from formulas available in the meteorological tables.

This work was supported in part by contract NAS 12-2129 from the National Aeronautics and Space Administration and grant SG 220004 from the Smithsonian Research Foundation.

[*] Smithsonian Meteorological Tables, 6th revised edition, prepared by R. J. List, Smithsonian Miscellaneous Collections, vol. 114, Washington, D.C., 1951, 527 pp.

The accuracy of the dew-point and absolute-humidity values decreases with decreasing temperature and relative humidity (Table 1). The relative uncertainties are therefore largest when the vapor density is low.

Table 1. Estimate of accuracies.

Temperature	Relative humidity	Dew point	Absolute humidity
80°F	75%	±3°F	±18%
60°F	50%	±4°F	±27%
40°F	50%	±5°F	±38%
20°F	25%	±8°F	±75%

Precipitation measurements (see Figure 9) were made with a conventional rain gauge. Readings were taken during and after periods of precipitation. Measurement accuracy was about ±0.01 inch.

Barometric-pressure measurements (see Figure 10) for the period July to December 1969 were taken hourly on knoll #2 with a U.S. Signal Corps Barograph ML-3-D. The instrument was calibrated once a week with a U.S. Weather Bureau aneroid barometer. Measurement accuracy was about ±0.01 inch.

Before July 1969, barometric-pressure readings were taken twice daily on knoll #3 with a Freiz & Co., Baltimore, circular face aneroid barometer.

Wind-speed and direction measurements (see Figures 11 to 15) were made on knoll #1 with a continuous-reading Bendix Freiz Instrument Aerovane Wind Recorder Model 141. Readings were taken hourly along with daily maximum wind speed and direction. Speed measurements were accurate to about ±1 mph. Wind direction was rounded off to the nearest compass direction (22°.5) before calculations were performed. Wind measurements were also made at the peak with a similar instrument for the period July to December 1969. Correlations of the wind speeds (see Figure 11) and wind directions (see Figure 16) have been included.

Nighttime cloud cover (see Figures 17 to 20) was taken visually four times a night by observers. This information was classified as clear, partly cloudy, or cloudy before calculations were performed. Clear nights were defined as those in which clear skies (0 to 20% cloud cover) were observed during three of the four observations and conditions were no worse than partly cloudy (30 to 70%) during the fourth. Cloudy nights are those in which the sky was cloudy (80 to 100%) during at least two of the four observations. General meteorological conditions were also recorded during the four nightly observations (see Figure 21).

Daytime cloud cover (see Figures 22 to 25) was continuously recorded at the summit with a sol-a-meter, an instrument for measuring solar energy, supplied by Dr. Nelder Medrud of the High Altitude Observatory at the National Center of Atmospheric Research in Boulder, Colorado. Dr. Medrud reduced the data and performed the necessary statistical analyses.

Cloud-cover correlation data (see Figures 26 and 27) have been compiled from the cloud-cover observations, and estimates extracted from the daytime sol-a-meter recorded data. The pertinent information in this analysis is the predictability of nighttime cloud cover from observations made the previous day.

2. WEATHER PATTERN

The yearly weather pattern at Mt. Hopkins can be divided into periods that correspond closely to the calendar seasons. The patterns discussed here are based on observations made during 1968 and 1969.

The spring season, from mid-March through June, is characterized by clear skies and very low precipitation. Clear afternoon skies appear to be an excellent indicator of clear nights to follow. Some snow storms accompanied by day-long heavy cloud cover occur during March.

The temperature ranges from March lows averaging about 30°F to June highs of about 70°F. The absolute humidity is on the rise throughout the spring. A typical value for March is about 3 g/m^3, while June averages about 5 g/m^3. During the spring season, winds at the ridge blow at a fairly steady 10 to 15 mph from a predominantly westerly direction. Maximum wind speeds are not very large except in March, when high winds from the west and northwest accompany occasional snow storms.

The summer season, from July through mid-September, is dominated by cloudy, stormy weather with large amounts of precipitation.

Temperatures typically range from 50° to 70°F, and the absolute humidity averages close to 10 g/m^3. Wind speeds average a fairly steady 5 to 10 mph, with high winds from the east reaching 45 to 50 mph during storms.

Summer storms move in rapidly from the southeast. A typical storm day begins with a clear sky in the early morning, cumulus clouds begin to collect by noontime, and complete overcast prevails by mid to late afternoon. During the late stages of the cloud buildup, the temperature falls by as much as 20°F in as little as 2 hours. A corresponding rise in relative humidity to saturation or near saturation occurs, and the barometric pressure falls rapidly. The wind direction becomes easterly, and wind speed increases. Rainfall begins and continues intermittently into the late evening, after which the skies begin to clear. Many storms are accompanied by lightning, which frequently strikes both the peak and the ridge of the mountain. Maximum precipation during a single storm may amount to 1 to 2 inches. The storm pattern is such that clear skies in the afternoon are still a fair indicator of clear nights to follow.

The fall, from mid-September to the end of November, is marked by clear skies and low precipitation. Clear daytime skies appear to be a good indicator of clear nights to follow.

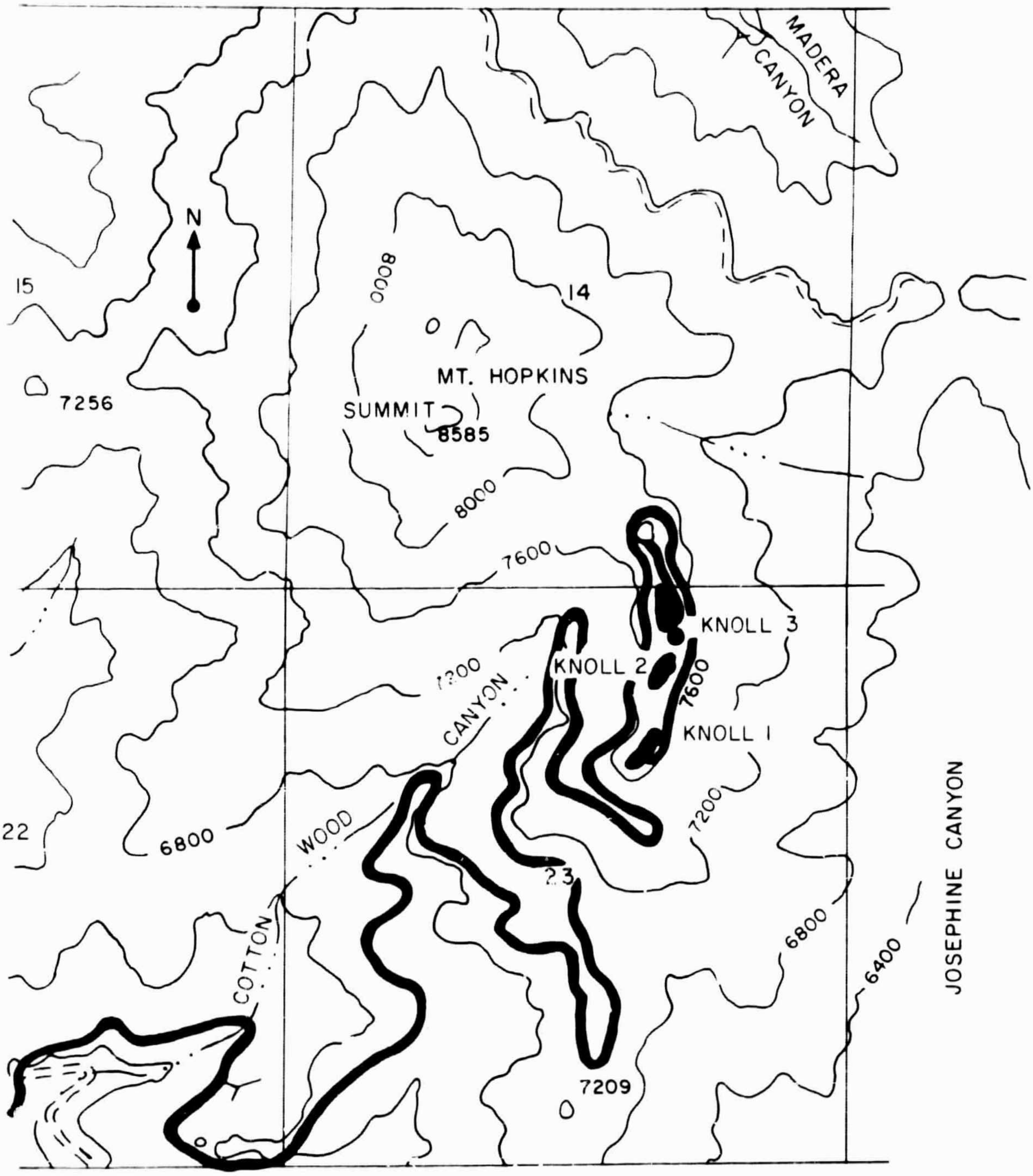
Temperatures vary from an average daily high in September of about 65°F to a typical low in November of about 32°F. The absolute humidity decreases during this time from an average September value of about 7 g/m^3 to about 3 g/m^3 in November. Once the summer storms are over, precipitation is extremely light until winter. An occasional snowfall may occur in November, with some very light snow as early as October.

Wind speeds at the knoll average a steady 5 to 10 mph during September and October and about 10 to 15 mph during November. In the fall, occasional periods of winds from the north and northeast in excess of 60 mph may last for several days. Comparison of daily peak and knoll wind data for the fall indicates that the high winds at the ridge are largely a function of local conditions and terrain.

From December to mid-March, winter skies are frequently cloudy. Snow storms from the north and northeast, with accumulations of 4 to 12 inches, are frequent, but melting and evaporation are rapid. Afternoon clear skies are a fair indicator of clear nights to follow, but the correlation is not so strong as in other seasons. On the other hand, cloudy afternoon skies are a very good indication that a cloudy night will follow.

The temperature during this period averages between 30° and 50°F but may fall as low as 10°F. Temperatures reach below 32°F on approximately half the days during the winter. The absolute humidity averages about 3 g/m^3, with frequent periods in which the vapor content is in the neighborhood of 1 g/m^3. In winter, rain and snow are infrequent.

In the winter season, average winds are relatively calm except for occasional high winds that may accompany a storm. During December and March, these high winds blow generally from the west, while those in January and February come predominantly from the south, contrary to the general east-west tendency the rest of the year.



MAP OF MT. HOPKINS AREA HEAVY LINE REPRESENTS THE ACCESS LINE

Figure 1.

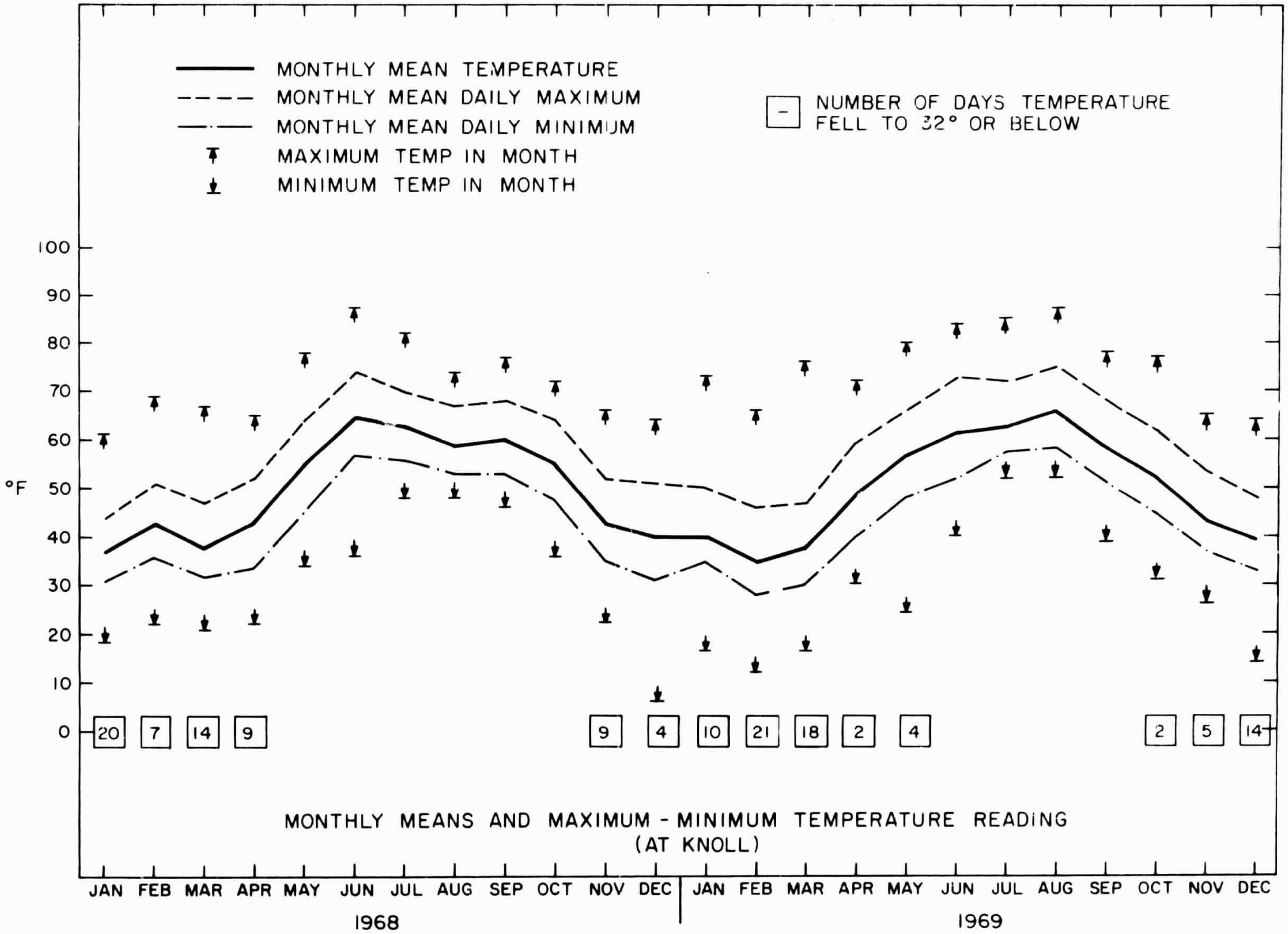

MONTHLY MEAN TEMPERATURE
MONTHLY MEAN DAILY MAXIMUM
MONTHLY MEAN DAILY MINIMUM
MAXIMUM TEMP IN MONTH
MINIMUM TEMP IN MONTH
NUMBER OF DAYS TEMPERATURE FELL TO 32° OR BELOW
°F
100
90
80
70
60
50
40
30
20
10
0
20
7
14
9
9
4
10
21
18
2
4
2
5
14
MONTHLY MEANS AND MAXIMUM - MINIMUM TEMPERATURE READING
(AT KNOLL)
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
1968
1969

Figure 2.

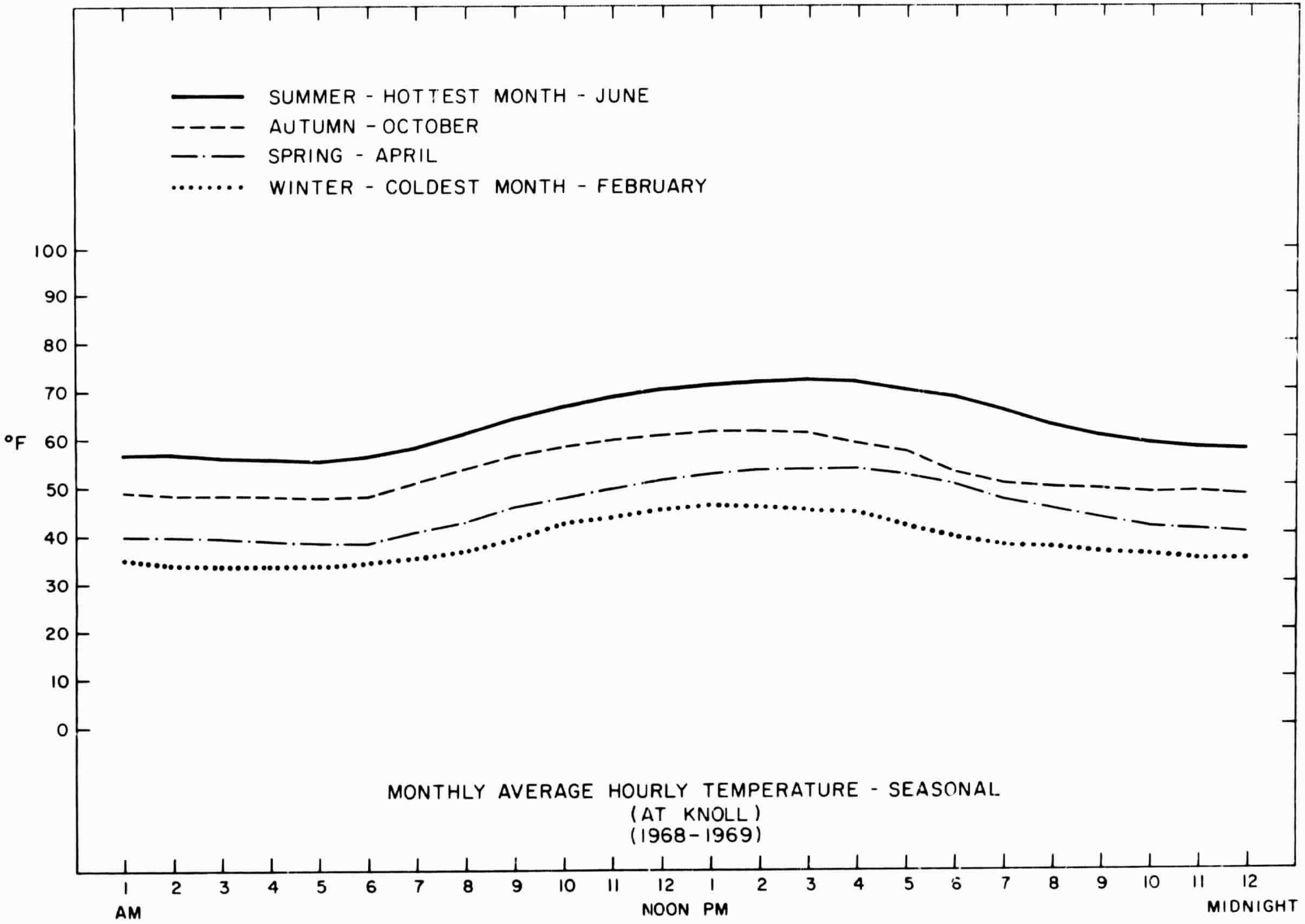

SUMMER - HOTTEST MONTH - JUNE
AUTUMN - OCTOBER
SPRING - APRIL
WINTER - COLDEST MONTH - FEBRUARY
°F
100
90
80
70
60
50
40
30
20
10
0
MONTHLY AVERAGE HOURLY TEMPERATURE - SEASONAL
(AT KNOLL)
(1968-1969)
1
AM
2
3
4
5
6
7
8
9
10
11
12
NOON
1
PM
2
3
4
5
6
7
8
9
10
11
12
MIDNIGHT

Figure 3.

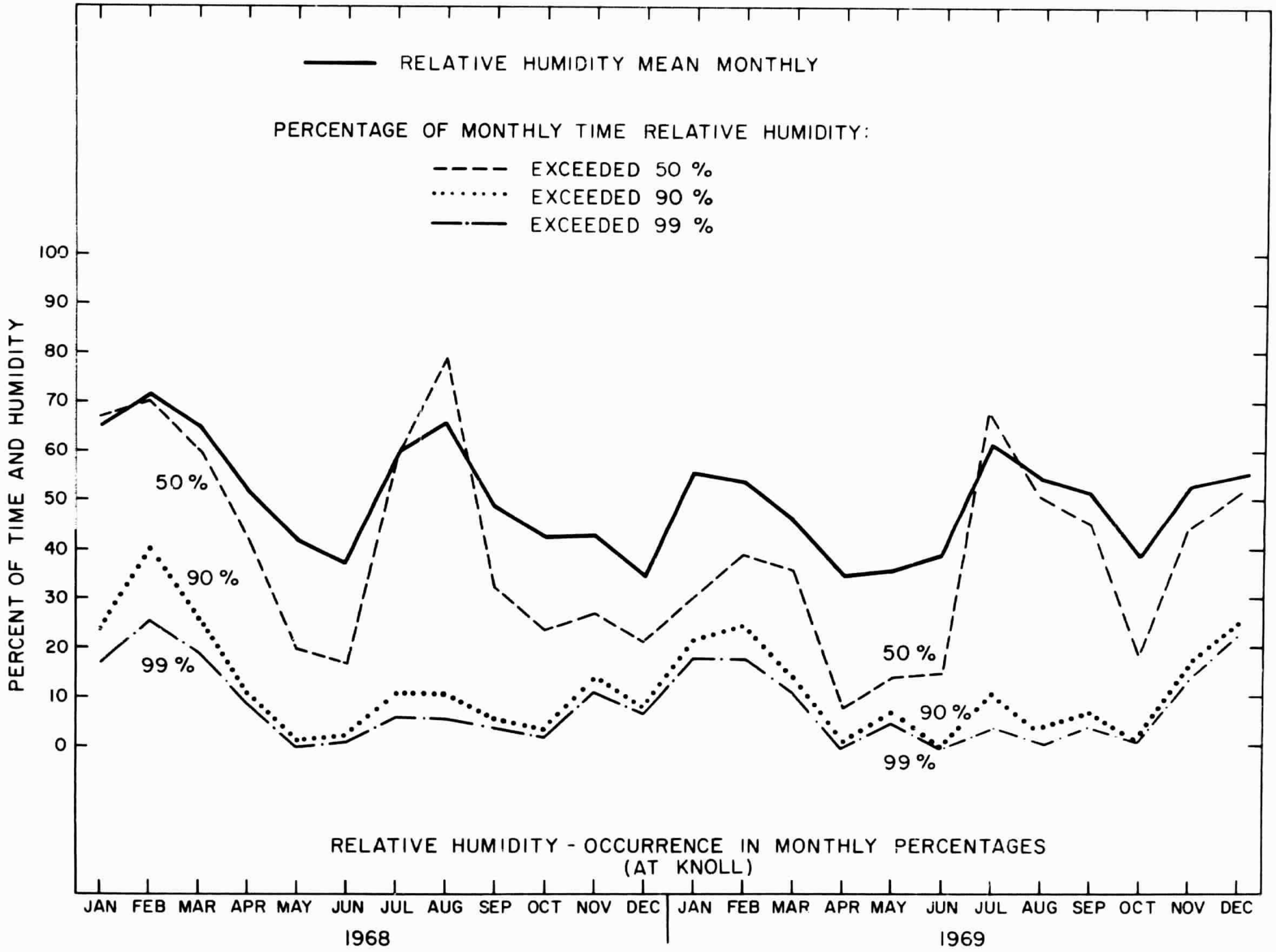

RELATIVE HUMIDITY MEAN MONTHLY
PERCENTAGE OF MONTHLY TIME RELATIVE HUMIDITY:
EXCEEDED 50 %
EXCEEDED 90 %
EXCEEDED 99 %
PERCENT OF TIME AND HUMIDITY
100
90
80
70
60
50
40
30
20
10
0
50 %
90 %
99 %
50 %
90 %
99 %
RELATIVE HUMIDITY - OCCURRENCE IN MONTHLY PERCENTAGES
(AT KNOLL)
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
1968
1969

Figure 4.

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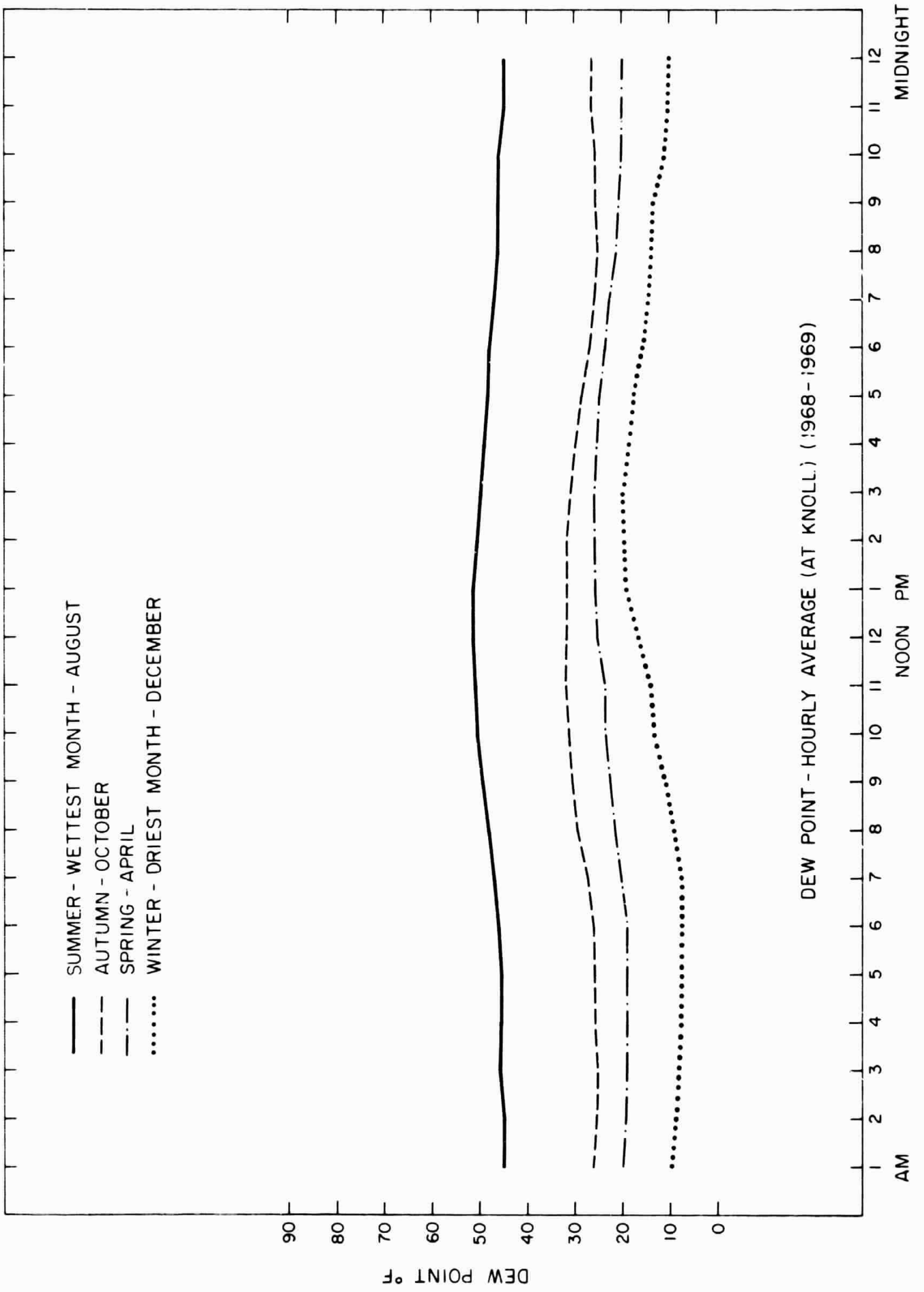


Figure 6.

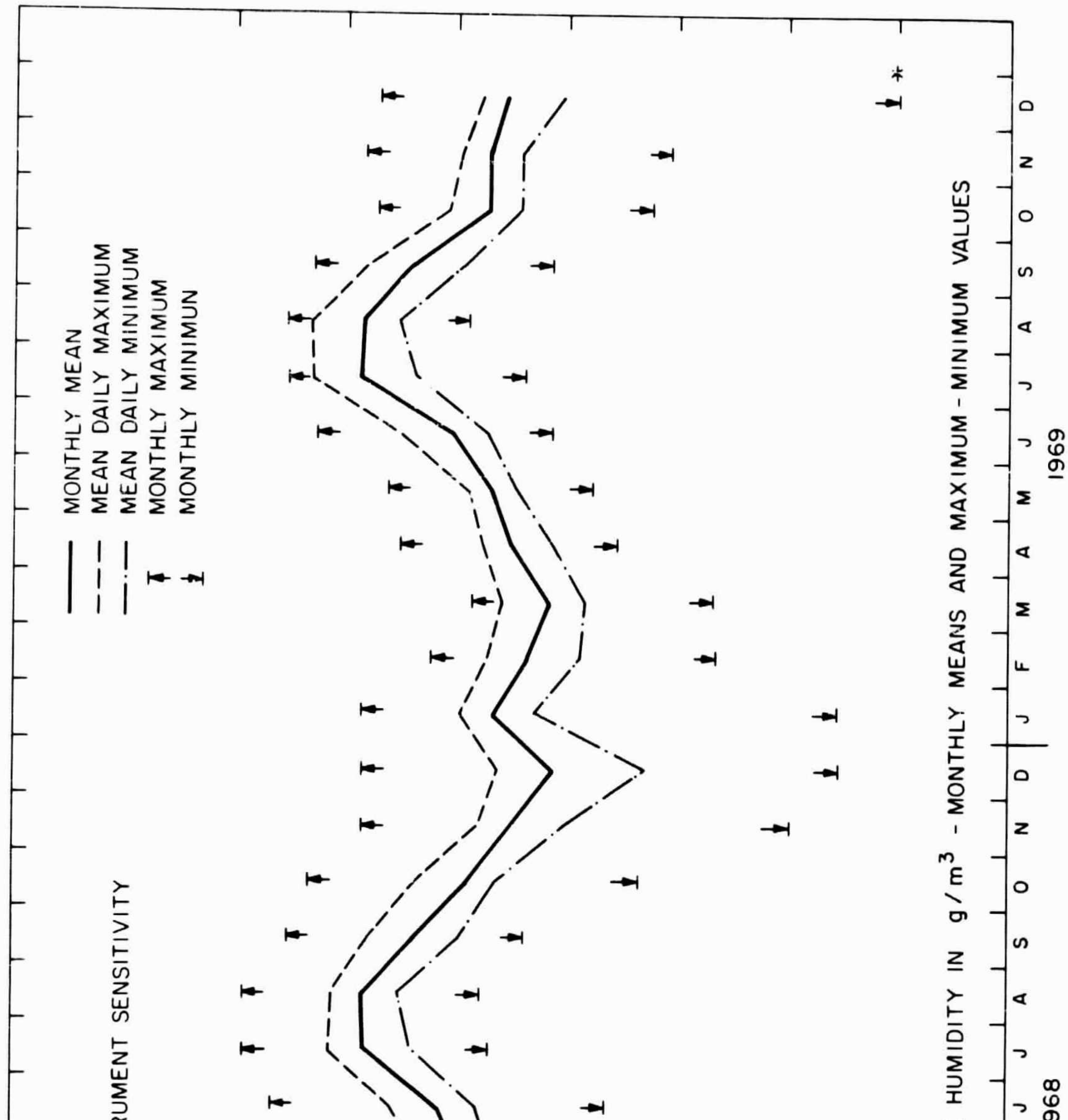

ABSOLUTE HUMIDITY IN g/m³ - MONTHLY MEANS AND MAXIMUM - MINIMUM VALUES
MONTHLY MEAN
MEAN DAILY MAXIMUM
MEAN DAILY MINIMUM
MONTHLY MAXIMUM
MONTHLY MINIMUN
* BELOW INSTRUMENT SENSITIVITY
g/m³
20
10
5
2
1.0
0.5
0.2
J F M A M J J A S O N D
1968
J F M A M J J A S O N D
1969

Figure 7.

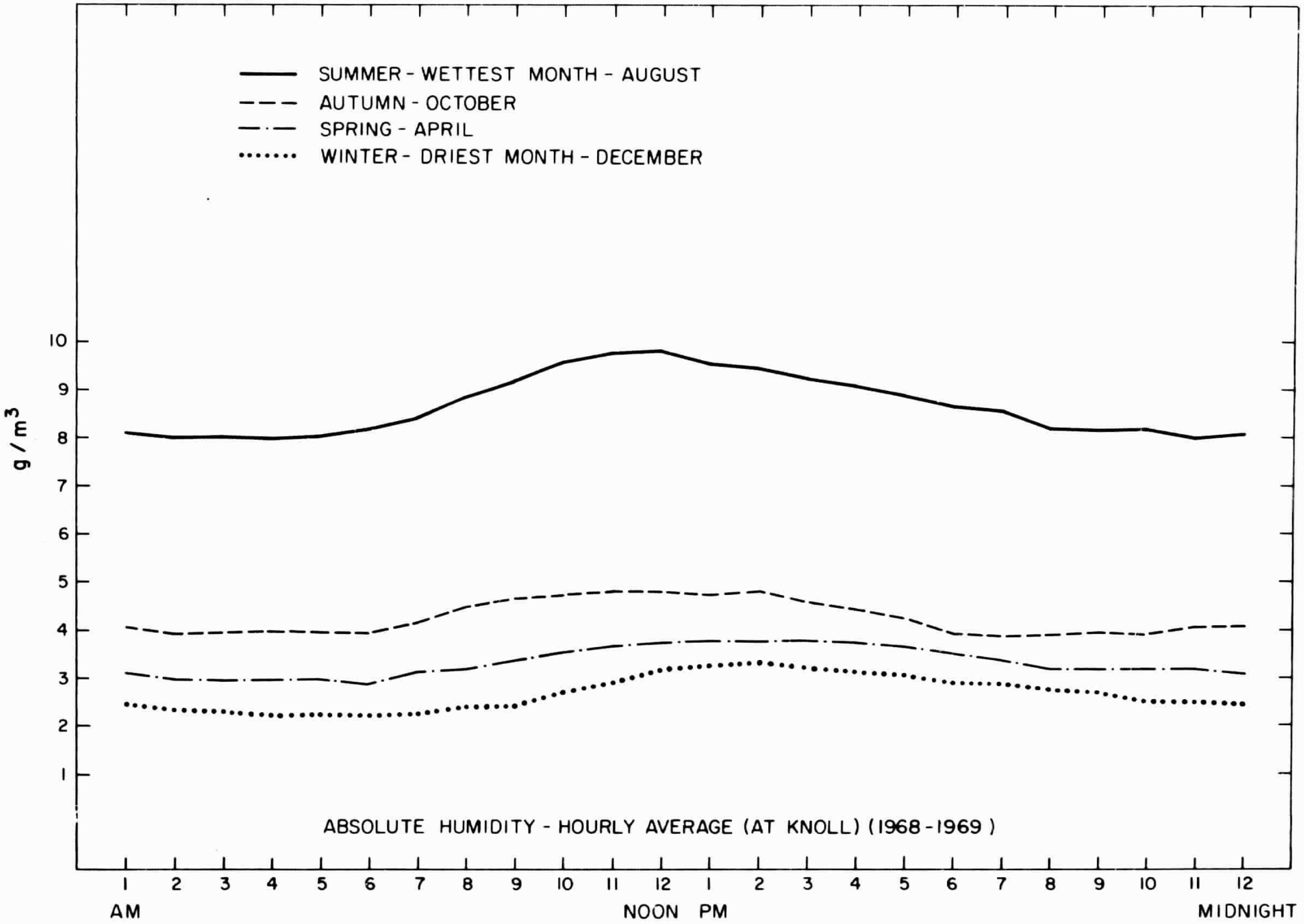

SUMMER - WETTEST MONTH - AUGUST
AUTUMN - OCTOBER
SPRING - APRIL
WINTER - DRIEST MONTH - DECEMBER
g / m³
10
9
8
7
6
5
4
3
2
1
ABSOLUTE HUMIDITY - HOURLY AVERAGE (AT KNOLL) (1968-1969)
1
2
3
4
5
6
7
8
9
10
11
12
1
2
3
4
5
6
7
8
9
10
11
12
AM
NOON PM
MIDNIGHT

Figure 8.

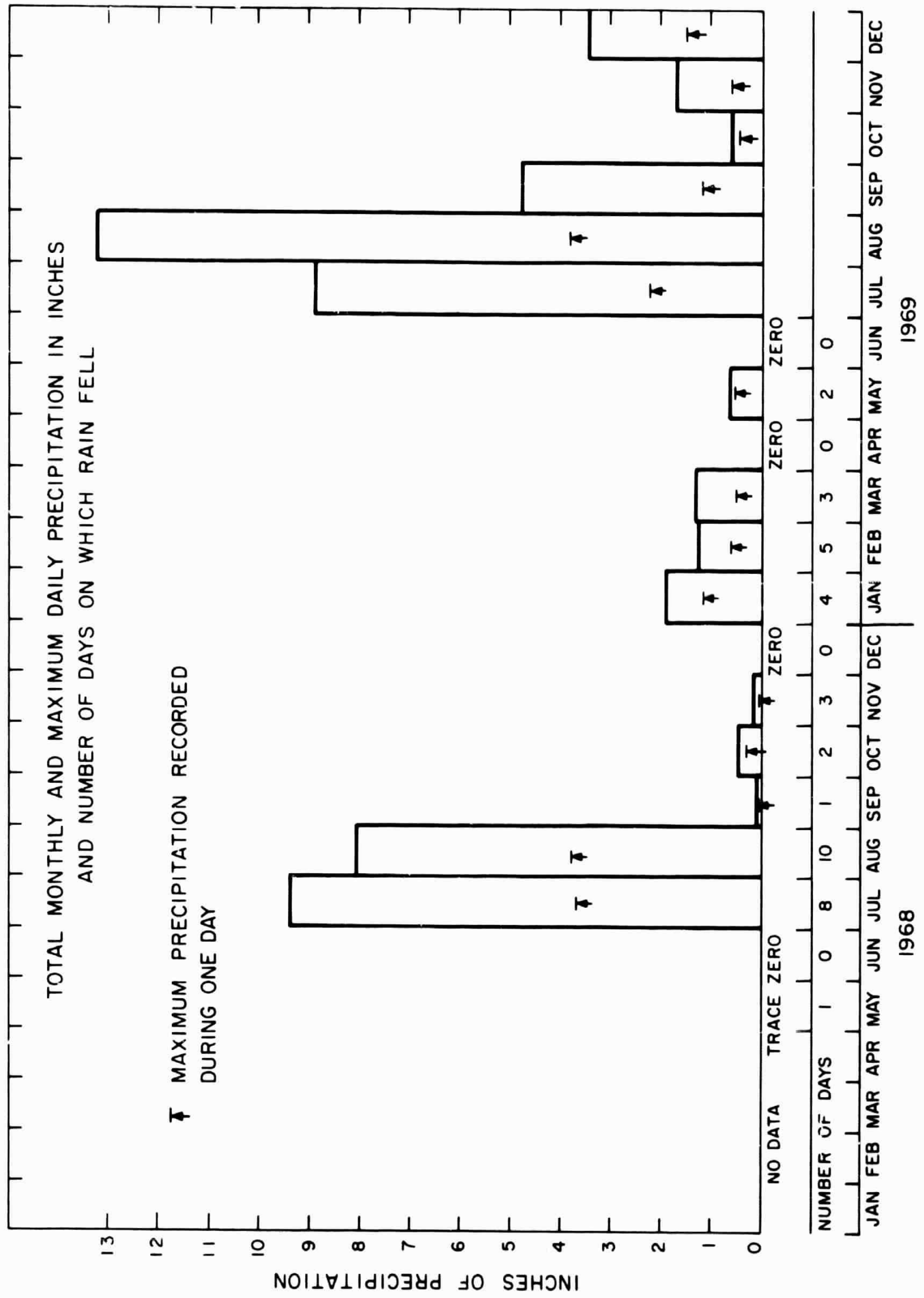

TOTAL MONTHLY AND MAXIMUM DAILY PRECIPITATION IN INCHES
AND NUMBER OF DAYS ON WHICH RAIN FELL
MAXIMUM PRECIPITATION RECORDED
DURING ONE DAY
INCHES OF PRECIPITATION
0
1
2
3
4
5
6
7
8
9
10
11
12
13
NO DATA
TRACE
ZERO
ZERO
ZERO
ZERO
NUMBER OF DAYS
I
0
8
10
I
2
3
0
4
5
3
0
2
0
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
1968
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
1969

Figure 9.

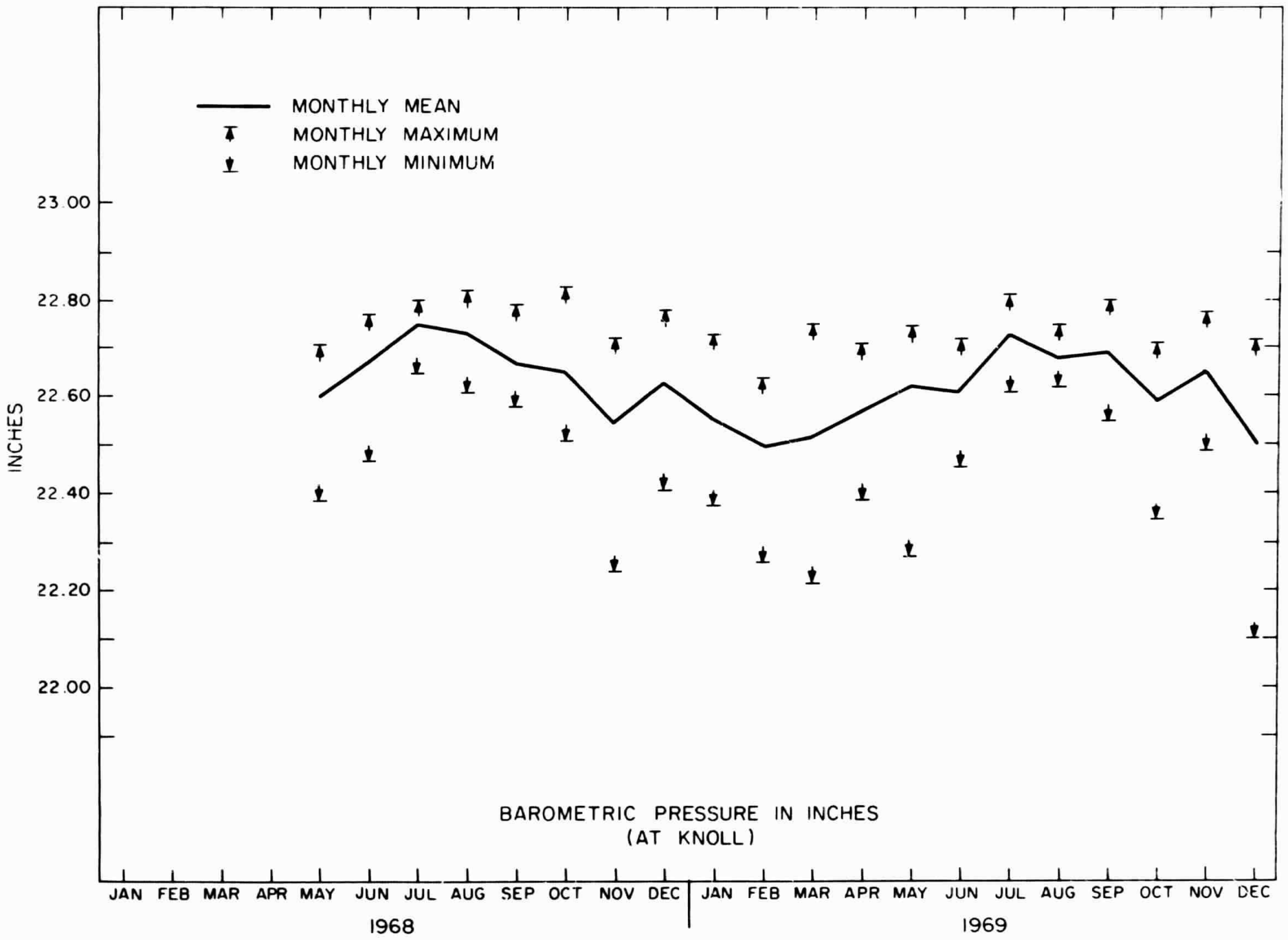

MONTHLY MEAN
MONTHLY MAXIMUM
MONTHLY MINIMUM
INCHES
23.00
22.80
22.60
22.40
22.20
22.00
BAROMETRIC PRESSURE IN INCHES
(AT KNOLL)
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
1968
1969

Figure 10.

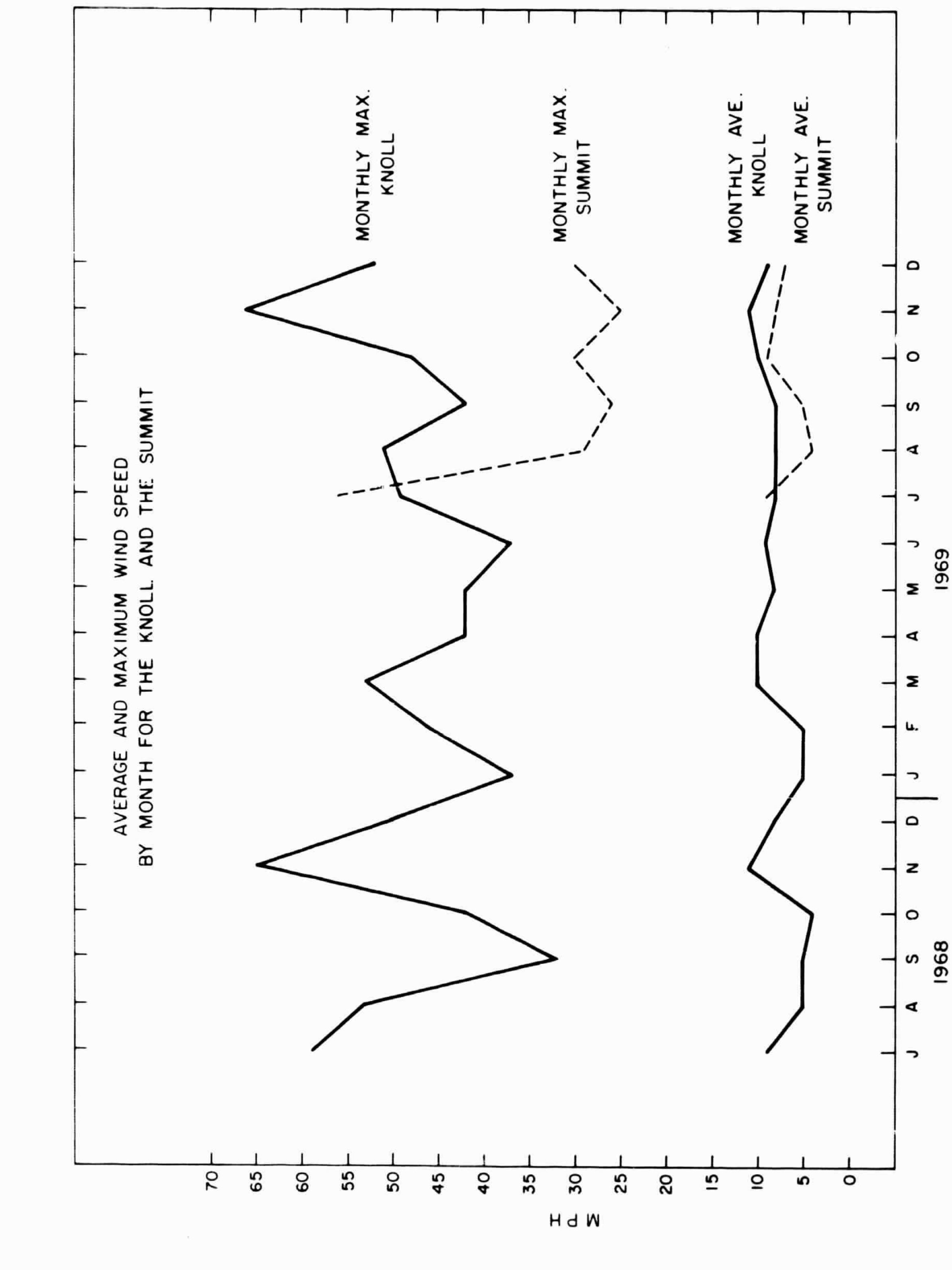

AVERAGE AND MAXIMUM WIND SPEED
BY MONTH FOR THE KNOLL AND THE SUMMIT
MONTHLY MAX. KNOLL
MONTHLY MAX. SUMMIT
MONTHLY AVE. KNOLL
MONTHLY AVE. SUMMIT
M P H
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
J
A
S
O
N
D
J
F
M
A
M
J
J
A
S
O
N
D
1968
1969

Figure 11.

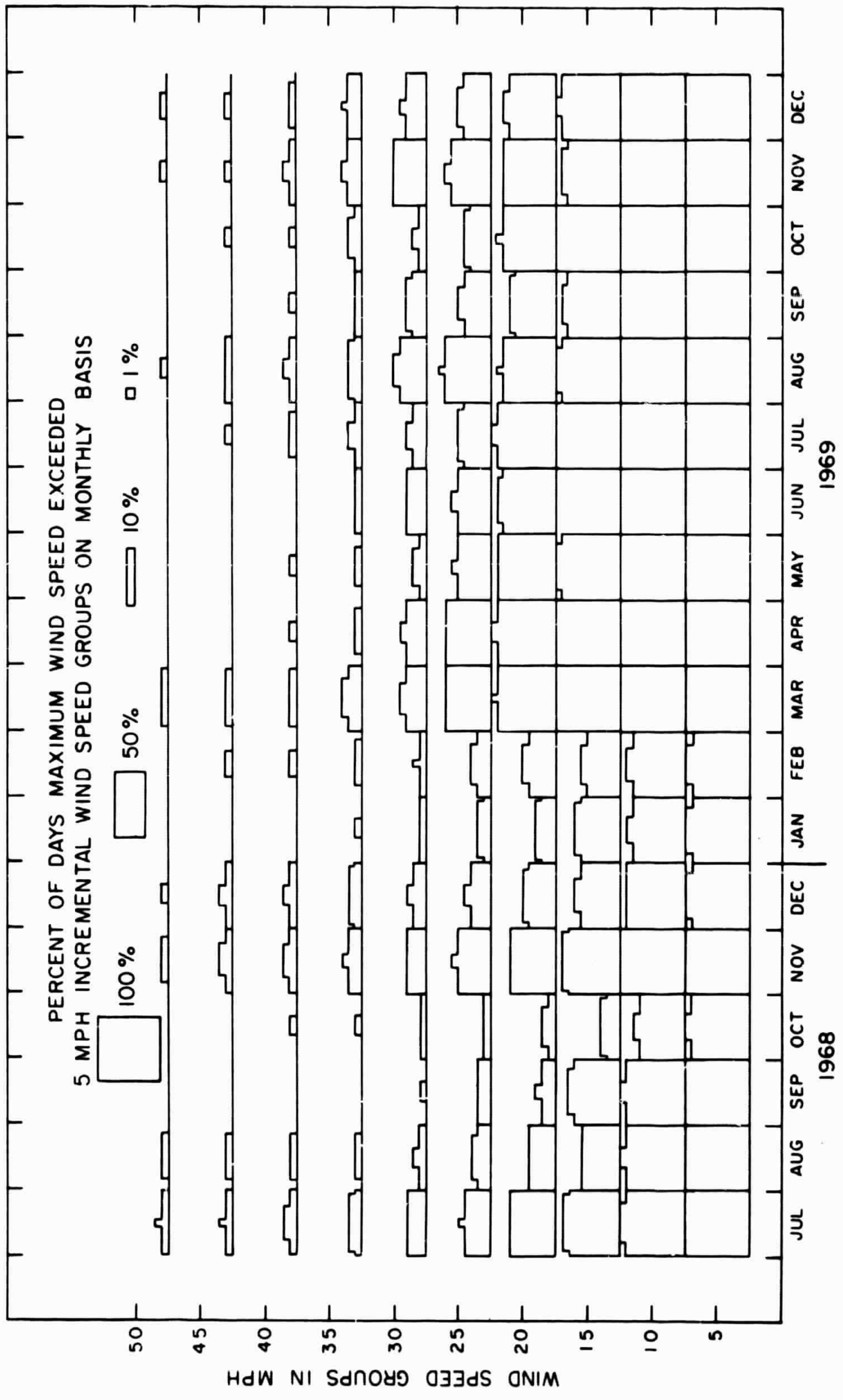

PERCENT OF DAYS MAXIMUM WIND SPEED EXCEEDED
5 MPH INCREMENTAL WIND SPEED GROUPS ON MONTHLY BASIS
100%
50%
10%
1%
WIND SPEED GROUPS IN MPH
50
45
40
35
30
25
20
15
10
5
JUL
AUG
SEP
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
1968
1969

Figure 12.

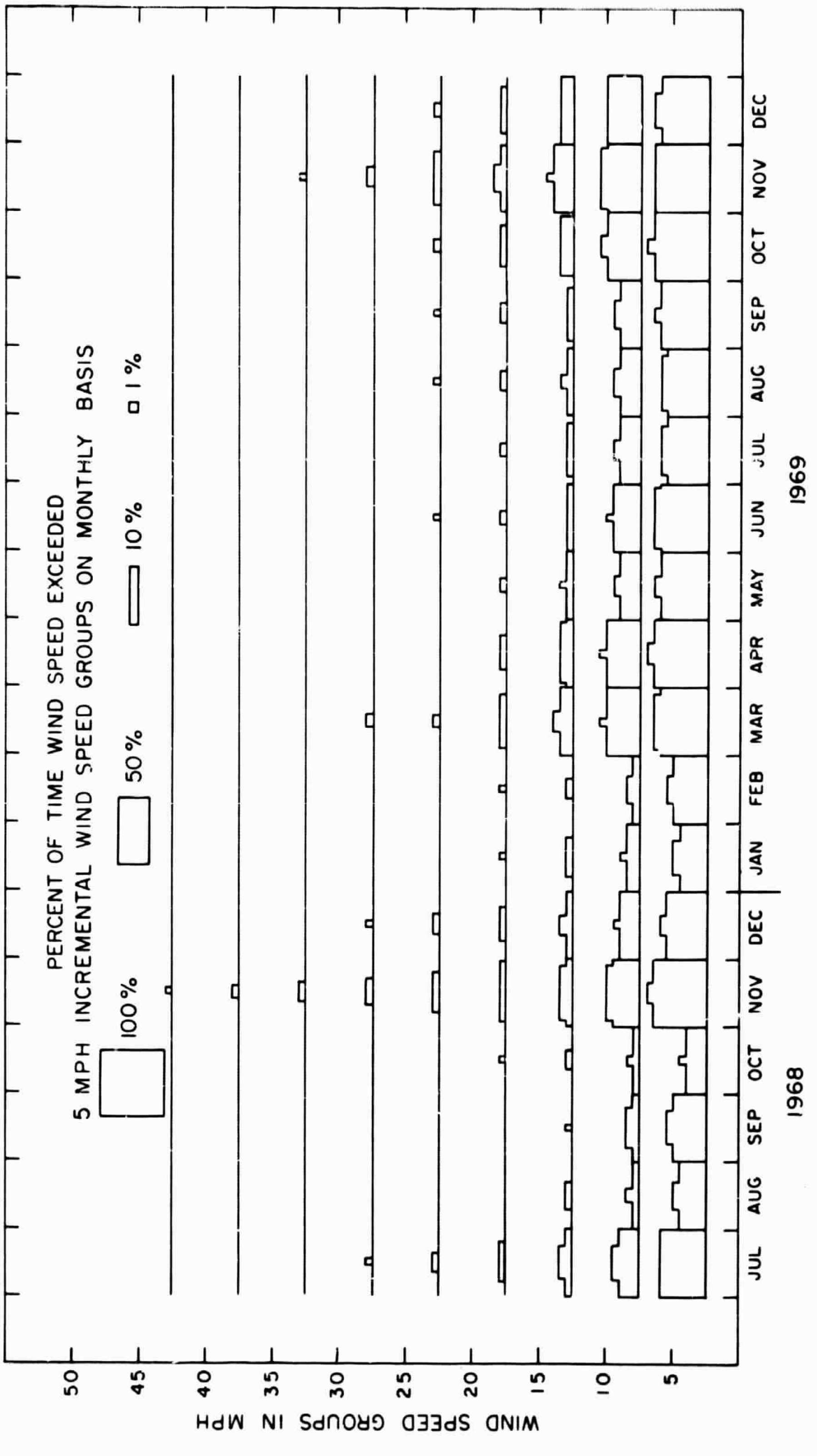

PERCENT OF TIME WIND SPEED EXCEEDED
5 MPH INCREMENTAL WIND SPEED GROUPS ON MONTHLY BASIS
100%
50%
10%
1%
WIND SPEED GROUPS IN MPH
5
10
15
20
25
30
35
40
45
50
JUL
AUG
SEP
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
1968
1969

Figure 13.

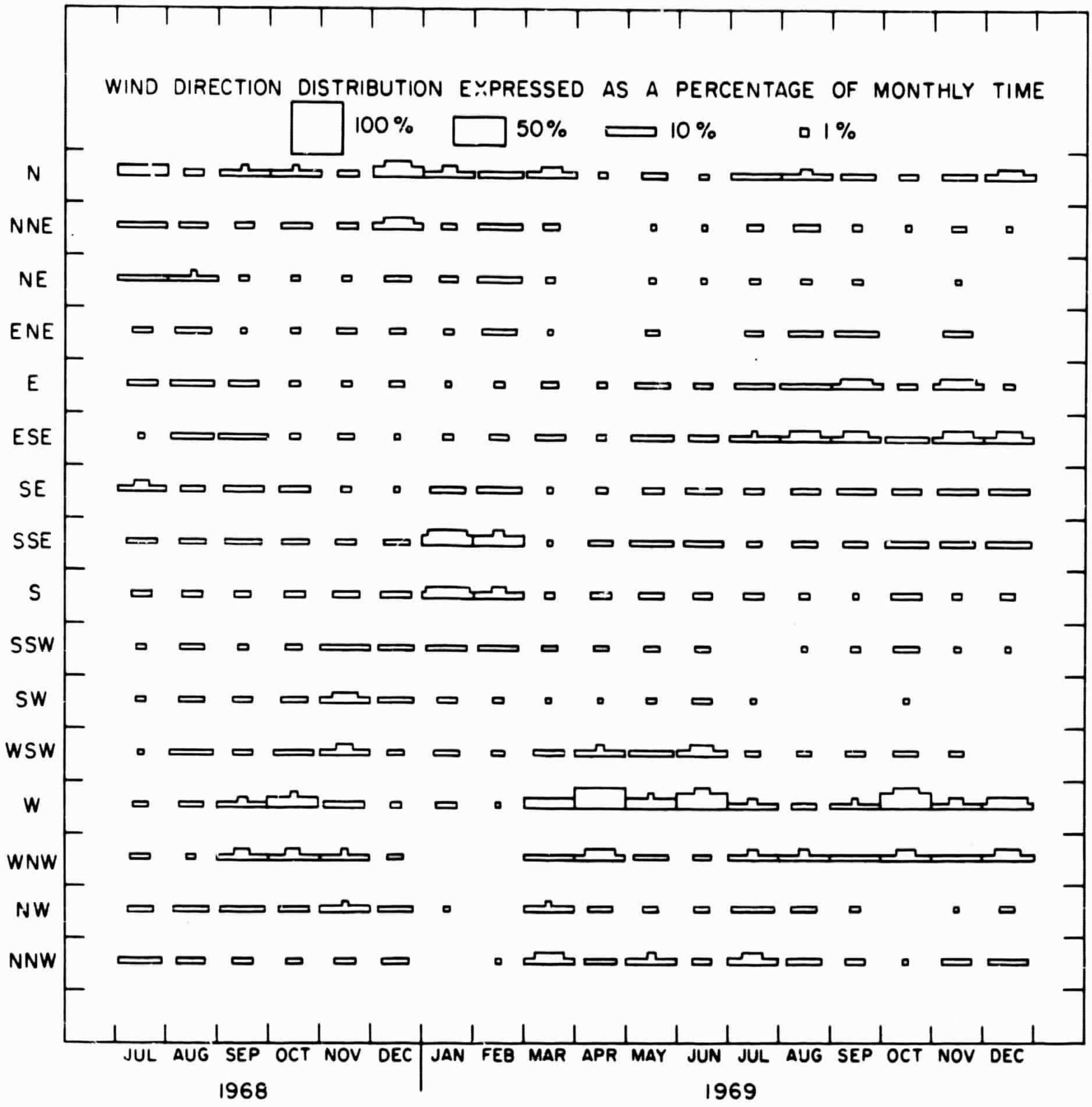

WIND DIRECTION DISTRIBUTION EXPRESSED AS A PERCENTAGE OF MONTHLY TIME
100%
50%
10%
1%
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
JUL
AUG
SEP
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
1968
1969

Figure 14.

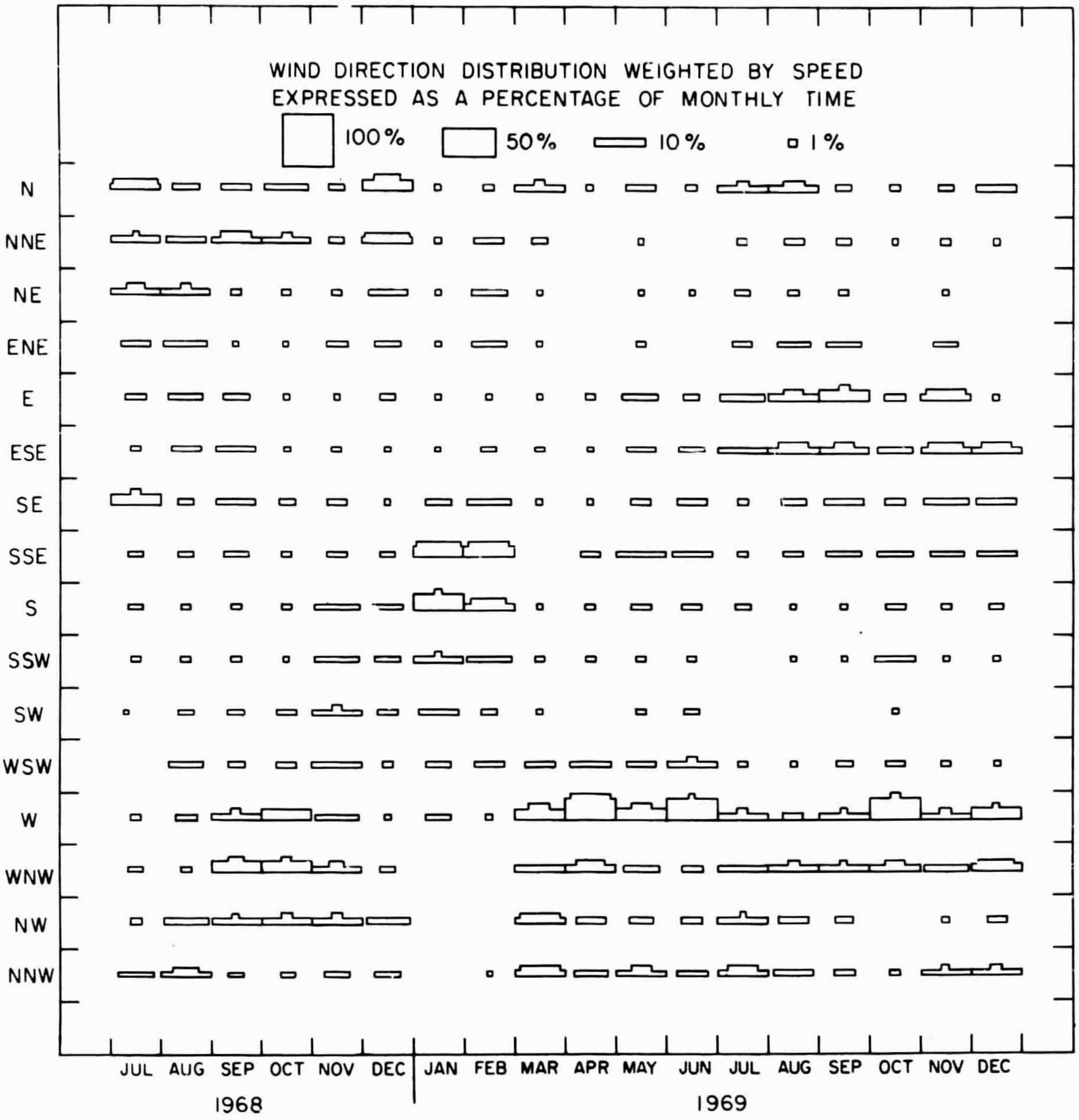

WIND DIRECTION DISTRIBUTION WEIGHTED BY SPEED
EXPRESSED AS A PERCENTAGE OF MONTHLY TIME
100%
50%
10%
1%
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
JUL
AUG
SEP
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
1968
1969

Figure 15.

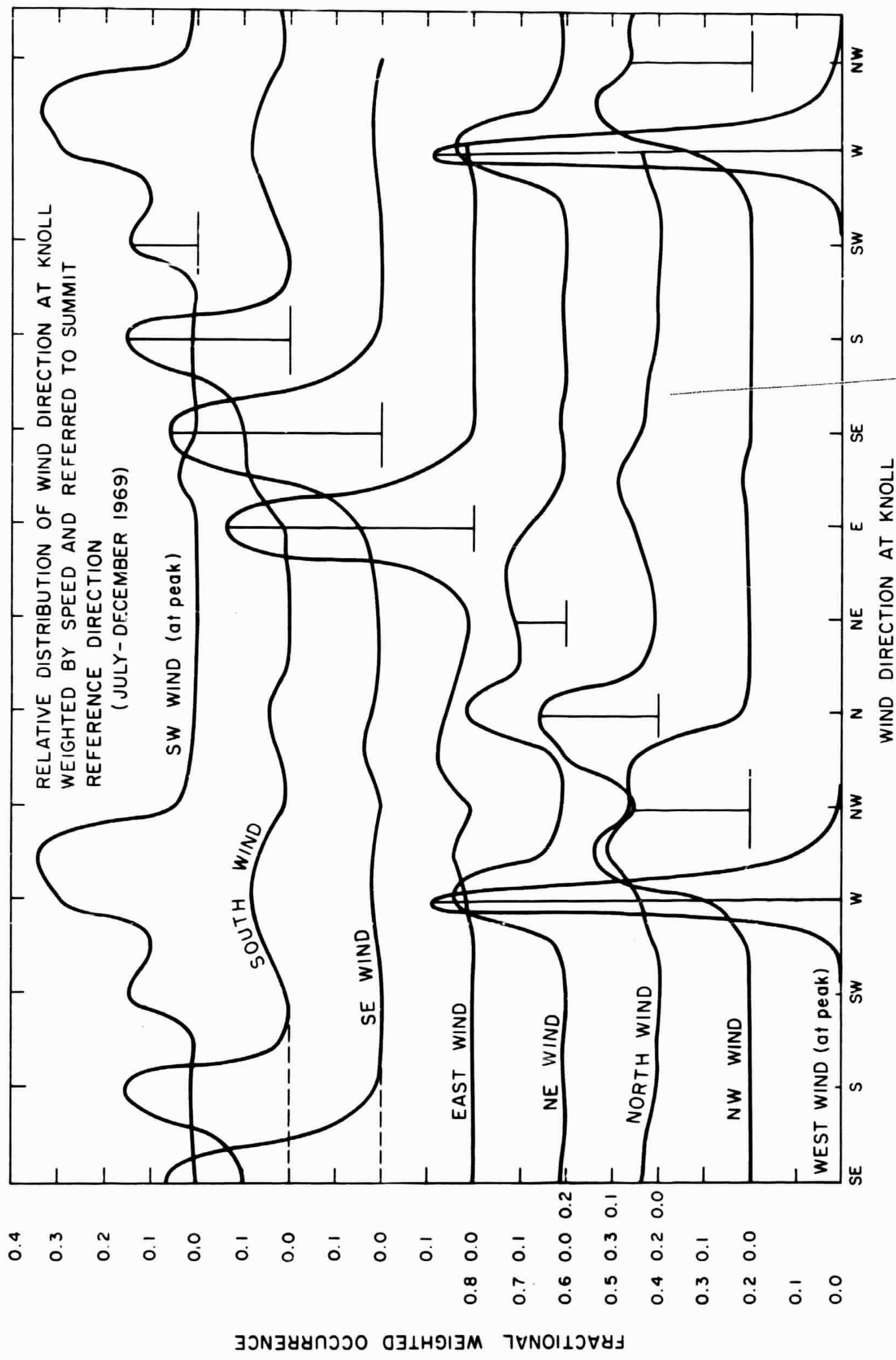

RELATIVE DISTRIBUTION OF WIND DIRECTION AT KNOLL
WEIGHTED BY SPEED AND REFERRED TO SUMMIT
REFERENCE DIRECTION
(JULY-DECEMBER 1969)
SW WIND (at peak)
SOUTH WIND
SE WIND
EAST WIND
NE WIND
NORTH WIND
NW WIND
WEST WIND (at peak)
SE
S
SW
W
NW
N
NE
E
SE
S
SW
W
NW
WIND DIRECTION AT KNOLL
0.4
0.3
0.2
0.1
0.0
0.1
0.0
0.1
0.0
0.1
0.8 0.0
0.7 0.1
0.6 0.0 0.2
0.5 0.3 0.1
0.4 0.2 0.0
0.3 0.1
0.2 0.0
0.1
0.0
FRACTIONAL WEIGHTED OCCURRENCE

Figure 16.

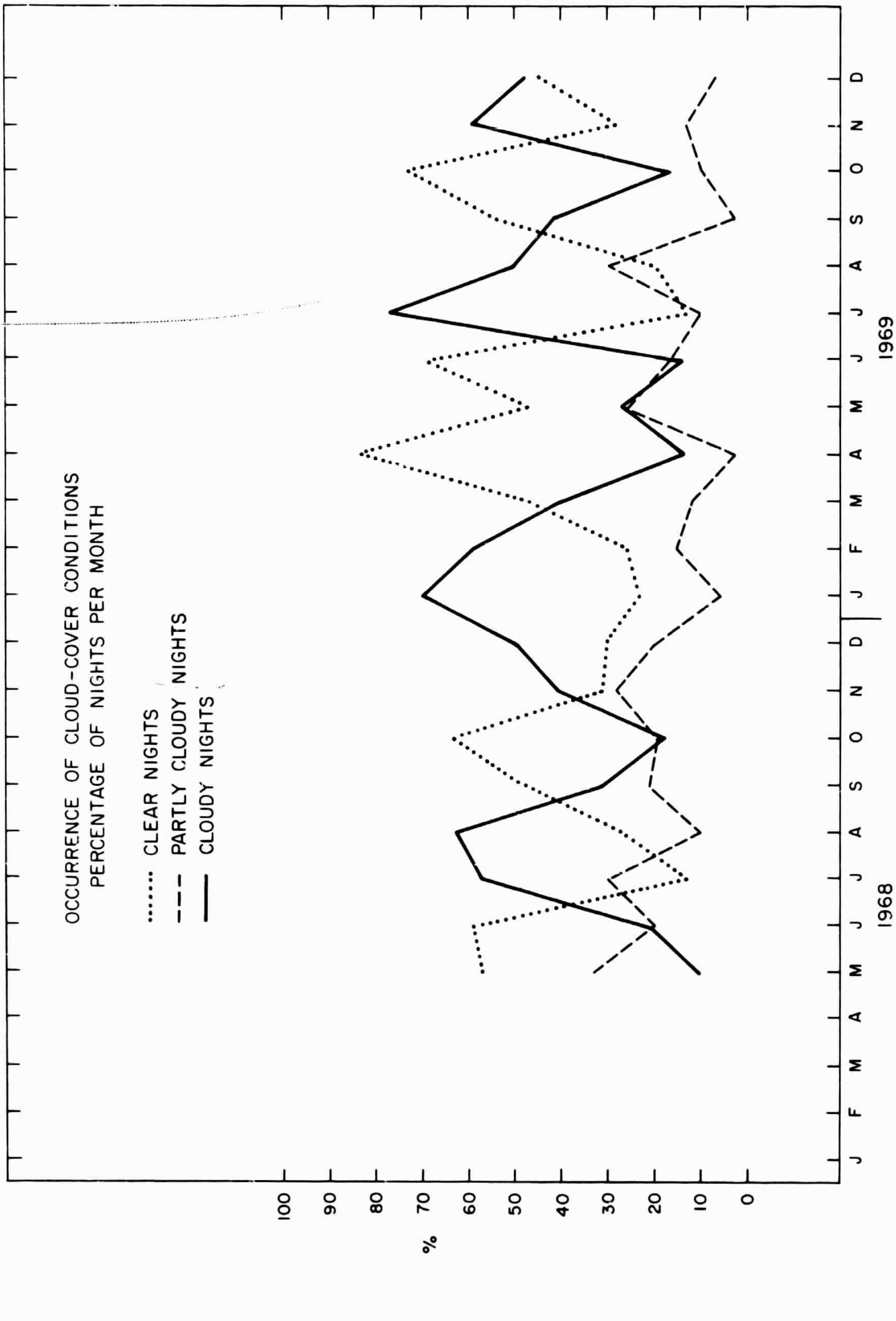

OCCURRENCE OF CLOUD-COVER CONDITIONS
PERCENTAGE OF NIGHTS PER MONTH
CLEAR NIGHTS
PARTLY CLOUDY NIGHTS
CLOUDY NIGHTS
%
100
90
80
70
60
50
40
30
20
10
0
J
F
M
A
M
J
J
A
S
O
N
D
J
F
M
A
M
J
J
A
S
O
N
D
1968
1969

Figure 17.

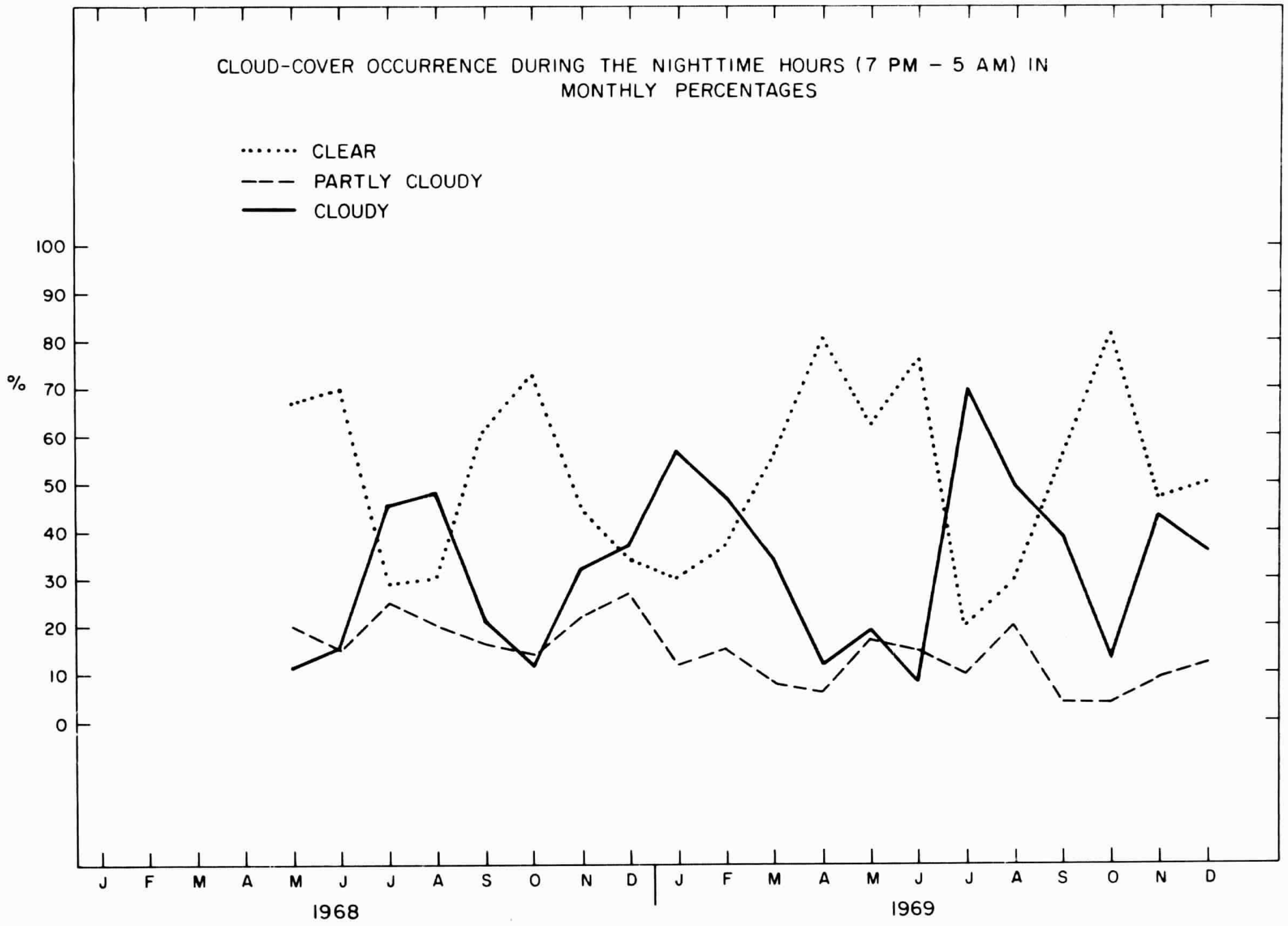

CLOUD-COVER OCCURRENCE DURING THE NIGHTTIME HOURS (7 PM – 5 AM) IN MONTHLY PERCENTAGES
CLEAR
PARTLY CLOUDY
CLOUDY
%
100
90
80
70
60
50
40
30
20
10
0
J
F
M
A
M
J
J
A
S
O
N
D
J
F
M
A
M
J
J
A
S
O
N
D
1968
1969

Figure 18.

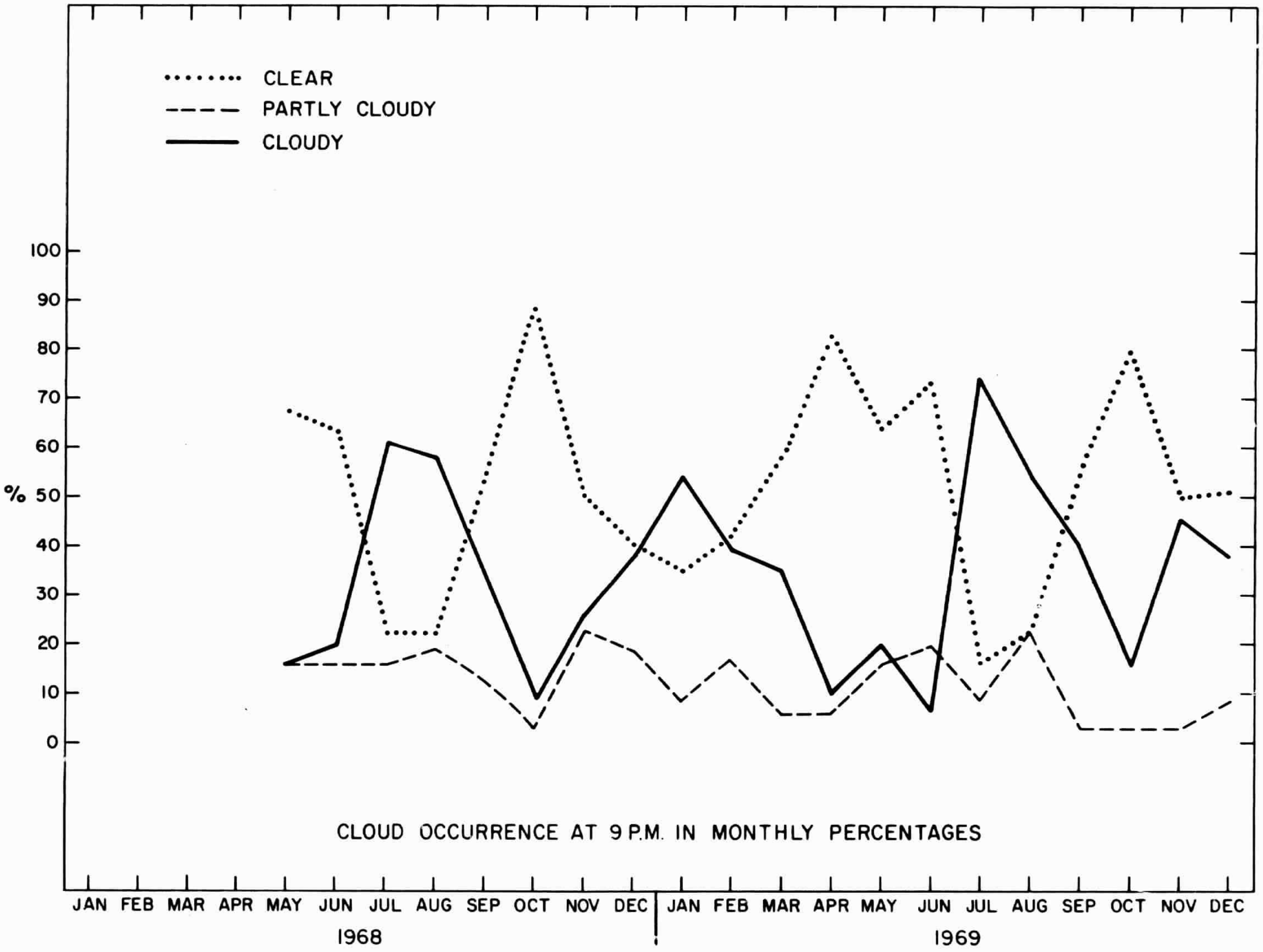

CLEAR
PARTLY CLOUDY
CLOUDY
100
90
80
70
60
% 50
40
30
20
10
0
CLOUD OCCURRENCE AT 9 P.M. IN MONTHLY PERCENTAGES
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
1968
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
1969

Figure 19.

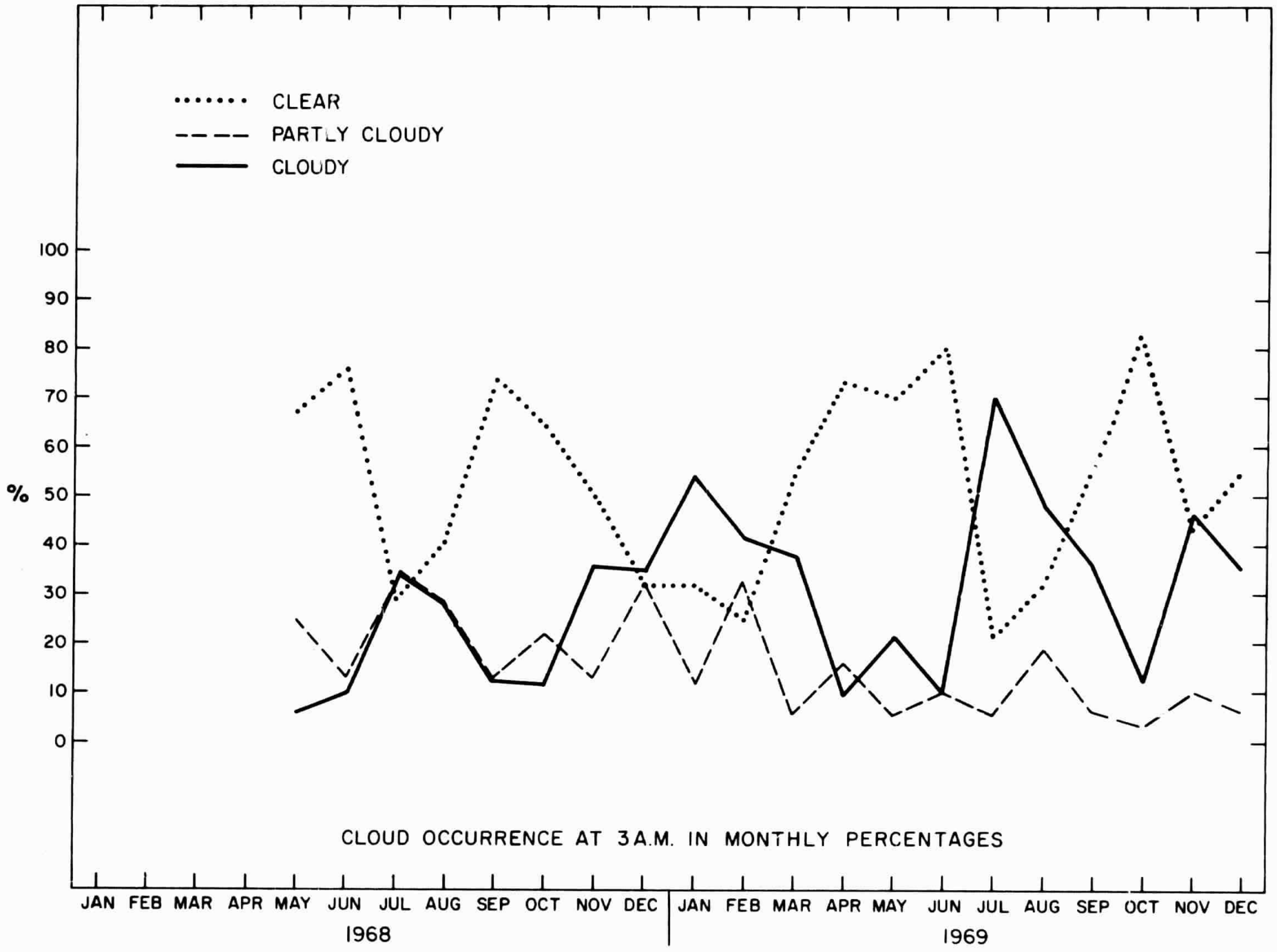
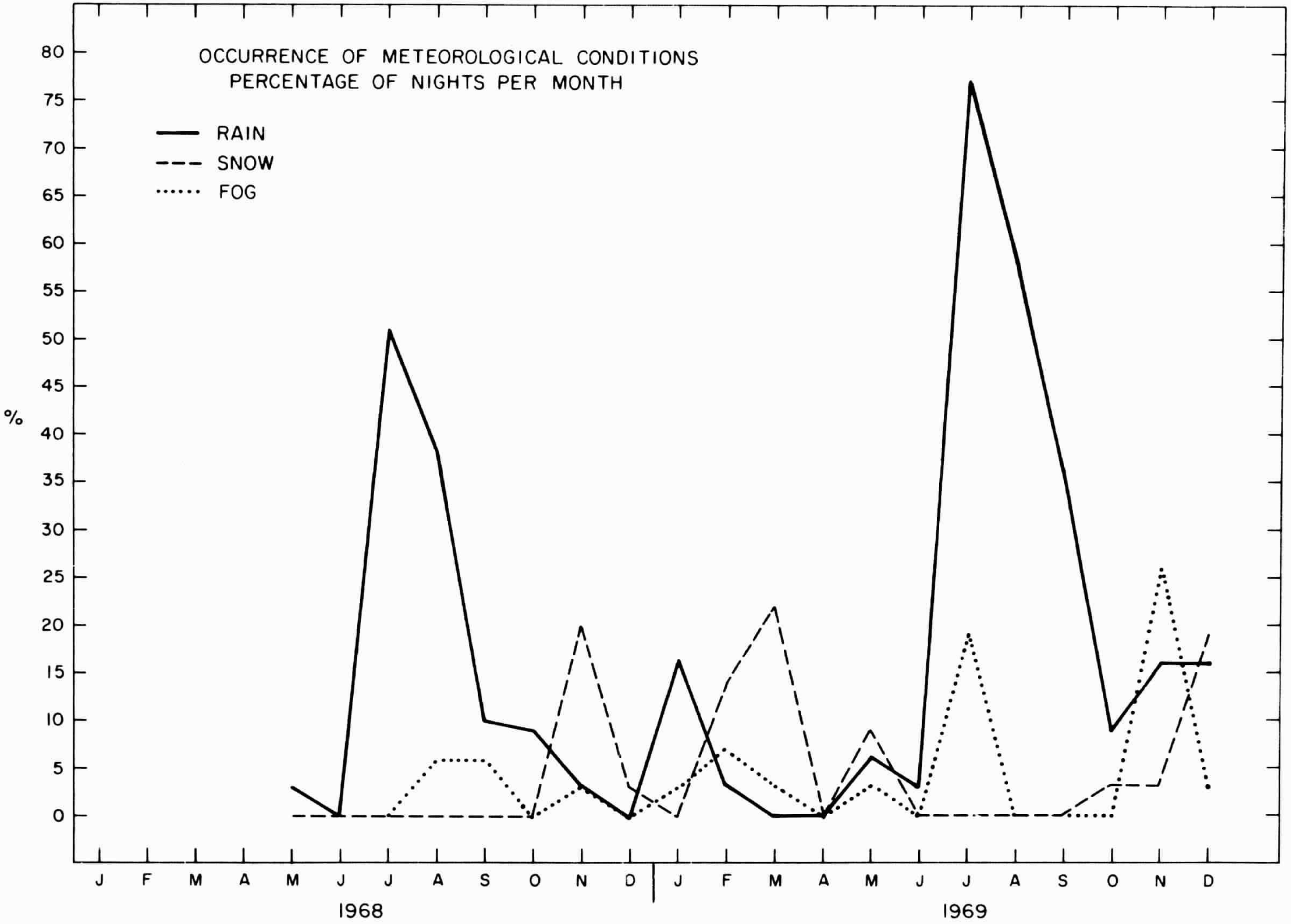

CLEAR
PARTLY CLOUDY
CLOUDY
%
100
90
80
70
60
50
40
30
20
10
0
CLOUD OCCURRENCE AT 3 A.M. IN MONTHLY PERCENTAGES
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
1968
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
1969

Figure 20.


OCCURRENCE OF METEOROLOGICAL CONDITIONS
PERCENTAGE OF NIGHTS PER MONTH
RAIN
SNOW
FOG
%
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
J
F
M
A
M
J
J
A
S
O
N
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J
F
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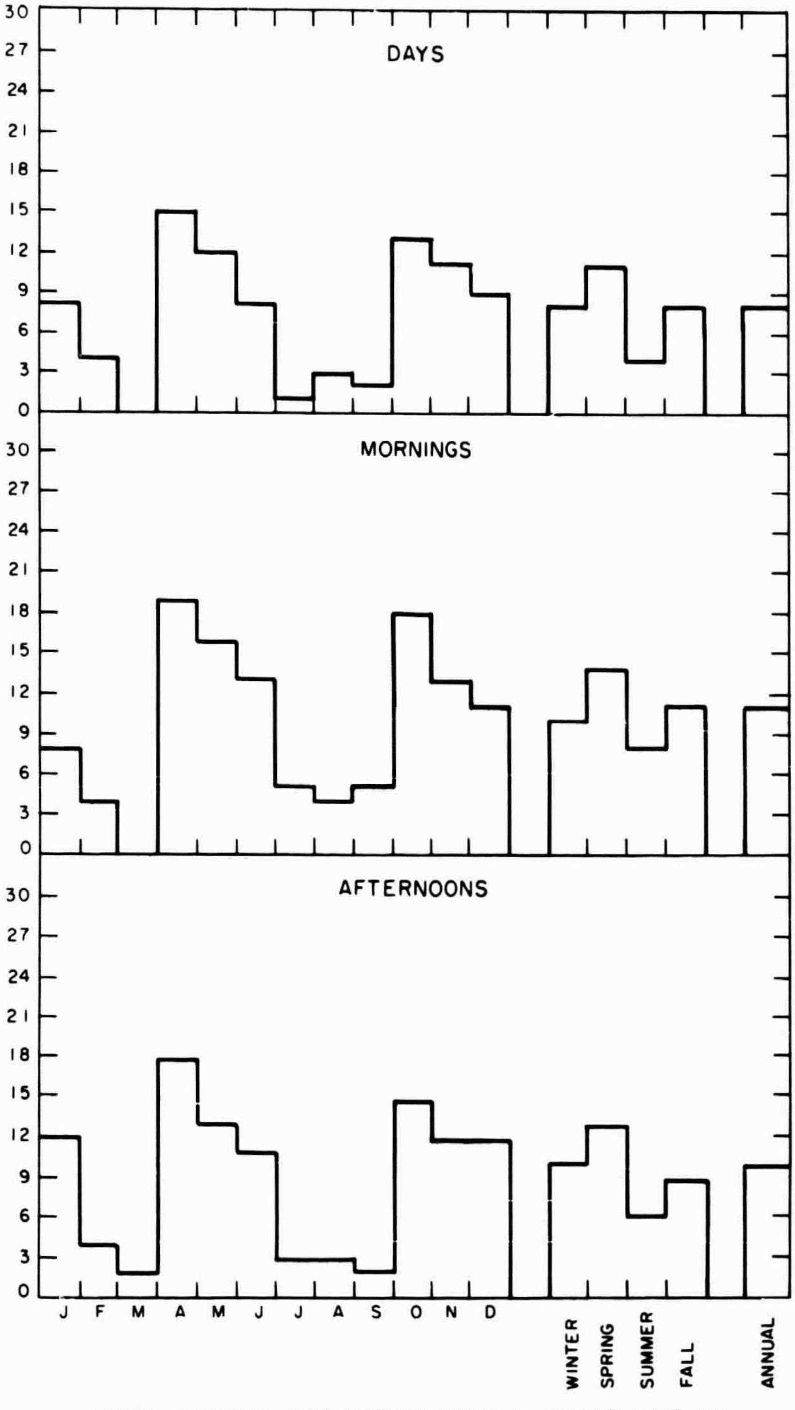
A
M
J
J
A
S
O
N
D
1968
1969

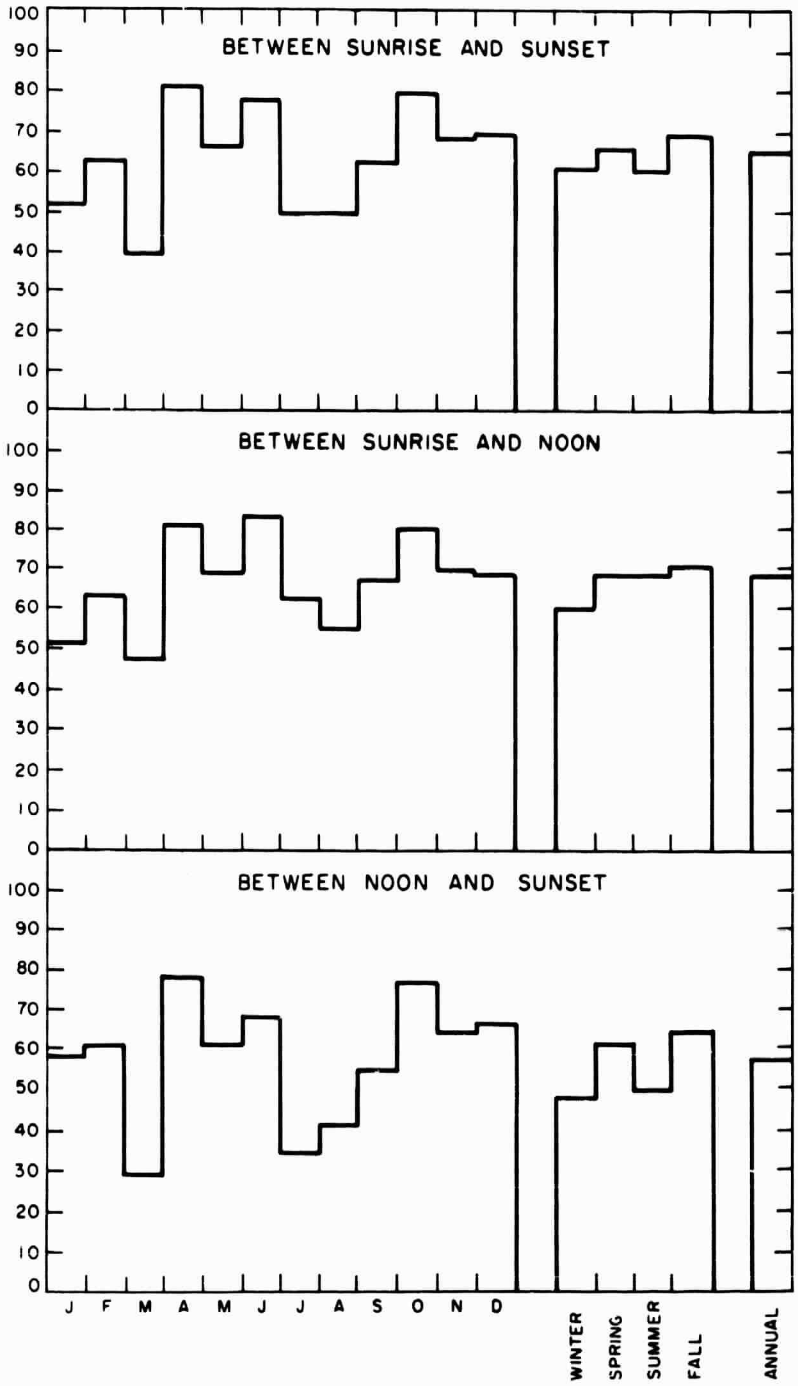
Figure 21.



MEAN NUMBER PER MONTH WITH A CLEAR LINE OF SIGHT TO THE SUN THROUGHOUT ALL DAYLIGHT HOURS

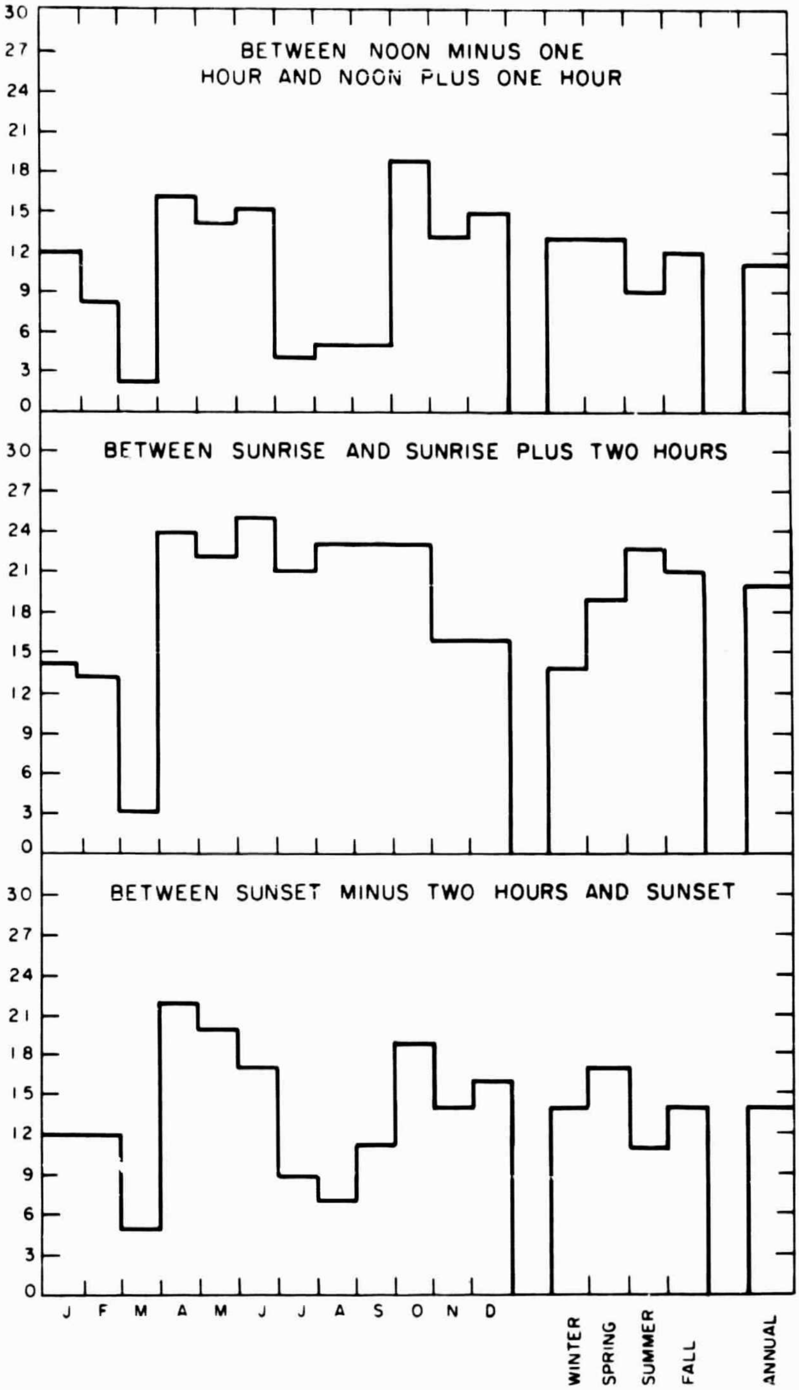
1968

Figure 22.



MEAN PERCENTAGE OF 10-MIN PERIODS WITH
A CLEAR LINE TO THE SUN AT GIVEN PERIODS
1968

Figure 23.



MEAN NUMBER OF DAYS PER MONTH
WITH A CLEAR LINE OF SIGHT TO THE SUN

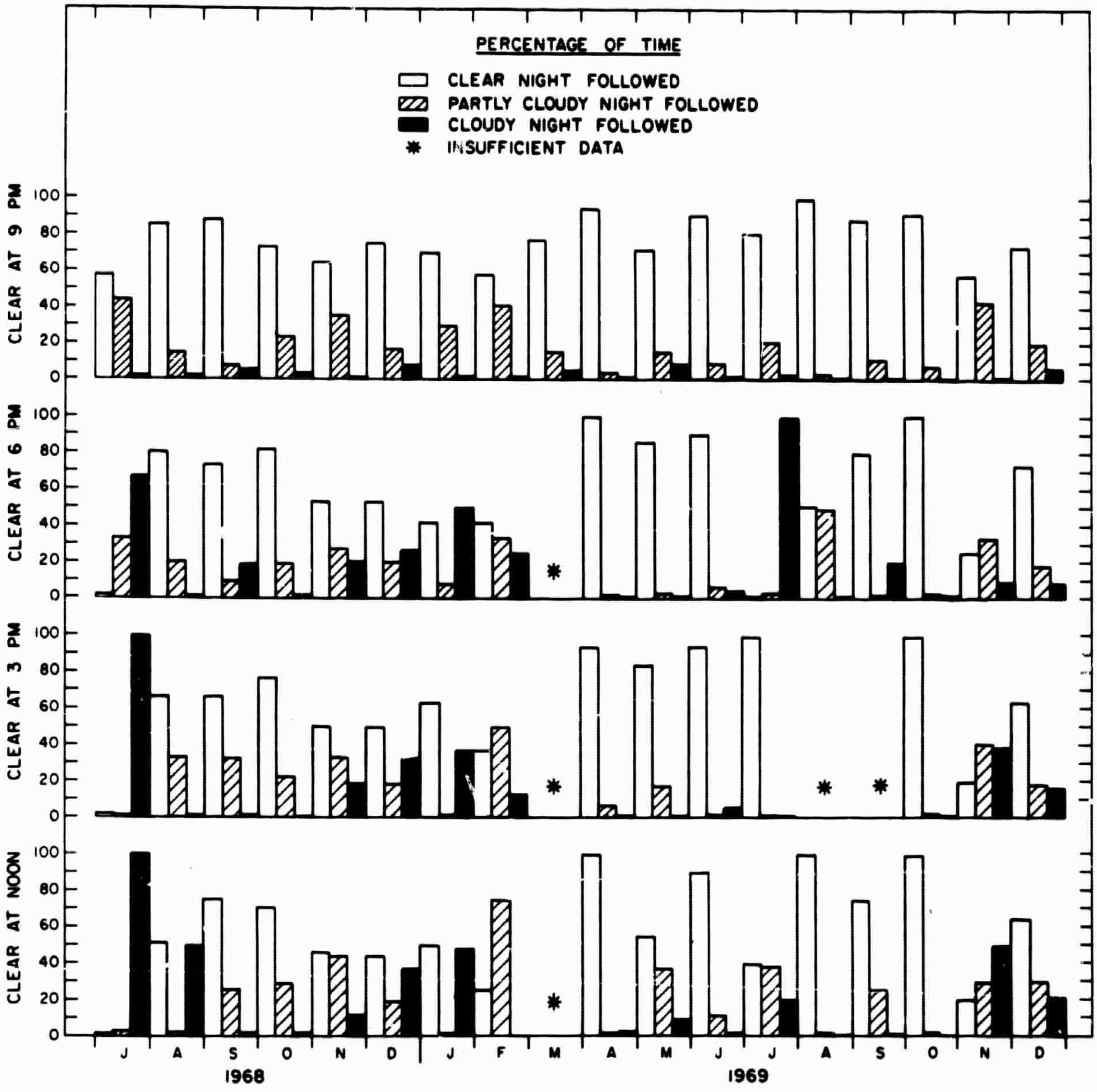
1968

Figure 24.

DURATION OF PERIODS OF A CLEAR LINE OF SIGHT TO THE SUN	J	F	M	A	M	J	J	A	S	O	N	D	WINTER	SPRING	SUMMER	FALL	ANNUAL
10 MIN	7	1	13	11	7	22	32	34	45	27	15	6	14	31	88	87	220
20 MIN	4	3	5	6	6	12	12	12	23	13	6	4	11	17	36	42	106
30 MIN	7	1	6	3	6	4	5	12	14	9	3	4	12	15	21	26	74
40 MIN	3	5	4	2	6	7	4	4	13	4	2	5	13	12	15	19	59
50 MIN	1	1	3	0	0	3	7	4	3	5	5	2	4	3	14	13	34
01:00 TO 01:50	7	5	9	4	7	14	15	14	22	18	8	6	18	20	43	48	129
02:00 TO 02:50	4	2	3	2	1	4	10	9	10	7	1	2	8	6	23	18	55
03:00 TO 03:50	2	1	3	2	6	8	7	6	6	5	2	2	5	11	21	13	50
04:00 TO 05:50	3	3	2	7	4	7	4	4	14	6	1	3	9	13	15	21	58
06:00 TO 07:50	2	0	1	3	4	6	5	0	1	4	6	1	3	8	11	11	33
08:00 TO 09:50	7	0	0	0	1	4	1	1	1	0	4	9	16	1	6	5	28
NUMBER OF DAYS WITH USEFUL DATA	29	7	13	22	30	30	27	23	30	31	30	29	65	65	80	91	301

FREQUENCY OF OCCURRENCE OF A CLEAR LINE OF SIGHT TO THE SUN FOR PERIODS OF SPECIFIED DURATIONS
OCT 1967 - SEP 1968

Figure 25.



CORRELATION OF NIGHTTIME SKY CONDITIONS WITH OBSERVED CLEAR DURING THE PRECEDING DAY AT TIMES SHOWN

Figure 26.

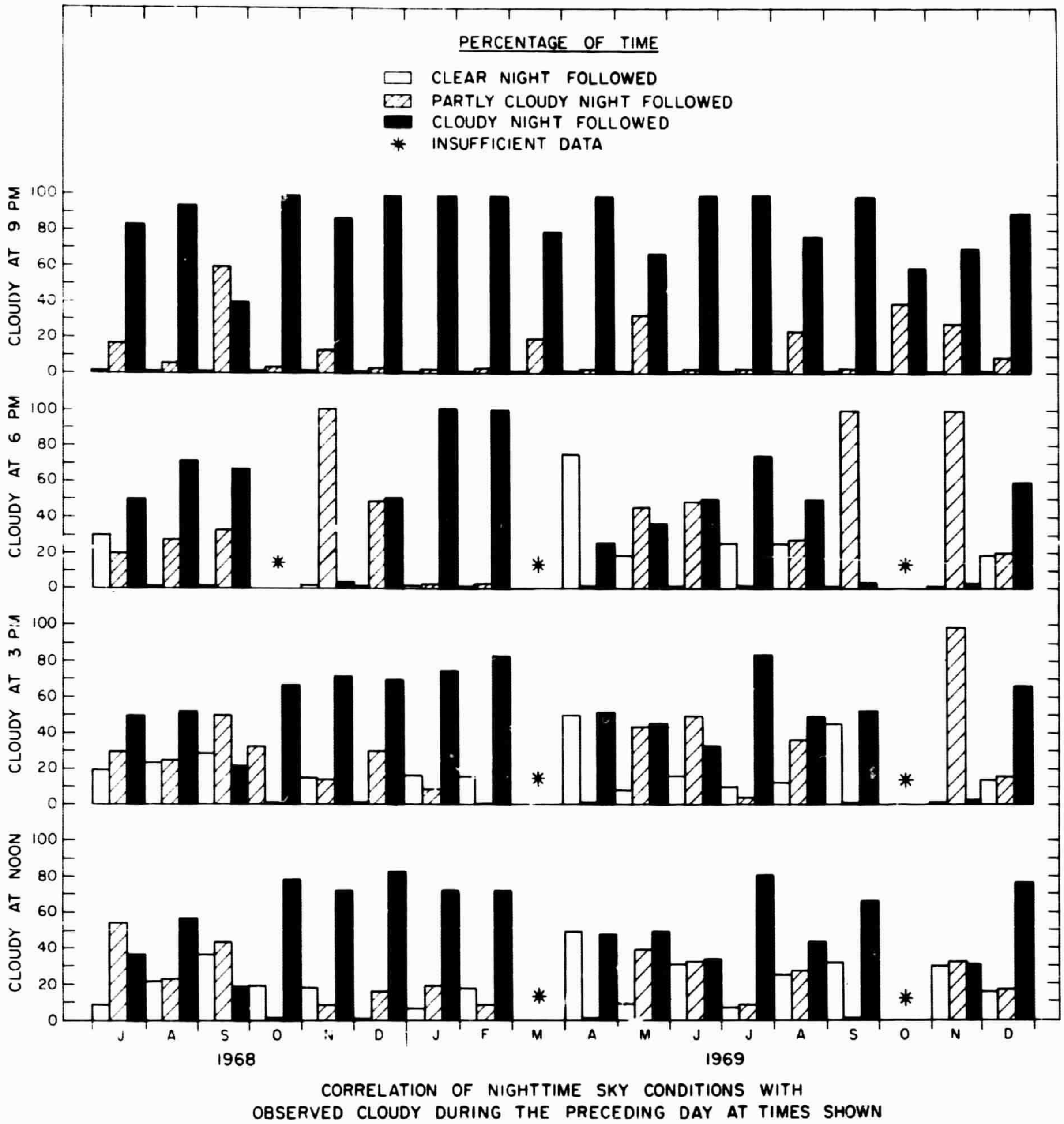

PERCENTAGE OF TIME
CLEAR NIGHT FOLLOWED
PARTLY CLOUDY NIGHT FOLLOWED
CLOUDY NIGHT FOLLOWED
* INSUFFICIENT DATA
CLOUDY AT 9 PM
CLOUDY AT 6 PM
CLOUDY AT 3 PM
CLOUDY AT NOON
0
20
40
60
80
100
J
A
S
O
N
D
J
F
M
A
M
J
J
A
S
O
N
D
1968
1969
CORRELATION OF NIGHTTIME SKY CONDITIONS WITH
OBSERVED CLOUDY DURING THE PRECEDING DAY AT TIMES SHOWN

Figure 27.

BIOGRAPHICAL NOTES

MICHAEL R. PEARLMAN received his B.S. in physics from the Massachusetts Institute of Technology in 1963 and his Ph.D. in physics from Tufts University in 1968.

Since joining the staff of Smithsonian Astrophysical Observatory in 1968, Dr. Pearlman has been a scientist in the Satellite Geophysics Group. He is currently working on laser satellite tracking and atmospheric investigations.

DONALD HOGAN received a B.S. degree in navigation from the Massachusetts Maritime Academy in 1957 and has attended Boston University, the University of New Mexico, and Pima Junior College, in Tucson.

Before joining Smithsonian Astrophysical Observatory in 1963, he was Operations Officer in communications and electronics in the Navy. After being on the observing staff at SAO field stations in New Mexico and Iran, Mr. Hogan transferred to Mt. Hopkins in 1967, where is is currently Manager of the Observer Services Division.

WERNER KIRCHHOFF received his B.S. in engineering from the University of Witwaterwand, South Africa, in 1956.

He became associated with the Smithsonian Astrophysical Observatory in 1958 as an honorary observer for the International Geophysical Year and joined the Observatory staff as an observer in 1959. In 1964 to 1965 he served as the Observatory's representative to the USAF's Oslo, Norway, Baker-Nunn station. In 1966 he was transferred to Observatory headquarters in Cambridge, Massachusetts, to assume the position of special technical advisor for the Southwest Observatory Project.

KENNETH GOODWIN received an Associates Degree in electrical engineering in 1962 from New York State University and has attended New Mexico State University.

Mr. Goodwin joined Smithsonian Astrophysical Observatory in 1962 and has been an observer and EECo timing specialist at SAO field stations in New Mexico, Spain, and Arizona. He has also been a laser leader and has worked on Project Scanner.

At present, Mr. Goodwin is in the Observer Services Division at Mt. Hopkins.

DeWAYNE KURTENBACH received a B. S. degree in mathematics and electronics from Southern State College in Springfield, South Dakota, in 1961. He has also attended the University of Arizona and Pima Junior College in Tucson.

Before coming to the Smithsonian Astrophysical Observatory in 1969, he taught mathematics and electronics at the high-school level.

Mr. Kurtenbach is currently working for the Observer Services Division at Mt. Hopkins.

STEPHEN ROCKETTO received his B. A. degree in philosophy from Boston University in 1966 and has attended New Mexico State University and the University of Arizona.

Since joining the staff of the Smithsonian Astrophysical Observatory in 1966, Mr. Rocketto has worked at field stations in Organ Pass, Arequipa, Woomera, and Mt. Hopkins as an observer and timing specialist.

He is currently working on the Barium-Ion Cloud Experiment at Wallops Island.

BASTIAAN VAN'T SANT received a Technical Diploma in Electronics from the Royal Dutch Air Force and has had four years of advanced education in electronics.

Before Mr. Van't Sant joined the Smithsonian Astrophysical Observatory staff, he was in the Dutch Royal Navy and worked for Philips Gloeilampen Fabrieken in Holland and the Council for Scientific and Industrial Research in South Africa.

Since 1960, he has been a timing specialist at Smithsonian Astrophysical Observatory sites in South Africa, Iran, and Ethiopia. He was transferred to the Observer Services Division at Mt. Hopkins in 1970.