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# THE WIND REGIME IN THE FIRST 62 METERS OF THE ATMOSPHERE

By  
FRANK V. HANSEN  
and  
VIRGIL D. LANG

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|--|------------|----|----|
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**ATMOSPHERIC SCIENCES LABORATORY**  
WHITE SANDS MISSILE RANGE, NEW MEXICO

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THE WIND REGIME IN THE FIRST 62  
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ECOM - 5058

June 1966

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#### ACKNOWLEDGEMENT

The authors wish to acknowledge the indispensable assistance of Miss Van Dyke Neill whose programming skill made this work possible.

### ABSTRACT

Wind regime data in the form of wind roses and frequency of occurrence for nine tower levels by the month and diurnal classification are presented. Results indicate that terrain features in the vicinity of the White Sands Meteorological Research Tower exhibit a modifying effect on the diurnal and seasonal wind regime. It was also found that seasonal variations were in the form of a three season regime system rather than the expected four.

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## INTRODUCTION

In 1958 a program was initiated to obtain wind and temperature data for climatological purposes as well as to determine the turbulent characteristics of the lower atmosphere in the vicinity of the Atmospheric Sciences Laboratory's Meteorological Research Tower (Rachele and McClardie, 1957). The data collection program lasted twenty-five months, terminating in April 1960. The climatological aspects of these data were partially analyzed by Carnes (1961) and by Hansen and Neill (1964). The turbulent characteristics of the locale were reviewed by Tourin and Hoidale (1962), Hansen (1963), and Swanson and Cramer (1965). Wind profile prediction techniques were tentatively established using these data by Helvey, Traylor and McClardie (1959), Helvey (1960a, 1960b) and Swanson and Hoidale (1962).

The purpose of this report is to present additional climatological statistics based upon the 25-month data sample. The current presentation is in the form of wind roses for all nine tower levels and percent frequency of occurrence of prevailing wind from the four cardinal and twelve ordinal points of the compass.

## DATA ANALYSIS

The 25-month data sample was analyzed utilizing high speed computer techniques with respect to occurrence of prevailing wind direction in five class intervals of wind speed.

The analysis provided monthly summaries of the data for 16 points of the compass for three diurnal classifications (1) daily summary; (2) daylight hours summary; and, (3) nocturnal hours summary. In addition, the percent frequency of occurrence for daylight and nocturnal hours was extracted from the primary computations for each of the sixteen wind directions by month. Wind roses for each tower level by the month and diurnal classification are presented in Figures 1 through 36. Frequency of occurrence for prevailing wind directions is given in Figures 37 to 48.

#### WIND REGIMES AT WHITE SANDS MISSILE RANGE

A perusal of Figures 1-48 reveals that many wind regimes exist in the first 62 meters of the atmosphere at White Sands Missile Range (WSMR). At first glance the flow characteristics appear to be chaotic and extremely complicated. However, order can be made of chaos, if the terrain features of WSMR are considered. The Missile Range is located in part in the Tularosa Basin of south-central New Mexico. The basin is oriented north-south between the Sacramento and San Andres Ranges of the southern Rockies, is approximately 64 km wide, and slopes gently in a northern direction from 1130m MSL at El Paso, Texas, to 1580m MSL at Carrizozo, New Mexico, at its northern extremity.

The research tower is located about 14 km east of the base of the Organ Mountains of the San Andres Range, the western



boundary of WSMR. The terrain surrounding the tower consists of bare sand, patchy vegetation and brush-covered hillocks one to three meters high. During the data collection period under discussion, the tower was instrumented at nine levels from 4.6 to 52 meters above the surface.

The characteristics of the wind profiles derived from tower data can be considered to be a function of the prevailing synoptic situation, the diurnal temperature regime, and the terrain features of the basin. The orientation and slope of the Tularosa Basin, the proximity of a mountain range upstream along the prevailing wind direction, and an extremely rough surface combine to provide many interrelated wind regimes.

From Figures 1 to 48 it can be noted that there are definite diurnal and seasonal trends in the mean flow in the vicinity of the tower. The months of December and January are dominated by downslope flow along the major axis of the basin. February is a transition month for the daylight hours, but exhibits an abrupt onset of nocturnal drainage winds from the Organ mountains as indicated by the large percentage of westerly winds at night. March and April statistics show the predominant strong westerly flow both day and night. May and June are transition months with the mean flow approaching the prevailing summertime southeasterlies. Drainage from the mountains at night is still significant, especially in June.

July and August are dominated by the southeasterlies, while September is a transition month with some northerly flow

during the day and mountain-valley winds appearing again during the nocturnal hours. October is characterized by light southerly winds, while November is a transition period from the summer-fall seasons to the first phase of the winter season.

A seasonal breakdown of the data reveals that winter has two distinct regimes, that of December-January and February. Spring also has two phases, the extremely windy period of March-April and the transition period May-June. Summer and fall can be combined into the same regime as southeasterly flow generally prevails from mid-June through November.

The extremely high percentage of drainage winds during the nocturnal hours is a function of the mountainous terrain immediately to the west of the tower location. The Organ Mountains rise abruptly from the basin floor to a height of 2600 m MSL in a horizontal distance of slightly more than 6.5 km. The differential in the rate of cooling of the mountain slopes and the basin floor results in large density differences which in turn lead to the sometimes intense gravity or mountain-valley winds (Berger, 1870).

The gentle slope of the basin proper provides the same mechanism on a smaller scale during the early winter season.

#### SUMMARY

Wind rose and frequency of occurrence data for a 25-month period have been presented for the first 62 meters of the atmosphere at White Sands Missile Range, New Mexico. The ter-

rain features of the Missile Range are shown to have a significant effect upon the mean flow characteristics such that downslope flow is a predominant characteristic of the nocturnal hours. Seasonal regimes dominate the daytime flow with essentially a three-season year: winter, spring, and a combined summer-fall situation.

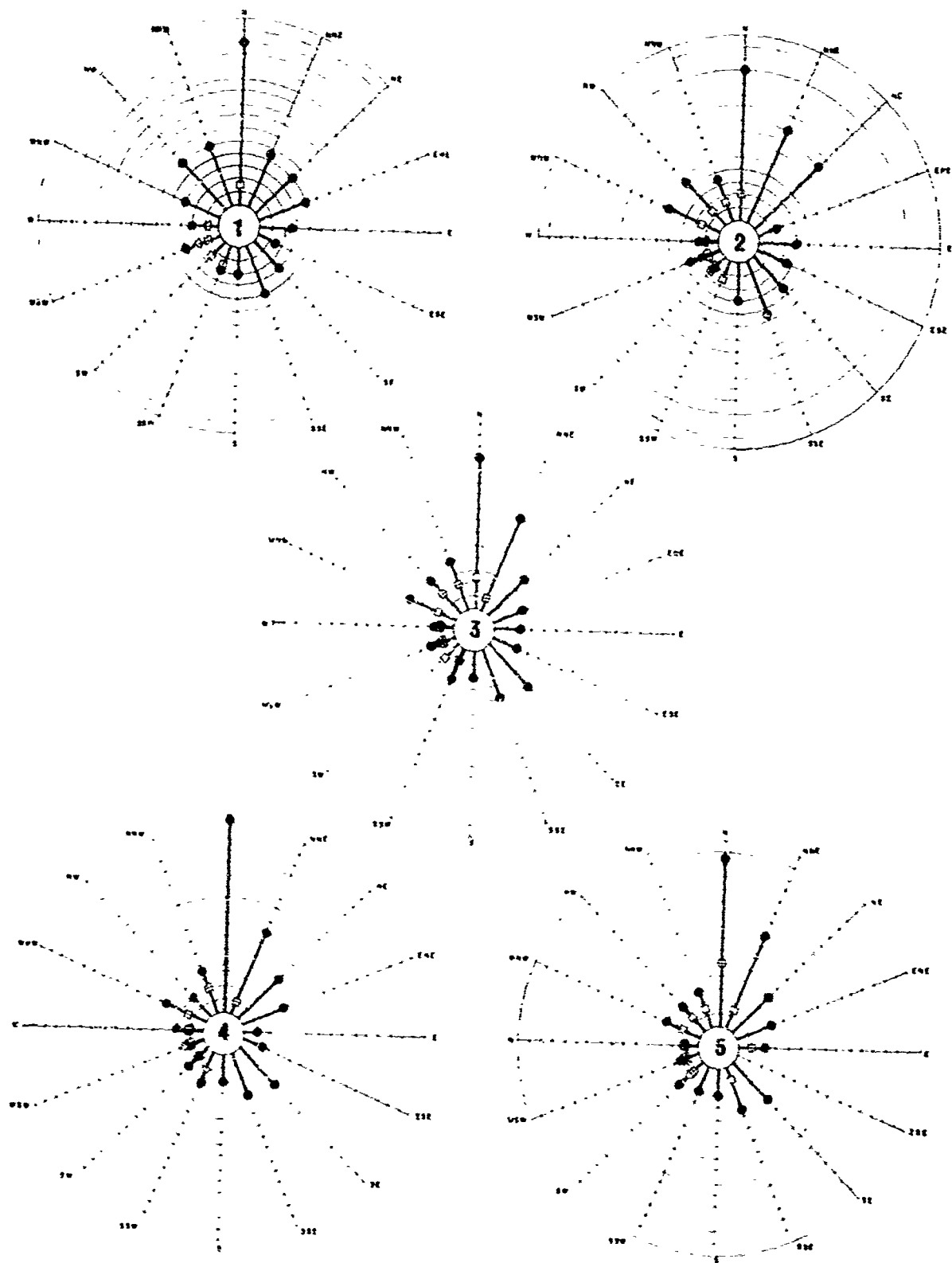


FIGURE 1 : WIND ROSES (24 HOUR) FOR JANUARY

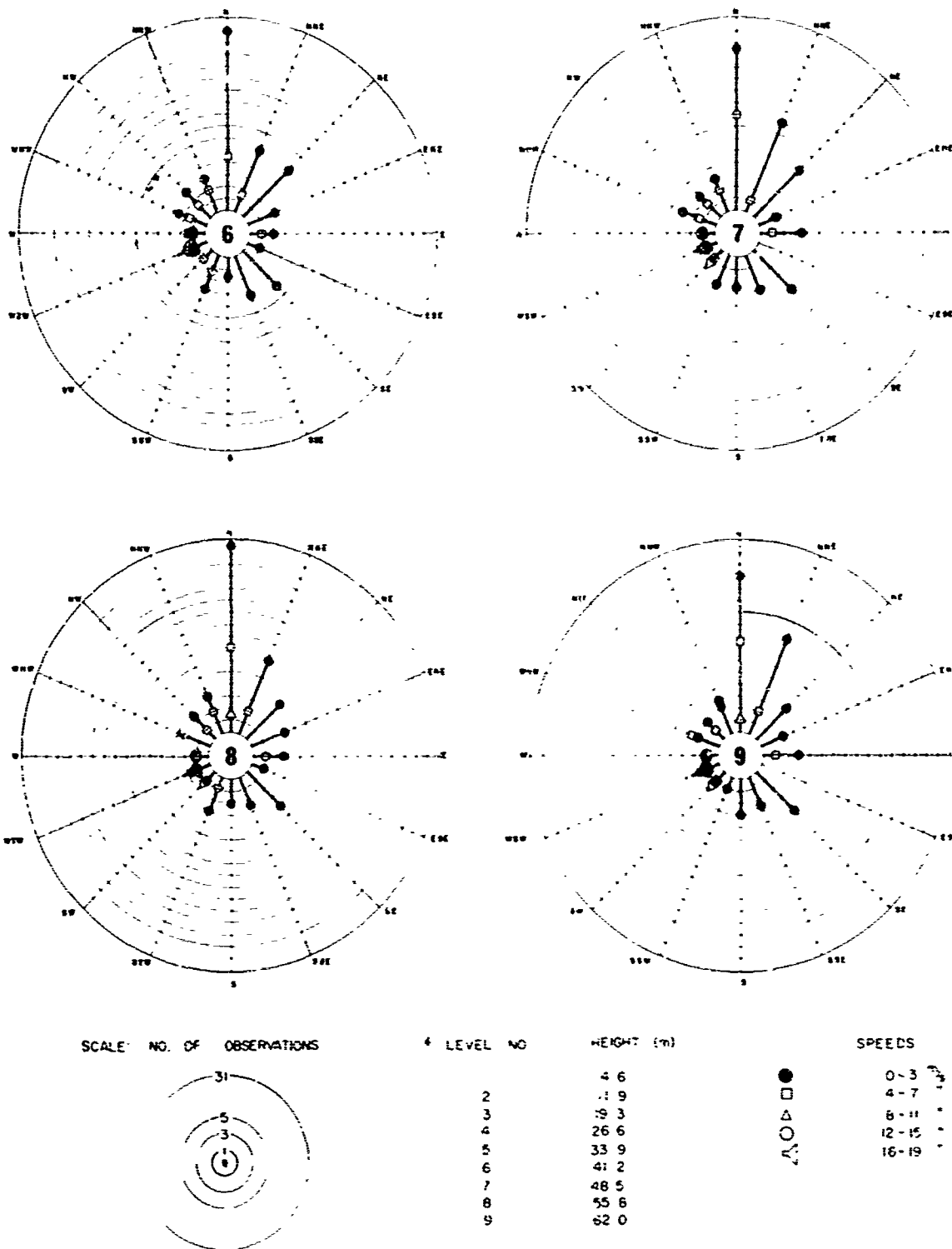


FIGURE 1 (CONT.): WIND ROSES (24 HOUR) FOR JANUARY

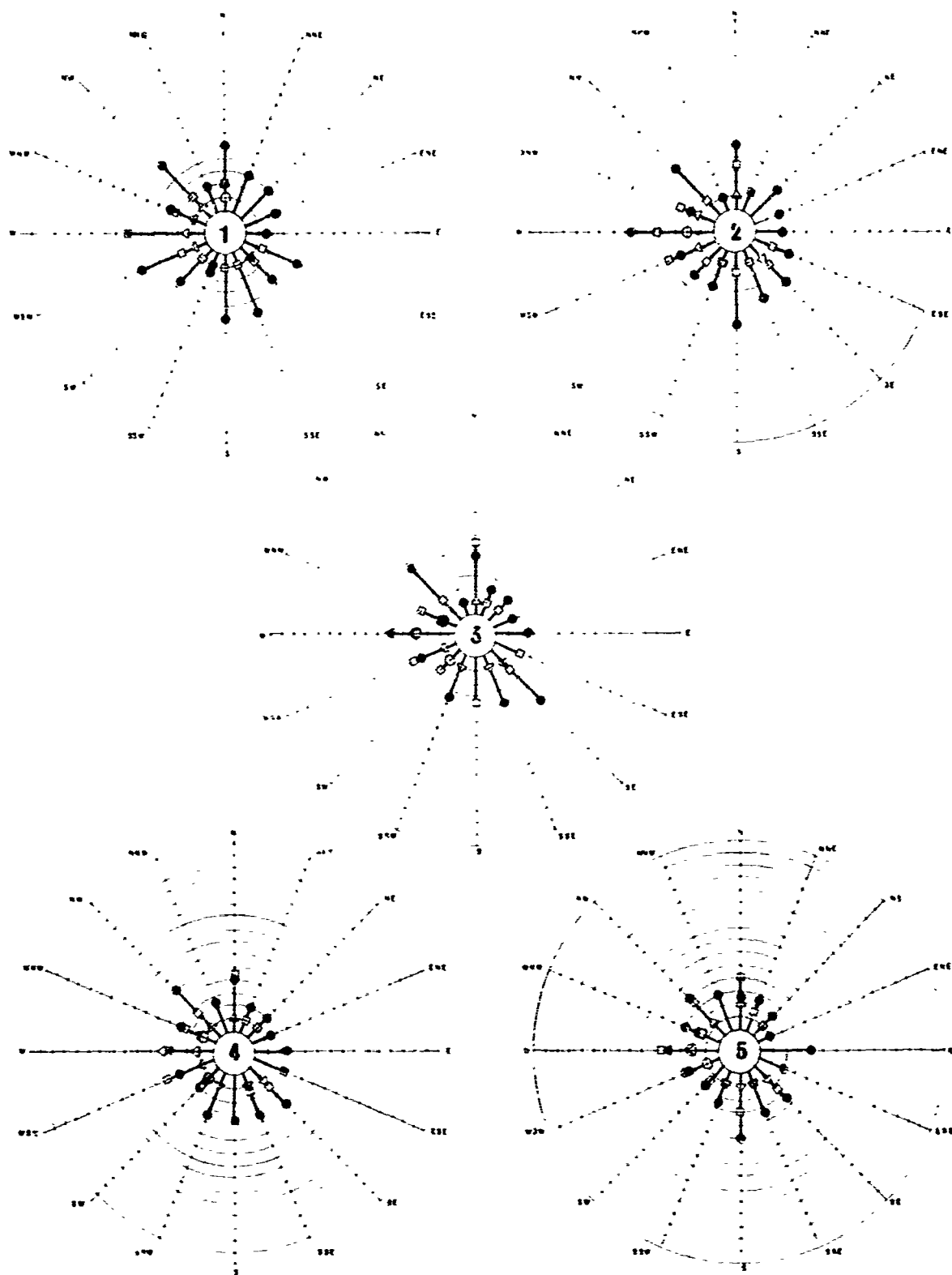
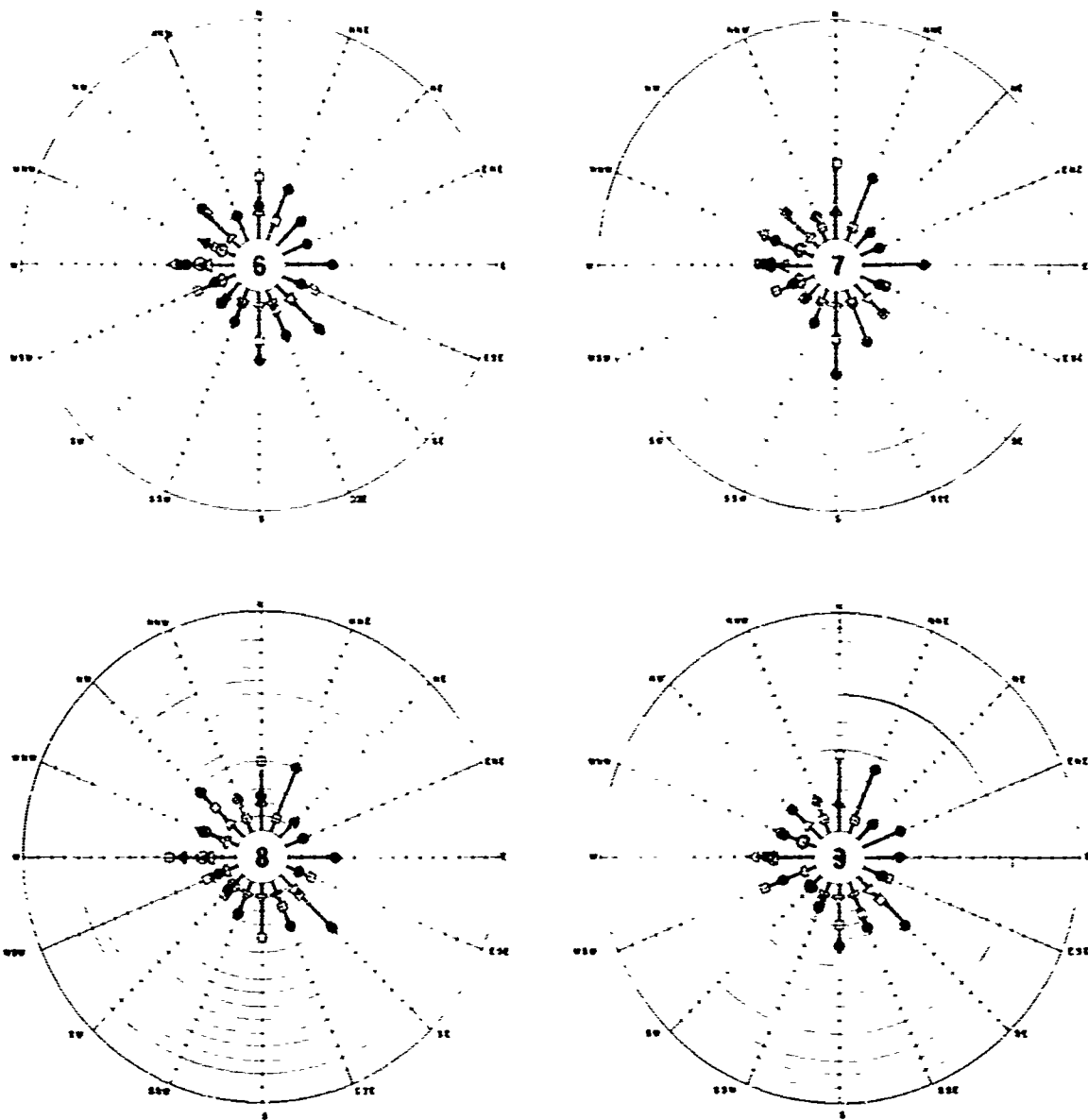
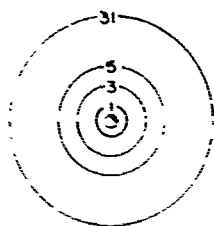


FIGURE 2: WIND ROSES (24 HOUR) FOR FEBRUARY



SCALE NO. OF OBSERVATIONS



LEVEL NO

1  
2  
3  
4  
5  
6  
7  
8  
9

HEIGHT (m)

4.6  
11.9  
19.3  
26.6  
33.9  
41.2  
48.5  
55.8  
62.0

SPEEDS

● 0-3 m/s  
○ 4-7 m/s  
△ 8-11 m/s  
▽ 12-15 m/s  
◇ 16-19 m/s

FIGURE 2 (CONT.): WIND ROSES (24 HOUR) FOR FEBRUARY

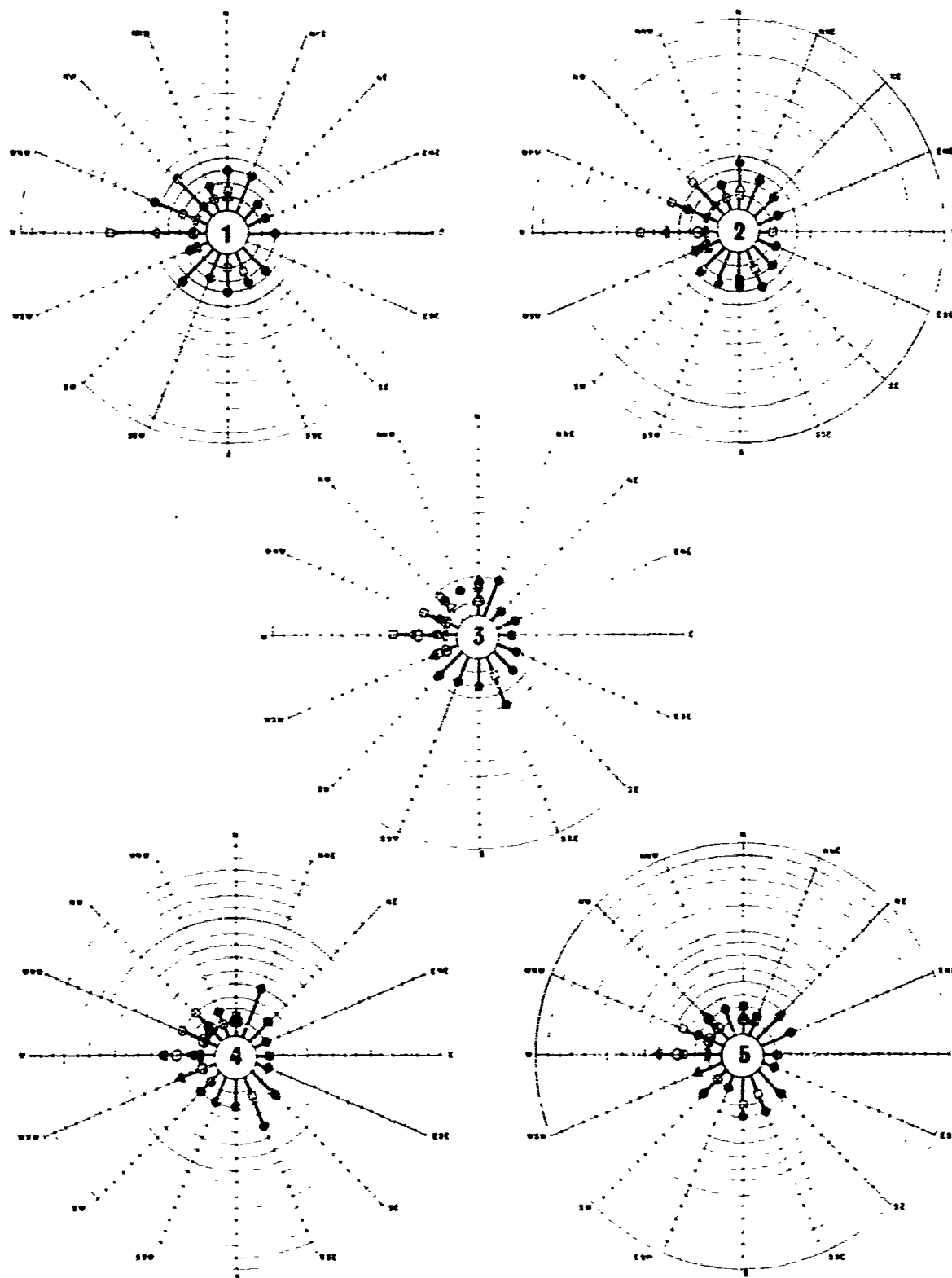
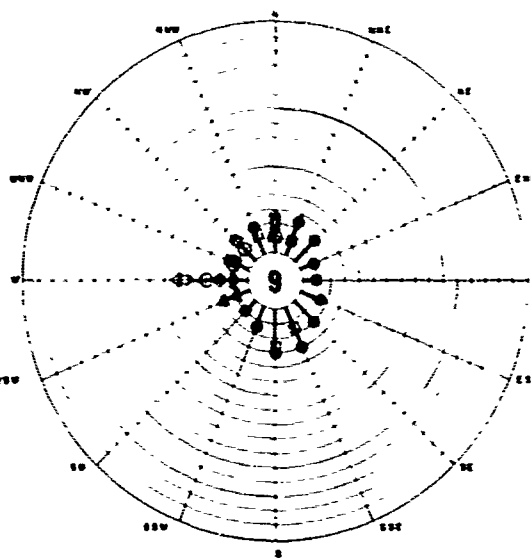
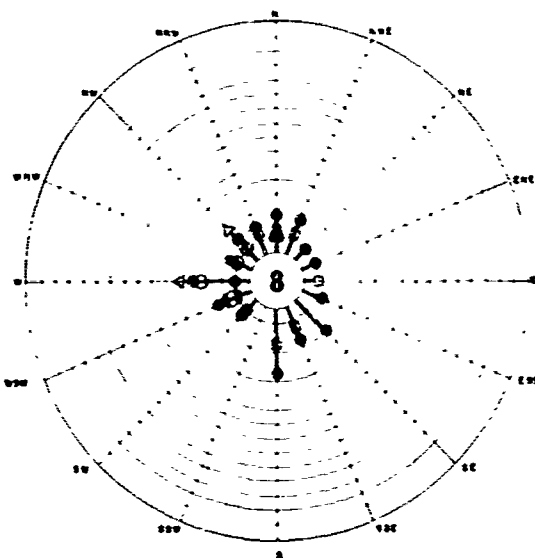
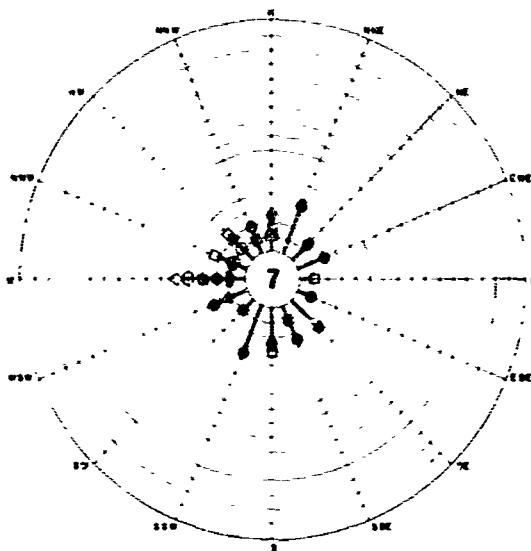
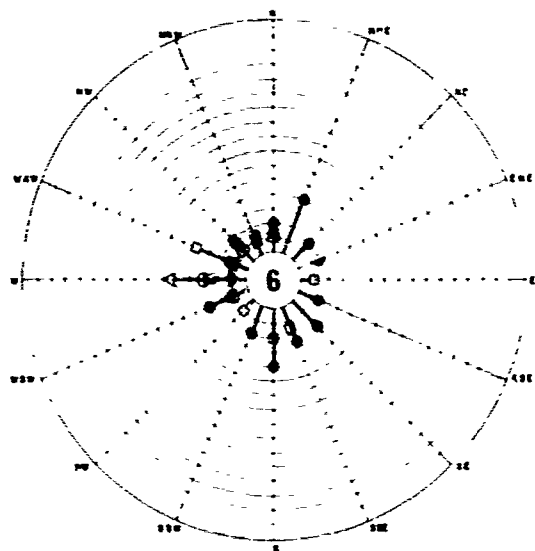
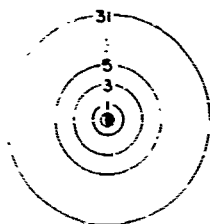


FIGURE 3: WIND ROSES (24 HOUR) FOR MARCH





SCALE NO. OF OBSERVATIONS



LEVEL NO

1  
2  
3  
4  
5  
6  
7  
8  
9

HEIGHT (m)

4.6  
11.9  
19.3  
26.6  
33.9  
41.2  
48.5  
55.9  
62.0

SPEEDS



0-3  
4-7  
8-11  
12-15  
16-19  
20-23

FIGURE 3 (CONT.): WIND ROSES (24 HOUR) FOR MARCH

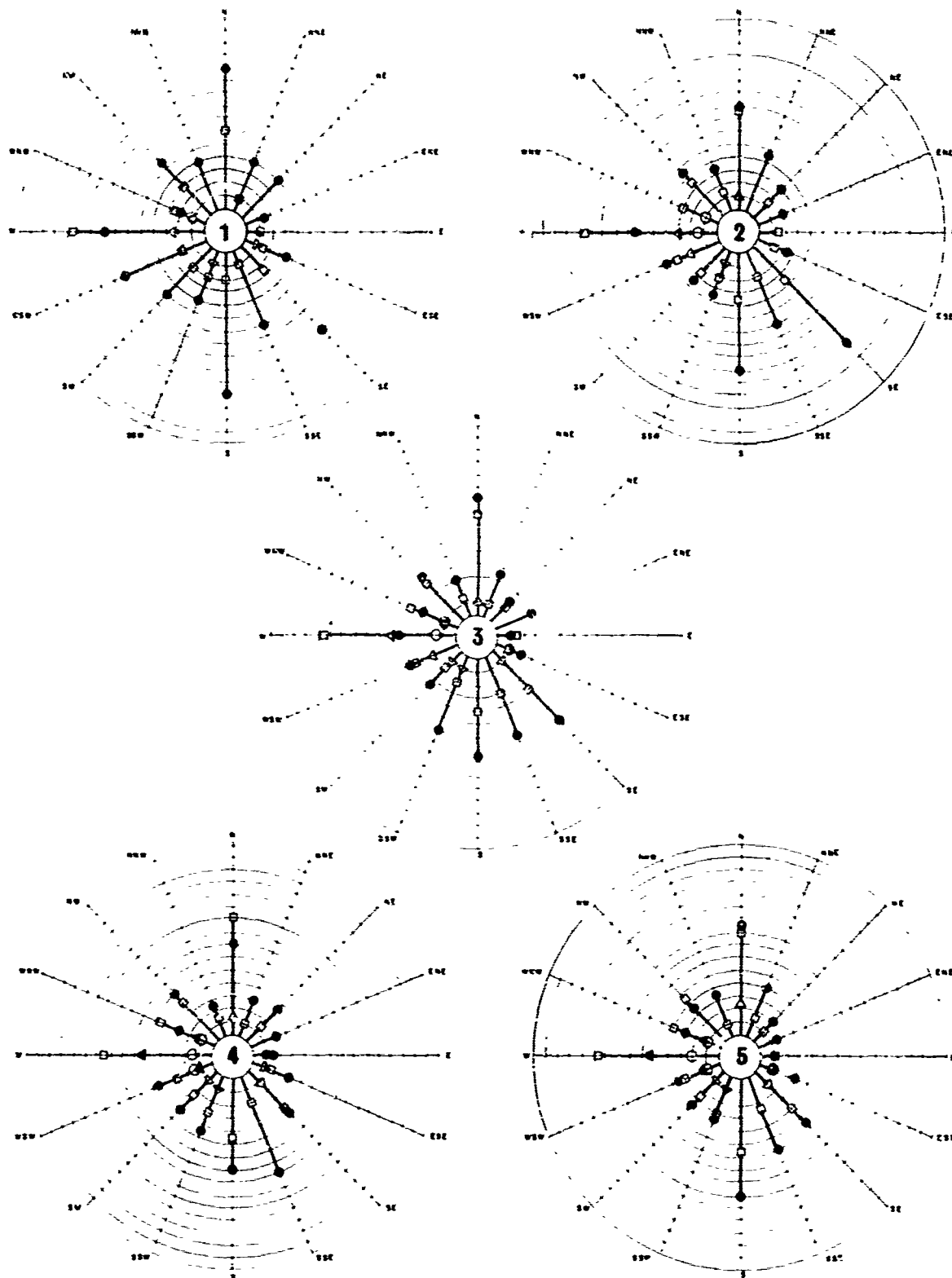
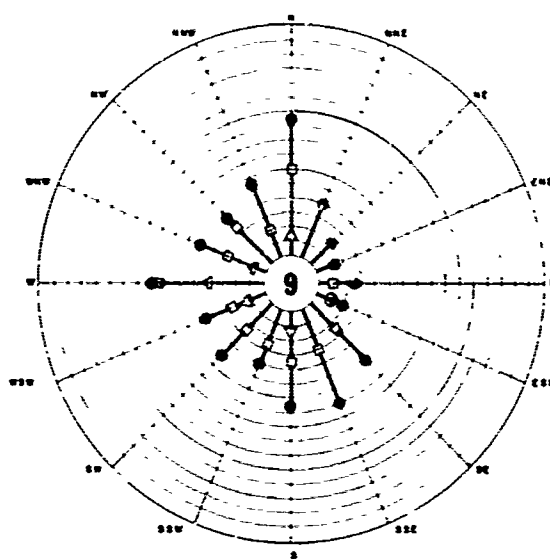
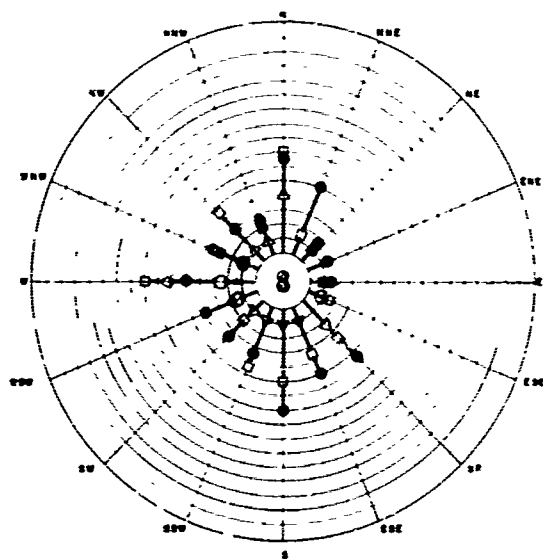
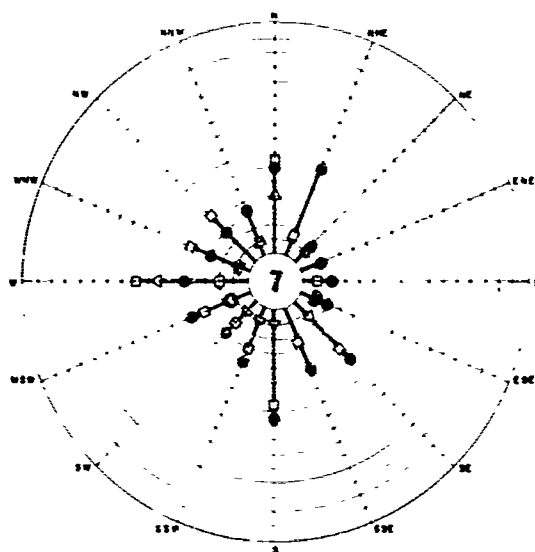
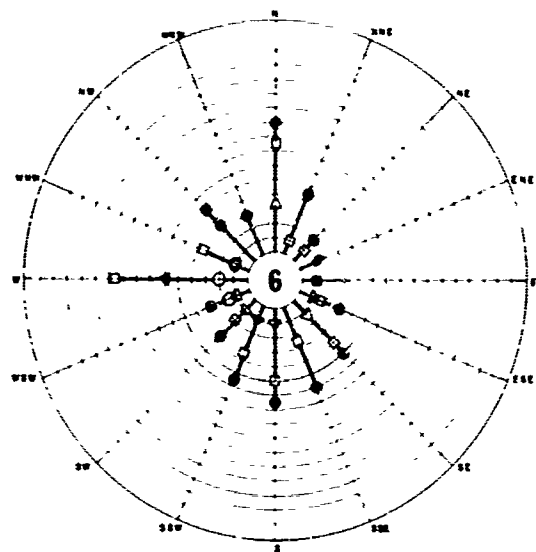
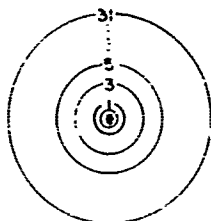


FIGURE 4: WIND ROSES (24 HOUR) FOR APRIL



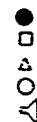
SCALE: NO. OF OBSERVATIONS



LEVEL NO

|   |      |
|---|------|
| 1 | 4 6  |
| 2 | 11 9 |
| 3 | 19 3 |
| 4 | 26 6 |
| 5 | 33 9 |
| 6 | 41 2 |
| 7 | 48 5 |
| 8 | 55 8 |
| 9 | 62 0 |

HEIGHT (m)



SPEEDS

|       |     |
|-------|-----|
| 0-3   | m/s |
| 4-7   | "   |
| 8-11  | "   |
| 12-15 | "   |
| 16-19 | "   |

FIGURE 4 (CONT.): WIND ROSES (24 HOUR) FOR APRIL

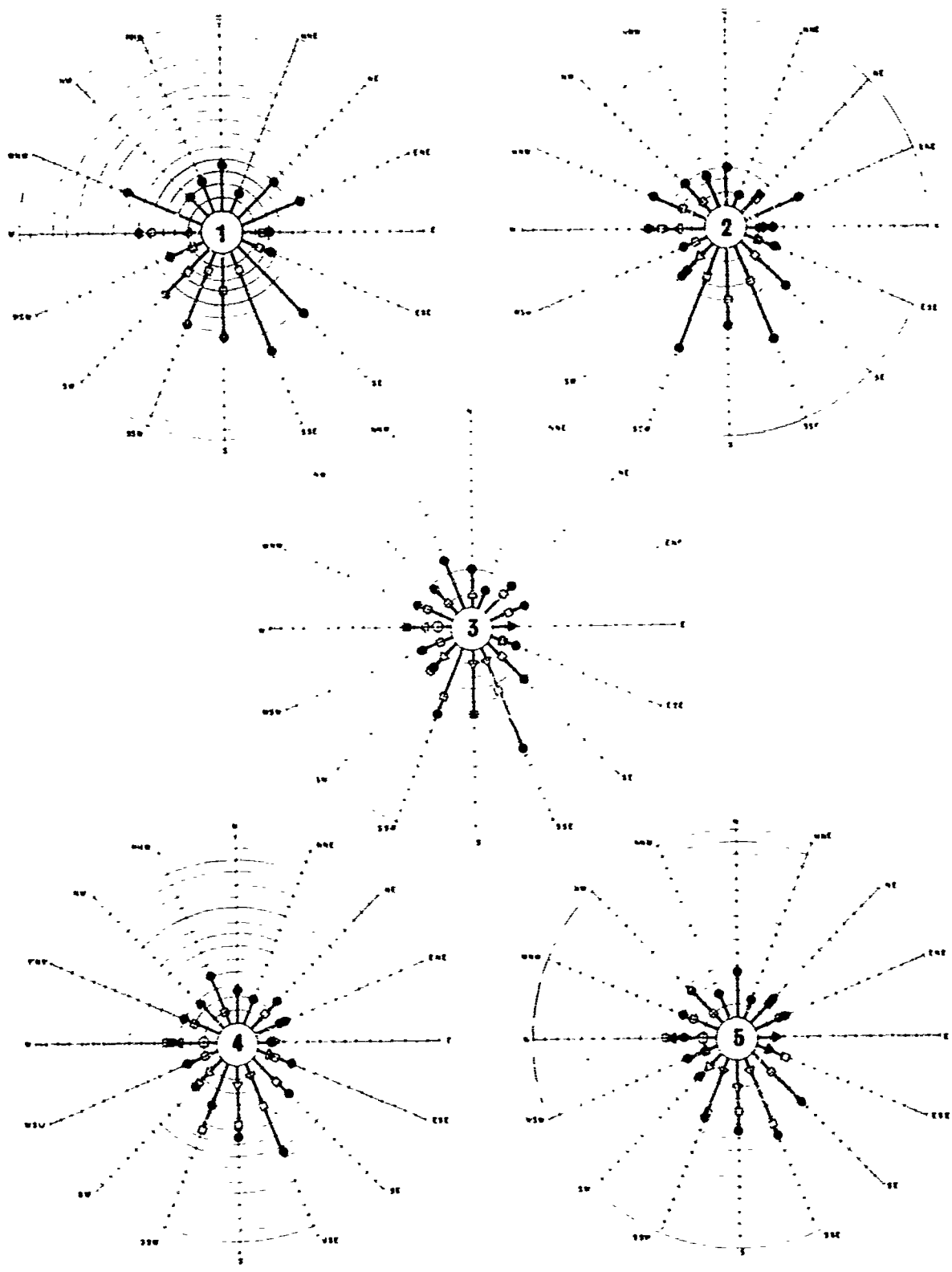
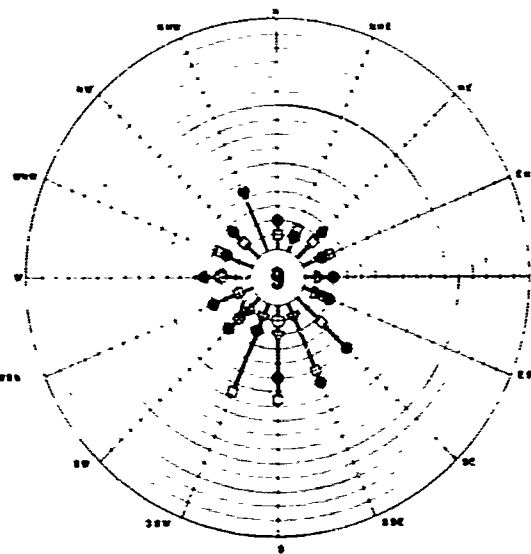
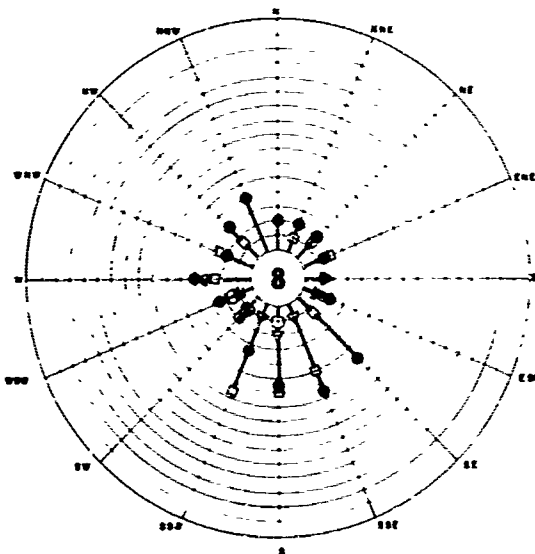
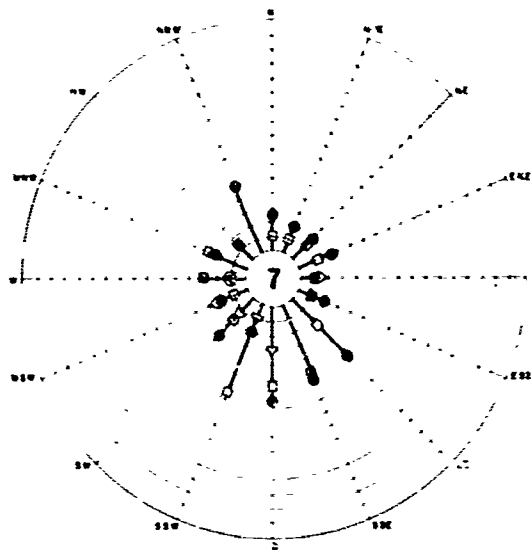
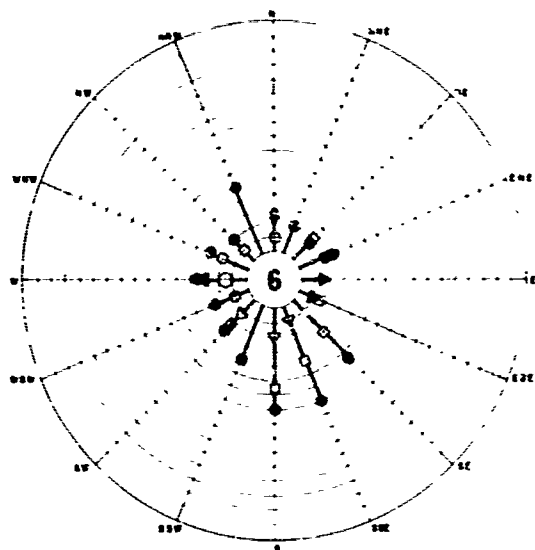
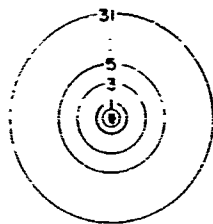


FIGURE 5: WIND ROSES (24 HOUR) FOR MAY



SCALE: NO. OF OBSERVATIONS



LEVEL NO

1  
2  
3  
4  
5  
6  
7  
8  
9

HEIGHT (m)

4 6  
11 9  
19 3  
26 6  
33 9  
41 2  
48 5  
55 8  
62 0

SPEEDS

●  
○  
□  
△

0-3 m/s  
4-7 m/s  
8-11 m/s  
12-15 m/s  
16-19 m/s

FIGURE 5 (CONT.): WIND ROSES (24 HOUR) FOR MAY

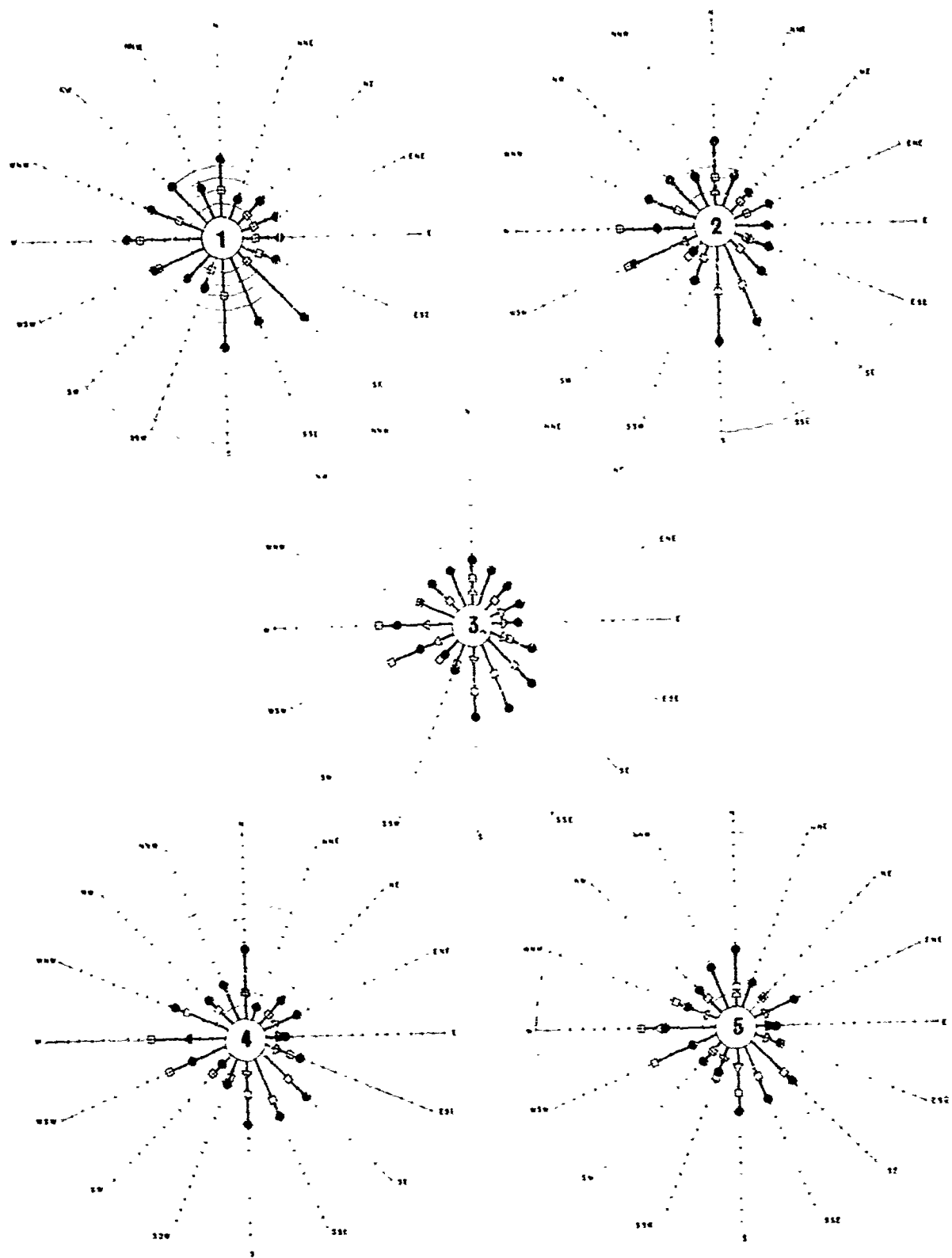


FIGURE 6: WIND ROSES (24 HOUR) FOR JUNE

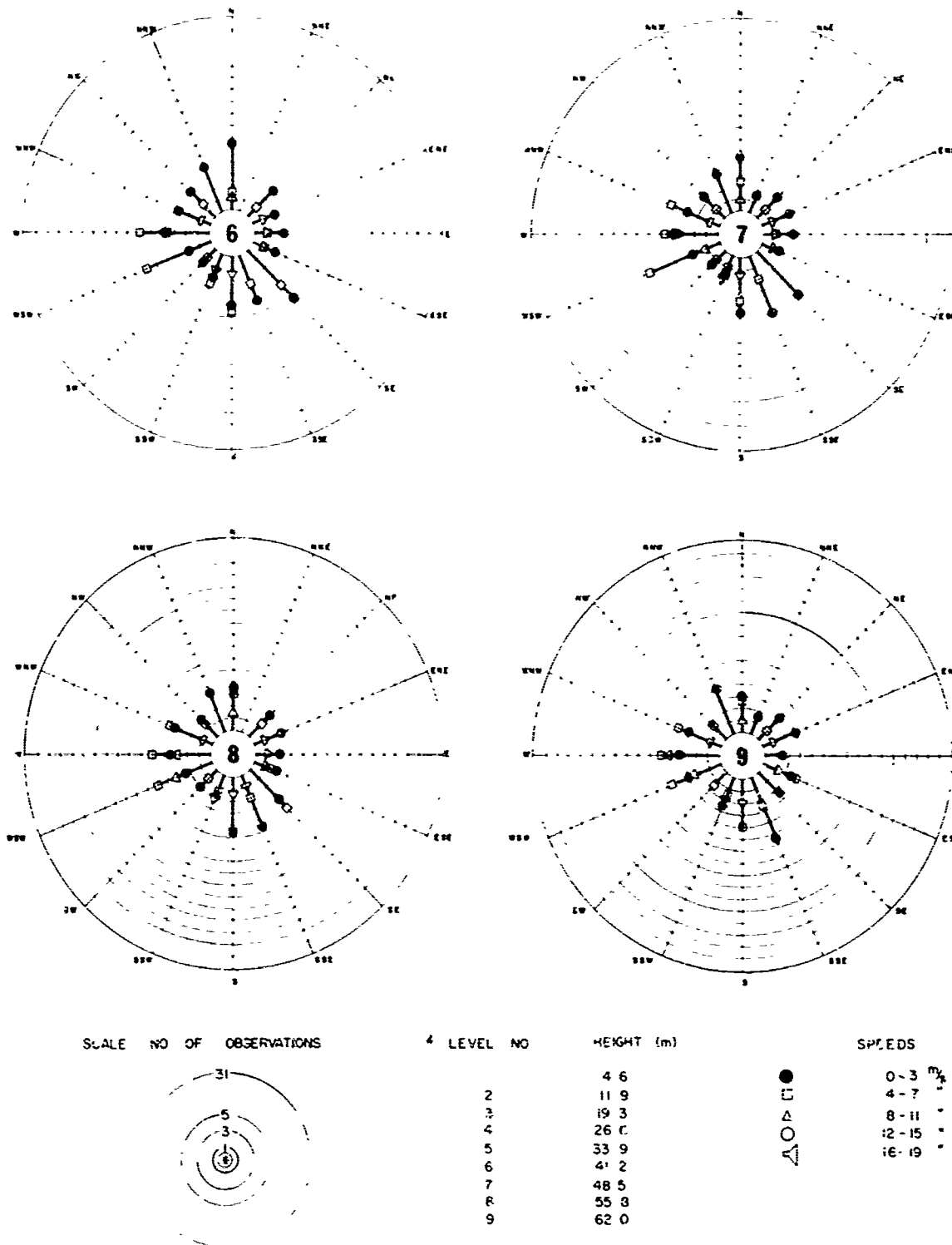


FIGURE 6 (CONT.): WIND ROSES (24 HOUR) FOR JUNE

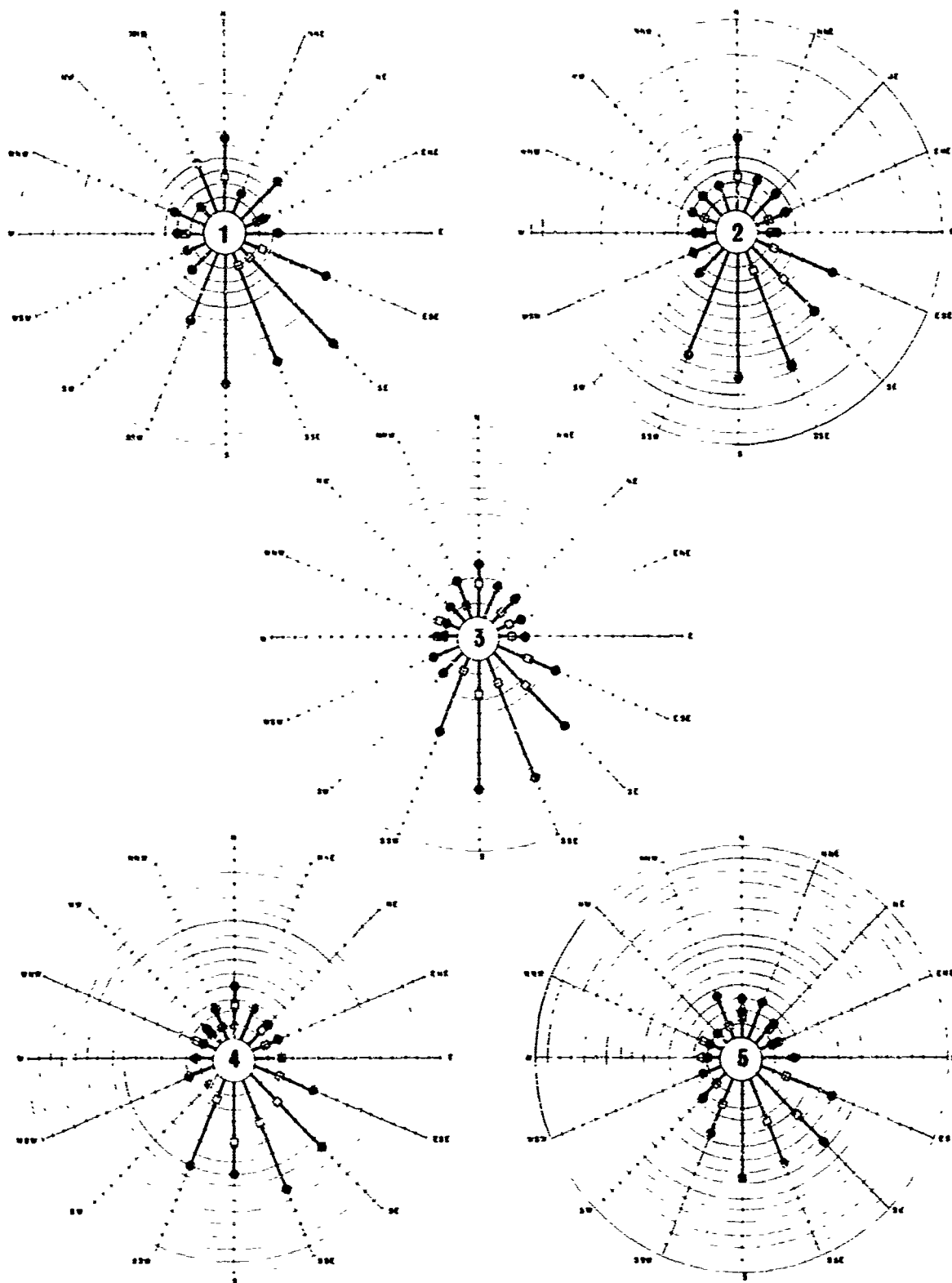


FIGURE 7: WIND ROSES (24 HOUR) FOR JULY



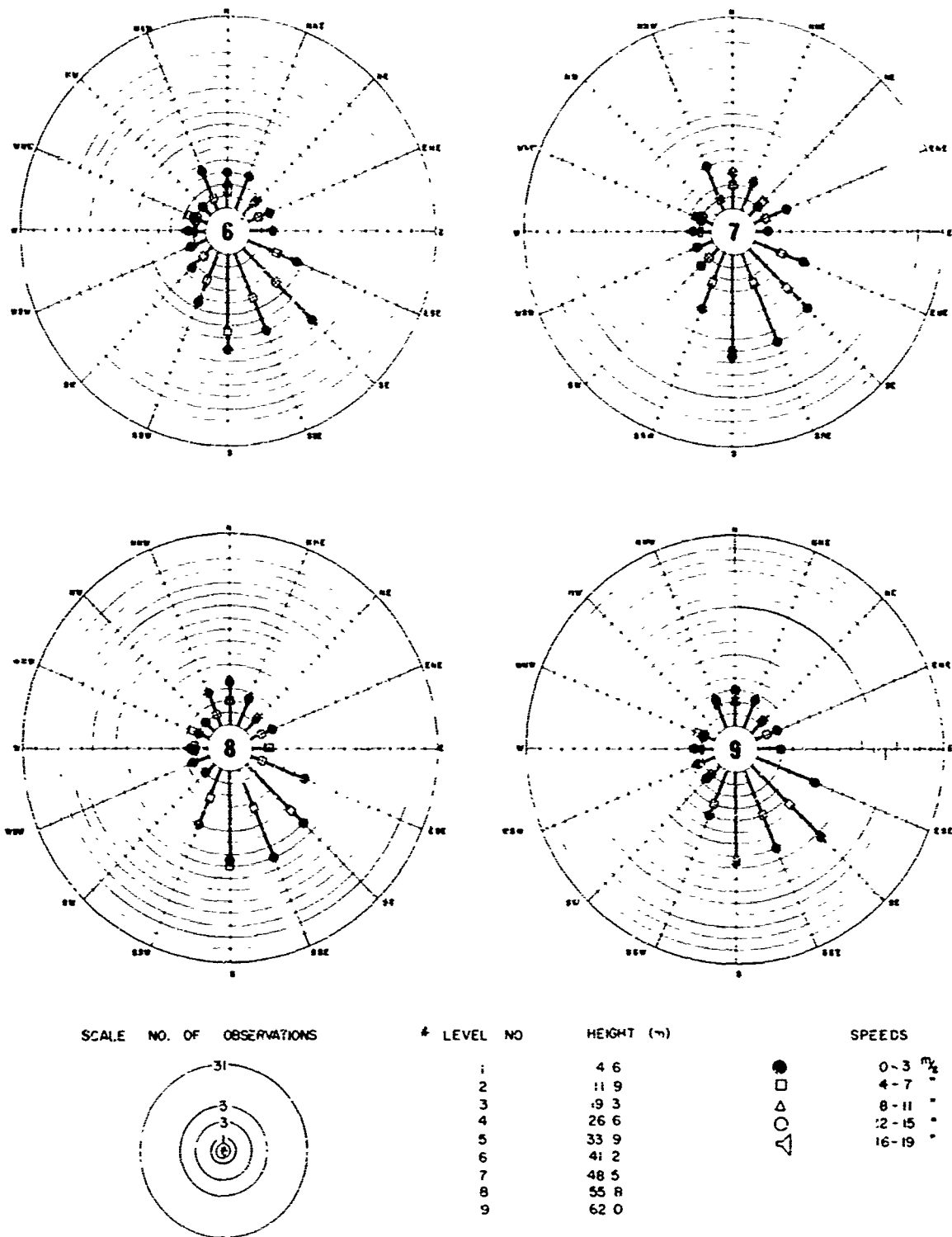


FIGURE 7 (CONT.): WIND ROSES (24 HOUR) FOR JULY

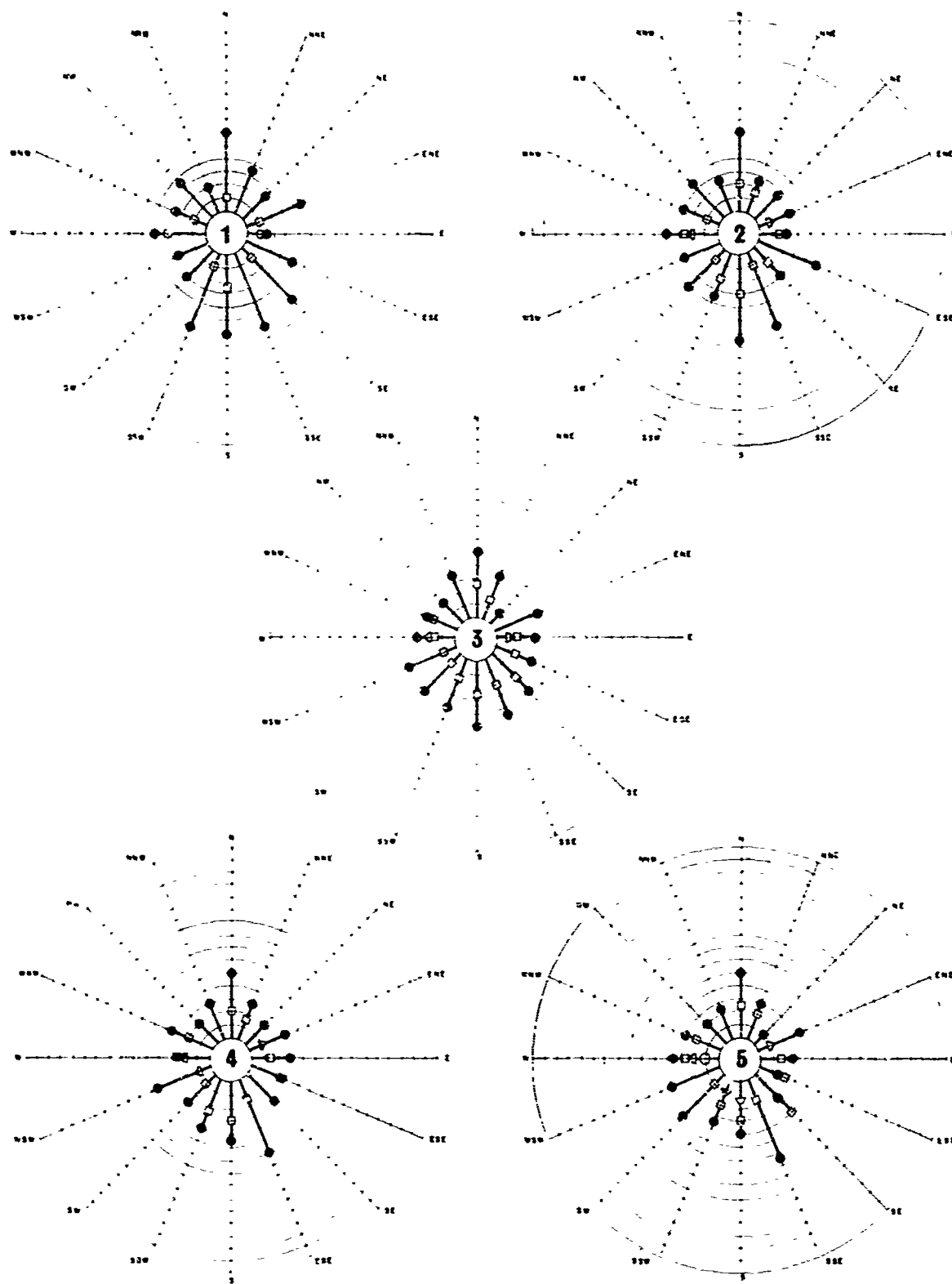


FIGURE 8 : WIND ROSES (24 HOUR) FOR AUGUST

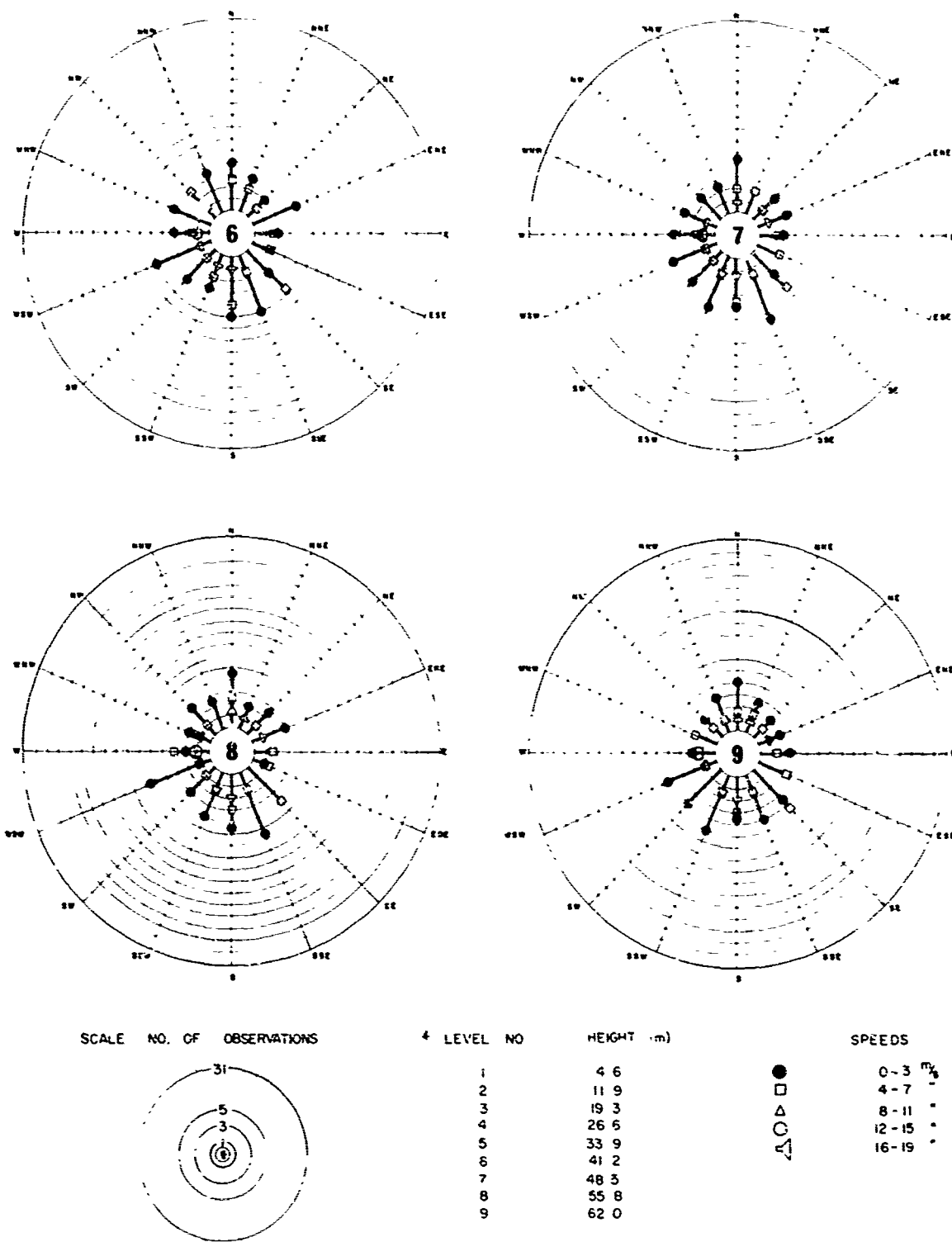


FIGURE 8 (CONT.): WIND ROSES (24 HOUR) FOR AUGUST

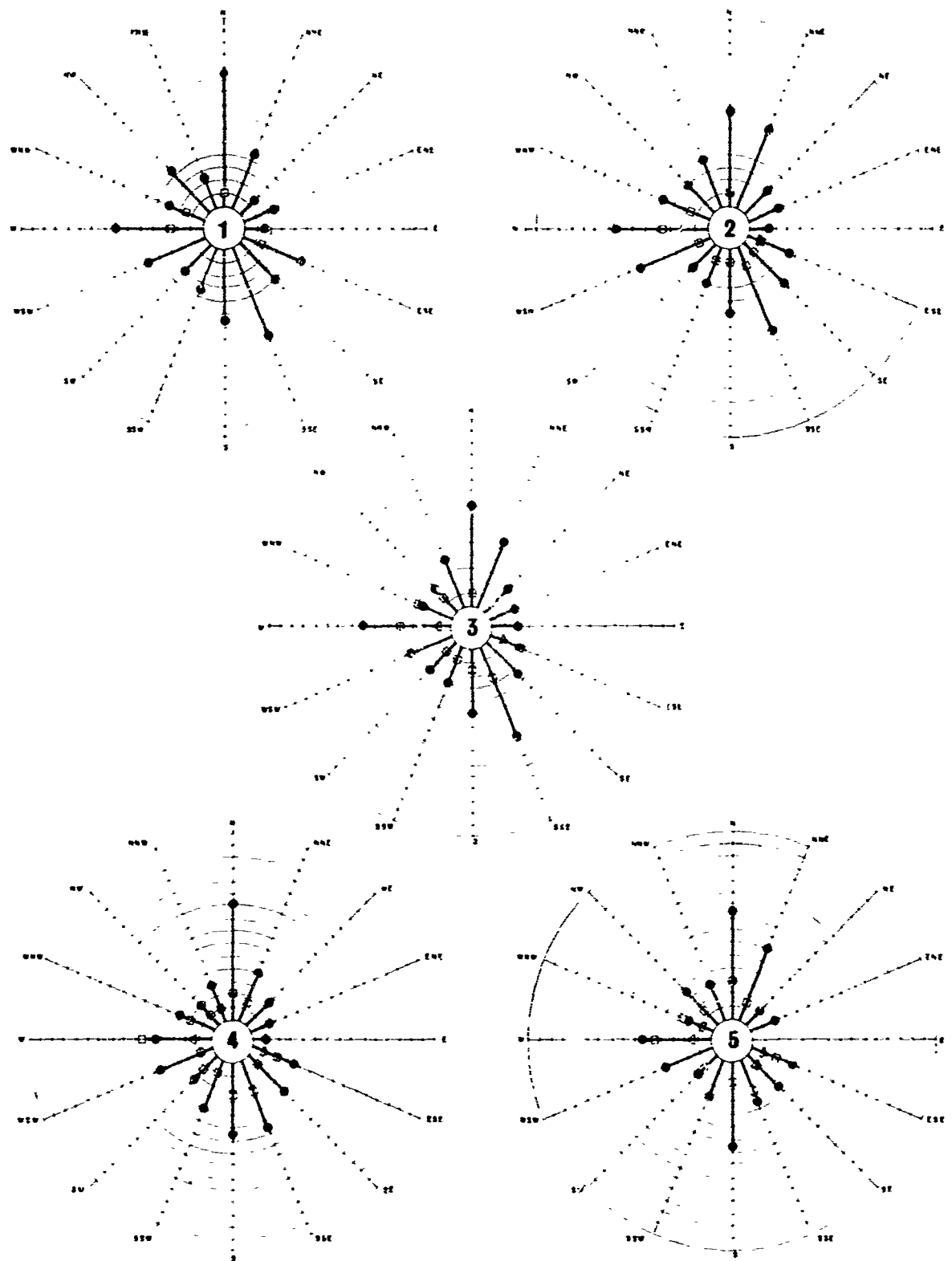


FIGURE 9 : WIND ROSES (24 HOUR) FOR SEPTEMBER

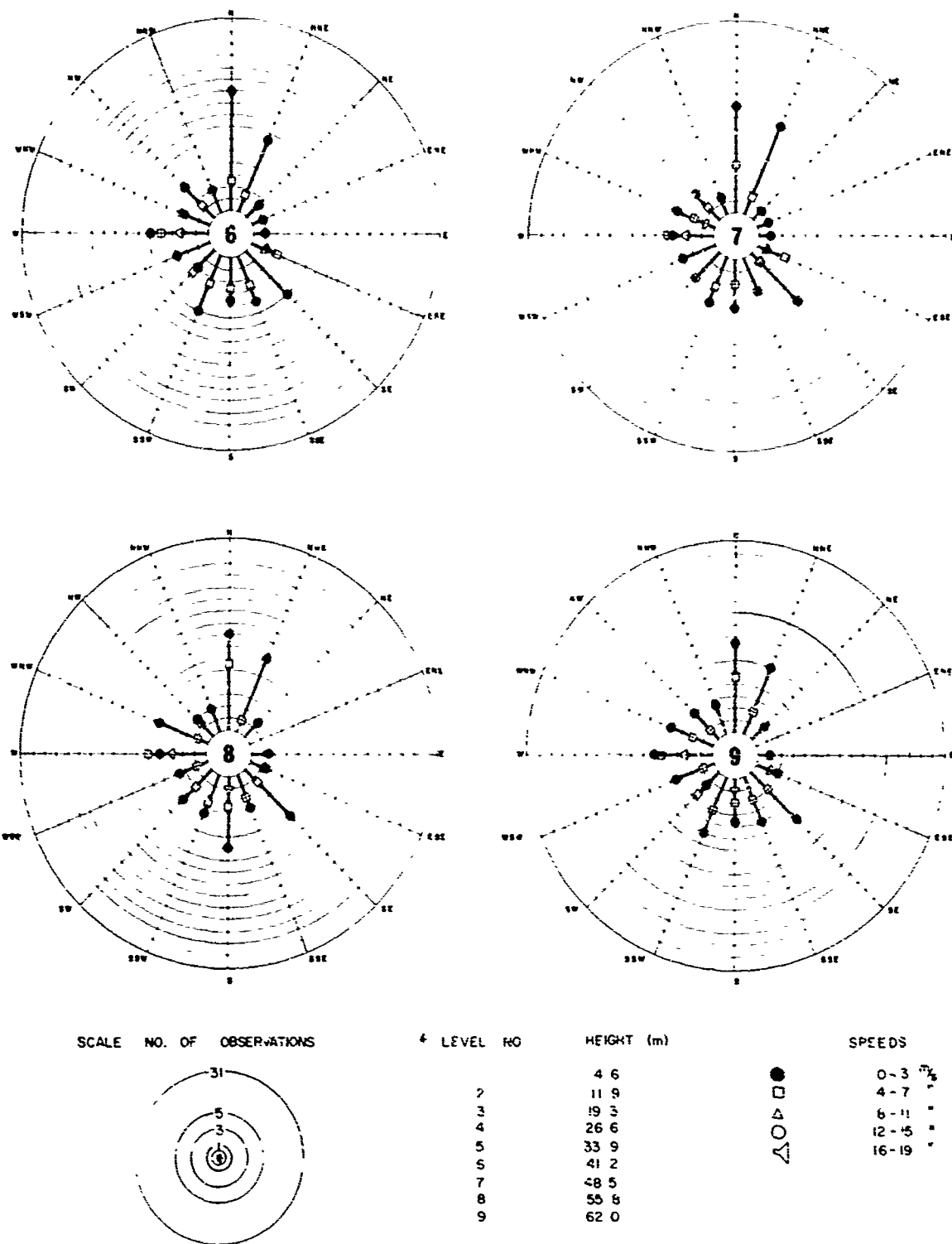


FIGURE 9 (CONT.): WIND ROSES (24 HOUR) FOR SEPTEMBER

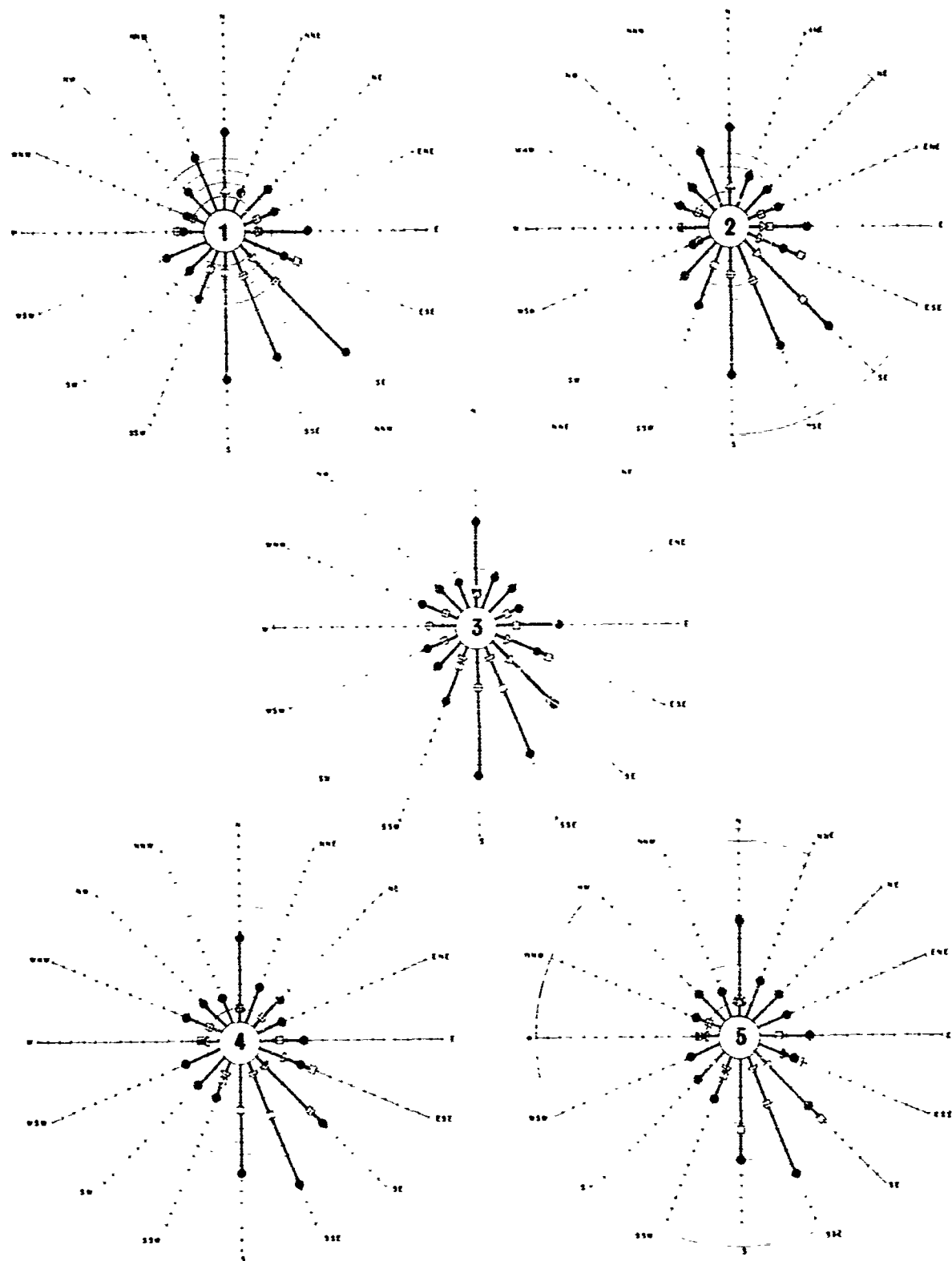


FIGURE 10: WIND ROSES (24 HOUR) FOR OCTOBER

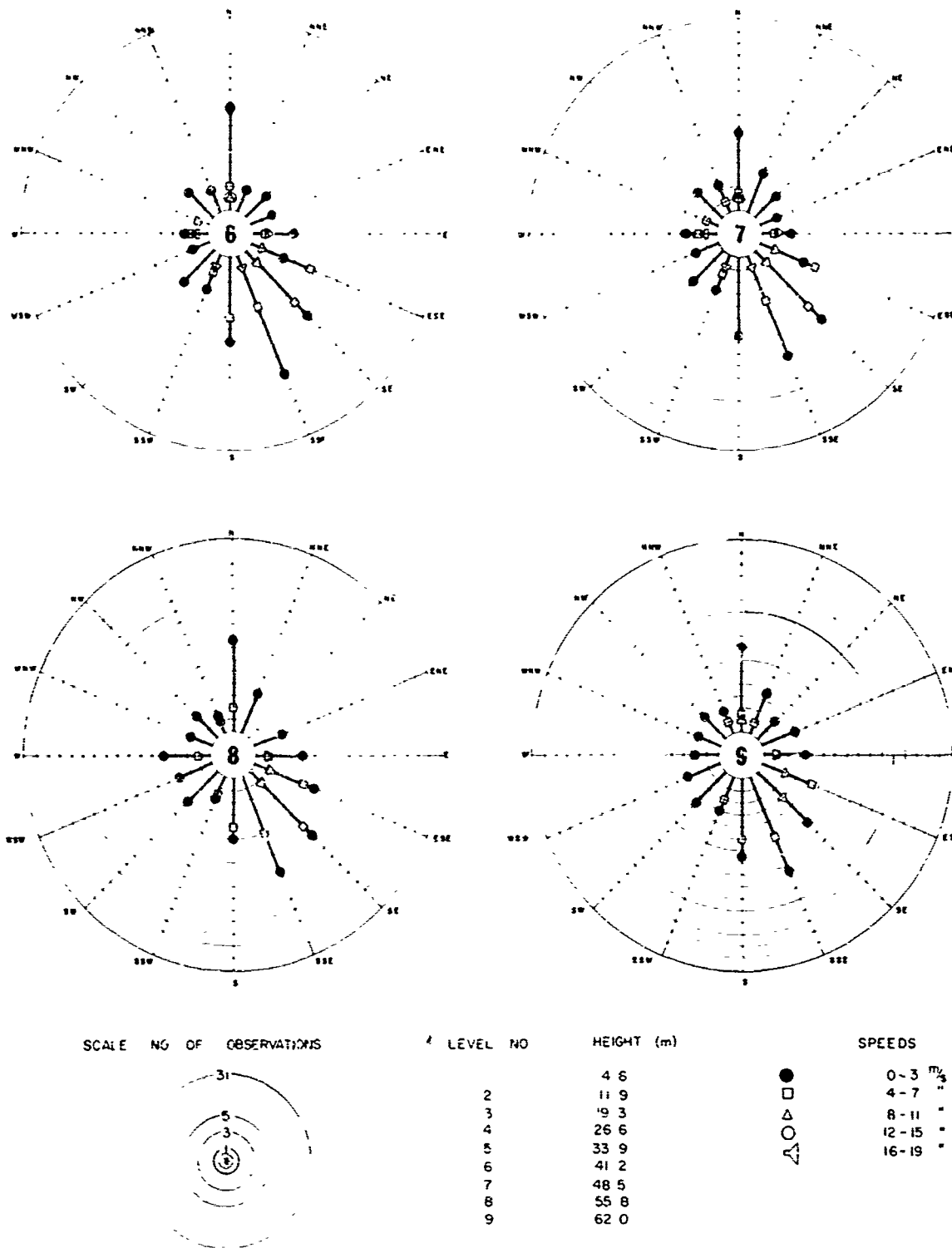


FIGURE 10 (CONT.): WIND ROSES (24 HOUR) FOR OCTOBER

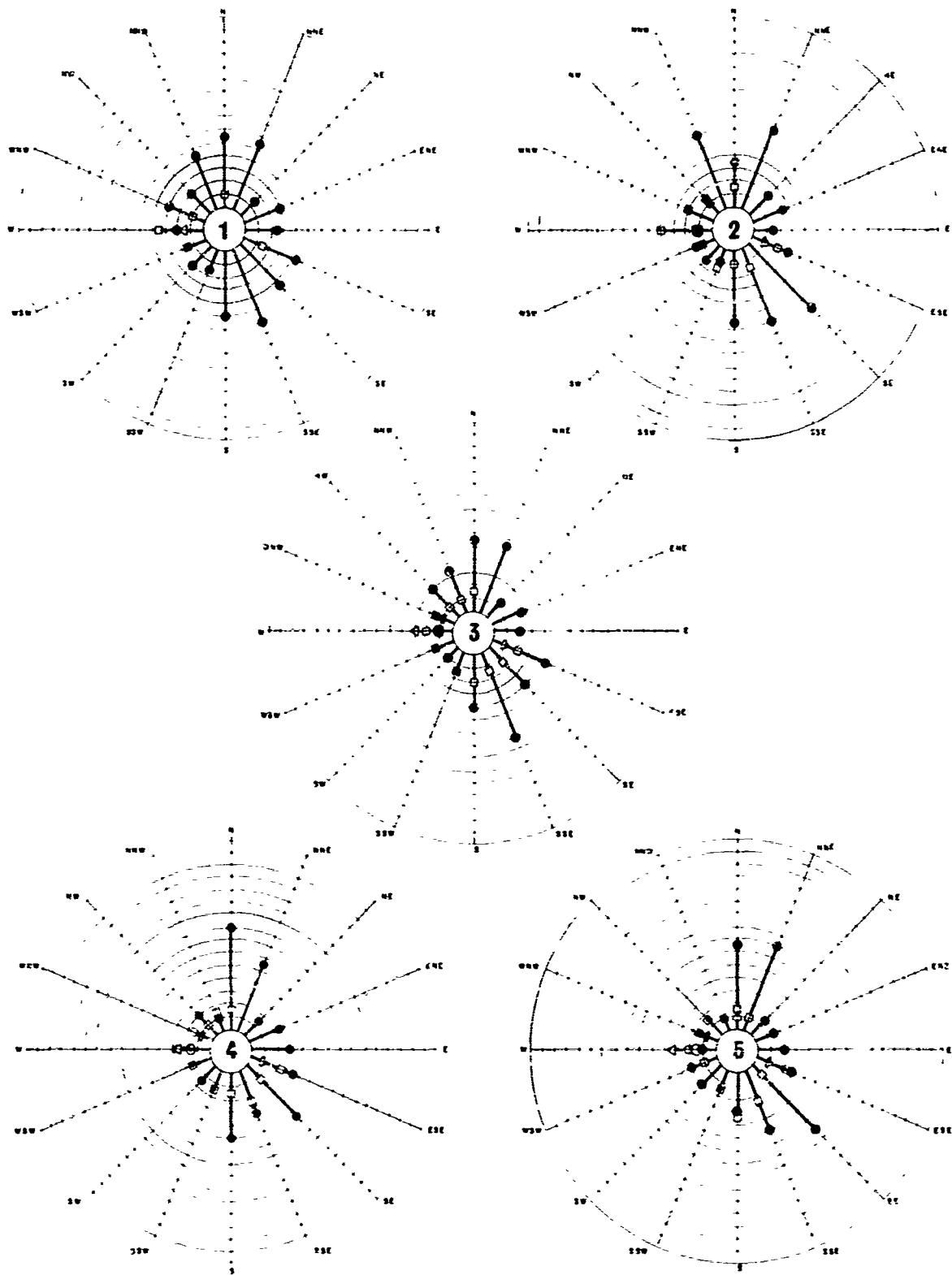
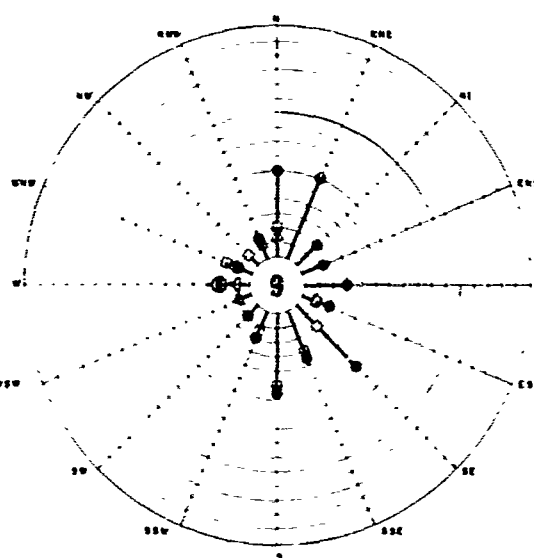
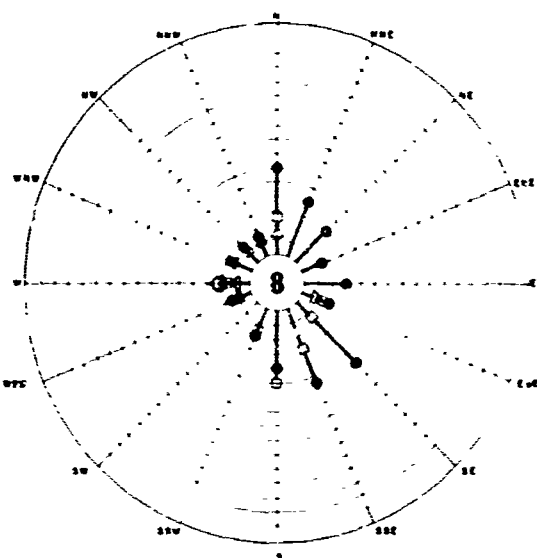
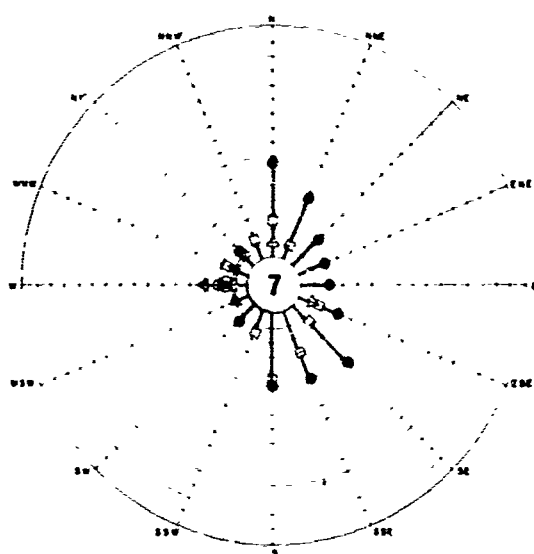
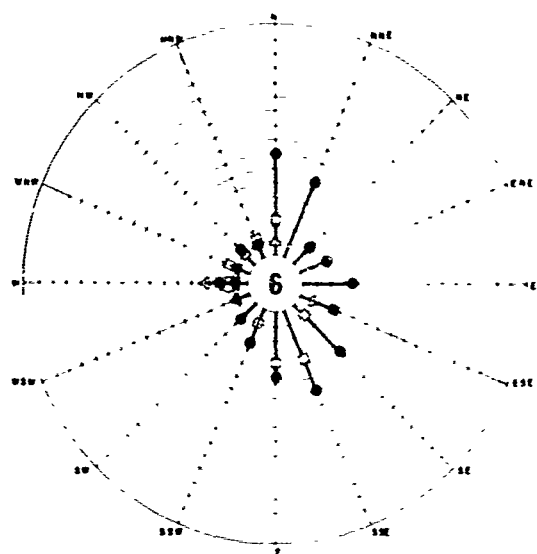
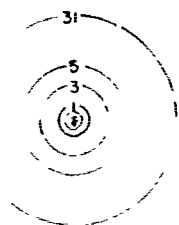


FIGURE 11: WIND ROSES (24 HOUR) FOR NOVEMBER





SCALE NO. OF OBSERVATIONS



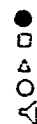
LEVEL NO

1  
2  
3  
4  
5  
6  
7  
8  
9

HEIGHT (m)

4.5  
11.2  
19.3  
26.6  
33.9  
41.2  
48.5  
55.8  
62.0

SPEEDS



0-3 m/s  
4-7 "  
8-11 "  
12-15 "  
16-19 "

FIGURE 11 (CONT.): WIND ROSES (24 HOUR) FOR NOVEMBER

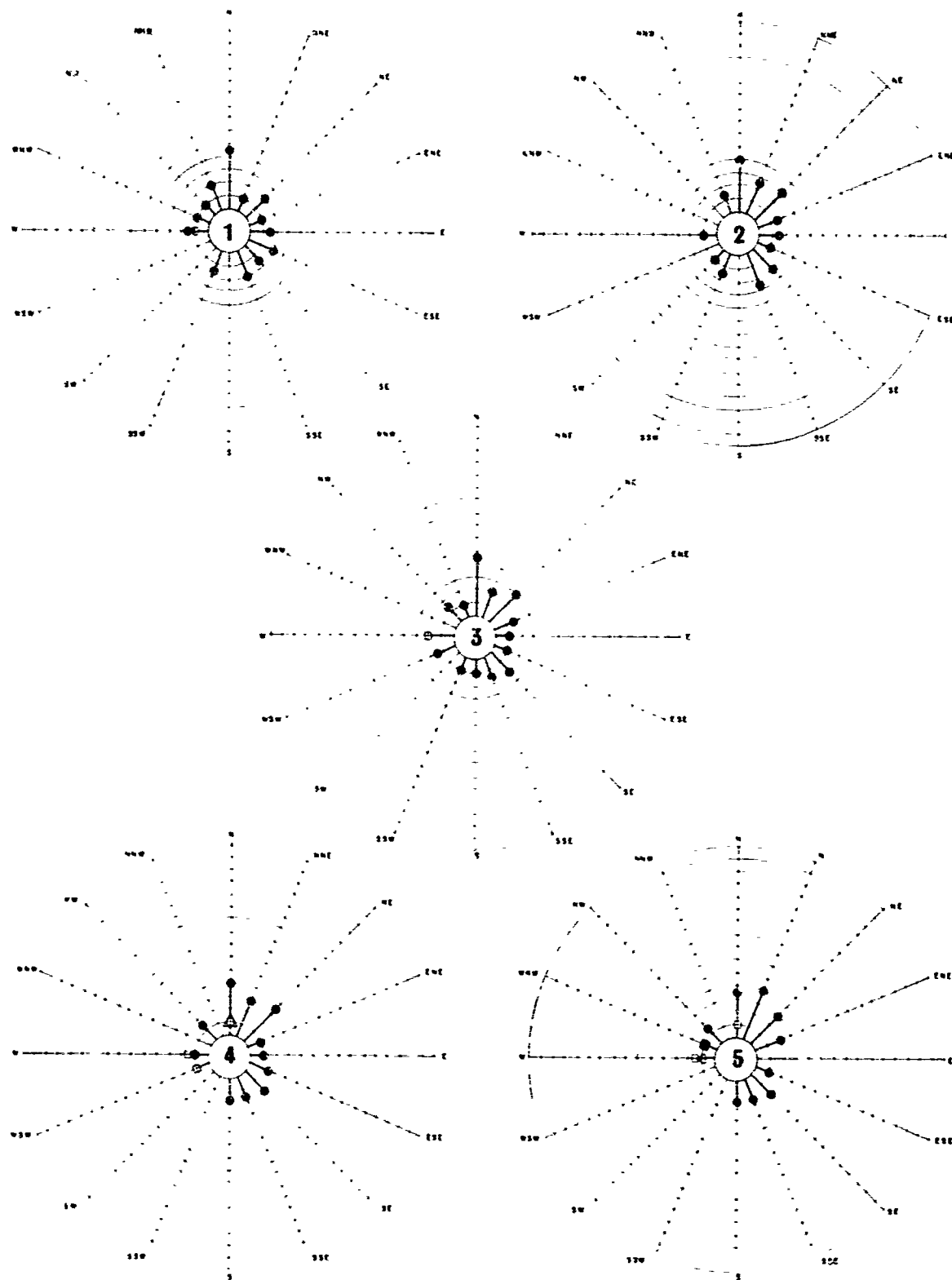


FIGURE 12: WIND ROSES (24 HOUR) FOR DECEMBER

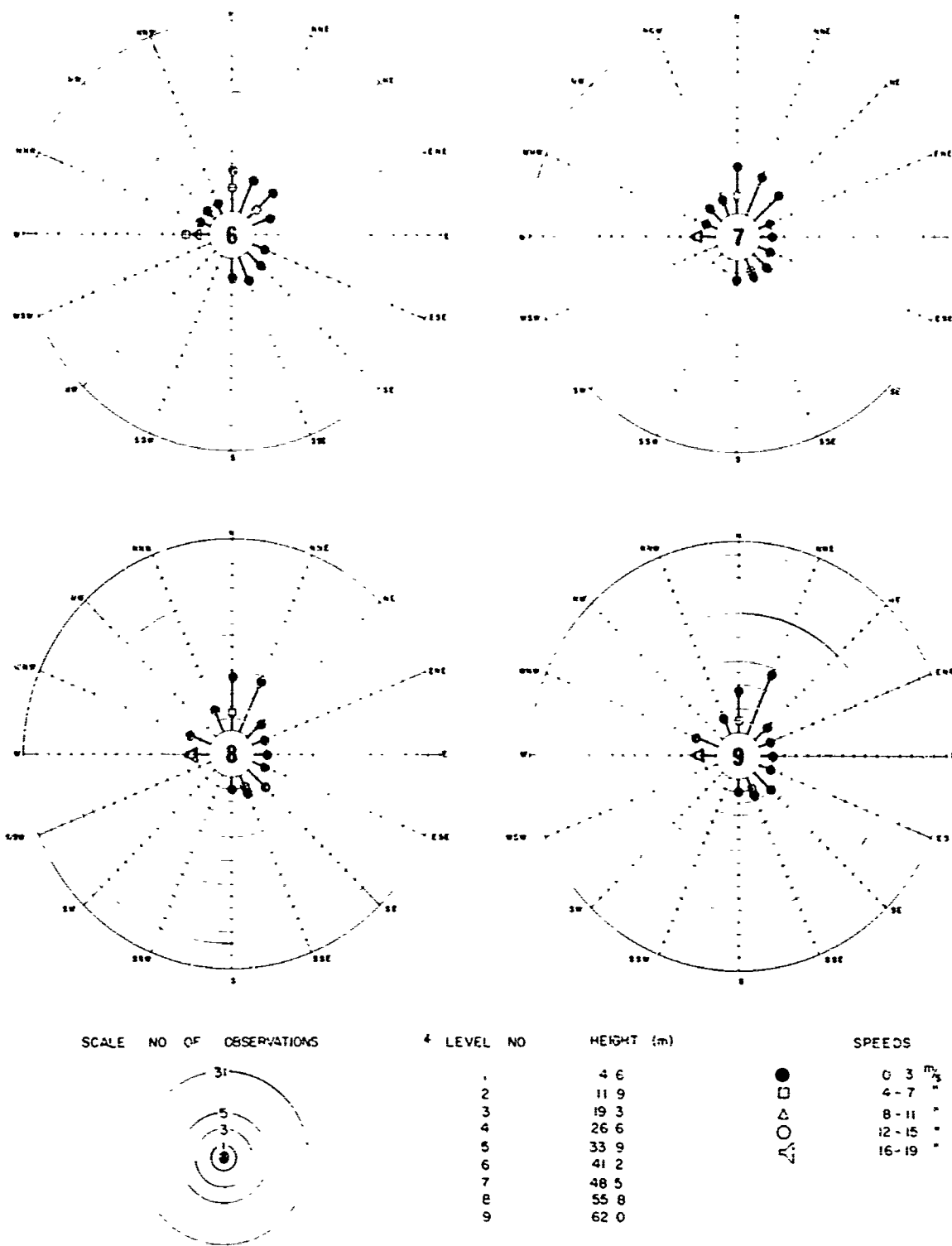


FIGURE 12 (CONT.): WIND ROSES (24 HOUR) FOR DECEMBER

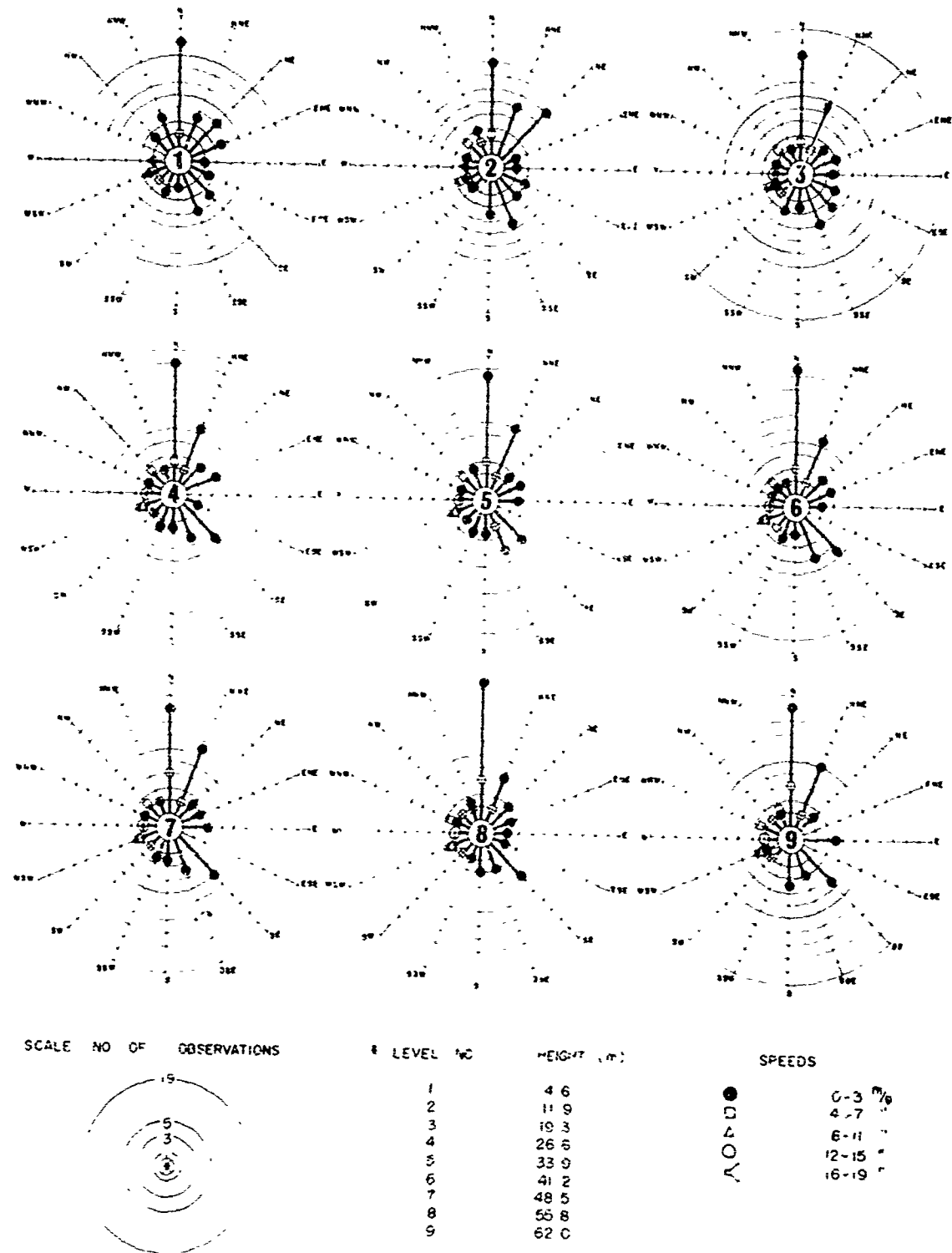


FIGURE 13 : DAYTIME WIND ROSES FOR JANUARY

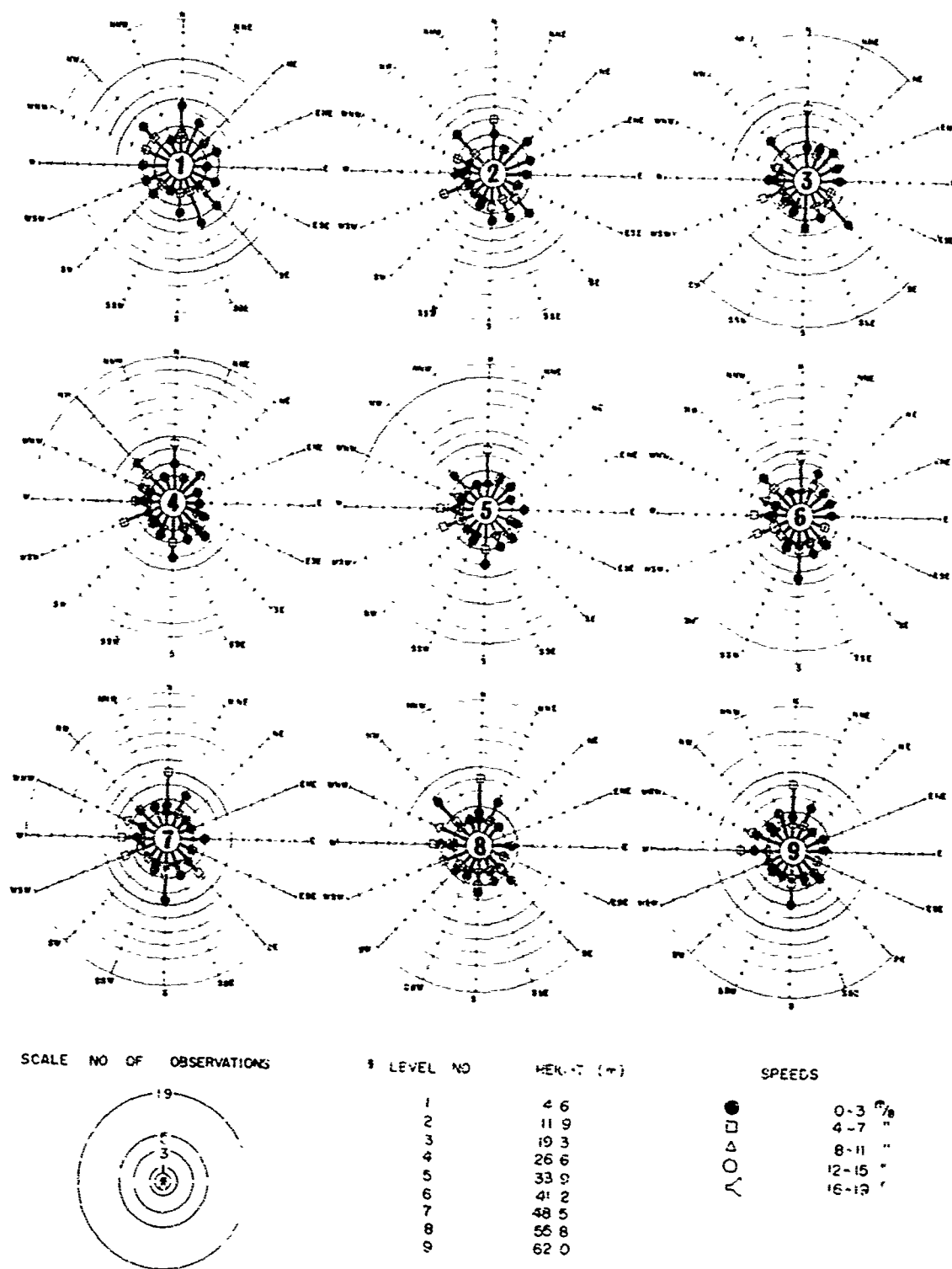


FIGURE 14 : DAYTIME WIND ROSES FOR FEBRUARY

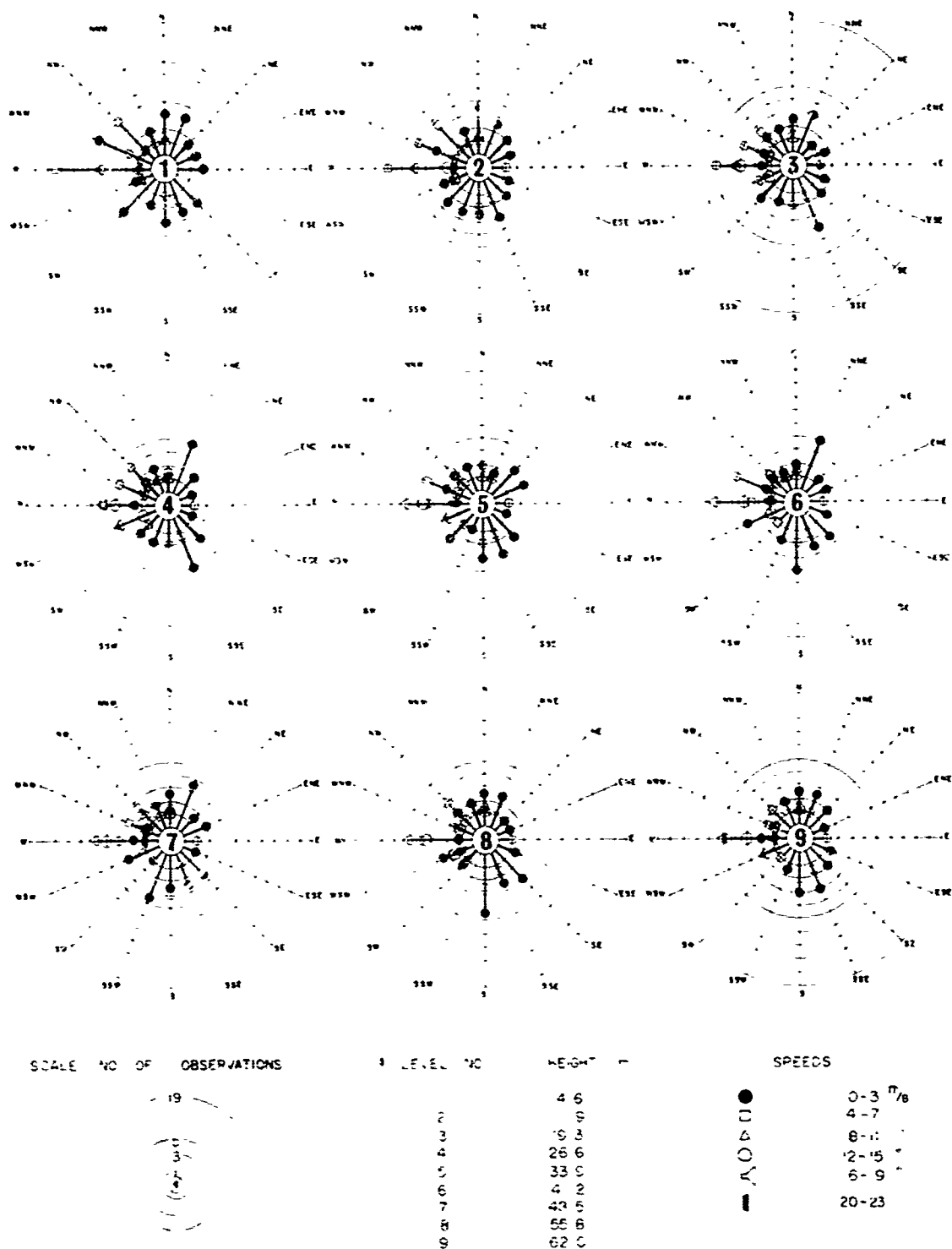


FIGURE 15 : DAYTIME WIND ROSES FOR MARCH

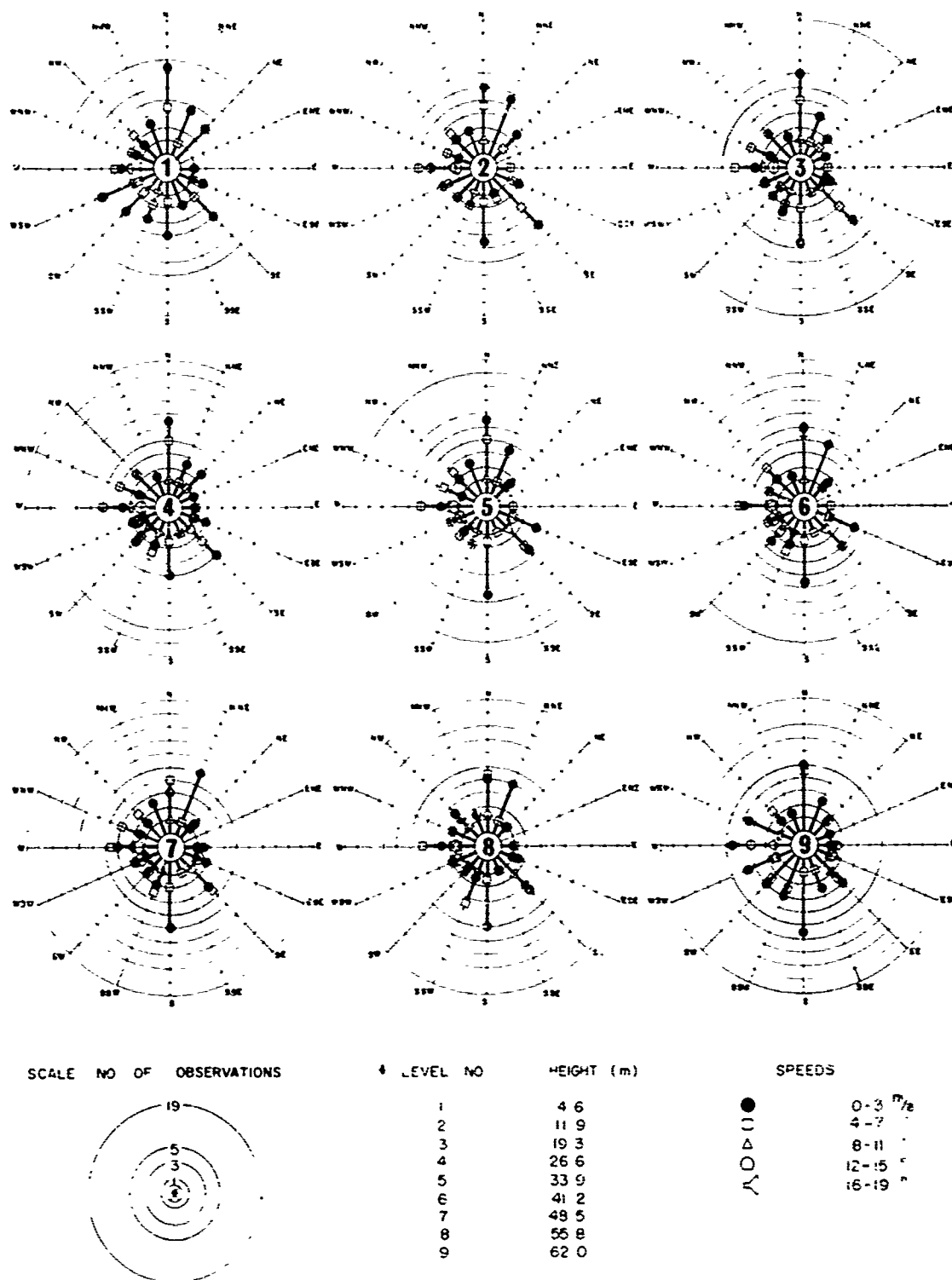
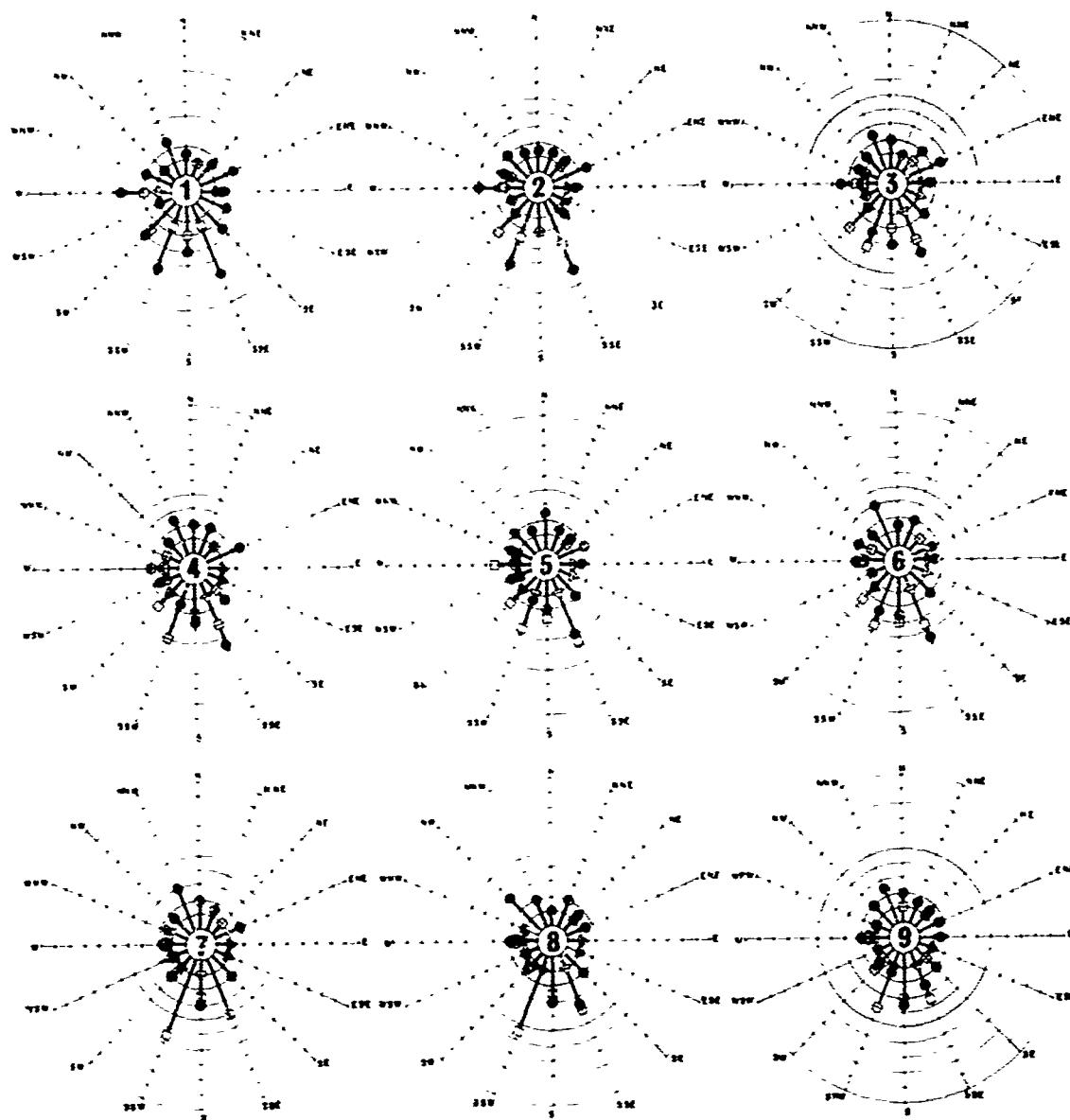
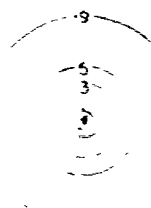


FIGURE 16 : DAYTIME WIND ROSES FOR APRIL



SCALE NO OF OBSERVATIONS



LEVEL NO

|   |      |
|---|------|
| 1 | 4 6  |
| 2 | 11 9 |
| 3 | 19 3 |
| 4 | 26 6 |
| 5 | 33 9 |
| 6 | 4 2  |
| 7 | 48 5 |
| 8 | 55 6 |
| 9 | 62 0 |

HEIGHT (m)

SPEEDS

|   |         |
|---|---------|
| ● | 0-3 m/s |
| □ | 4-7 "   |
| △ | 8-11 "  |
| ○ | 12-15 " |
| ~ | 16-19 " |

FIGURE 17: DAYTIME WIND ROSES FOR MAY



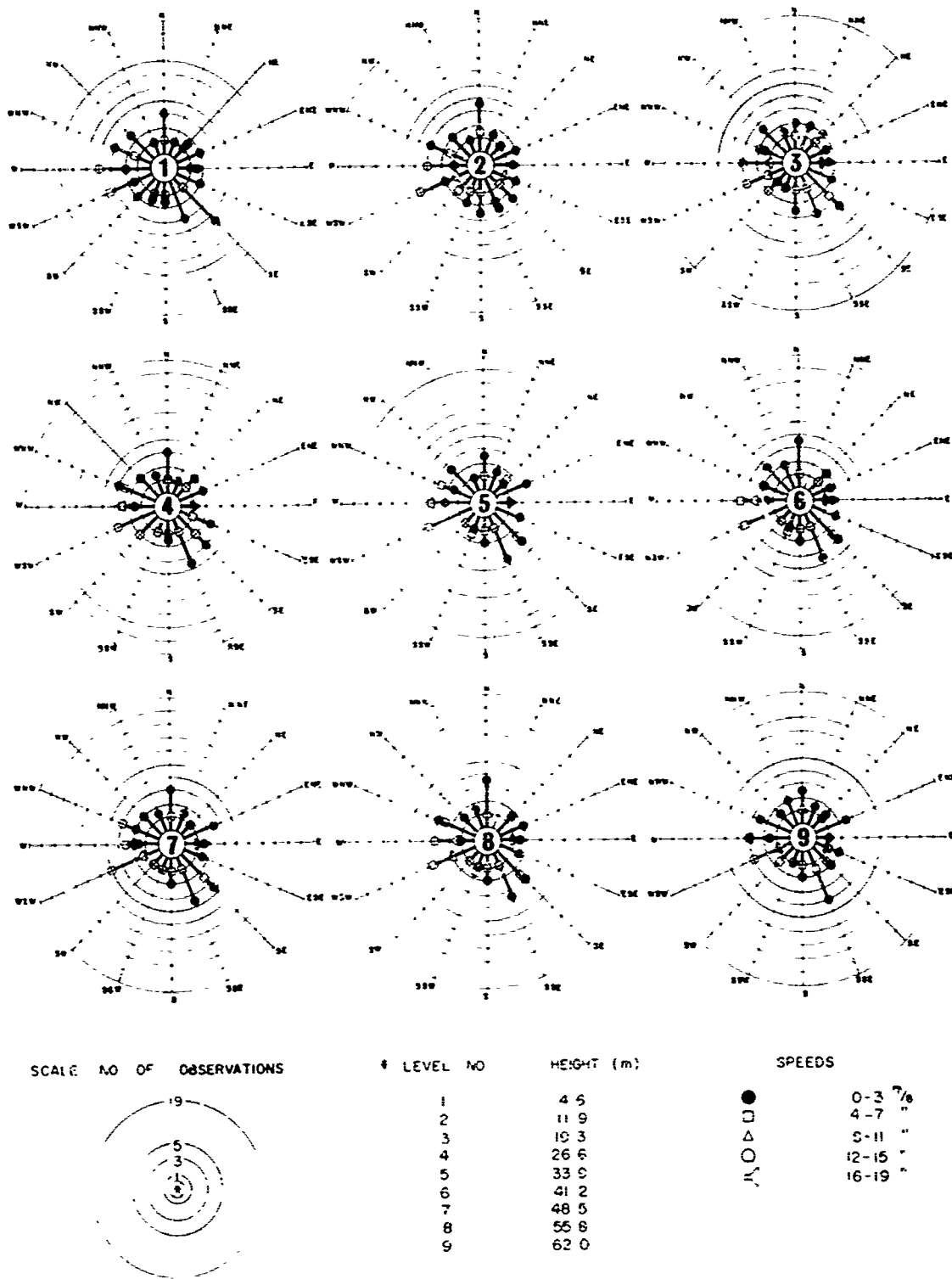


FIGURE 18 : DAYTIME WIND ROSES FOR JUNE

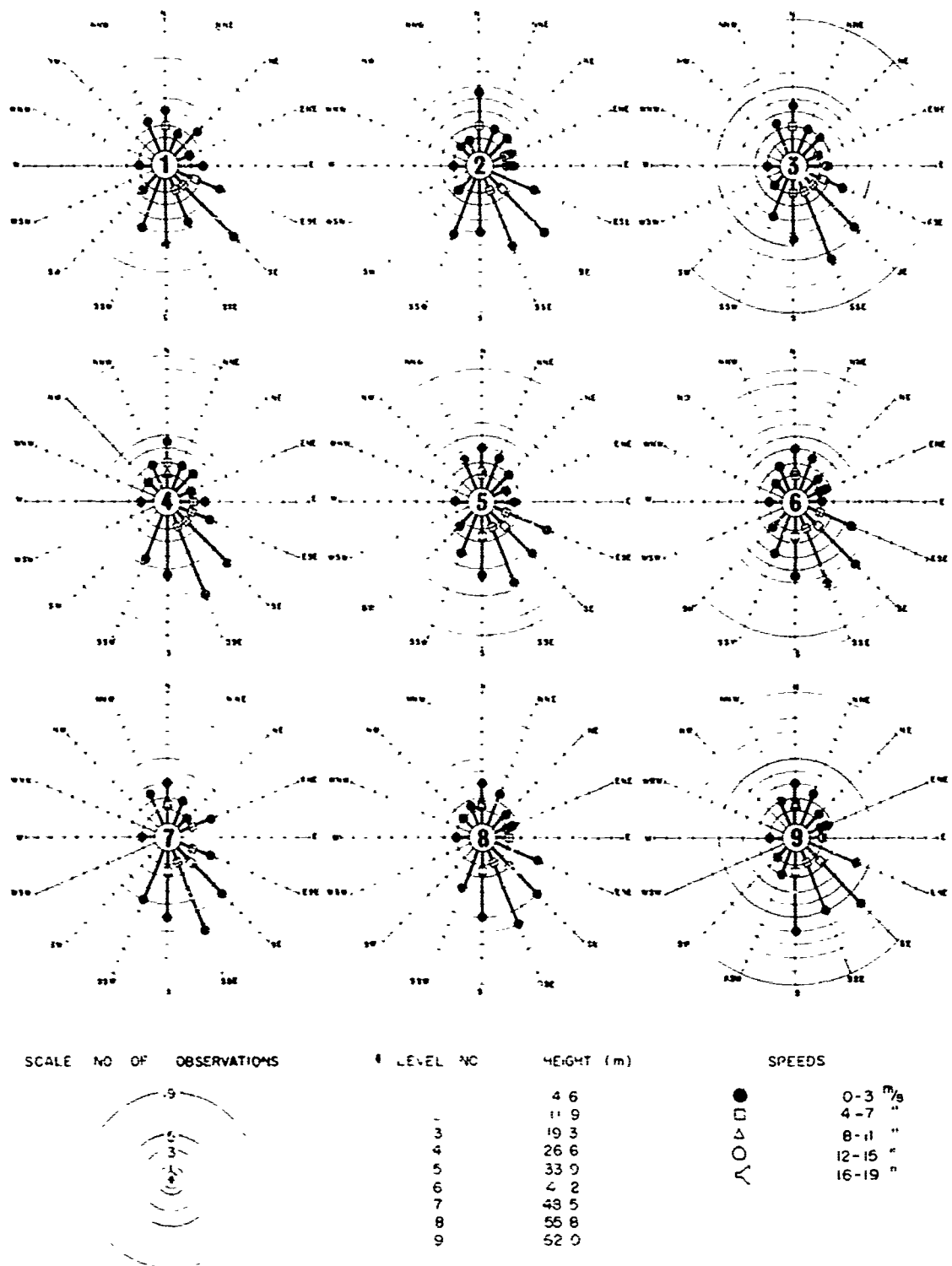


FIGURE 19: DAYTIME WIND ROSES FOR JULY

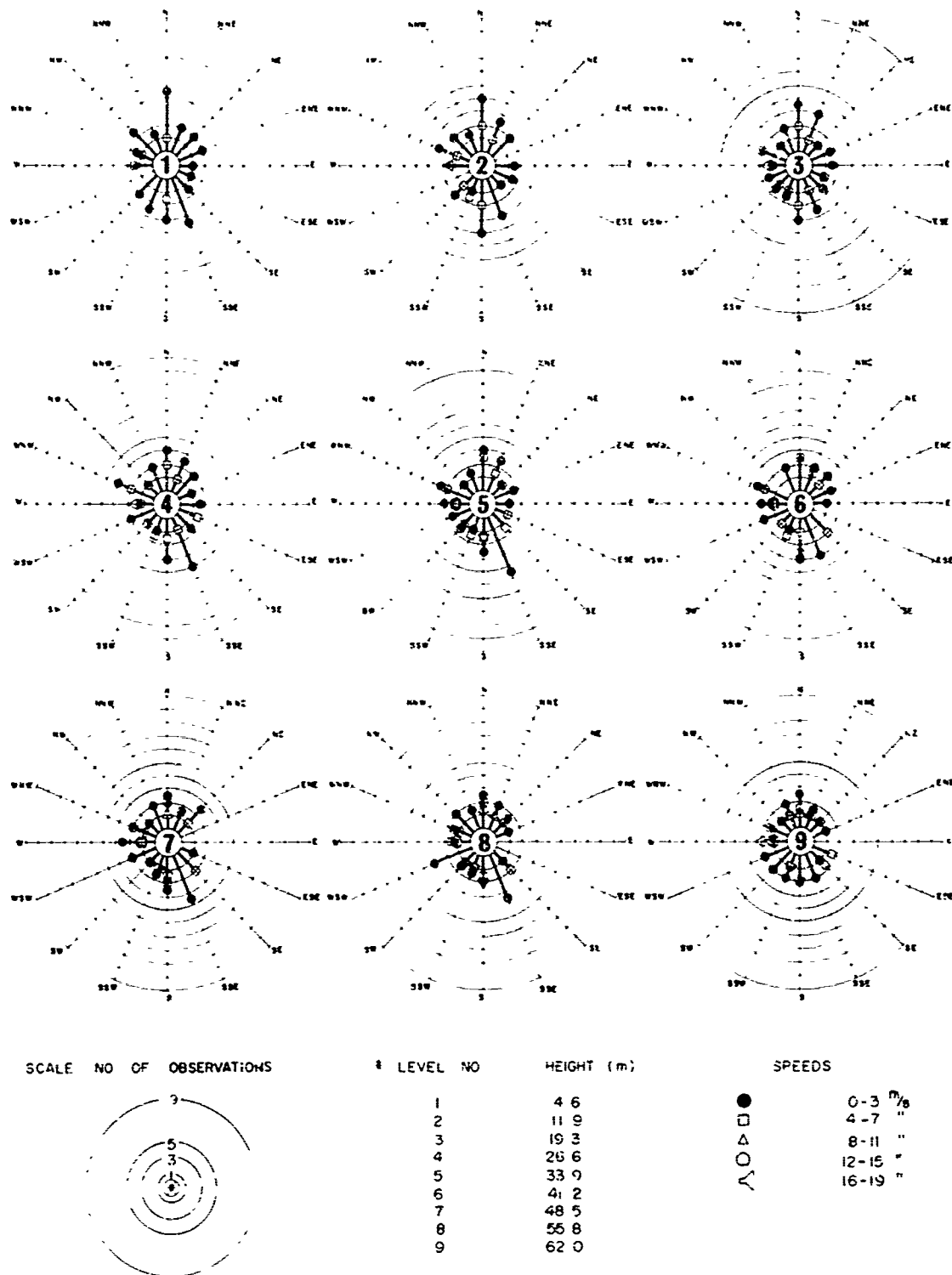
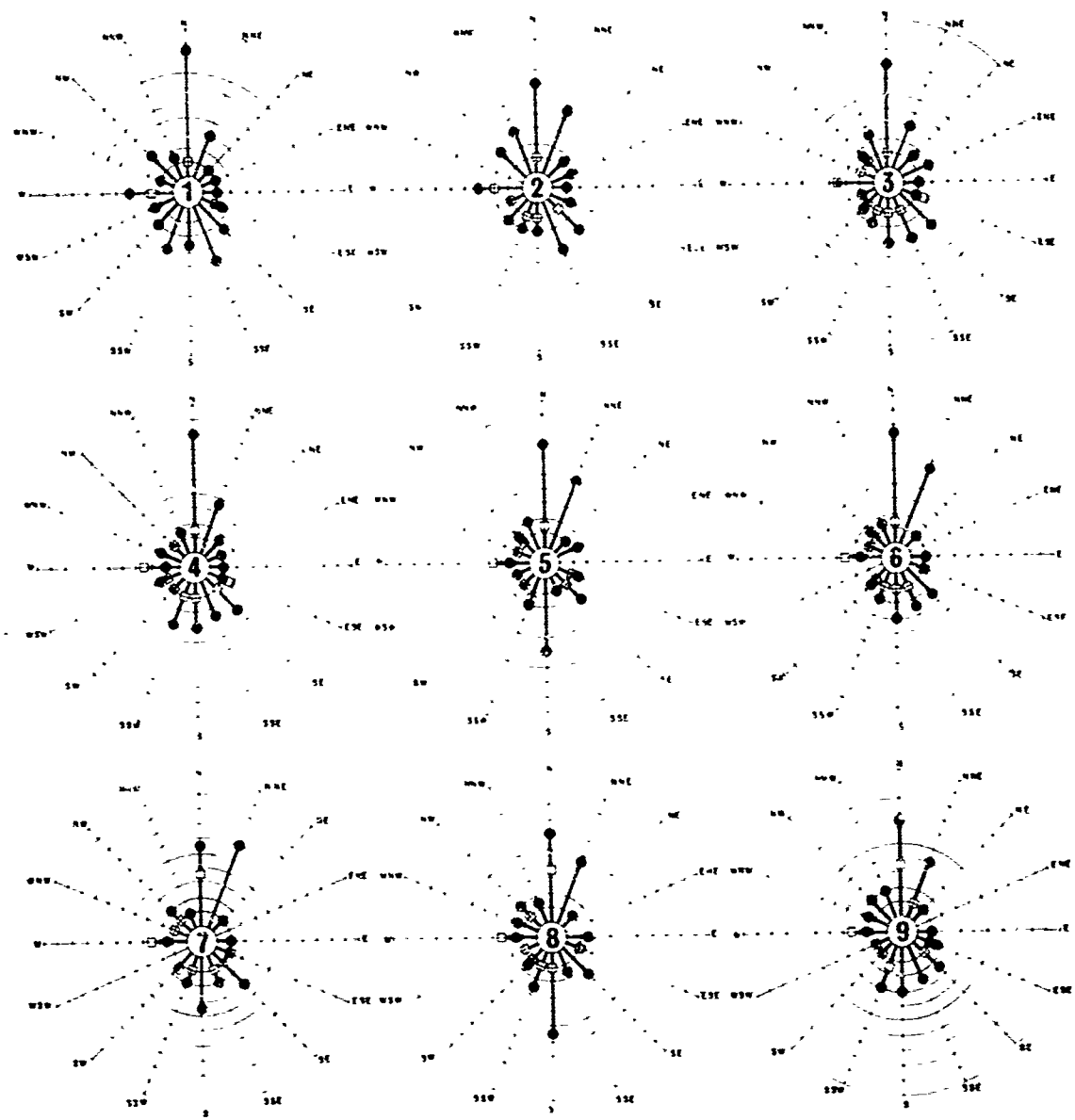
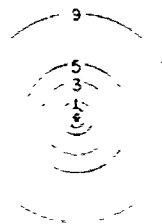


FIGURE 20: DAYTIME WIND ROSES FOR AUGUST



SCALE NO OF OBSERVATIONS



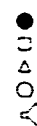
LEVEL NO

2  
3  
4  
5  
6  
7  
8  
9

HEIGHT (m)

4.6  
1.9  
18.3  
26.6  
33.9  
4.2  
48.5  
55.5  
62.0

SPEEDS



0-3 m/s  
4-7 "  
8-11 "  
12-15 "

FIGURE 21: DAYTIME WIND ROSES FOR SEPTEMBER

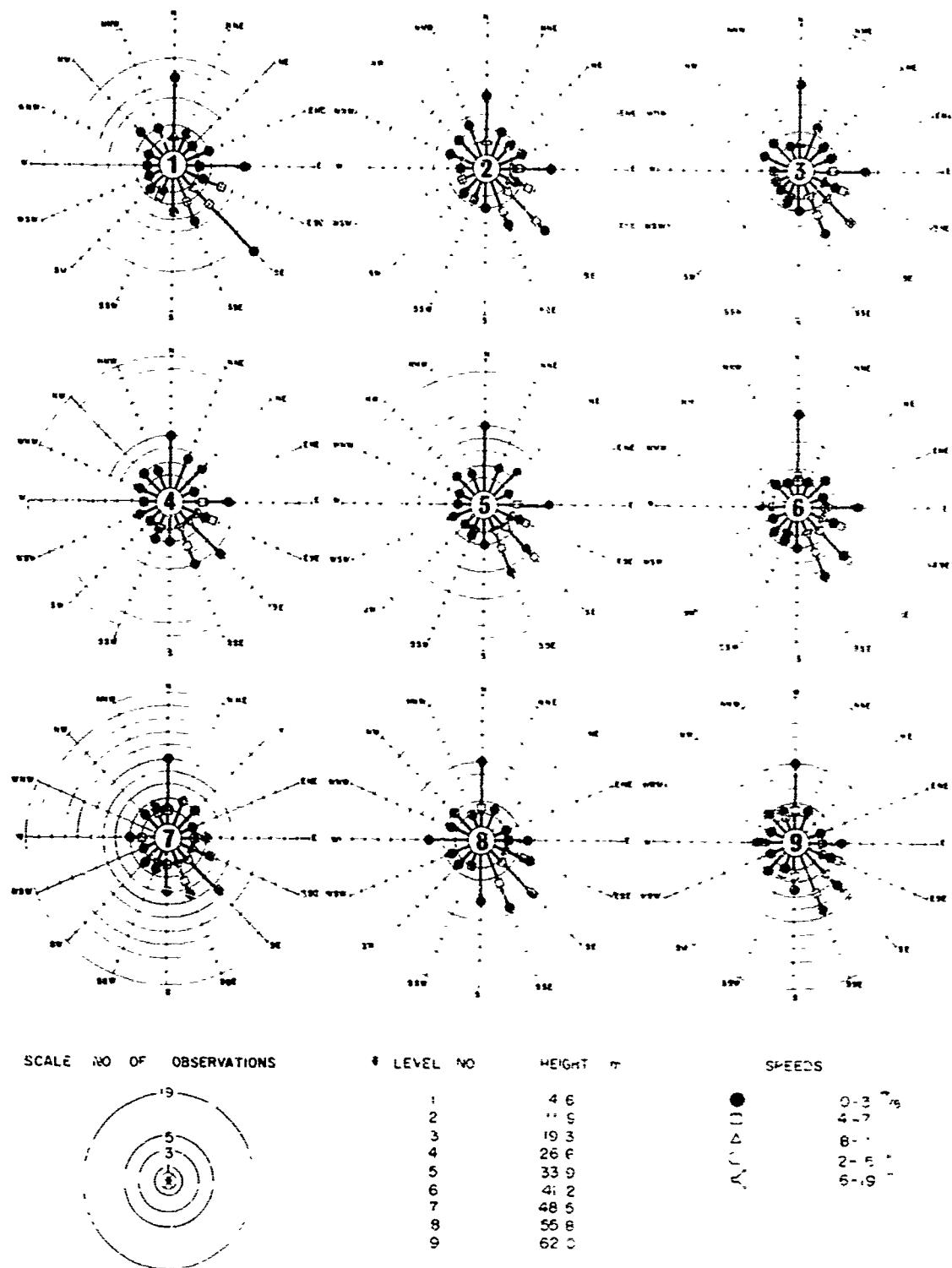
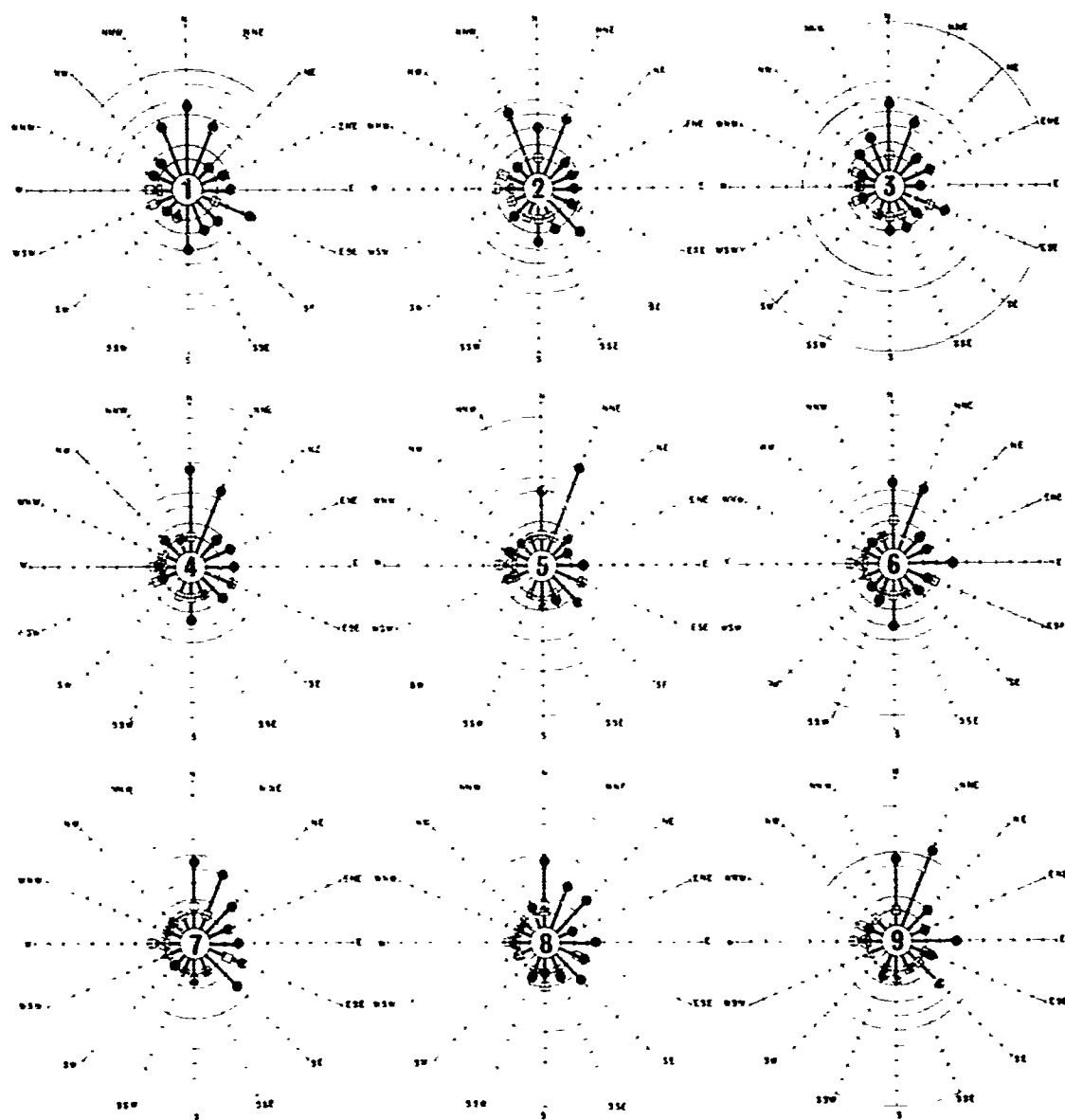


FIGURE 22: DAYTIME WIND ROSES FOR OCTOBER



SCALE NO OF OBSERVATIONS



# LEVEL NO

1  
2  
3  
4  
5  
6  
7  
8  
9

HEIGHT (m)

4 6  
9 9  
15 3  
26 6  
33 9  
4 2  
48 5  
55 8  
62 0

SPEEDS

●  
□  
△  
○  
○

0-3 m/s  
4-7  
8-11  
12-15  
16-19

FIGURE 23: DAYTIME WIND ROSES FOR NOVEMBER

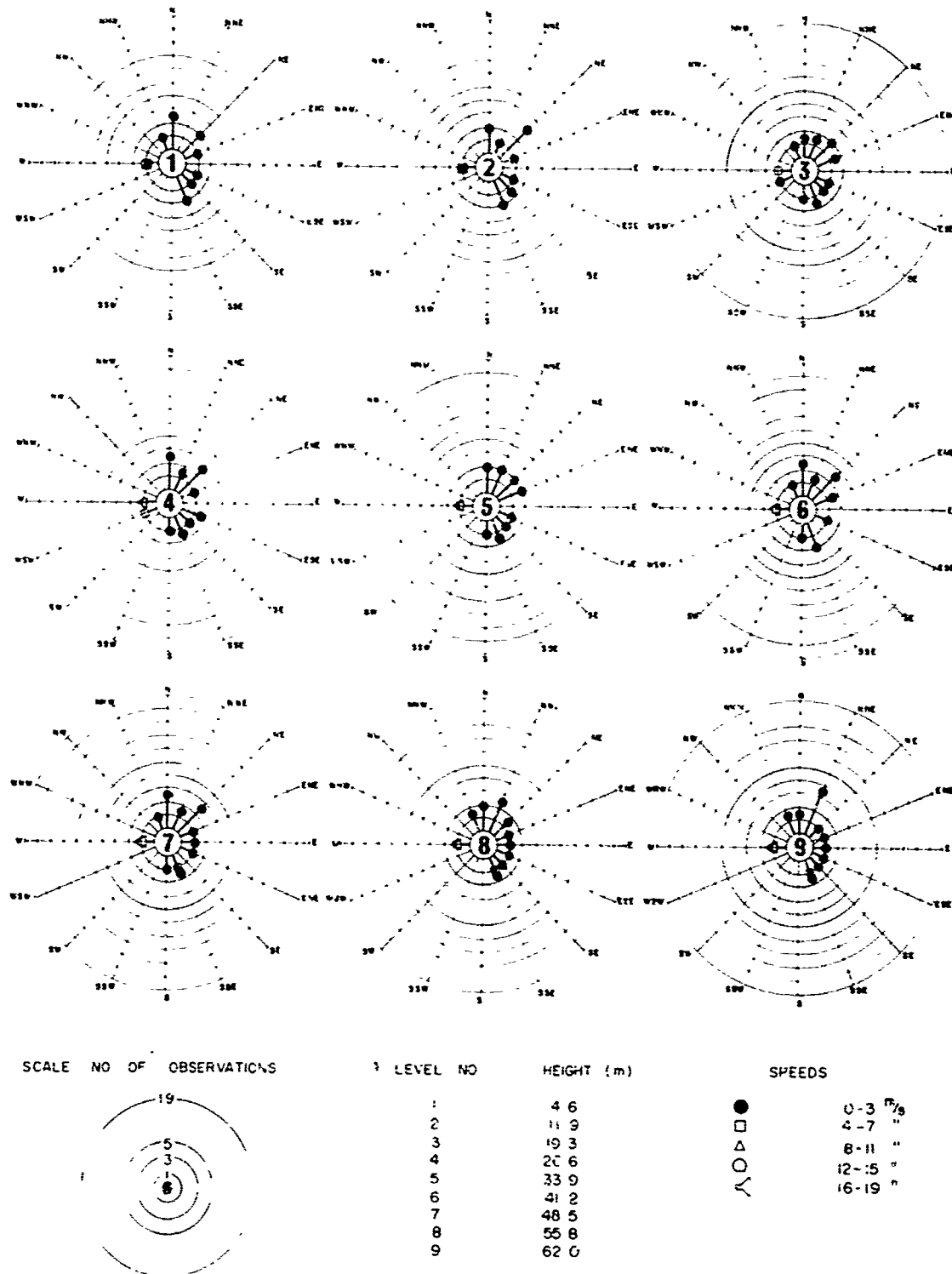
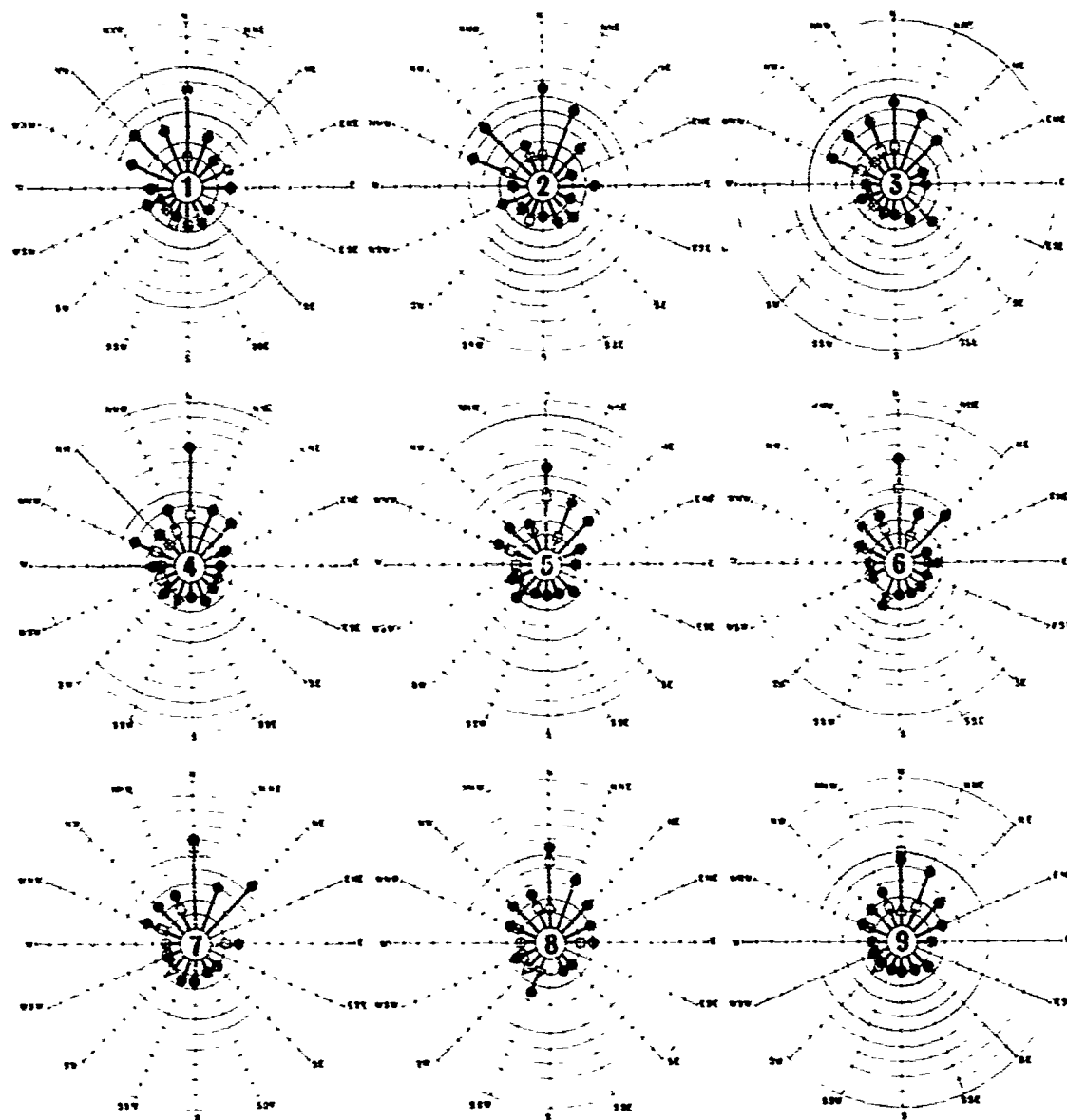
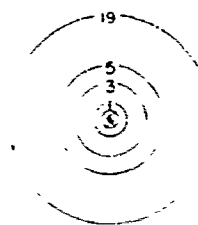


FIGURE 24: DAYTIME WIND ROSES FOR DECEMBER



SCALE NO OF OBSERVATIONS



LEVEL NO

1  
2  
3  
4  
5  
6  
7  
8  
9

HEIGHT (m)

4.6  
11.9  
19.3  
26.6  
33.9  
41.2  
48.5  
55.8  
62.0

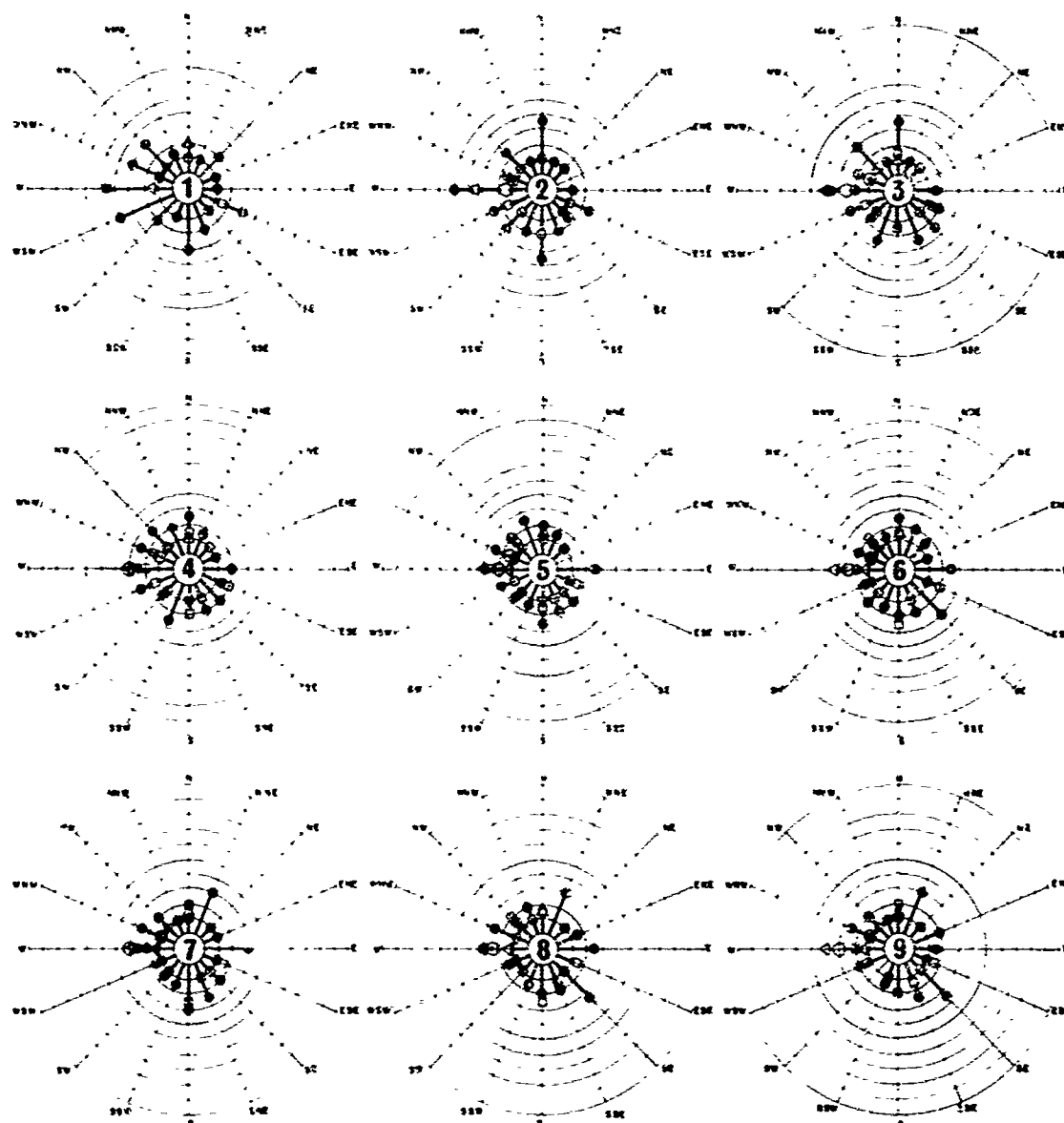
SPEEDS

● □ △ ∇

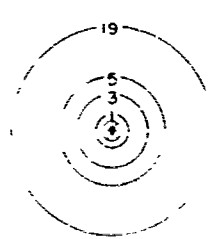
0-3  
4-7  
8-11  
12-15  
16-19

FIGURE 25: NIGHTTIME WIND ROSES FOR JANUARY





SCALE NO OF OBSERVATIONS



# LEVEL NO

- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9

HEIGHT (m)

- 4.6
- 11.9
- 19.3
- 26.6
- 33.9
- 41.2
- 48.5
- 55.8
- 62.0

SPEEDS

- 0-3 m/s
- 4-7 "
- 8-11 "
- 12-15 "
- 16-19 "

FIGURE 26: NIGHTTIME WIND ROSES FOR FEBRUARY

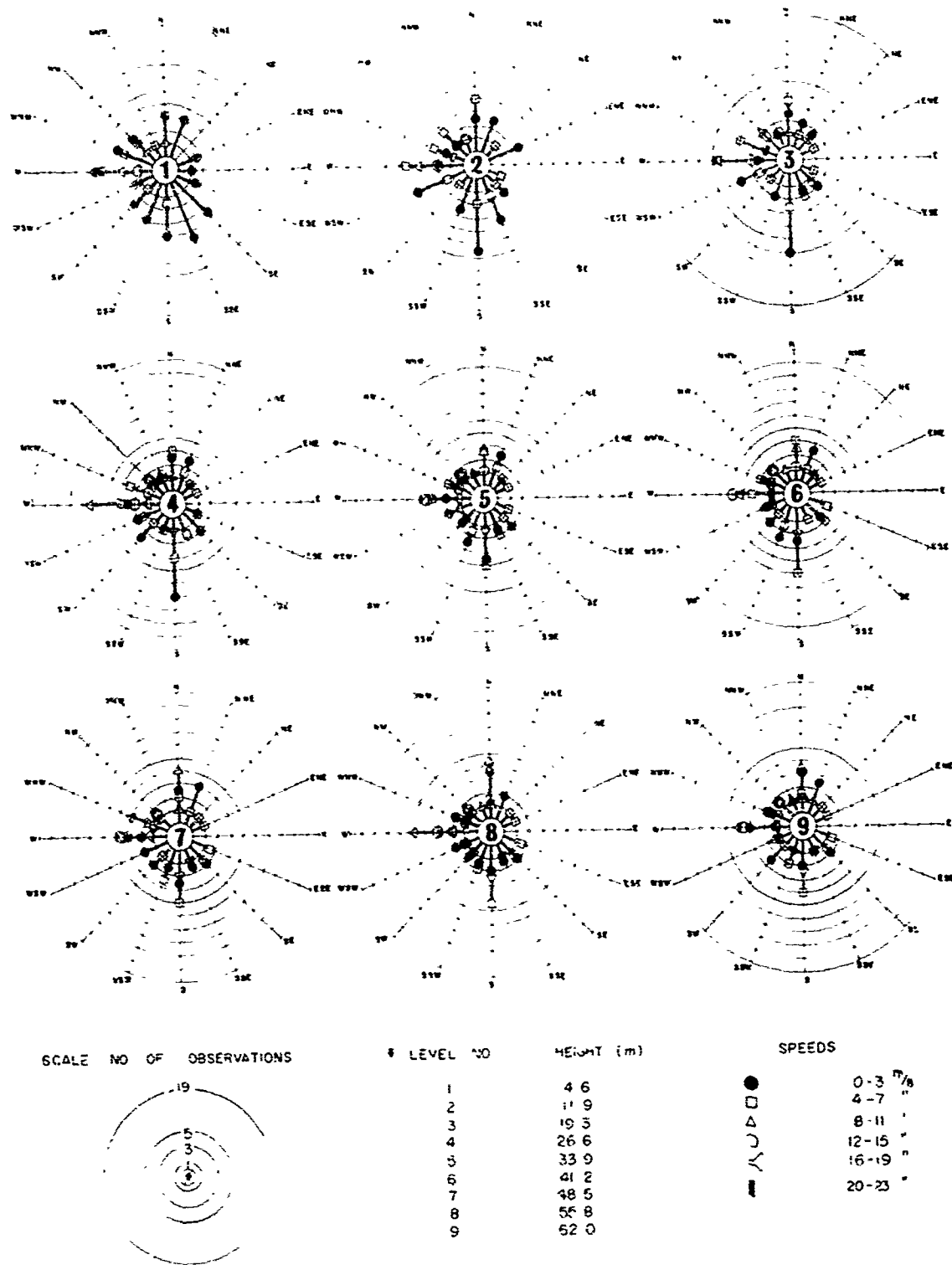


FIGURE 27 NIGHTTIME WIND ROSES FOR MARCH

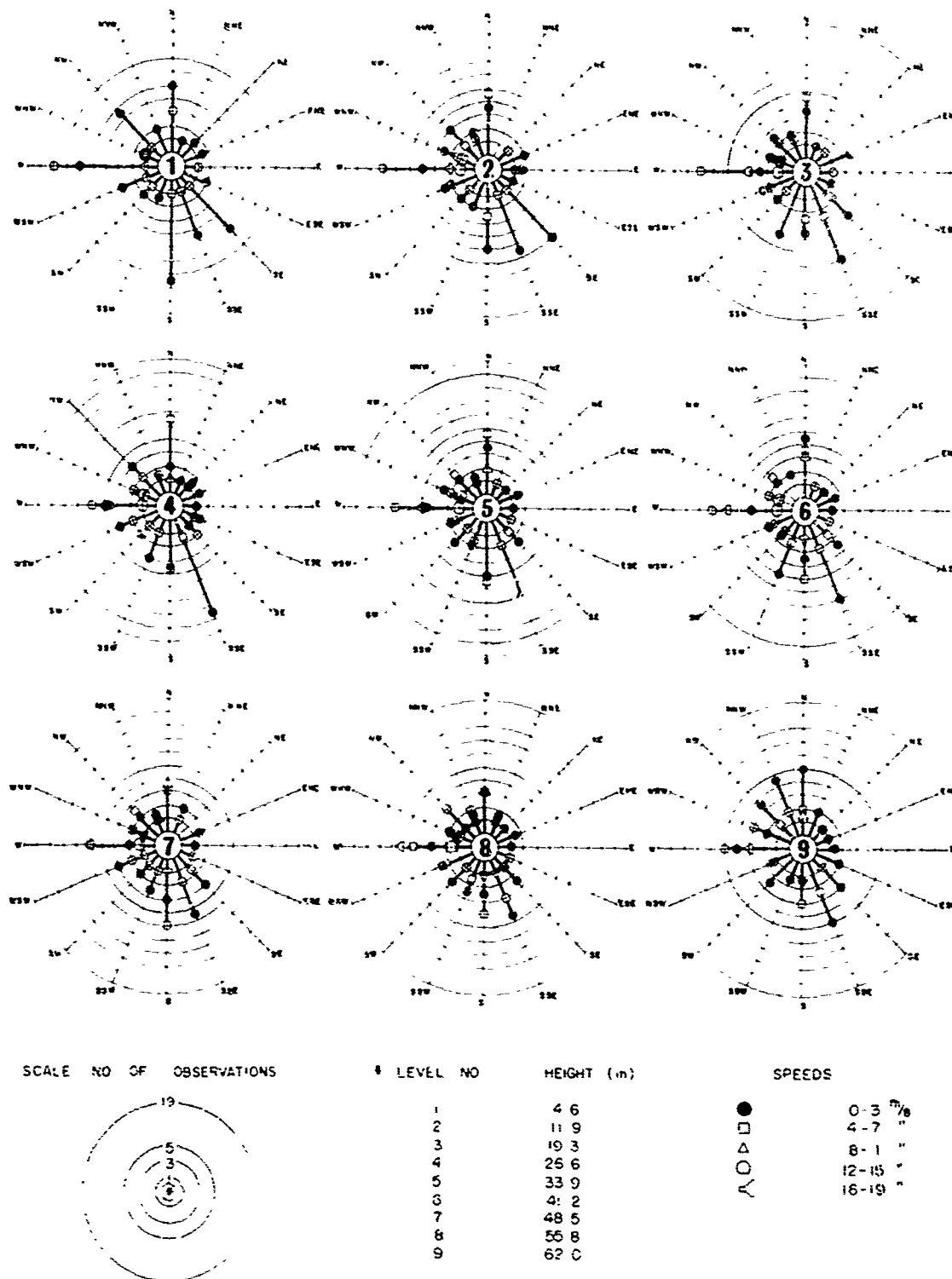
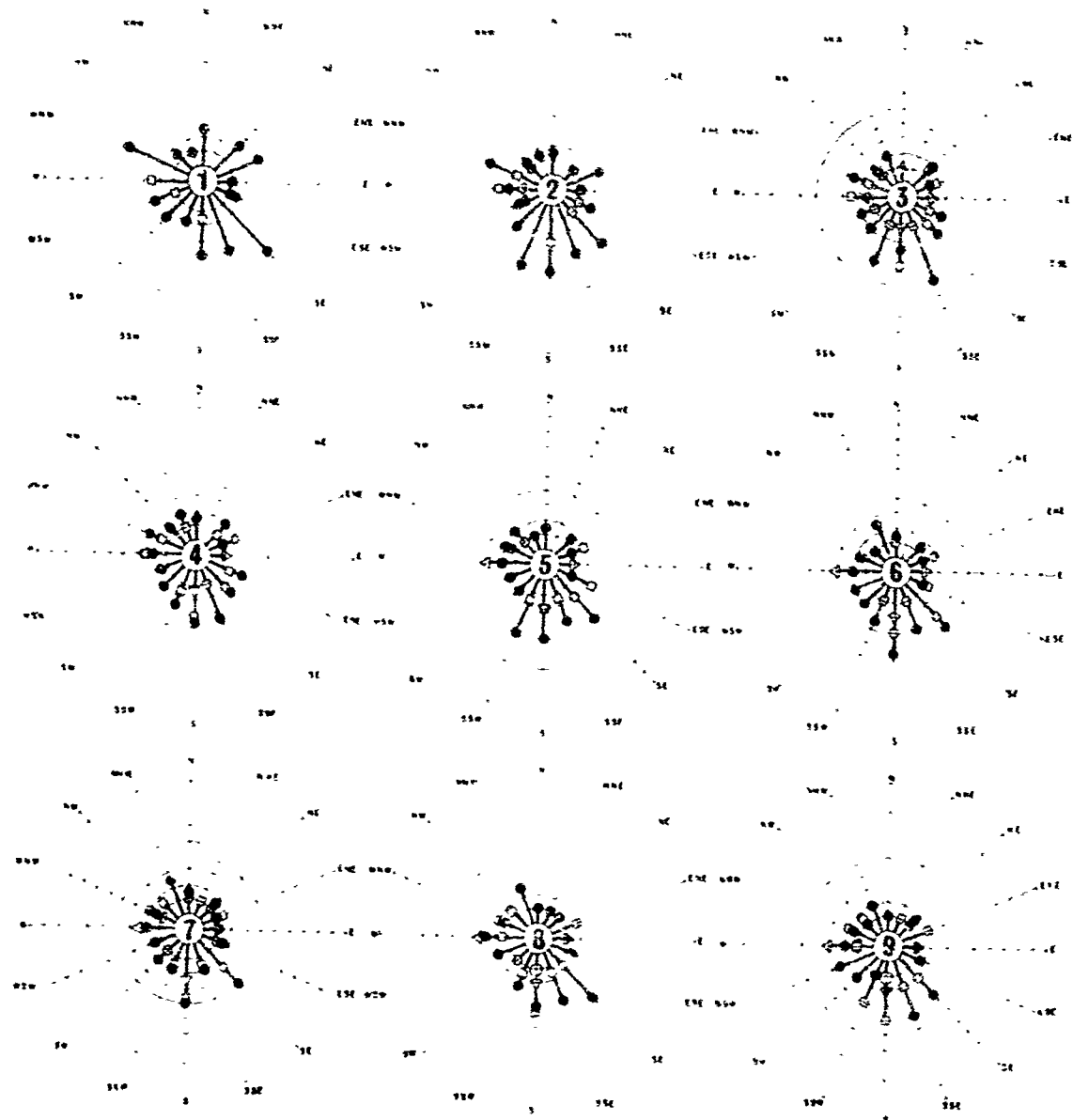
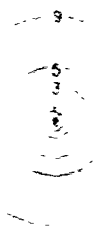


FIGURE 28: NIGHTTIME WIND ROSES FOR APRIL



SCALE NO. OF OBSERVATIONS



LEVEL NO.

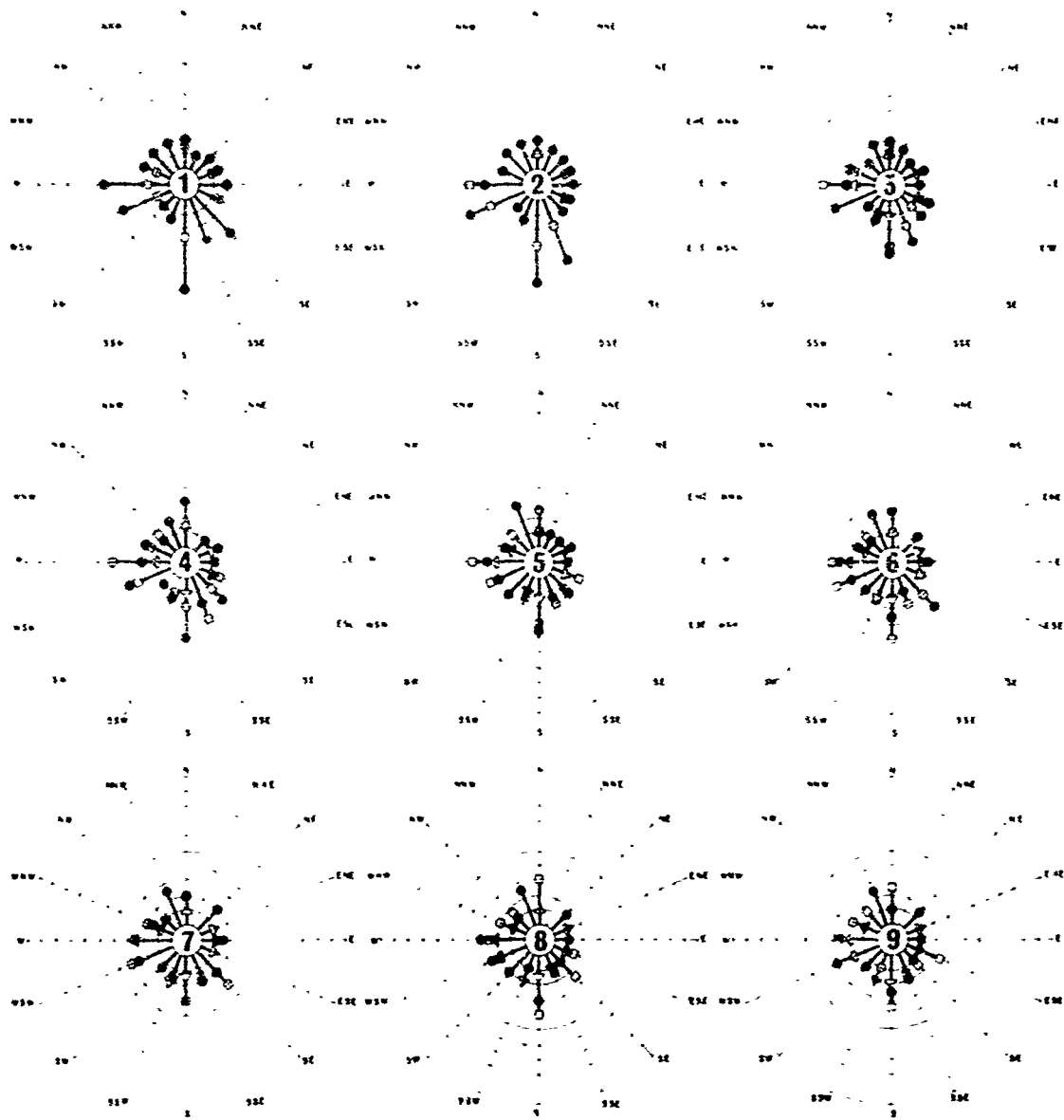
HEIGHT m

|   |      |
|---|------|
| 2 | 4.6  |
| 3 | 9.3  |
| 4 | 13.9 |
| 5 | 19.4 |
| 6 | 25.0 |
| 7 | 30.6 |
| 8 | 36.2 |
| 9 | 41.8 |

SPEEDS

|   |           |
|---|-----------|
| ● | 0-3 m/s   |
| ○ | 4-7 m/s   |
| ○ | 8-11 m/s  |
| ○ | 12-15 m/s |
| ○ | 16-19 m/s |

FIGURE 29. NIGHTTIME WIND ROSES FOR MAY



SCALE NO. OF OBSERVATIONS

\* LEVEL NO

HEIGHT (m)

SPEEDS

9

1

4.6

0-3

2

1.9

4-7

3

15.3

8-11

4

25.6

12-15

5

33.9

16-19

6

41.2

7

48.5

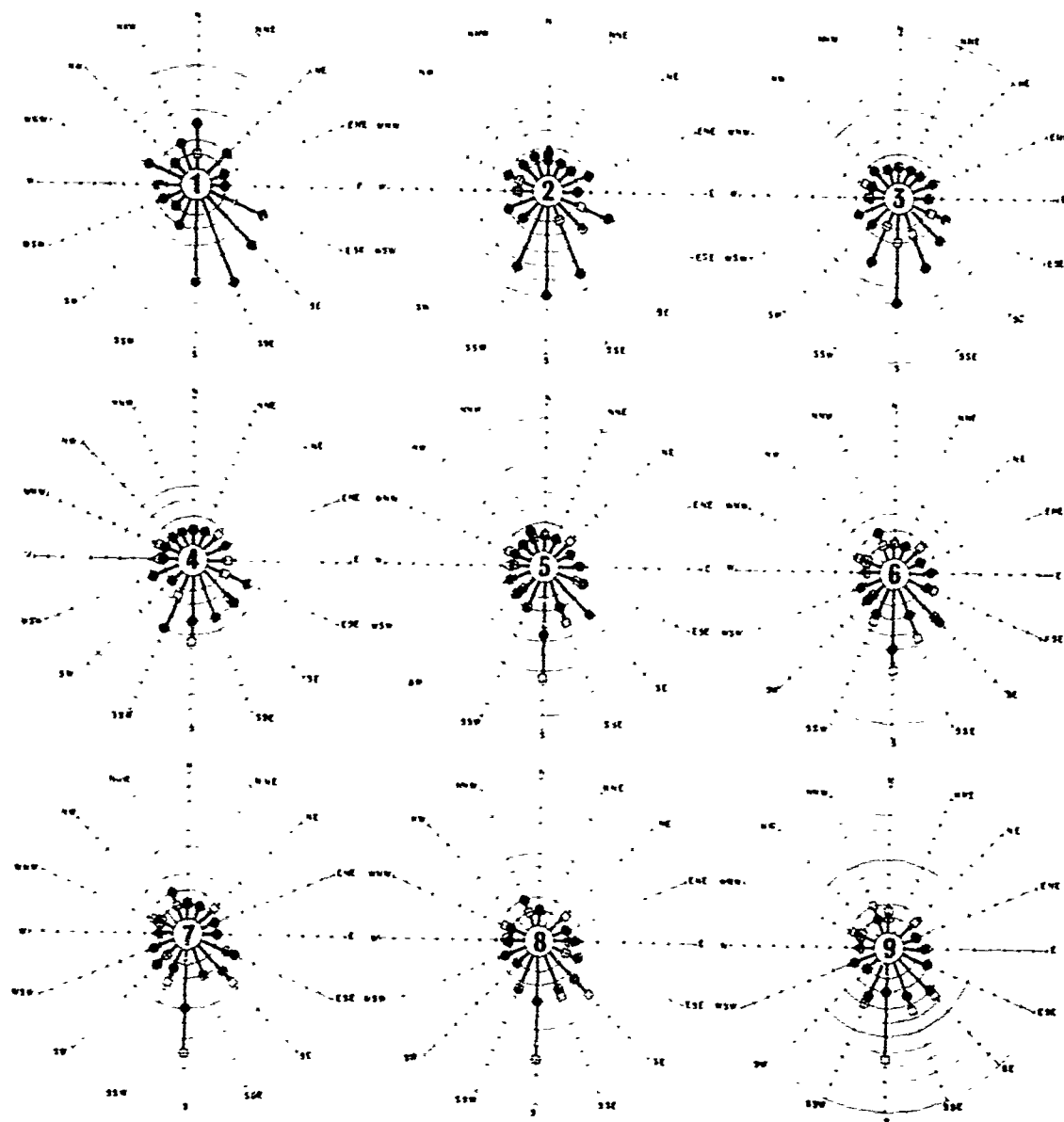
8

55.8

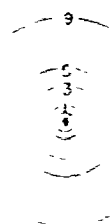
9

62.0

FIGURE 30: NIGHTTIME WIND ROSES FOR JUNE



SCALE NO OF OBSERVATIONS



# LEVEL NO

HEIGHT (m)

|   |      |
|---|------|
| 2 | 4.6  |
| 3 | 9    |
| 4 | 15.3 |
| 5 | 26.6 |
| 6 | 33.9 |
| 7 | 42   |
| 8 | 48.5 |
| 9 | 55.8 |
|   | 62.0 |

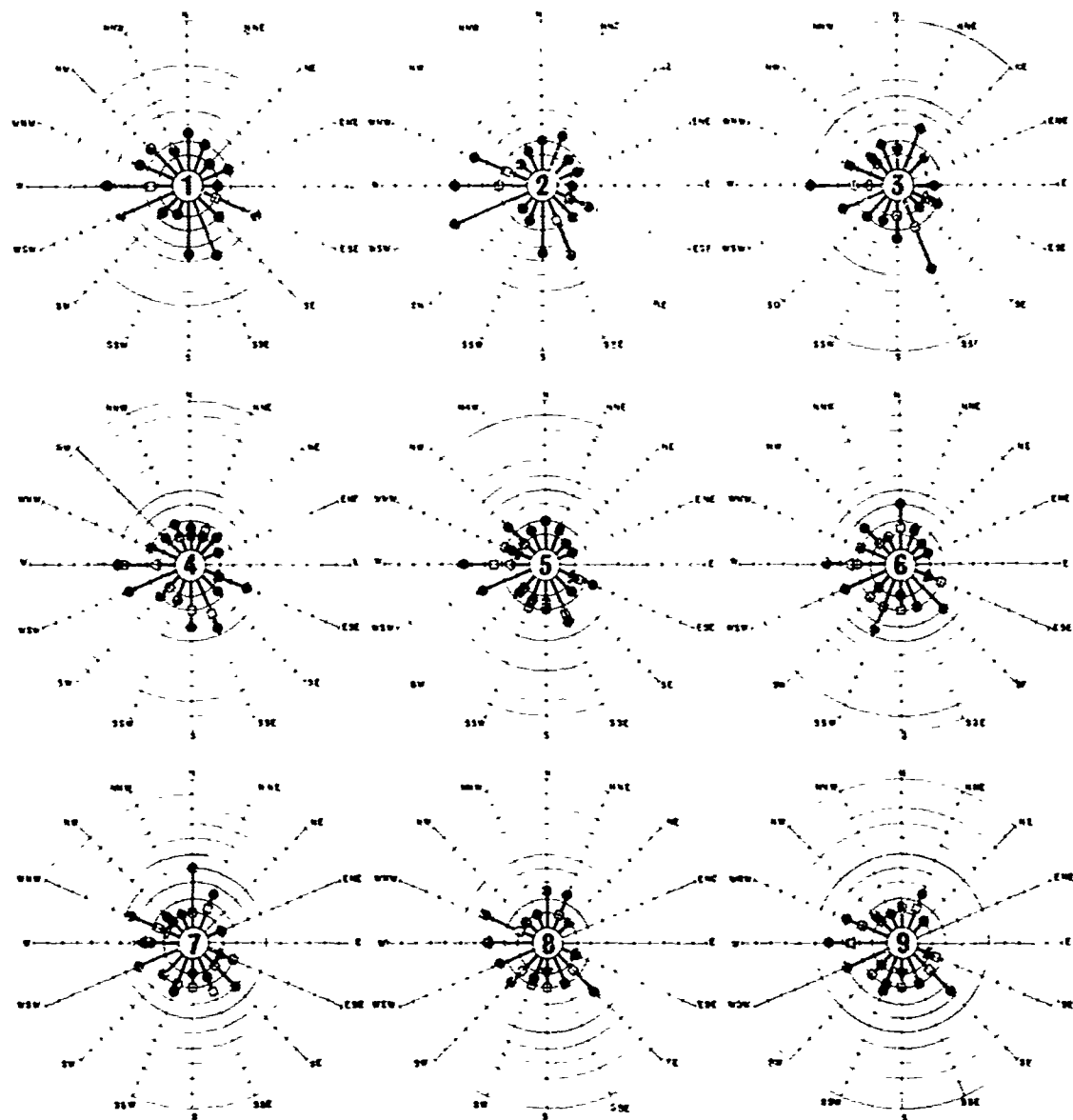
SPEEDS

ROAD

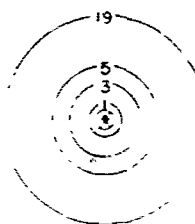
|       |     |
|-------|-----|
| 0-3   | m/s |
| 4-7   | "   |
| 8-11  | "   |
| 12-15 | "   |
| 16-19 | "   |

FIGURE 31: NIGHTTIME WIND ROSES FOR JULY





SCALE NO OF OBSERVATIONS



# LEVEL NO

HEIGHT (m)

SPEEDS

|   |      |
|---|------|
| 1 | 4 6  |
| 2 | 11 9 |
| 3 | 19 3 |
| 4 | 26 6 |
| 5 | 33 3 |
| 6 | 41 2 |
| 7 | 45 5 |
| 8 | 55 8 |
| 9 | 62 0 |

|   |         |
|---|---------|
| ● | 0-3 m/s |
| ○ | 4-7 "   |
| △ | 8-11 "  |
| ▽ | 12-15 " |
| ◇ | 16-19 " |

FIGURE 33: NIGHTTIME WIND ROSES FOR SEPTEMBER



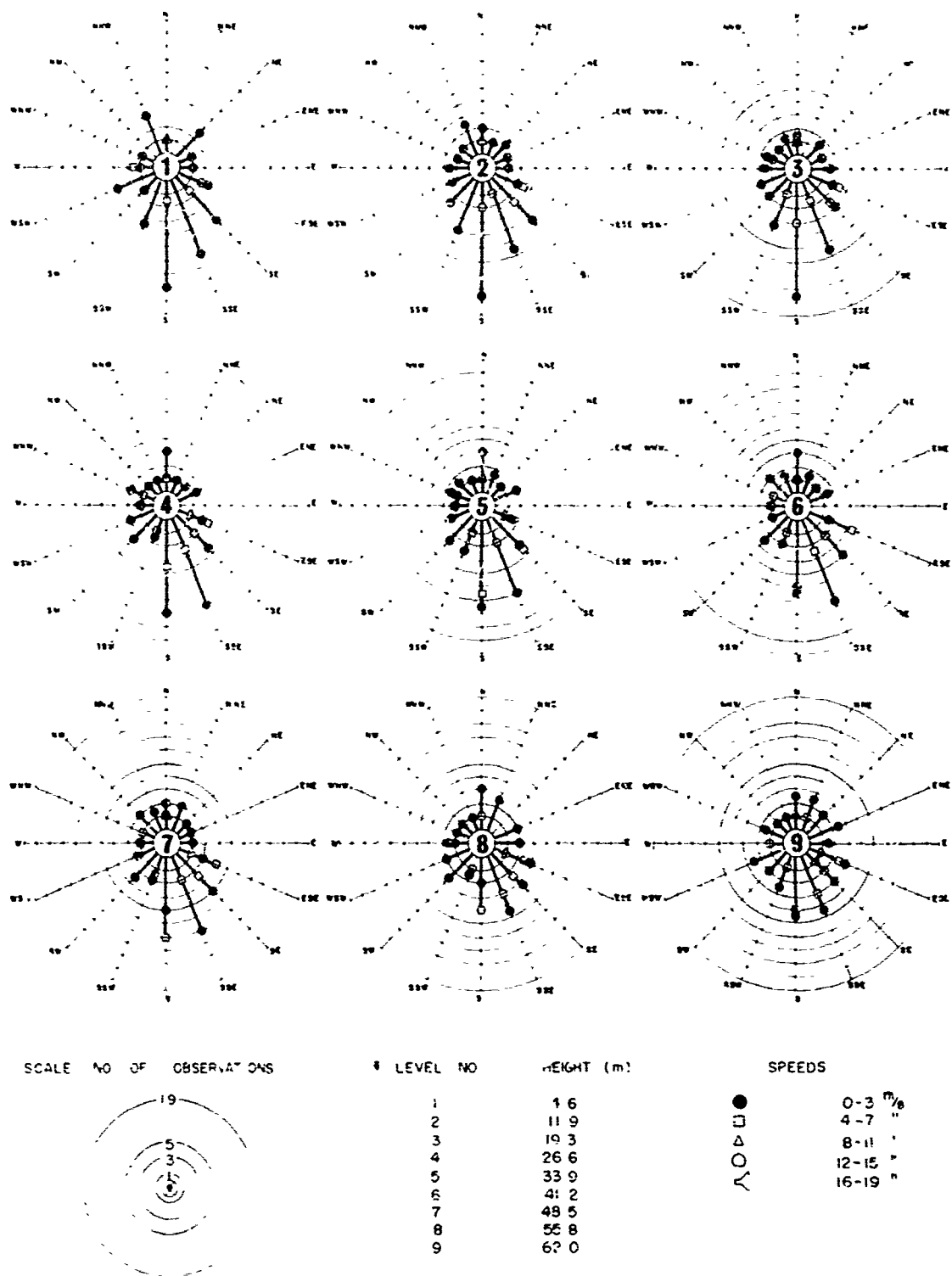
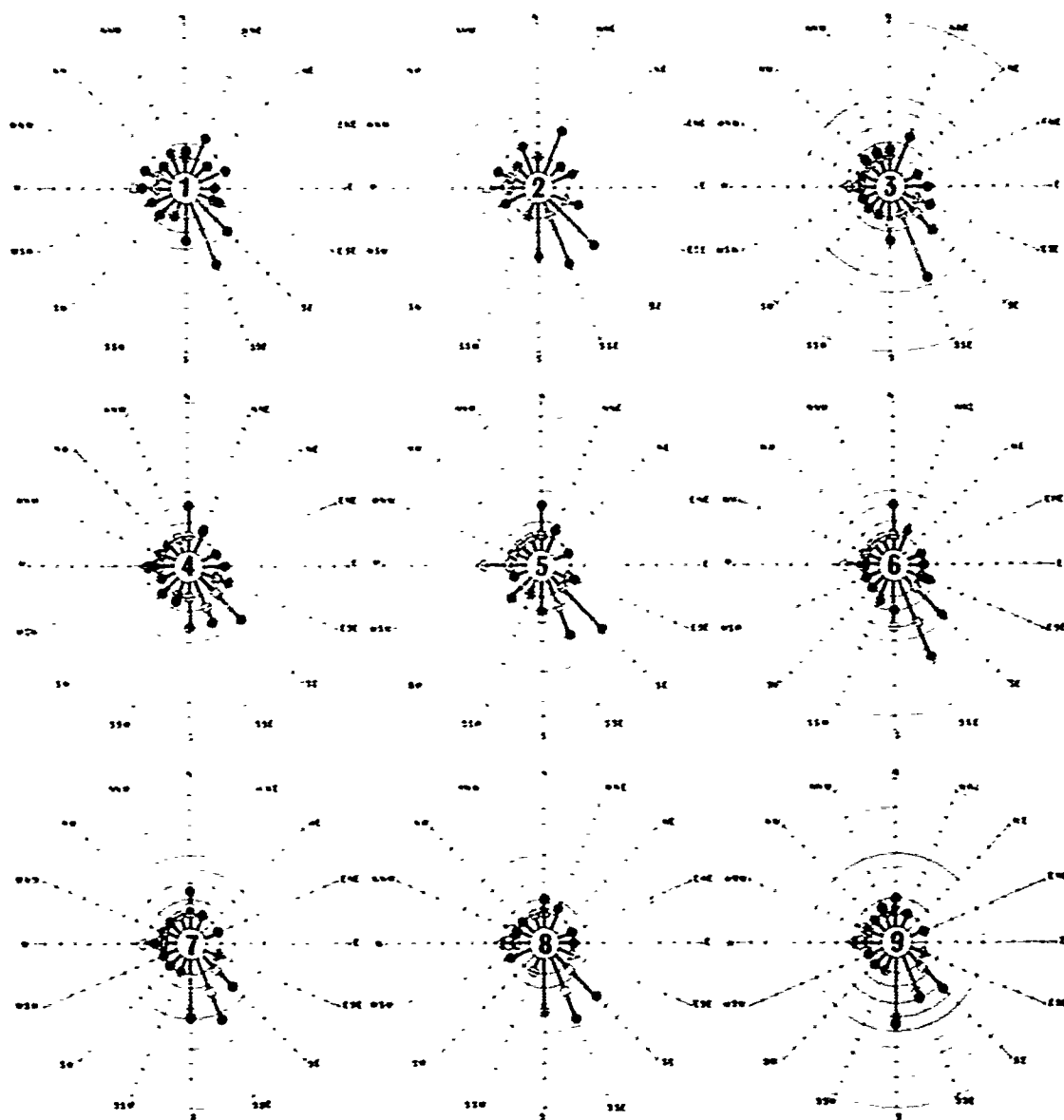
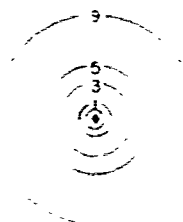


FIGURE 34: NIGHTTIME WIND ROSES FOR OCTOBER



SCALE NO. OF OBSERVATIONS



LEVEL NO

1  
2  
3  
4  
5  
6  
7  
8  
9

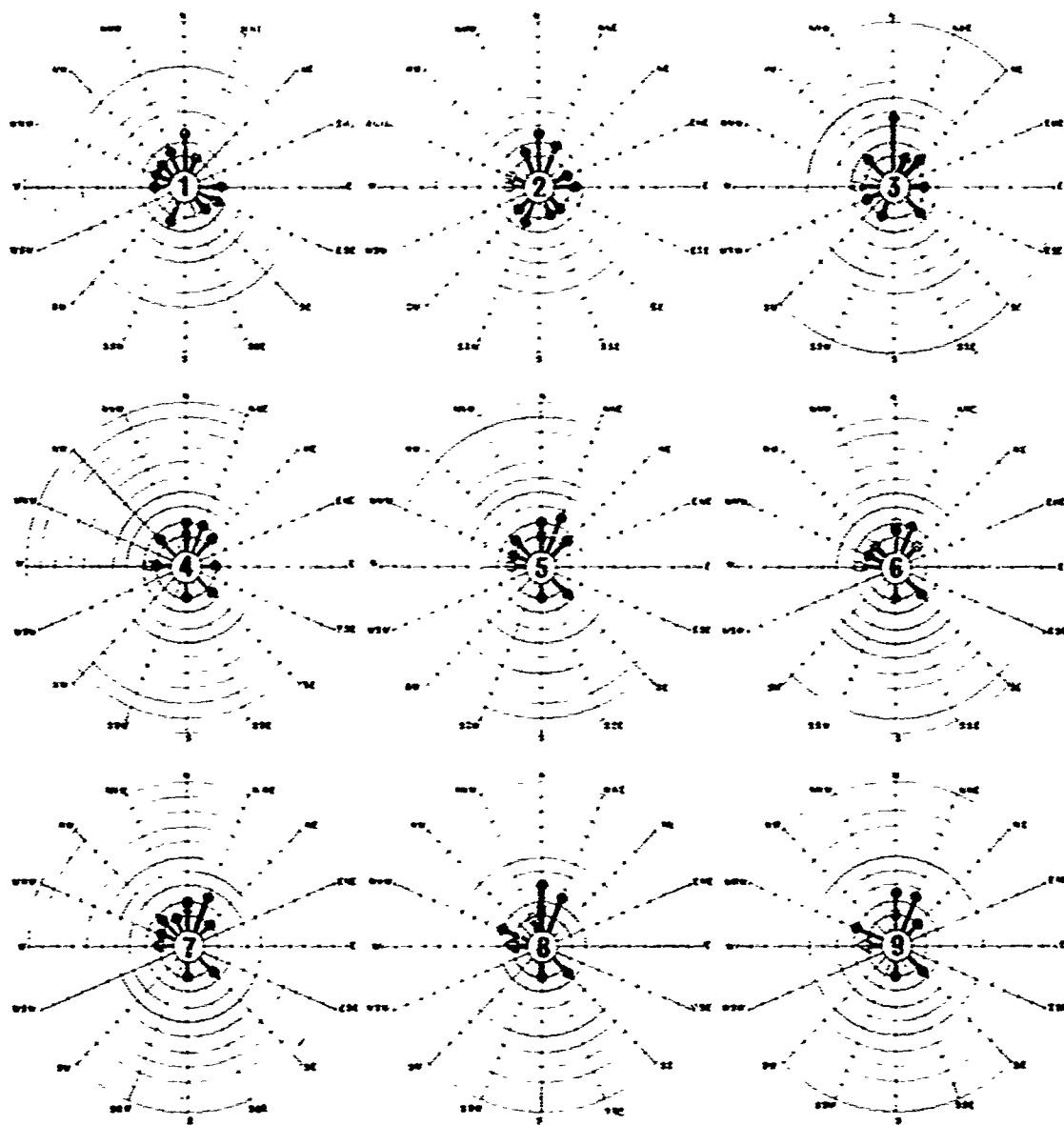
HEIGHT (m)

4.6  
1.9  
15.3  
26.6  
33.9  
4.2  
48.5  
55.8  
62.0

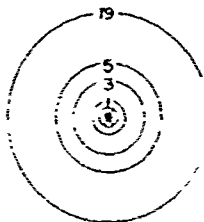
SPEEDS

● 0-3 <sup>7</sup>/<sub>8</sub>  
□ 4-7 "  
△ 8-11 "  
○ 12-15 "  
∧ 15-19 "

FIGURE 35: NIGHTTIME WIND ROSES FOR NOVEMBER



SCALE NO OF OBSERVATIONS



LEVEL NO

1  
2  
3  
4  
5  
6  
7  
8  
9

HEIGHT (m)

4.6  
11.9  
19.3  
26.6  
33.9  
41.2  
48.5  
55.8  
62.0

SPEEDS

● □ △ ○

0-3  
4-7  
8-11  
12-15  
16-19

FIGURE 36: NIGHTTIME WIND ROSES FOR DECEMBER

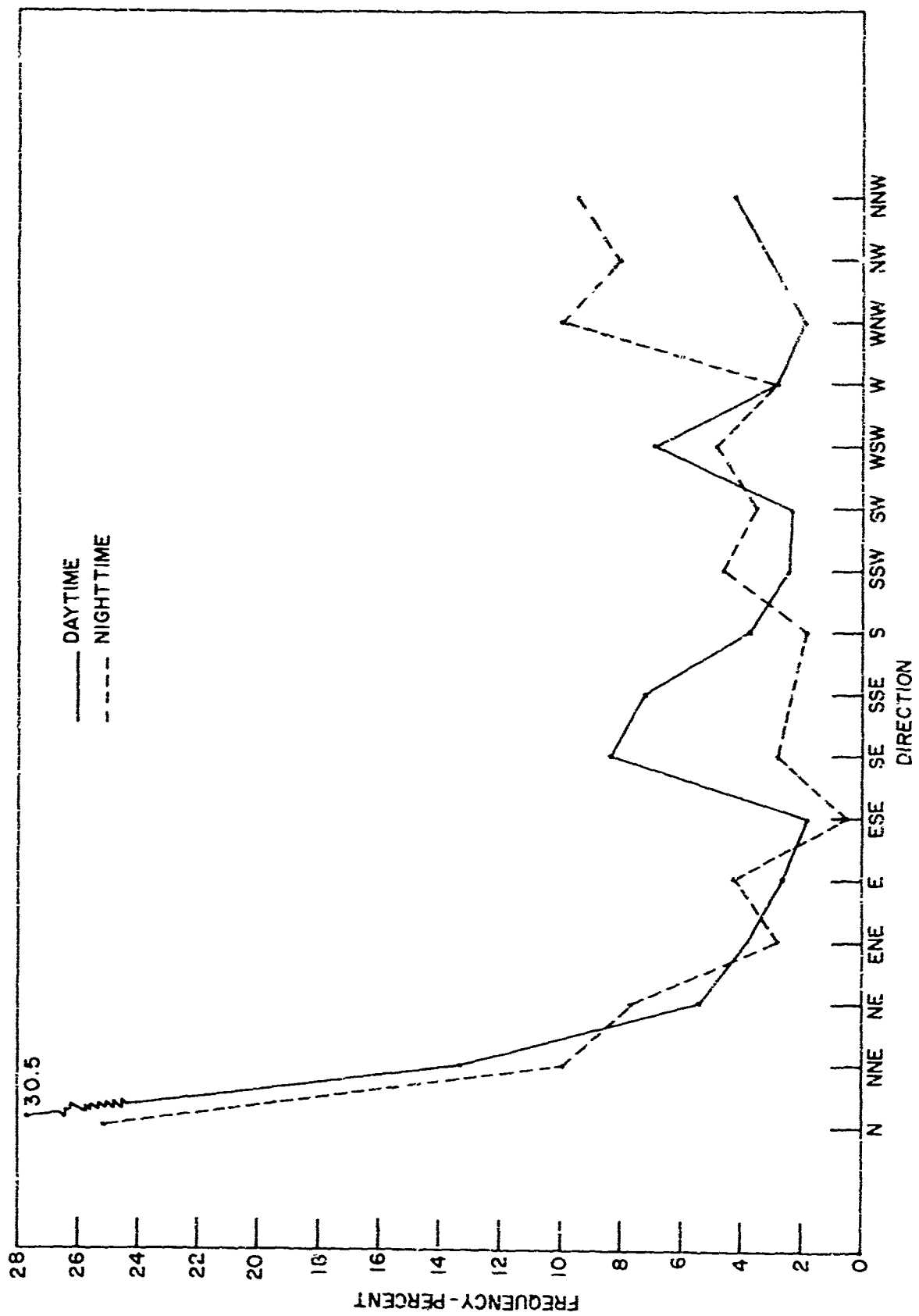


FIGURE 37. PERCENT FREQUENCY OF OCCURRENCE OF WIND DIRECTION, JANUARY

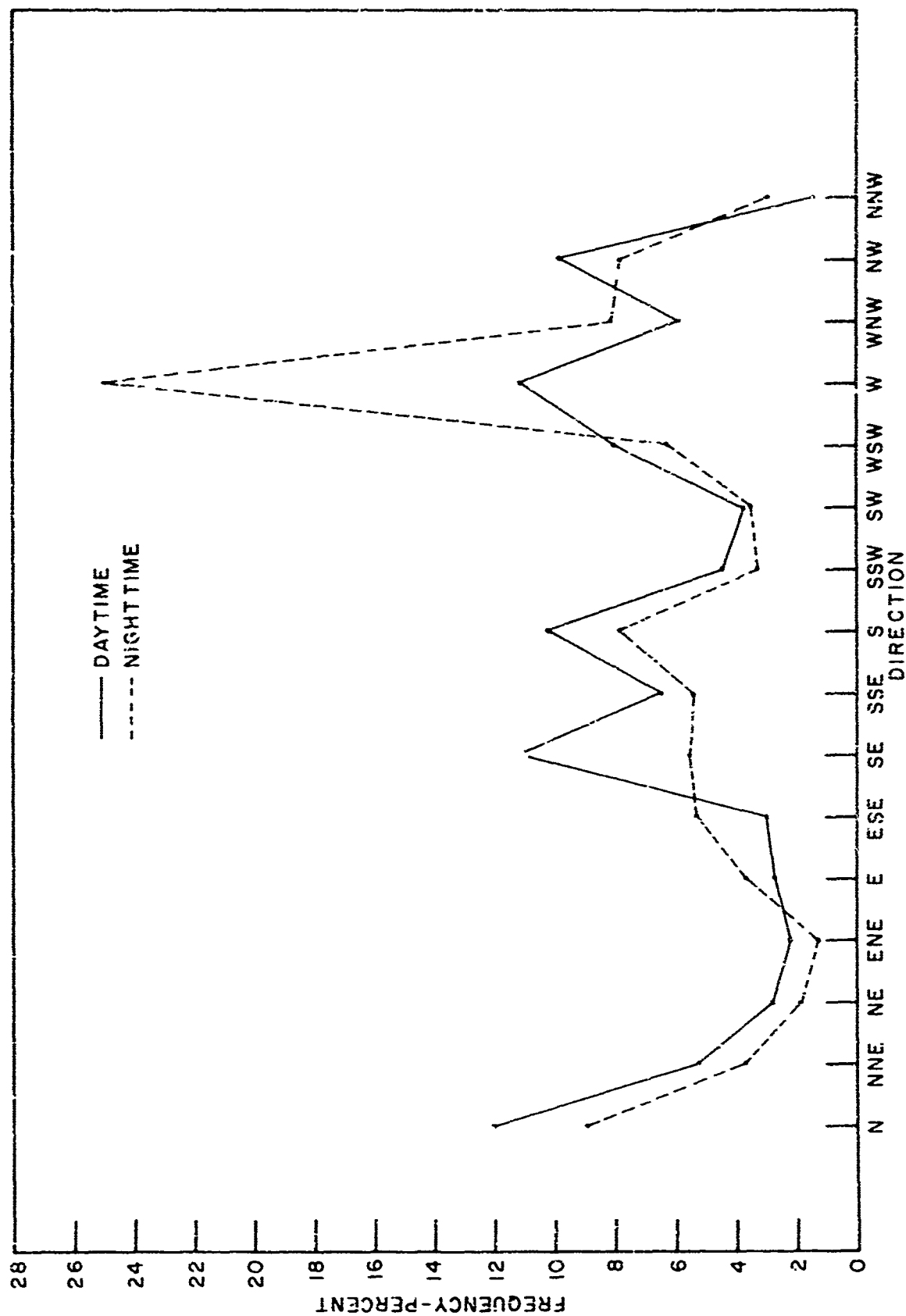


FIGURE 38. PERCENT FREQUENCY OF OCCURRENCE OF WIND DIRECTION, FEBRUARY

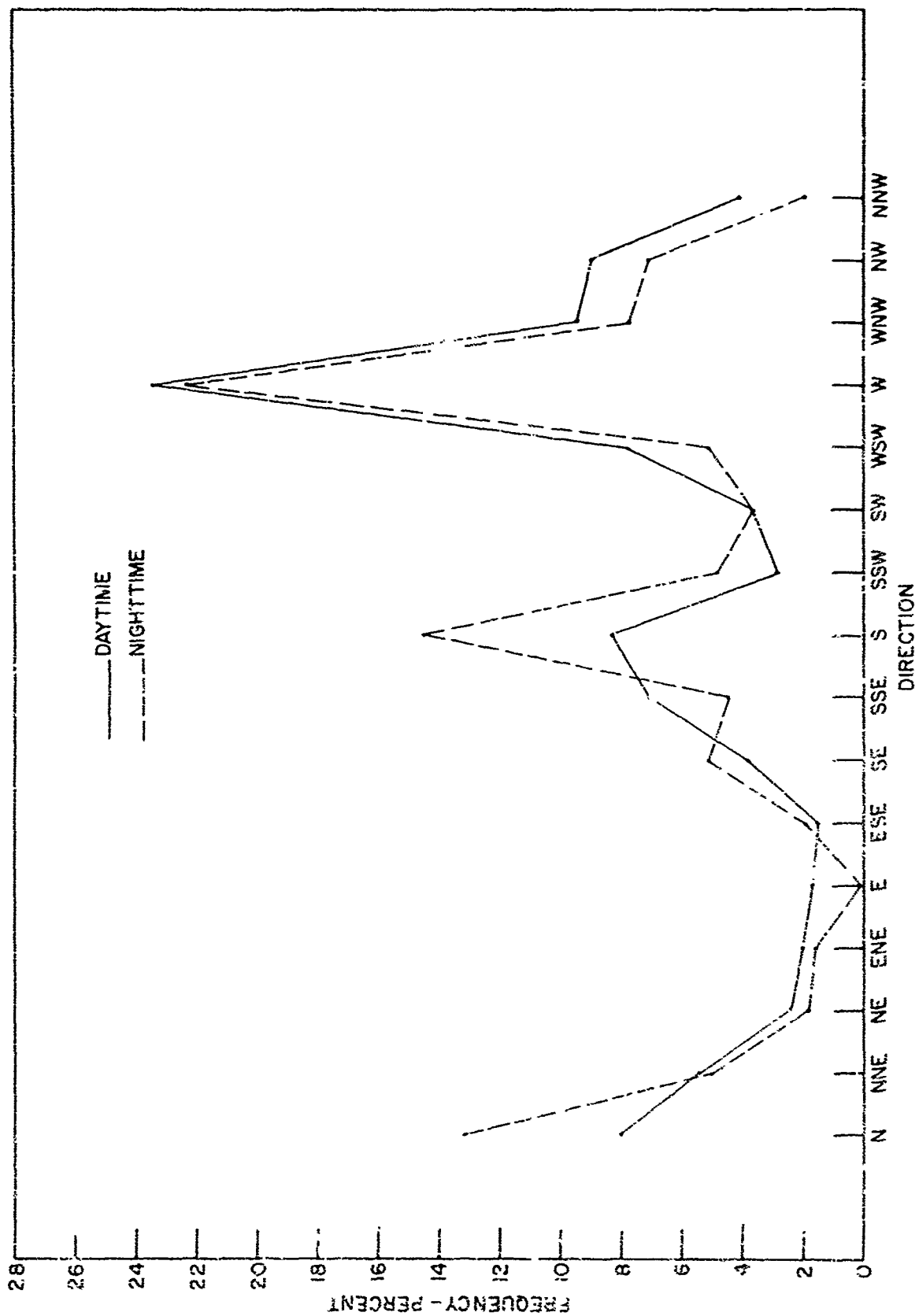


FIGURE 39 PERCENT FREQUENCY OF OCCURRENCE OF WIND DIRECTION, MARCH



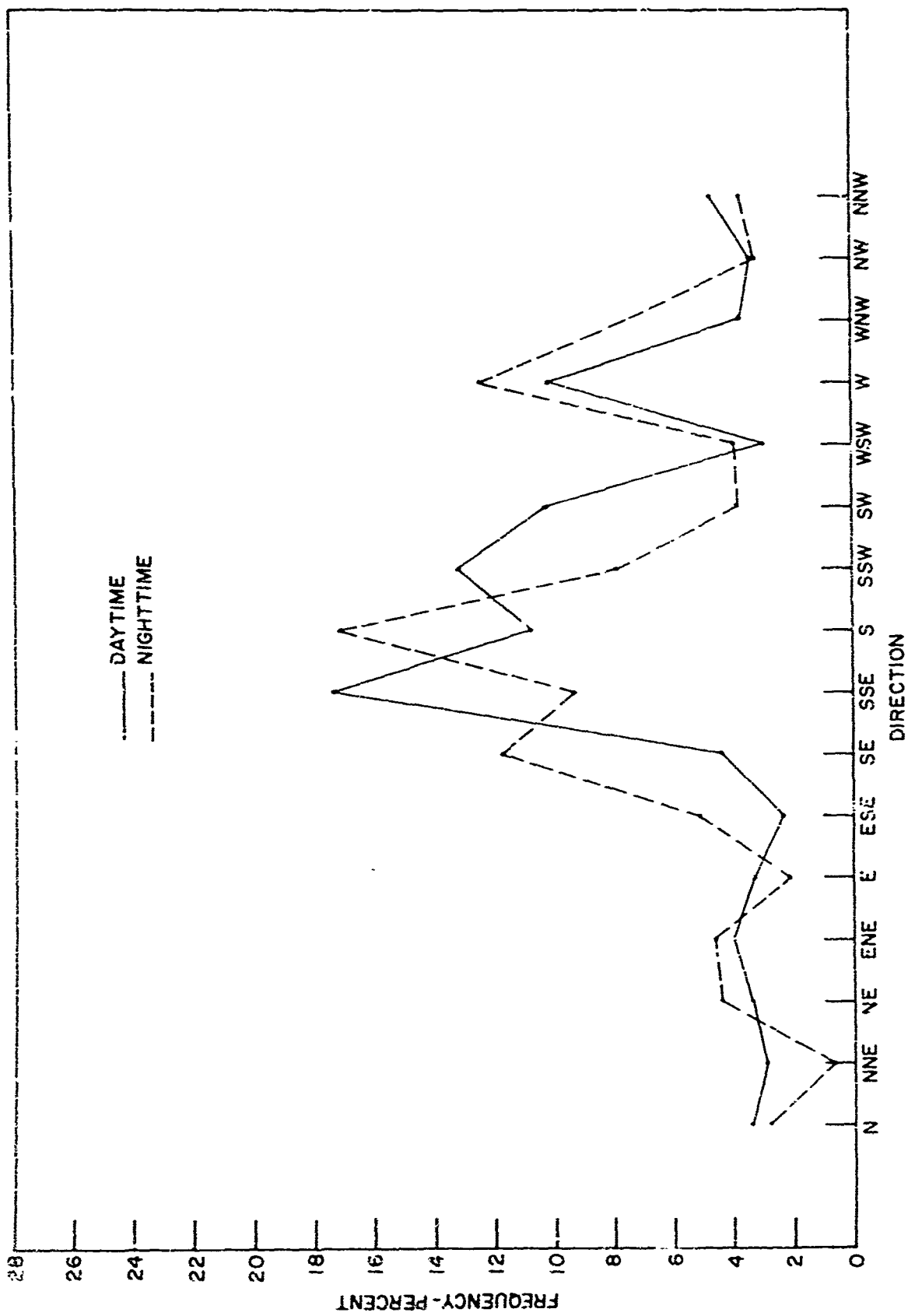


FIGURE 41: PERCENT FREQUENCY OF OCCURRENCE OF WIND DIRECTION, MAY



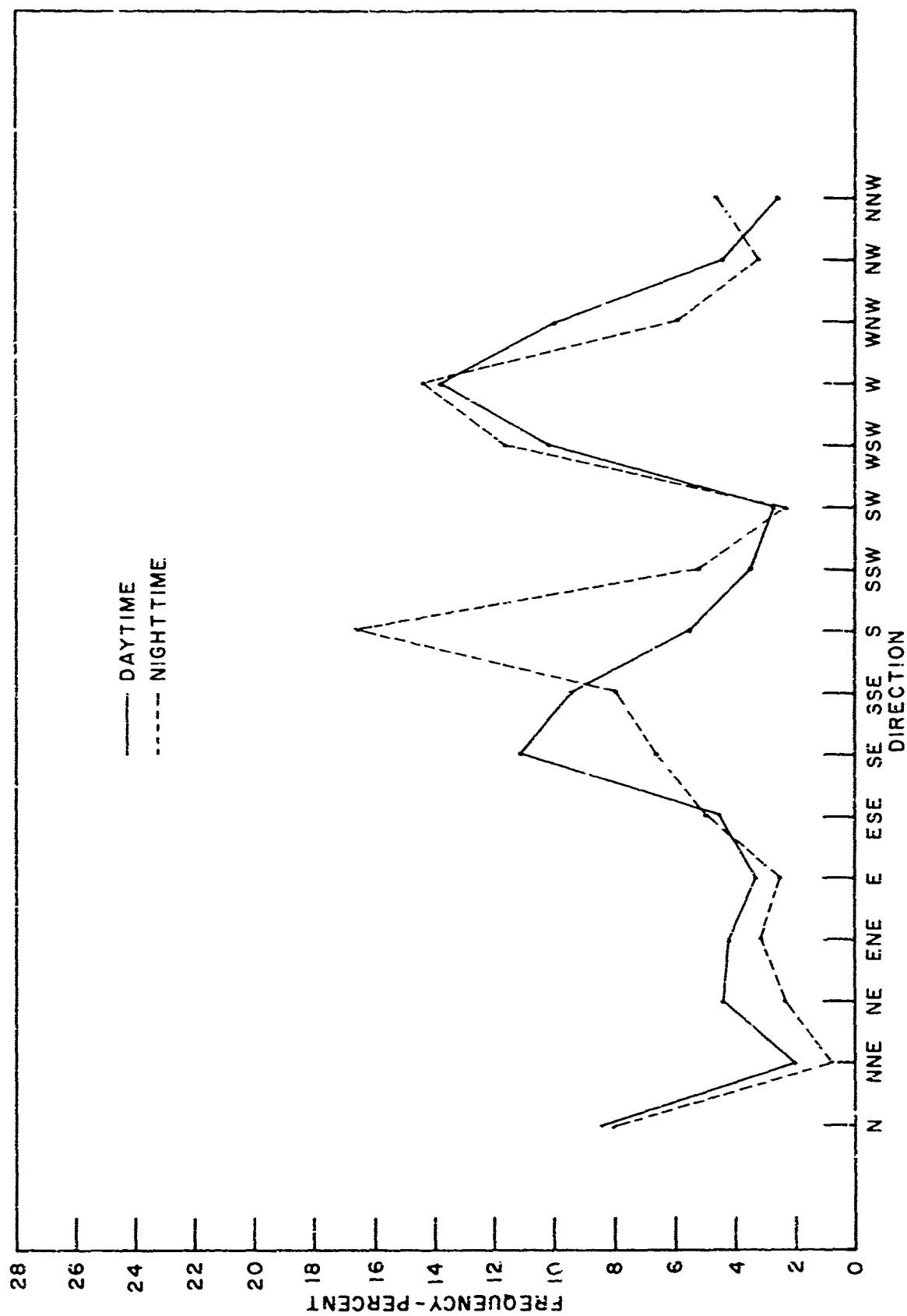
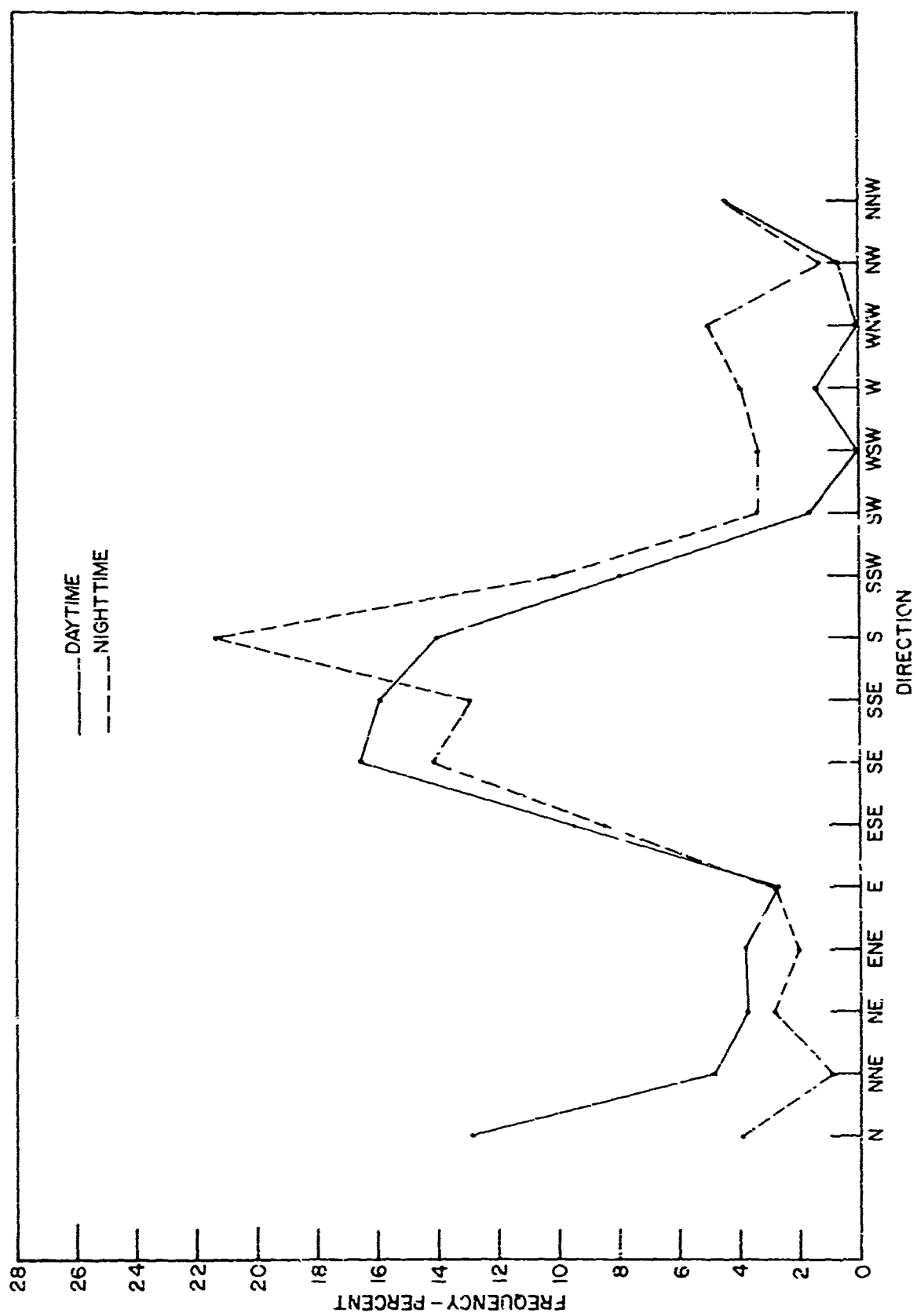


FIGURE 42: PERCENT FREQUENCY OF OCCURRENCE OF WIND DIRECTION, JUNE



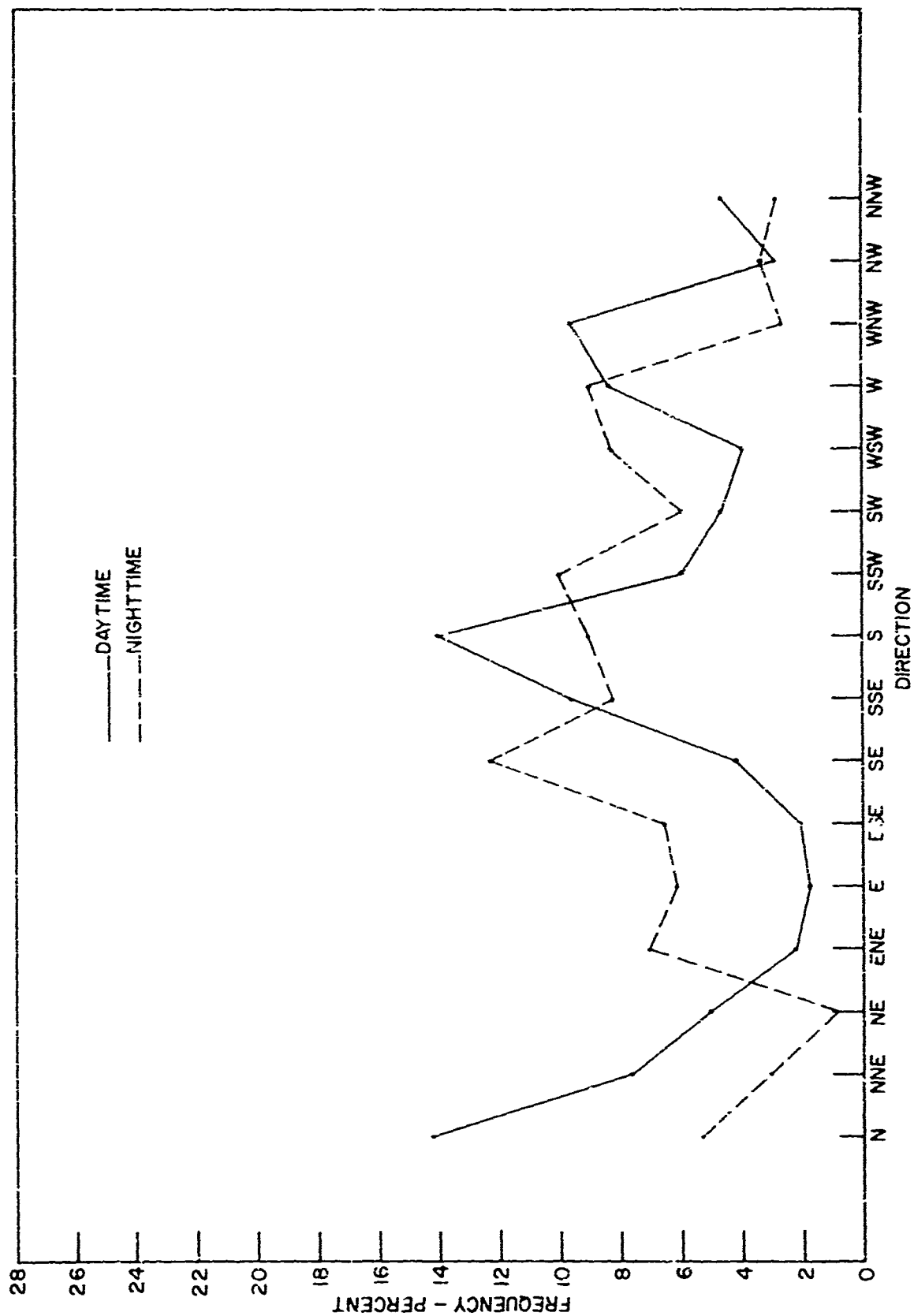


FIGURE 44: PERCENT FREQUENCY OF OCCURRENCE OF WIND DIRECTION, AUGUST

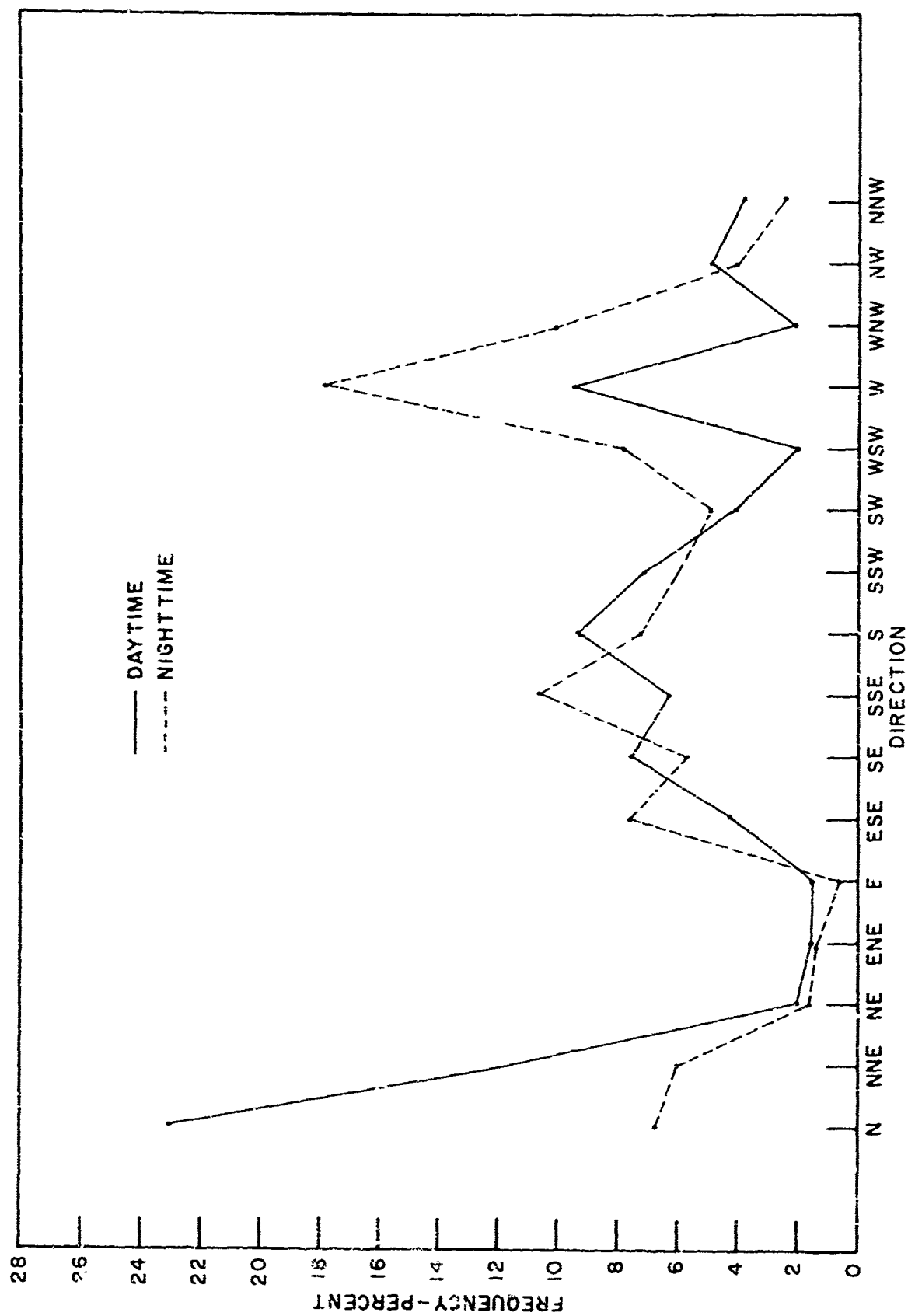


FIGURE 45: PERCENT FREQUENCY OF OCCURRENCE OF WIND DIRECTION, SEPTEMBER

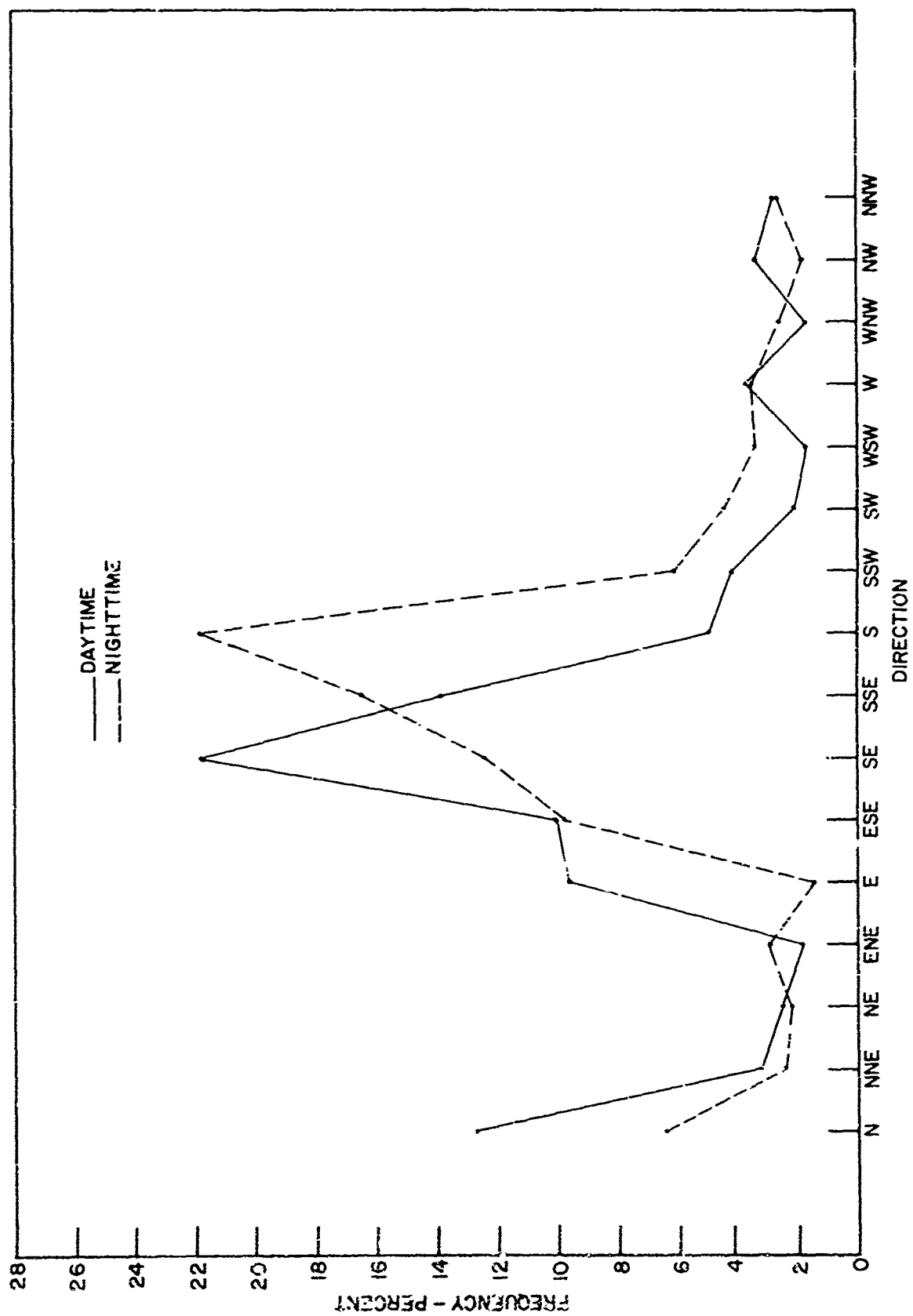


FIGURE 46: PERCENT FREQUENCY OF OCCURRENCE OF WIND DIRECTION, OCTOBER

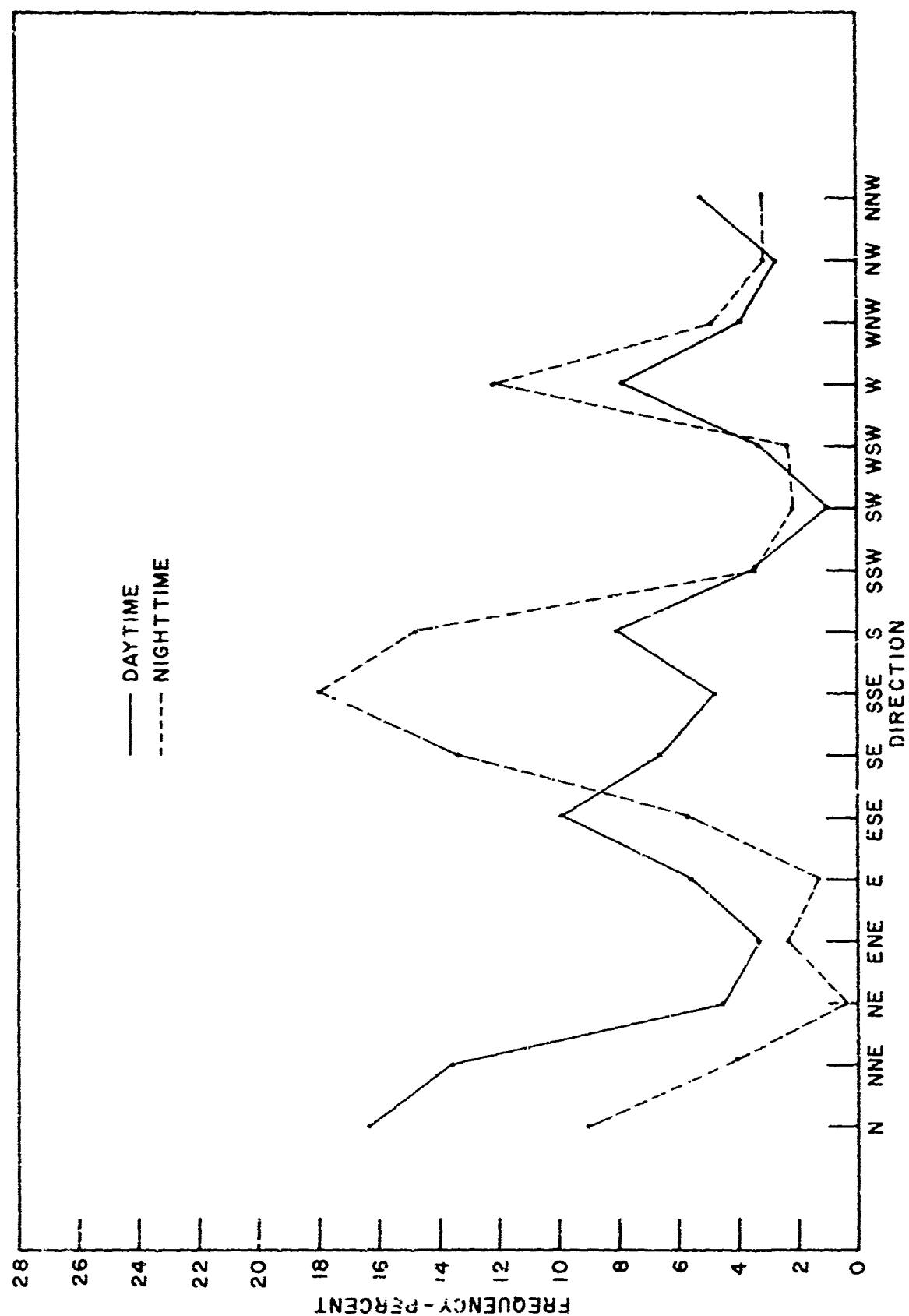


FIGURE 47: PERCENT FREQUENCY OF OCCURRENCE OF WIND DIRECTION, NOVEMBER

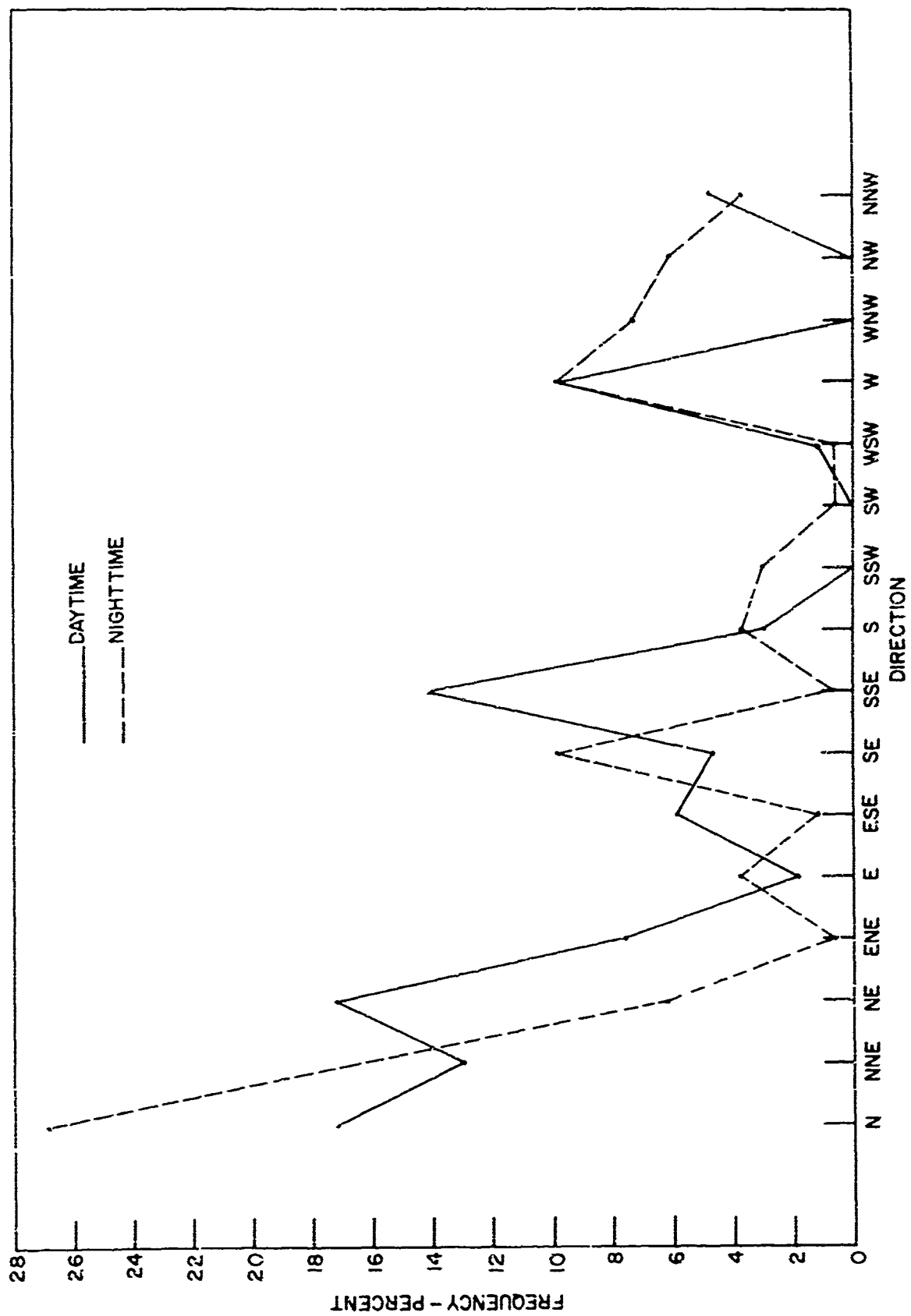


FIGURE 48: PERCENT FREQUENCY OF OCCURRENCE OF WIND DIRECTION, DECEMBER

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