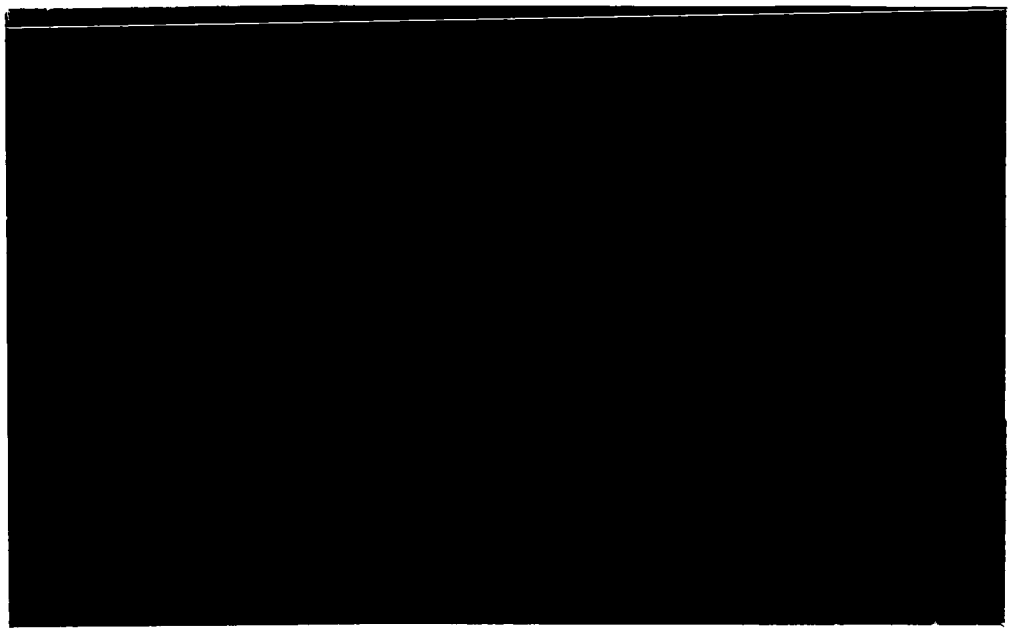


Arbeitsberichte der Schweizerischen Meteorologischen Zentralanstalt
Rapports de travail de l'Institut Suisse de Météorologie
Rapporti di lavoro dell'Istituto Svizzero di Meteorologia
Working Reports of the Swiss Meteorological Institute

Zürich

No. 19

Visibility, cloud base, wind velocity and direction, hydrometeors and thunderstorm at Zurich-Airport

by

C. H. Fourcy

Climatology 551.582.2:656.71(494.34)

April 1971

Summary :

This study aims at providing the user with operational and climatological data in a accessible form and at underscoring fundamental relations applicable for forecasting.

Résumé :

Ce travail a été conçu pour donner à l'utilisateur une idée claire de la climatologie opérationelle de l'aéroport de Zürich-Kloten. Certaines tendances fondamentales observées peuvent être utilisées en prévision.

Zusammenfassung :

Diese Arbeit versucht eine klare klimatologische Darstellung verschiedener Wetterelemente im Flughafen Zürich-Kloten zu bieten. Gewisse grundsätzliche Tendenzen daraus können als Prognosenunterlage verwendet werden.

Introduction :

The following diagrams for Zurich-Airport are based on data published in 1960 as "Meteorological summaries of observational data of the airports of Geneva-Cointrin and Zürich-Kloten". The observations used in the summaries were actual reports (AERO) taken over the period 1949-1958. These data were gathered under operational conditions and might, therefore, show some shortcomings if compared to strict scientific observations.

In view of a data reduction, it was decided to consider one out of two half-hourly observations only (H+45). All times are given in GMT (Central European Time minus one hour).

1. Graphs of frequencies of simultaneous occurrence of visibility and height of the base of the lowest cloud layer covering more than half of the sky ($N_s \geq 5$)

1.1 General remarks

Frequencies in per thousands for the different months of the years were computed as follows:

For: Jan., March, May, July, Aug., Oct., December $\quad F = \frac{\text{number of cases}}{10 \times 31}$

April, June, Sept., November $\quad F = \frac{\text{number of cases}}{10 \times 30}$

February $\quad F = \frac{\text{number of cases}}{10 \times 28 + 2}$

Frequencies in per thousands are cumulative (cf. summaries published in 1960). Since visibility and ceiling values occur simultaneously, all cases where one of the two parameters was beyond the limits were not considered. The graphs, therefore, depict merely the worst conditions in each class (see legend on graphs). Thus, e.g. the following cases were not considered: 6/8 at 6'000 ft and visibility 200 m, 8/8 at 800 ft and visibility 6'000 m.

"Sunrise"and"sunset" were defined as day-night limits and taken from AIP Switzerland (4) where "night" is defined as "the time between the end of civil evening twilight and the beginning of the civil morning twilight". The time at mid-month was chosen.

1.2 Discussion of the graphs (p. 20-25)

The statistical probability for the airport to remain closed during the whole day (ceiling below 200 ft) (4) in the months November, December, January is very small. The longest continuous fog period was experienced from December 14th to December 25th, 1951 (8) (13). The marked increase of poor visibilities and ceilings at the beginning of

September results from an increased effect of radiation cooling over the Swiss Plateau. The persistence of this stagnant cold air is favoured by orographic features of this region lying between the Alps and the Jura mountains. This cold air may form in any season; between November until mid-February, however, the insolation is no longer sufficient to overcome the nocturnal inversions. In summer foggy conditions do not last longer than three hours after sunrise. The rapid improvement of very bad conditions of visibility and ceiling observed in spring is very likely associated with the higher frequency of moderate and strong surface wind during this season. In autumn, on the other hand, the deterioration of visibility and ceiling is spread out over longer time intervals (see chapter 5). The autumn is a more stable season on the Swiss Plateau producing an increase of the already mentioned effects of radiation cooling and also due to the attenuation of the activity of cold air outbreaks by the time this area is reached. Especially in winter these air mass changes may often take place above the stagnant cold air (300-800 m above ground).

The poor conditions at 1500 GMT in March relate to two heavy snowfalls.

2. Graphs of frequencies of simultaneous occurrence of visibilty with sky clear or total amount of clouds 4/8 and less ($N \leq 4$)

2.1 General remarks

Per thousands were computed on a monthly basis and as explained under 1.1, sunrise and sunset were defined as under 1.1.

This group of obeervations comprises all cases of fog with sky visible as well as fog patches with cloud cover $\leq 4/8$.

2.2 Discussion of the graphs (p. 26-29)

The frequency distribution of bad visibility is very irregular, this being apparently due to the inhomogeneity of the statistical populations; a more detailed discrimination of the cloud cover might have led to a more homogeneous distribution. The criteria $N \leq 4/8$ and $N \geq 5/8$ appear to be entirely arbitrary in the light of the variability of the cloud cover and the estimation by the observer. Sunrise and sunset seem to be related to marked changes of visibility. Two reasons may account for these changes: a) the activation of condensation nuclei (1) (2) (3) (16); b) a change in the observation technique (at night by electrical light sources, during day by contrast on visible markings).

Daily variations are clearly featured with the greatest frequency of good visibilities coinciding with culmination of the sun.

3. Graphs of frequencies of simultaneous occurrence of visibility with total amount of cloud cover $\geq 5/8$ ($N \geq 5$)

3.1 General remarks

Per thousands were again computed on a monthly basis and as explained under 1.1, sunrise and sunset were also used as defined under 1.1.

This group of observations comprises the cases of fog with sky visible or fog patches with cloud cover $\geq 5/8$ as well as fog with sky invisible.

3.2 Discussion of the graphs (p. 30-37)

The distribution of bad visibilities occurs in a more homogeneous population than that studied in chapter 2. Here again, a marked increase of poor visibilities occurs at sunrise and sunset (see 2.2). The diurnal variation is featured clearly, especially for the warmest months. Snowfall account for the very bad visibilities shown at 1500 GMT in March and at 1000 GMT in April.

4. Comparison of the frequency of visibility and height of cloud base to the meteorological seasons and various periods of the day

4.1 General remarks

Time groups were selected as a criterion of formation and dissipation of fog during winter and autumn, and were carried through the other seasons. Due to the difficulty of separating the four seasonal periods of one diurnal variation, some groups include day as well as night observations in addition to twilight observations.

Per thousands were computed individually as related to the total number of observations in each time group for each season. They are not cumulative.

Visibility is expressed in hundreds of meters, cloud base in hundreds of feet.

4.2 Discussion of the graphs (p. 38-57)

The graphs feature clearly diurnal variations with increasing frequency of bad visibility and low ceiling especially at sunrise in every season, but also at sunset in autumn and winter. A characteristic annual variation is obvious, the better conditions occurring during spring and summer.

4.3 Anomalies

Remark: Values given in the text refer to visibility and ceiling in that order.

4.3.1. Yearly distribution

No yearly secondary maximums are discernible. However, there are two large categories, the first comprising the poor visibilities together with low ceiling, and the second the relatively better visibilities and ceilings above the limits considered critical for airline operations. During autumn and winter a limited number of observations showing

intermediate values between these main groups occur, whereas in spring and summer the grouping is quite distinct.

4.3.2 Seasonal distributions

4.3.2.1 Spring distribution (p. 38-42)

The 009/000 (i.e. visibility 900 m with ceiling below 100 ft). 009/001 and 009/002 secondary maxima of the time interval 2300 - 0200 GMT are repeated between 0300 and 0600 GMT with poorer visibilities (007/000 and 007/002) and lasting occasionally until 1000 GMT. Snow and drizzle are responsible for some of these.

The 049/009 maxima of the 2300 - 0200 GMT and 0300 - 0600 GMT periods appear to be caused by low stratus which is not unfrequent in March. These increases are not repeated in autumn, low stratus being more frequent at all levels. They do not last beyond 0700 GMT.

4.3.2.2 Summer distribution (p. 43-47)

The few small increases found (e.g. 049/000) are caused by forming or dissolving fog.

4.3.2.3 Autumn distribution (p. 48-52)

The 049/003 and 023/003 increases found between 2300 and 0200 GMT are repeated between 0300 and 0600 GMT with poorer visibilities. From 0700 to 1000 GMT visibility and ceiling values remain unchanged but frequencies increase. The secondary maxima disappear between 1100 and 1600 GMT but can again be found between 1700 and 2200 GMT within the limits 023/003 and 015/003. Main causes of these elevations

seem to be thick mist and drizzle which are fairly frequent during this season. A similar occurrence is found between 2300 and 0200 GMT for 015/002 decreasing to 011/002 (0300 - 0600 GMT and 0700 - 1100 GMT).

4.3.2.4 Winter distribution (p. 53-57)

The 015/002 (2300 - 0200 GMT) maximum, the 015/002 and 011/002 (0300 - 0600 GMT) maxima are found again between 0700 and 1600 GMT with visibility and ceiling values of 0700/002 and 005/002. Between 1700 and 2200 GMT these increases are found in the groups 015/002 and 011/002. These variations are probably caused by snow and drizzle coupled with temperatures below freezing.

Other special features (e.g. 015/004 or 009/006 between 1100 and 1600 GMT) are most likely the result of snowfall.

5. Seasonal distribution of surface wind direction and surface wind speed (night/day)

5.1 General remarks

The first two diagrams show the distribution of surface wind direction (expressed in per thousands) as indicated by an anemometer with respect to the geographical north. Per thousands were computed as follows:

$$F = \frac{\text{number of cases of one direction (dd) for one season} \times 1000}{\text{total number of observations during that season}}$$

The runway directions (RW) were added on the diagrams.
A FUESS pneumatic direct transmission anemometer was used.

5.2 Discussion of the first two diagrams (p. 58)

Due to human factors a predilection of the main directions appears. This bias can be eliminated by averaging between dd + 10° and dd - 10° for the main directions.

The relatively large frequency of calms and variable wind directions in autumn and winter during daytime is characteristic and is influenced by two factors:

- accumulation of a shallow layer of cold air near the ground during autumn and winter, winds being mostly calm although only 50 or 100 m above that layer wind speeds could be measured;
- variation of measurable threshold values of the anemometer varying from 4 knots in winter (increased viscosity of lubricants) to 2 knots in summer.

5.2.1 Daytime (p. 58, 08-19 GMT)

These diagrams show similar distribution for spring and summer while autumn and winter together show common characters. This leads to a comparison of these two groups of seasons.

A clear predominance of westerlies and south-westerlies is evident, the quadrant from east to south showing relatively small frequencies. The differentiation between westerly and south-westerly wind directions with respect to seasons is related to evolutionary aspects of the general meteorological situation. Wind directions from 280° to 300° are dominating during the summer months, this being explained partly as a local topographical effect and resulting insolation (e.g. uphill breezes undisturbed by the general circulation on sunny summer days in the Glatt Valley). North-easterly directions dominate in spring and are caused by the general meteorological situation.

5.2.2 Night-time (p. 58, 20-07 GMT)

The general frequency distribution undergoes a major change although south-west and north-east still predominate. A noteworthy increase of south-easterly directions occurs which is caused by canalized winds along the Glatt Valley (mountain breeze effect) although winds from this direction occur throughout the year. The smallest frequency of calm and variable winds occurs in the most perturbed season.

5.3 Distribution of surface wind speed (p. 59-62)

5.3.1 General remarks

Per thousands' distribution was computed as follows:

$$F = \frac{\text{total occurrence in each speed group in direction dd} \times 1000}{\text{total occurrence in that direction dd}}$$

This computation was done for each season, separately for day and night. Due to the wide variation of the computed values, a sliding scale was used in the graphs.

As a result of the above per thousands' computation, an apparent reversal of frequencies is shown on the diagrams in the distribution of speeds when speeds in the range of 1-6 knots are compared to those $\geq$ 7 knots. In reality the directions with the largest absolute number of cases of strong winds ($\geq$ 7 knots) are also the directions where the largest absolute number of light winds are observed.

Wind frequencies at Zürich Airport were compared to the frequency of occurrence of synoptic situations as classified by Hess and Brezowsky (7).

5.3.2 Calms and variable winds between 1 and 6 knots (p.59-62)

Variable winds were considered together with calms since variable winds account at most for 3 %o of the observations in any season. The frequency of calms and variable winds exceeds by 110-240 %o the frequency of the corresponding synoptic situations. Two explanations are offered for this fact: a) performance characteristics of the wind measuring equipment (see 5.2); b) accumulation of stagnant cold air during night-time especially during some seasons (see 5.2).

The winds of the speed range 1-6 knots being largely the result of local orographic effects, no attempt was made to relate them to synoptic situations.

5.3.3 Seasonal comparison of wind speeds of 7 knots or more (night and day)

5.3.3.1 Spring and summer (daytime)(p.59-60, III-V + VI-VIII 08-19 GMT)

North and north-easterly winds are observed more frequently in spring than in summer, this being in accordance with the frequency of synoptic situations, while north-westerlies are more frequent in summer than in spring. The increased occurrence of north-westerly wind directions is, however, smaller than could be expected from the occurrence of corresponding synoptic situations which is nearly double and is explained as well by the sheltering effect of the hilly country to the north-west of the airport as by diversion effects of the Alps and the Jura mountains to more westerly and south-westerly directions over the whole Swiss Plateau.

Southerly and south-westerly wind directions are more frequent in summer than in spring, although the frequency of synoptic situations diminishes by 25 %o. Wind speeds in excess of 22 knots do not occur often enough for the purpose of drawing comparisons.

5.3.3.2 Spring and summer (night-time) (III-V + VI-VIII 20-07 GMT)

The transition of spring to summer is associated with decreasing wind speeds, Zurich Airport being less affected by synoptic situations with high winds in summer.

5.3.3.3 Transition summer/autumn

During daytime the relative frequency of wind speeds less than 10 knots decreases while wind speeds in excess of 10 knots increase with respect to summer. At night a general increase of wind speeds is noted. Day and night effects tend to be less marked in autumn due to smaller insolation and more frequent synoptic perturbations.

5.3.3.4 Autumn and winter (daytime), (p.61-62, IX-XI + XII-II 08-19 GMT)

North-easterly and easterly winds become more frequent in winter as do respective synoptic situations. The decrease of south-easterly and southerly winds is tied to a corresponding decreased frequency of synoptic situations. Similarly the greater frequency of south-westerly winds in winter reflects the increased frequency of corresponding synoptic situations. The smaller frequency of north-westerlies in winter is again not related with the larger number of corresponding synoptic situations but due to the

Visibility is expressed in hundreds of meters, cloud base in hundreds of feet.

Per thousands were computed as follows:

$$F = \frac{\text{number of cases of a given visibility and a given wind speed in a given group of cloud height} \times 1000}{\text{total number of cases observed in one group of given cloud height}}$$

This computation is different from that applied in chapter 4. Per thousands cannot therefore be compared.

6.2 Discussion of the diagrams

Generally speaking, no facts emerge from these diagrams which would not already have been found in the diagrams of chapter 4, except perhaps the fact that very bad visibilities may occur with ceilings of $\leq$ 400 ft as well as with ceilings $\geq$ 1000 ft but disappear nearly without exception under ceiling conditions between 500 and 900 ft. The following explanation is offered: snow and fog may occur up to 400 ft ceiling. At and above ceilings of 1000 ft fog with sky visible may occur under an overcast of cirrus. Between 500 and 900 ft, on the other hand, occassional fog may occur together with precipitation during winter.

7. Hydrometeors and electric phenomena (p. 70)

The graphs of this chapter show the observed frequency of specified hydrometeors expressed in per thousands. For all diagrams per thousands were computed in the same way as in chapter 1. Precipitation amounts in millimeters have not been considered. Electric phenomena comprise thunderstorms at the observation site or in its immediate vicinity as well as distant thunder heard or only distant lightning observed. The number of cases are the number of observations of a given hydrometeor.

7.1 Hydrometeors and electric phenomena graph

This graph calls for no comment.

7.2 Annual and daily variation of frequency of precipitation and thunderstorms

These graphs are also shown as per thousand frequency.

7.2.1 Rain (p. 71)

No discrimination was made between continuous rain and rain showers. No clearly defined minimum appears on this graph. Diurnal effects connected with an influence of the sun do not have a marked effect on the distribution of the cases of rain. Fairly clear maxima, however, appear towards evening (beginning at 1700 GMT) extending into the night. If the April maximum is not completely understood due to convective precipitation, the August maximum seems to be closely related to decaying meso-systems, since it occurs simultaneously with a sharp maximum of electric phenomena (see 7.2.5).

7.2.2 Drizzle (p. 72)

The hourly occurrence of drizzle reflects a diurnal variation due to solar influence. A clear monthly maximum is evident in November and a small secondary maximum appears in October. The following explanation of these maxima is offered : subsequently to a polar air invasion a shallow cold air layer forms, the process being helped by radiation at night. An inversion results at 1200-1500 meters/m.s.l. (2500-3500 ft above ground).

Below the inversion condensation occurs resulting in the formation of a low stratus occasionally producing drizzle. This low cloud layer is frequently associated with a north-easterly flow ("Bise") in the lowest 1000 m. The maximum occurrence of drizzle

at 0600 GMT (in fact 0645 GMT observation) in November seems to be related to the average time of sunrise during this month. A logical assumption would be to relate this maximum to a structural change of photo-electric origin within the stratus (1) (2) (3). As soon as the rising sun reaches a given elevation, the drizzle stops and partial or complete dissolution of the low stratus may occur. When radiation cooling becomes stronger than the solar warming, low stratus will form again or increase. The April maximum is less marked because the general meteorological situation fluctuates to a larger extent, which in turn makes the formation of a persistent cold air lake more difficult on the Swiss Plateau.

7.2.3 Snow (p. 73)

This diagram shows that snow is never observed at Zürich Airport only during four months. Greatest frequencies of snow occurrence are found logically in relatively small occurrences of rain isohyetes. It should furthermore be noted that the heaviest snowfalls are always related to a cold air mass over the Swiss Plateau associated with an advection of warm moist air overrunning the stagnant cold air. Snowfall may be observed with wet-bulb temperatures up to $+3^{\circ}$ C at ground level (9).

7.2.4 Soft hail and hail (p. 74)

The diurnal effect is clearly recognizable on the occurrence of hail. Soft hail, often associated with post-frontal conditions, only occurs in months when the freezing level is found below 1000 m/m.s.l. The small number of cases precludes other estimates, this remark applying to the whole diagram. Further-

more, the surrounding terrain features protect Zürich Airport fairly well against very strong thunderstorms, the main drift routes of these avoiding the airport (see attached general plan).

7.2.5 Electric phenomena (p. 75)

This graph is of relatively little interest since it incorporates thunderstorms at the station and its vicinity as well as audible thunder and visible lightning. Following factors have introduced an element of error in the statistical material :

a) the noise of aircraft landing and taking-off has most certainly influenced the statistic of audible thunder;

b) during the hours of darkness lightning may be visible from as far as Genoa. It must be assumed that during daylight lightning may be visible over a distance of about 20 km, this distance increasing to about a maximum of 500 km during darkness. The dashed lines on the graph are the day/night limits ("sunrise" and "sunset") as defined under 1.1 and are obviously related to the above mentioned day/night effect.

The observational material considered precludes valid conclusions. The facts are interesting in themselves, e.g. the maximum registered at 1300/1400 GMT appears to be related to local thunderstorms. These thundery cells undergo dissolution and regeneration processes throughout the afternoon as they progress across Switzerland. These mesosystems can be detected very clearly over Switzerland by using appropriate chart scales and methods of analysis (11) (12).

8. Meteorological visibility (QBA) versus runway visual range (RVR) in various precipitations

The relationship meteorological visibility/runway visual range is of interest to pilots and airlines using operating minima expressed as RVR if no RVR forecast is available. The influence of various precipitations on this relationship was found to be smaller than expected. Variations in lighting intensity influence greatly on the relationship QBA/RVR; experience has shown the following intensities to be most favourable at Zürich Airport :

- daylight = 100 % intensity
- night = 30 % intensity (to offset glare-effect at landing)

8.1 Definition of day, night and twilight

The time interval between the earliest hour of the month preceding the beginning (or ending) of daylight as defined in AIP Switzerland (4) and the latest hour of the month following (or preceding) the ending of daylight is called twilight. The remaining hours of daylight are the day, those of darkness being the night.

8.2 Relationship QBA/RVR in various precipitations

8.2.1 Fog, sky not visible (p. 76-78)

The fog density does not appear to have an influence on the relationship QBA/RVR; the following values were found to apply:

- daylight and twilight: RVR = 2 QBA
- darkness: RVR = 2 1/2 to 3 QBA

8.2.2 Fog, sky visible (p. 79-81)

The thickness of the fog layer was found to have no influence on the relationship QBA/RVR. Applicable values are identical to those found for fog, sky invisible (see 8.2.1).

Remark:

For QBA values of less than 100 m related RVR values were found to vary very considerably. This large variation is due to the spacing of the runway lights (30 m and 50 m) on which RVR measurements are taken. There is no possibility for the observer to interpolate, and intermediate lights every 10 m would be needed to eliminate this variation. Due to this, RVR may be wrong by as much as 20 % although the fundamental relation shows that 100 m QBA equal 300 m RVR.

8.2.3 Snow (p. 82-83)

The RVR/QBA ratio might be expected to be less favourable in snow than in fog due to the refraction and reflection properties of snow crystals limiting the visual possibilities of an observer or a pilot. The graphs showed this assumption to be erroneous. A separation according to snow types (dry snow/wet snow) was intended but the limited number of observations made this impossible. Day and night values of the RVR/QBA relationship confirmed the value found previously for fog. In connection with twilight a factor of 3 was found to apply.

8.2.4 Other meteorological phenomena

Lack of homogeneity and the small number of observations available in fog patches, mist, rain and drizzle makes these unsuited for discussion; the general tendency, however, seems to be similar to that found for fog (see 8.2.1).

8.3 Rule and concluions

The following rule results from the above:

- daylight : RVR = 2 QBA
- night : RVR = 2 1/2 to 3 QBA
- twilight : RVR = 2 QBA (3 QBA in snow)

These values are slightly below those found for fog in London (Heathrow), Gatwick and Manchester (6), although Zürich Airport is virtually free of smog. Two reasons may explain this fact: a) difference in light intensities used (100 % in the United Kingdom day and night); b) RVR observations taken under routine conditions at Zürich Airport and not resulting from scientific experimental instrumentation which would involve the use of a transmissometer and intermediate visual markers (i.e. lamps).

The values found in the United Kingdom were the following:

- daylight: RVR = 2,5 QBA
- night: RVR = 3 QBA

These values are nearly the same as those found in Zürich, and seem to indicate that, in spite of very different climatological conditions, values of RVR/QBA may be nearly the same for each fog, at least in the temperate zone if observed under identical conditions.

9. Description of specific meteorological sectors at Zürich Airport

9.1 General remarks (p. 84)

Scale 1 : 100'000. Lines of equal elevations are drawn every 100 m with indication of highest and lowest points. Runways are numbered at their extremities. The central circle is drawn around the observing station,and the figures indicate specific meteorological sectors at Zürich Airport.

All per thousands were computed on the total number of possible occurrences during the 10-year period covered by the study.

9.2 Specific meteorological phenomena and related sectors

The following remarks apply to all descriptions:

- fog does not form or persist together with wind speeds exceeding 6 knots;
- large amounts of snow mostly occur with wind speeds smaller than 7 knots.

1) Wind from sector 100° to 020° (E to NE)

Canalization effect on surface wind (Jura and Alps) combined with local orographic effects. Frequent low stratus (15 %o) at 500 ft (150 m) for above. Occasional reduction of visibility down to 1 km in drizzle or drifting snow. Moderate to slight snowfall. Turbulence after take-off on runways 28/10 with wind $\geq$15 knots.

2) Sector 020° to 320° (N to NW)

Frequently "Stau" (barrage) effect against Alps. Cloud base usually (17 %o) at 1000 ft (300 m) or above. Advection fog along Glatt Valley extending from the Rhine Valley. Occasional drizzle, moderate to heavy snowfall reducing visibility down to 300 m.

3) Sector 320° to 260° (NW to W)

Worst sector with cloud base frequently (19 %o) down to 500 ft (150 m) or less. Radiation fog forming along the Glatt Valley and some cases of advection fog (see 2, sector 020° to 320°). Moderate to heavy snowfall by light wind. Turbulence after take-off on runway 34/16 under strong surface wind conditions due to sheltering effect.

4) Sector 260° to 200° (S to W)

Advection of moist warm air masses. Strong mist, visibility between 3 and 8 km. Ceiling unlikely below 1000 ft (300 m).

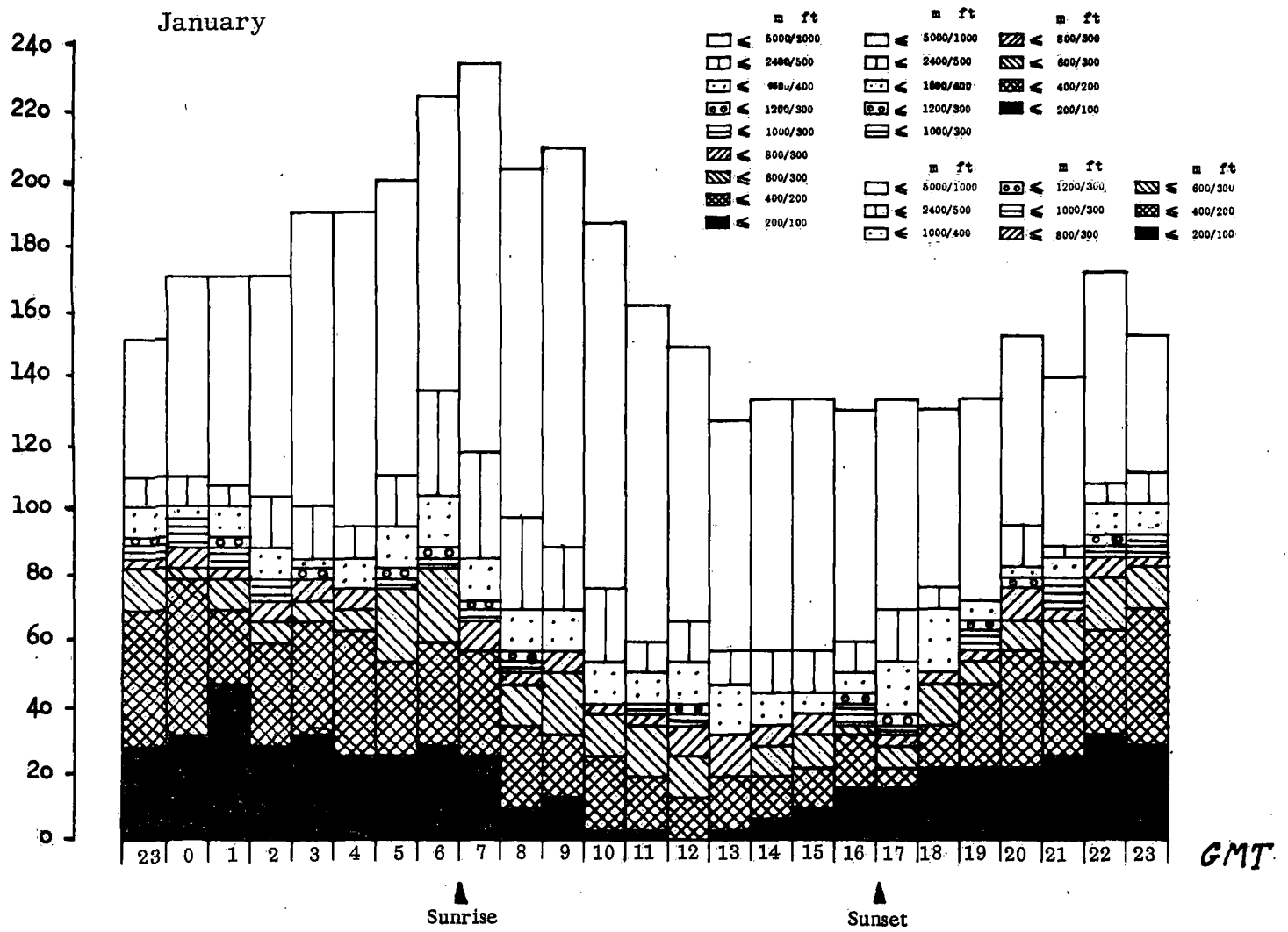
5) Sector 200° to 100° (S to SE)

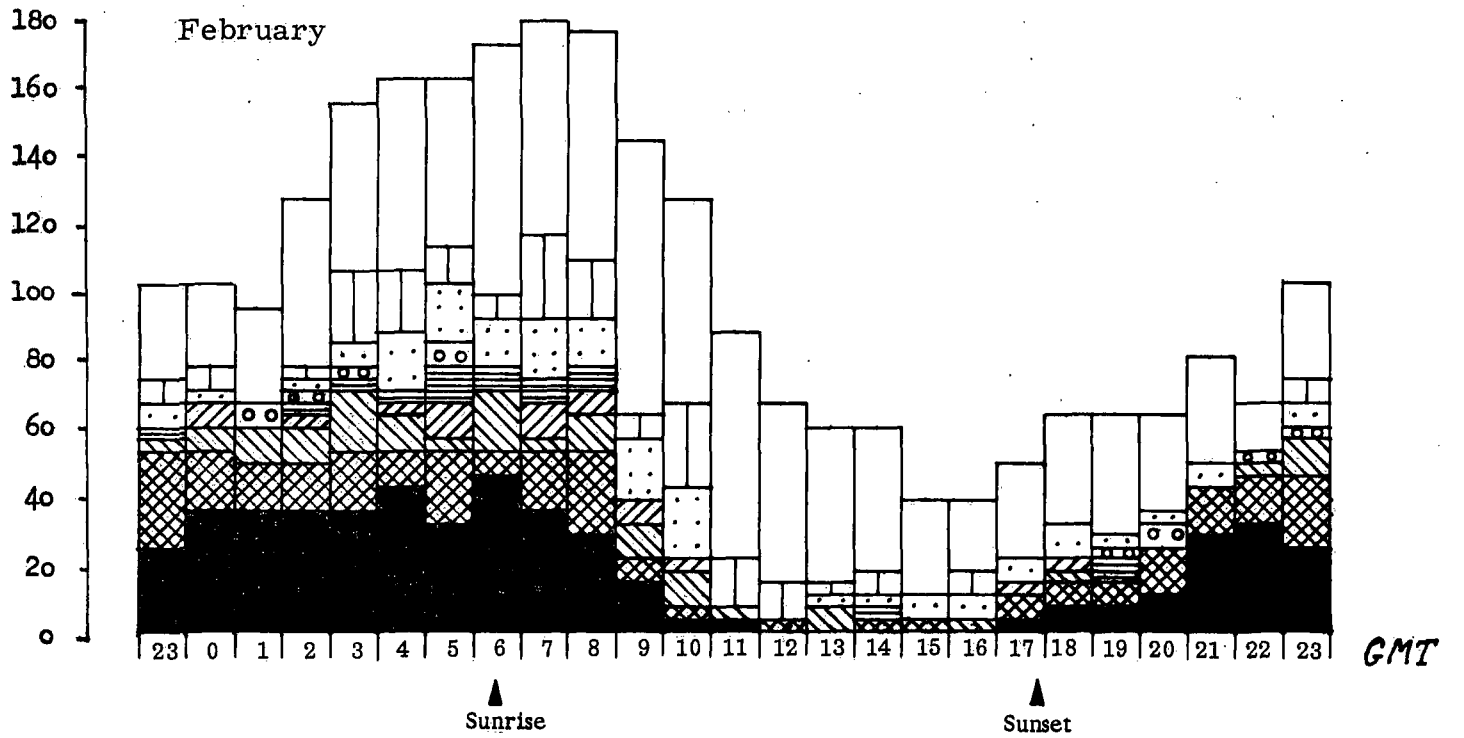
Ceiling unlikely below 1000 ft (300 m). Visibility to the south may be excellent when "Foehn" reaches the Airport.

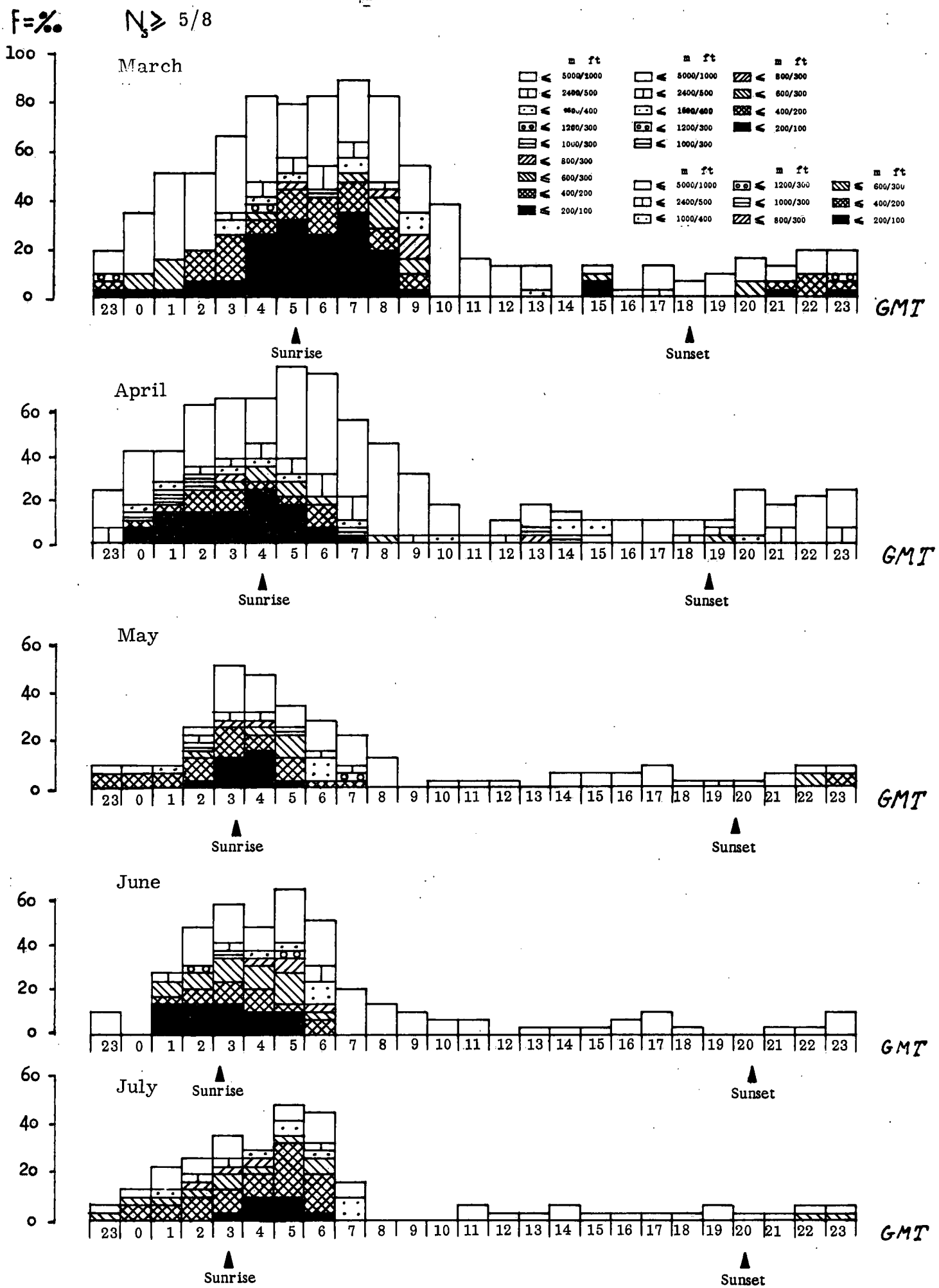
T_s and T'_s

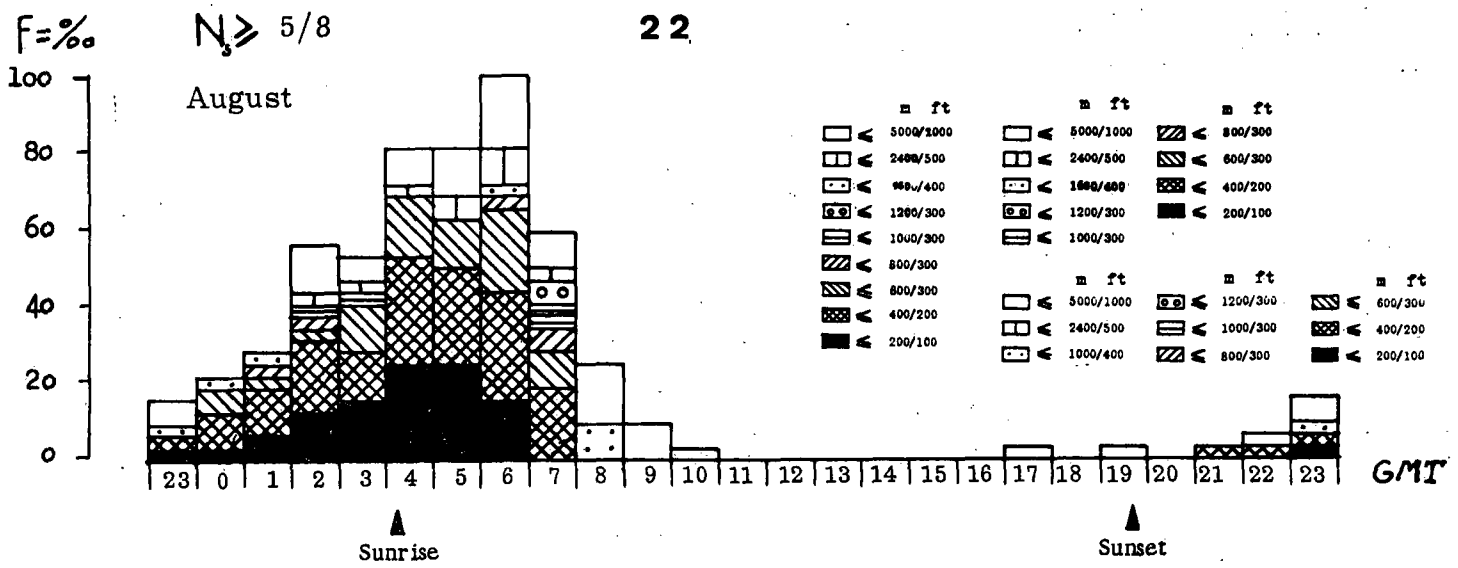
Main thunderstorm (T_s) tracks in the vicinity of the airport.

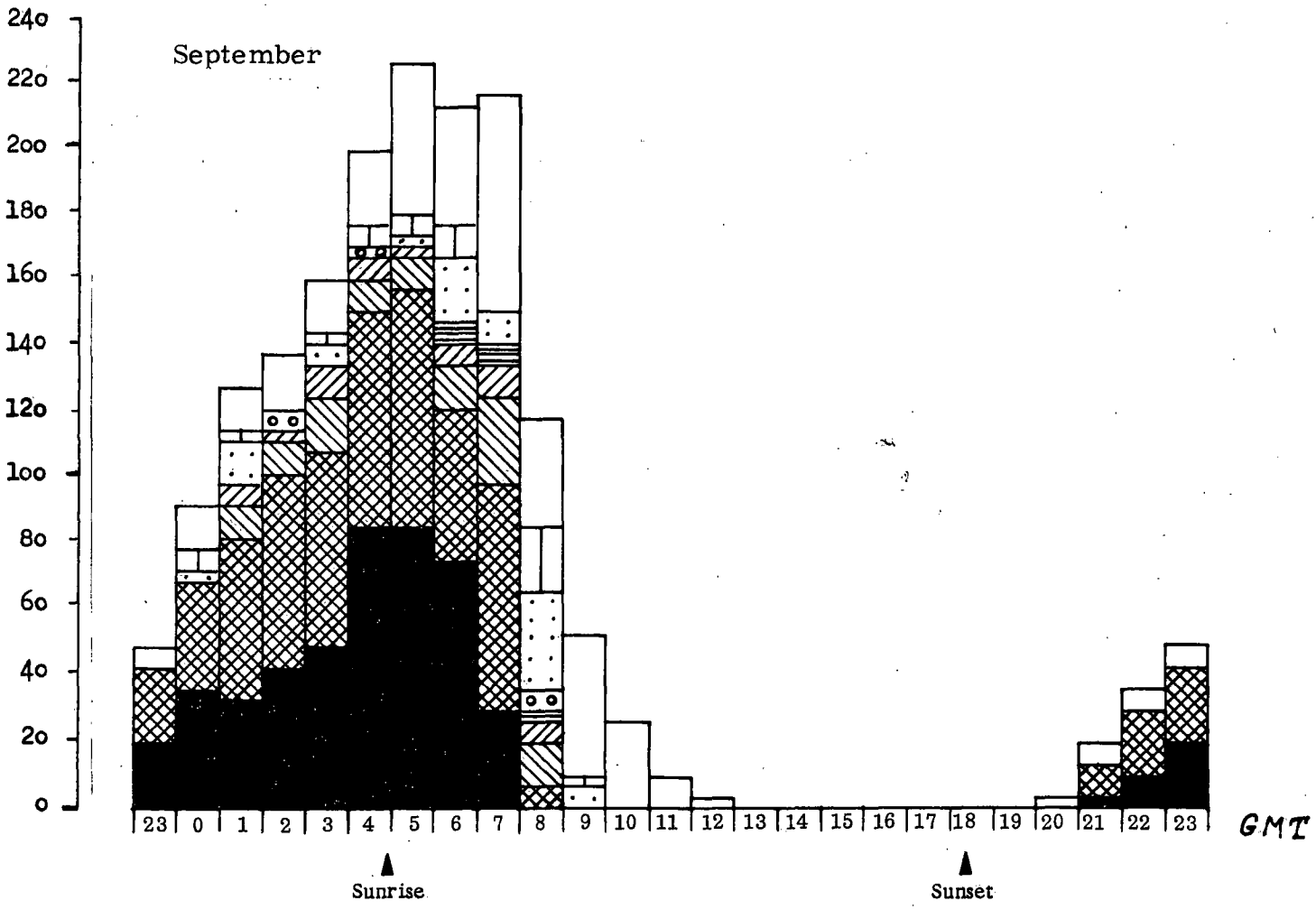
F=‰ $N_s \geq 5/8$

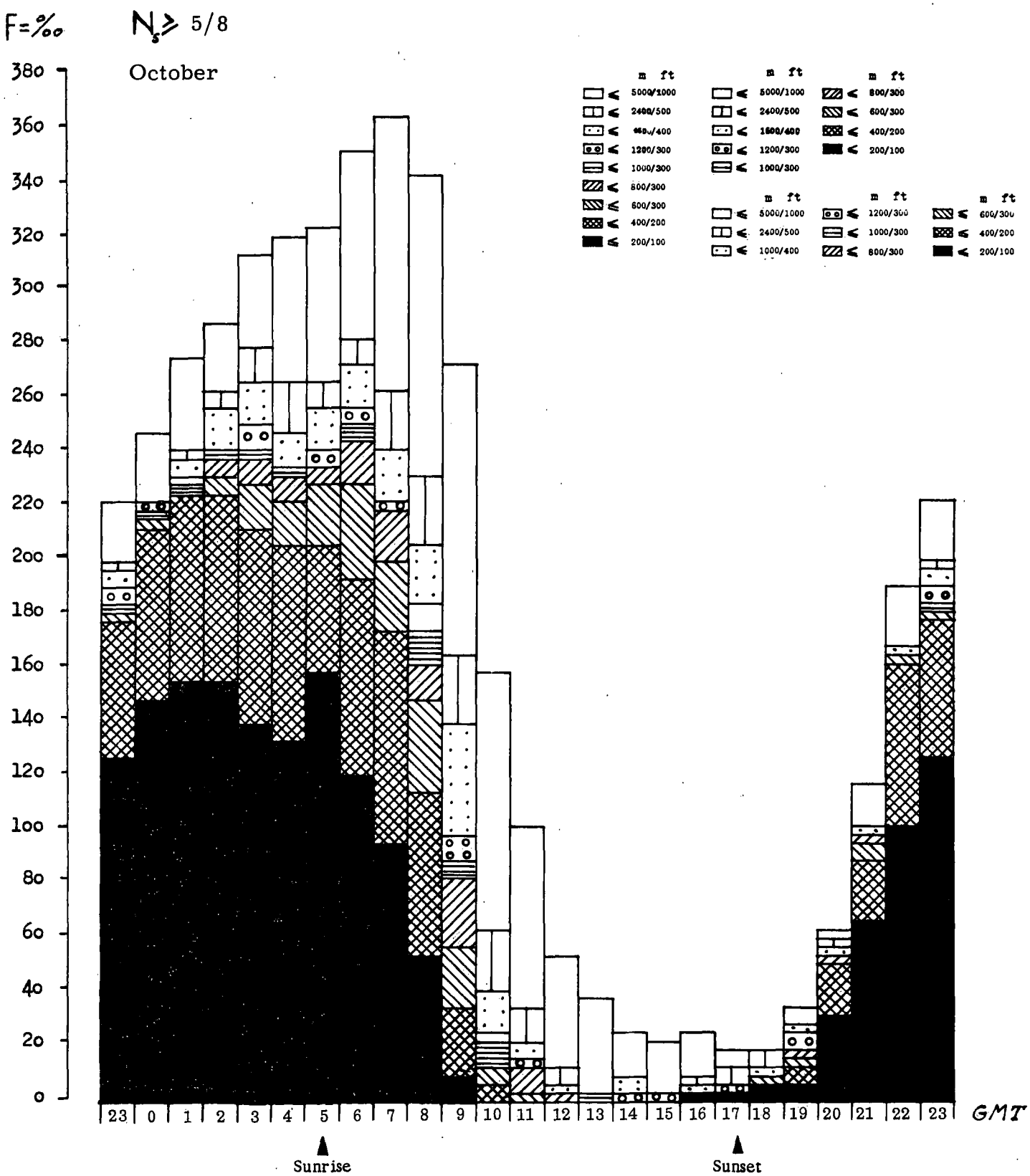

January
m ft
5000/1000
2400/500
1200/300
1000/300
800/300
600/300
400/200
200/100
m ft
5000/1000
2400/500
1000/400
m ft
1200/300
1000/300
800/300
m ft
600/300
400/200
200/100
240
220
200
180
160
140
120
100
80
60
40
20
0
23 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
GMT
Sunrise
Sunset

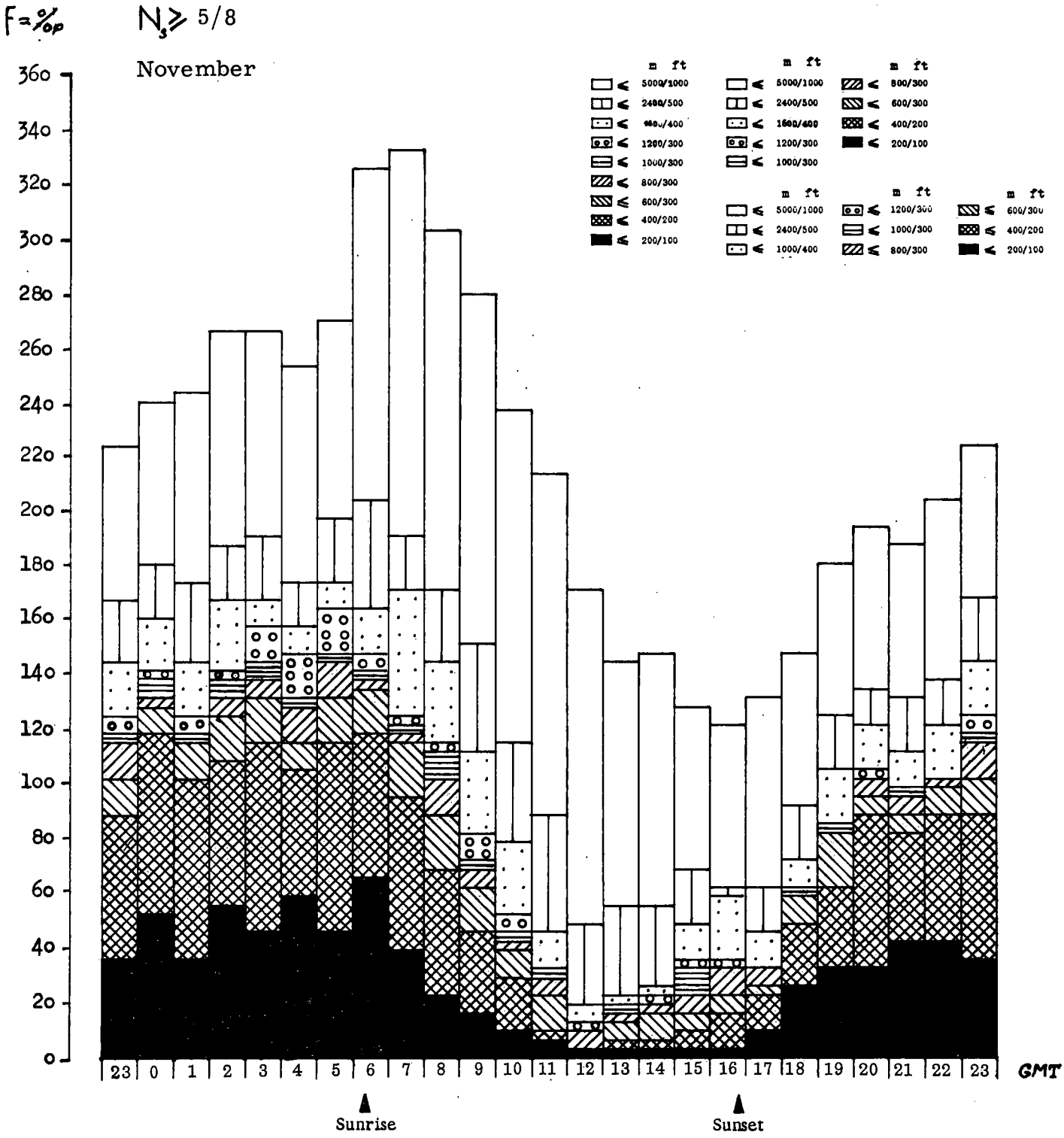

February
180
160
140
120
100
80
60
40
20
0
23 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
GMT
Sunrise
Sunset

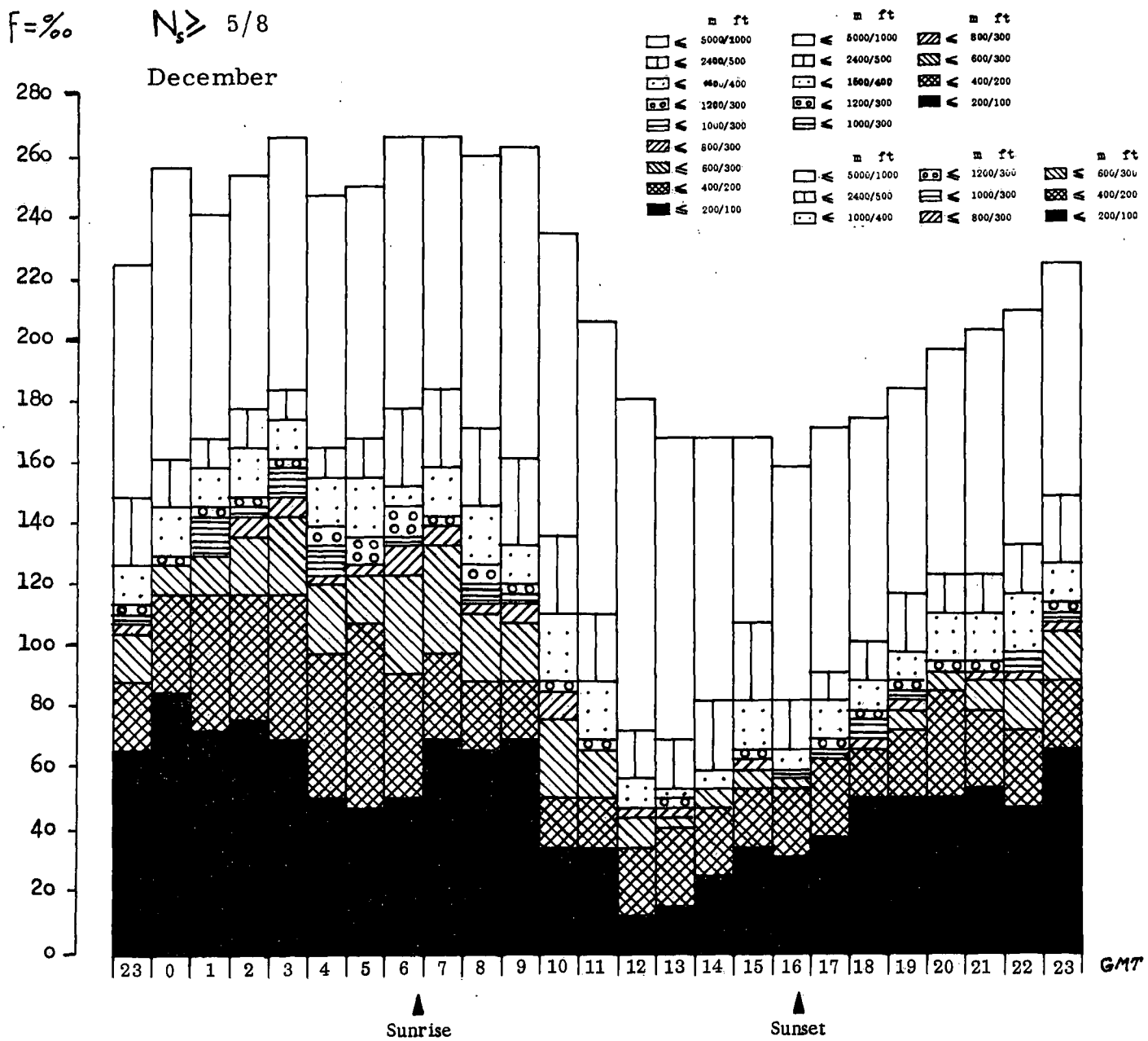

f=‰
$N_s \geq 5/8$
March
April
May
June
July
m ft
5000/1000
2400/500
1000/400
1200/300
1000/300
800/300
600/300
400/200
200/100
Sunrise
Sunset
GMT

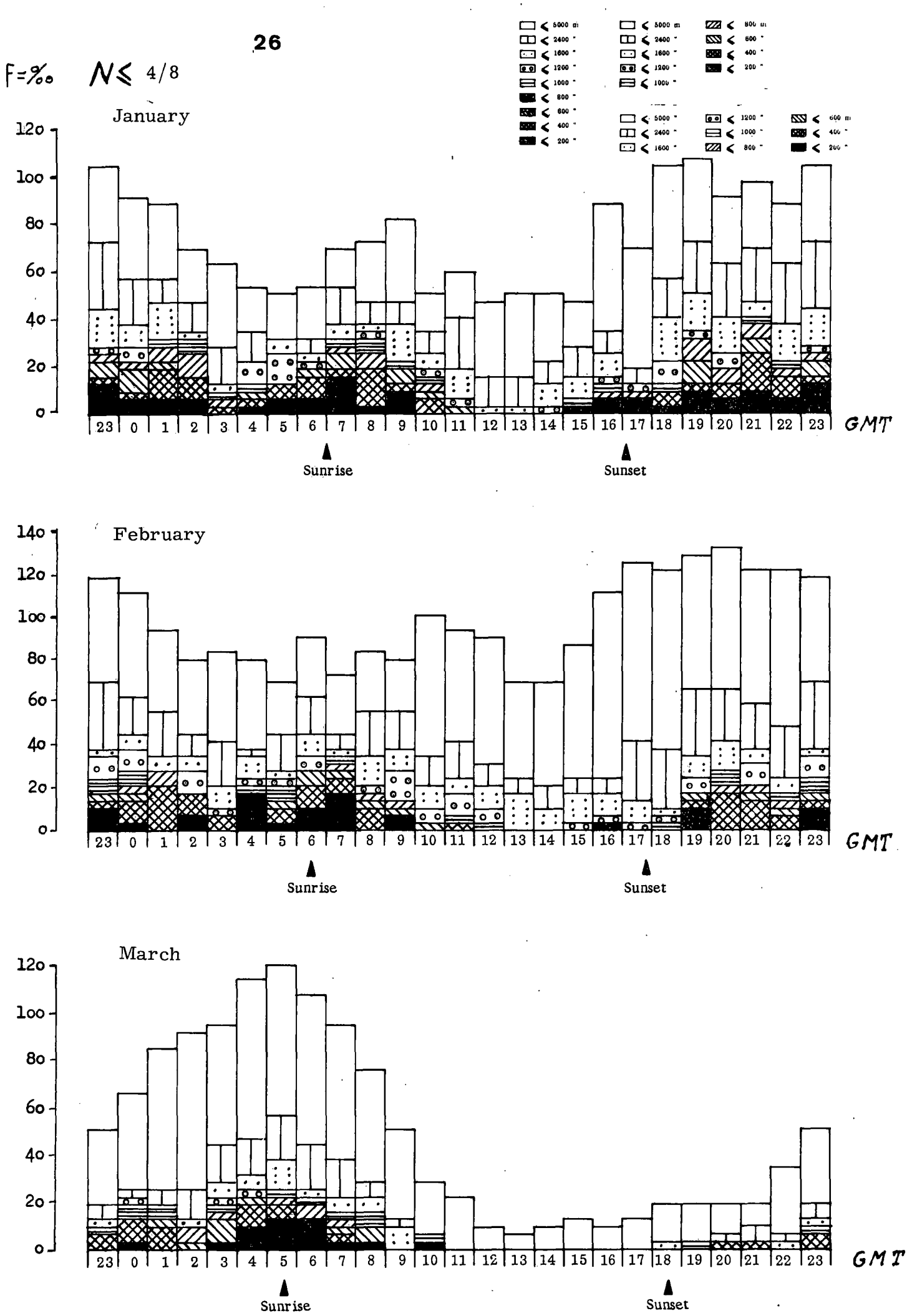

F=‰
N ≥ 5/8
August
m ft
5000/1000
2400/500
1200/300
1000/300
800/300
600/300
400/200
200/100
1000/400
GMT
Sunrise
Sunset


September
GMT
Sunrise
Sunset

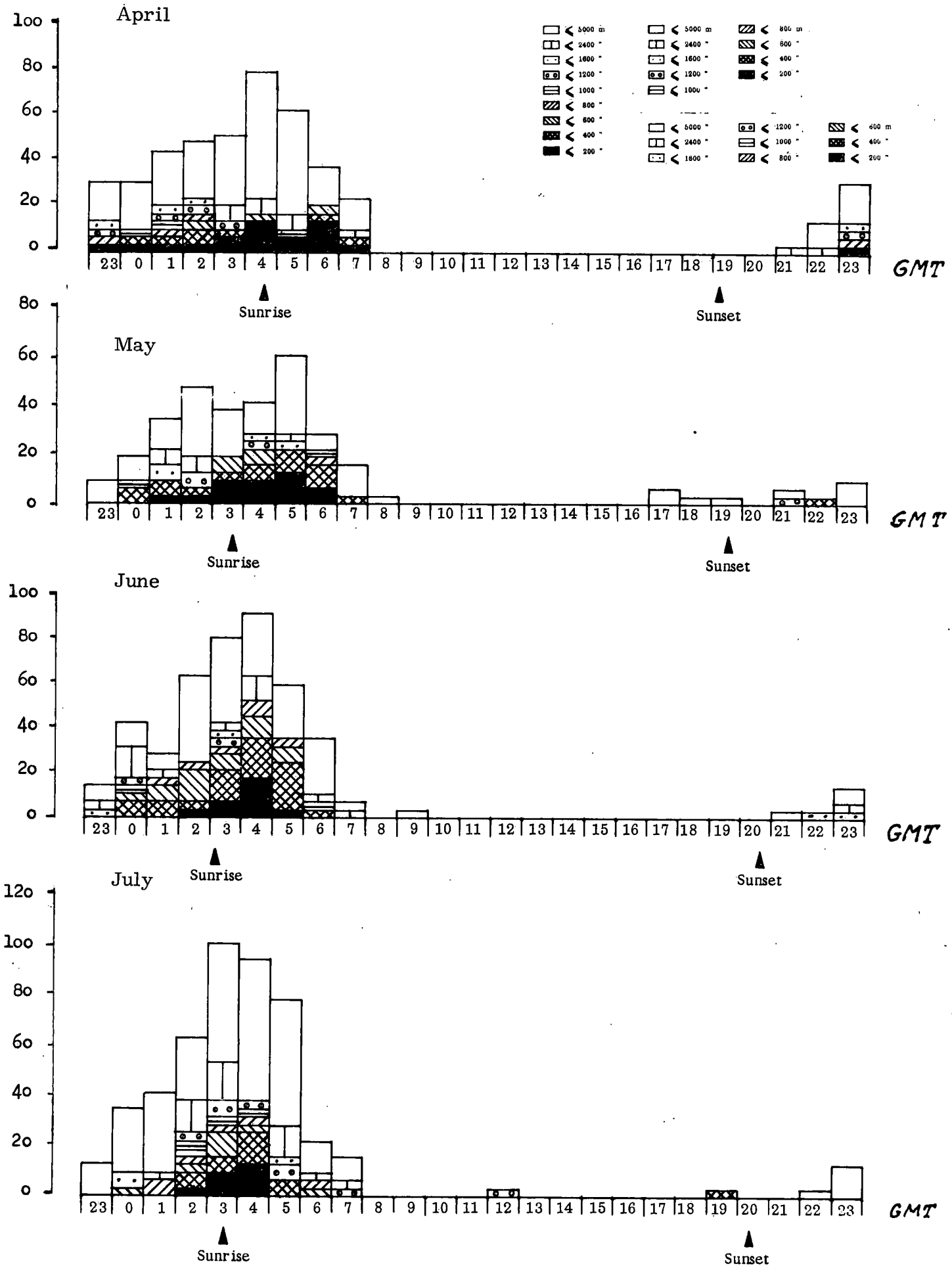

F=‰
$N_s \geq 5/8$
October
380
360
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
m ft
5000/1000
2400/500
1000/400
1200/300
1000/300
800/300
600/300
400/200
200/100
23 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
GMT
Sunrise
Sunset

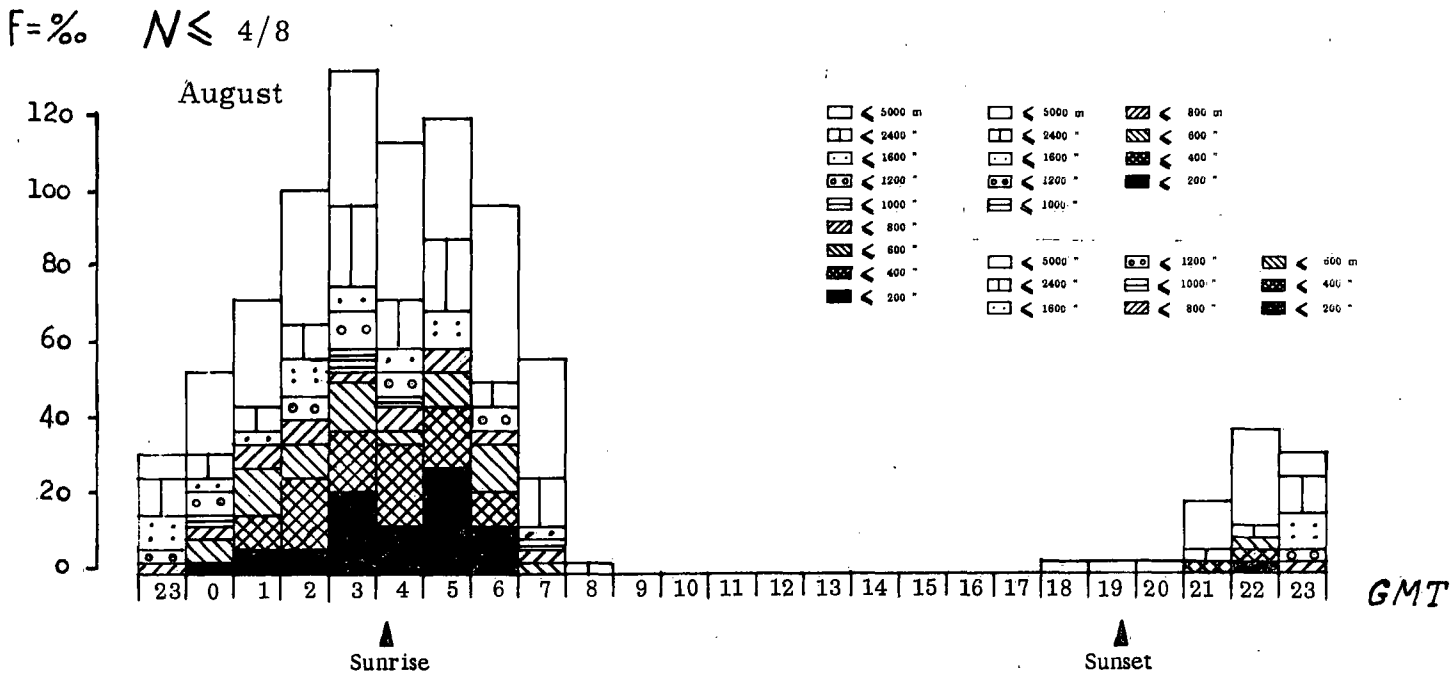

F = %op
N3 ≥ 5/8
November
m ft
5000/1000
2400/500
1200/300
1000/300
800/300
600/300
400/200
200/100
1000/400
360
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
23 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
GMT
Sunrise
Sunset

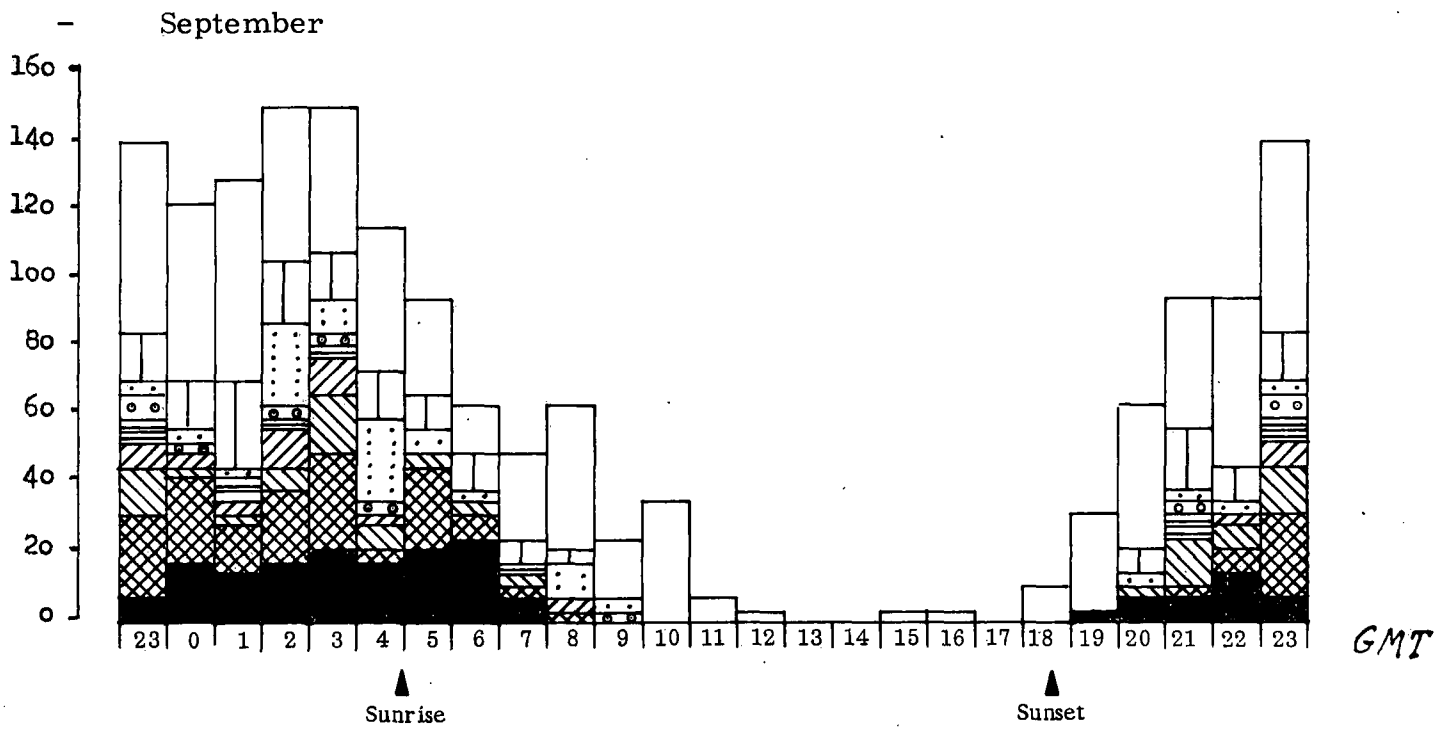

F=‰
$N_s \geq$ 5/8
December
m ft
5000/1000
2400/500
1200/300
1000/300
800/300
600/300
400/200
200/100
1000/400
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
23 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
GMT
Sunrise
Sunset

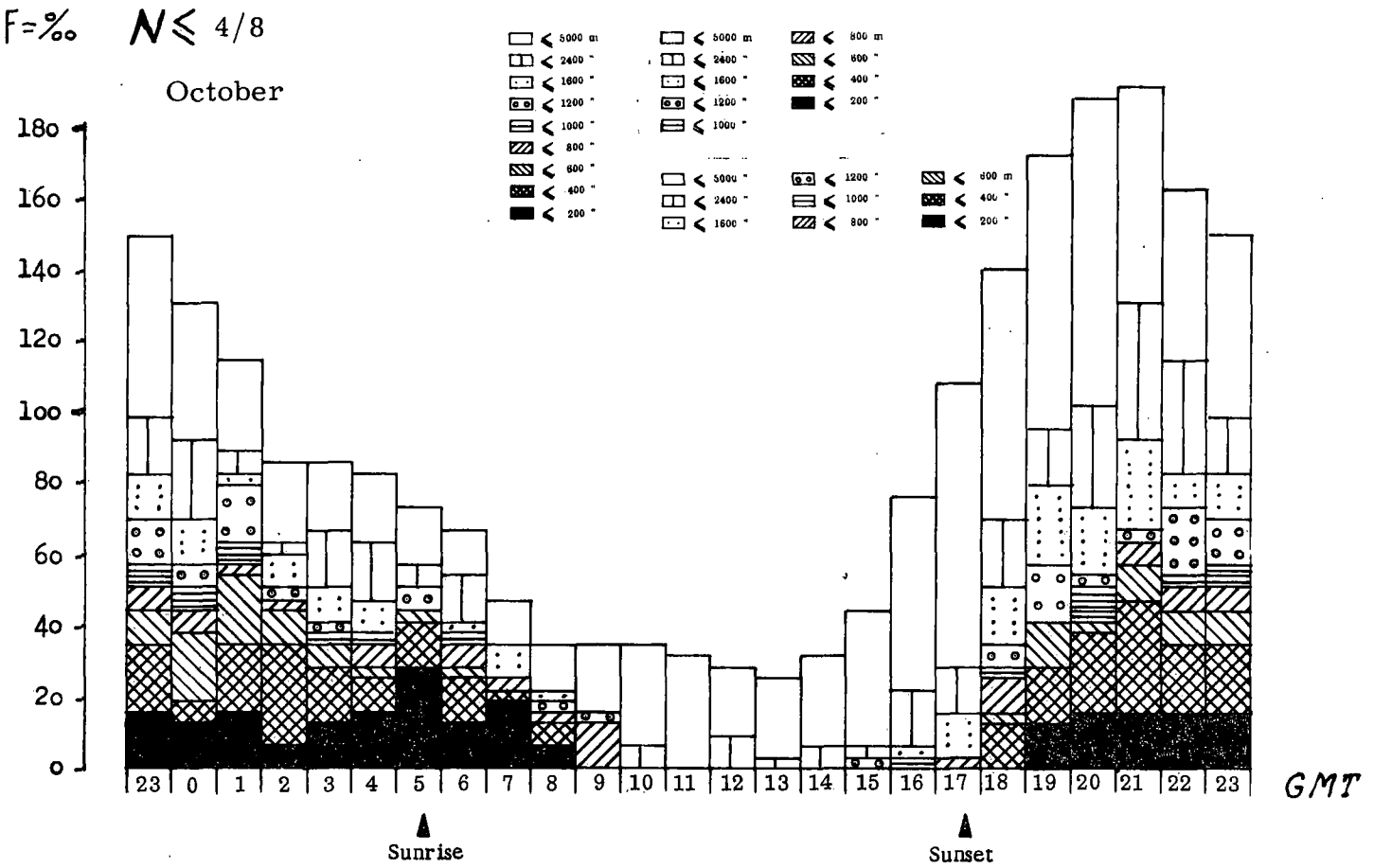

F=‰
N≤ 4/8
January
February
March
GMT
Sunrise
Sunset

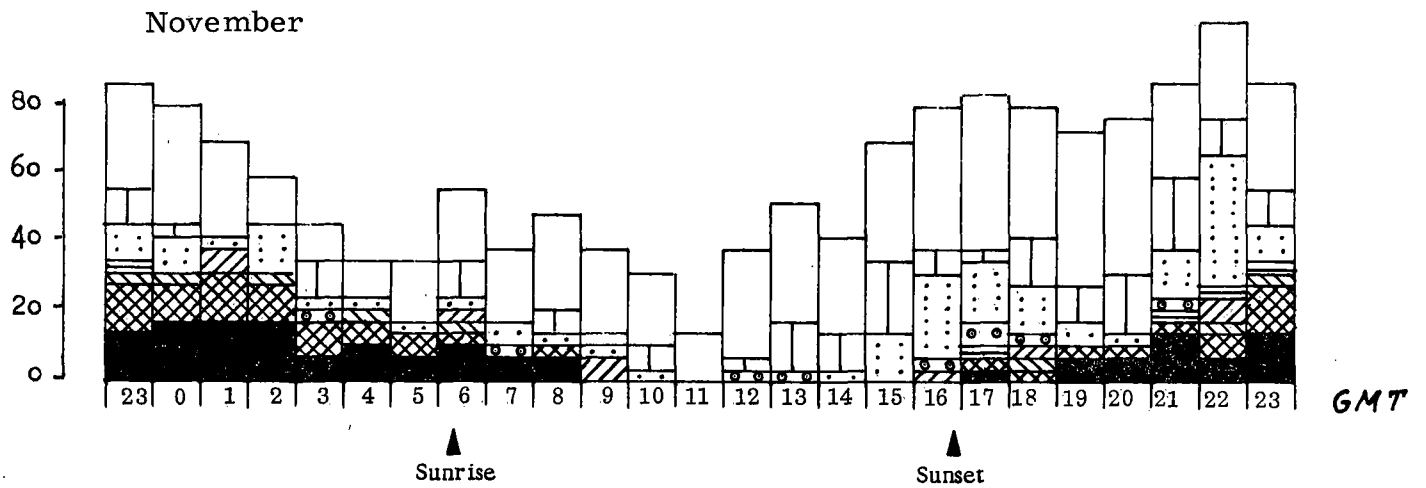
F=‰ N ≤ 4/8

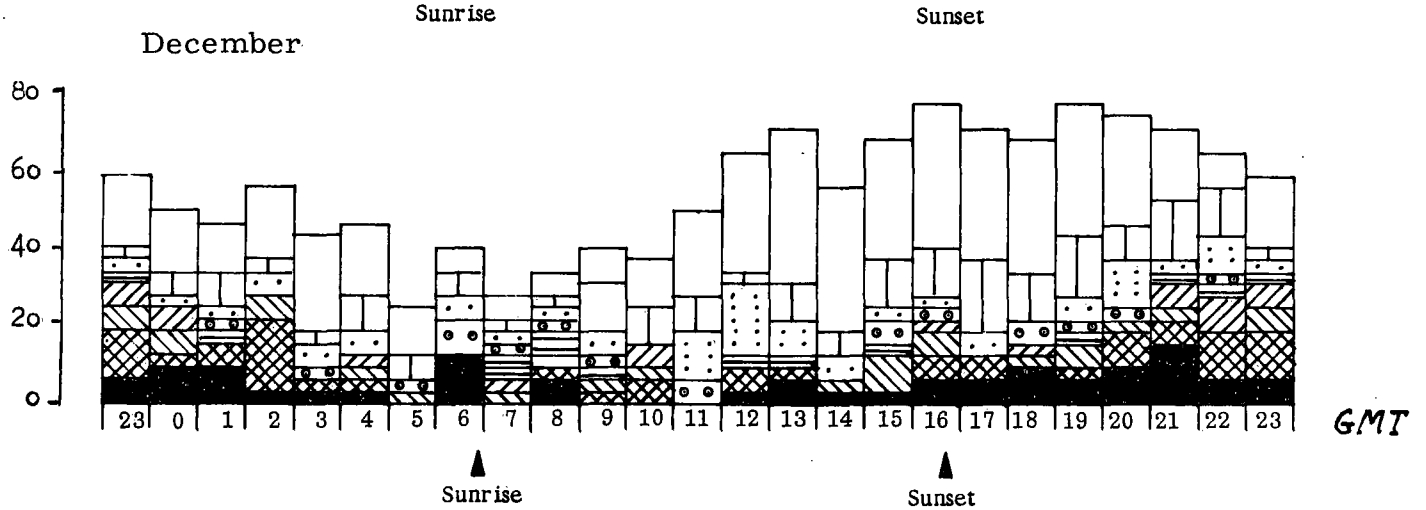


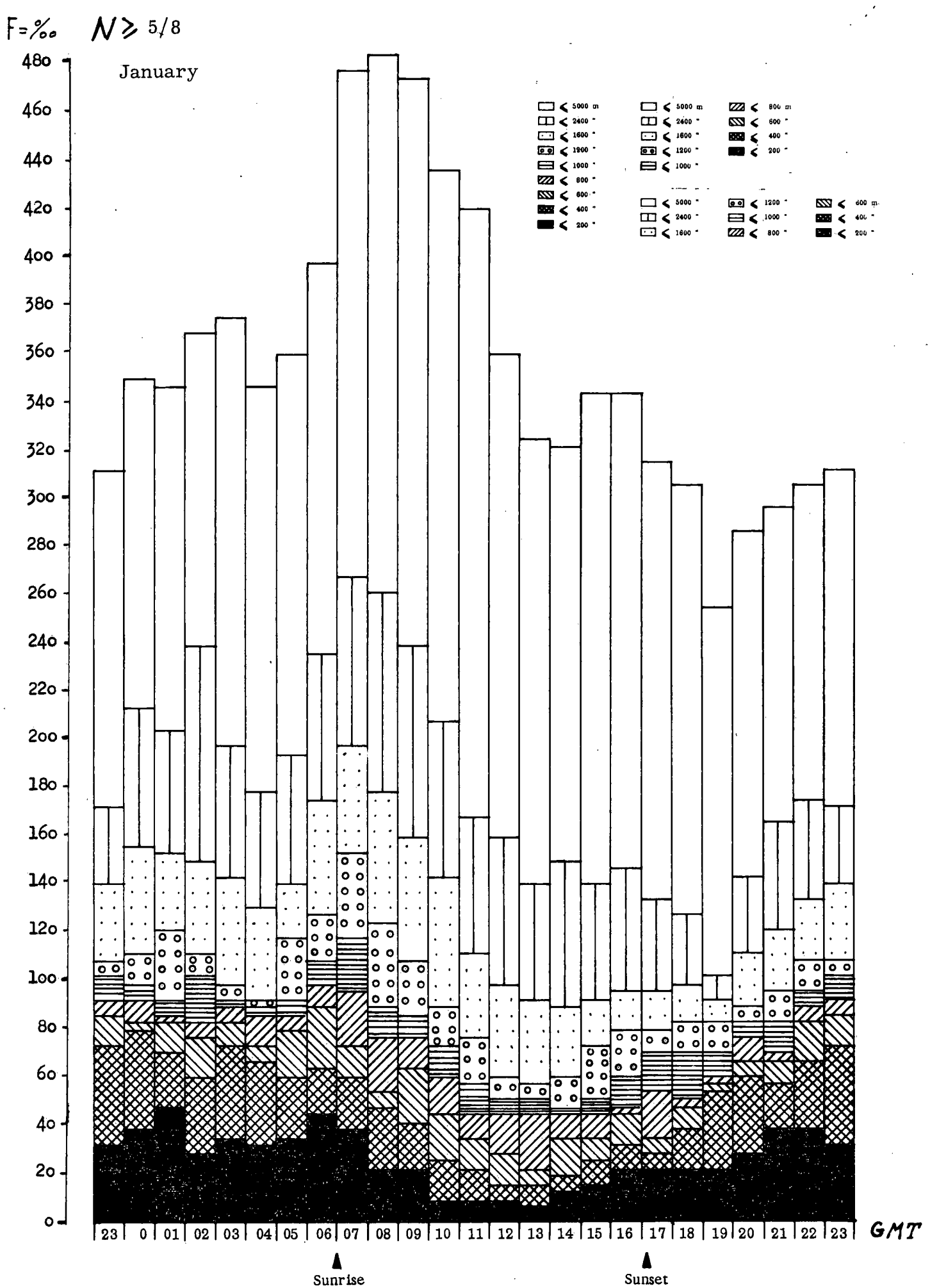

F=‰
N≤ 4/8
August
120
100
80
60
40
20
0
23 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
GMT
Sunrise
Sunset

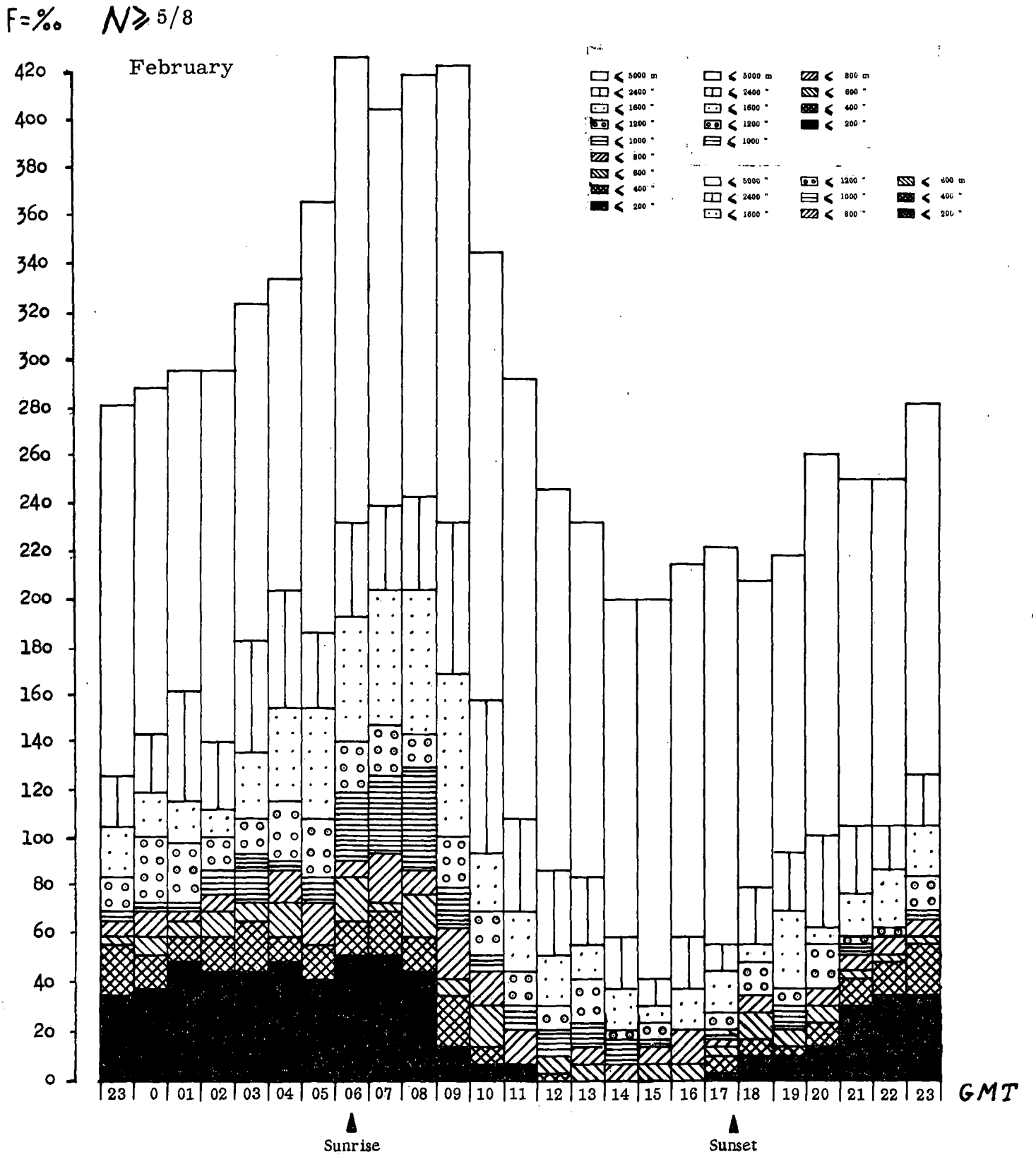

September
160
140
120
100
80
60
40
20
0
23 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
GMT
Sunrise
Sunset

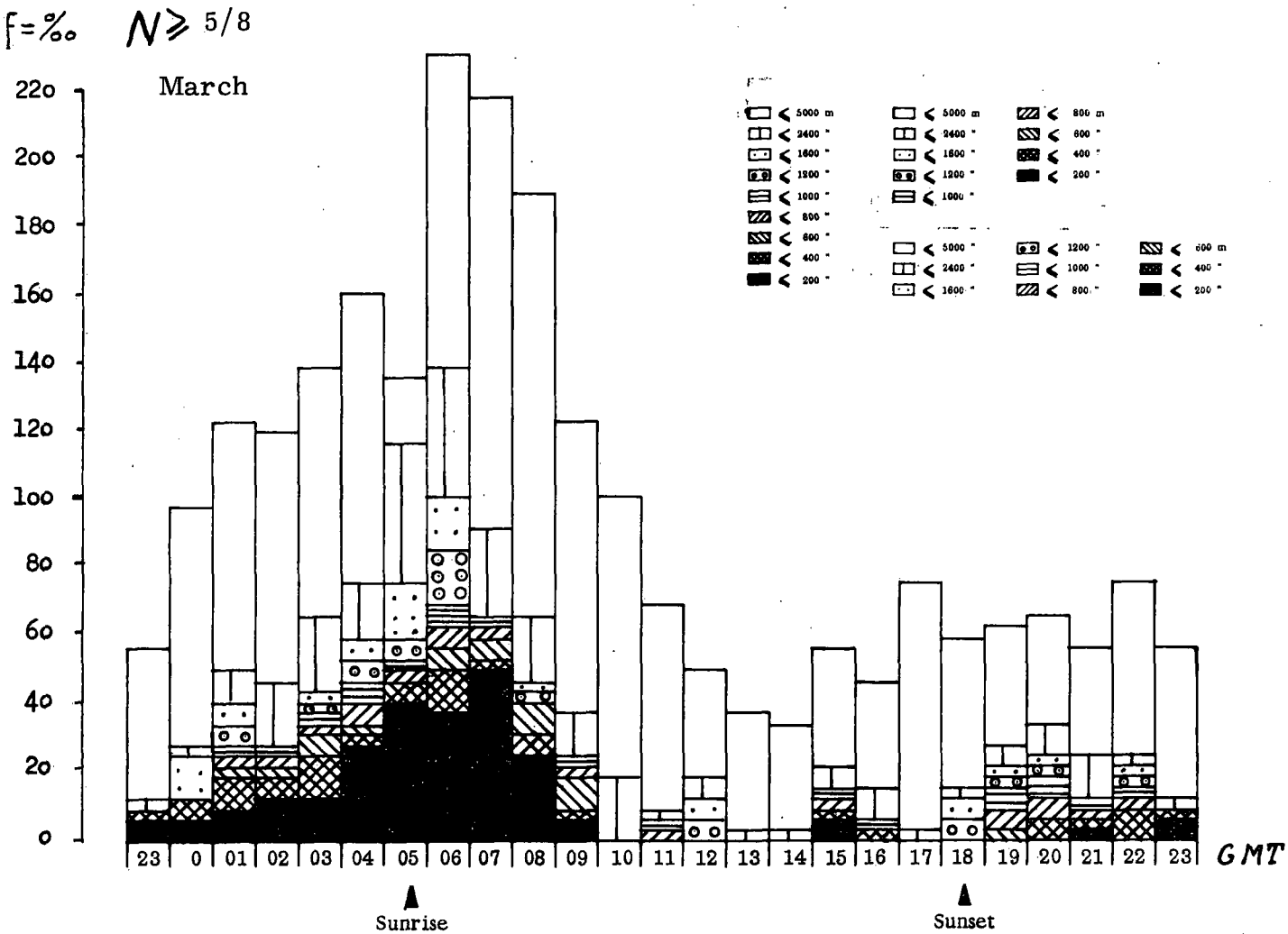

F=‰
N ≤ 4/8
October
< 5000 m
< 2400 "
< 1600 "
< 1200 "
< 1000 "
< 800 "
< 600 "
< 400 "
< 200 "
< 800 m
< 600 "
< 400 "
< 200 "
180
160
140
120
100
80
60
40
20
0
23 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
GMT
Sunrise
Sunset

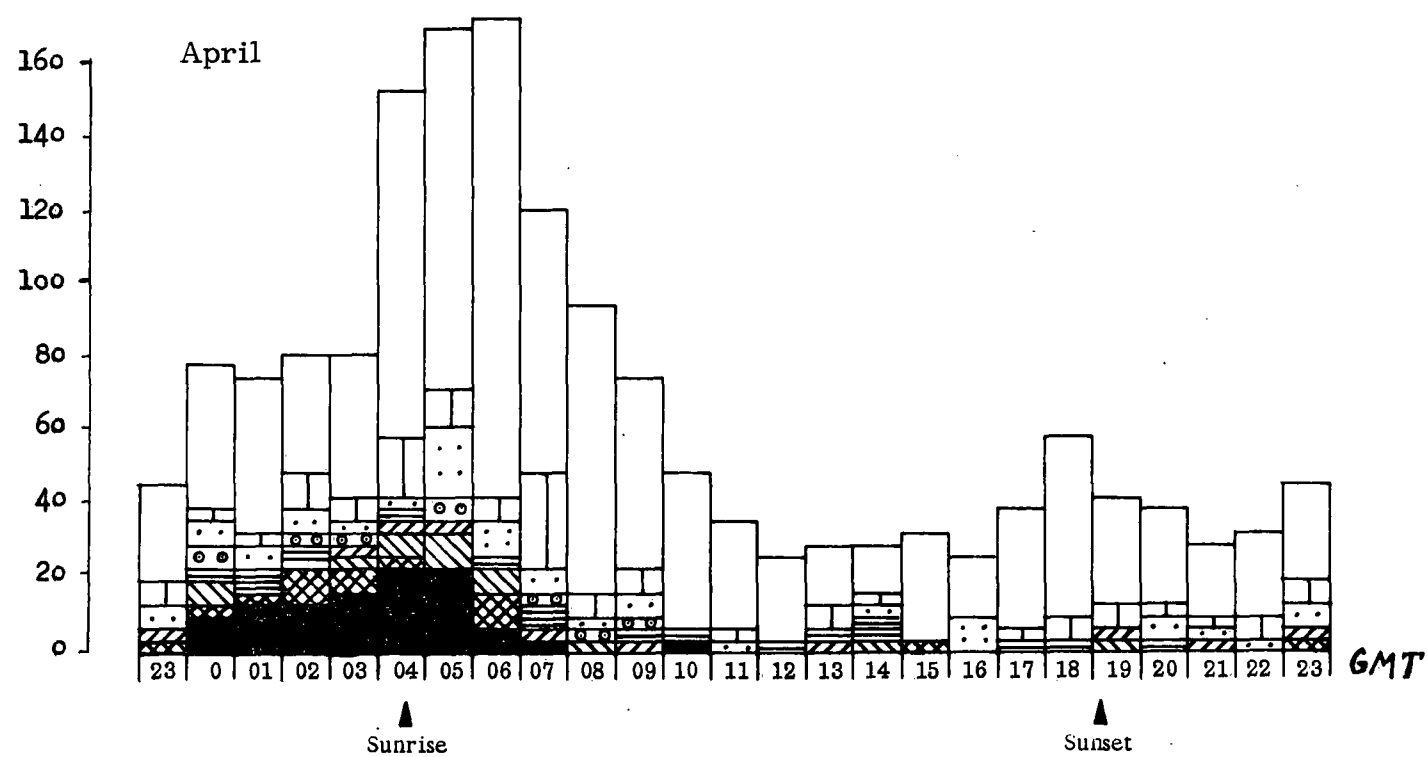

November
80
60
40
20
0
23 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
GMT
Sunrise
Sunset


December
80
60
40
20
0
23 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
GMT
Sunrise
Sunset

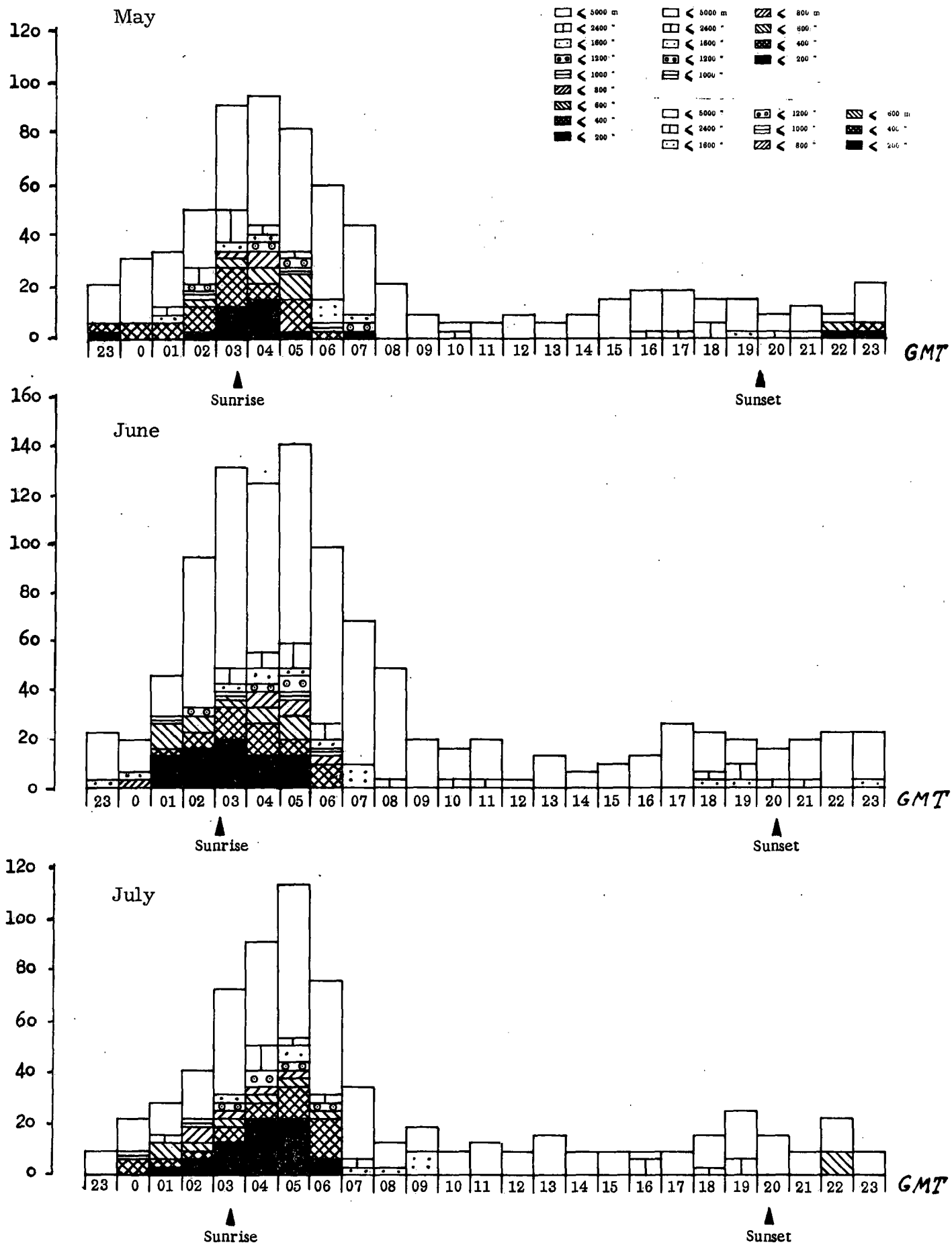

F=‰
N ≥ 5/8
January
480
460
440
420
400
380
360
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
23 0 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23
GMT
Sunrise
Sunset

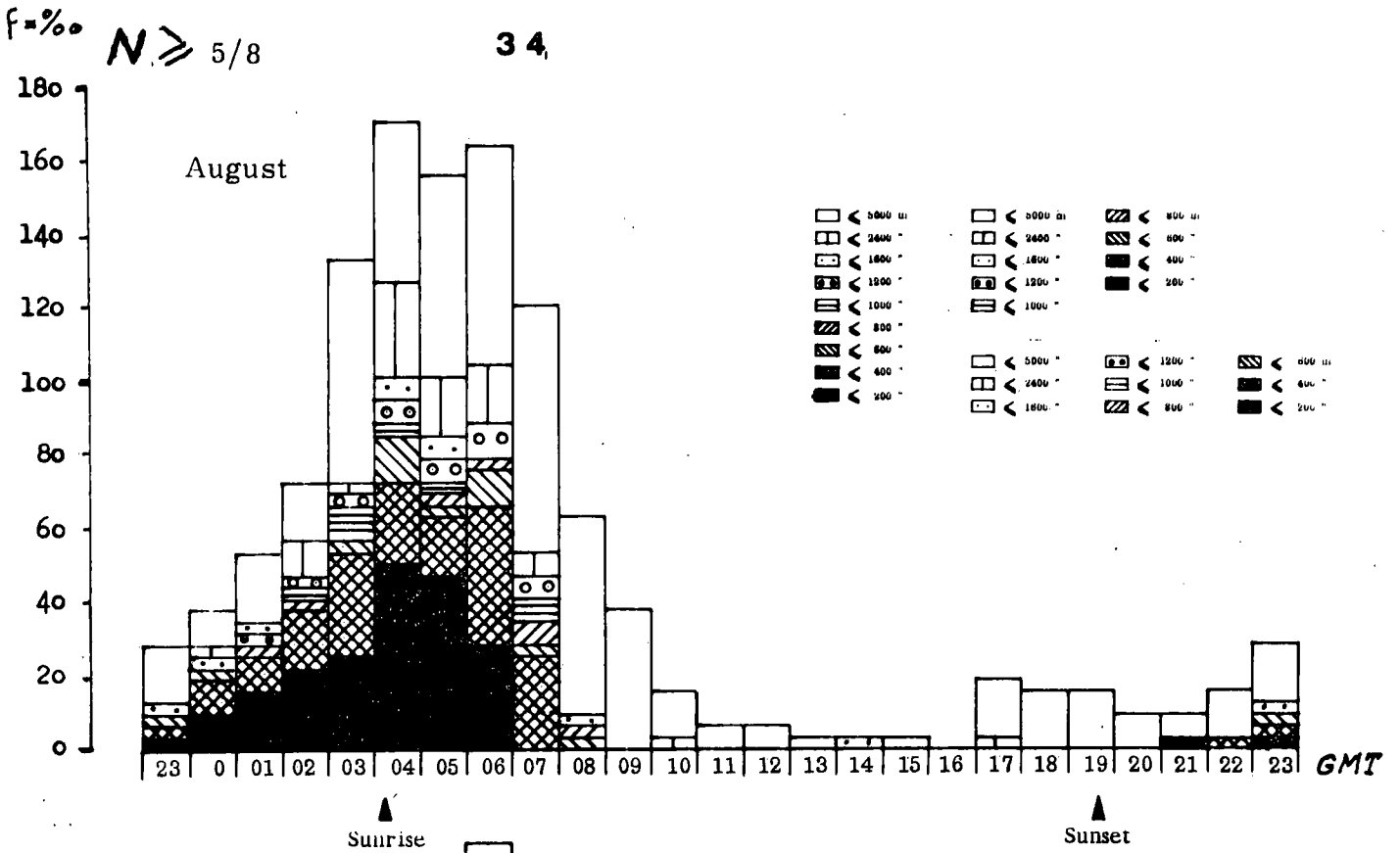

F=‰
N≥5/8
February
420
400
380
360
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
23 0 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23
GMT
Sunrise
Sunset

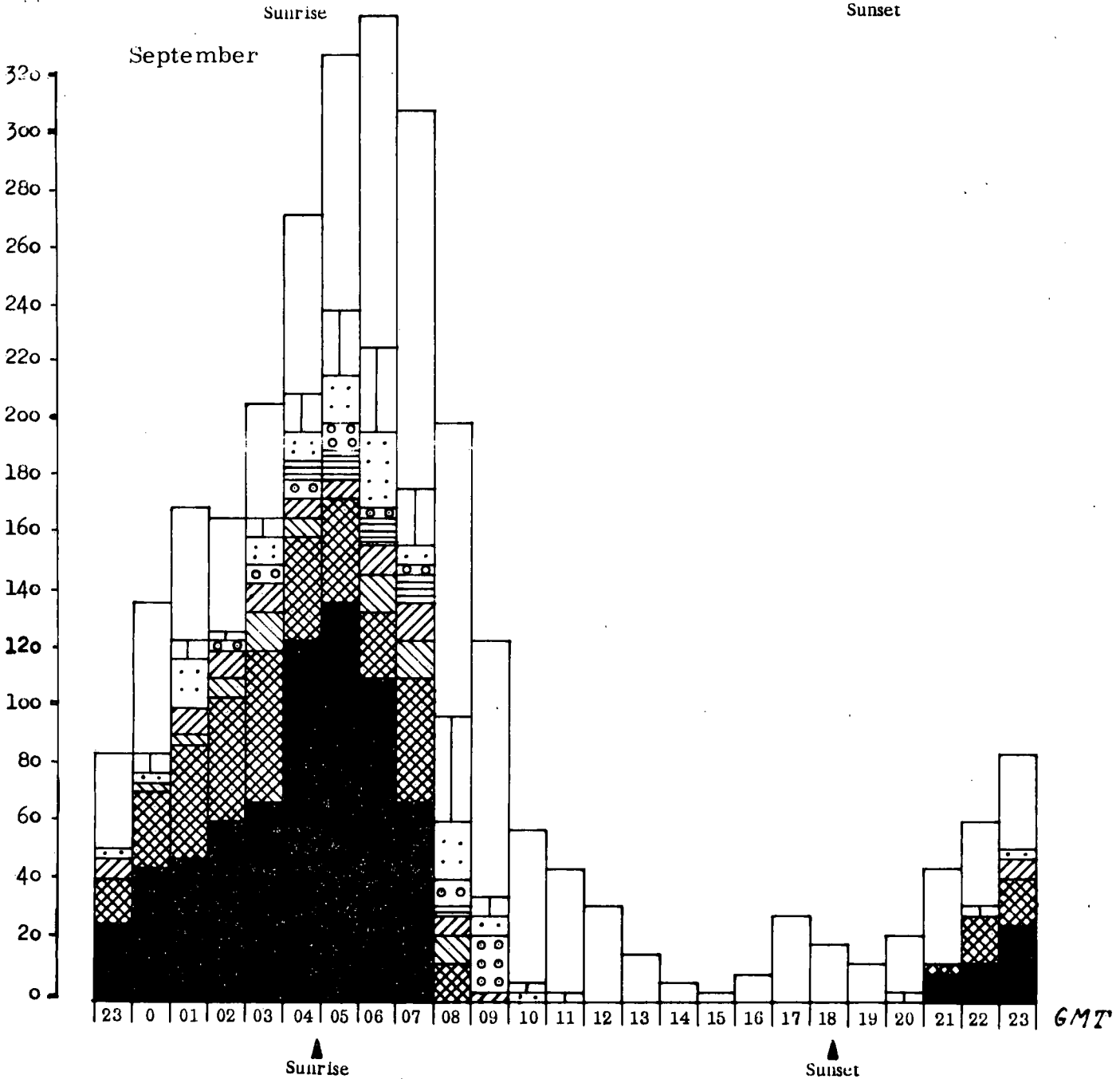

f=‰
N≥ 5/8
March
220
200
180
160
140
120
100
80
60
40
20
0
23 0 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23
GMT
Sunrise
Sunset

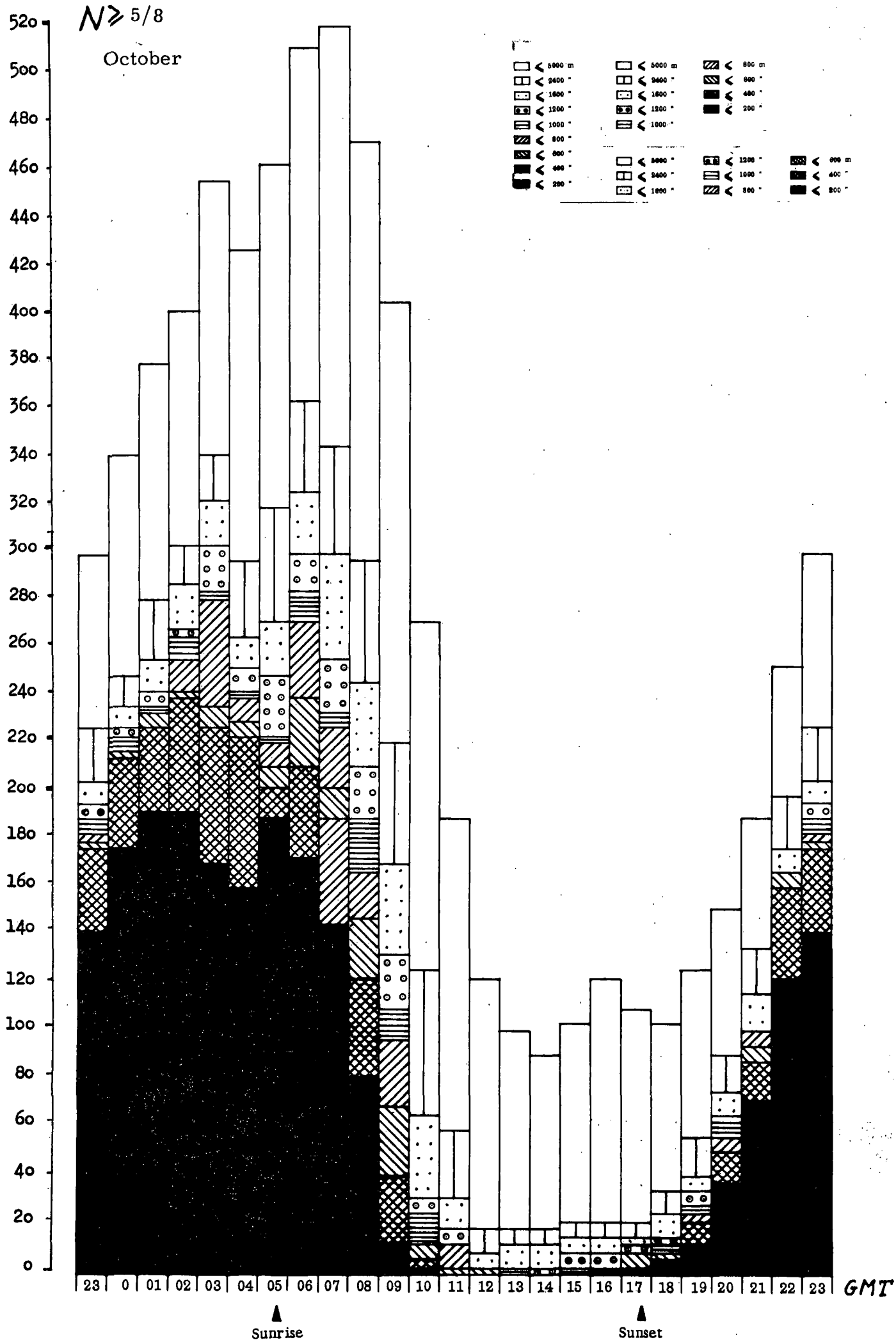

April
160
140
120
100
80
60
40
20
0
23 0 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23
GMT
Sunrise
Sunset

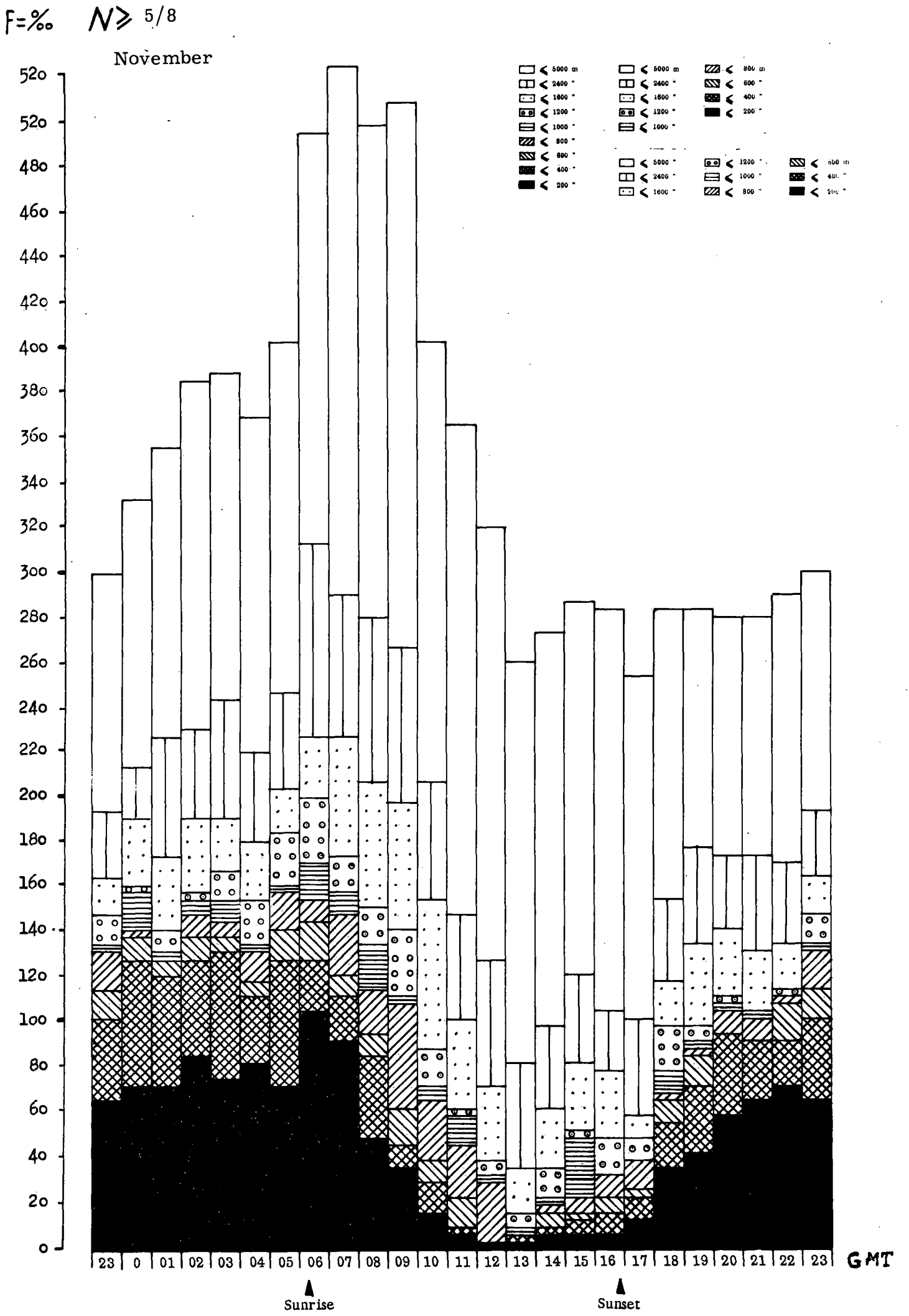
F=‰ N≥ 5/8

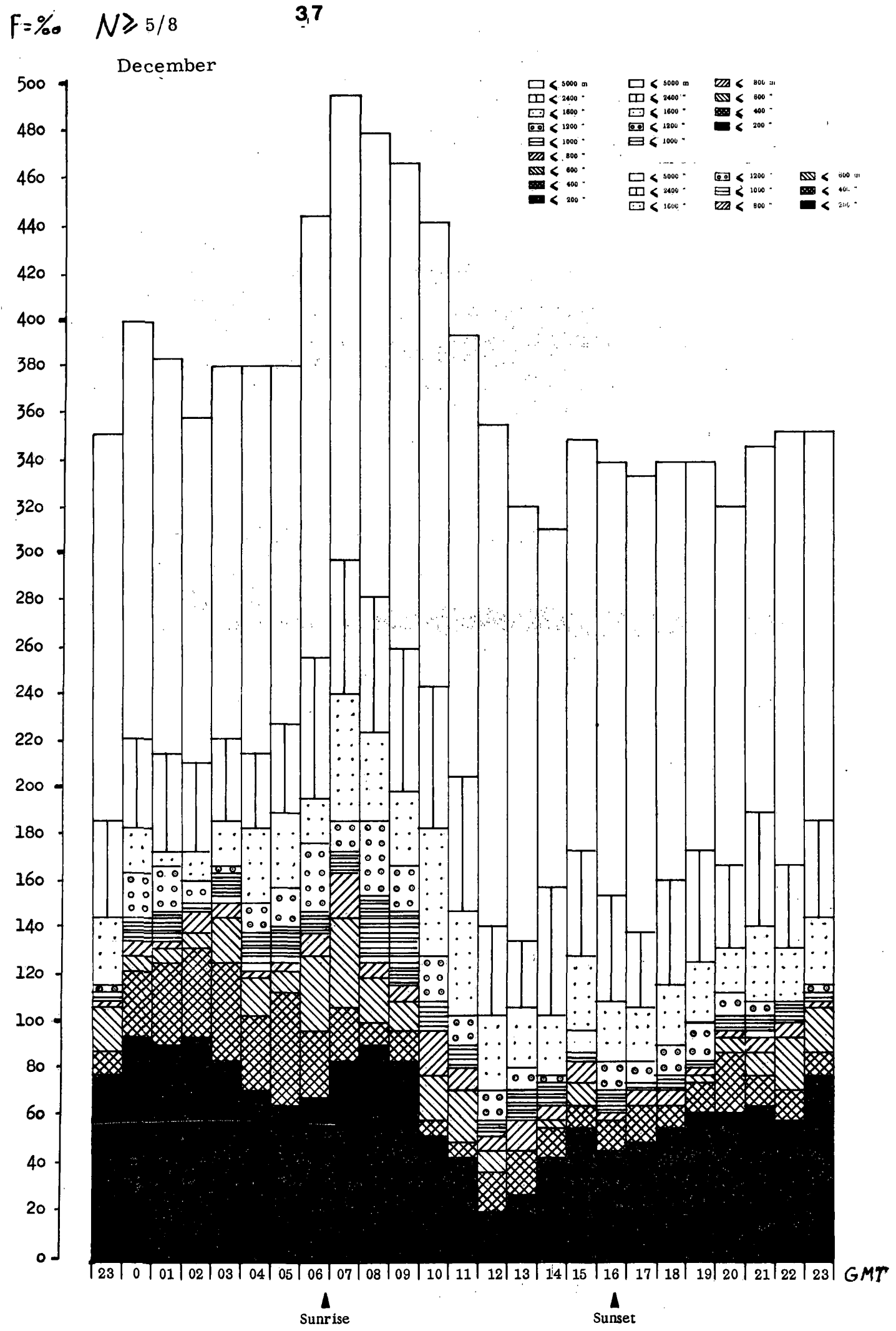



f=‰
N ≥ 5/8
August
180
160
140
120
100
80
60
40
20
0
23 0 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23
GMT
Sunrise
Sunset


September
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
23 0 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23
GMT
Sunrise
Sunset

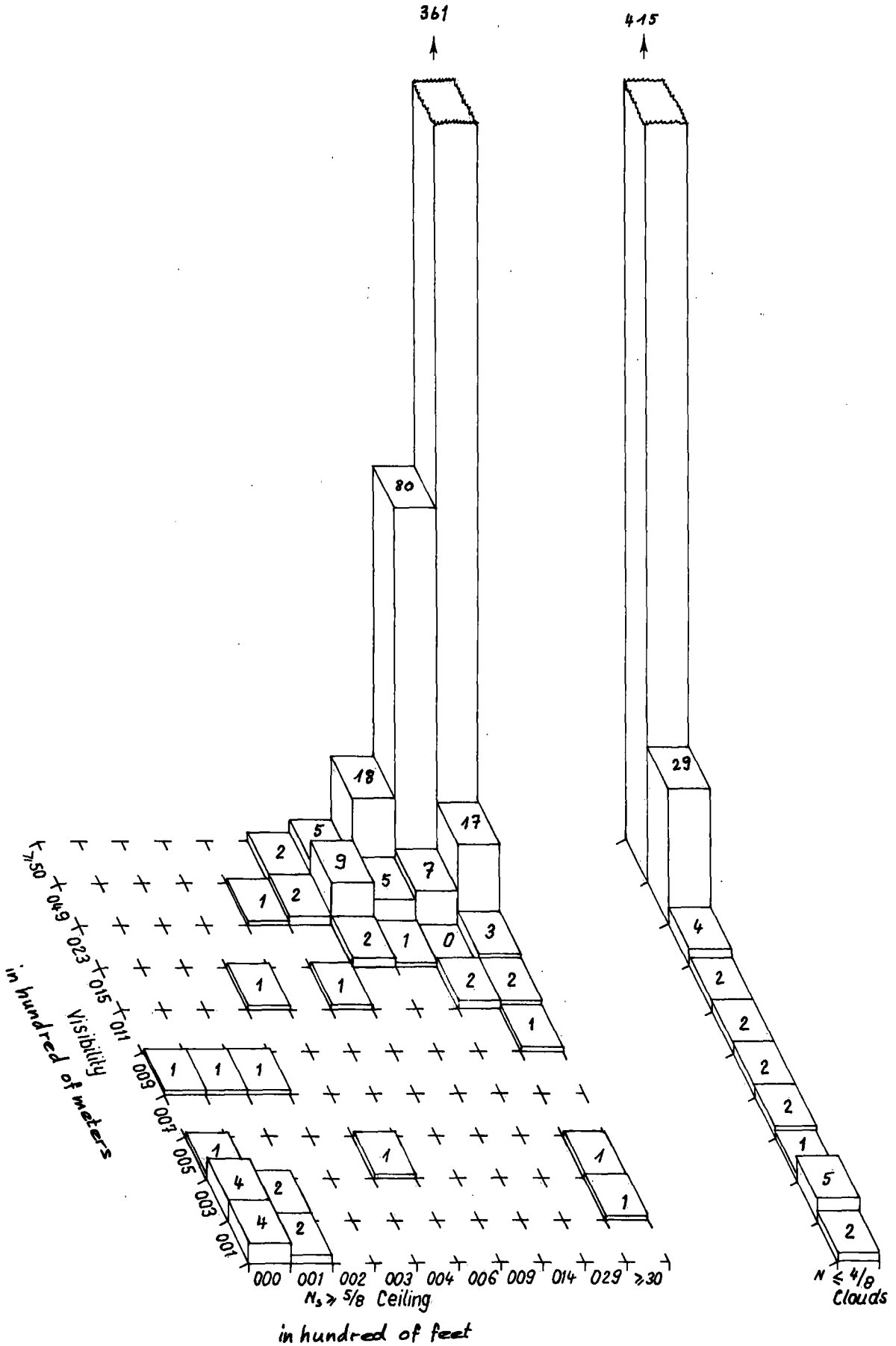

N ≥ 5/8
October
520
500
480
460
440
420
400
380
360
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
23 0 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23
GMT
Sunrise
Sunset

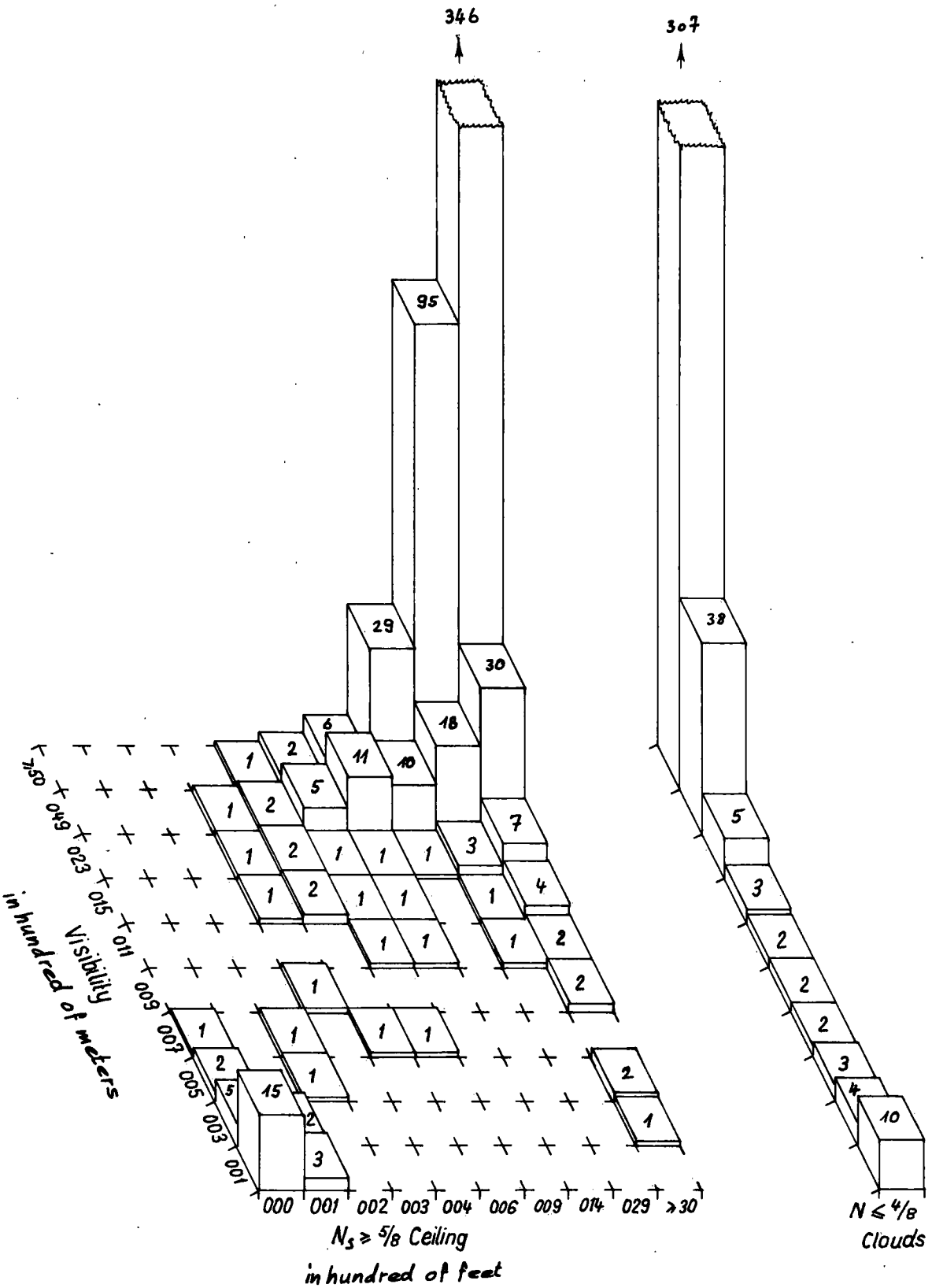

F=‰
N≥ 5/8
November
520
520
480
460
440
420
400
380
360
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
23 0 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23
GMT
Sunrise
Sunset


F=‰
N≥5/8
December
500
480
460
440
420
400
380
360
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
23 0 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23
GMT
Sunrise
Sunset

III - V

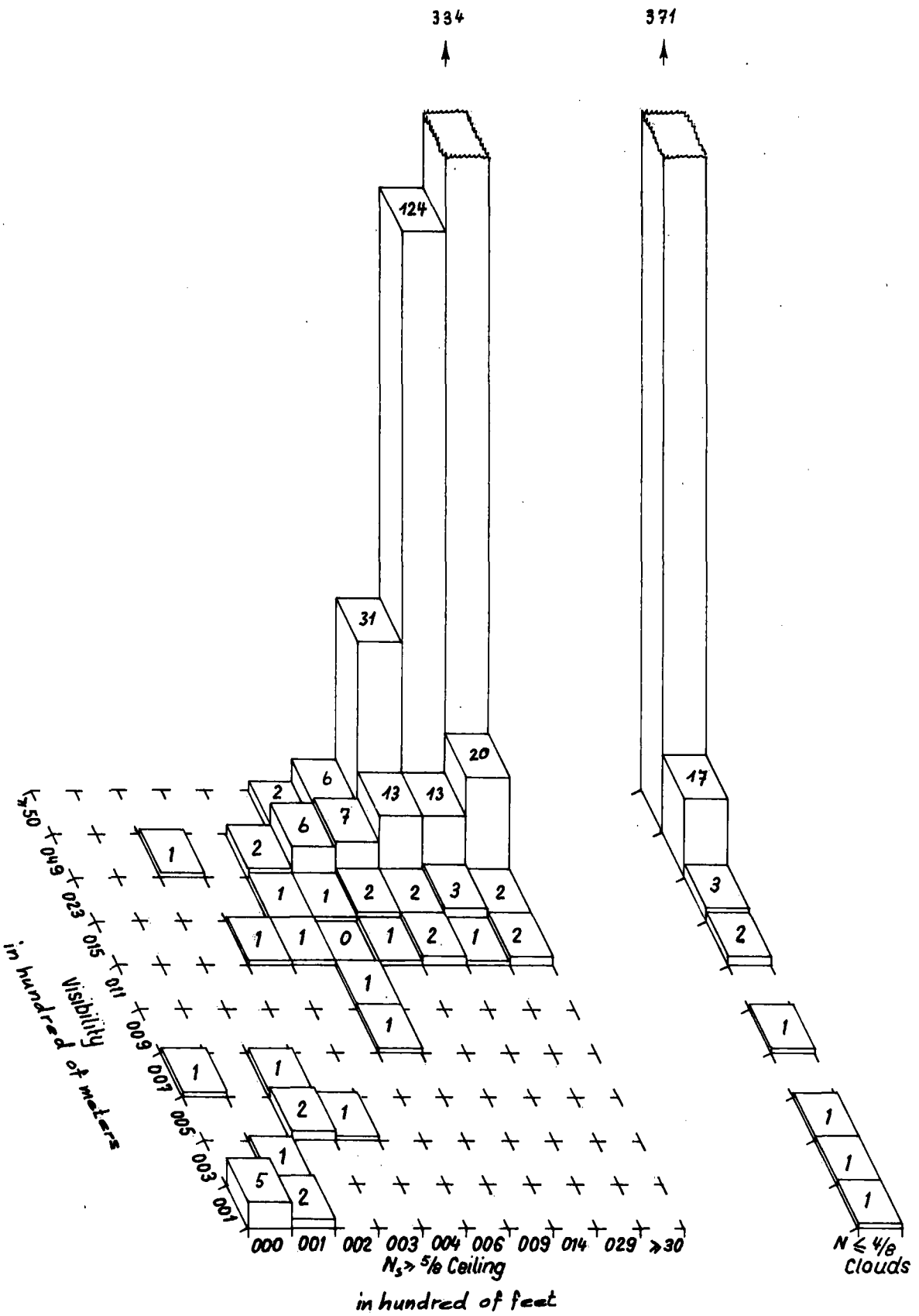
23 - 02 GMT



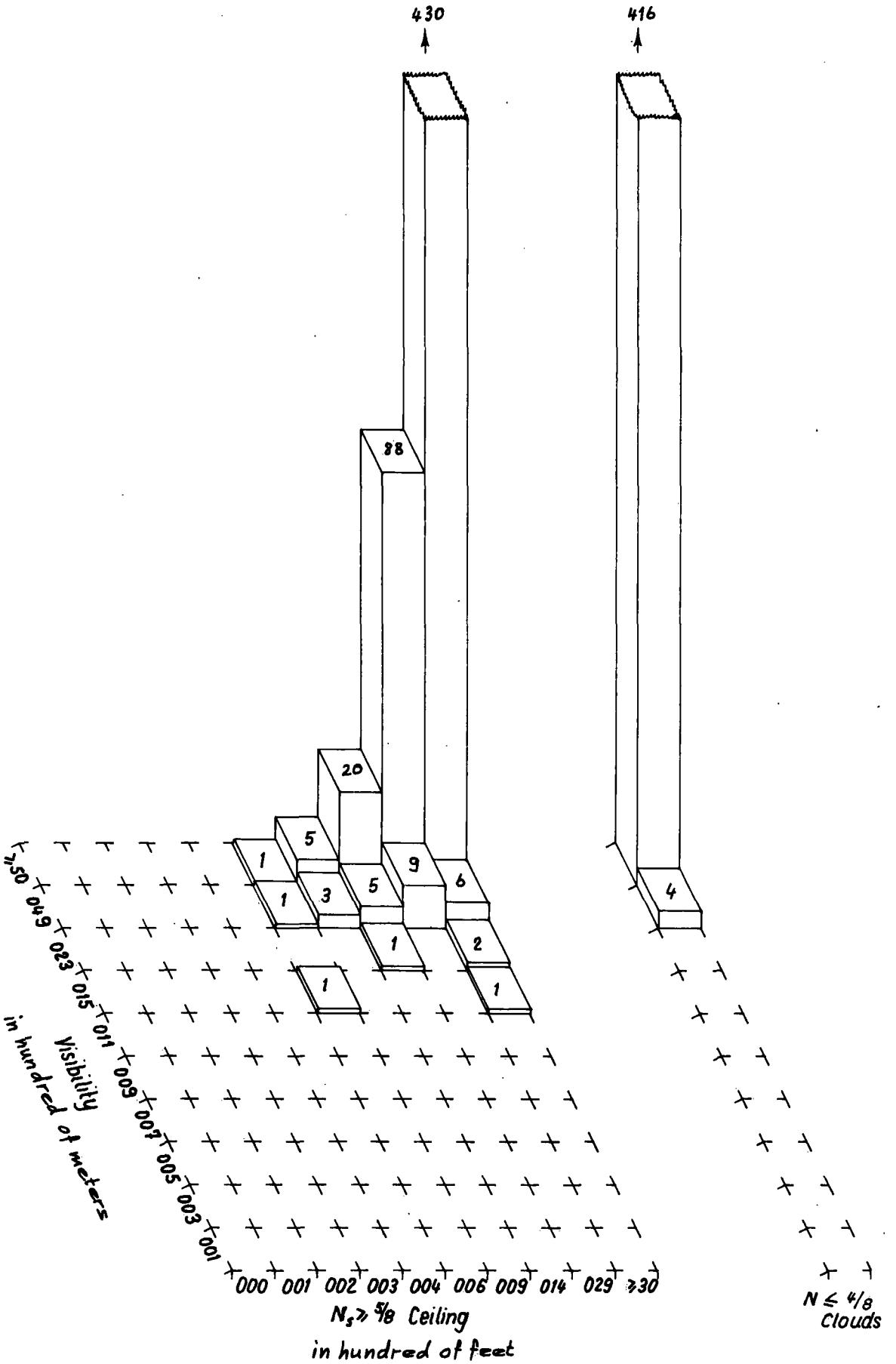

346
307
95
29
30
18
6
11
10
38
5
7
3
4
2
1
15
10
Visibility
in hundred of meters
>50
049
023
015
011
009
007
005
003
001
000
001
002
003
004
006
009
014
029
>30
$N_s \geq 5/8$ Ceiling
in hundred of feet
$N \leq 4/8$
Clouds

III-V

07-10 GMT

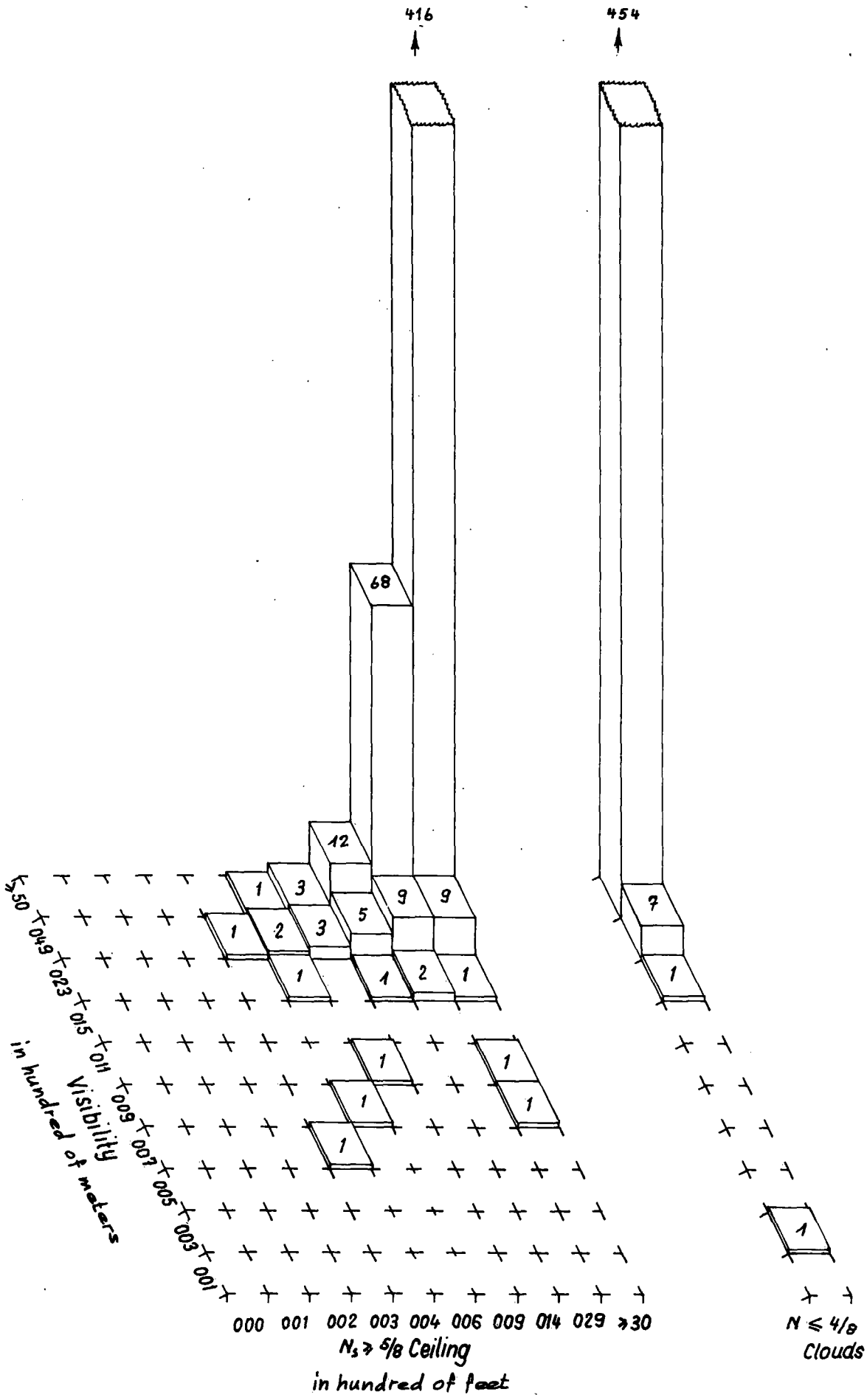


III-V
11-16 GMT



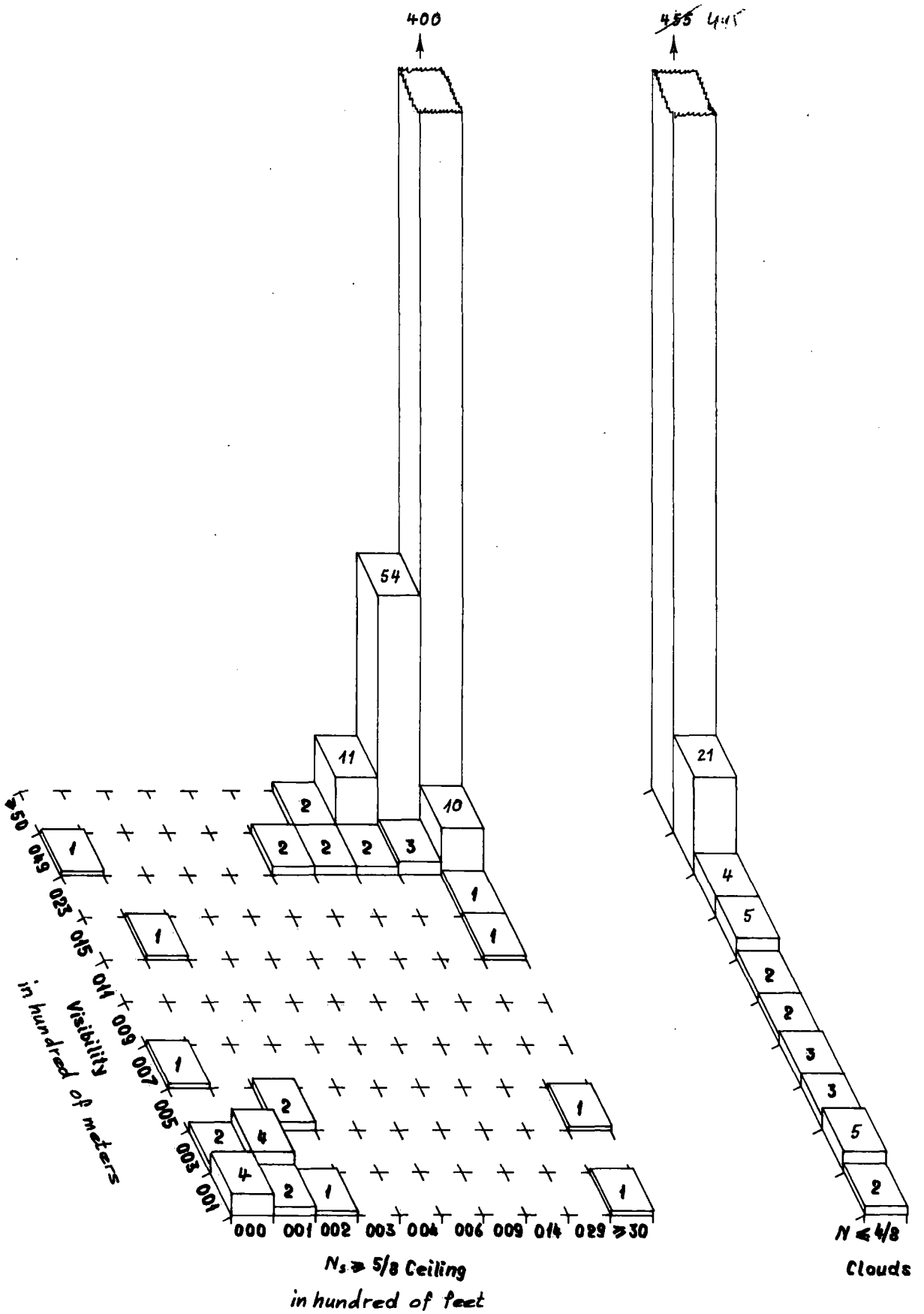
III-V

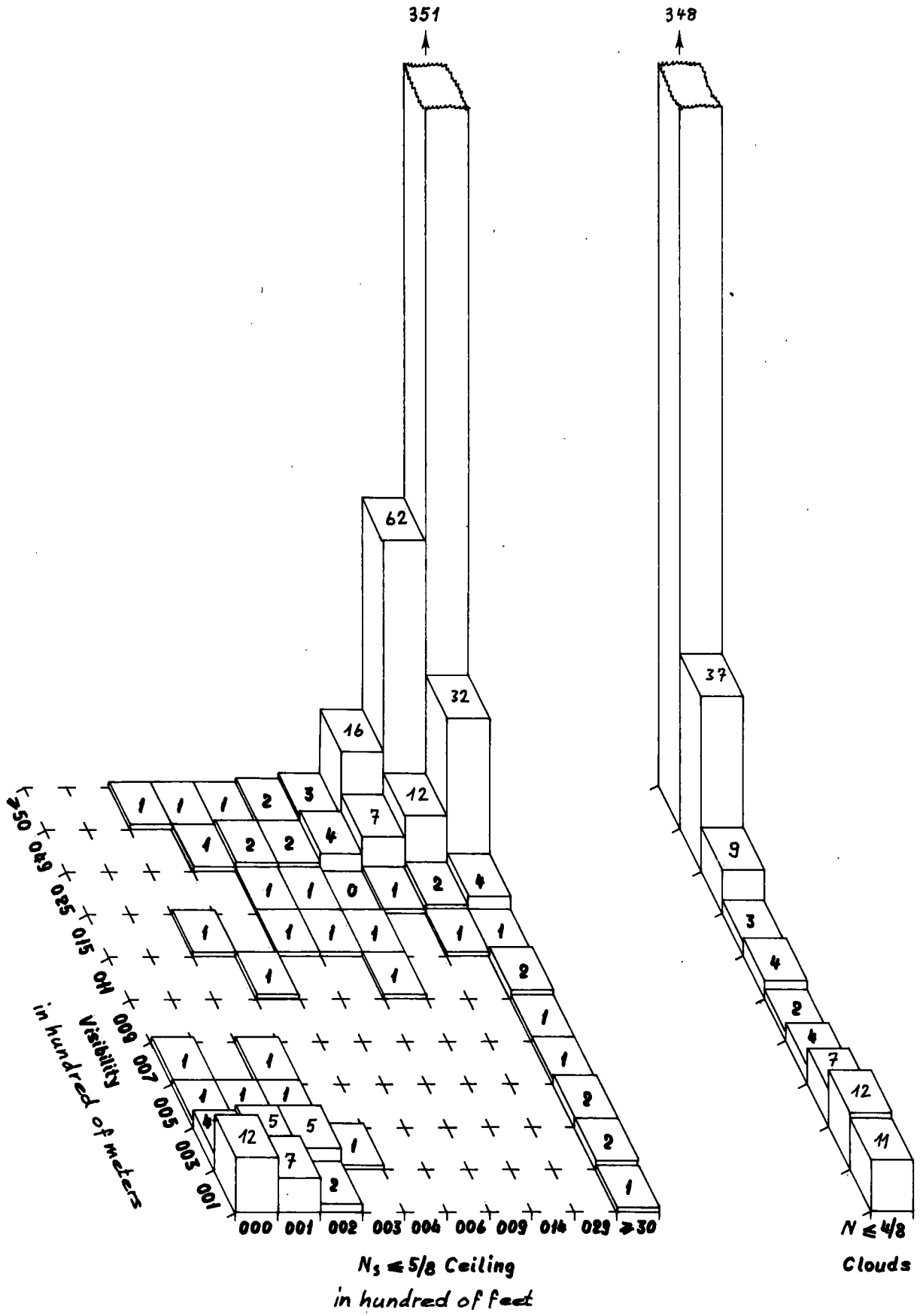
17-22 GMT



VI - VIII

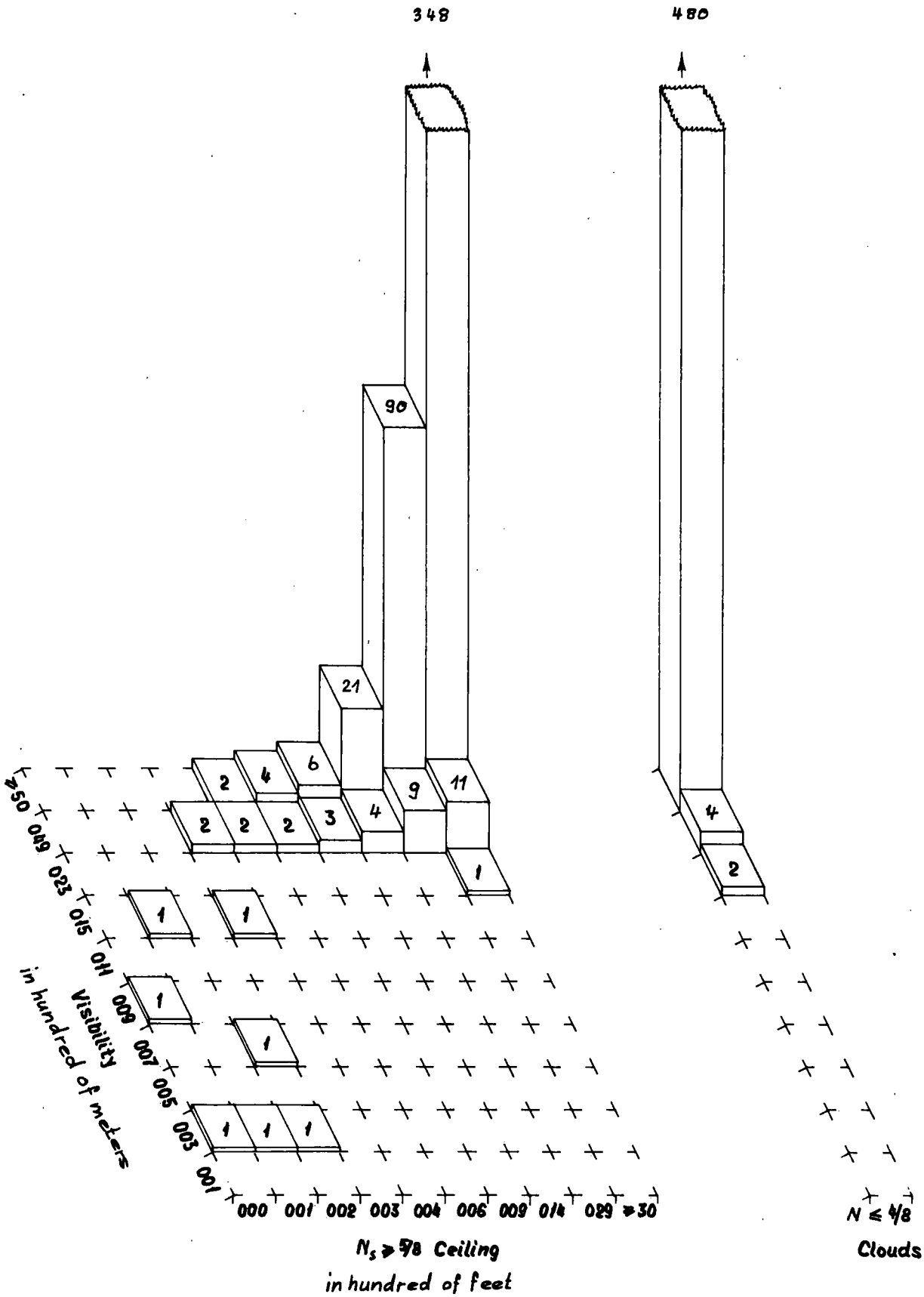
23 - 02 GMT




351
348
62
32
16
12
7
37
9
Visibility
in hundred of meters
≥50 049 025 015 011 009 007 005 003 001
000 001 002 003 004 006 009 014 029 ≥30
$N_s \leq 5/8$ Ceiling
in hundred of feet
$N \leq 4/8$
Clouds

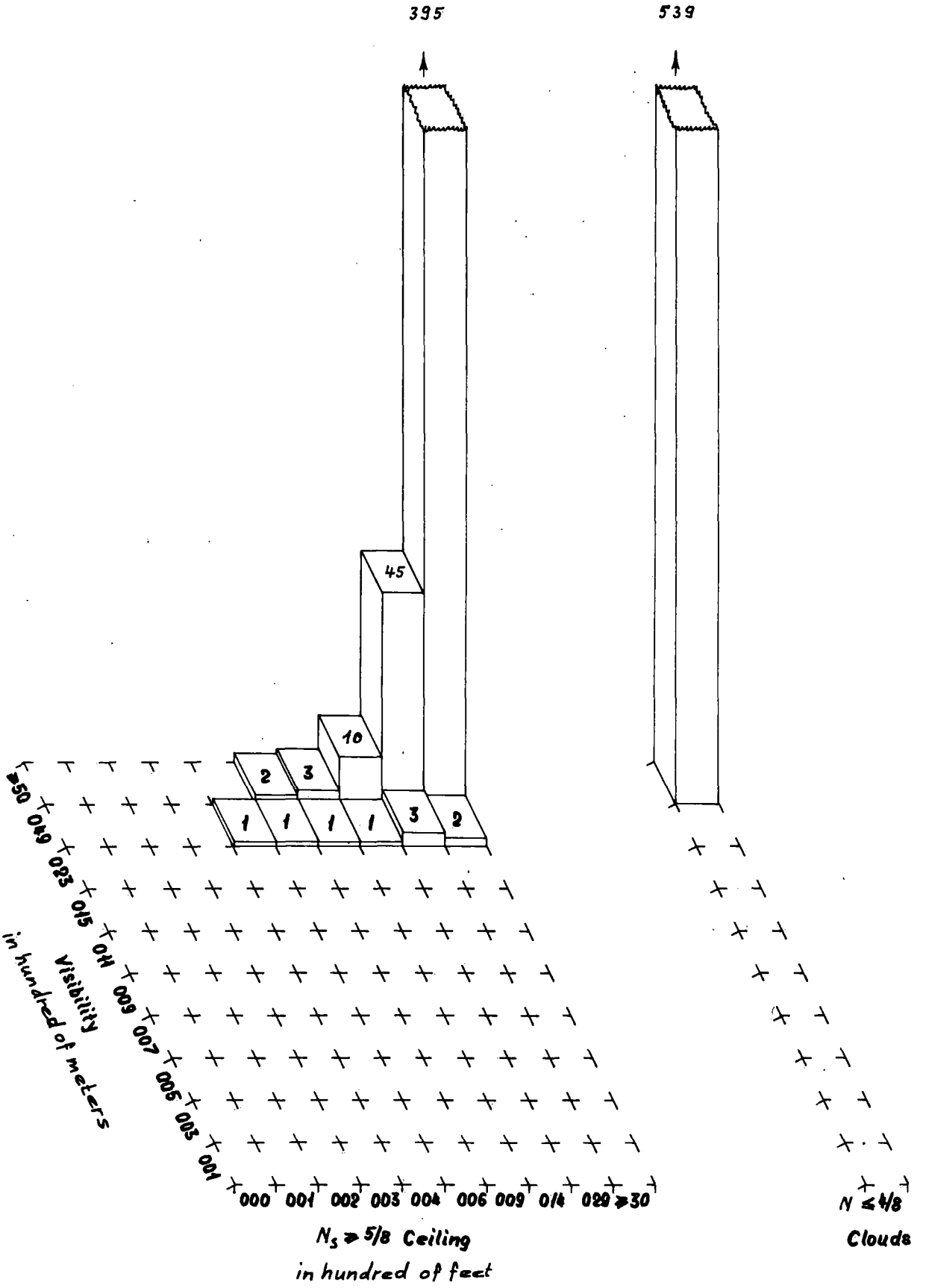
VI-VIII

07-10 GMT



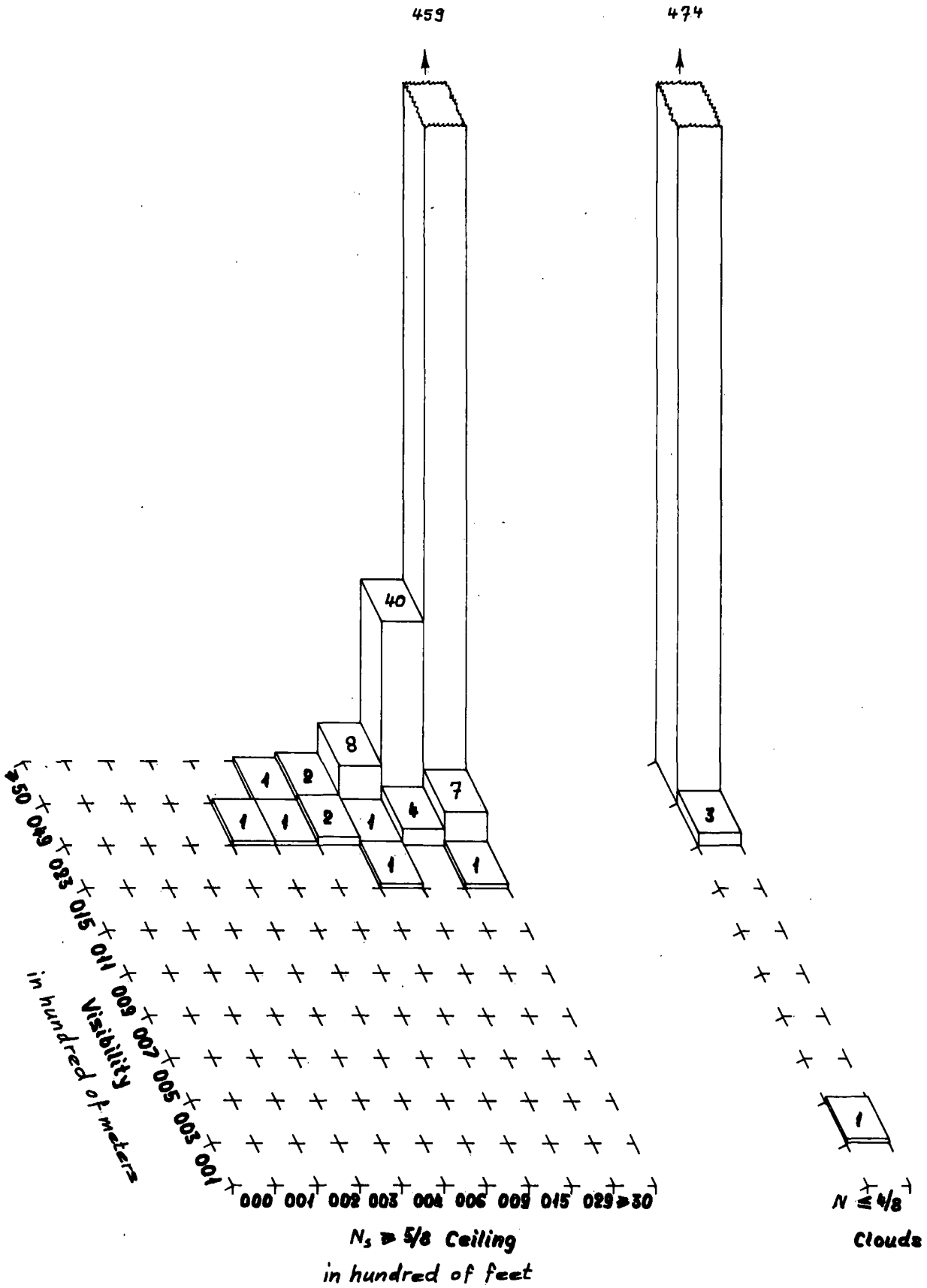
VI – VIII

11-16 GMT



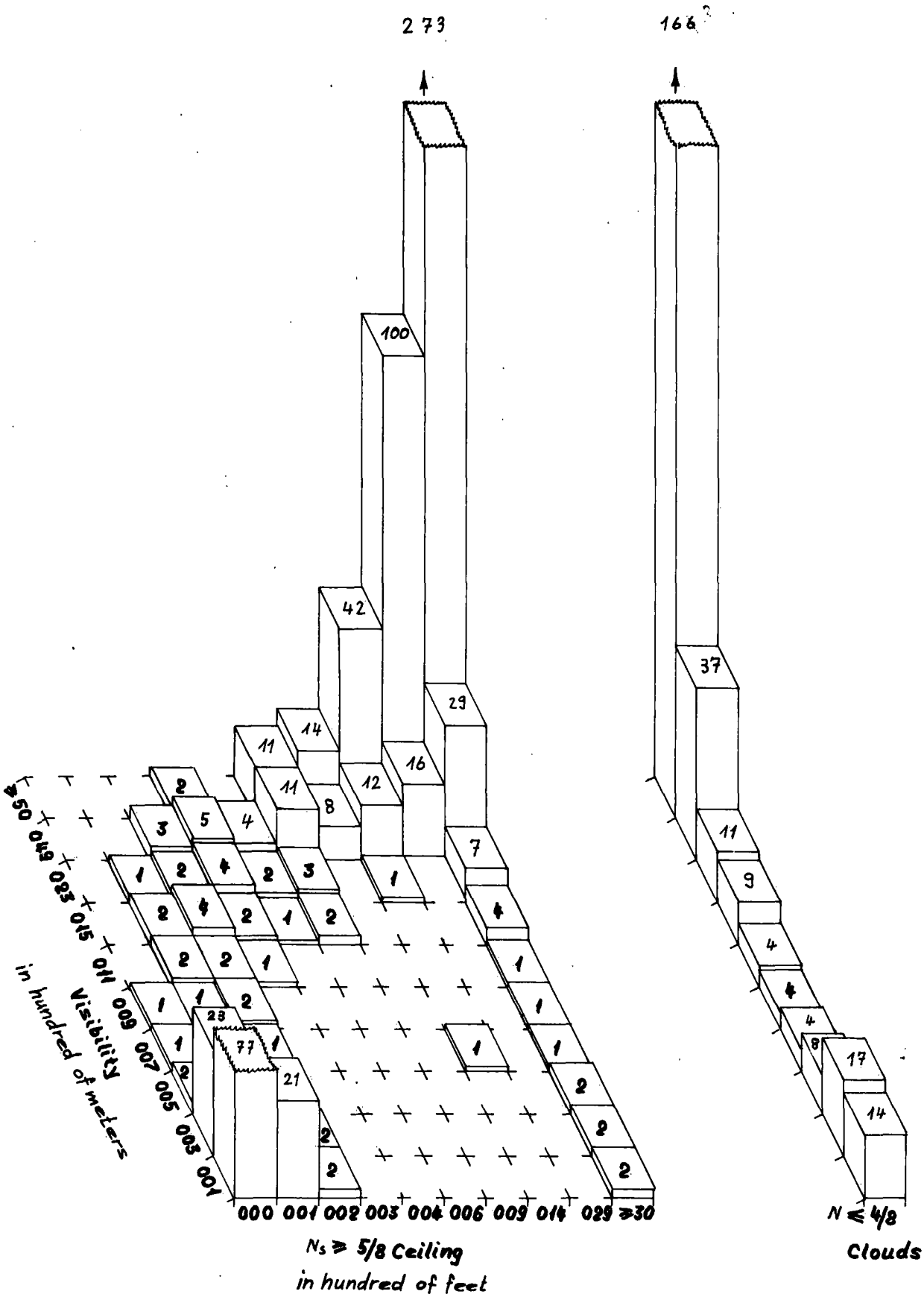
VI – VIII

17 – 22 GMT

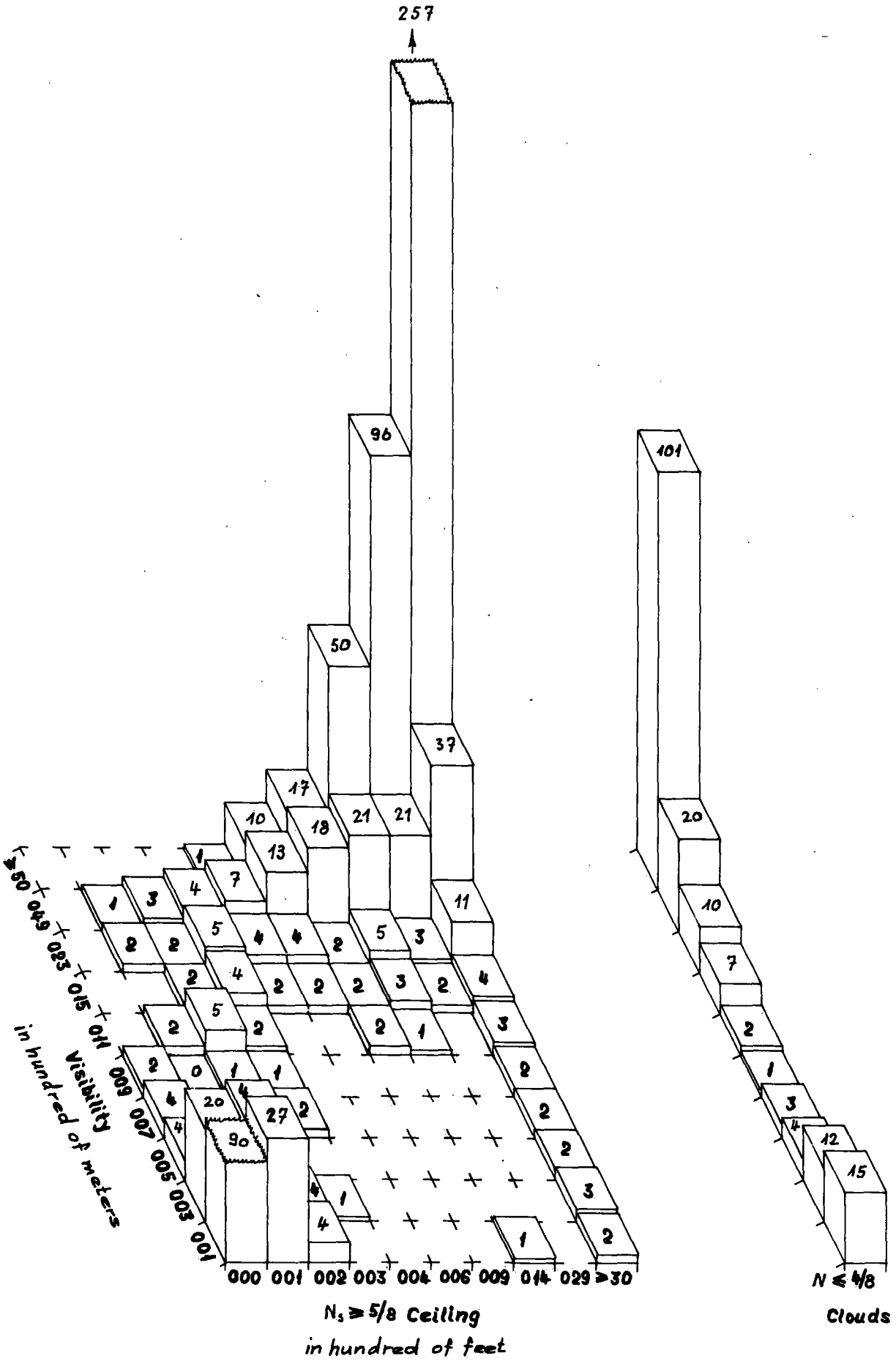


IX–XI

23–02 GMT

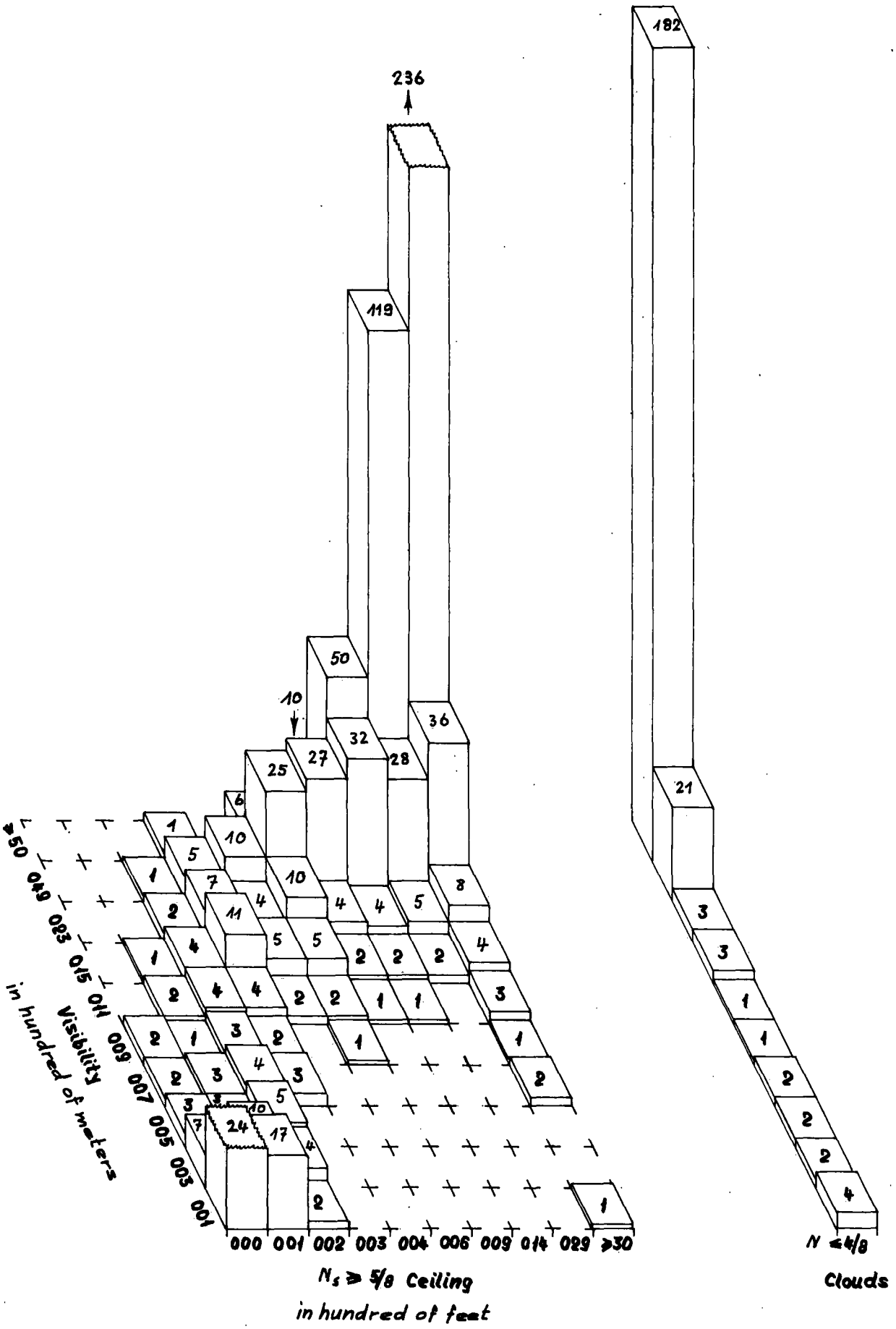


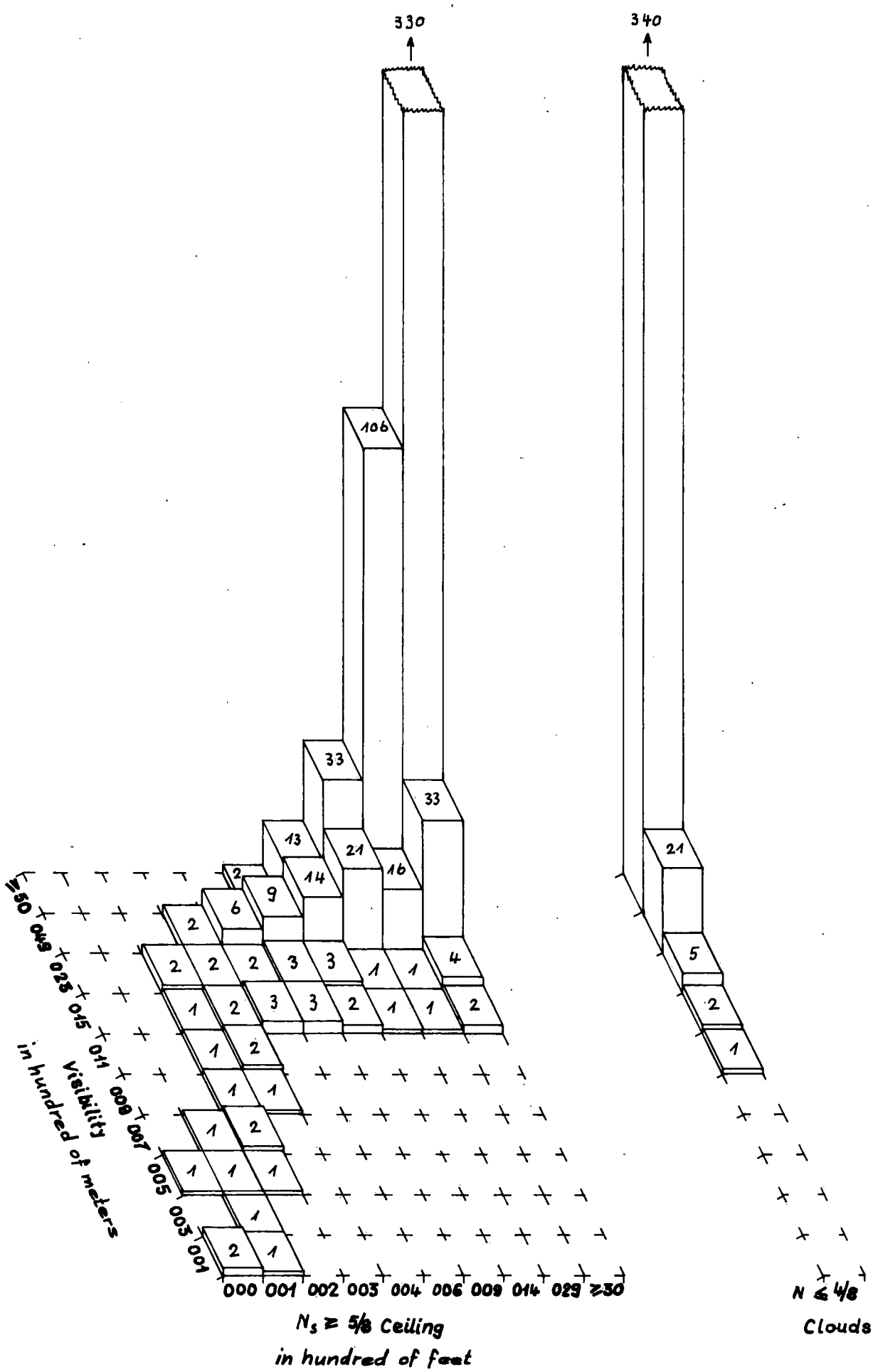
03-06 GMT

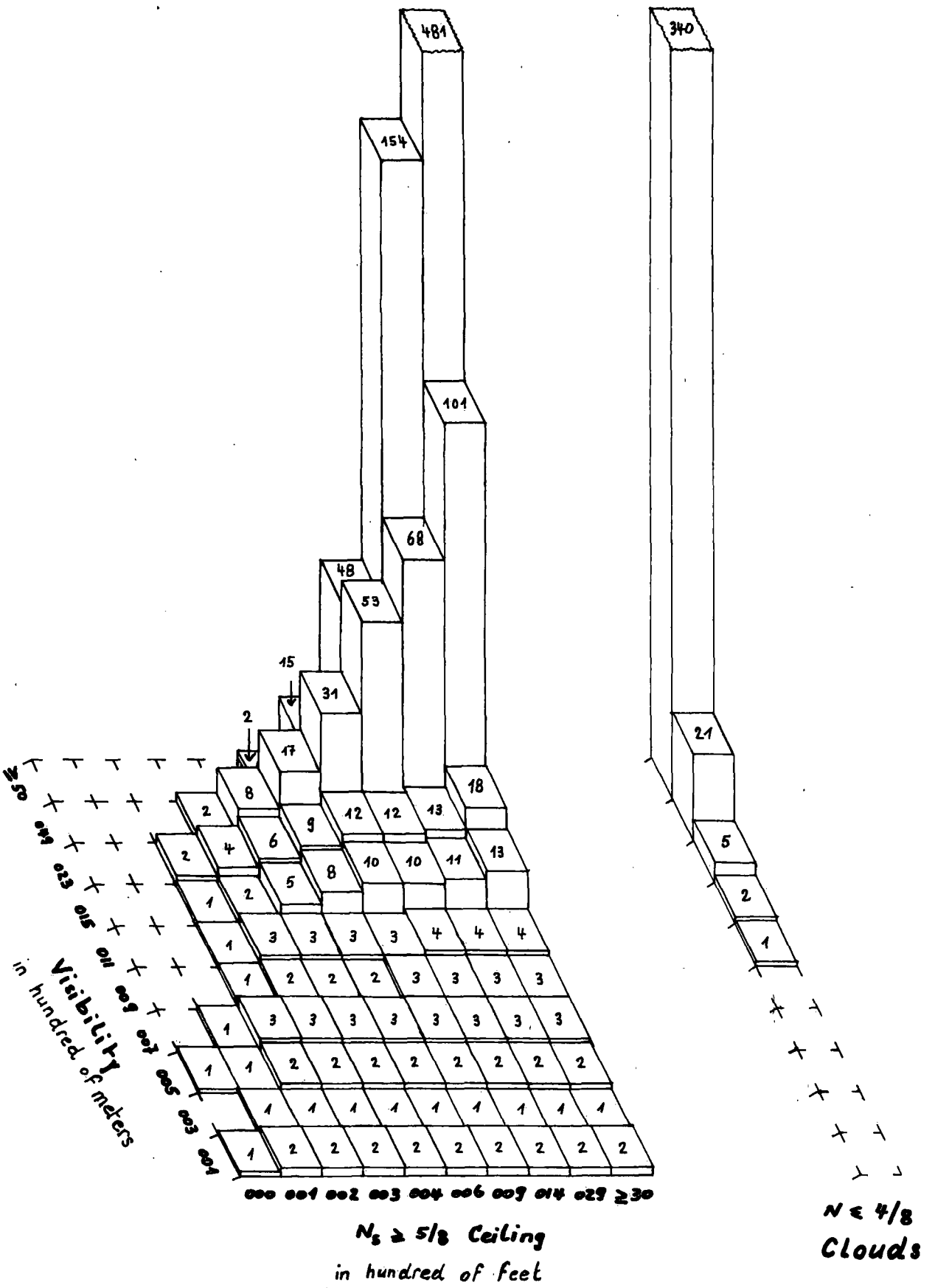

257
96
50
37
17
10
18
21
21
13
7
11
101
20
10
7
2
1
3
4
12
15
Visibility
in hundred of meters
≥50
049
023
015
011
009
007
005
003
001
000
001
002
003
004
006
009
014
029
≥30
$N_s \geq 5/8$ Ceiling
in hundred of feet
$N \leq 4/8$
Clouds

IX – XI

07–10 GMT

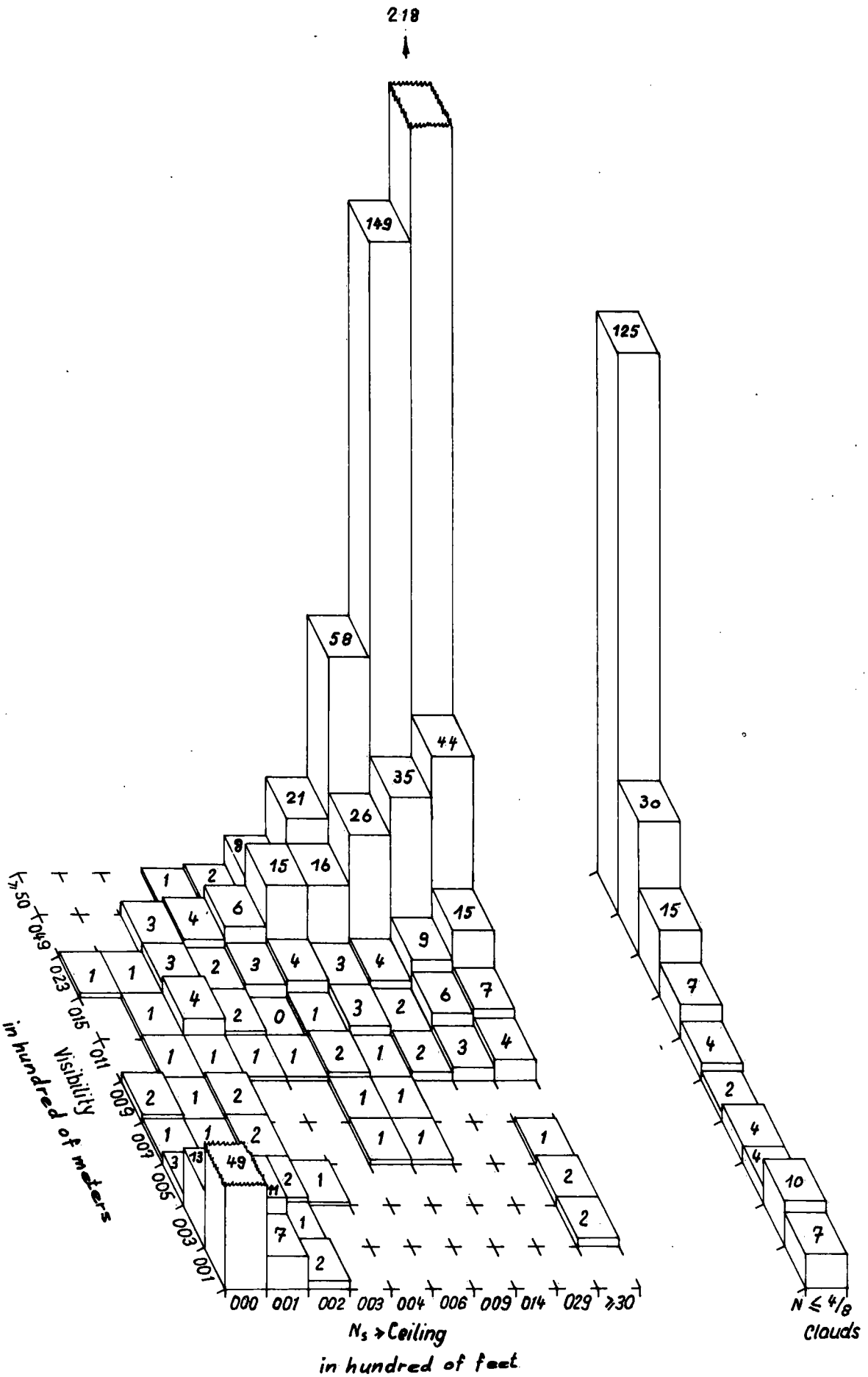



330
340
106
33
33
13
21
16
14
9
6
2
2
2
2
2
3
3
1
1
4
1
2
3
3
2
1
1
2
1
2
1
1
1
2
1
1
1
1
2
1
2
1
≥50
049
023
015
011
009
007
005
003
001
Visibility
in hundred of meters
000
001
002
003
004
006
009
014
029
≥30
$N_s \geq 5/8$ Ceiling
in hundred of feet
21
5
2
1
$N \leq 4/8$
Clouds


481
154
101
68
48
53
15
31
2
17
8
18
2
9
12
12
13
2
4
6
8
10
10
11
13
1
2
5
1
3
3
3
3
4
4
4
1
2
2
2
3
3
3
3
1
3
3
3
3
3
3
3
3
1
1
2
2
2
2
2
2
2
2
1
1
1
1
1
1
1
1
1
1
2
2
2
2
2
2
2
2
2
340
21
5
2
1
≥50
049
023
015
011
009
007
005
003
001
Visibility
in hundred of meters
000
001
002
003
004
006
009
014
029
≥30
$N_s \geq 5/8$ Ceiling
in hundred of feet
$N \leq 4/8$
Clouds

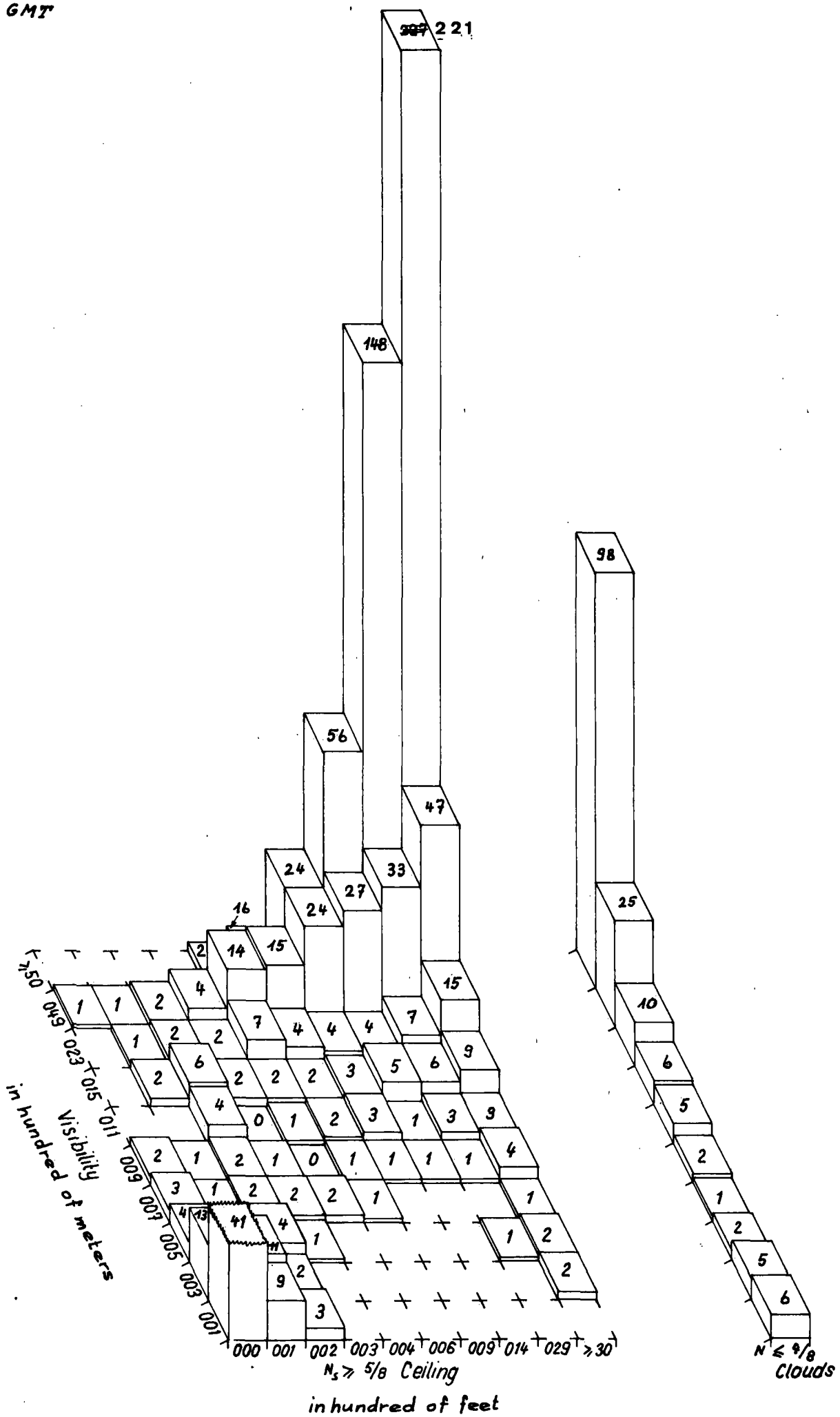
XII - II

23-02 GMT



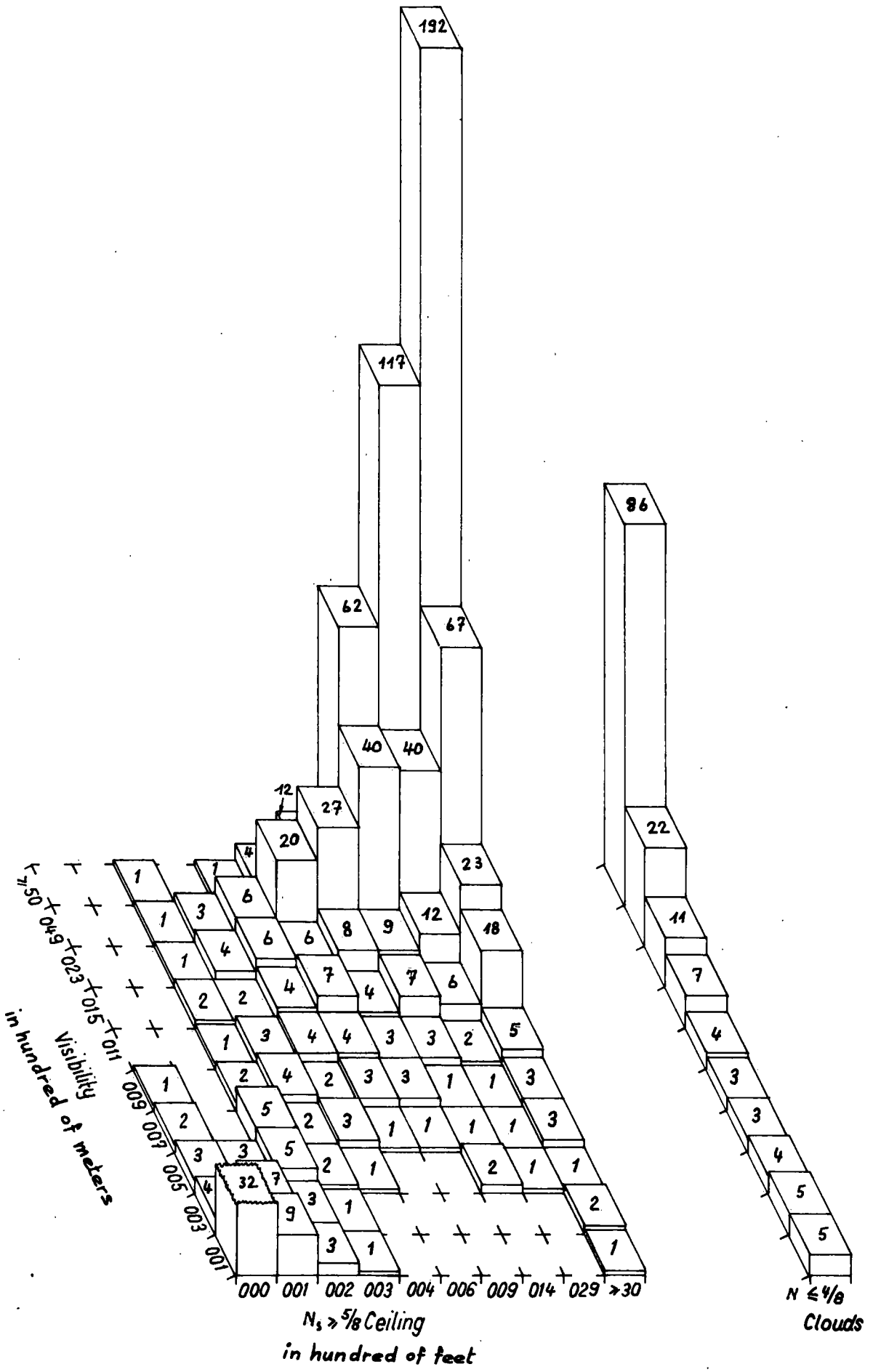
XII - II

03 - 06 GMT



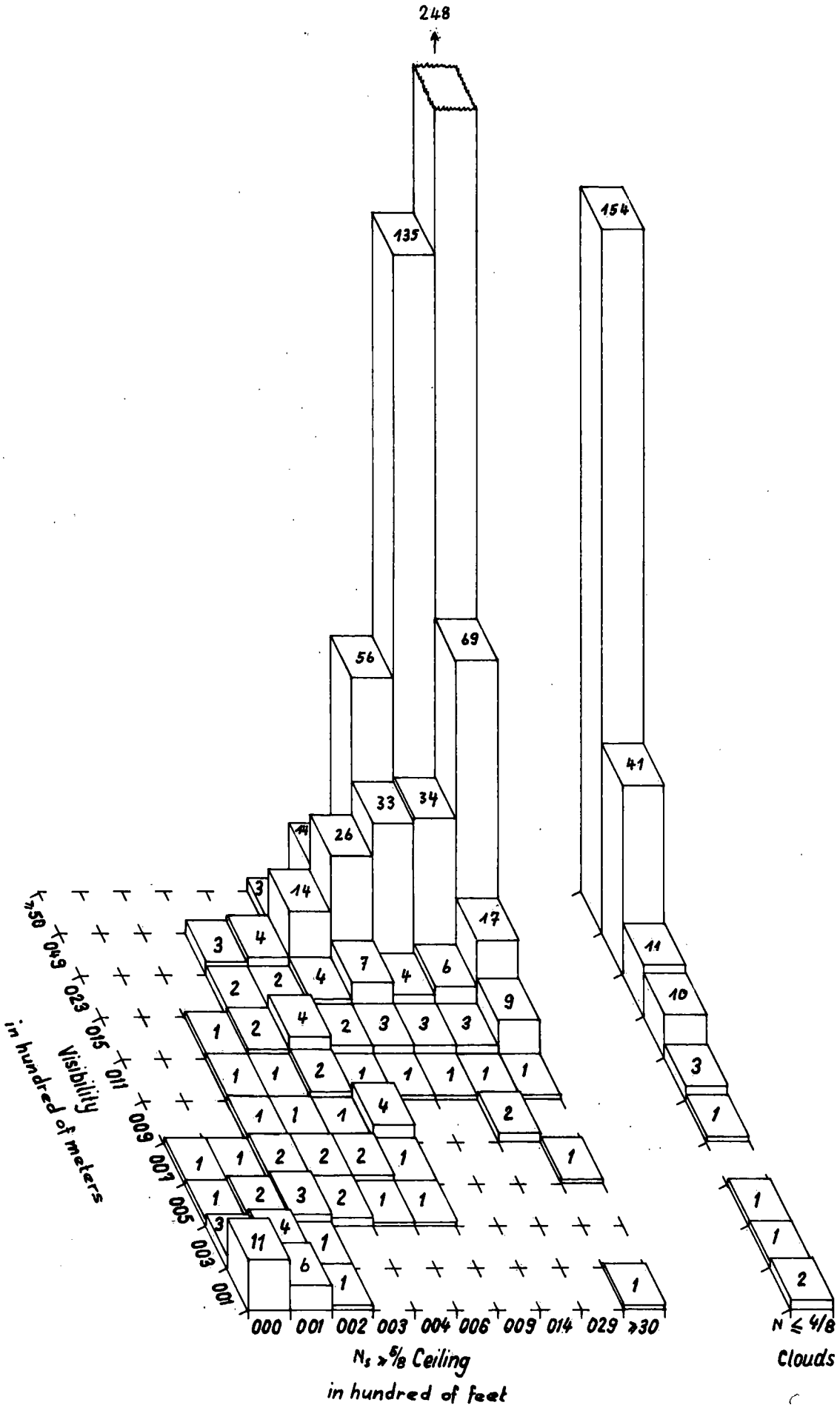
XII-II

07 · 10 GMT



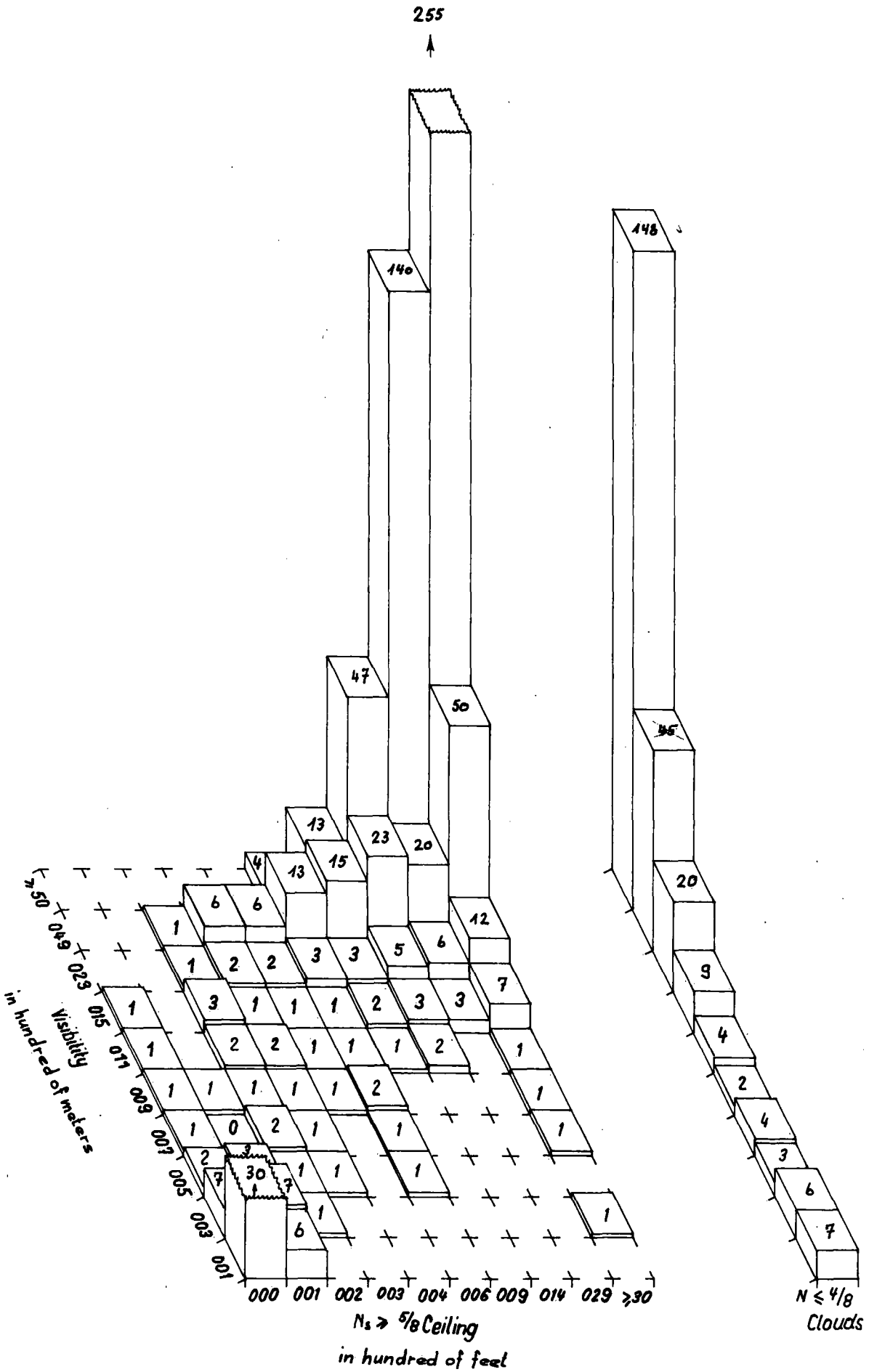
XII-11

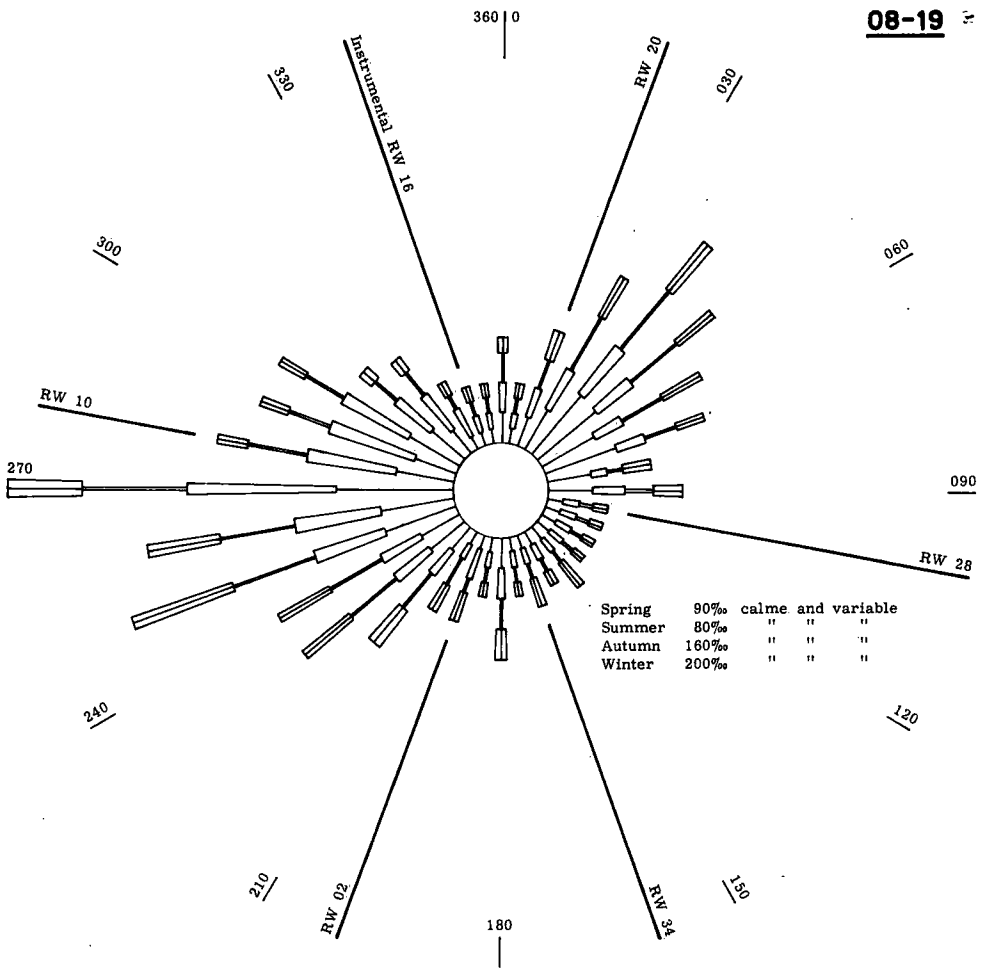
11-16 GMT

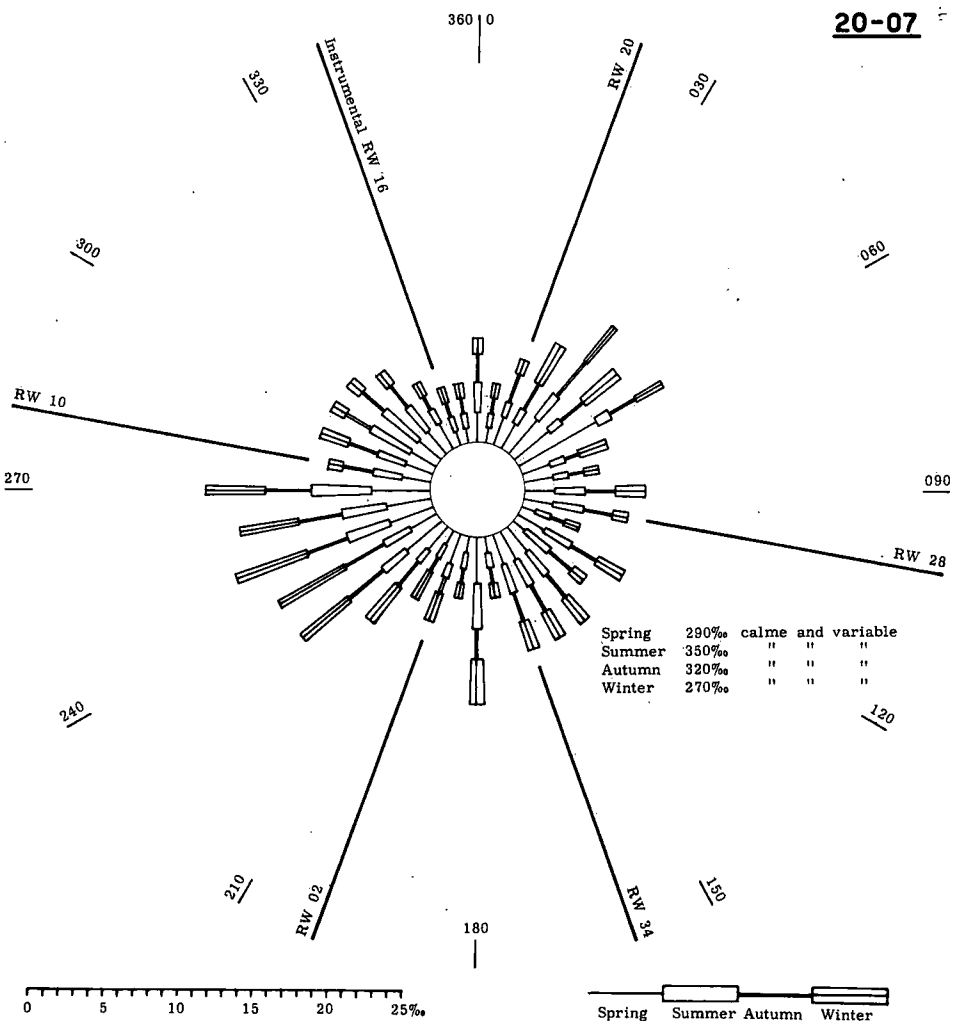


XII - II

17 - 22 GMT

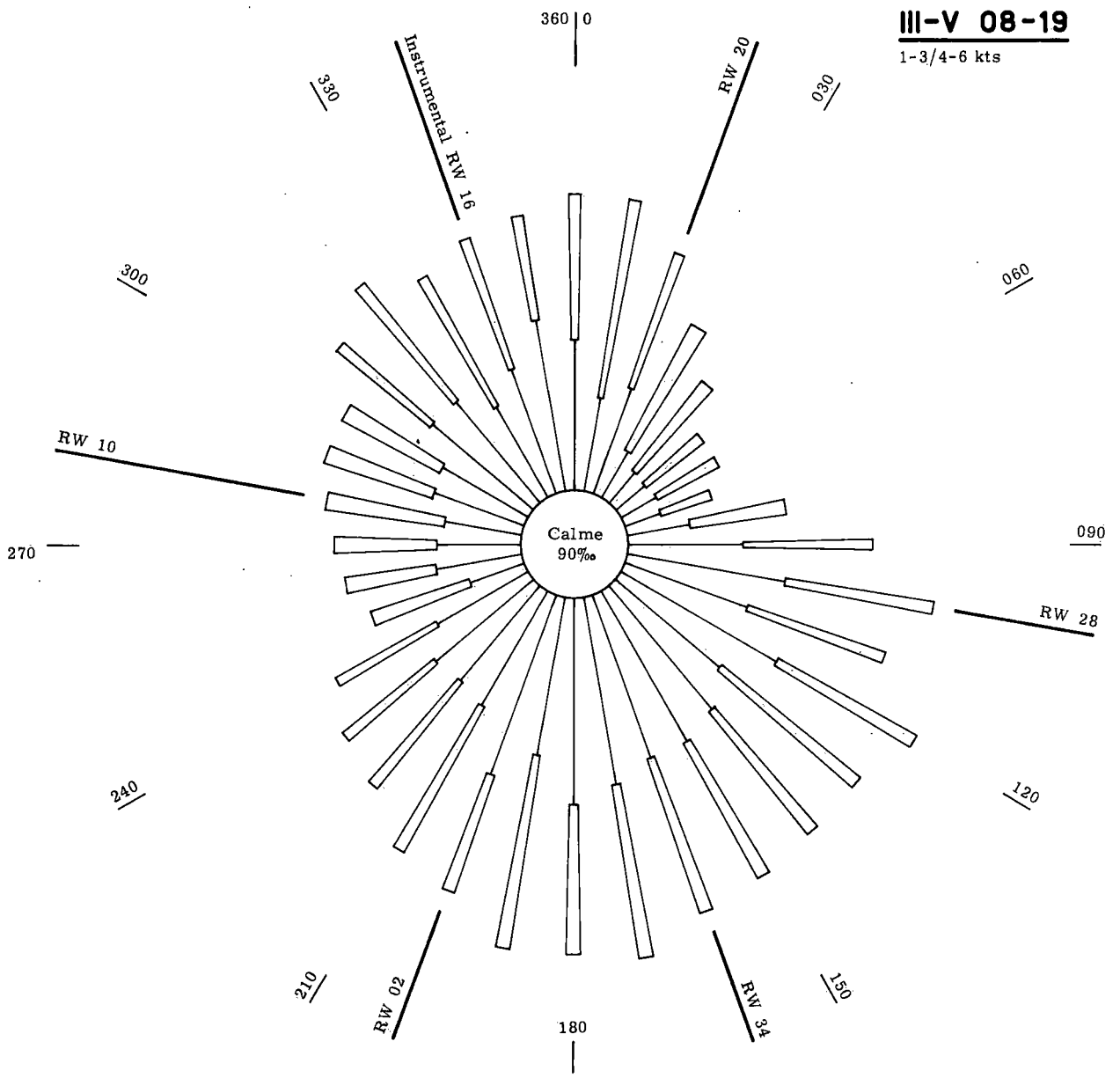


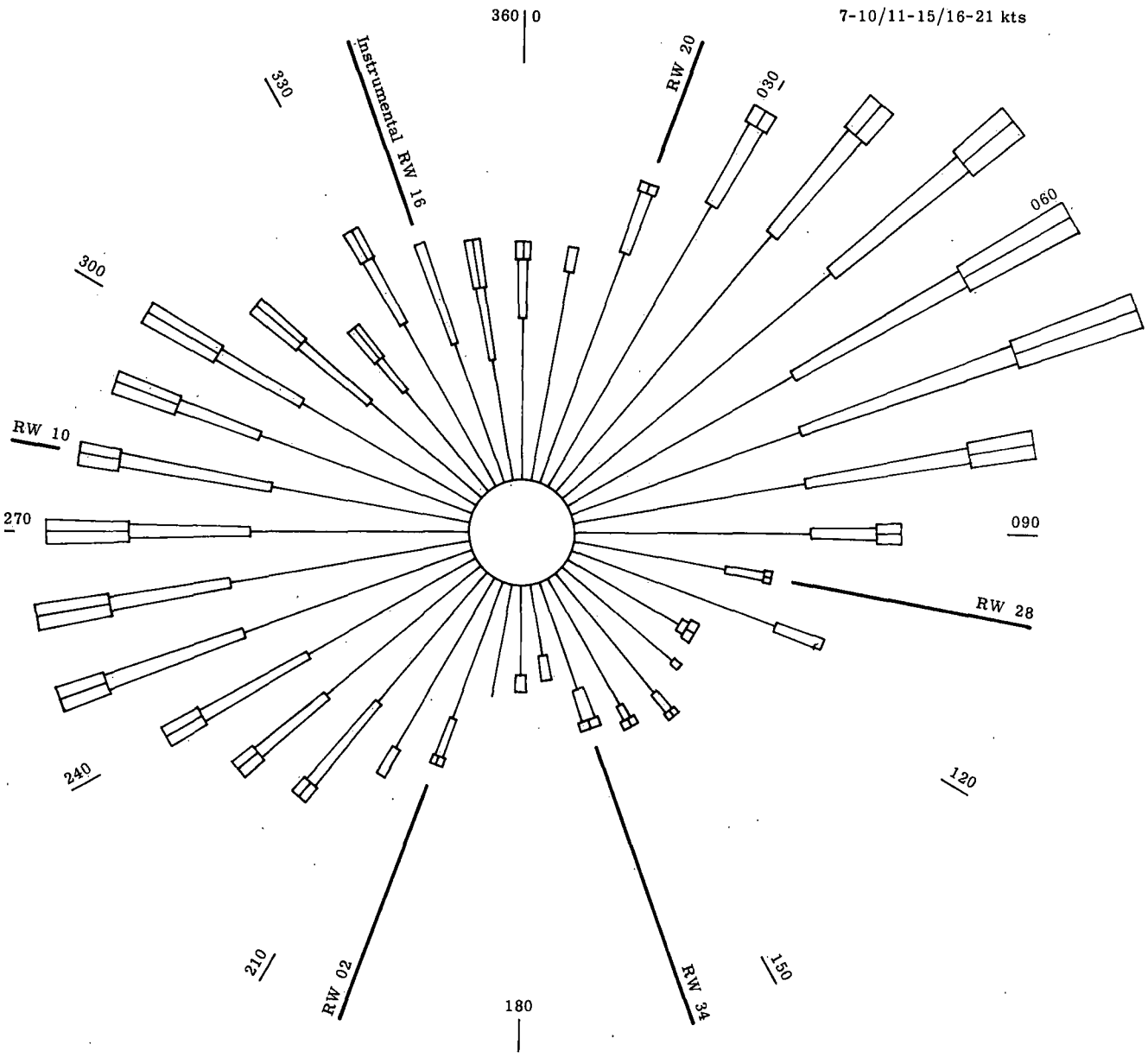

08-19
360 | 0
Instrumental RW 16
RW 20
330
030
300
060
RW 10
270
090
RW 28
Spring 90‰ calme and variable
Summer 80‰ " " "
Autumn 160‰ " " "
Winter 200‰ " " "
240
120
210
RW 02
RW 34
150
180


20-07
360 | 0
Instrumental RW 16
RW 20
330
030
300
060
RW 10
270
090
RW 28
Spring 290‰ calme and variable
Summer 350‰ " " "
Autumn 320‰ " " "
Winter 270‰ " " "
240
120
210
RW 02
RW 34
150
180
0 5 10 15 20 25‰
Spring Summer Autumn Winter

III-V 08-19

1-3/4-6 kts



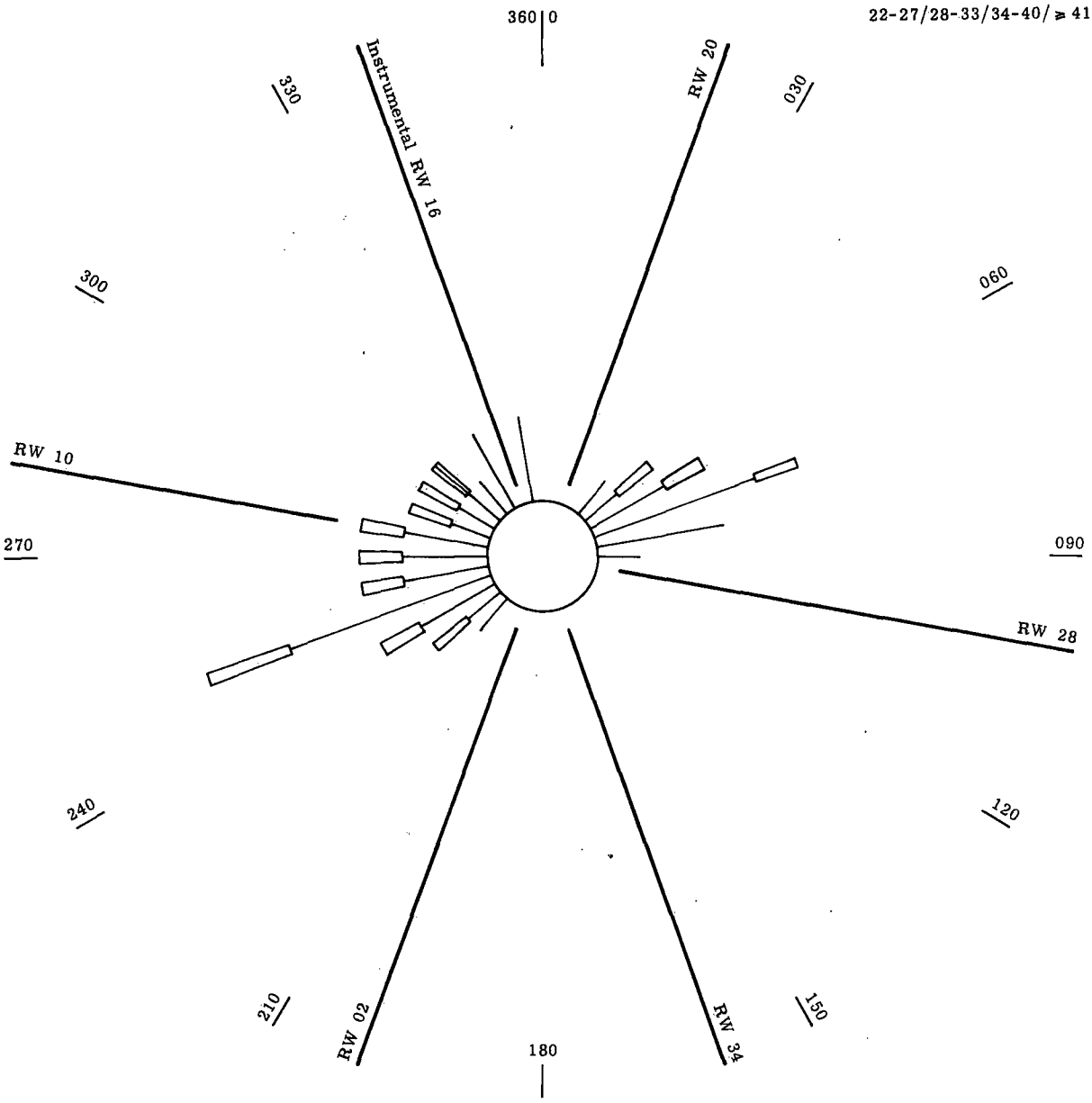

7-10/11-15/16-21 kts
360 | 0
Instrumental RW 16
RW 20
330
030
060
300
RW 10
270
090
RW 28
240
120
210
RW 02
RW 34
150
180


0
200
400
600
800
1000‰
1 - 3
4 - 6
Ktn


0
100
200
300
400
500‰
7 - 10
11 - 15
16 - 21
Ktn

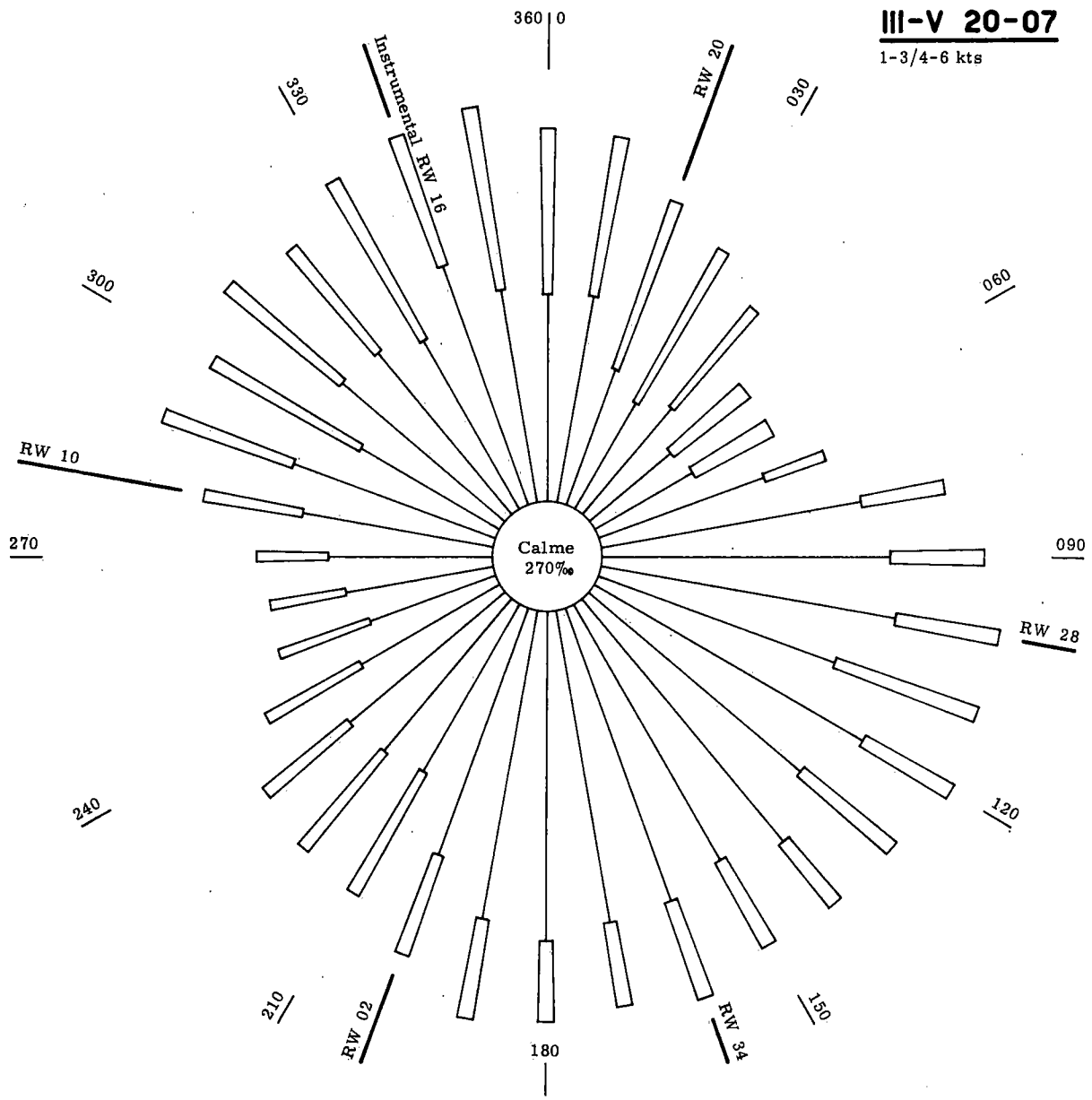

0
20
40
60
80
100‰
22 - 27
28 - 33
34 - 40
≥ 41
Ktn

22-27/28-33/34-40/ ≥ 41 kts



III-V 20-07

1-3/4-6 kts



0 200 400 600 800 1000‰

1 - 3 4 - 6 Ktn

---

0 100 200 300 400 500‰

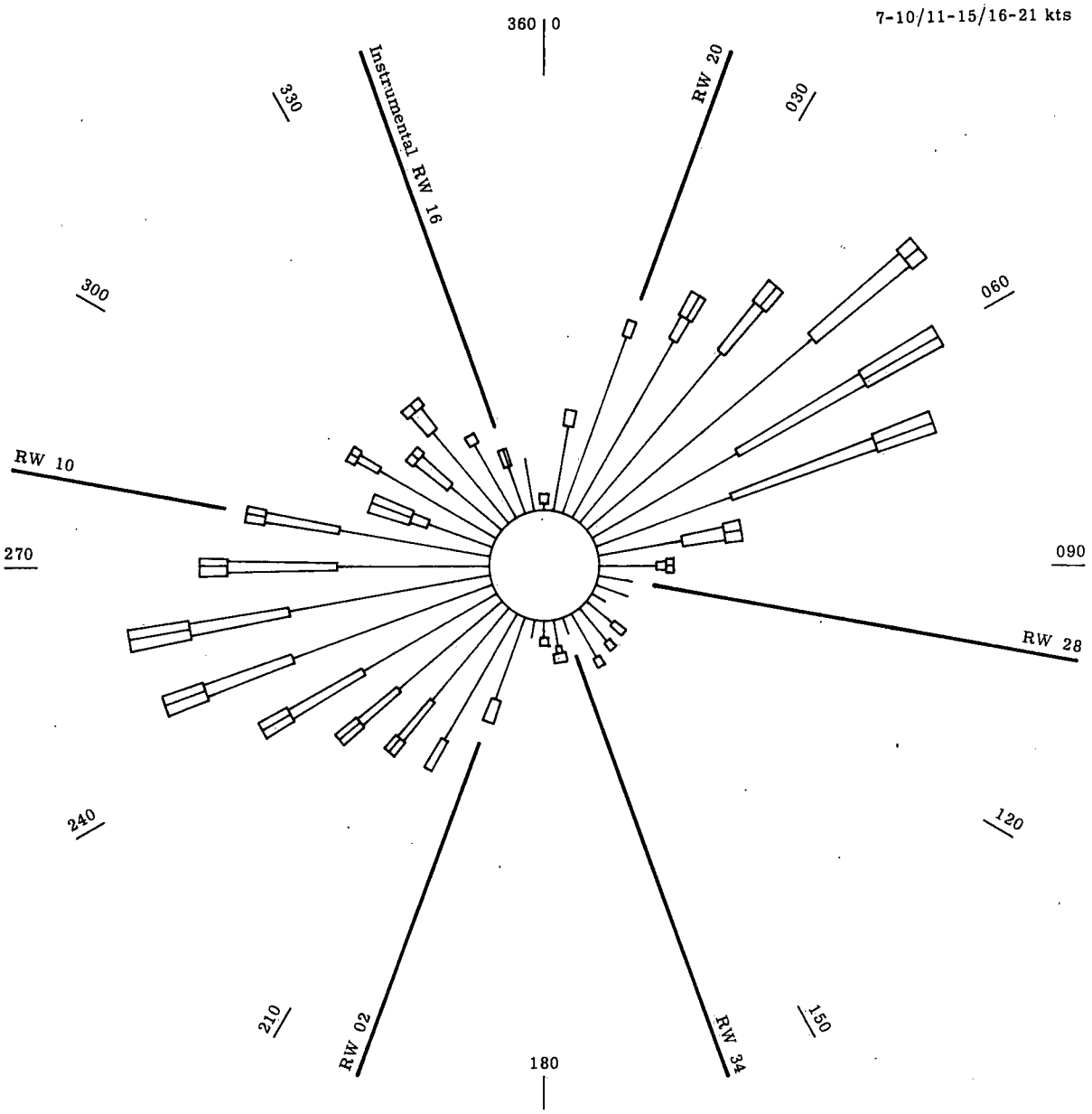
7 - 10 11 - 15 16 - 21 Ktn

---

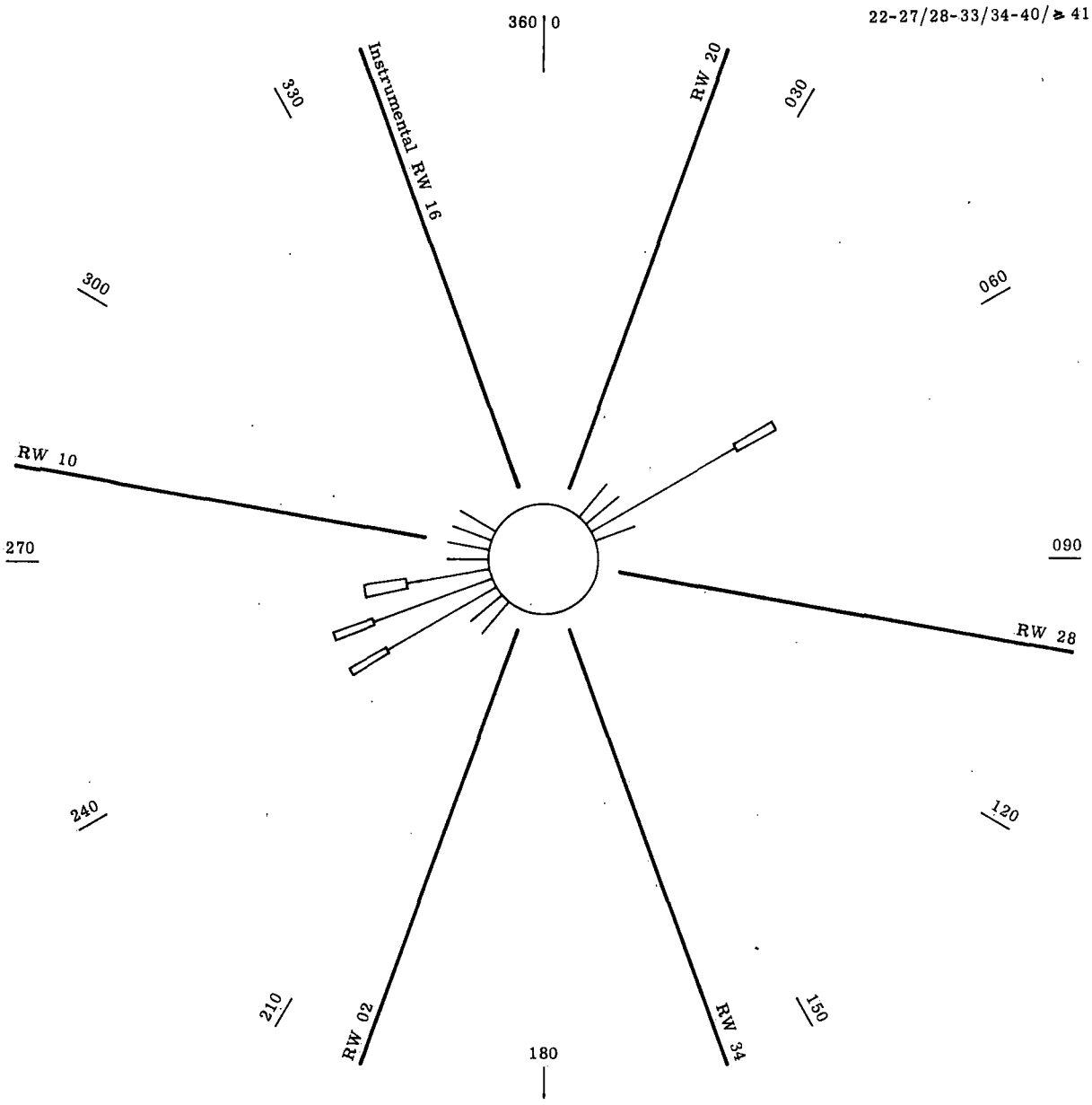
0 20 40 60 80 100‰

22 - 27 28 - 33 34 - 40 ≥ 41 Ktn

7-10/11-15/16-21 kts

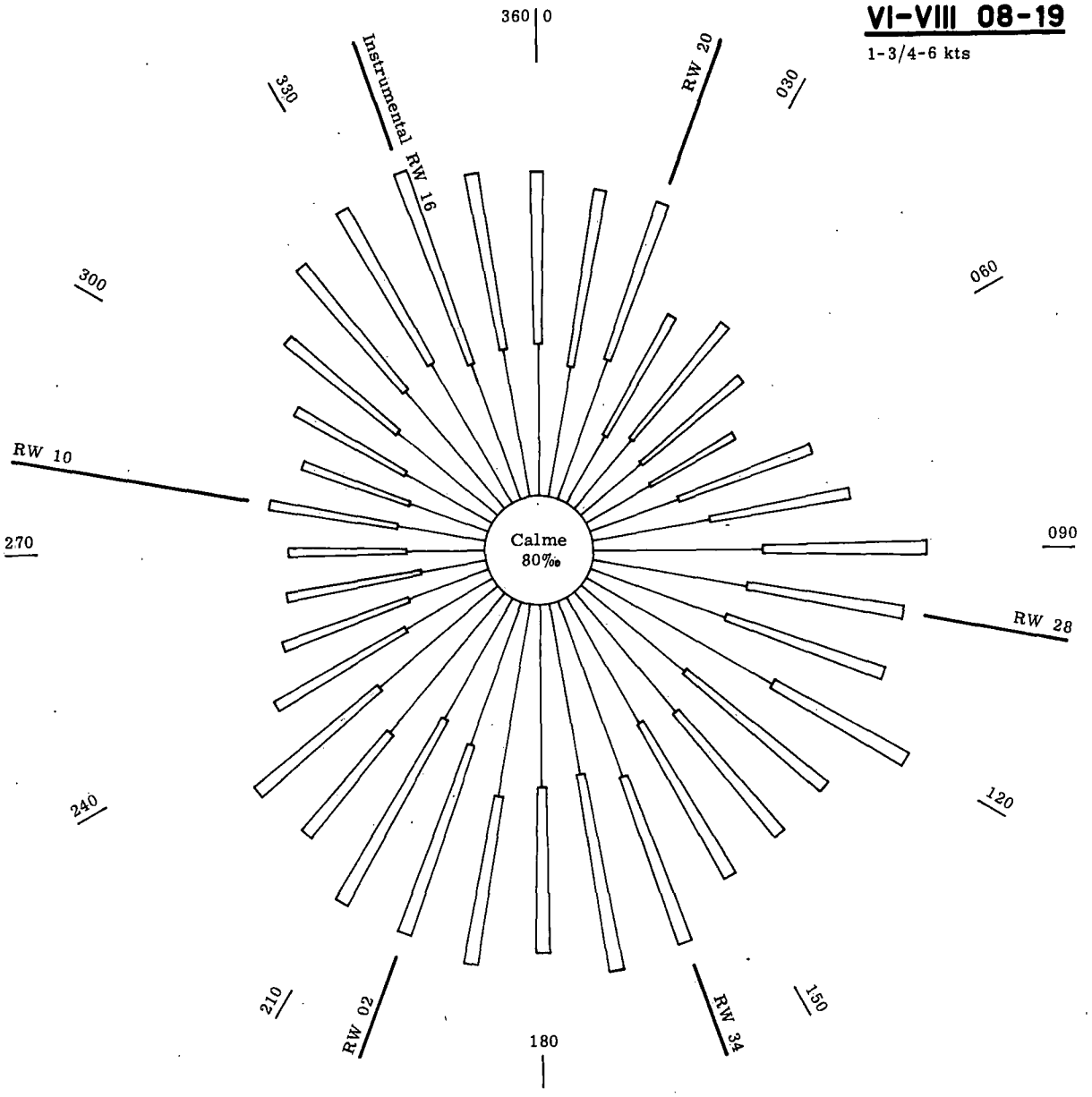


22-27/28-33/34-40/≥ 41 kts



VI-VIII 08-19

1-3/4-6 kts



0 200 400 600 800 1000‰

1 - 3 4 - 6 Ktn

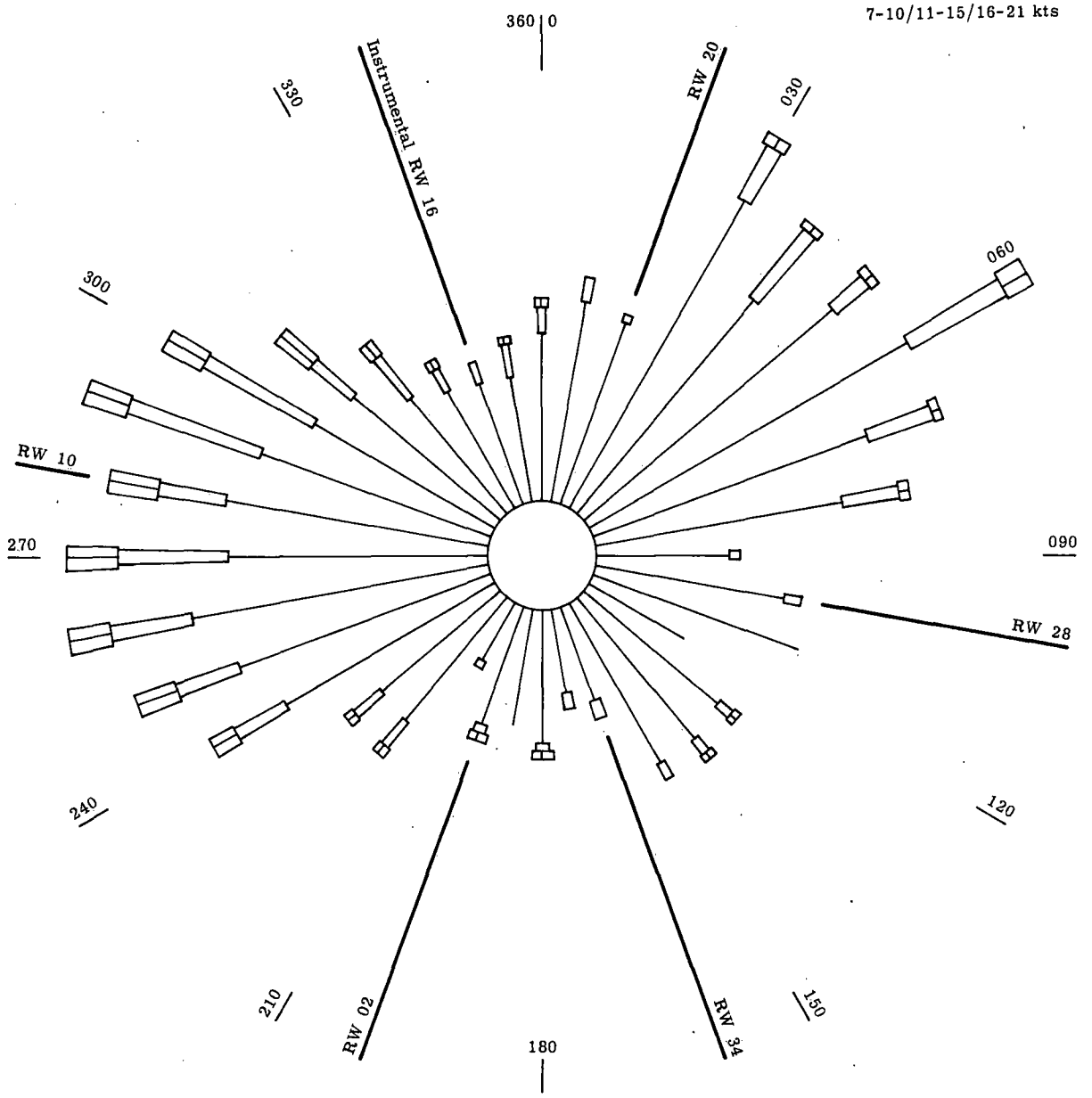
0 100 200 300 400 500‰

7 - 10 11 - 15 16 - 21 Ktn

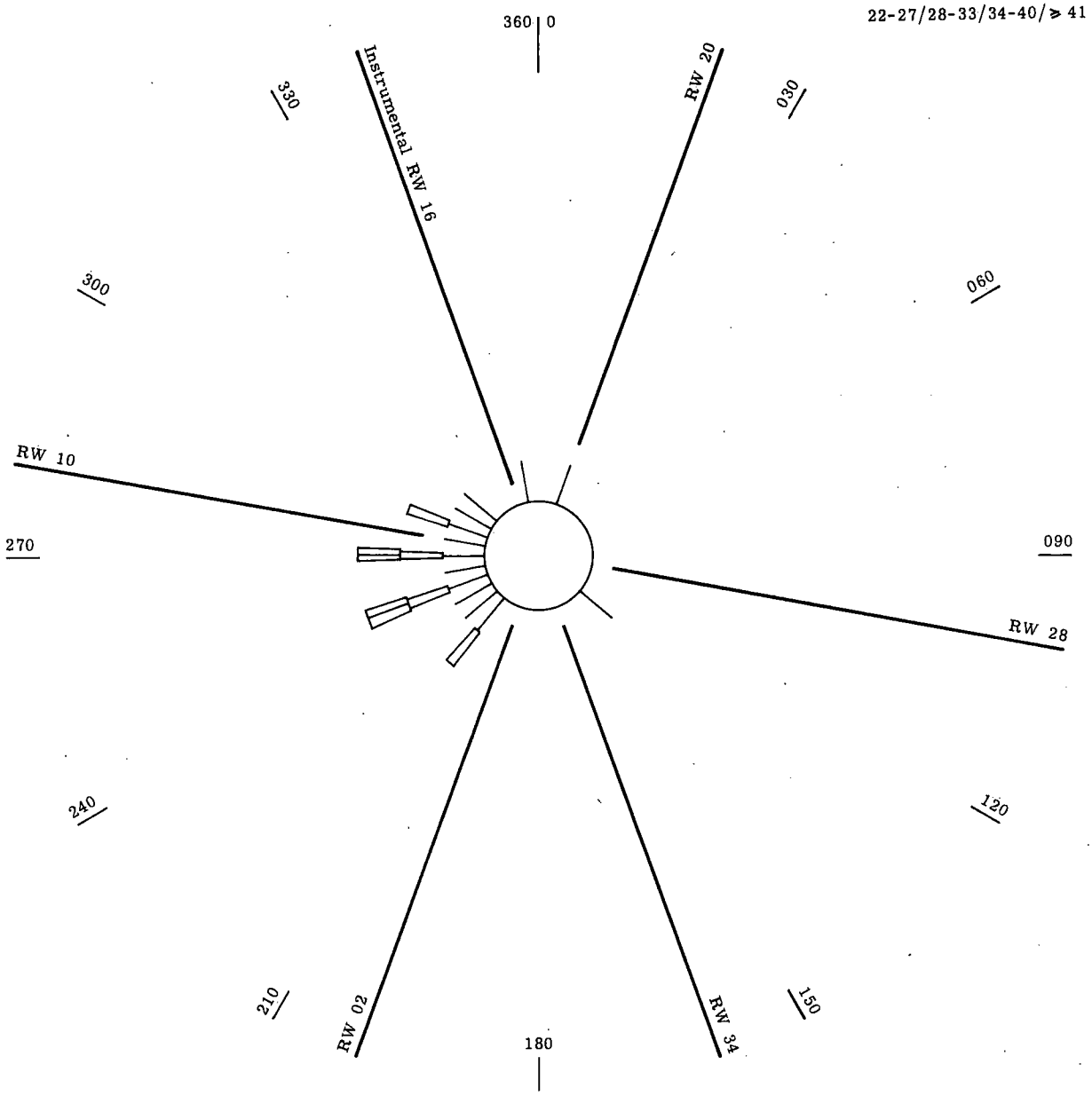
0 20 40 60 80 100‰

22 - 27 28 - 33 34 - 40 ≥ 41 Ktn

7-10/11-15/16-21 kts

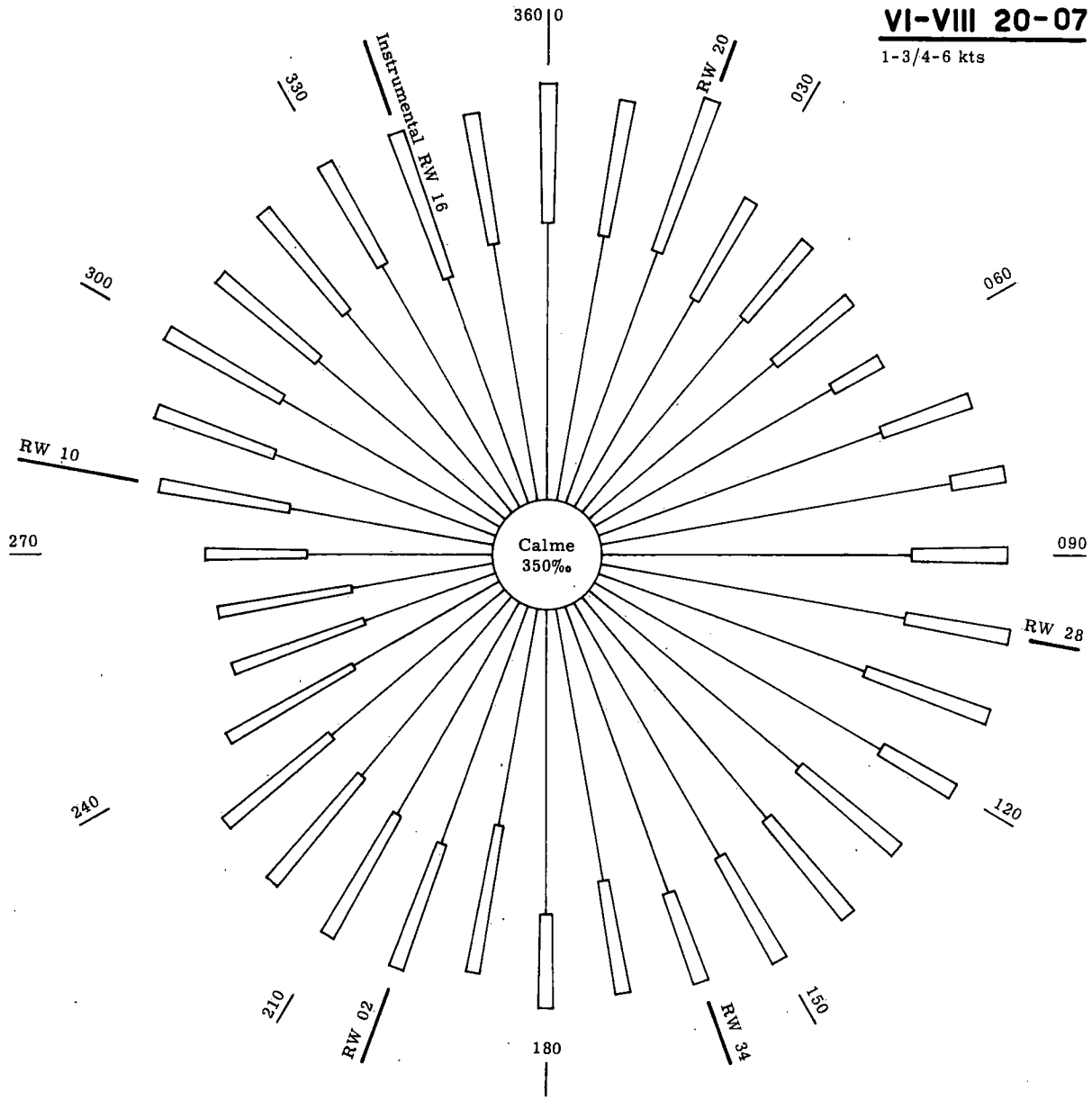


22-27/28-33/34-40/≥ 41 kts

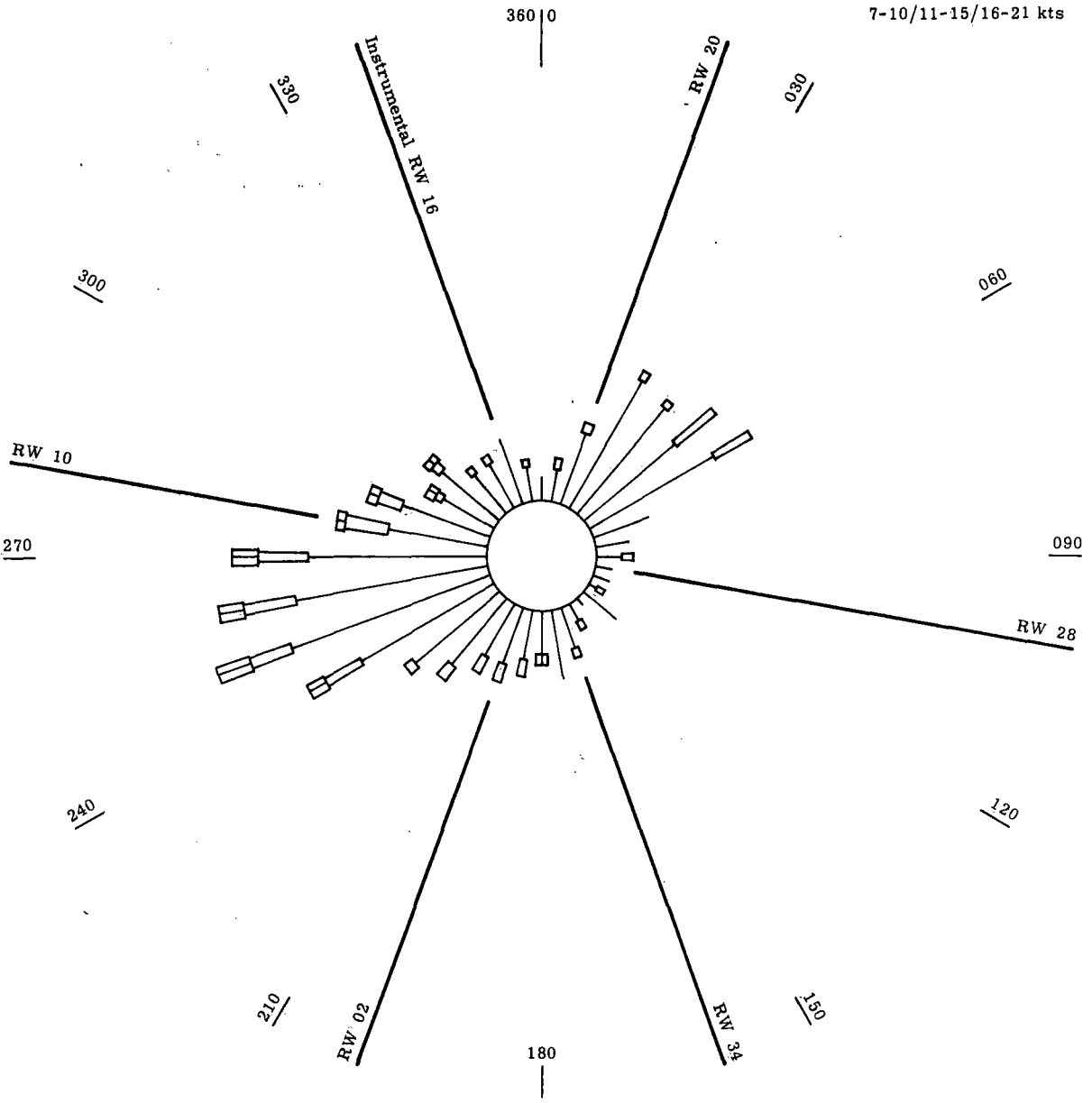


VI-VIII 20-07

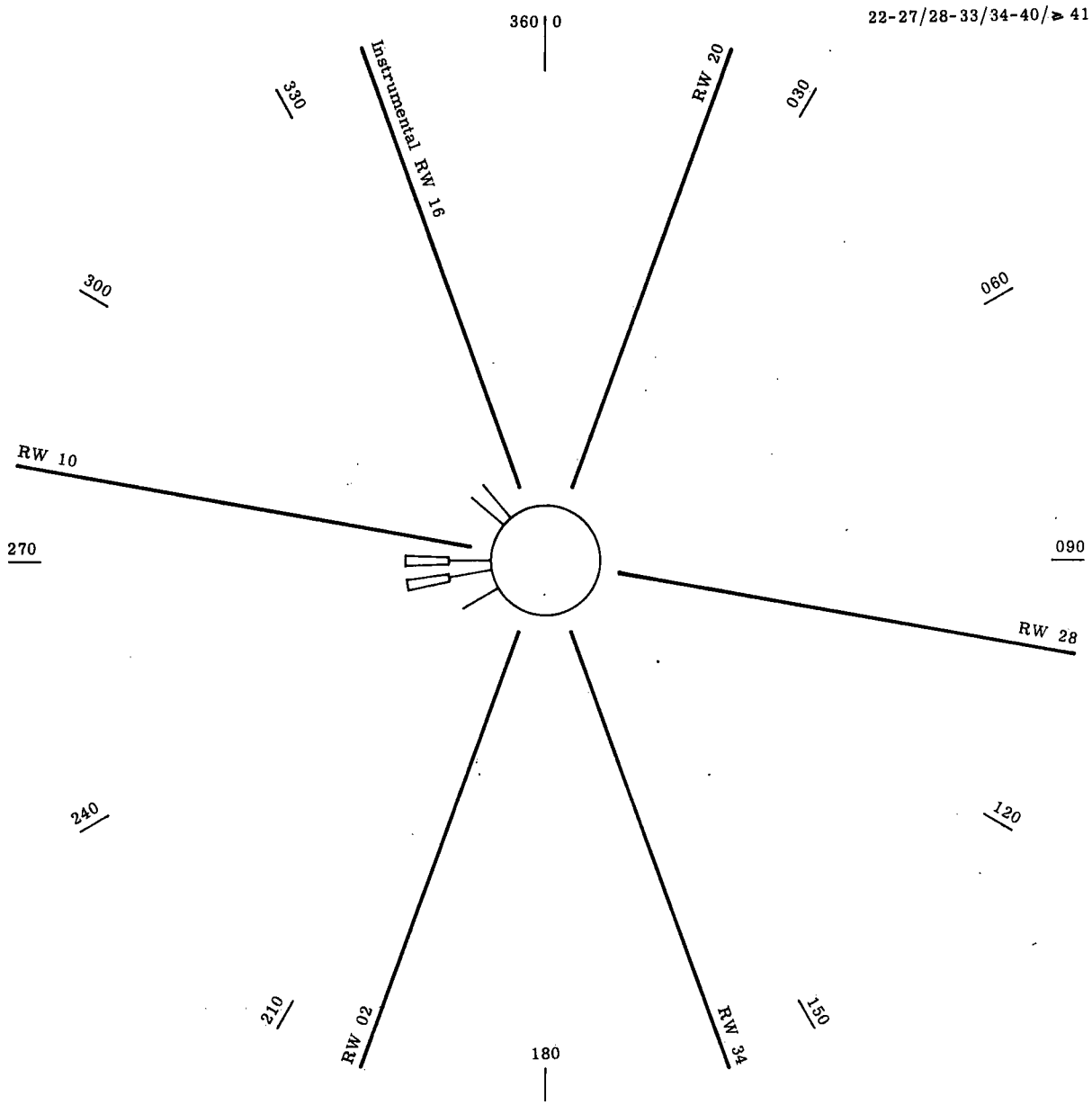
1-3/4-6 kts



7-10/11-15/16-21 kts



22-27/28-33/34-40/≥ 41 kts



0 200 400 600 800 1000‰

1 - 3 4 - 6 Ktn

---

0 100 200 300 400 500‰

7 - 10 11 - 15 16 - 21 Ktn

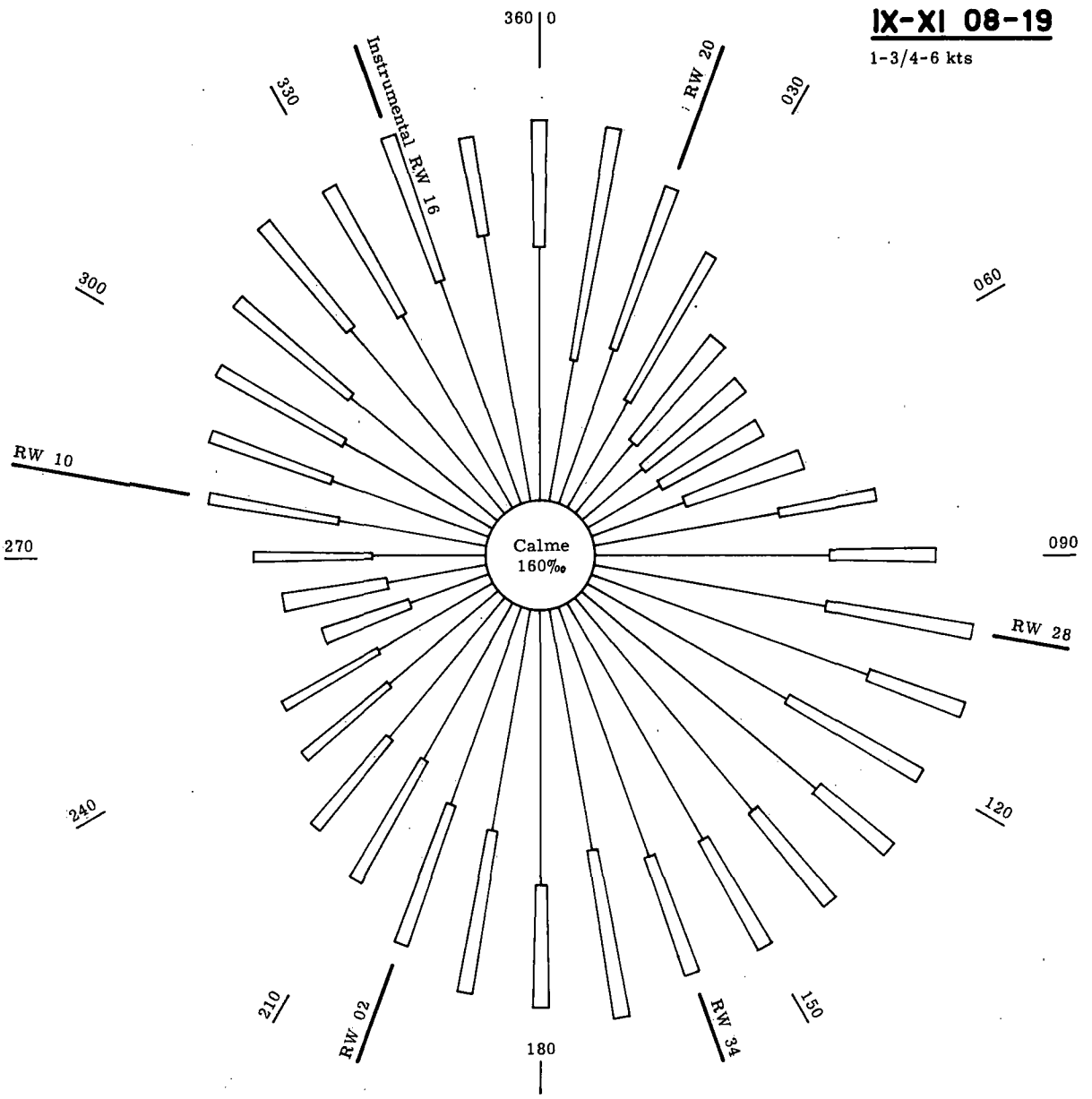
---

0 20 40 60 80 100‰

22 - 27 28 - 33 34 - 40 ≥ 41 Ktn

IX-XI 08-19

1-3/4-6 kts



0 200 400 600 800 1000‰

1 - 3 4 - 6 Ktn

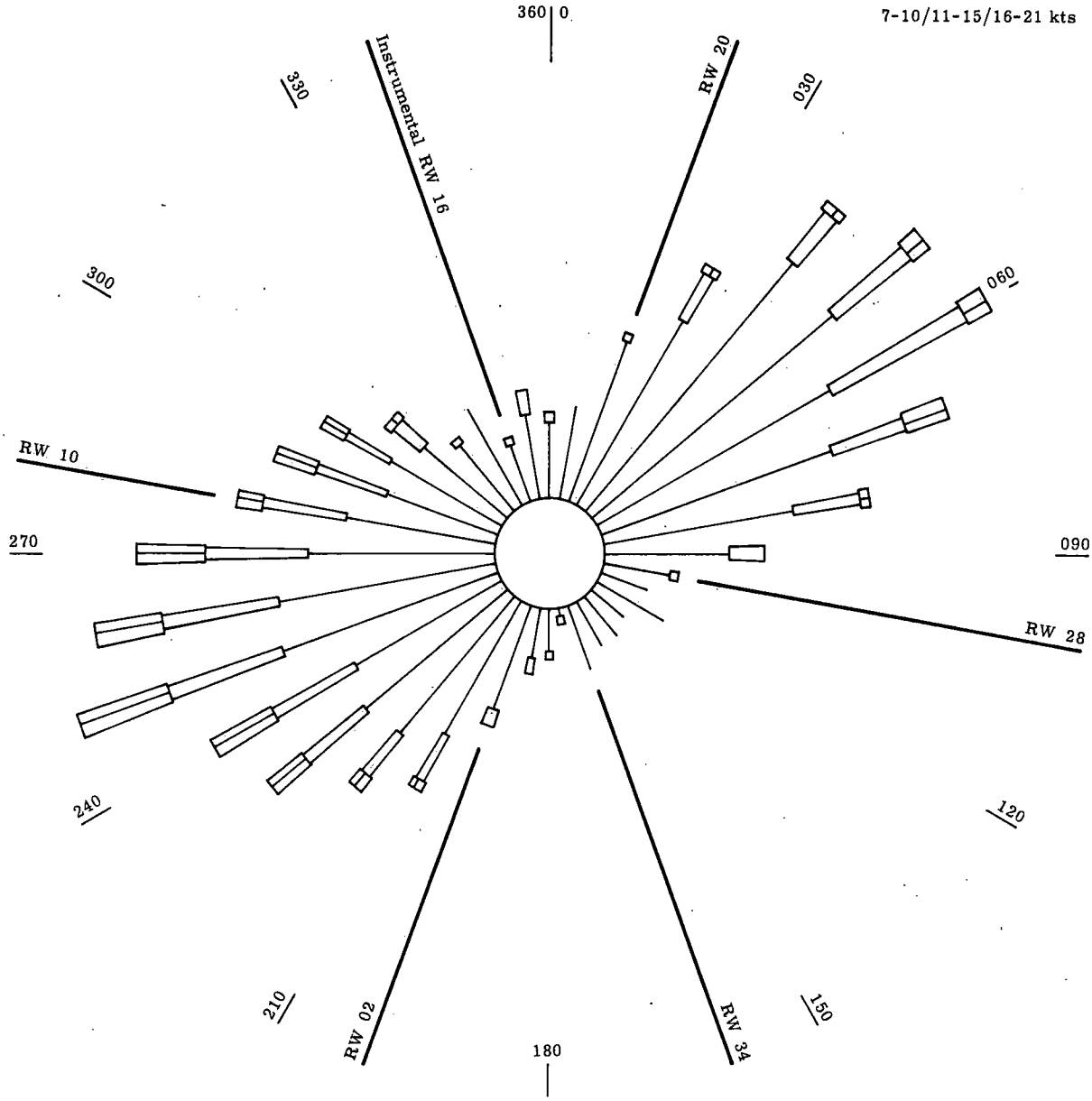
0 100 200 300 400 500‰

7 - 10 11 - 15 16 - 21 Ktn

0 20 40 60 80 100‰

22 - 27 28 - 33 34 - 40 ≥ 41 Ktn

7-10/11-15/16-21 kts



0 200 400 600 800 1000‰

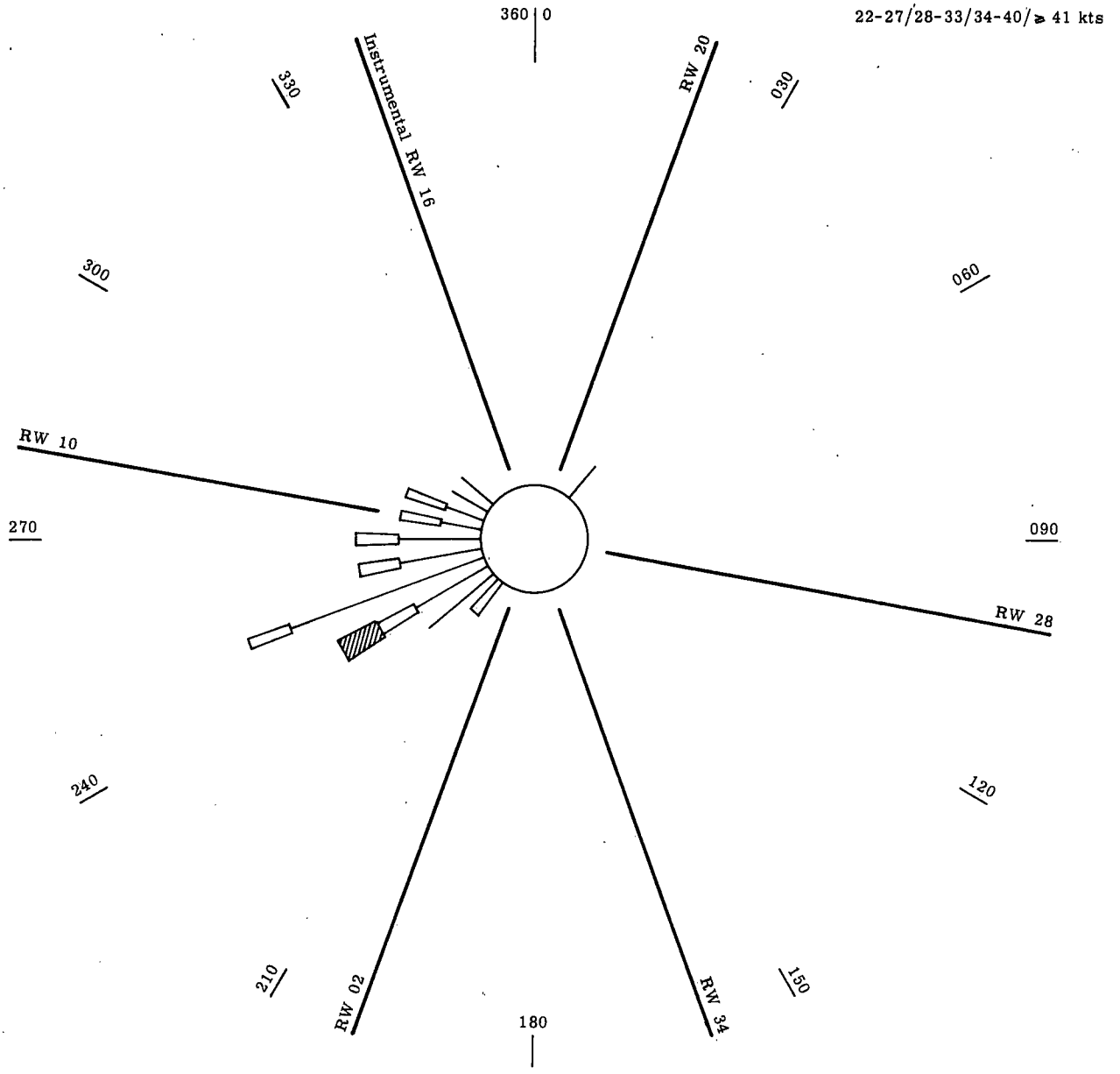
1 - 3 4 - 6 Ktn

0 100 200 300 400 500‰

7 - 10 11 - 15 16 - 21 Ktn

0 20 40 60 80 100‰

22 - 27 28 - 33 34 - 40 ≥ 41 Ktn


22-27/28-33/34-40/≥ 41 kts
360 | 0
Instrumental RW 16
RW 20
330
030
300
060
RW 10
270
090
RW 28
240
120
210
RW 02
180
RW 34
150

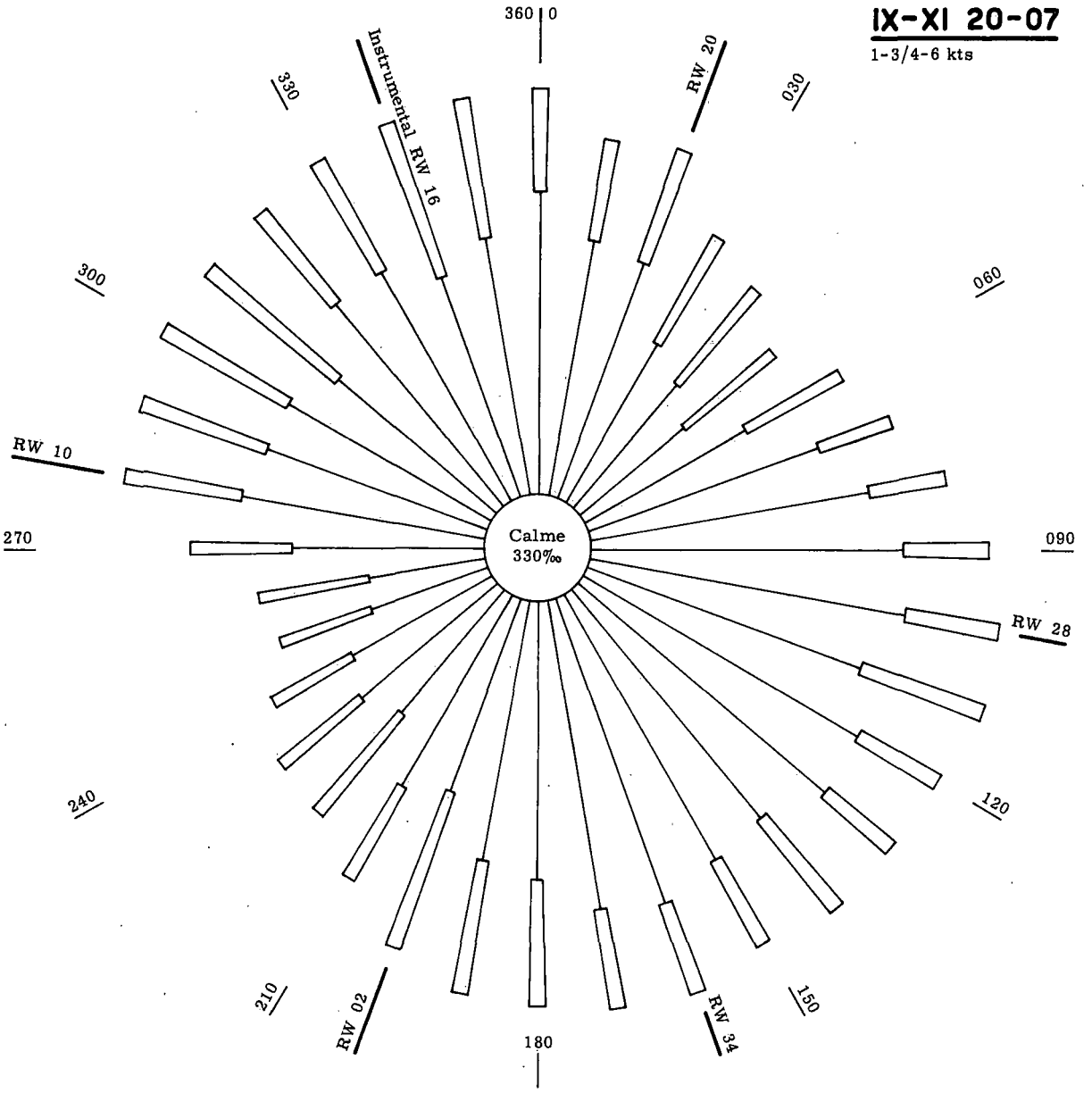

0 200 400 600 800 1000‰
1 - 3
4 - 6
Ktn


0 100 200 300 400 500‰
7 - 10
11 - 15
16 - 21
Ktn


0 20 40 60 80 100‰
22 - 27
28 - 33
34 - 40
≥ 41
Ktn

IX-XI 20-07

1-3/4-6 kts



0 200 400 600 800 1000‰

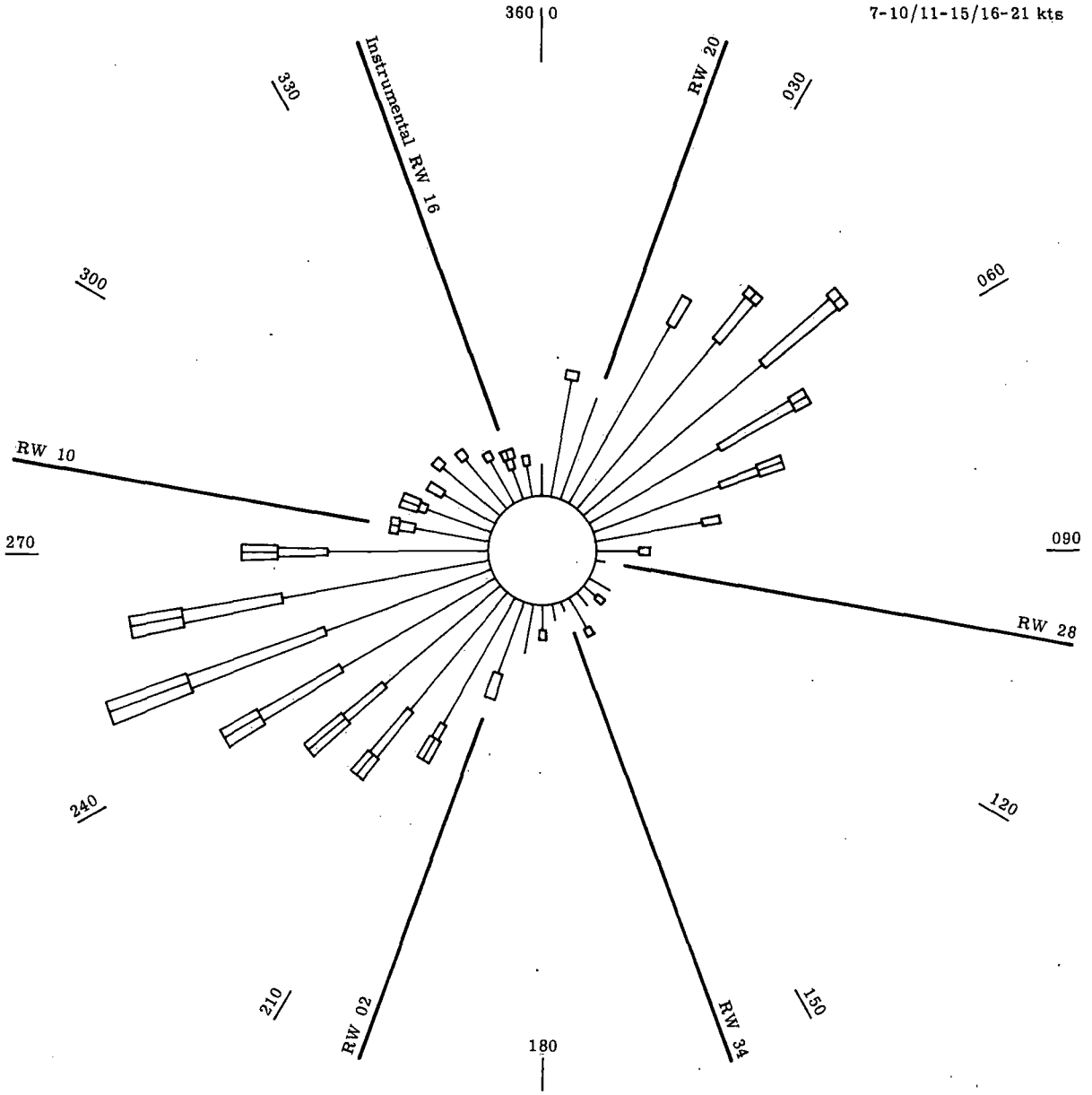
1 - 3 4 - 6 Ktn

0 100 200 300 400 500‰

7 - 10 11 - 15 16 - 21 Ktn

0 20 40 60 80 100‰

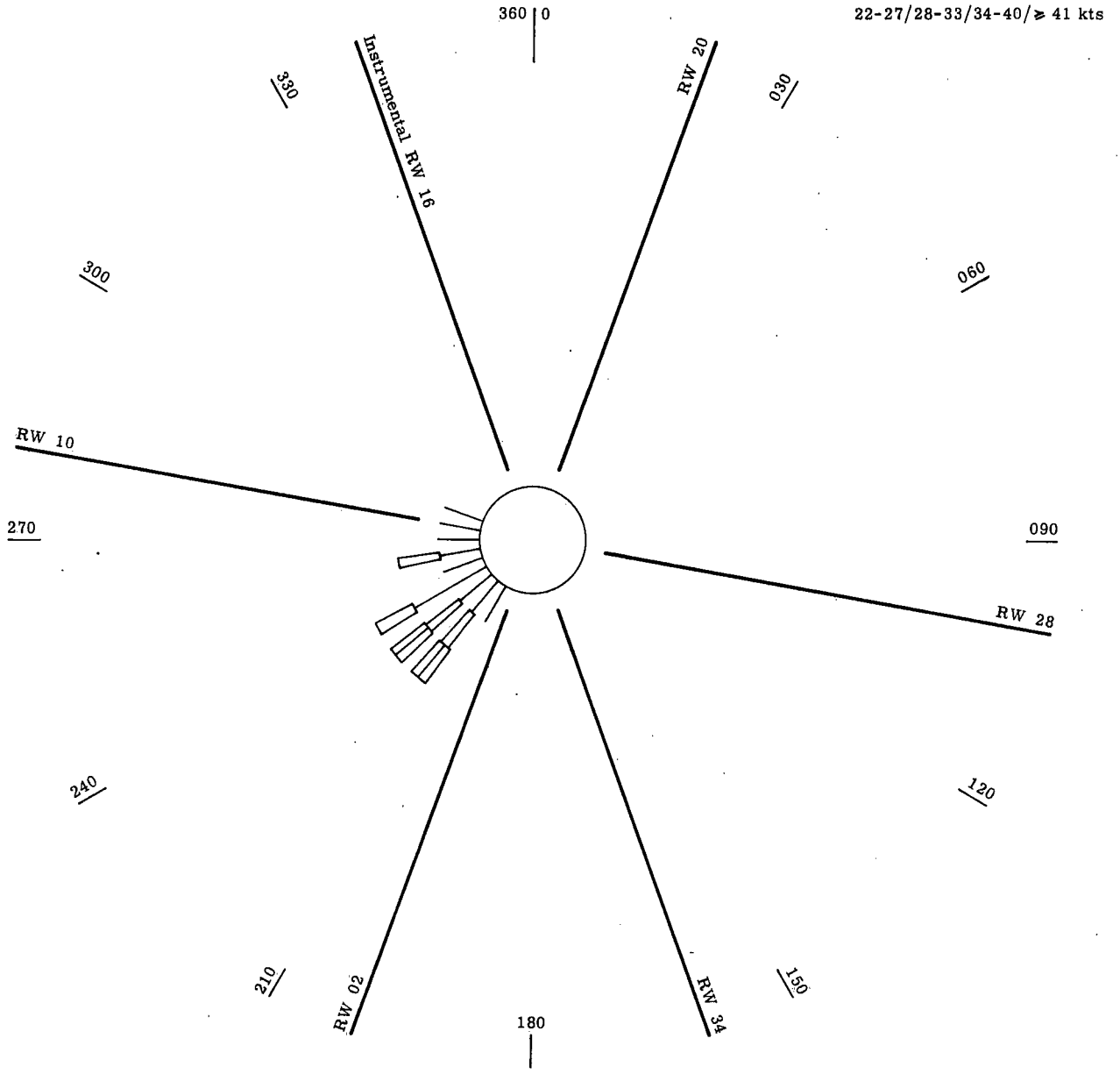
22 - 27 28 - 33 34 - 40 ≥ 41 Ktn


360 0
7-10/11-15/16-21 kts
Instrumental RW 16
RW 20
330
030
300
060
RW 10
270
090
RW 28
240
120
210
RW 02
RW 34
150
180


0 200 400 600 800 1000‰
1 - 3
4 - 6
Ktn


0 100 200 300 400 500‰
7 - 10
11 - 15
16 - 21
Ktn


0 20 40 60 80 100‰
22 - 27
28 - 33
34 - 40
≥ 41
Ktn


22-27/28-33/34-40/≥ 41 kts
360 0
Instrumental RW 16
RW 20
330
030
300
060
RW 10
270
090
RW 28
240
120
210
RW 02
RW 34
150
180

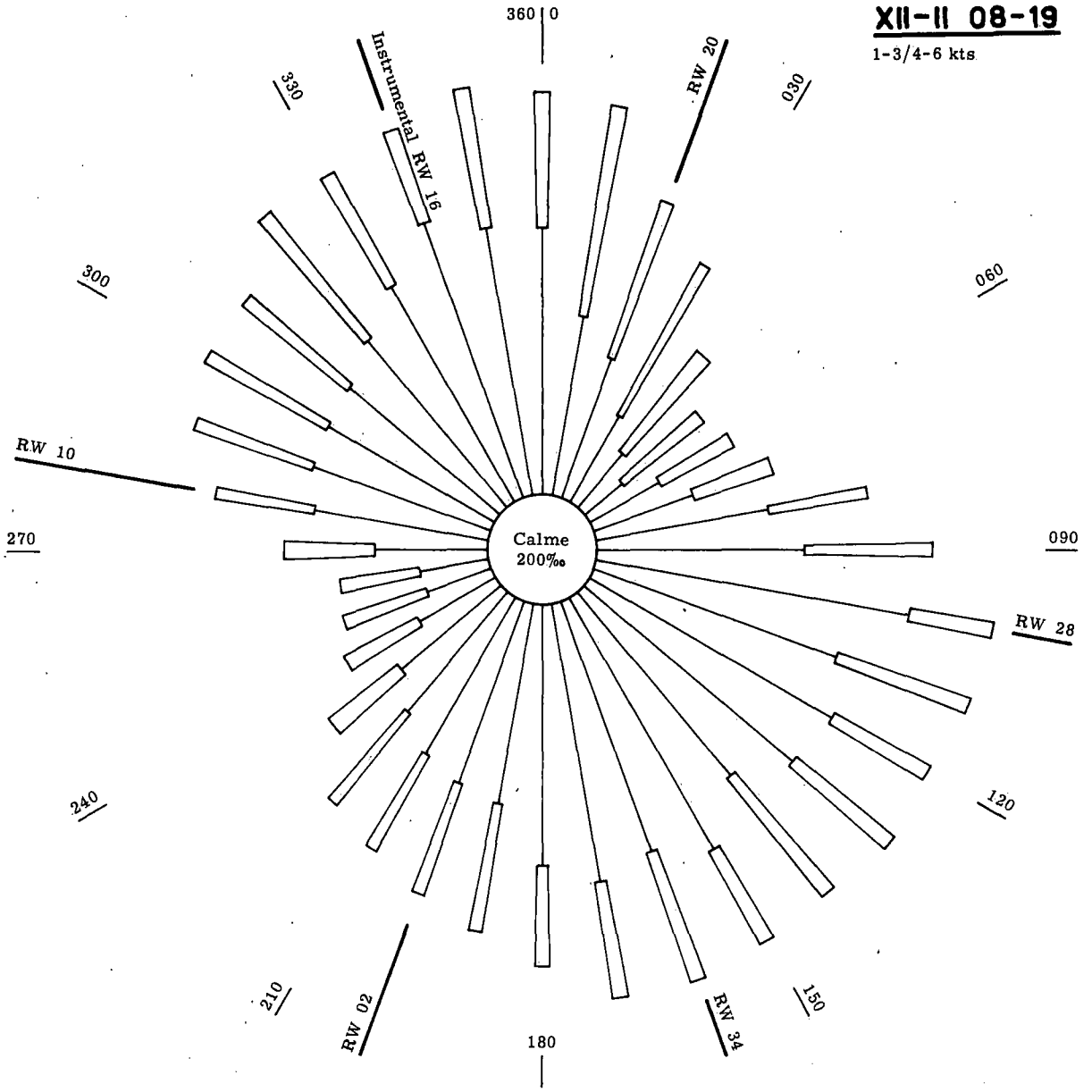

0 200 400 600 800 1000‰
1 - 3
4 - 6
Ktn


0 100 200 300 400 500‰
7 - 10
11 - 15
16 - 21
Ktn

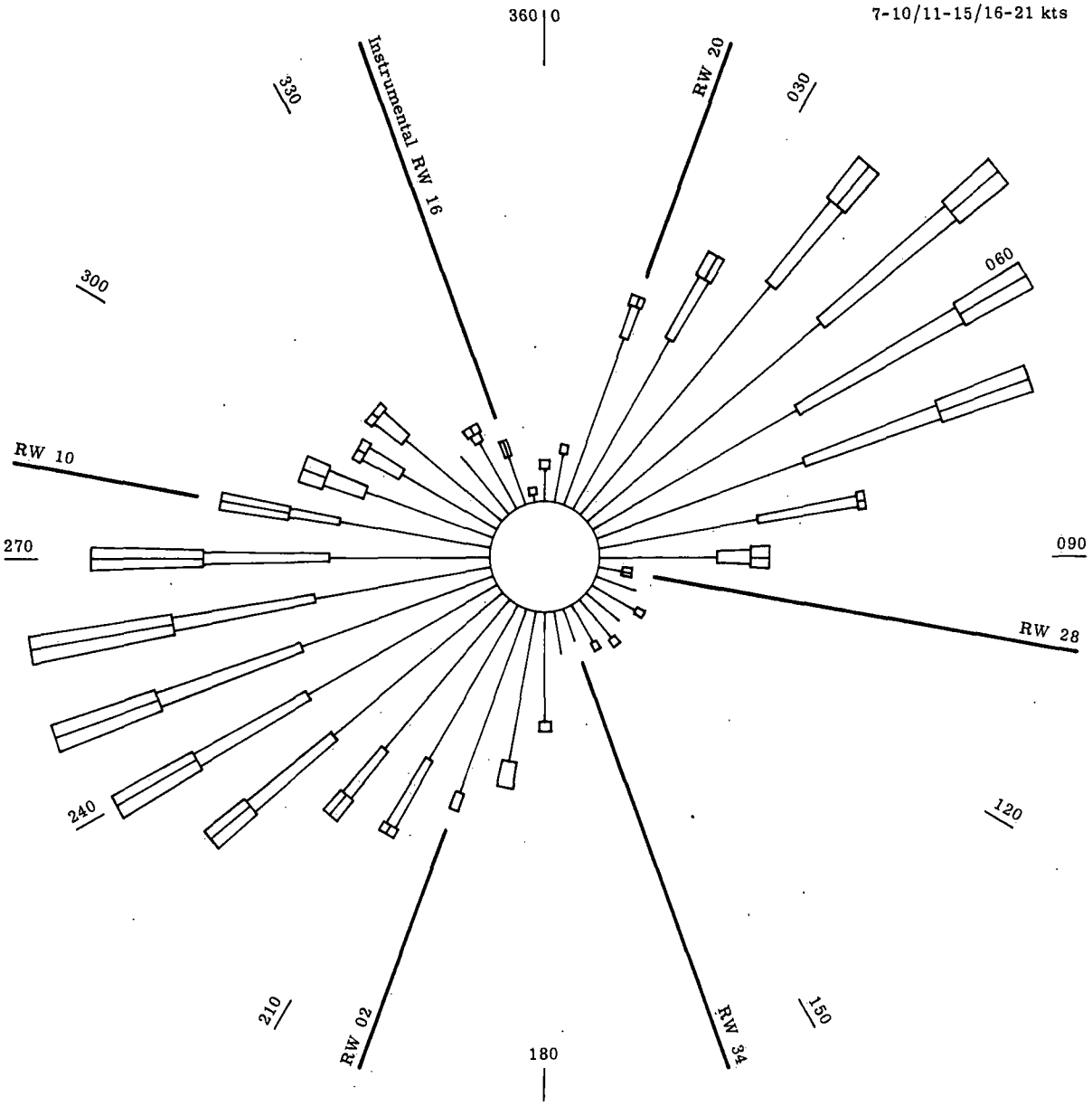

0 20 40 60 80 100‰
22 - 27
28 - 33
34 - 40
≥ 41
Ktn

XII-II 08-19

1-3/4-6 kts



7-10/11-15/16-21 kts



0 200 400 600 800 1000‰

1 - 3 4 - 6 Ktn

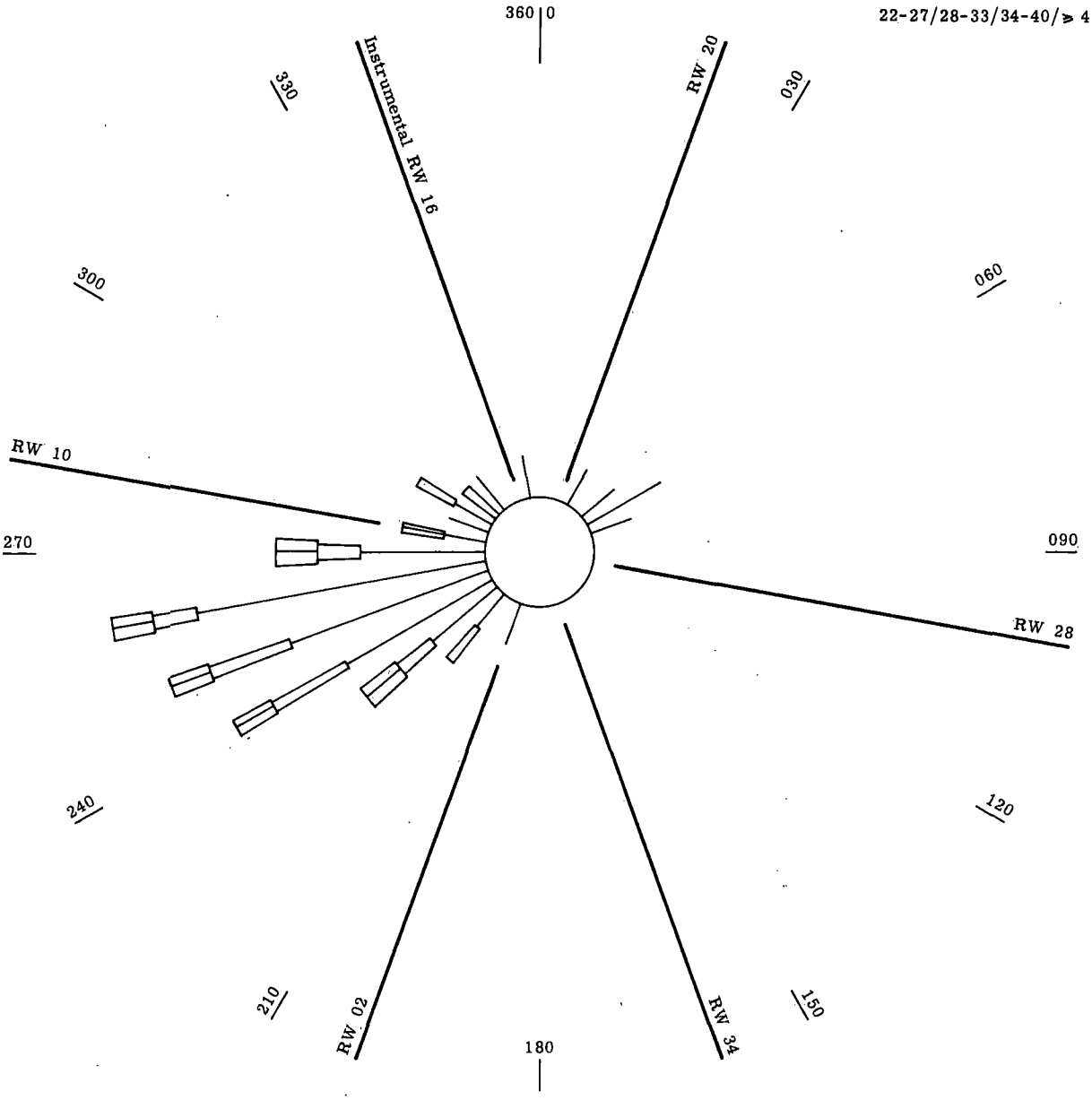
0 100 200 300 400 500‰

7 - 10 11 - 15 16 - 21 Ktn

0 20 40 60 80 100‰

22 - 27 28 - 33 34 - 40 ≥ 41 Ktn

22-27/28-33/34-40/≥ 41 kts



0 200 400 600 800 1000‰

1 - 3 4 - 6 Ktn

0 100 200 300 400 500‰

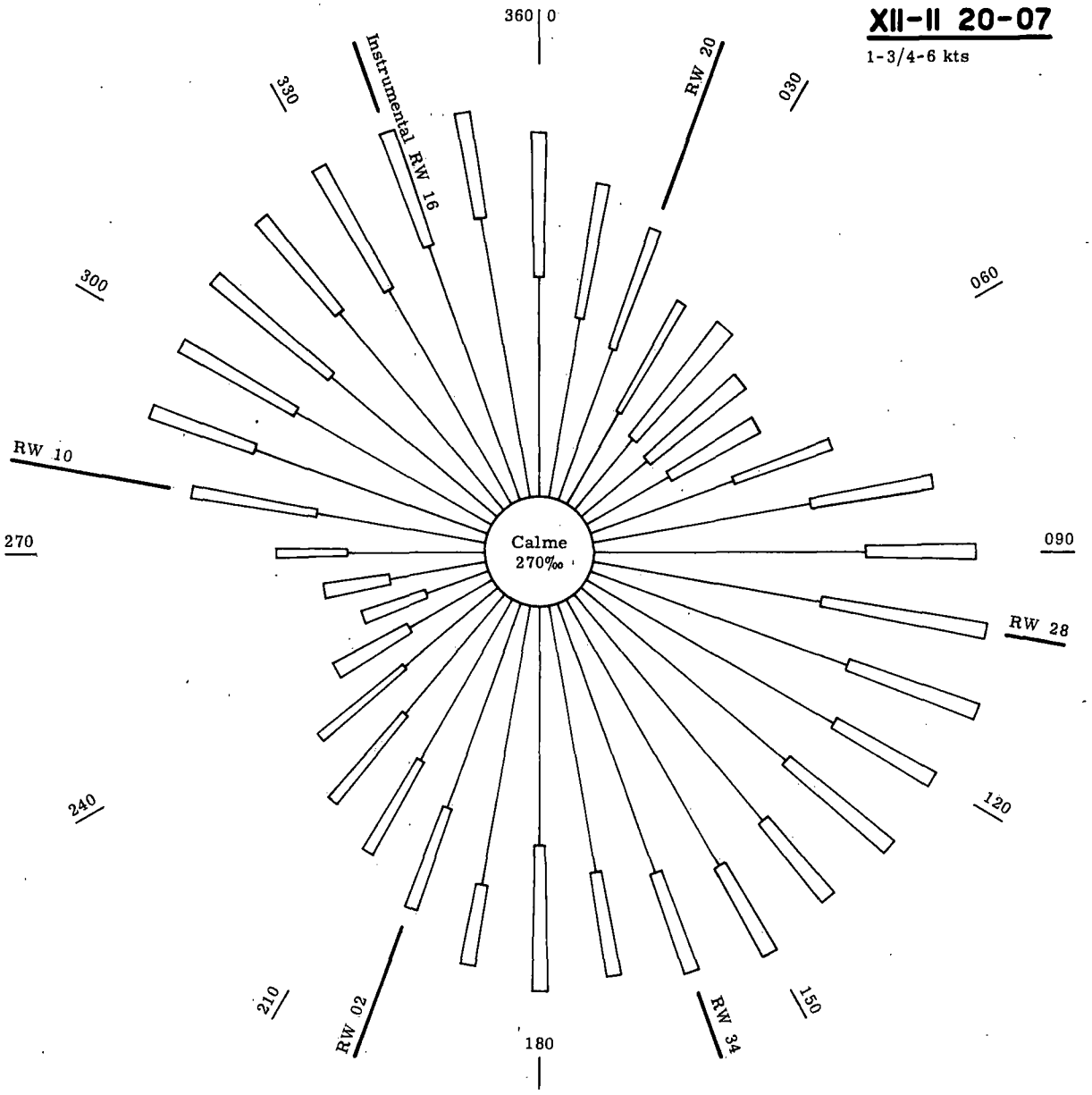
7 - 10 11 - 15 16 - 21 Ktn

0 20 40 60 80 100‰

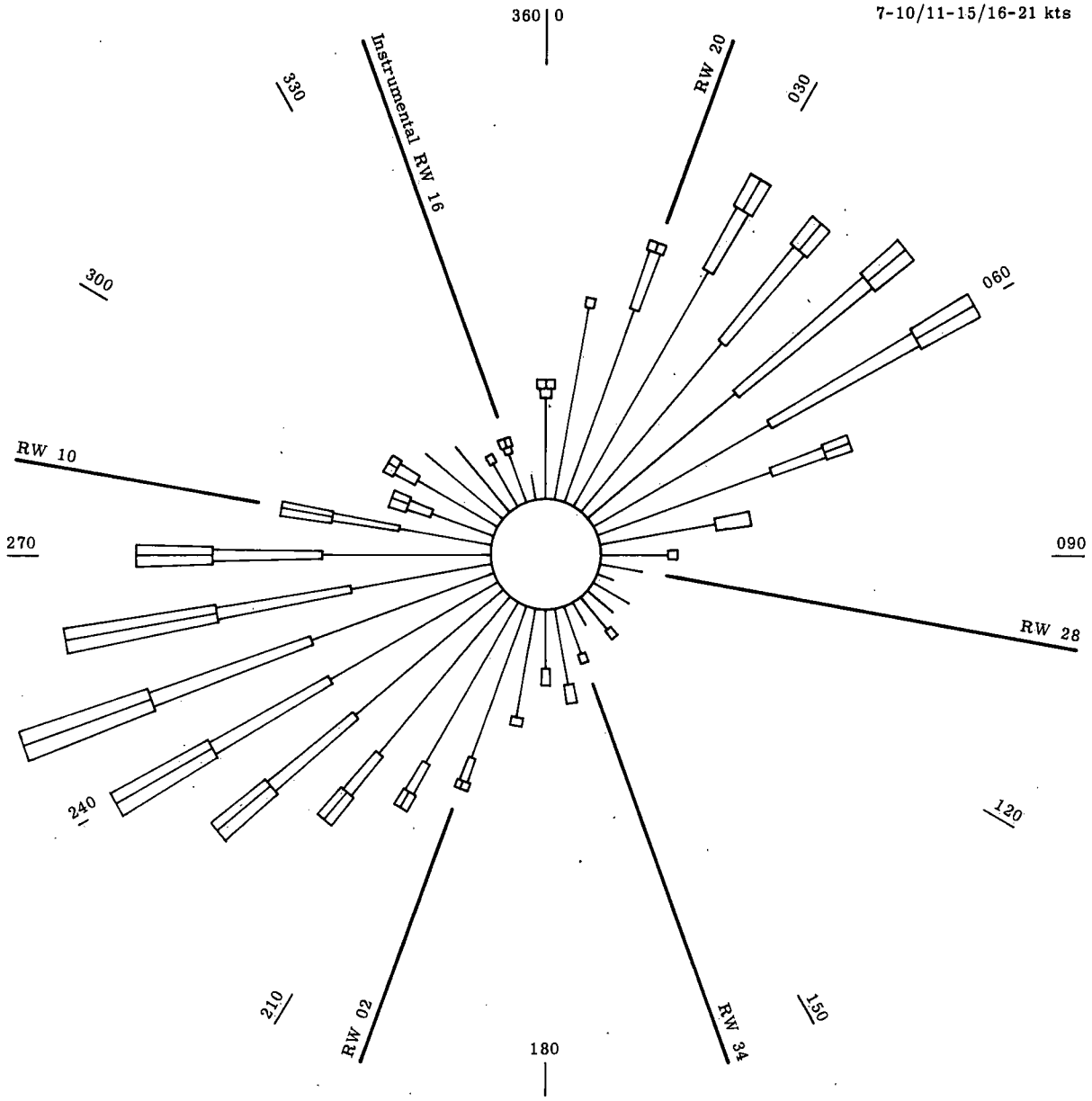
22 - 27 28 - 33 34 - 40 ≥ 41 Ktn

XII-II 20-07

1-3/4-6 kts



7-10/11-15/16-21 kts



0 200 400 600 800 1000‰

1 - 3 4 - 6 Ktn

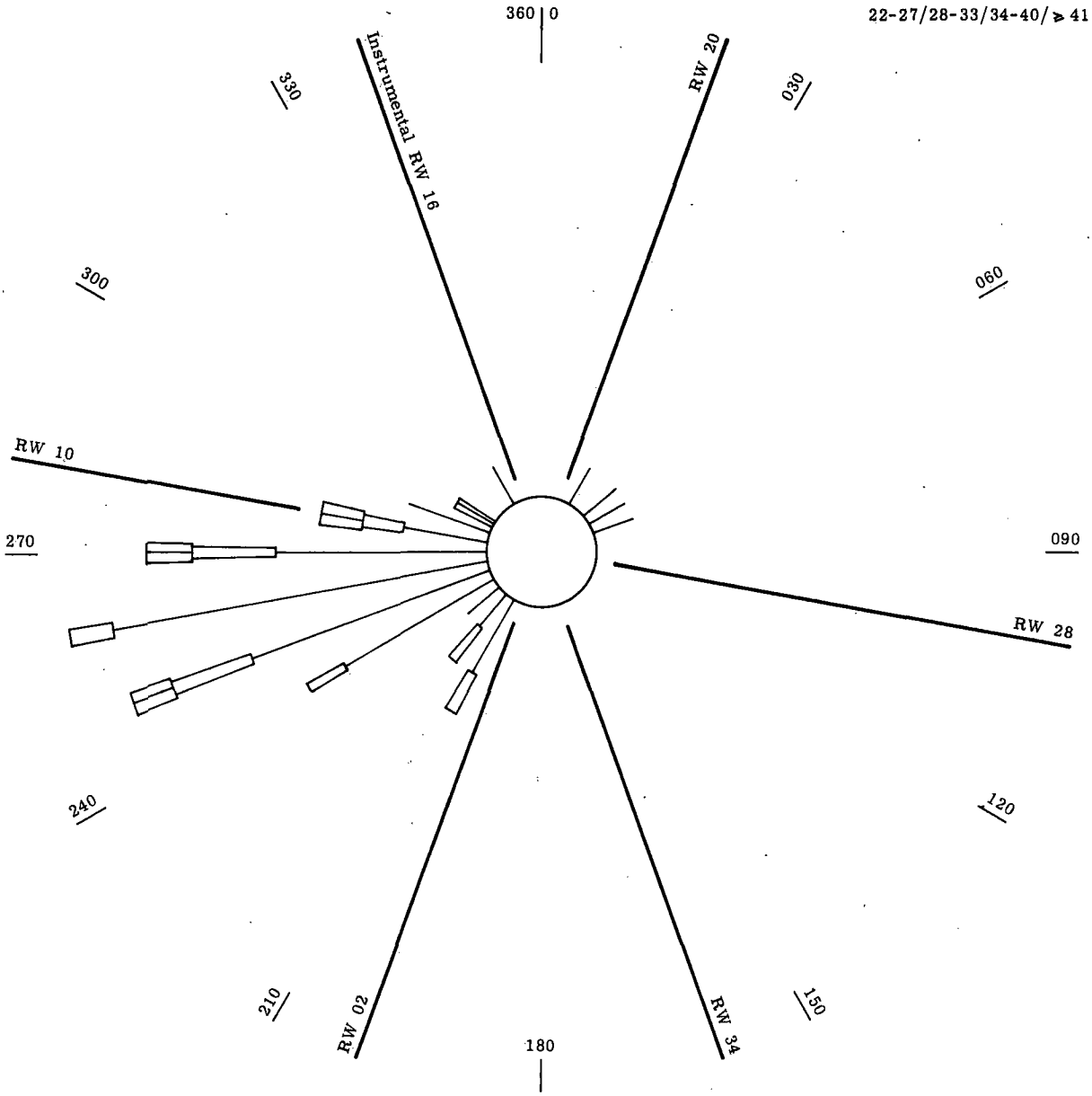
0 100 200 300 400 500‰

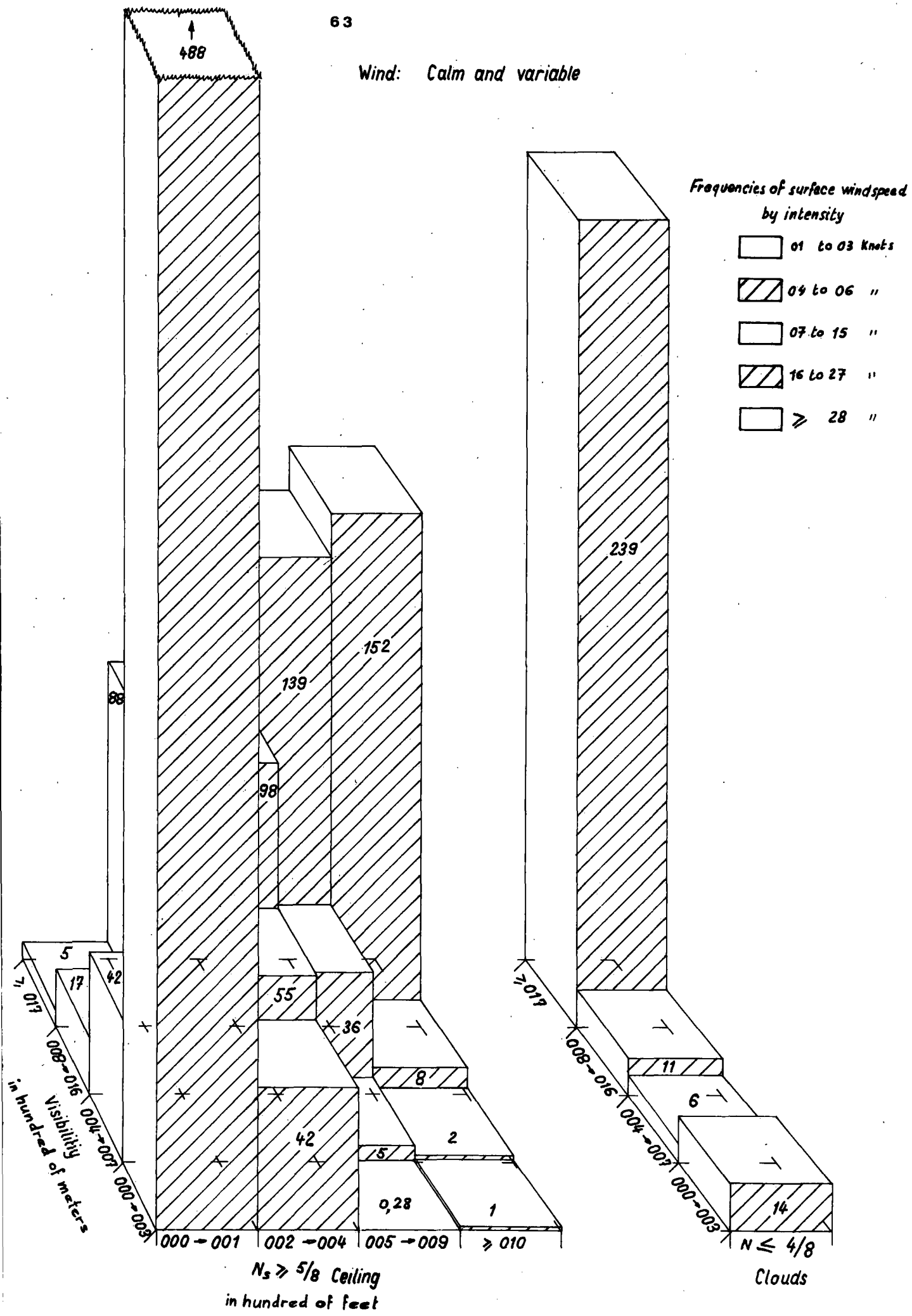
7 - 10 11 - 15 16 - 21 Ktn

0 20 40 60 80 100‰

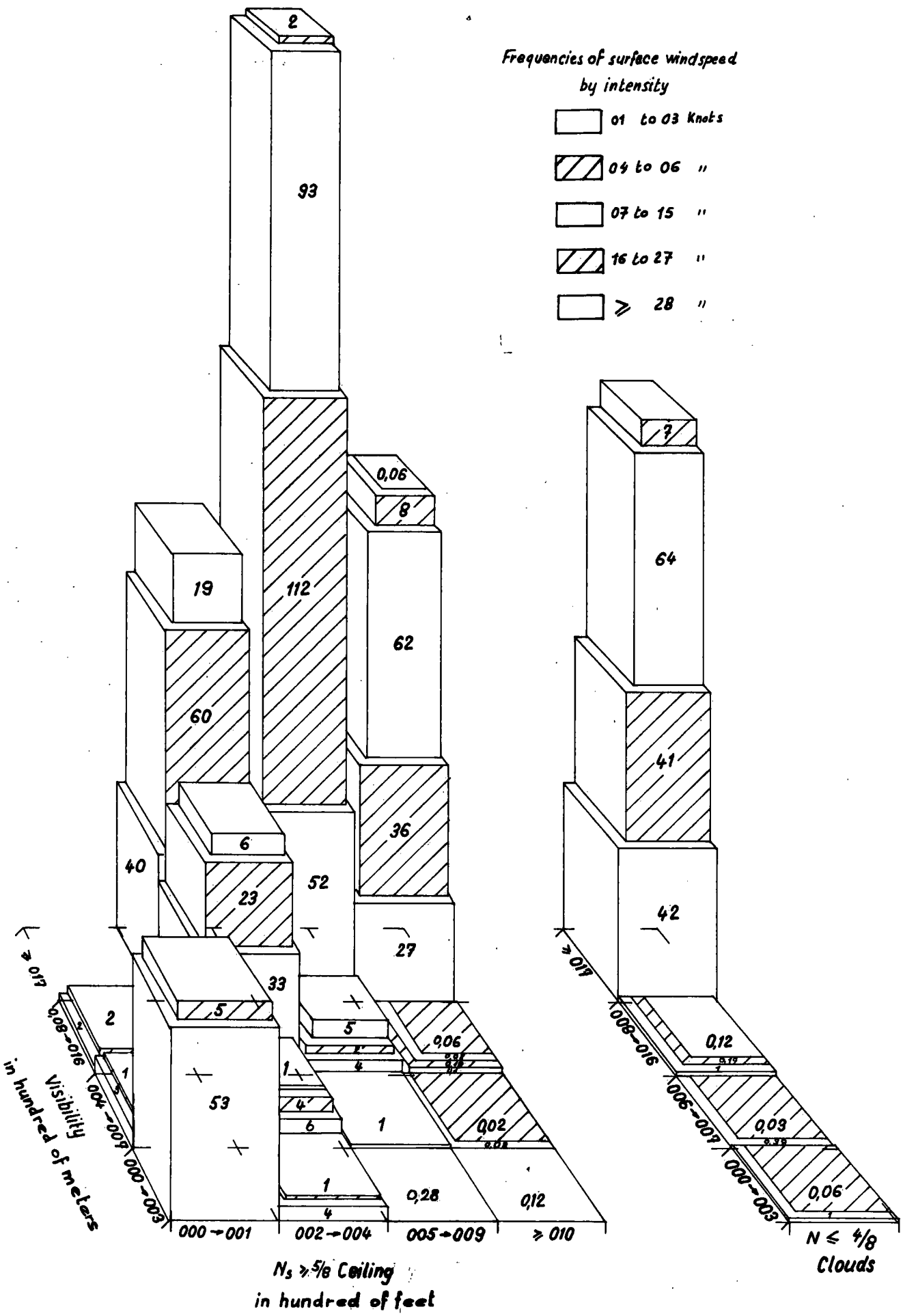
22 - 27 28 - 33 34 - 40 ≥ 41 Ktn

22-27/28-33/34-40/≥ 41 kts

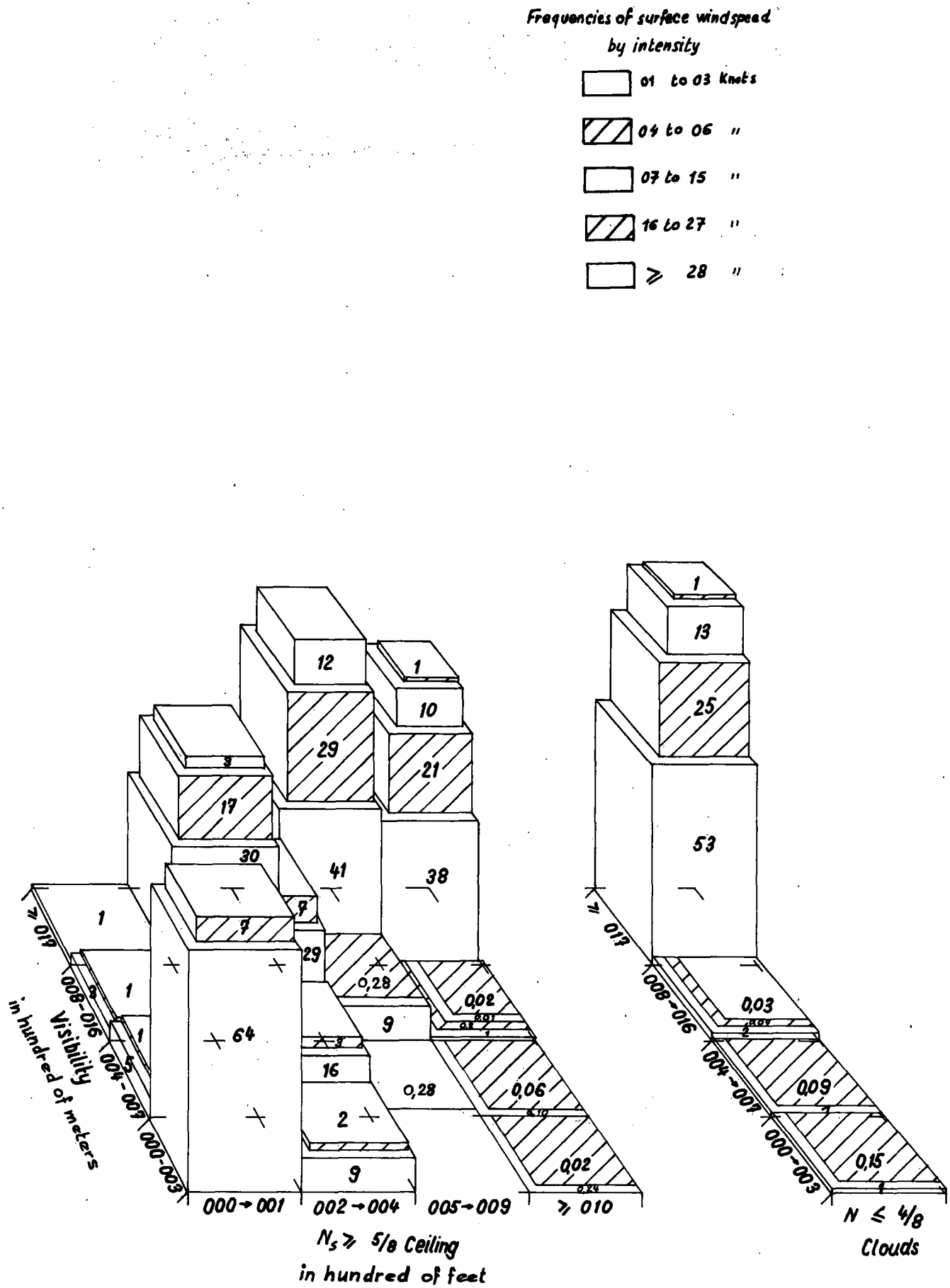



Wind: Calm and variable
488
Frequencies of surface windspeed by intensity
01 to 03 knots
04 to 06 "
07 to 15 "
16 to 27 "
≥ 28 "
88
5
17
42
139
152
98
55
36
8
42
5
2
0,28
1
239
11
6
14
≥ 017
008 → 016
004 → 007
000 → 003
Visibility in hundred of meters
000 → 001
002 → 004
005 → 009
≥ 010
Ns ≥ 5/8 Ceiling in hundred of feet
N ≤ 4/8
Clouds

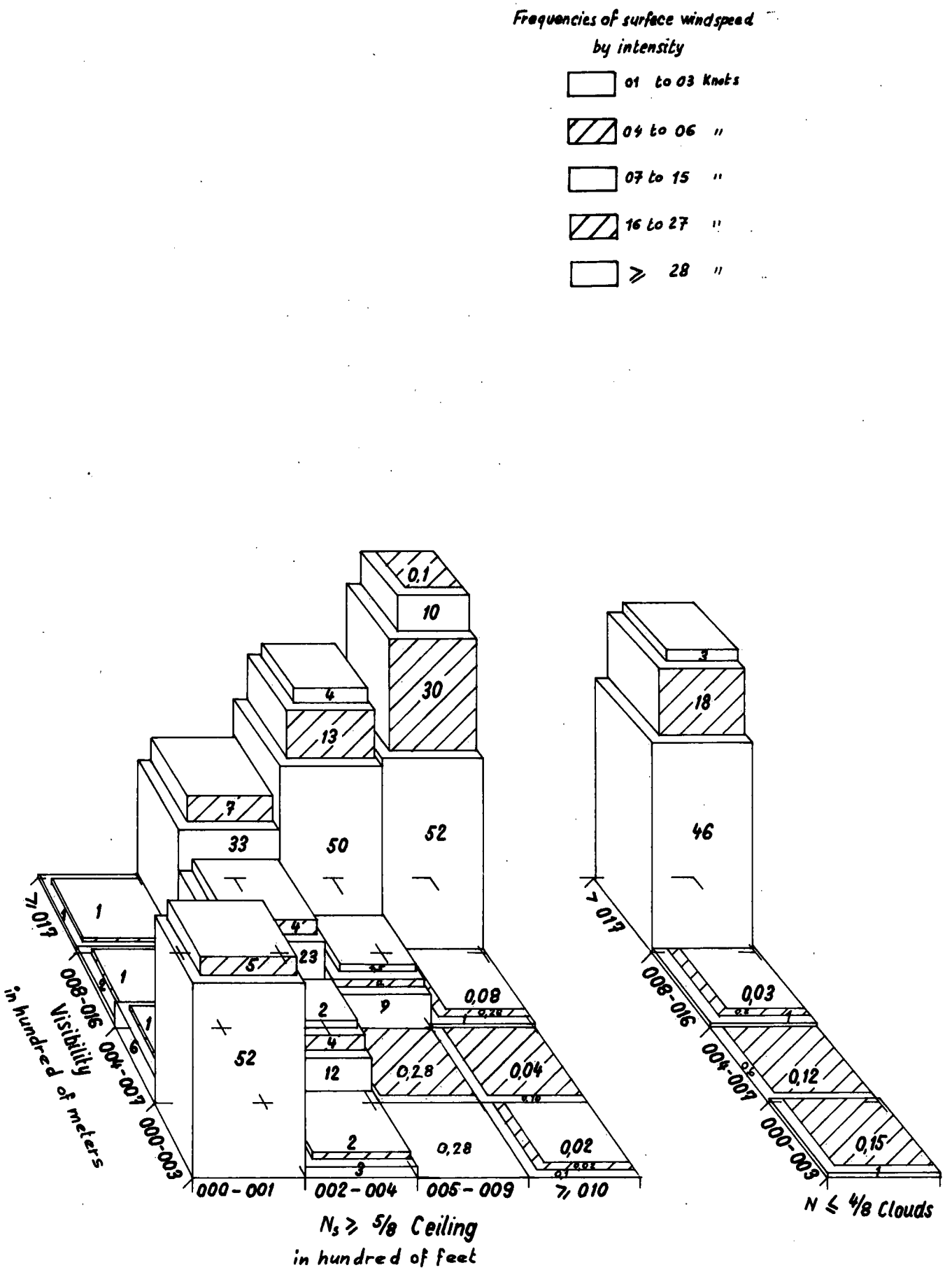
Winddirection: 020 to 070



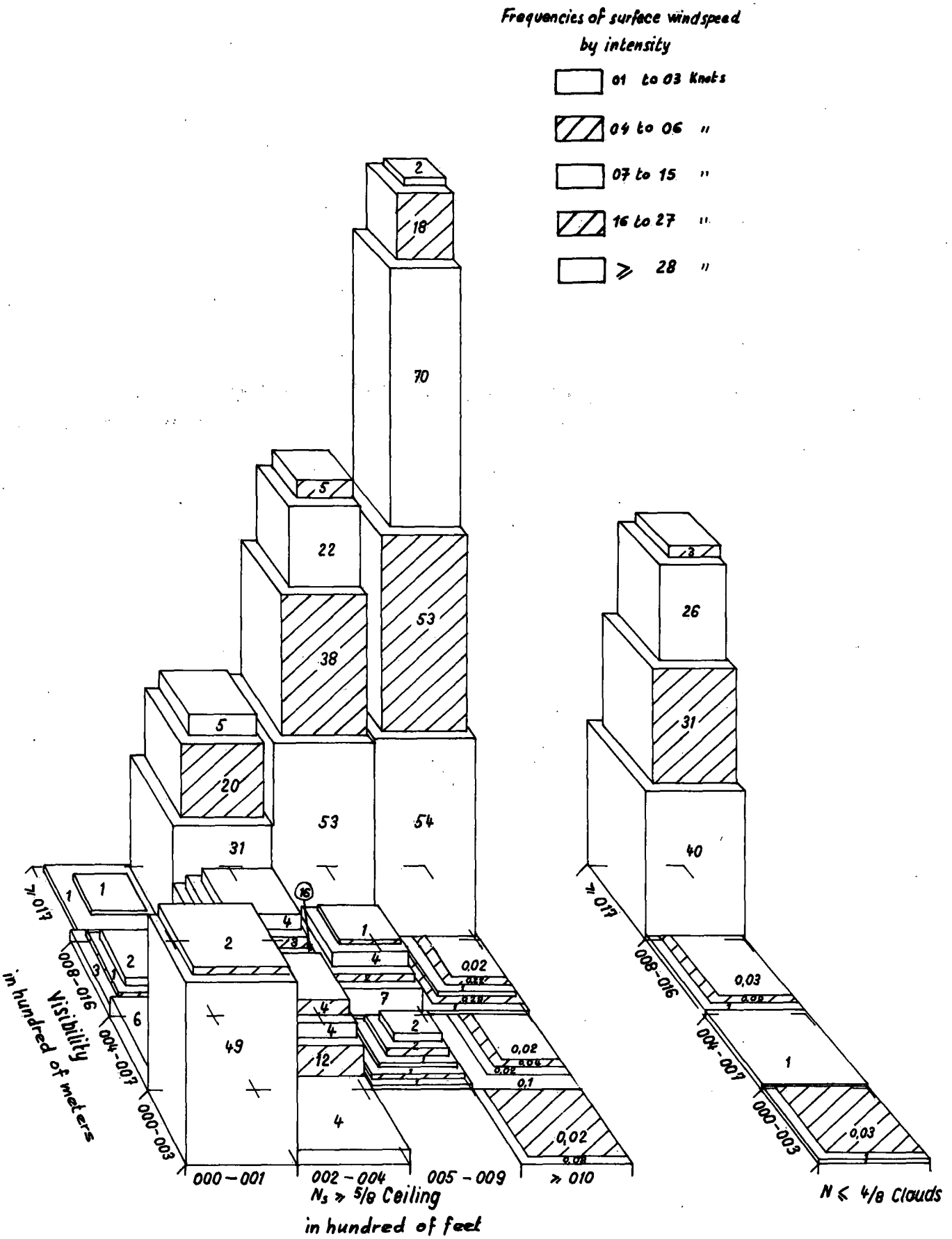
dd 080 → 130°


Frequencies of surface windspeed
by intensity
01 to 03 Knots
04 to 06 "
07 to 15 "
16 to 27 "
≥ 28 "
Visibility
in hundred of meters
≥ 017
008-016
004-007
000-003
000→001
002→004
005→009
≥ 010
N_s ≥ 5/8 Ceiling
in hundred of feet
N ≤ 4/8
Clouds

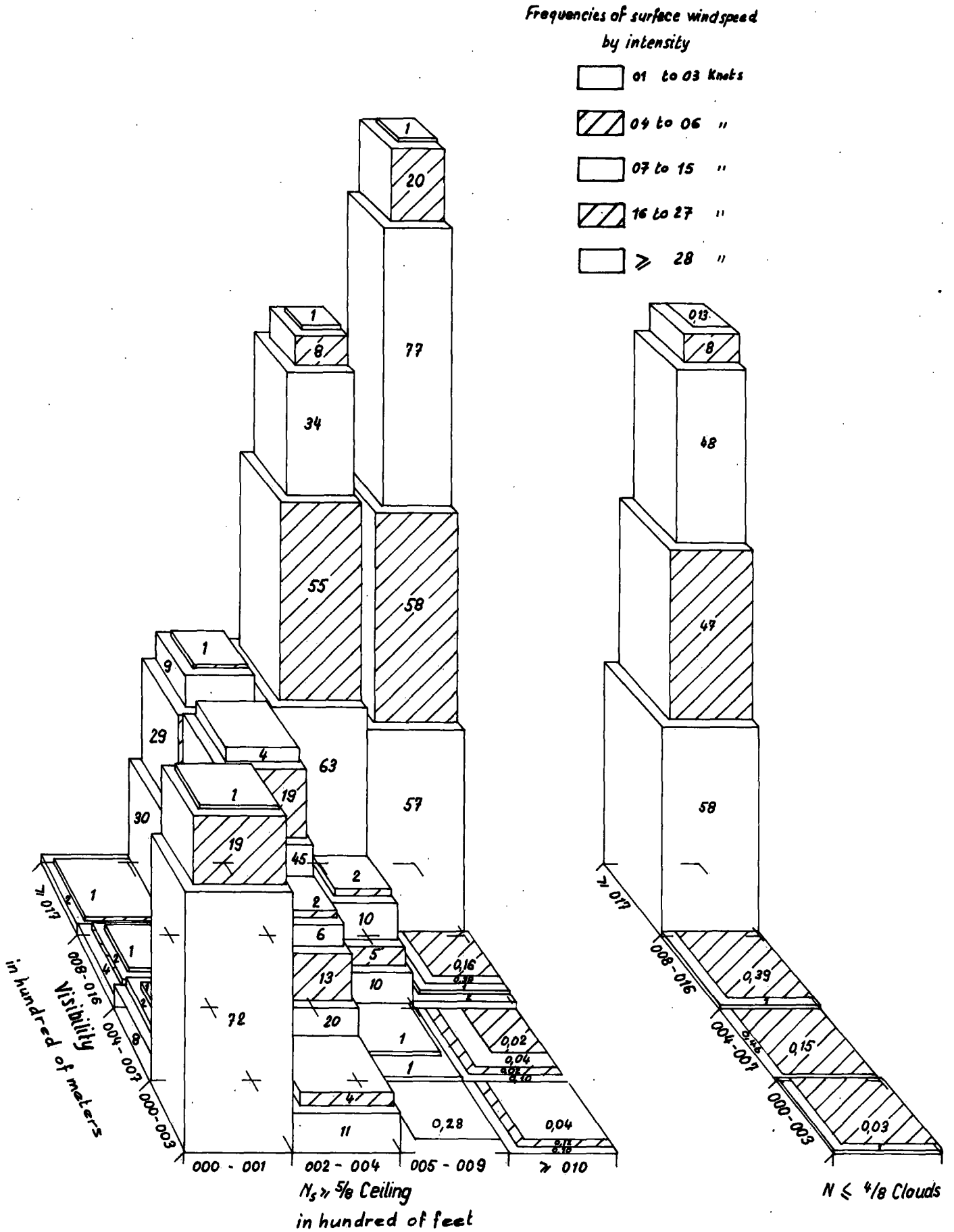
dd 140 → 190°


Frequencies of surface windspeed
by intensity
01 to 03 Knots
04 to 06 "
07 to 15 "
16 to 27 "
≥ 28 "
0,1
10
30
4
13
7
33
50
52
1
4
23
5
52
2
9
4
12
0,08
0,28
0,04
2
0,28
0,02
3
3
18
46
0,03
0,12
0,15
≥ 017
008-016
004-007
000-003
Visibility
in hundred of meters
000-001
002-004
005-009
≥ 010
Ns ≥ 5/8 Ceiling
in hundred of feet
N ≤ 4/8 Clouds

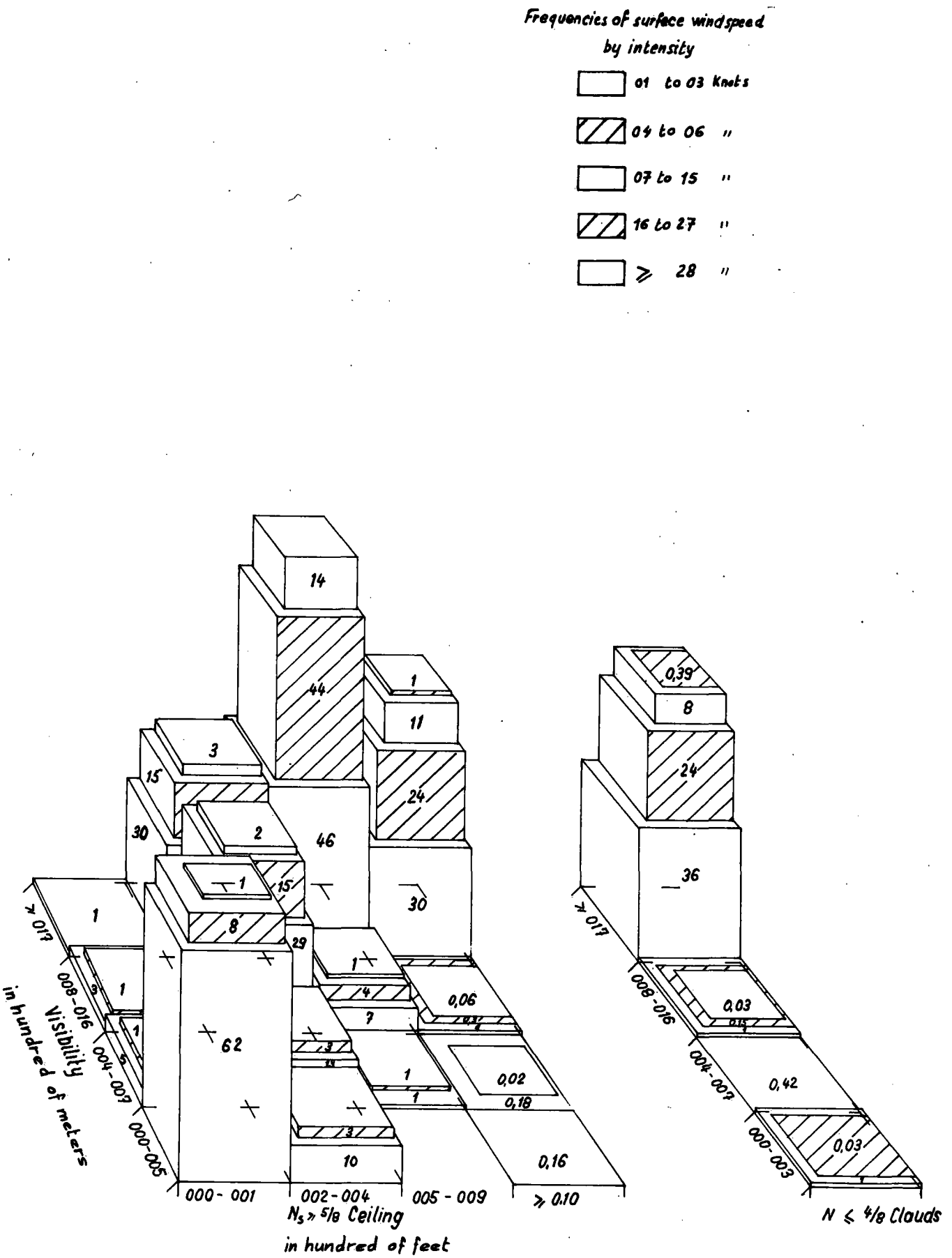
dd 200 — 250°


Frequencies of surface windspeed
by intensity
01 to 03 Knots
04 to 06 "
07 to 15 "
16 to 27 "
≥ 28 "
Visibility
in hundred of meters
≥ 017
008-016
004-007
000-003
000-001
002-004
005-009
≥ 010
Ns ≥ 5/8 Ceiling
in hundred of feet
N ≤ 4/8 Clouds

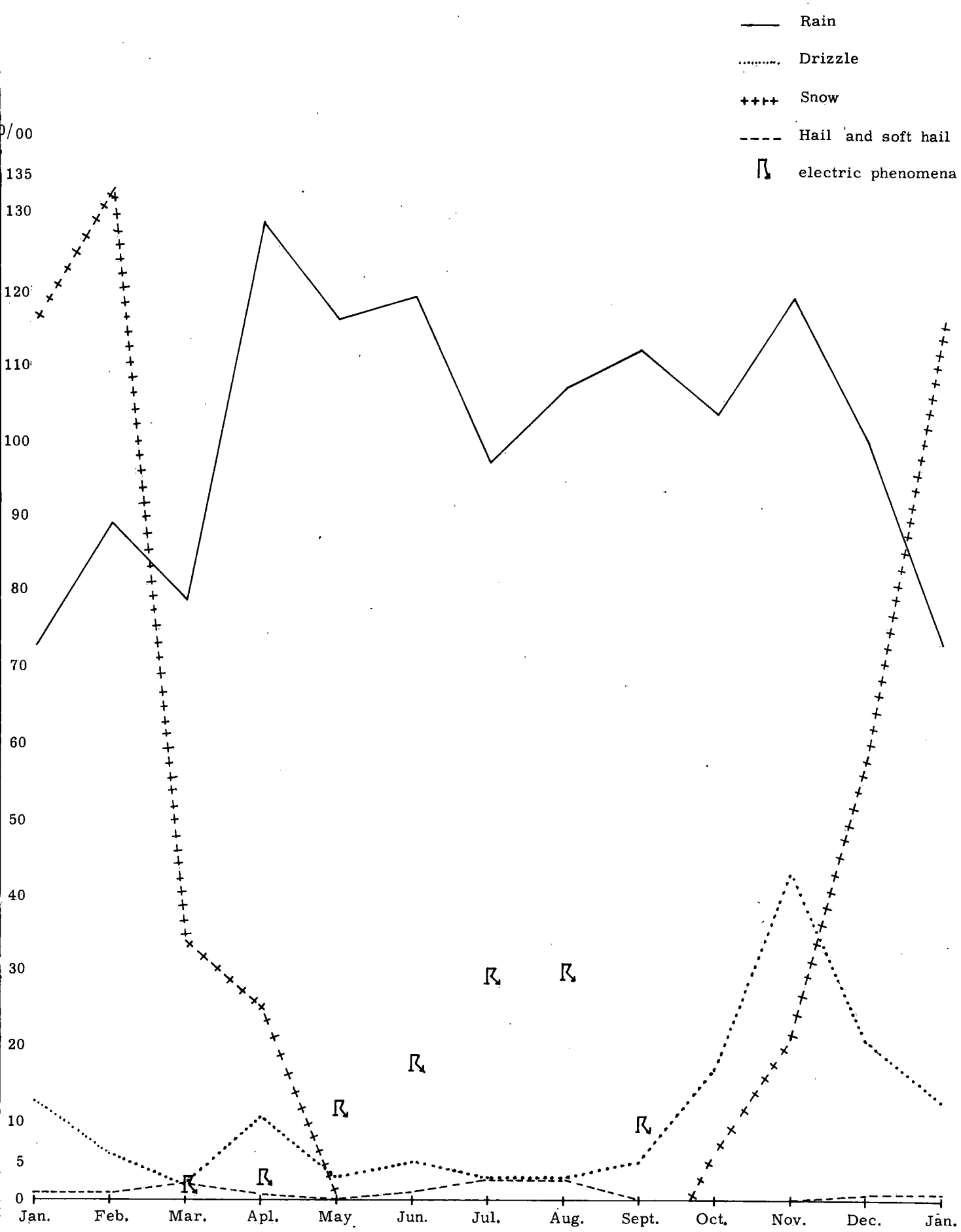
dd 260 → 310°


Frequencies of surface windspeed
by intensity
01 to 03 Knots
04 to 06 "
07 to 15 "
16 to 27 "
≥ 28 "
Visibility
in hundred of meters
≥ 017
008 - 016
004 - 007
000 - 003
000 - 001
002 - 004
005 - 009
≥ 010
$N_s \geq 5/8$ Ceiling
in hundred of feet
$N \leq 4/8$ Clouds

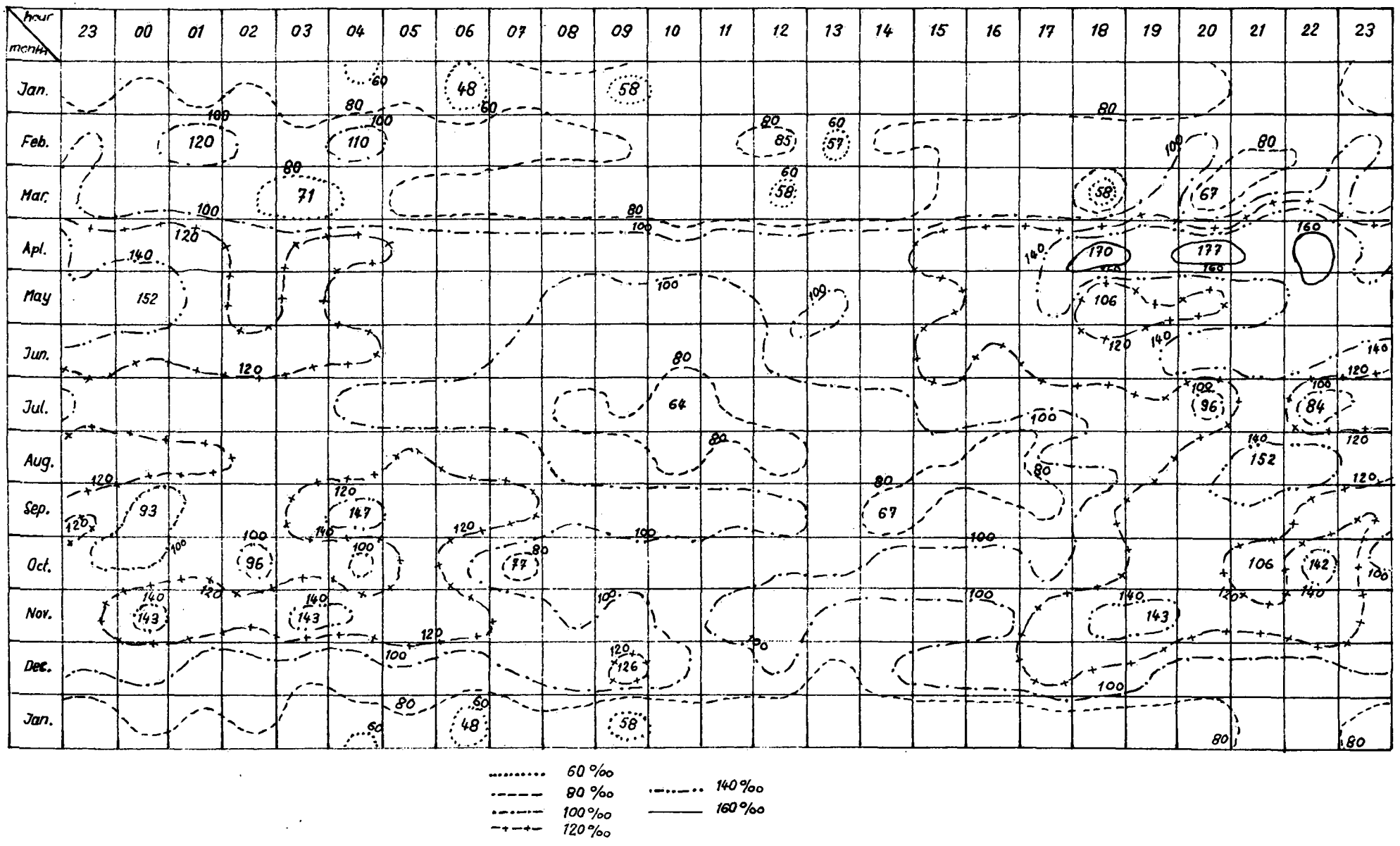
dd 320 → 360 → 010



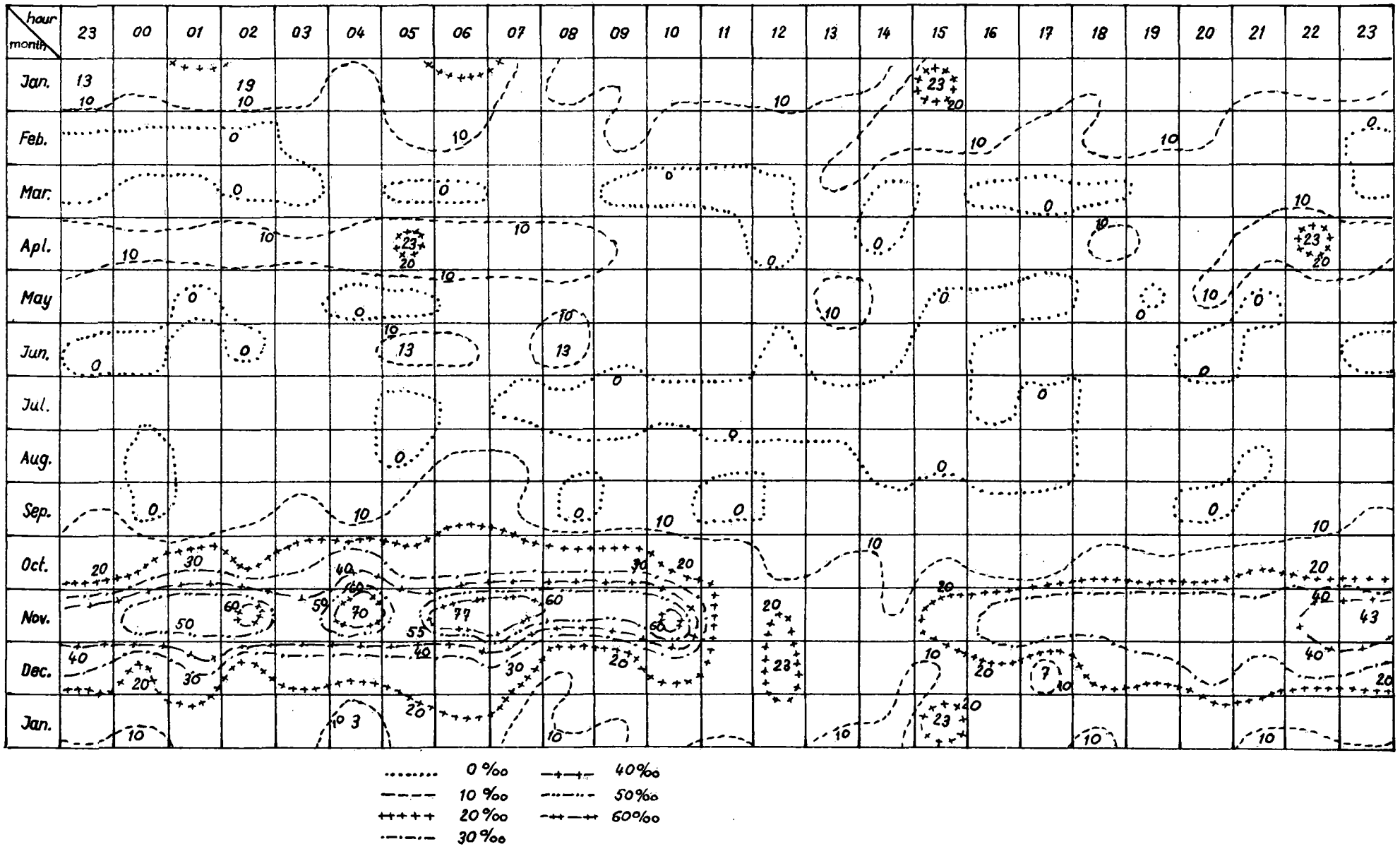
HYDROMETEORS and ELECTRIC PHENOMENA



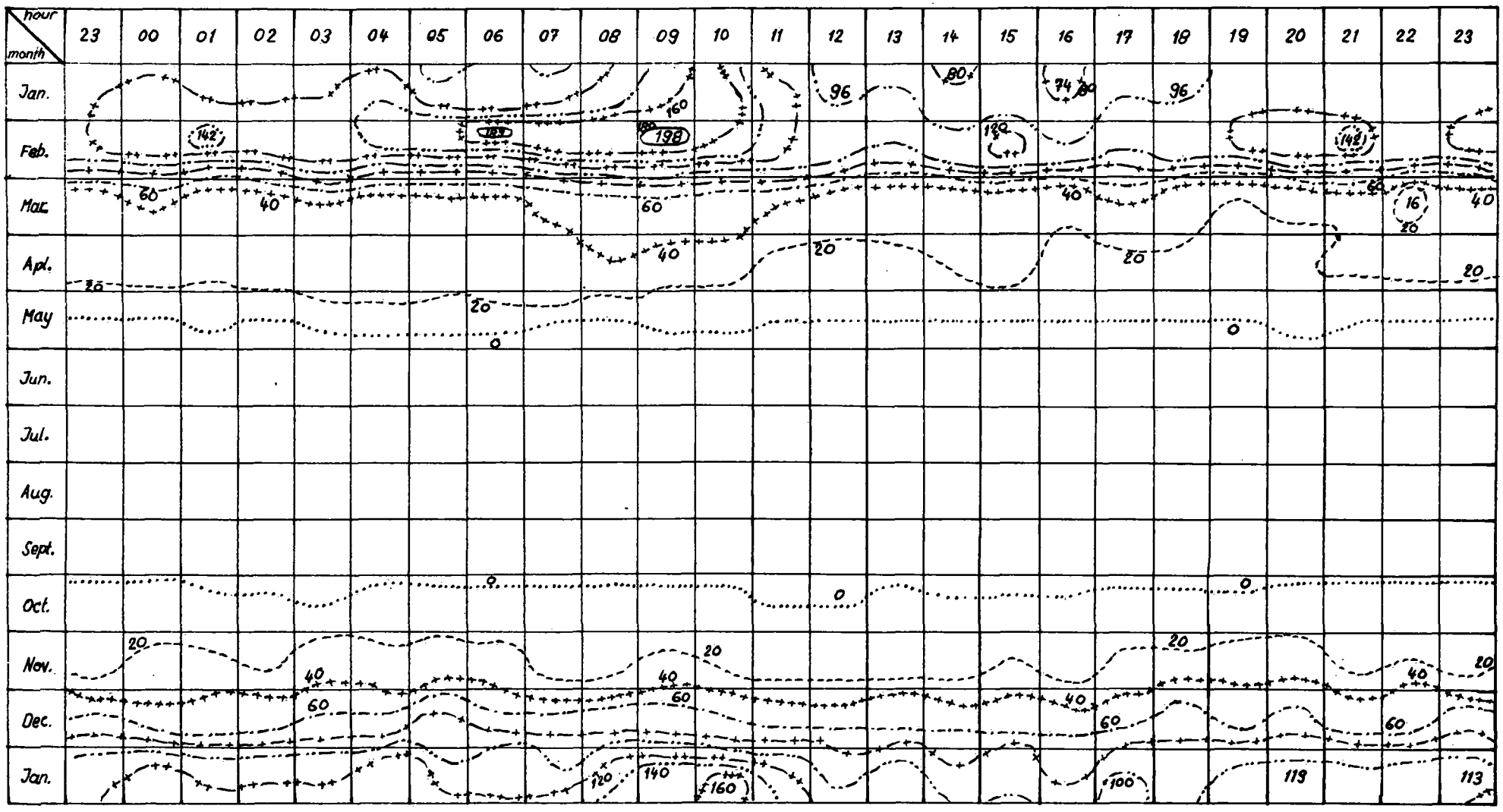
RAIN


hour
month
23
00
01
02
03
04
05
06
07
08
09
10
11
12
13
14
15
16
17
18
19
20
21
22
23
Jan.
Feb.
Mar.
Apl.
May
Jun.
Jul.
Aug.
Sep.
Oct.
Nov.
Dec.
Jan.
60 ‰
80 ‰
100 ‰
120 ‰
140 ‰
160 ‰

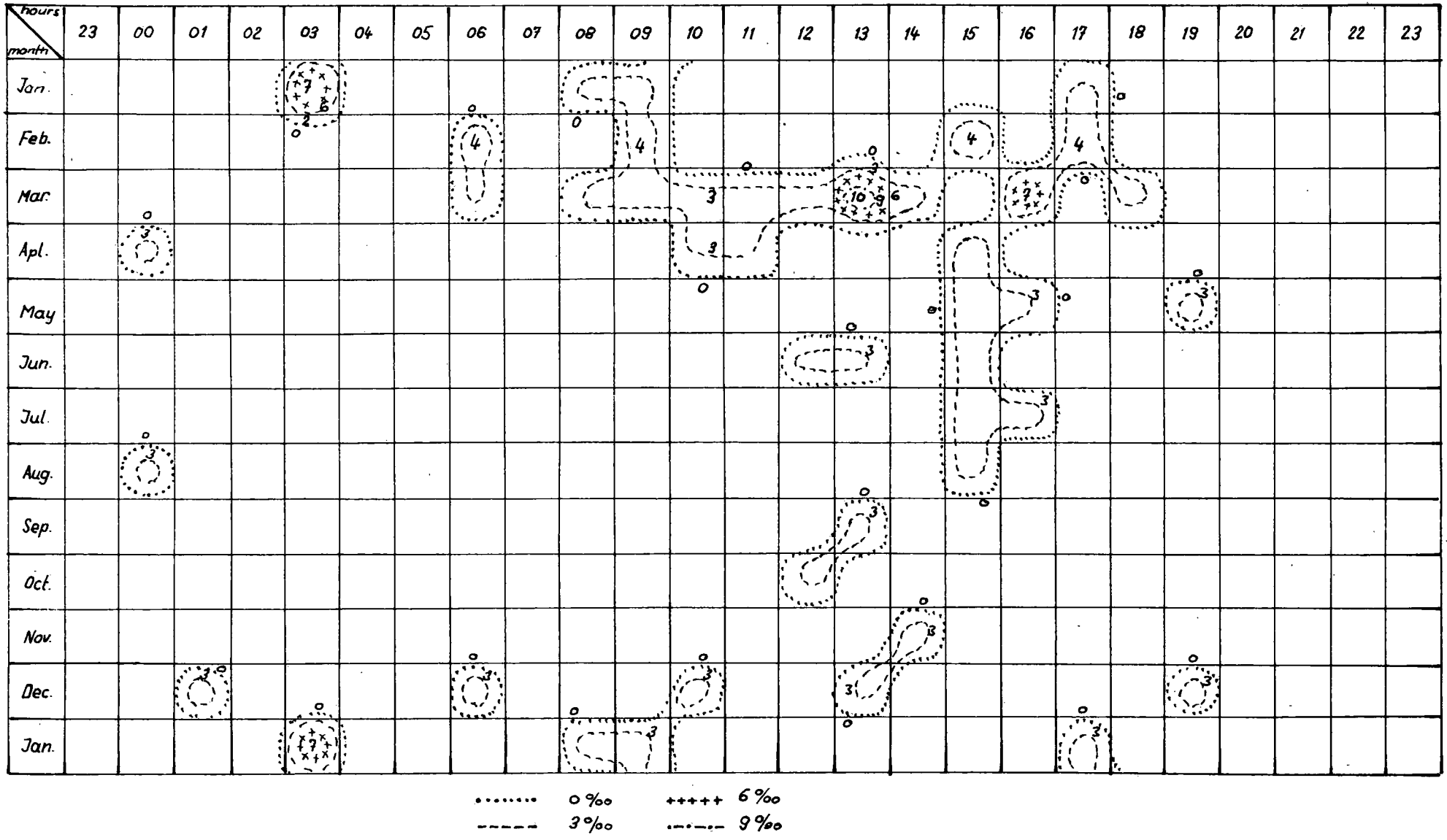
DRIZZLE


hour
month
23 00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Jan.
Feb.
Mar.
Apl.
May
Jun.
Jul.
Aug.
Sep.
Oct.
Nov.
Dec.
Jan.
0 ‰
10 ‰
20 ‰
30 ‰
40 ‰
50 ‰
60 ‰

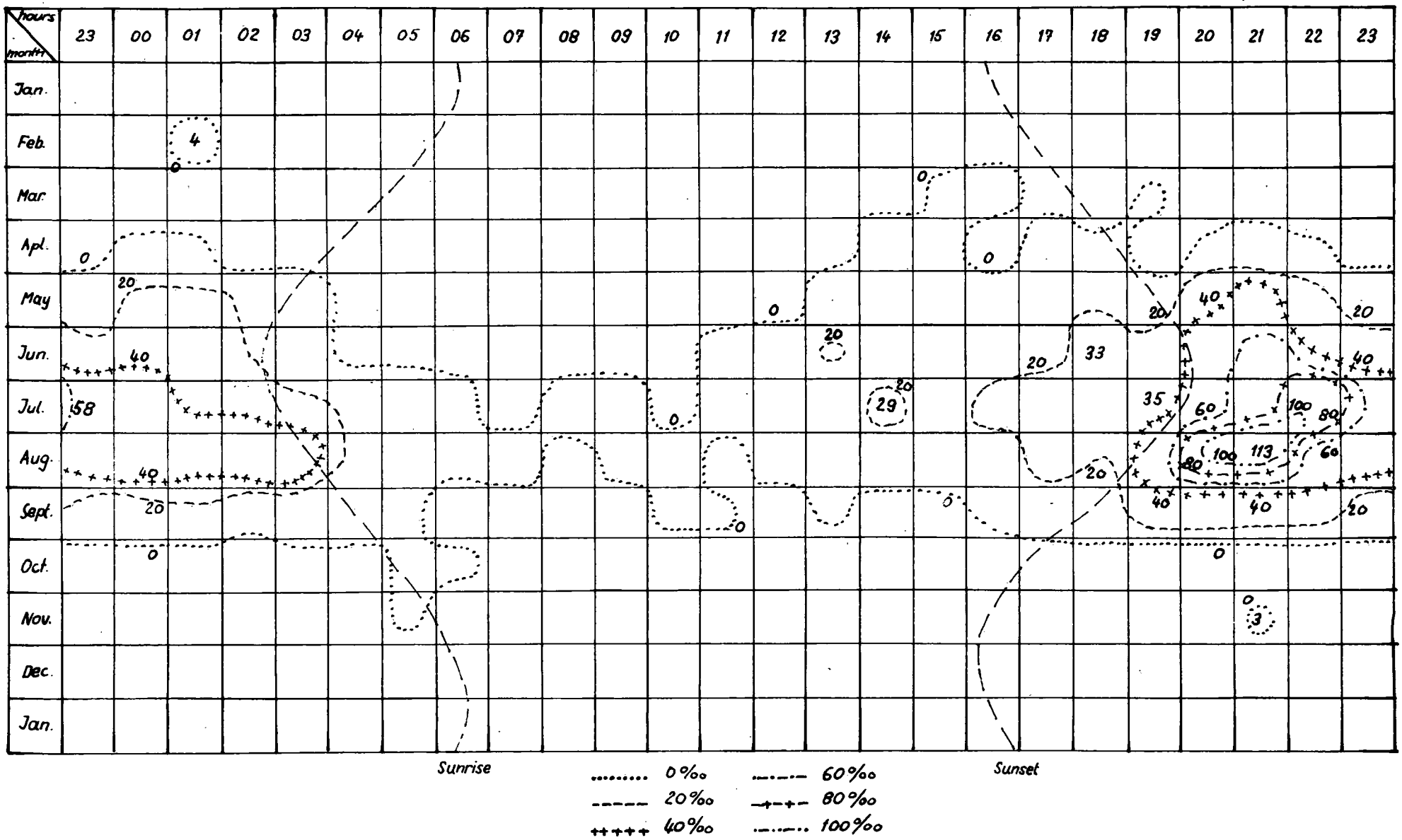
SNOW


hour
month
23
00
01
02
03
04
05
06
07
08
09
10
11
12
13
14
15
16
17
18
19
20
21
22
23
Jan.
Feb.
Mar.
Apl.
May
Jun.
Jul.
Aug.
Sept.
Oct.
Nov.
Dec.
Jan.
0 ‰
20 ‰
40 ‰
60 ‰
80 ‰
100 ‰
120 ‰
140 ‰
160 ‰
180 ‰

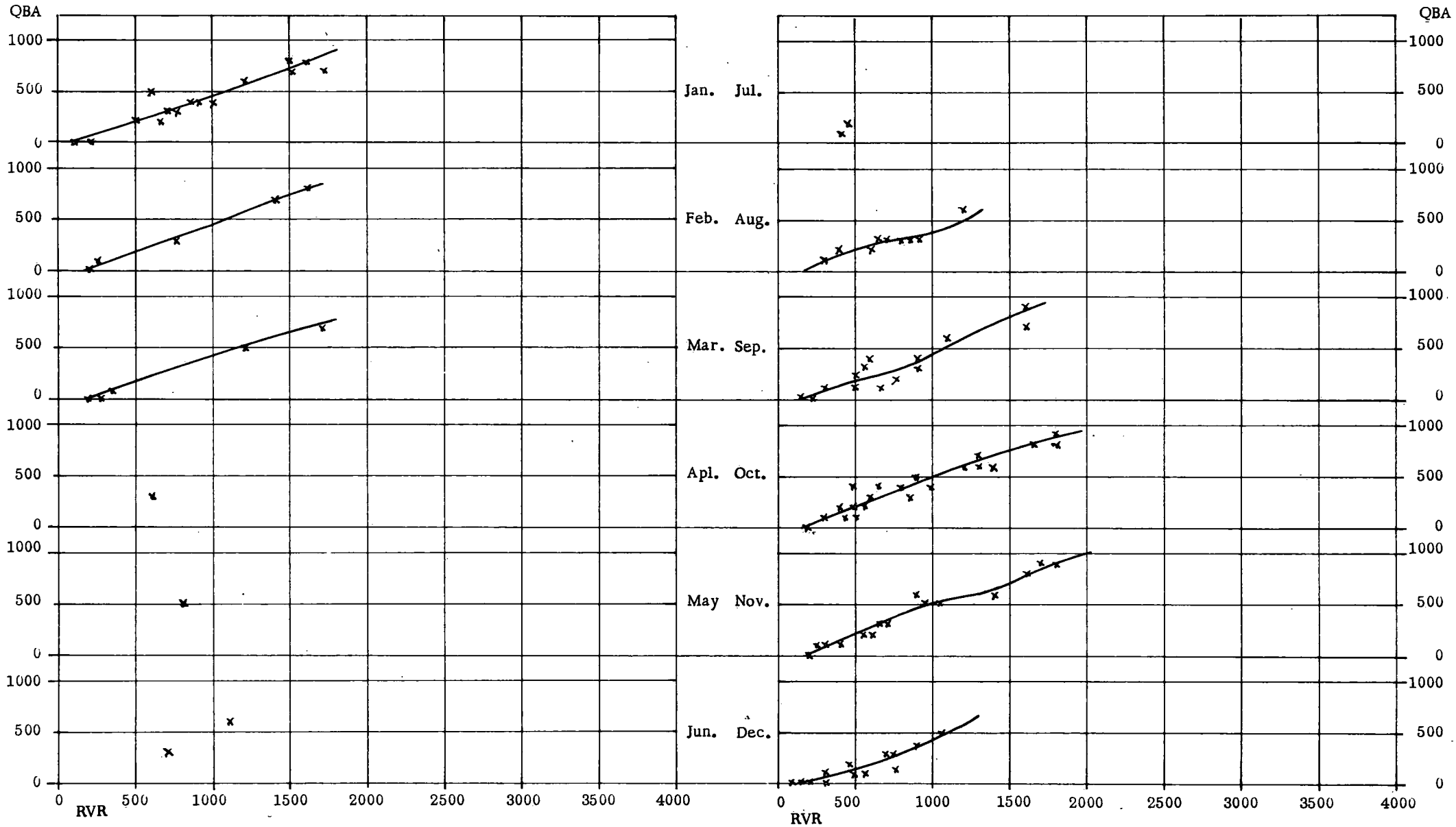
HAIL AND SOFT HAIL



ELECTRIC PHENOMENA

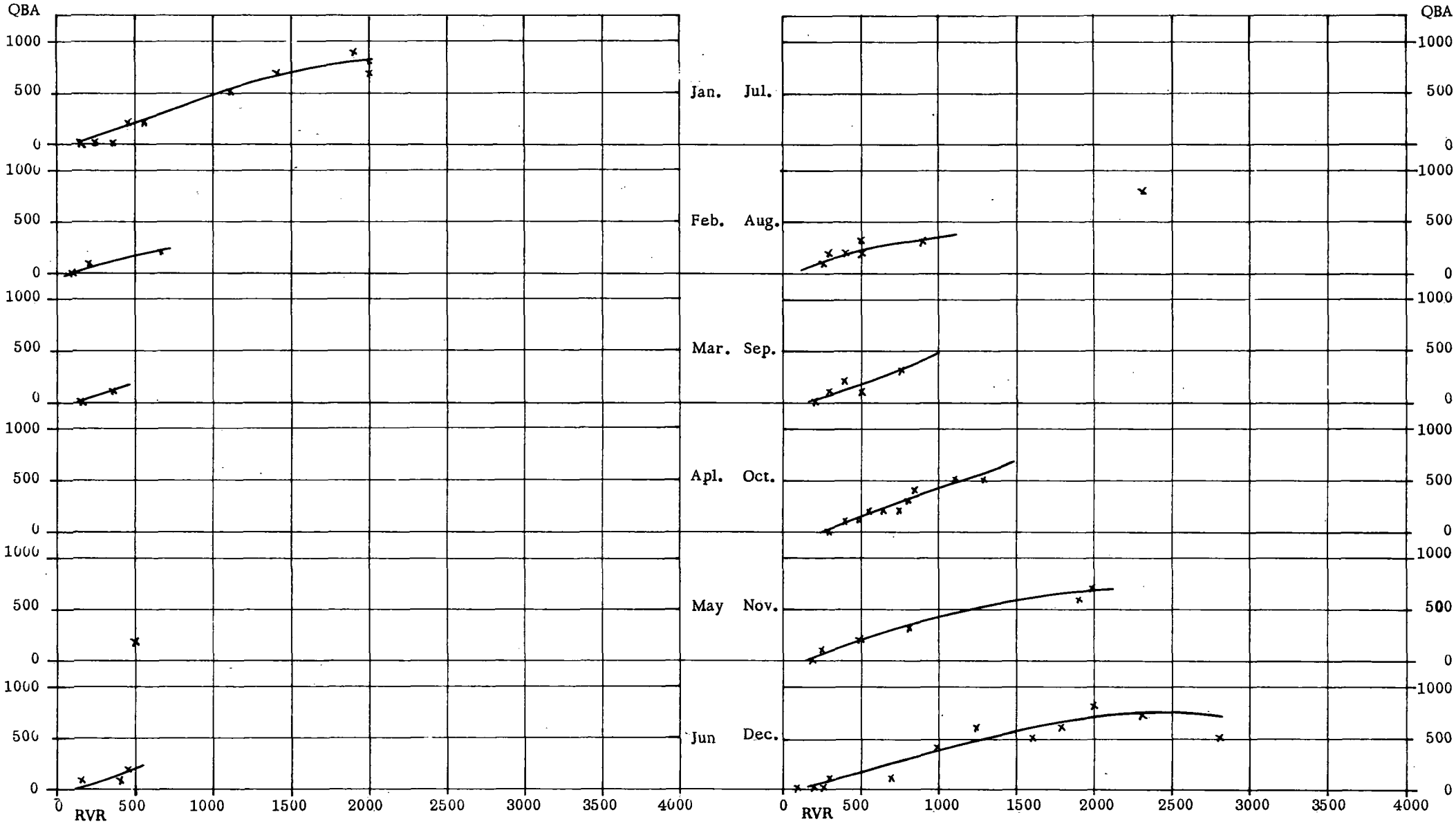


FOG SKY NOT VISIBLE DURING HOURS OF DAYLIGHT



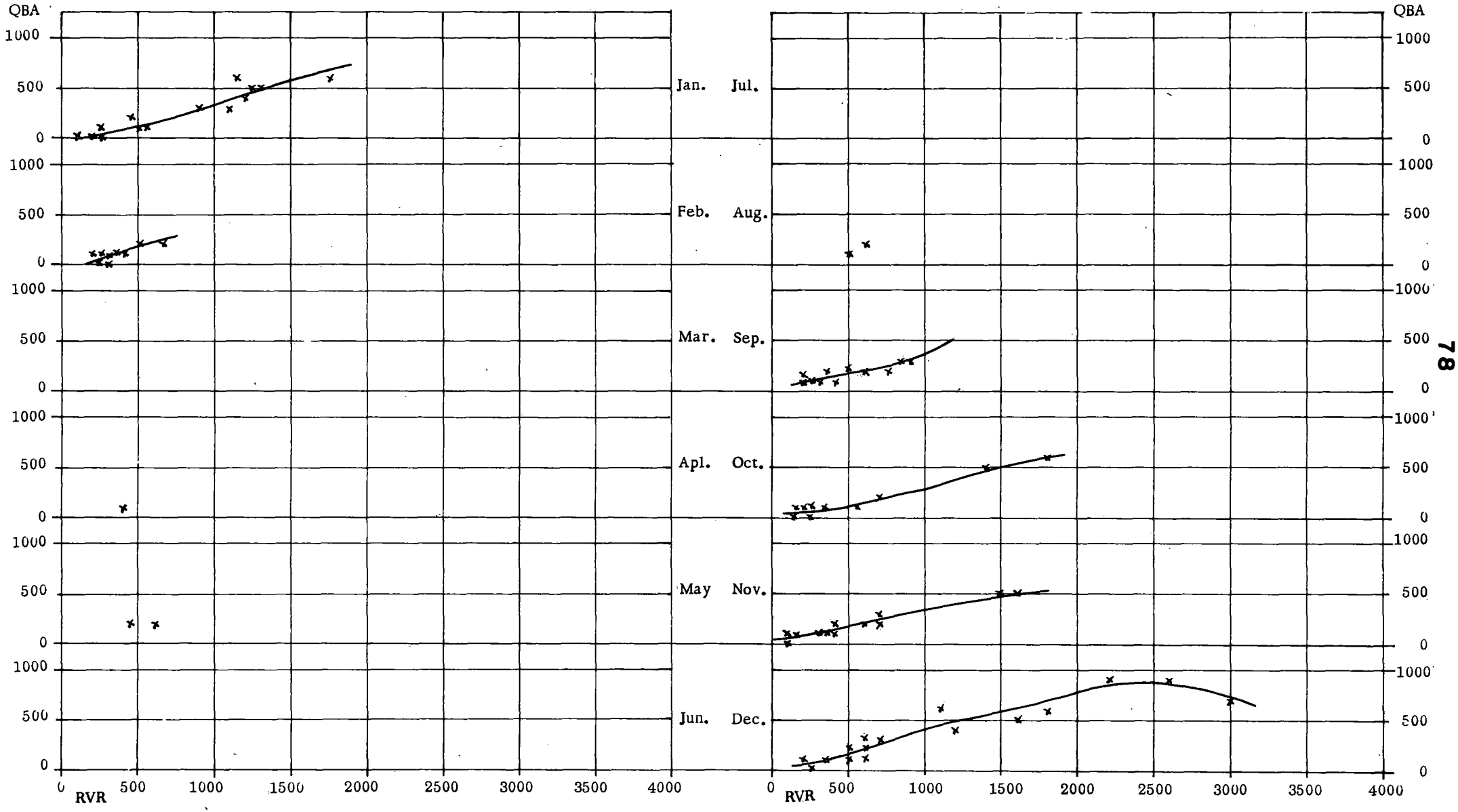
QBA and RVR are expressed in meters

FOG SKY NOT VISIBLE DURING TWILIGHT



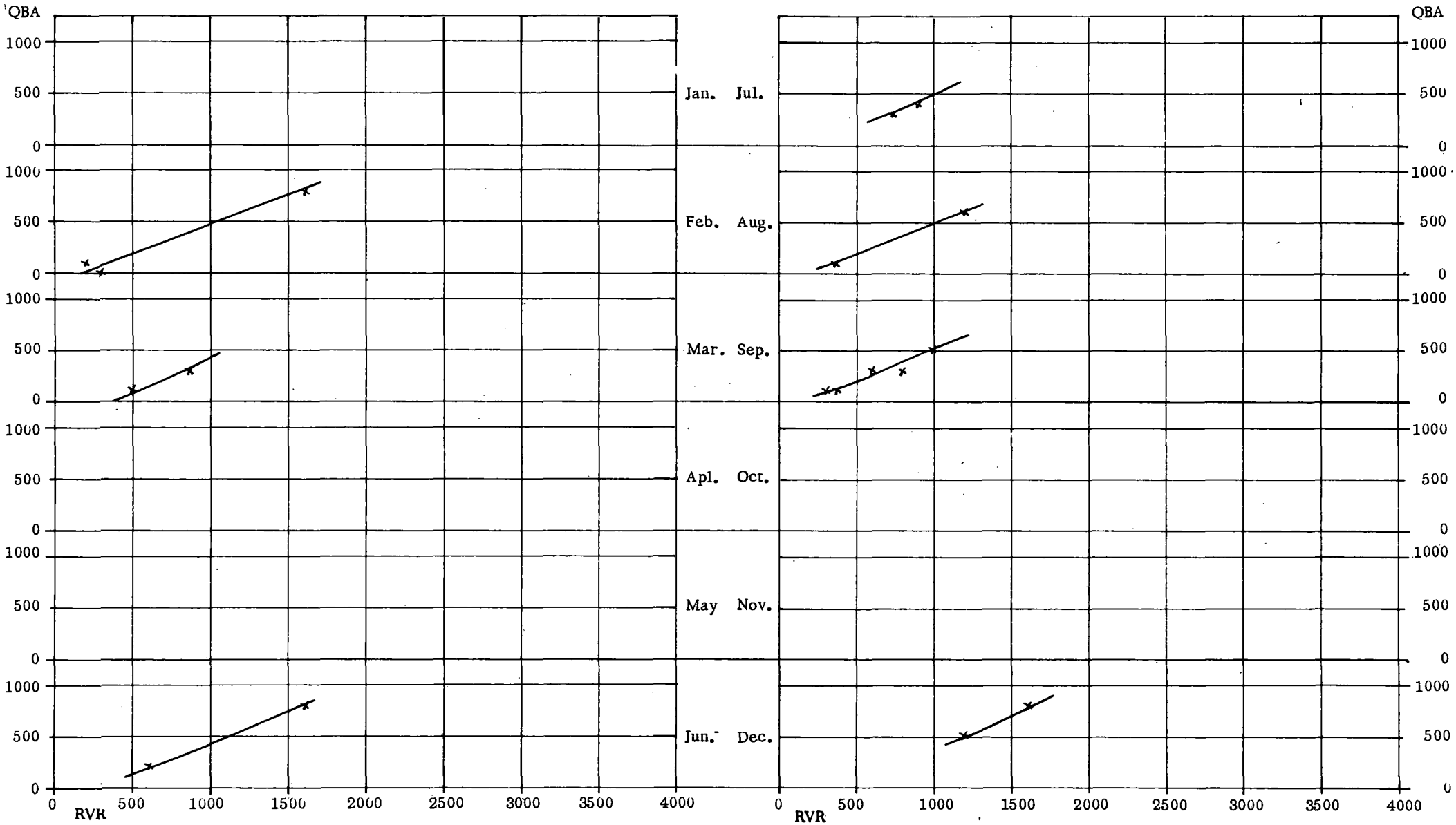
QBA and RVR are expressed in meters

FOG SKY NOT VISIBLE DURING HOURS OF DARKNESS



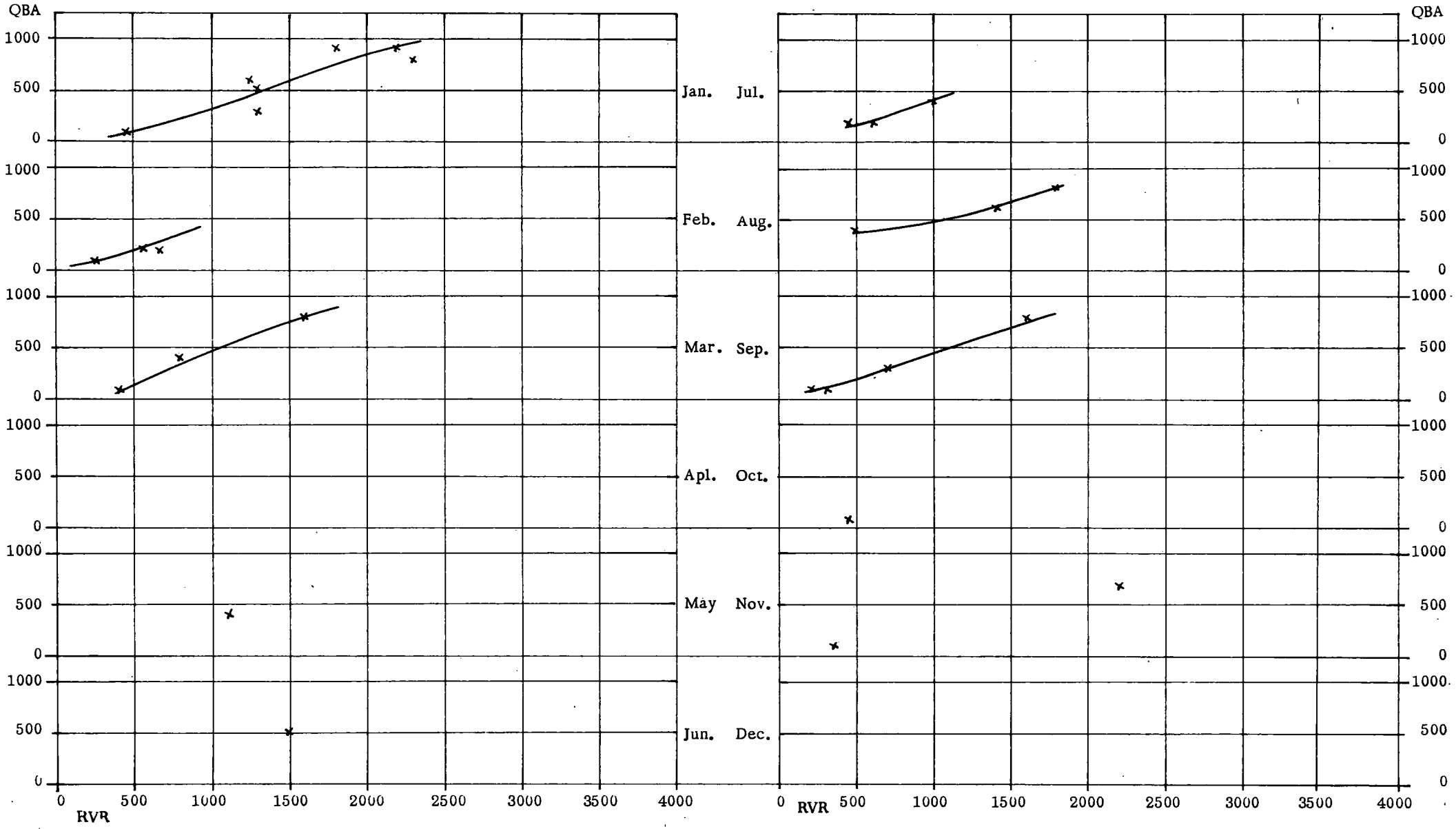
QBA and RVR are expressed in meters

FOG SKY VISIBLE DURING HOURS OF DAYLIGHT



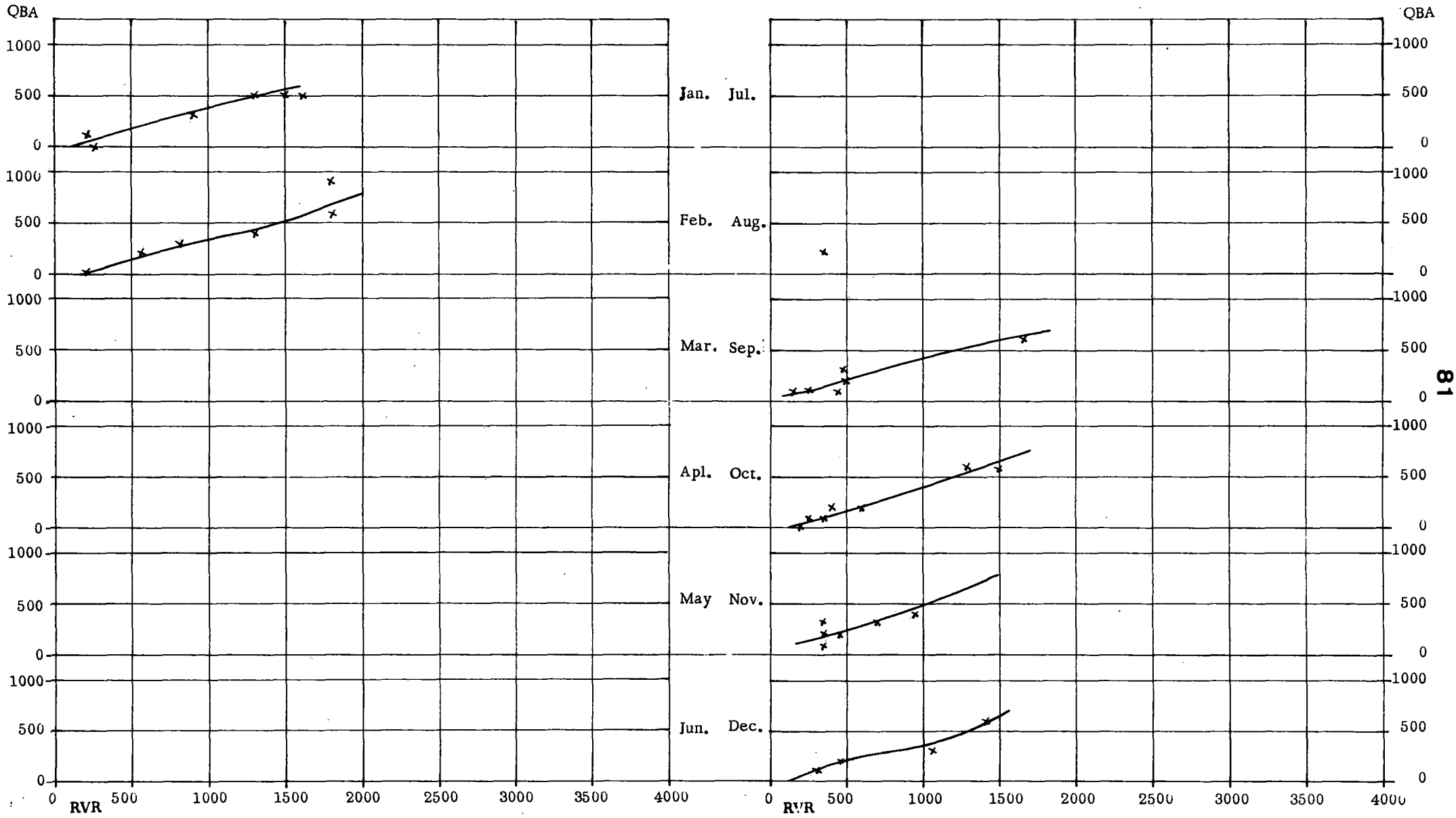
QBA and RVR are expressed in meters

FOG SKY VISIBLE DURING TWILIGHT



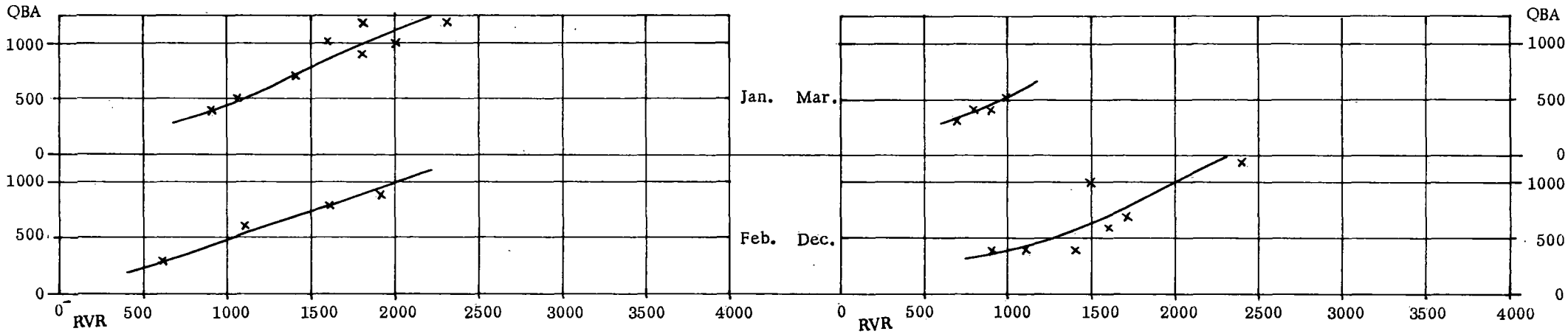
QBA and RVR are expressed in meters

FOS SKY VISIBLE DURING HOURS OF DARKNESS



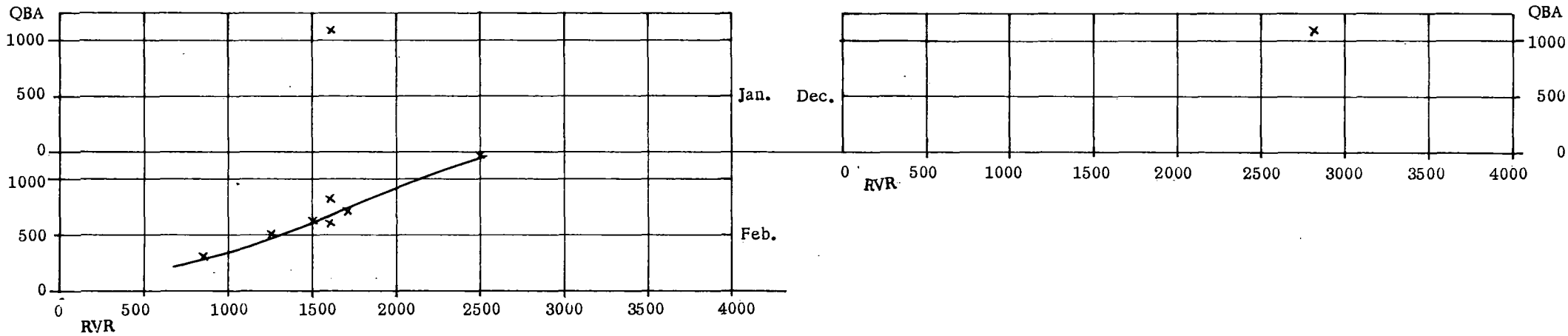
QBA and RVR are expressed in meters

SNOW DURING HOURS OF DAYLIGHT



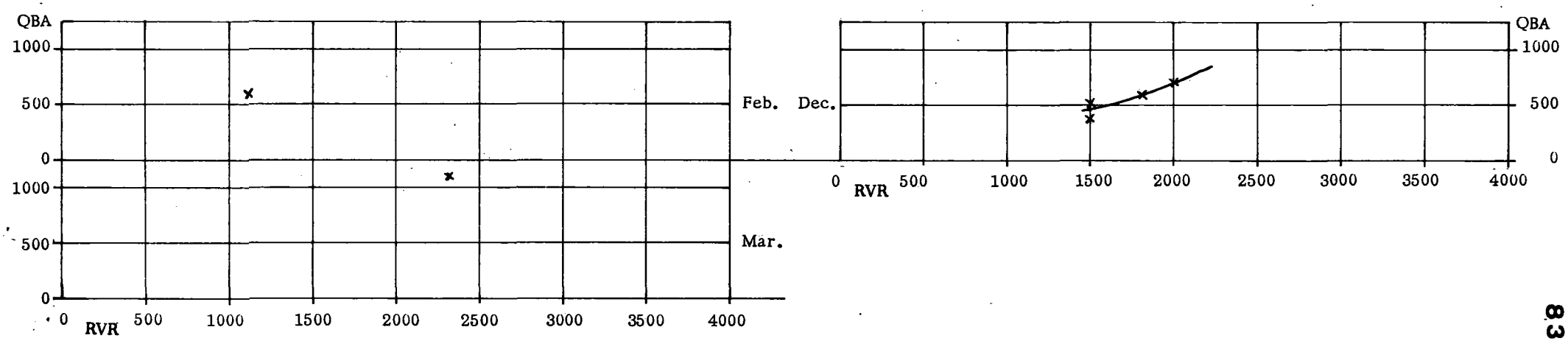
QBA and RVR are expressed in meters

SNOW DURING HOURS OF DARKNESS

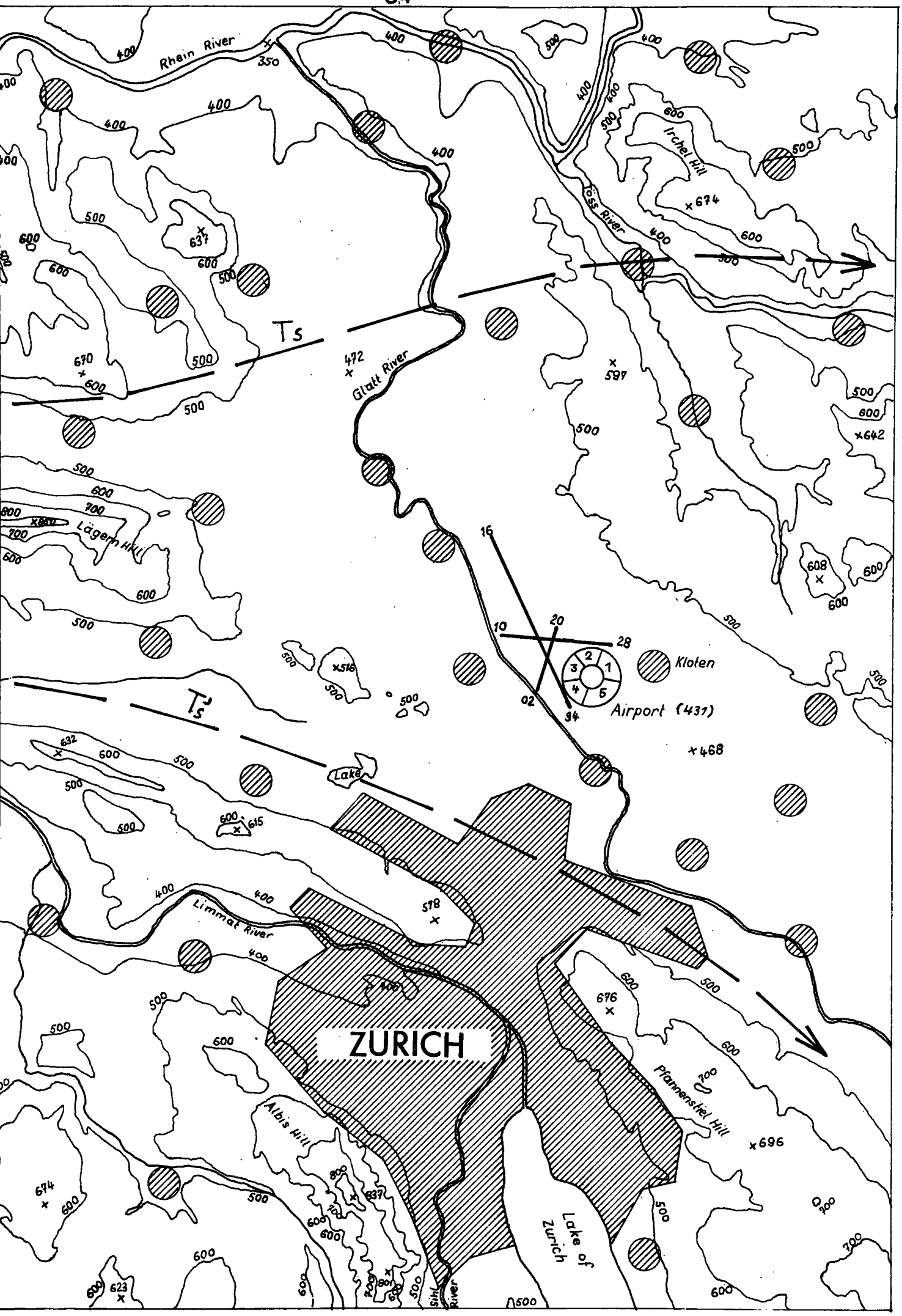


QBA and RVR are expressed in meters

SNOW DURING TWILIGHT



QBA and RVR are expressed in meters


Rhein River
Irchel Hill
Töss River
Glatt River
Lägern Hill
Kloten
Airport (431)
Lake
Limmat River
ZURICH
Albis Hill
Pfannenstiel Hill
Lake of Zurich
Sihl River

Bibliography

1. ACKERMANN, P. : Kondensationskernzählung in Payerne. Verhandlungen der Schweiz.Naturforschenden Gesellschaft (1954)

2. BIDER, M. : Ergebnisse eineinhalbjähriger Registrierungen der Anzahl der Kondensationskerne in Basel. Verhandlungen der Schweiz.Naturforschenden Gesellschaft (1954)

3. COURVOISIER, H.W. : Nebelperioden und ganztägige Nebel in Zürich-Kloten und deren Prognose Flugwetterzentrale Zürich-Flughafen (1962) not publ.

4. FEDERAL AIR OFFICE : AIP Switzerland, Bern

5. GRISOLLET, F., GUILMET, B., ARLERY, R.: Climatologie, méthodes et pratiques. (Paris 1962).

6. HARROWER, T.N.S. : Runway visual range, slant visual range and meteorological visibility The Meteorological Magazine, No. 1086, Vol. 82 (January 1963)

7. HESS, P., BREZOWSKY, H. : Katalog der Grosswetterlagen Europas. Bericht des Deutschen Wetterdienstes in der U.S.-Zone, Nr. 33 (1952)

8. LEHMANN, J. : Bildung und Auflösung von Strahlungsnebel und Hochnebel auf dem Flughafen Zürich-Kloten Flugwetterzentrale Zürich Flughafen (1959) not publ.

9. LUMB, F.E. : Downward penetration of snow in relation to intensity of precipitation The Meteorological Magazine, No. 1086, Vol. 82 (January 1963)

10. MAURER, J., BILLWILLER jr., HESS, C. : Das Klima der Schweiz p 265 - 284, Frauenfeld (1909)

11. PEDGLEY, D.E. : A meso-synoptic analysis of the thunderstorms on 28th August 1958 Geophysical Memoirs, No. 106, London (1962)

12. SCHMID, O.: Untersuchung über Entstehung und Verlagerung von Böenlinien in der Schweiz unter Anwendung der Mesoanalyse Flugwetterzentrale Zürich-Flughafen (1962) not publ.

13. SCHNEIDER, R.: Etude sur la fréquence et la prévision du brouillard sur les aéroports de Zürich-Kloten et Zürich-Dübendorf Flugwetterzentrale Zürich-Flughafen (1949) not publ.

Brouillards et stratus bas (brouillards élevés à l'aéroport de Zürich-Kloten, période 1948-1953 Institut Suisse de Météorologie, Annales (1953)

Formation et dissolution des brouillards à l'aéroport de Zürich-Kloten Institut Suisse de Météorologie, Annales (1956)

14. WORLD METEOROLOGICAL ORGANIZATION : Technical Regulations, Volume II. WMO-No. 49 BD 3, Geneva

15. Meteorological Summaries of observational data of the airports of Geneva-Cointrin and Zürich-Kloten.

16. MUELLER, W., THAMS, J.C. : Zum Problem des Sonnenaufgangseffektes der Kondensationskerne Geofis. Pura e Appl. 52 : 214-226 (1962)