TECHNICAL REPORT

70-4-ES

AREAL AND TEMPORAL OCCURRENCE OF HIGH DEW POINTS AND ASSOCIATED TEMPERATURES

by

Arthur V. Dodd

August 1969

UNITED STATES ARMY
NATICK LABORATORIES
Natick, Massachusetts 01760

U.S. ARMY MATERIEL COMMAND

Earth Sciences Laboratory

ES-49

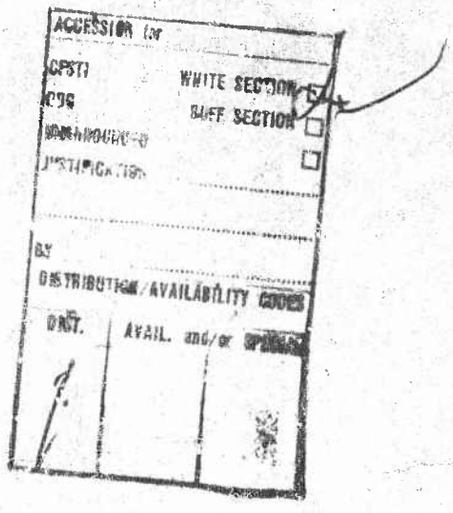
282

BLANK PAGES
IN THIS
DOCUMENT
WERE NOT
FILMED

This document has been approved for public release and sale; its distribution is unlimited.

Citation of trade names in this report does not constitute an official indorsement or approval of the use of such items.

Destroy this report when no longer needed. Do not return it to the originator.



AD_____

TECHNICAL REPORT
70-4-ES

AREAL AND TEMPORAL OCCURRENCE OF HIGH DEW POINTS AND ASSOCIATED TEMPERATURES

by

Arthur V. Dodd
Earth Sciences Laboratory

August 1969

Project Reference:
1T062112A129

Series:
ES-49

Earth Sciences Laboratory
U. S. ARMY NATICK LABORATORIES
Natick, Massachusetts

FOREWORD

The Earth Sciences Laboratory, as well as its predecessor organizations within the Quartermaster Corps, has long had as part of its mission the goal of determining realistic climatic limits for consideration in the design and testing of materiel. Results of research efforts aimed at this goal are utilized formally in such documents as Army Regulation 70-38 (formerly AR 705-15), "Research, Development, Test and Evaluation of Materiel for Extreme Climatic Conditions," and the research itself is reported in technical reports. Two previous reports have dealt with the overall topic of high humidities in conjunction with high temperatures. This third one, based on analysis of 215 stations between latitudes 40° N and 40° S, is far more comprehensive than the others. The report was prepared under Project 1T062112A129.

Sincere appreciation is extended by the author to Miss Olive Lesueur and Mr. Aubrey Greenwald, Jr., Chief, Cartography Office, for their considerable assistance in the compilation of data and the cartographic preparation of maps and graphs in this report.

CONTENTS

CONTENTS (cont'd)

LIST OF FIGURES

LIST OF FIGURES (cont'd)

LIST OF FIGURES (cont'd)

*No table of data

LIST OF FIGURES (cont'd)

*No table of data

LIST OF FIGURES (cont'd)

* A sectional location map is printed opposite each sectional dew point map.

LIST OF TABLES
(in the Appendix)

ABSTRACT

This report is a condensation of information currently available in the Earth Sciences Laboratory concerning the frequency of occurrence of high dew points and the temperatures that are associated with high dew points.

In the first section of the report, graphs showing the frequency of occurrence of high dew points and temperatures at 78 stations for the mid-season months of January, April, July, and October are presented. Tables showing the maximum, minimum, and median temperatures associated with dew points above 75°F supplement the information on the frequency graphs. This information is presented to illustrate the likelihood of occurrence of high dew points and high temperatures.

In the second section of the report, maps showing the frequency of occurrence each month of dew points above 76°F, 80°F, and 84°F at 215 stations between latitudes 40° N and 40° S are presented. Data for each station are presented on circular graphs, making possible quick comprehension of the seasonal pattern of occurrence of high dew points at the individual stations, and the inclusion of the circular graphs on the maps gives some insight into the areal distribution of the occurrence of high dew points.

The information on the association of high temperatures and high dew points and the frequency of occurrence and areal distribution of high dew points is necessary for realistic consideration of humidity extremes and associated temperatures set forth in documents presenting environmental guidance for design of military materiel. The application of the information in this report to a revision of the humidity extremes in the new Army Regulation 70-38 (formerly AR 705-15), "Research, Development, Test and Evaluation of Materiel for Extreme Climatic Conditions," is discussed in the Appendix.

AREAL AND TEMPORAL OCCURRENCE OF HIGH DEW POINTS AND ASSOCIATED TEMPERATURES

I. Purpose, Scope, Definitions

1. Introduction

The adverse effects of high temperatures and high humidities on both men and materiel have long been recognized, but the requisite data to delimit where and how often stress conditions occur have not been available. As the observation network and the availability of data around the world improve, this situation will change, but this will take time, and therefore the data currently available in the Natick Laboratories files were used for this report. Graphs and maps are presented which depict the distribution of occurrence and frequency of occurrence of high dew points at selected stations between latitudes 40° N and 40° S. Because the stress caused by high moisture content of the atmosphere is usually dependent also on the associated temperature, graphs showing dew point and temperature frequencies and tables depicting the joint occurrence of high dew points and temperatures are also included.

2. Previous Related Studies

The graphs, tables, and maps in this report furnish information supplementing three recent studies. One of these studies, "Simultaneous Occurrence of High Temperatures and High Dew Points," has information on dew points associated with very high temperatures (109°F and higher) for 17 stations (1). Another military study is the excellent "Atmospheric Humidity Atlas - Northern Hemisphere" published in 1966 by the Air Force Cambridge Research Laboratories (2). Records for 1500 surface stations and 400 upper-air stations were utilized in this report. The third study, "Die Mittlere Wasserdampfferteilung auf der Erde," by Landsberg, includes world maps showing the mean vapor pressure (directly related to dew point) based on data from 2300 stations, including recent ship data (3).

3. Purpose

The purposes of the present report are: (1) to make available information on the frequency of occurrence of high dew points and high temperatures for 78 stations in graphical form; (2) to present in tabular form the joint occurrence of high dew points and high temperatures for most of these 78 stations; and (3) to show on maps the monthly variation in the occurrence of high dew points for 215 stations around the world between latitudes 40° N and 40° S.

4. Basic Considerations and Humidity Nomenclature

Water vapor is water in its gaseous state and is the most important of the variable constituents of the atmosphere. Very little water vapor is present in a cold atmosphere, but a warm and humid atmosphere contains up to 4 or 5 percent water vapor by volume. This is not surprising, since water vapor enters the atmosphere primarily by evaporation from water surfaces, or moist ground, and also by transpiration from vegetation. The amount of water vapor that can be present in the air* is dependent only on the temperature. When water is evaporated into air in a closed system at a constant temperature, there will come a point when condensation at the air-water surface balances evaporation. At that point the maximum possible amount of water vapor is present in the air. The air is then said to be "saturated." Stated another way, the relative humidity is 100 percent.

The amount of water vapor in the atmosphere can be expressed in a number of ways, each expression having its advantages and disadvantages. Absolute humidity is the mass of water vapor in a specified volume of air; absolute humidity varies as the pressure and the volume vary and this measure of humidity is used mainly where pressure and volume are fixed. Specific humidity is the mass of water vapor per unit mass of moist air. The mixing ratio is the mass of water vapor per unit mass of dry air. Since the atmosphere contains relatively little water vapor, the specific humidity and the mixing ratio are often considered to be approximately equal. They are useful in meteorology because they do not change except by the actual addition or removal of water vapor.

Vapor pressure is the pressure exerted by the water vapor in the atmosphere. It is a useful measure as long as the atmospheric pressure is approximately constant. Relative humidity is the ratio of the amount of water vapor in the air to the amount that would constitute saturation. It is expressed as a percentage. Relative humidity is the most common expression of humidity, but its use has been much abused. A given relative humidity has a far different meaning on a cool day than on a warm day. This results because the amount of water vapor which can be present in the atmosphere increases with temperature. For example, the saturation vapor pressure at 90°F equals 1.42 inches of mercury. When the temperature is 90°F and the relative humidity is 50 percent, the actual vapor pressure is one half of 1.42 inches of mercury or 0.71 inches of mercury - a relatively high

---

*Actually the water vapor present is almost entirely independent of the amount and type of other gaseous constituents of the atmosphere.

moisture content of the atmosphere. In comparison, the saturation vapor pressure at a temperature of 40°F equals 0.24 inches of mercury. When the temperature is 40°F and the relative humidity is 50 percent, the actual vapor pressure is 0.12 inches of mercury - a modest moisture content of the atmosphere. In the first case (90°F temperature), a relative humidity of 50 percent is a high humidity. In the second case (40°F temperature), the same relative humidity of 50 percent is a moderate humidity. It is apparent that relative humidity is an incomplete expression of the water vapor present, and for most applications is a term to be avoided.

From a climatological point of view, the dew point is probably the most convenient measure of humidity, since it can be expressed on the same scale as the temperature. Dew point is the temperature at which saturation occurs if air is cooled at constant pressure. Because it is an actual measure of water vapor present, and because it is expressed on the same scale as the temperature, dew point has been selected as the measure of humidity used in this report.

II. The Data

1. Source of Data Used

The data analyzed in this study were obtained from the National Weather Records Center at Asheville, North Carolina (4). Three separate data summaries were used:

a. Climatic frequencies for low-latitude stations, by C-E-I-R, Inc. (5)

b. Temperature-dew point-wind summaries, by U.S.A.F. (6)

c. Psychrometric summaries, part E of U.S.A.F. summaries (7)

In most cases the station name that was used by the National Weather Records Center to identify the station is also used in this report. In a few cases this name has been altered for the sake of clarity. The latitude, longitude, and station elevation are included on the graphs to identify accurately the location of the stations.

2. Limitations of Present Data

In recent inventories of geographic research of the humid tropics and deserts, the lack of meteorological observations in tropical areas was stressed (8, 9). In both these studies the lack of adequate data for these

areas was attributed to underdevelopment in much of the area. The compilation of an adequate data base for low-latitude areas will be a long and deliberate operation. The decision to analyze the data which are now available was made with this in mind, since both the quality and the quantity of the data available are marginal for the purposes of this report.

The formats for the three summaries were not compatible in all respects and none of the summaries had uniform periods or lengths of record. In most cases the length of record was between 3 and 5 years. At some stations the best records available were derived from observations taken before World War II, while at many stations the only records available were based on observations taken during World War II. Some records are based on more recent observations. Another limitation of each of the summaries is the presentation of temperature and dew point frequencies in 2 F° classes. This must be considered when the data are interpreted.

The amount of data available for the study is limited mainly because dew points either are not observed or the observations are not summarized at many weather stations in the tropical areas of the world. At some stations dew points are taken once or twice a day, but these observations are not adequate to define the dew point regime because of the diurnal variation in dew point. The average diurnal variation in dew point in some dry climates may be as much as 10 F° (10). Fortunately, the stations where observations are taken frequently are also the stations where humidity normally is observed.

In many cases the stations are located at United States Air Force airfields. Observations were taken by well trained Air Force observers and were summarized at the Air Force Climatic Center, National Weather Records Center, Asheville, North Carolina. These data are considered reliable*. In a few cases the National Weather Records Center obtained data from published sources. These records are also considered reliable, although knowledge of the original method of observation may not be known. In most cases the temperature and the dew point were derived from psychrometric observations (wet bulb and dry bulb thermometer readings).

---

*It is necessary to qualify the term "reliable." Humidity is extremely difficult to measure accurately. When errors are made they usually are in the direction of values higher than the "real" values. In the collation of data for this report extremely high dew points which did not appear to be likely to occur at the station in question had to be evaluated separately. The possibility of an observational or data-reduction error must be considered as the dew point graphs in this report are interpreted. In some cases questionable data were eliminated, while in other cases they were judged to be valid and were included.

In many cases observations were missing or the records were interrupted so that the length of record does not adequately describe the record. The practice in this report is to indicate on the graphs the number of observations from which the record is derived.

3. Considerations in Selecting the Data

The quality of the data base available for this study varies considerably from area to area. In a few areas hourly data for a number of stations were available. For example, there were a number of stations in the islands of the Caribbean with hourly data for a 5-year period. Data for several of these stations are considered in the graphs, tables, and maps in this report, but it is not necessary or practicable to include frequencies and joint occurrences of dew points and temperatures for all these stations.

Most low-latitude areas have less data than that available for the Caribbean, and less selectivity was necessary. Records for less than 5-year periods and less than hourly observations (but never less than 3 times a day) were used. For example, the Djakarta, Indonesia, record (Fig. 1.20) is based on observations taken 3 times a day and in a 5-year period of record there were some missing observations. In a climate characterized by more variability in temperature and dew point, the number of observations available for Djakarta would not be acceptable.

Both temperature and dew point normally decrease with elevation and the joint occurrence of high temperatures and high dew points does not constitute a problem at elevations above 3,000 to 4,000 feet. Only six of the 78 stations for which temperature and dew point frequency graphs are plotted in Figures 1.1 to 1.78 are at elevations above 1,000 feet and only three of these stations [Khartoum (Sudan), Chiang Mai (Thailand), and Taipingsze (China)] experienced dew points above 80°F. Only 36 of the 215 stations for which the frequency of occurrence of high dew points are depicted on maps (Figs. 3-5) are at elevations above 1,000 feet.

Data were available for many more stations in the Northern Hemisphere than in the Southern Hemisphere. To some extent, this is a reflection of the fact there is slightly more land in tropical latitudes in the Northern Hemisphere, but the main reason is the lack of development of tropical South America and tropical Africa south of the equator.

III. Cumulative Frequencies and Joint Occurrences of Dew Points and Temperatures During Midseason Months

1. Introduction

Cumulative frequencies of dew points and temperatures during the months of January, April, July, and October for 78 stations around the world are presented in Figures 1.1 to 1.78.* Locations of the stations are shown in Figure 1.0. On the pages facing most graphs there are tables which show the joint occurrence of dew point and temperature for the occasions when dew points are high ($\geq$ 76°F at all stations except Carnarvon, Australia, where they are $\geq$ 75°F). The information on the figures and in the tables was usually derived from the same source, but since the "Part E" summaries (7) do not show the joint occurrence of temperature and dew point, it was necessary to use other summaries for the tables for three stations (Bangkok, Saint John's, and Tripoli) or to omit the tables for three stations (Miami, Mobile, and Washington). The Part E summaries were used only at the above six stations. The number of observations available for the data summaries is indicated on both the figure and the table.

As indicated in Section I, the purpose of this report is to present data on the frequency of occurrence of high dew points and the joint occurrence of high dew points and high temperatures in a form for ready reference. It is beyond the scope of this report to discuss the temperature and humidity regimes at each station in detail, but it is useful to point out some of the typical features of these regimes, and some of the anomalous regimes at selected stations. This discussion is organized according to latitude (high, intermediate, or low), since latitude (and related solar regime) is the prime climatic control. Stations at latitudes outside the tropics will be discussed first. These stations generally have the most seasonal variation in temperature and dew point. Stations between latitudes 10° and 23 1/2° N and S will be considered next. Finally, the low-latitude stations (between 10° N and S) will be considered. First an example shows how to interpret the graphs and tables.

2. Interpretation of the Graphs and Tables (Sample Station: Tripoli, Libya)

Figure 1.76, Tripoli, Libya, Cumulative Frequencies of Temperatures and Dew Points, has been selected as a sample station because it is the station with the most observations. The cumulative frequencies of dew points are indicated in blue for the midseason months of January, April,

---

*Figures 1.1 to 1.78 (listed in front pages of this report) are located between the body of the report and the Appendix, pages 24 through 179.

July, and October, and the cumulative frequencies of temperature are indicated in black for the same months in the figure.

In order to facilitate comparisons from station to station, a standardized format was adopted. This necessitated limiting the range of temperature and dew point to 80 F° between 30° and 110°F. Temperatures and dew points below 30°F are not indicated. The maximum temperature class is indicated when it is above 110°F. The maximum temperature at Tripoli is in the 117 to 118°F class.

In interpreting the curves it must be recalled that they were derived from data summarized in 2 F° classes. This presents a cartographic problem which requires an explanation. Near the termination of each of the dew point frequency curves a short line and a month indicator (e.g., "J" for January, "Jul" for July, etc.) are placed. Thus at Tripoli the highest dew point class in July is the 81° to 82°F class and the lowest class is the 31° to 32°F class. The July indicator for termination of high dew points is placed at 82°F, but the curve is continued to 83°F to indicate there were 0 percent occurrences of a dew point of 83°F in agreement with the heading "percent of observations equal to or greater than the indicated value". Indicators for termination of the temperature curves were not used because in some cases they might be confused with the indicators for the dew point curves.

The temperature and dew point curves based on the many observations available for Tripoli are quite regular. At most stations there are not as many observations available, and at a number of stations the curves are not as smooth because of the limited number of observations.

The table which accompanies the temperature and dew point frequency graph for Tripoli was derived from a different summary than the graph, as already explained. The table shows that dew points equal to or greater than 76°F occurred in 71 of 3,705 observations in July with a maximum dew point in the 80 to 81°F class. The data for August are not presented, but August is indicated as the month with most frequent occurrence of high dew points.

3. High-latitude Stations (23 1/2° to 40° N and S)

a. Tripoli (Libya) and Carnarvon (Australia)

As already stated, Tripoli (Wheelus Air Force Base) is the station with the longest period of record. Hourly observations for an 18-year period have been summarized at this station (over 13,000 observations per month). From inspection of Figure 1.76 it can be seen that the temperature and humidity regimes at Tripoli reflect a very regular seasonal variation typical of higher-latitude stations. The weather station is

located near the Mediterranean Sea, and the moderating effects of that sea are apparent in the relatively mild summer temperatures. These summer temperatures are considerably lower than those found inland in the Sahara Desert. Summer dew points at Tripoli are generally higher than those inland although the maximum dew points are not higher (compare Tripoli and Khartoum). It is apparent from the table that high dew points generally occur at Tripoli when temperatures are not high. The most severe combination of high temperature and high humidities in July were dew points of 80° or 81°F in combination with temperatures of 89° or 90°F.

Conditions typical of the interior infrequently prevail at Tripoli. The maximum temperature in July is in the 117 to 118°F class; however, temperatures above 100°F were observed less than 1 percent of the time in that month. Dew points below 30°F occurred in January, April, and October, and the minimum dew point in July was in the 32° to 33°F class.

The graph for Tripoli is indicative of the normal seasonal progression of temperature and dew point at stations beyond the tropics (poleward from lat. 23 1/2° N and S). As temperatures rise from the winter minimum, dew points also rise, but there is a lag in these regimes behind the seasonal progression of the sun, so that October is warmer and has higher dew points than April in the Northern Hemisphere.

A station in the Southern Hemisphere which has a regime very similar to that at Tripoli is Carnarvon on the dry western coast of Australia (Fig. 1.10). Temperature and dew point ranges and seasonal variation at Carnarvon are very similar to those at Tripoli and in these aspects the climates at the two stations can be considered analogous. Dew points at Carnarvon in April, during the southern hemisphere autumn, generally are higher than in October. There is a more frequent occurrence of low dew points in April, however.

b. Peking, Tokyo, and Washington

The seasonal variations evident at Tripoli and Carnarvon are even more apparent at higher-latitude stations. Peking, Tokyo, and Washington all have winter temperatures and dew points much lower than those at Tripoli or Carnarvon because the former stations are located at higher latitudes in areas susceptible to invasion of cold dry air. It is important to note that at all three stations very hot and humid conditions occur during the summer. In fact, Peking at 39° 55' N has very high summer dew points and a large seasonal variation in temperature and dew point. Dew points above 70°F occur during more than half the hours in July at Peking. There are a few observations of dew points above 85°F. On the other hand, January is very cold and dry with temperatures below 32°F during 80 percent of the time, and dew points below 32°F almost all the time.

c. Dhahran (Saudi Arabia), Abadan (Iran), and Puerto Penasco (Mexico)

Some stations at latitudes outside the tropics have experienced very high summer dew points because of their location near warm bodies of water. Dhahran (Saudi Arabia) and Abadan (Iran), on the coast of the Persian Gulf, are well known for their extremes of heat and humidity. These are desert stations with very little rainfall during the summer season of high humidity. The conditions at these stations are indicative of the high humidities which occur in the summer along the entire littoral of the Persian Gulf. Dew points above 80°F associated with temperatures above 110°F have been reported at the Port of Abadan in July, August, and September (1). Temperatures associated with high dew points are slightly lower at Dhahran, but are still extreme, and indicate the severe physiological stress that residents of this area experience in summer. It is necessary to point out that these extreme conditions occur only on the immediate coast. Maximum dew points a few miles inland are approximately 20 F° lower (1). It also should be stressed that the high humidities of the Persian Gulf coast do not occur most of the time. For example, at Abadan, dew points are above 80°F approximately 10 percent of the time in July. However, at times dew points can be low. The humidity regime of the Persian Gulf coast is a distinctly different regime than that of the wet tropics where relative humidities and dew points are consistently high.

The station in North America with highest dew points is Puerto Penasco, Mexico, on the northern coast of the Gulf of California (Fig. 1.59). There is a 3-year record available at Puerto Penasco with temperatures and dew points observed every 3 hours.

The highest dew point in July at Puerto Penasco was in the 86° to 87°F class, and was associated with a temperature in the 91° to 92°F class. Higher July dew points were observed on the Persian Gulf coast, but dew points were consistently higher at Puerto Penasco. The minimum dew point in July at Puerto Penasco was in the 62° to 63°F class, and dew points of 76° or higher occurred two-thirds of the time.

It is apparent that the high dew points at Puerto Penasco are caused by the high water-surface temperatures of the northern Gulf of California in the same way that the high dew points at Abadan and Dhahran are caused by the high water temperatures of the Persian Gulf. Details on the site of the observations at Puerto Penasco are not available, but it can be surmised that the observations were taken on the immediate coast, because an inland location would certainly have higher temperatures than those observed at Puerto Penasco. Yuma (Ariz.), 120 miles northwest of Puerto Penasco, has an average maximum temperature in July of 106°F, but at Puerto Penasco the highest temperature in July was 97 or 98°F in the 3-year record. Summer dew points at Yuma are much lower than at Puerto Penasco.

There is more frequent occurrence of high dew points at Puerto Penasco in August than in July although the maximum dew points were in the same class in both months. For example, dew points equal to or greater than 80°F occurred 17 percent of the 741 observations in July, while the comparable percentage for August was 30 percent.

d. Gaya (India) and Karachi (West Pakistan)

In the Indian sub-continent the normal seasonality in temperature and humidity is altered by the monsoonal circulation of the region. At Gaya, India, the highest temperatures occur in April before the onset of the summer monsoon, and the range of temperatures in April is larger than in July (Fig. 1.25). The median April temperature (at the 50 percent level on the graph) is 84°F, approximately 1 F° higher than the median July temperature. There also is a greater range in April dew points than in July dew points at Gaya, but July clearly has higher dew points with no values below 70°F.

Karachi, West Pakistan, is normally a much drier station than Gaya, but both are under the influence of the same humid air mass in July, as indicated by the analogy of the dew point regimes in that month (Fig. 1.39).

Another important relationship between temperature and dew point in the Indian sub-continent is revealed by inspection of the tables for Gaya and Karachi. At both these stations (and probably throughout the Indian sub-continent) the highest dew points are usually associated with temperatures below 90°F, and are always associated with temperatures below 100°F.

e. Meshed (Iran)

Meshed, Iran, is the highest station, and also one of the most northerly stations (lat. 36° 17' N) included in this study. The seasonality associated with inland location and relatively high latitude and altitude is apparent in the range of temperature between a cold January and a hot July (Fig. 1.49). The relatively low dew points at Meshed must be attributed primarily to the higher elevation of the station, but to some extent it is also an indication that the humid monsoon maritime air mass apparent at Karachi in July does not reach Meshed. Spring is the rainy season at Meshed, and dew points average slightly higher in April than in October.

4. Intermediate-latitude Stations (10° to 23 1/2° N and S)

a. Southeast Asia Stations

The marked tendency for maximum temperatures to occur in spring, evident in India and Pakistan, is also apparent at stations in Southeast Asia. Bangkok and Chiang Mai in Thailand and Saigon, South

Vietnam, experience higher temperatures in April than in July. Farther north at Hanoi, North Vietnam, however, July is definitely the warmest month. The effect of latitude is also apparent in the dew point distributions, for at Bangkok and Saigon high dew points occur most of the year, while at Hanoi more seasonal variation in dew points is evident with highest dew points in July.

b. Khartoum (Sudan)

Khartoum, Sudan, at 15° 36' N, and on the periphery of the Sahara Desert, displays temperature and humidity regimes in some aspects like the monsoonal regimes of Asia (Fig. 1.40). Khartoum is subject to very high temperatures most of the year because of its relatively low latitude and interior desert location. Tropical air masses progress as far north as Khartoum in summer, bringing rain, higher humidities, and maximum temperatures which are not as high as maximum temperatures in the spring. Conditions at Khartoum represent the climatic transition between tropical and desert conditions in Africa. The records indicate that, at times, very high dew points associated with temperatures near or above 100°F can occur. Such extreme conditions probably are transient. They occur when the moisture on the hot ground is evaporating after a summer shower. The extreme ranges in dew points in all months, but particularly in April, indicates the differences in desert and wet tropical air masses which alternate in this transitional area.

c. Island Stations

Island stations normally have less seasonal and daily variation in temperature and dew point than continental stations because of the moderating influence of the sea. Maritime stations also generally have a considerable lag in the occurrence of mean maximum temperatures and dew points after the period of high sun, and the lag in dew point sometimes is longer than the lag in temperature. This is the case at intermediate latitudes in the Caribbean, where the average highest dew points occur as late as October, as illustrated by the graphs for Guantánamo Bay (Cuba), Kingston (Jamaica), Port-au-Prince (Haiti), and Saint John's (Antigua). The cumulative frequency of dew points at Aguadilla (Puerto Rico) is approximately the same in October as in July.

5. Low-latitude Stations (between 10° N and 10° S)

a. Typical Stations

The consistently warm and humid tropical environment is best exemplified by data from stations close to the equator. The two best examples for which data were available for this study are Belém, Brazil (lat. 1° 28' S) and Christmas Island in the Line Islands (lat. 1° 51' N).

Dobodura, Papua (lat. 8° 46' S), and Zamboanga, Philippine Islands (lat. 6° 54' N), are examples of slightly more poleward stations with year-round tropical conditions. At each of the four stations, dew points are above 60°F throughout the year; dew points are above 70°F 90 percent of the hours, and are above 80°F for a few observations each year. Extremes of temperatures do not occur in these areas. Temperatures are rarely below 70°F or above 90°F. It is the persistence of moderately high temperatures and high humidities in association with frequent and heavy rain which constitutes the warm humid tropical environment.

b. Anomalous Stations

There are many areas which have the temperature, humidity, and rainfall regimes representative of the humid tropics for most but not all of the year. Accra, Ghana (05° 36' N), is an example of such a station. In "winter" (January) Accra is subject to north winds, referred to as the harmattan, which transport very dry and unseasonably warm air from the Sahara. Dew points between 40° and 60°F associated with temperatures between 85° and 90°F are typical at Accra during harmattan conditions. In other seasons dew points are rarely below 70°F. Another anomaly in the Accra climate is the occurrence of the coolest weather in "summer" (July). Marshall, Liberia, the other Guinea coast station for which data were available, also has a harmattan condition in "winter" and a relatively cool summer. The cool summer conditions at both these stations have been ascribed to the increased cloudiness of that season, and also to the upwelling of cold water in the Gulf of Guinea (11).

The Galapagos Islands, astride the equator west of South America, are in another low-latitude area with anomalous conditions. Temperatures and dew points are normally highest in April and lowest in October. At Salinas, Ecuador, January and April are distinctly warmer and more humid than July and October. The temperature and dew point regimes at both stations are influenced by the upwelling of relatively cold water near the equator from the South American coast to well west of the Galapagos Islands (12). Even during the warmer more humid months at these stations, temperatures and dew points are not as high as would be expected near the equator.

IV. Maps Showing Distribution of Occurrence of High Dew Points*

1. Description and Explanation

Figures 3, 4, and 5 show the monthly variation in the occurrence of high dew points by use of circular graphs overprinted on maps. Each figure has three sections to afford world coverage between latitudes 40° N and 40° S. Section "a" covers Southeastern Asia and Africa; Section "b" includes Southern Europe, Southwestern Asia, and Africa, and Section "c" covers

*These maps are located on pages 185-201.

North and South America. Figure 3 (a, b, and c) shows the monthly frequency of occurrence of dew points of 76°F and higher. Figures 4 and 5 similarly show the frequency of occurrence of dew points of 80°F and higher and 84°F and higher, respectively. The values, 76°, 80°, and 84°F, were dictated partially by the class limits of the data summaries in 2 F° classes. In a few cases, however, the data were summarized with class limits offset 1 F° from the selected limits. For example, at several stations the data were summarized in classes of 75° to 76°F, 77° to 78°F, etc., rather than 76° to 77°F, 78° to 79°F, etc. Because of the inherent limitations in the data, the 1 F° is not considered significant. At a few stations, therefore, dew points equal to or greater than 75°, 79°, and 83°F are shown on the map, even though they are represented as being equal to 76°, 80°, and 84°F.

The use of the circular graphs overprinted on the maps allows presentation of the occurrence of high dew points on both an areal and temporal basis. The frequency of occurrence of dew points $\geq$ 76°, 80°, and 84°F is presented for each month in five frequency classes: no occurrence, occurrence less than 1 percent of the time, occurrence 1 to less than 5 percent of the time, occurrence 5 to less than 10 percent of the time, and occurrence 10 or more percent of the time. These circular graphs are included for a total of 215 stations in the three sections of each figure. Most of the stations for which data were presented are at elevations below 1,000 feet. The maps, therefore, are not representative of highland conditions. In evaluating the dew point regimes, it is important to know the elevation of the higher stations. Therefore, the elevations of stations above 1,000 feet are indicated on the station location map included on the back of each map. There is a brief explanation of the maps, including an example of the interpretation of a sample circular graph on the page preceding the nine maps.

2. Severity of Dew Points Mapped

The values mapped in Figures 3, 4, and 5 were also selected to represent three degrees of severity of the occurrence of high dew points from a physiological point of view. It is convenient to consider a simple temperature-vapor pressure index referred to as "humiture" developed by Lally and Watson (13) to illustrate and physiological severity of dew points of 76°, 80°, and 84°F*. According to Lally and Watson, an index

---

*According to the Lally and Watson index:
h = T-h where H = humiture, T = temperature (°F) and h = e-10 where e is the vapor pressure in millibars. A dew point of 76°F is approximately equivalent to a vapor pressure of 31 millibars; a dew point of 80°F is approximately equivalent to a vapor pressure of 35 millibars; and a dew point of 84°F is approximately equivalent to a vapor pressure of 40 millibars.

of 100 is uncomfortable and an index of 115 is too severe for unrestricted labor.

Applying the humiture equation and information in the footnote, the humiture resulting from a dew point of 76°F concurrent with a temperature of 76°F is 97 - very close to the level for discomfort. If the temperature is higher concurrent with a dew point of 76°F, the level of discomfort is reached. A dew point of 80°F concurrent with a temperature of 80°F results in a humiture of 105 - a severe condition. A dew point of 84°F concurrent with a temperature of 84°F results in a humiture of 114, which is near the point where labor must be restricted. Higher temperatures with these dew points result in correspondingly high humitures.

Any comfort index which ignores consideration of radiation and air movement is incomplete. Nevertheless, the Lally-Watson index helps illustrate the relative severity of dew points of 76°, 80°, and 84°F.

3. Monthly Occurrence of Dew Points of 76°F and Higher

a. Figure 3a, Southeastern Asia and Australia

Dew points of 76°F or higher occur relatively frequently in most low-latitude areas. There are more low-latitude stations depicted on the Southeastern Asia and Australia map (Fig. 3a) than on the other maps, and correspondingly, there are more stations with year-round or near year-round occurrence of dew points of 76°F or higher more than 10 percent of the time on this map. In Figure 3a there is only one station between latitudes 15° N and 15° S which does not have an appreciable occurrence of dew points of 76°F or higher most of the year. The exception is Bangalore, India, at an elevation of more than 3,000 feet. The lower dew points at Bangalore are directly attributable to the higher elevation.

The decrease in the number of months subject to the occurrence of dew points of 76°F or higher with increasing latitude is apparent in Figure 3a. In the Northern Hemisphere, dew points of 76°F or higher are experienced during one to four summer months at stations north of 30° N, but the Southern Hemisphere stations in southern Australia rarely experience dew points at this level in any month.

b. Figure 3b, Southern Europe, Africa, and Southwestern Asia

The pattern of occurrence of dew points of 76°F or higher in southern Europe, Africa, and Southwestern Asia indicates a diversity of regimes not evident on the Southeastern Asia and Australia map. This is partly due to the lack of data for equatorial Africa, where, at low elevations, dew points of 76°F or higher 10 percent of the time would be expected

to occur in most months of the year. The diversity of humidity regimes is also the result of the increase in continental effects in this area.

The anomalous dew point and temperature regimes on the Guinea coast have been discussed in Section III.5.b where seasonal variations in the dew point of Accra (Ghana) and Marshall (Liberia) are ascribed to upwelling of cold water near the coast. These two stations north of the equator have a seasonal distribution of the occurrence of dew points of 76°F or higher, which is typical of stations in the Southern Hemisphere. Farther west and north, along the west coast of Africa, the tendency for higher dew points during the period of low sun is reversed, and the more normal high sun occurrence of high dew points is found. Bolama, Portuguese Guinea, experiences a 6-month season with dew points of 76°F or higher more than 10 percent of the time, and Dakar, Senegal, farther west and north, has this condition for 3 months.

Dew points of 76°F or higher occur only in summer at stations north of 30° N. There are no stations in the Southern Hemisphere south of 30° S, but the expected southward decrease in the length of the season subject to high dew points at four stations on the east coast of Africa is a good indication that dew points higher than 76°F are rare south of latitude 30° S.

In the limited periods of record available for this study, some Saharan stations never experienced dew points as high as 76°F, and only one interior station in northern Africa (Maiduguri, Nigeria) had a month with a dew point of 76°F or higher more than 5 percent of the time. It seems likely that almost any hot desert station might experience very high dew points for a short period of time after a rainshower, when the moisture is evaporating from the hot surface. Much of Africa between the Sahara and the equatorial rainforests is seasonally subjected to high humidities; Maiduguri (Nigeria) is the only station available for this study which portrays this situation.

Dew points of 76°F or higher occur more than 10 percent of the time during a 2- to 5-month period at coastal stations of the Arabian Peninsula, Iran, West Pakistan, and India. In these areas dew points inland from the warm coastal waters are lower.

c. Figure 3c, North and South America

There are not enough data for South America south of the equator to adequately show the occurrence of dew points of 76°F or higher. Most of the Amazon Basin, for example, would be expected to have dew points of 76°F or higher more than 10 percent of the time in most (if not all) months.

The data base for the Caribbean and the United States, and Central America are adequate to delimit the occurrence of dew points of 76°F or

higher, but more data are needed for Mexico to define the area of occurrence of high dew points. The stations in the Americas which exhibit frequent occurrence of dew points of 76°F or higher most of the year, are located on the north and northeast coast of South America, in the Amazon Basin, and in Central America. Belem (Brazil) and Coco Solo (Panama) are two examples. Undoubtedly, there are areas for which data are not available which would have a consistent occurrence of high dew points.

The lag in season of highest dew points in the Caribbean and the infrequent occurrence of high dew points near the equator on the west coast of South America and westward beyond the Galapagos Islands have been discussed. These features are apparent in Figure 3c.

Stations on the Gulf and Atlantic coasts of the United States as far north as Charleston (South Carolina) experience dew points of 76°F or higher over 10 percent of the time from June through September, and Burrwood, Louisiana, has dew points of 76°F or higher over 10 percent of the time through October. Dew points of 76°F or higher are rare west of the 100th meridian. This is partly a consequence of higher elevations in the west and partly because the source of water vapor for much of the United States in summer is south and east of the continent. Relatively low stations in the west such as Sacramento or Monterey, California, did not experience dew points as high as 76°F during their periods of record because they are far removed from the primary source of water vapor.

4. Monthly Occurrence of Dew Points of 80°F and Higher (Fig. 4)

Most lowland stations for which data were available for this report have experienced dew points of 80°F or higher, but frequent occurrence of dew points at this level is restricted to a relatively few stations. Only 24 of the 215 stations for which data were available had dew points of 80°F or higher 5 or more percent of the time in at least one month. Sixteen of these 24 stations are in southeastern Asia, or the islands north of Australia. There are two stations in North America (Puerto Penasco, Mexico, and Burrwood, Louisiana), and one station in South America (Buenaventura, Colombia). Four of the remaining five stations are on the coast of the Arabian Peninsula, and one station (Karachi) is near the West Pakistan coast of the Arabian Sea.

5. Monthly Occurrence of Dew Points of 84°F and Higher (Fig. 5)

Between one third and one half of the 215 stations on the three maps which comprise Figure 5 have experienced dew points of 84°F or higher. Dhahran (Saudi Arabia) and Puerto Penasco (Mexico) are the only stations, however, with records of dew points of 84°F or higher more than 5 percent

of the time in any month*. There are 10 additional stations (all on Fig. 5a) which experience dew points of 84°F or higher more than 1 percent of the time in at least one month.

V. Summary

This report makes available additional information on the areal and temporal distribution of the occurrence of high humidities. Tables and complementing graphs are included with information on the joint occurrence of high dew points and high temperatures. The report supplements 3 recent studies of humidity distributions. From the maps, graphs, and tables included it is apparent that few simple generalizations can be made concerning so complex an element as humidity. The data in this report of Abadan (Iran) and Dhahran (Saudi Arabia) substantiate the occurrence of very high dew points on the desertic Persian Gulf coast. One station on the northern Gulf of California coast (Puerto Penasco), also desertic, experiences comparatively high dew points in the summer months. In these coastal areas the occurrences of high dew points is the result of proximity to very warm bodies of water.

The coastal desert stations mentioned above most frequently experience dew points of 84°F or higher, but it is apparent from perusal of the maps in this report that many lowland stations have infrequently (less than 1 percent of the time in any month) experienced dew points as high as 80°F.

As would be expected, the season of possible occurrence of relatively high dew points (76°F or higher) is longest at low latitudes and decreases with increasing latitude. Higher latitude stations, such as Washington, Nanking, or Tokyo experience relatively high dew points more than 1 percent of the time only in two or three summer months. Variations from this pattern occur in some low-latitude areas, however, with anomalous seasonality in the expectancy of occurrence of high dew points.

---

*Recently available data furnished by the National Weather Records Center indicate that very high dew points occurred in the Red Sea littoral. Assab and nearby Ras Andahglie on the Red Sea coast of Eritrea (Ethiopia) had <u>average</u> afternoon dew points higher than 84°F. Jidda (Saudi Arabia) experienced dew points above 84°F 1 percent of the hours in August in a 5-year record.

REFERENCES*

1. Dodd, Arthur V. Simultaneous occurrence of high temperatures and high dew points, Tech rpt 66-55-ES. U.S. Army Natick Labs, Natick, Mass., June 1966.

2. Gringorten, I. I., et al. Atmospheric humidity atlas - Northern Hemisphere, AFCRL-66-621. Air Force surveys in geophysics No. 186. Air Force Cambridge Res Labs, Office of Aerospace Res, U.S.A.F., Bedford, Mass., Aug 1966.

3. Landsberg, H. E. Die mittlere Wasserdampfferteilung auf der Erde, Meteorologische Rundschau 17(4): 102-103. (1964)

4. National Weather Records Center. Unpublished summaries of temperature versus dew point for low-latitude stations. Asheville, N. C. [1968]. (Available in files of Earth Sciences Lab, Natick Labs, Natick, Mass.)

5. Misho, James (Proj. Mgr.). Climatic frequencies for low-latitude stations, U.S. Army Contract No. DA19-129-QM-1971, by C-E-I-R, Inc., Cambridge, Mass. (Climatic tabulations available in files of the Earth Sciences Lab, U.S. Army Natick Labs, Natick, Mass.)

6. U.S. Air Force, Air Weather Service Climatic Center, Data Control Div. Temperature - dew point - wind summaries. Asheville, N. C.

7. U.S. Air Force, Air Weather Service Climatic Center, Data Control Unit. Part E (psychrometric summary). Asheville, N. C.

8. Reitan, C. H. and C. Green. Inventory of research on weather and climate of desert environments, U.S. Army Contract DA49-092-ARO-71, Office of Arid Lands Res, Univ Ariz, Tucson, 1967.

9. Vogel, Harvey (Program Mgr.). An inventory of geographic research of the humid tropic environment, vol 2: compendium and appendices, chap IV, weather and climate, U.S. Army Contract No. DA49-092-ARO-33, by Texas Instruments, Inc., Dallas, Texas, Dec 1966.

10. Dodd, Arthur V. Areal distribution and diurnal variation of water vapor near the ground in the contiguous United States, Tech rpt ES-17. U.S. Army Natick Labs, Natick, Mass., Nov 1965.

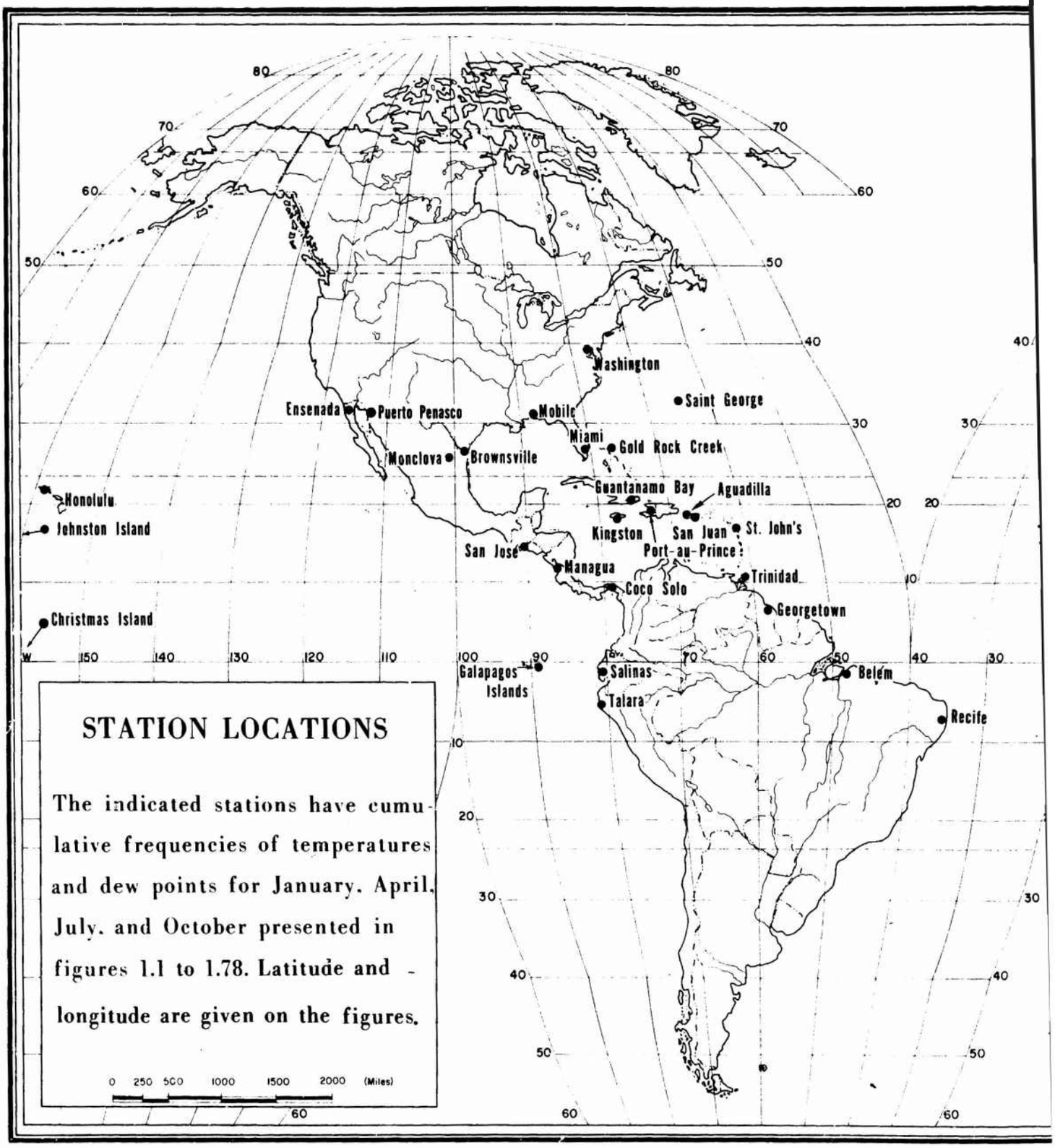
---

*References used in the Appendix are listed separately at the end of the Appendix.

11. Trewartha, Glenn. The earth's problem climates, chap 7. Univ Wis Press, Madison, 1961.

12. Palmer, C. E., and R. L. Pyle. The climatological setting of the Galapagos, In: The Galapagos Proceedings of the Symposia of the Galapagos. Univ Calif Press, Los Angeles, 1966.

13. Lally, V. E., and B. F. Watson. Humiture revisited. Weatherwise 13(6): 254-256. (Dec 1960)


Washington
Saint George
Ensenada
Puerto Penasco
Mobile
Miami
Gold Rock Creek
Monclova
Brownsville
Guantanamo Bay
Aguadilla
Honolulu
Johnston Island
Kingston
San Juan
St. John's
San Jose
Port-au-Prince
Managua
Trinidad
Coco Solo
Georgetown
Christmas Island
Galapagos Islands
Salinas
Belem
Talara
Recife
STATION LOCATIONS
The indicated stations have cumulative frequencies of temperatures and dew points for January, April, July, and October presented in figures 1.1 to 1.78. Latitude and longitude are given on the figures.
0 250 500 1000 1500 2000 (Miles)

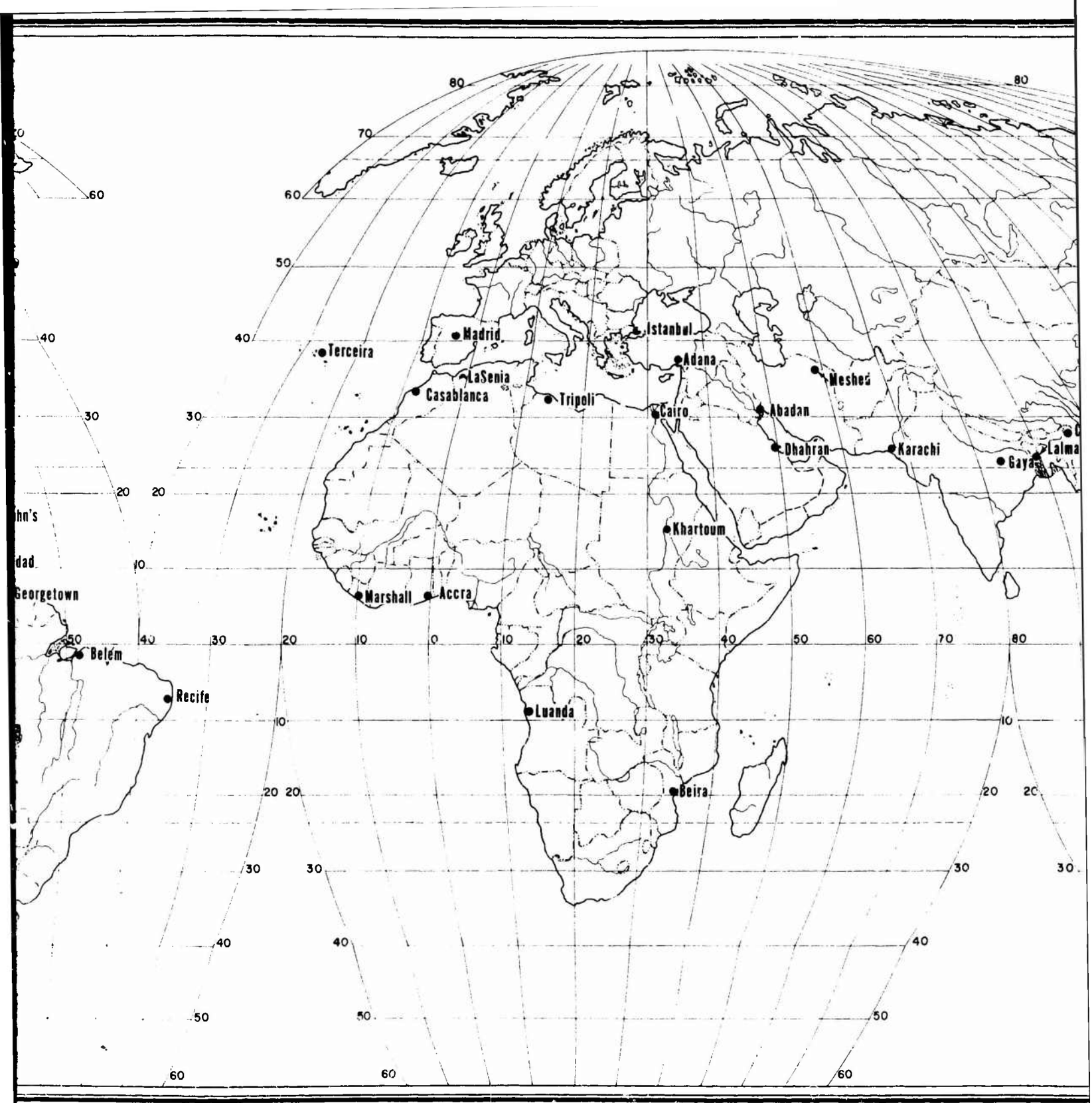
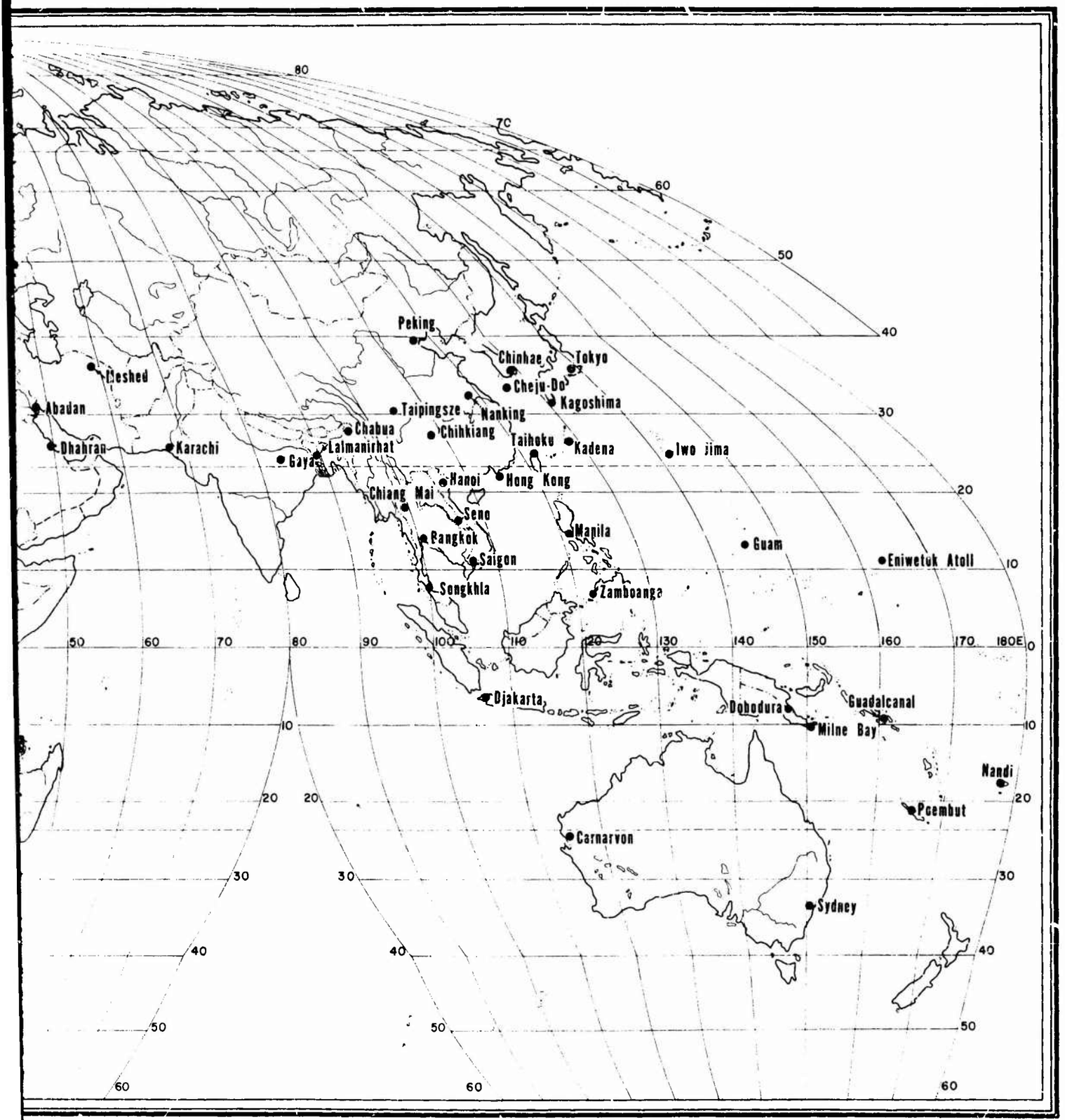

Terceira
Madrid
Istanbul
Adana
Meshed
LaSenia
Casablanca
Tripoli
Cairo
Abadan
Dhahran
Karachi
Gaya
Khartoum
Marshall
Accra
Georgetown
Belem
Recife
Luanda
Beira

Figure 1.0


Peking
Chinhae
Tokyo
Cheju-Do
Kagoshima
Meshed
Abadan
Taipingsze
Nanking
Chabua
Chihkiang
Taihoku
Kadena
Iwo Jima
Dhahran
Karachi
Lalmanirhat
Gaya
Hanoi
Hong Kong
Chiang Mai
Seno
Manila
Guam
Eniwetok Atoll
Bangkok
Saigon
Songkhla
Zamboanga
Djakarta
Dobodura
Guadalcanal
Milne Bay
Nandi
Pcembut
Carnarvon
Sydney
80
70
60
50
40
30
20
10
0
50
60
70
80
90
100
110
120
130
140
150
160
170
180E

GRAPHS AND RELATED TABLES (78 STATIONS)*

SHOWING CUMULATIVE FREQUENCIES AND JOINT OCCURRENCES

OF DEW POINTS AND TEMPERATURES DURING MIDSEASON MONTHS

*Stations are listed alphabetically on pp. vi-ix; their locations are shown on Figure 1.0, p. 21.

ABADAN, IRAN

CUMULATIVE FREQUENCIES OF TEMPERATURES AND DEW POINTS

January, April, July, October

30°20' N 48°18' E Elevation 10 feet

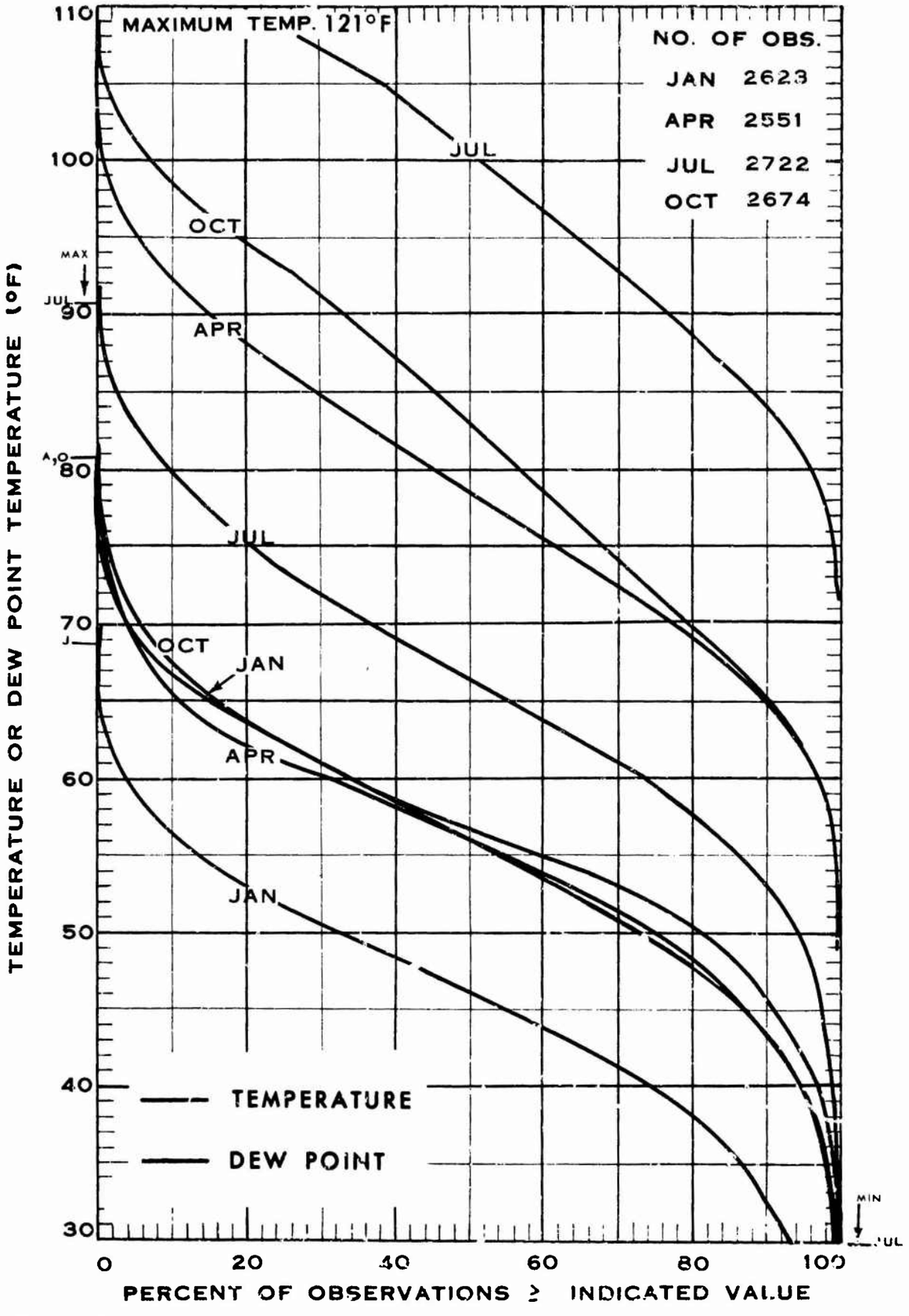


Figure 1.1

ABADAN, IRAN

TEMPERATURE-DEW POINT RELATIONSHIPS FOR DEW POINTS ≥ 76°F

MONTH	DEW POINT CLASS	TEMPERATURE CLASS			NUMBER OF OBSERVATIONS
		LOWEST	MEDIAN	HIGHEST	
JAN	None				
(2623)*					
APR	76/77	83/84	97/98	101/102	15
(2551)*	78/79	95/96		101/102	6
	80/81	97/98		101/102	3
JUL	76/77	83/84	105/106	119/120	118
(2722)*	78/79	81/82	107/108	119/120	140
	80/81	81/82	107/108	117/118	89
	82/83	83/84	99/100	119/120	63
	84/85	85/86	97/98	119/120	60
	86/87	87/88	105/106	115/116	27
	88/89	89/90	101/102	115/116	22
	90/91	95/96		105/106	9
OCT	76/77	75/76	85/86	103/104	18
(2674)*	78/79	79/80		103/104	8
	80/81	85/86		87/88	2

*Total number of observations in indicated month.

#Month(s) with most frequent occurrence of high dew points - JUL, AUG.

ACCRA, GHANA

CUMULATIVE FREQUENCIES OF TEMPERATURES AND DEW POINTS

January, April, July, October

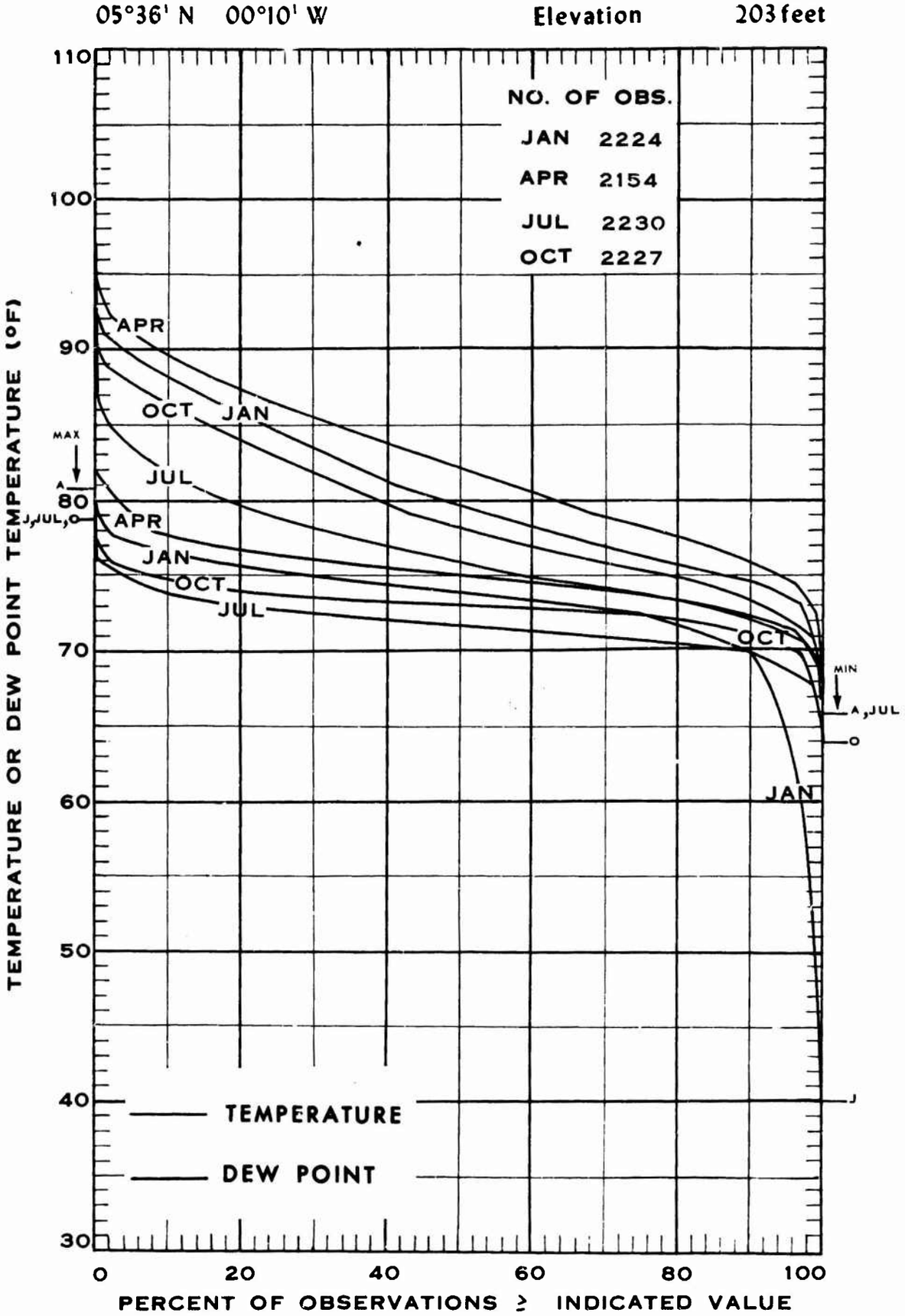


Figure 1.2

ACCRA, GHANA

TEMPERATURE-DEW POINT RELATIONSHIPS FOR DEW POINTS ≥ 76°F#

MONTH	DEW POINT CLASS	TEMPERATURE CLASS			NUMBER OF OBSERVATIONS
		LOWEST	MEDIAN	HIGHEST	
JAN	76/77	75/76	79/80	89/90	378
(2224)*	78/79	77/78	81/82	87/88	63
APR	76/77	75/76	81/82	93/94	580
(2154)*	78/79	77/78	83/84	93/94	170
	80/81	81/82		89/90	7
JUL	76/77	79/80		85/86	5
(2230)*	78/79		85/86		1
OCT	76/77	75/76	79/80	87/88	51
(2227)*	78/79	79/80		83/84	4

* Total number of observations in indicated month.

Month(s) with most frequent occurrence of high dew points - MAR, APR.

ADANA, TURKEY

CUMULATIVE FREQUENCIES OF TEMPERATURES AND DEW POINTS

January, April, July, October

36°59'N 35°18'E Elevation 254 feet

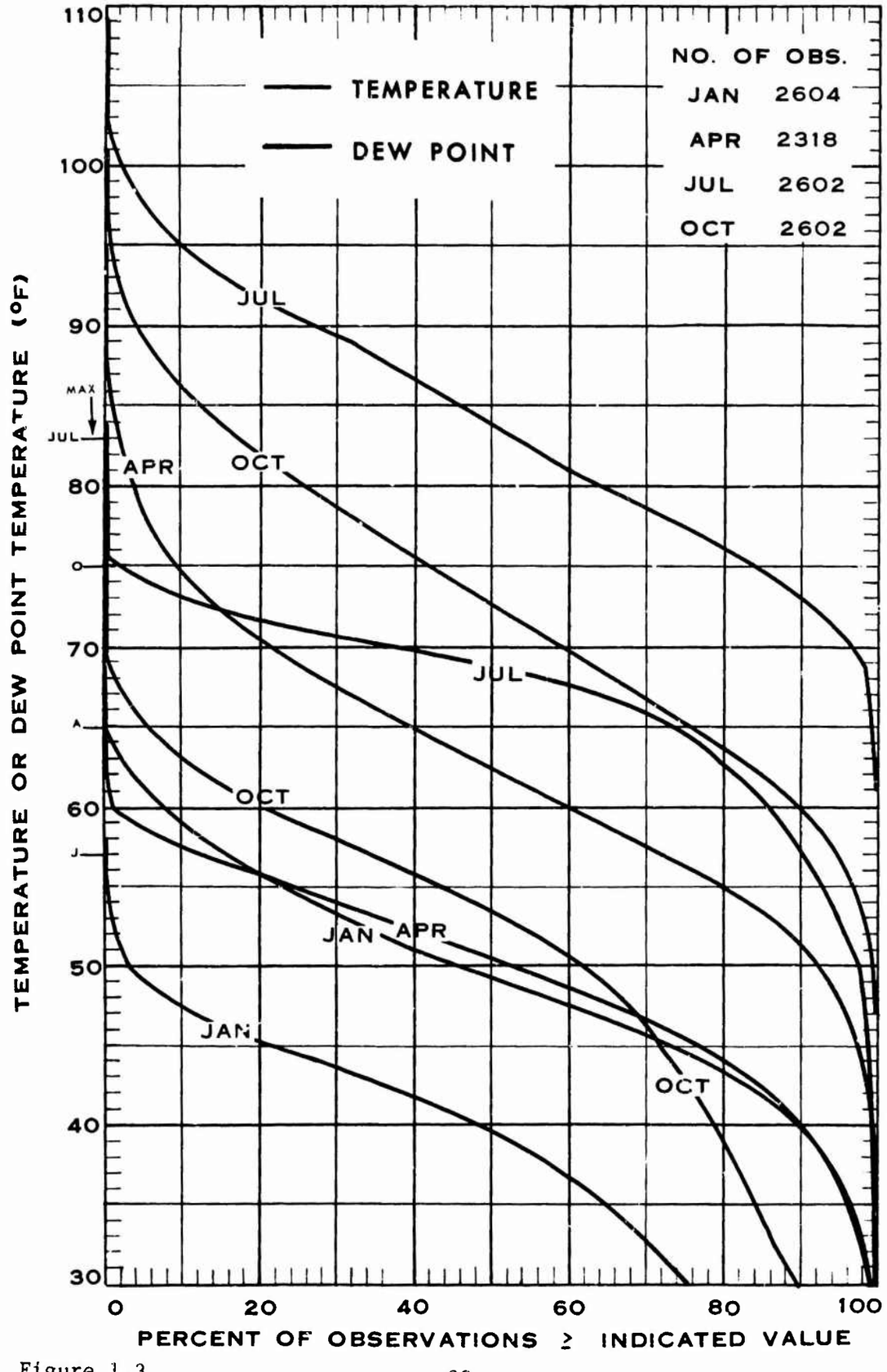


Figure 1.3

ADANA, TURKEY

TEMPERATURE-DEW POINT RELATIONSHIPS FOR DEW POINTS ≥ 76°F#

MONTH	DEW POINT CLASS	TEMPERATURE CLASS			NUMBER OF OBSERVATIONS
		LOWEST	MEDIAN	HIGHEST	
JAN	None				
(2604)*					
APR	None				
(2318)*					
JUL	76/77	81/82		89/90	3
(2602)*	80/81		89/90		1
	82/83		89/90		1
OCT	None				
(2602)*					

*Total number of observations in indicated month.

#Month(s) with most frequent occurrence of high dew points - AUG.

AGUADILLA, PUERTO RICO

CUMULATIVE FREQUENCIES OF TEMPERATURES AND DEW POINTS

January, April, July, October

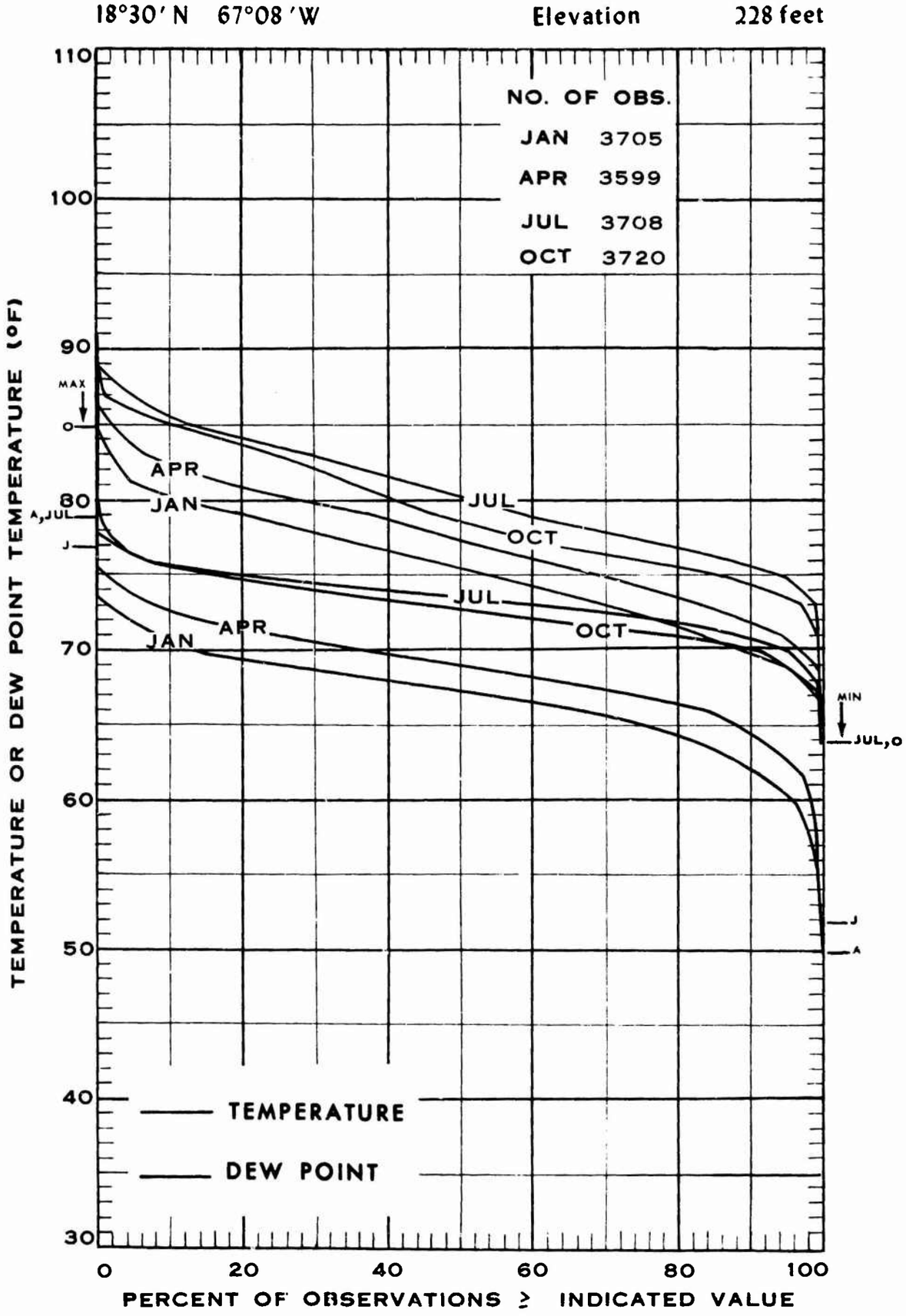


Figure 1.4

AGUADILLA, PUERTO RICO

TEMPERATURE-DEW POINT RELATIONSHIPS FOR DEW POINTS ≥ 76°F#

MONTH	DEW POINT CLASS	TEMPERATURE CLASS			NUMBER OF OBSERVATIONS
		LOWEST	MEDIAN	HIGHEST	
JAN	76/77		79/80		1
(3705)*					
APR	76/77	75/76	81/82	85/86	15
(3599)*					
JUL	76/77	75/76	83/84	87/88	300
(3708)*	78/79	77/78	83/84	87/88	30
OCT	76/77	77/78	83/84	89/90	202
(3720)*	78/79	79/80	84/85	89/90	51
	80/81	83/84		85/86	9
	82/83	85/86		87/88	4
	84/85		85/86		1

*Total number of observations in indicated month.

#Month(s) with most frequent occurrence of high dew points - AUG, SEP.

BANGKOK, THAILAND

CUMULATIVE FREQUENCIES OF TEMPERATURES AND DEW POINTS

January, April, July, October

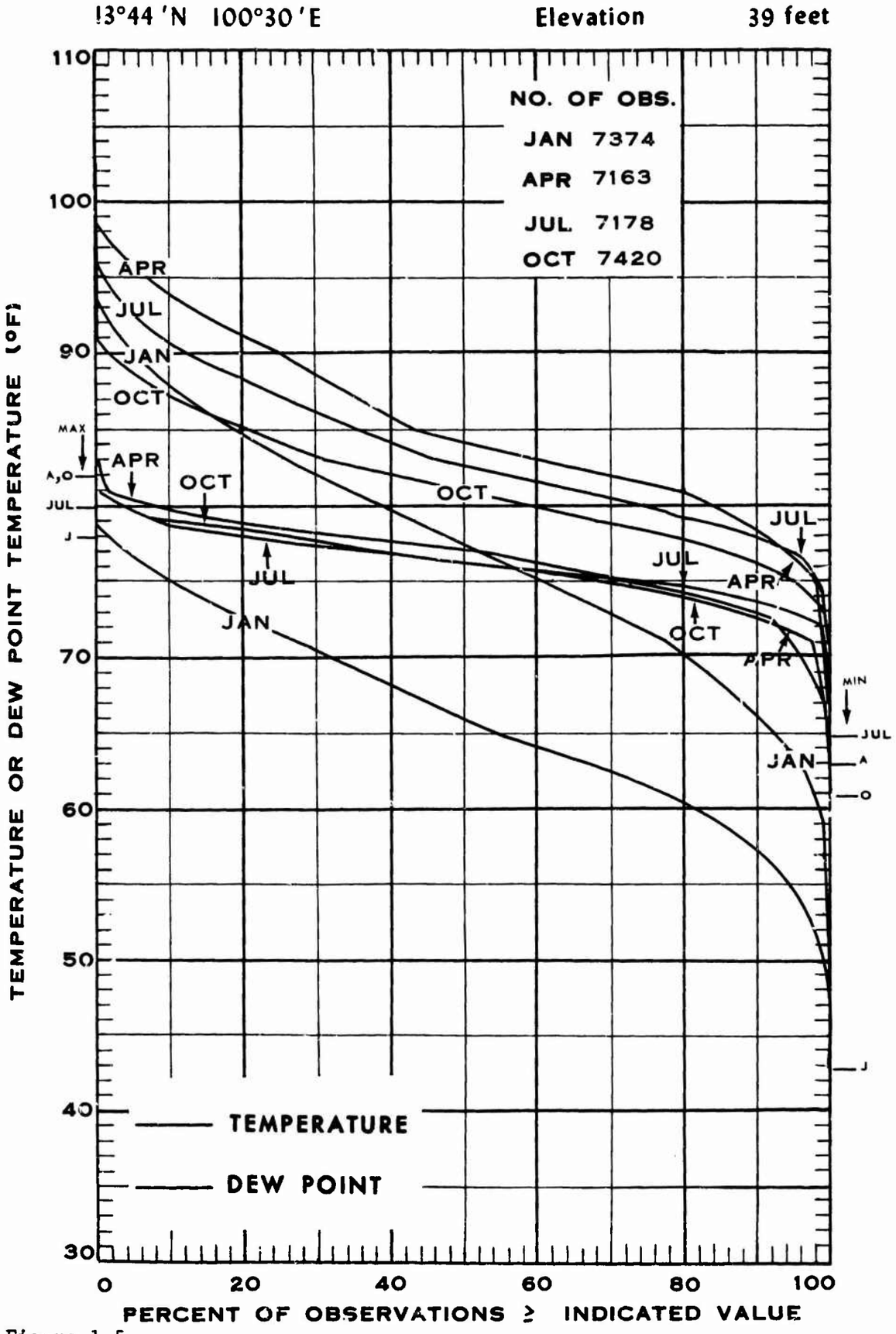


Figure 1.5

BANGKOK, THAILAND

TEMPERATURE-DEW POINT RELATIONSHIPS FOR DEW POINTS ≥ 76°F#

MONTH	DEW POINT CLASS	TEMPERATURE CLASS			NUMBER OF OBSERVATIONS
		LOWEST	MEDIAN	HIGHEST	
JAN	76/77	75/76	81/82	85/86	80
(959)*	78/79	81/82		85/86	9
	80/81		89/90		2
APR	76/77	75/76	81/82	97/98	198
(924)*	78/79	77/78	83/84	97/98	65
	80/81	79/80		87/88	6
	84/85		85/86		1
JUL	76/77	75/76	79/80	93/94	254
(896)*	78/79	77/78	83/84	91/92	50
	80/81		89/90		1
OCT	76/77	75/76	81/82	91/92	303
(1051)*	78/79	77/78	83/84	91/92	87
	80/81	81/82		85/86	6
	82/83		85/86		1

*Total number of observations in indicated month.

#Month(s) with most frequent occurrence of high dew points - SEP, OCT.

BEIRA, MOZAMBIQUE
CUMULATIVE FREQUENCIES OF TEMPERATURES AND DEW POINTS
January, April, July, October

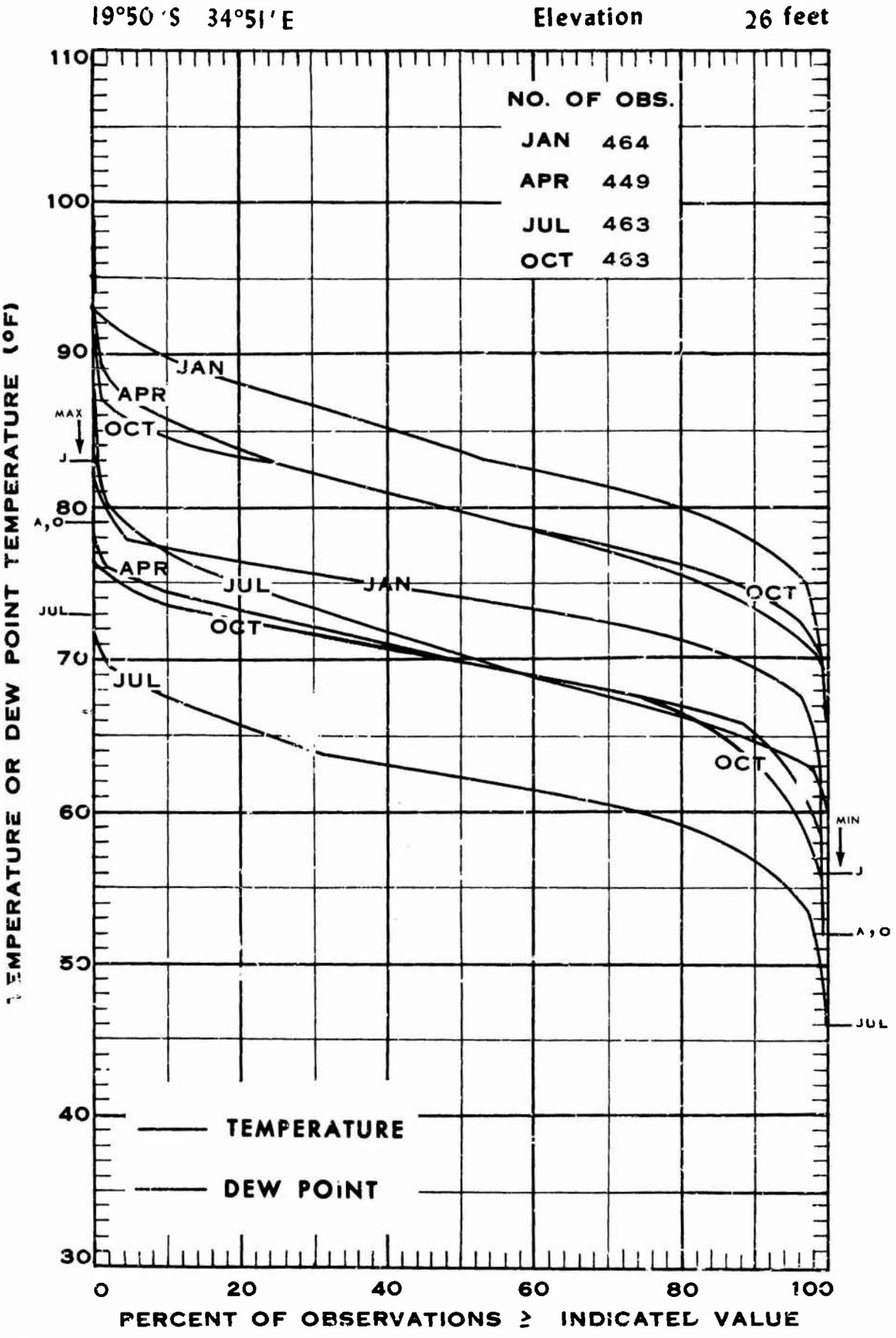


Figure 1.6

BEIRA, MOZAMBIQUE

TEMPERATURE-DEW POINT RELATIONSHIPS FOR DEW POINTS ≥ 76°F#

MONTH	DEW POINT CLASS	TEMPERATURE CLASS			NUMBER OF OBSERVATIONS
		LOWEST	MEDIAN	HIGHEST	
JAN	76/77	77/78	83/84	95/96	93
(464)*	78/79	81/82	89/90	91/92	22
	80/81	89/90		91/92	4
	82/83		89/90		
APR	76/77	77/88		87/88	10
(449)*	78/79	85/86		87/88	2
JUL	None				
(468)*					
OCT	76/77	77/78		83/84	8
(463)*	78/79		83/84		1

*Total number of observations in indicated month.

#Month(s) with most frequent occurrence of high dew points - FEB.

BELÉM, BRAZIL

CUMULATIVE FREQUENCIES OF TEMPERATURES AND DEW POINTS

January, April, July, October

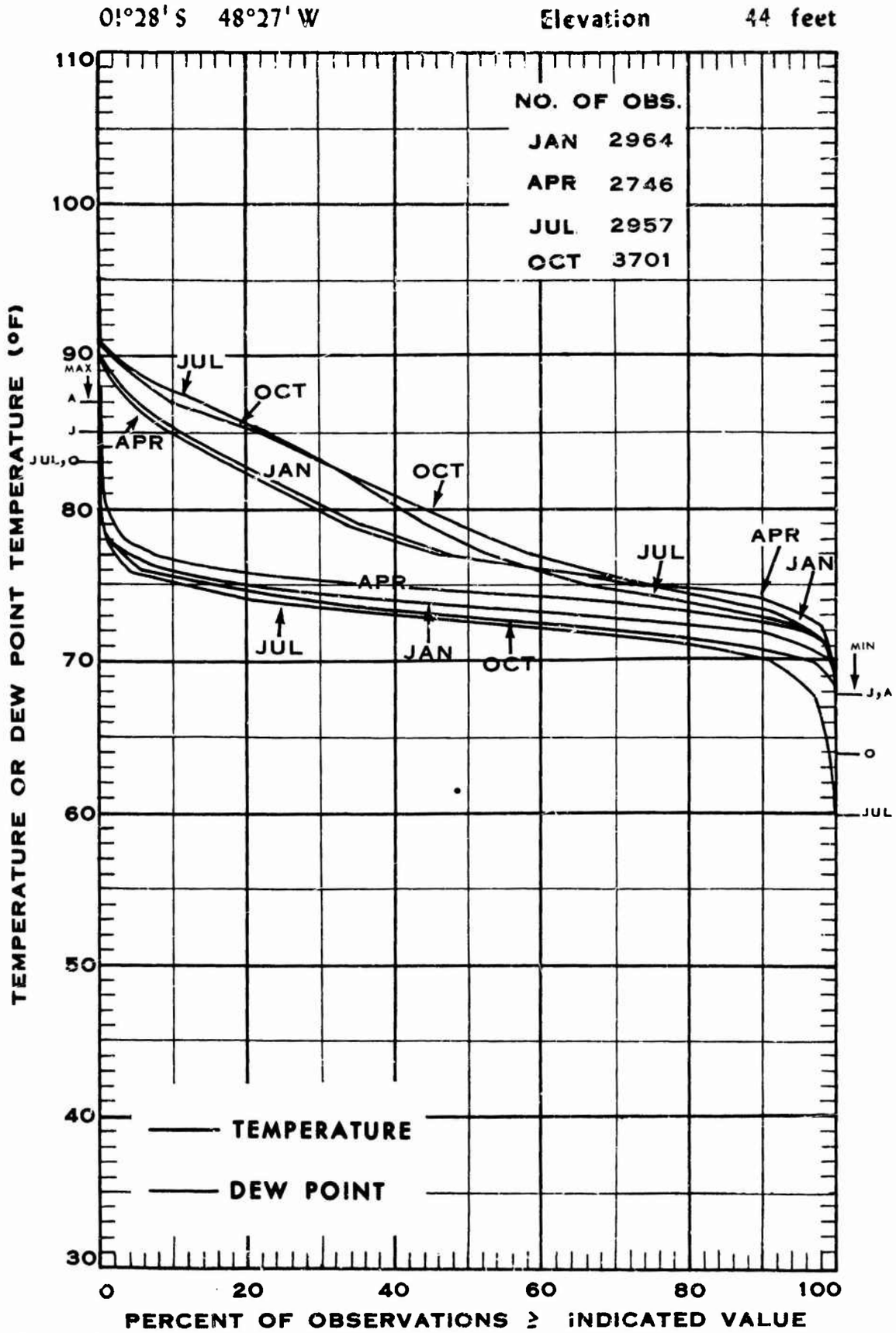


Figure 1.7

BELÉM, BRAZIL

TEMPERATURE-DEW POINT RELATIONSHIPS FOR DEW POINTS ≥ 76°F#

MONTH	DEW POINT CLASS	TEMPERATURE CLASS			NUMBER OF OBSERVATIONS
		LOWEST	MEDIAN	HIGHEST	
JAN	76/77	75/76	81/82	91/92	274
(2964)*	78/79	79/80	83/84	89/90	30
	80/81	81/82		91/92	3
	82/83		91/92		2
	84/85		89/90		1
APR	76/77	75/76	79/80	89/90	425
(2746)*	78/79	77/78	83/84	91/92	64
	80/81	79/80	85/86	87/88	18
	82/83	83/84		87/88	4
	84/85	85/86		89/90	4
	86/87		87/88		1
JUL	76/77	75/76	83/84	87/88	90
(2957)*	78/79	79/80	85/86	89/90	25
	80/81	81/82		83/84	3
	82/83		85/86		1
OCT	77/78	75/76	83/84	89/90	203
(3701)*	78/79				

* Total number of observations in indicated month.

Month(s) with most frequent occurrence of high dew points - APR.

BROWNSVILLE, TEXAS
CUMULATIVE FREQUENCIES OF TEMPERATURES AND DEW POINTS
January, April, July, October

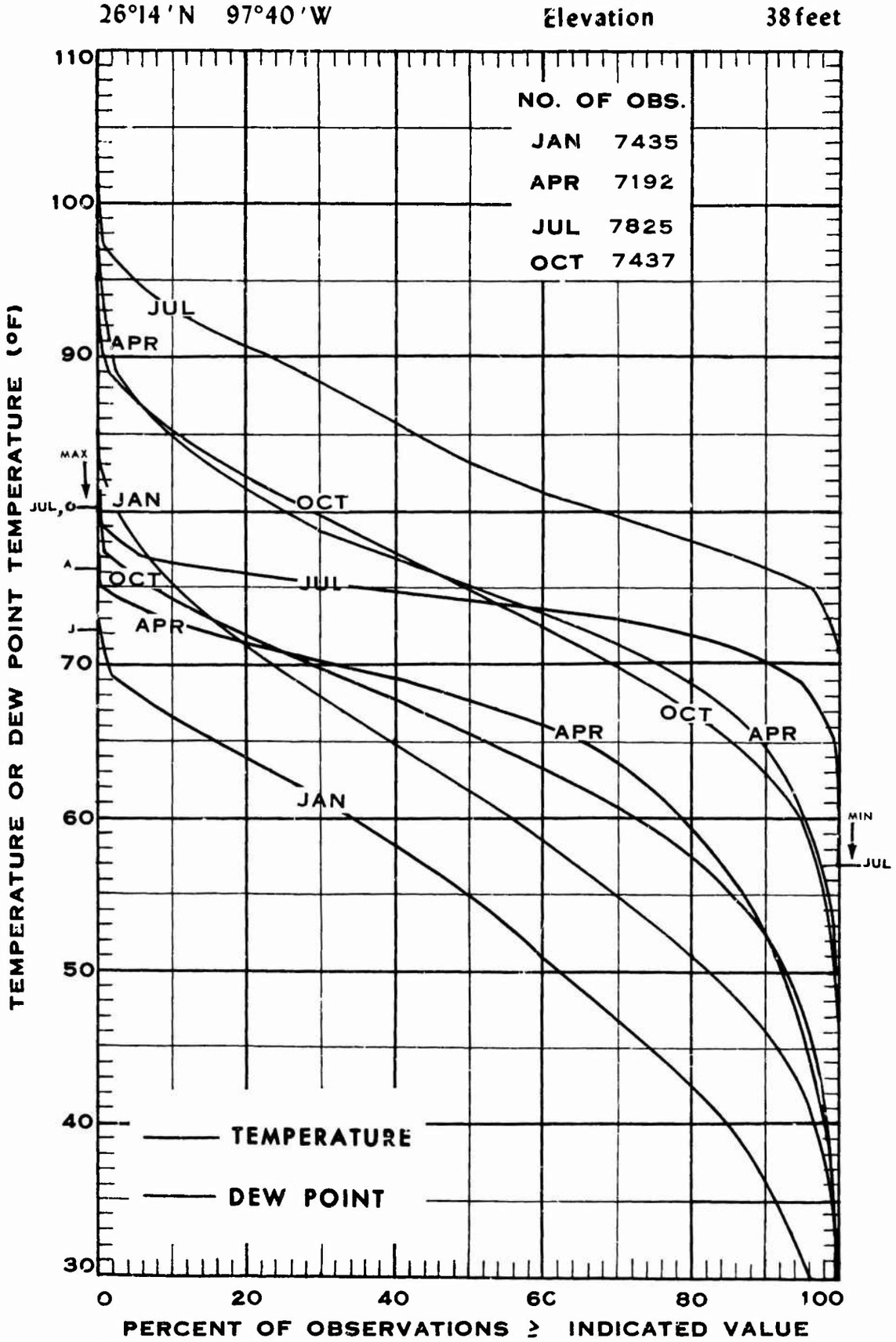


Figure 1.8

BROWNSVILLE, TEXAS

TEMPERATURE-DEW POINT RELATIONSHIPS FOR DEW POINTS ≥ 76°F

MONTH	DEW POINT CLASS	TEMPERATURE CLASS			NUMBER OF OBSERVATIONS
		LOWEST	MEDIAN	HIGHEST	
JAN	None				
(7435)*					
APR	None				
(7192)*					
JUL	None				
(7825)*					
OCT	None				
(7437)*					

*Total number of observations in indicated mon

#Month(s) with most frequent occurrence of high dew points - JUL, AUG.

CAIRO, EGYPT
CUMULATIVE FREQUENCIES OF TEMPERATURES AND DEW POINTS
January, April, July, October

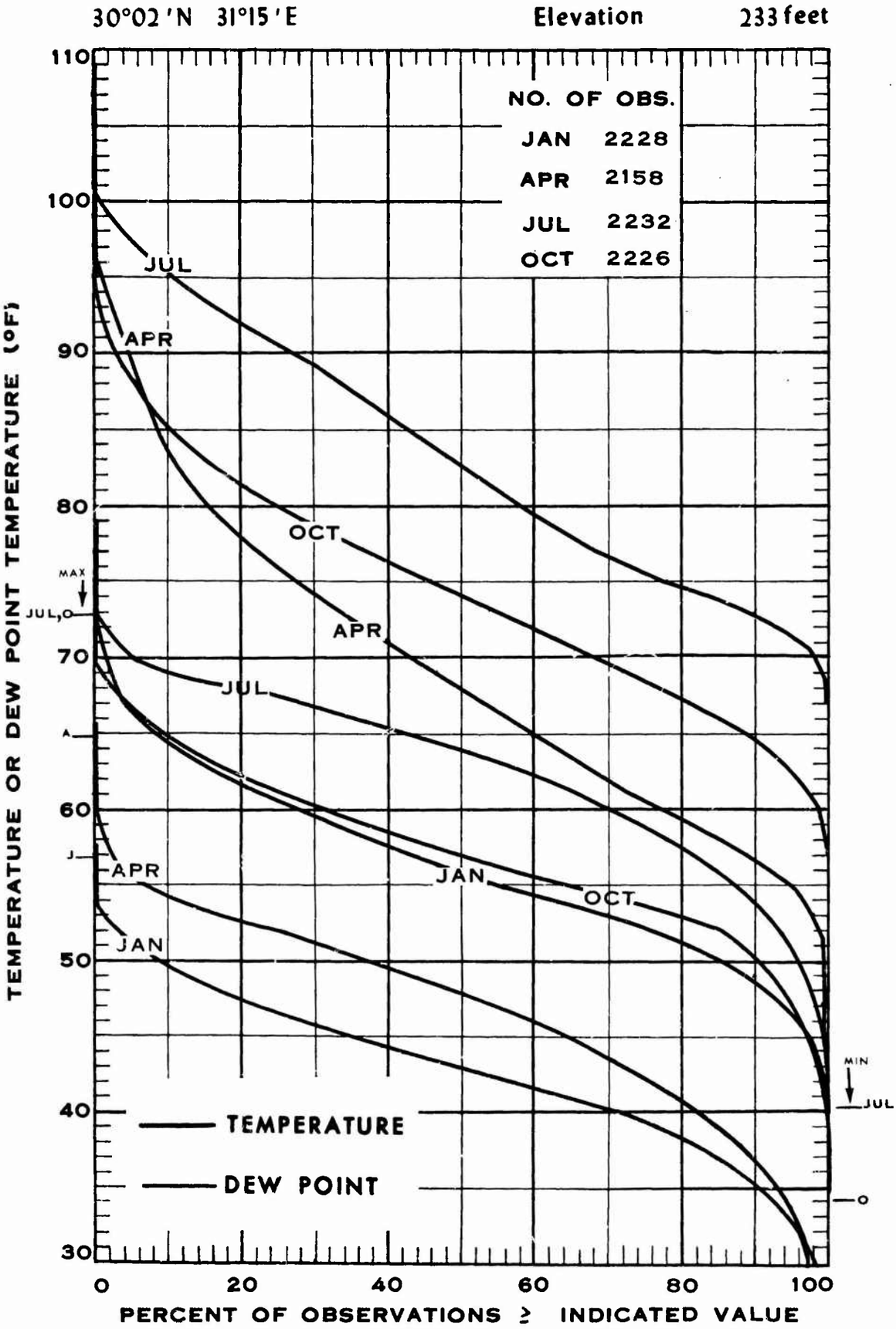


Figure 1.9

CAIRO, EGYPT

TEMPERATURE-DEW POINT RELATIONSHIPS FOR DEW POINTS ≥ 76°F#

MONTH	DEW POINT CLASS	TEMPERATURE CLASS			NUMBER OF OBSERVATIONS
		LOWEST	MEDIAN	HIGHEST	
JAN	None				
(2228)*					
APR	None				
(2158)*					
JUL	None				
(2232)*					
OCT	None				
(2226)*					

*Total number of observations in indicated month.

#Month(s) with most frequent occurrence of high dew points - JUL, AUG.

CARNARVON, AUSTRALIA
CUMULATIVE FREQUENCIES OF TEMPERATURES AND DEW POINTS
January, April, July, October

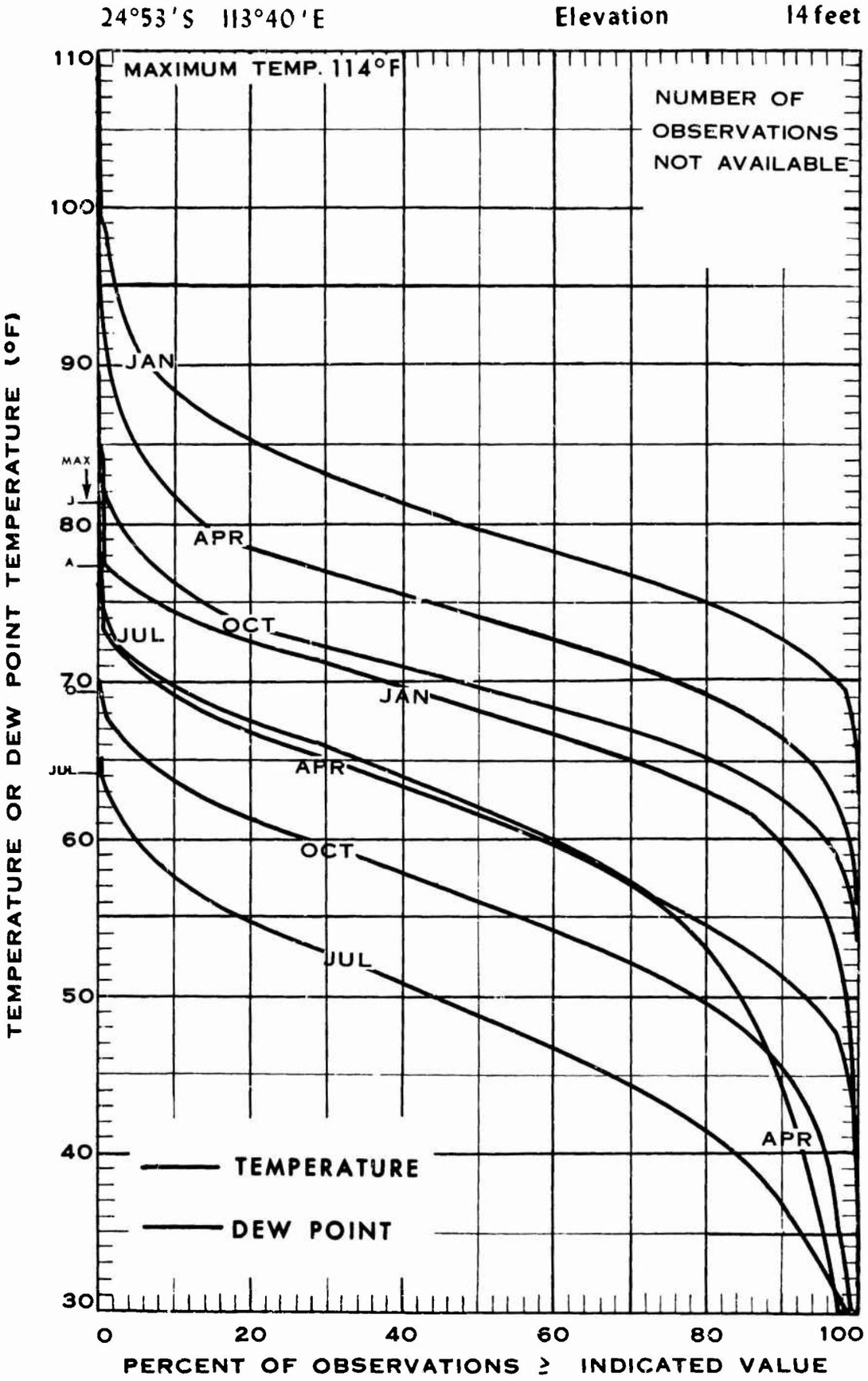


Figure 1.10

CARNARVON, AUSTRALIA

TEMPERATURE-DEW POINT RELATIONSHIPS FOR DEW POINTS ≥ 75°F

MONTH	DEW POINT CLASS	TEMPERATURE CLASS			PERCENT OF OBSERVATIONS
		LOWEST	MEDIAN	HIGHEST	
JAN	75/76	78/79	80/81	90/91	5.1
( )*	77/78	80/81		84/85	0.9
	81/82		92/93		0.1
APR	75/76		83/84		0.1
	77/78		69/70		0.1
JUL	None				
OCT	None				

*Number of observations not available.

#Month(s) with most frequent occurrence of high dew points - JAN, FEB.

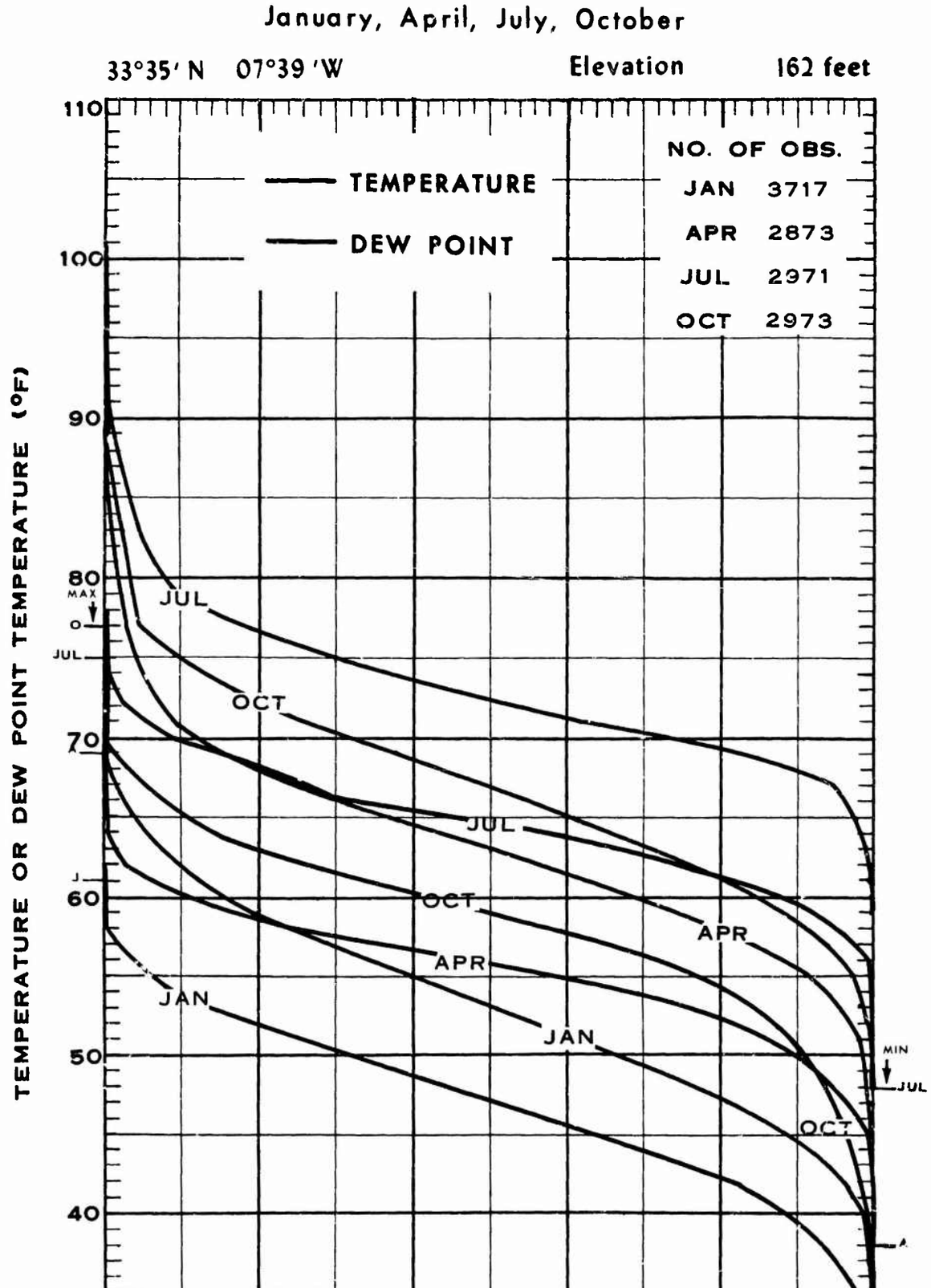

CASABLANCA, MOROCCO
CUMULATIVE FREQUENCIES OF TEMPERATURES AND DEW POINTS
January, April, July, October
33°35' N 07°39 'W
Elevation 162 feet
TEMPERATURE
DEW POINT
NO. OF OBS.
JAN 3717
APR 2873
JUL 2971
OCT 2973
TEMPERATURE OR DEW POINT TEMPERATURE (°F)
PERCENT OF OBSERVATIONS ≥ INDICATED VALUE
MAX
MIN
JUL
OCT
APR
JAN

Figure 1.11

CASABLANCA, MOROCCO

TEMPERATURE-DEW POINT RELATIONSHIPS FOR DEW POINTS ≥ 76°F

MONTH	DEW POINT CLASS	TEMPERATURE CLASS			NUMBER OF OBSERVATIONS
		LOWEST	MEDIAN	HIGHEST	
JAN	None				
(3717)*					
APR	None				
(2873)*					
JUL	None				
(2971)*					
OCT	None				
(2973)*					

* Total number of observations in indicated month.

Month(s) with most frequent occurrence of high dew points - AUG.

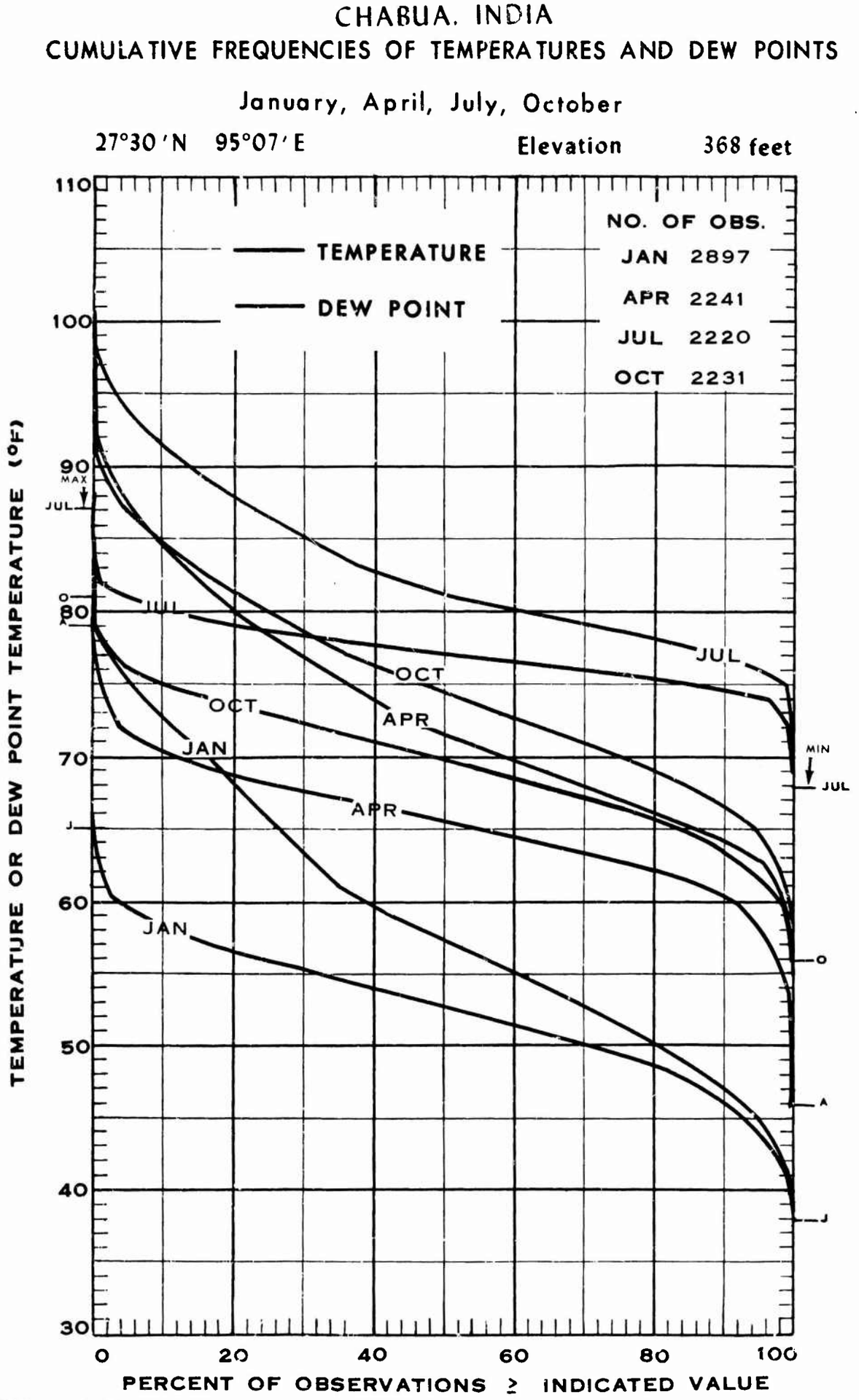

CHABUA. INDIA
CUMULATIVE FREQUENCIES OF TEMPERATURES AND DEW POINTS
January, April, July, October
27°30'N 95°07'E
Elevation 368 feet
NO. OF OBS.
JAN 2897
APR 2241
JUL 2220
OCT 2231
TEMPERATURE
DEW POINT
TEMPERATURE OR DEW POINT TEMPERATURE (°F)
PERCENT OF OBSERVATIONS ≥ INDICATED VALUE
110
100
90
80
70
60
50
40
30
0
20
40
60
80
100
MAX
JUL
MIN
JUL
JUL
OCT
APR
JAN
OCT
APR
JAN
O
A
J

Figure 1.12

CHABUA, INDIA

TEMPERATURE-DEW POINT RELATIONSHIPS FOR DEW POINTS ≥ 76°F#

MONTH	DEW POINT CLASS	TEMPERATURE CLASS			NUMBER OF OBSERVATIONS
		LOWEST	MEDIAN	HIGHEST	
JAN	None				
(2897)*					
APR	76/77		83/84		2
(2241)*	78/79		81/82		1
JUL	76/77	75/76	79/80	97/98	794
(2220)*	78/79	77/78	83/84	99/100	577
	80/81	79/80	87/88	99/100	210
	82/83	83/84	91/92	97/98	21
	84/85		95/96		1
	86/87		87/88		1
OCT	76/77	75/76	79/80	93/94	89
(2231)*	78/79	79/80	81/82	97/98	29
	80/81		85/86		1

*Total number of observations in indicated month.

#Month(s) with most frequent occurrence of high dew points - JUL, AUG.

CHEJU-DO, KOREA
CUMULATIVE FREQUENCIES OF TEMPERATURES AND DEW POINTS

January, April, July, October

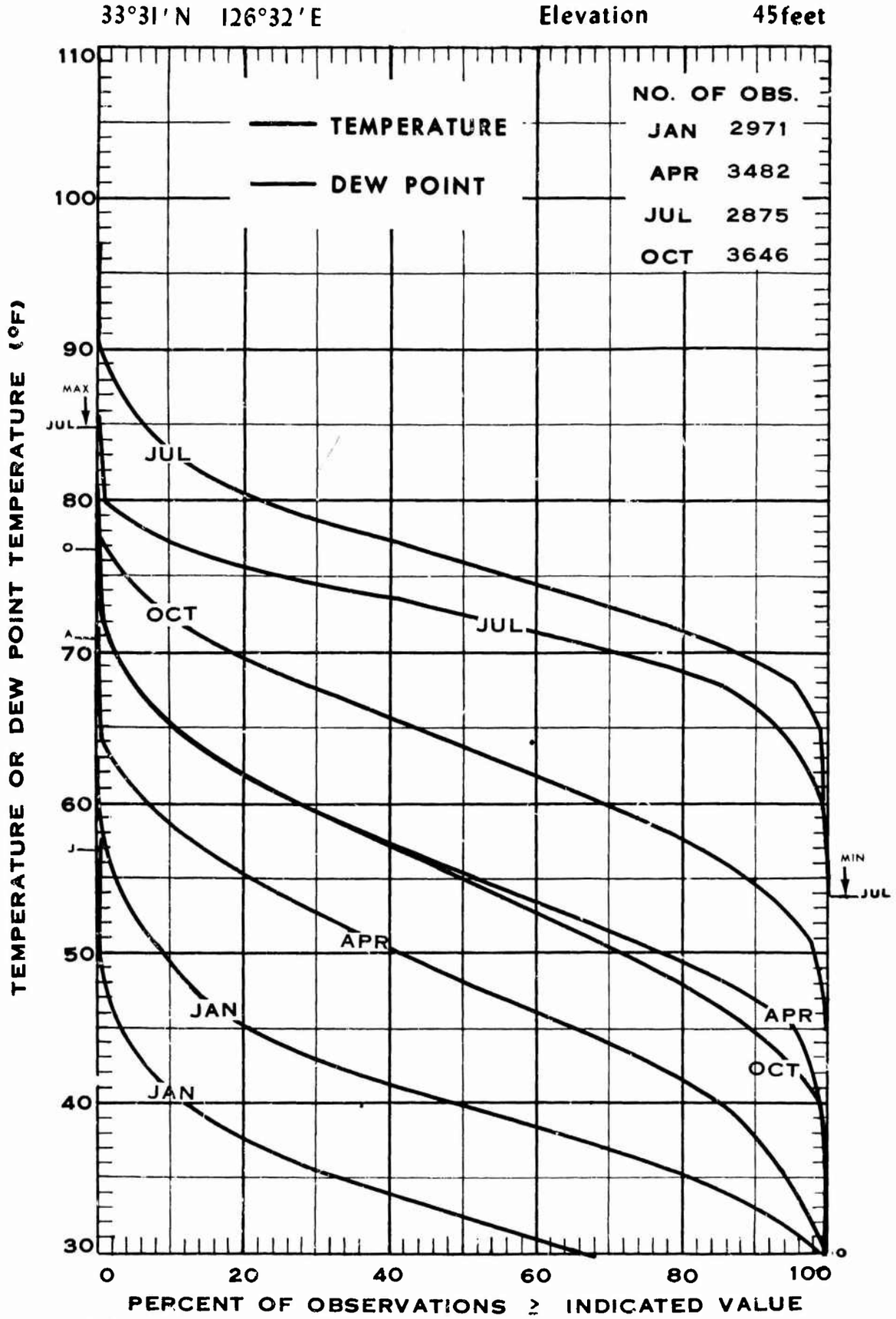


Figure 1.13

CHEJU-DO, KOREA

TEMPERATURE-DEW POINT RELATIONSHIPS FOR DEW POINTS ≥ 76°F

MONTH	DEW POINT CLASS	TEMPERATURE CLASS			NUMBER OF OBSERVATIONS
		LOWEST	MEDIAN	HIGHEST	
JAN	None				
(2971)*					
APR	None				
(3482)*					
JUL	76/77	75/76	79/80	93/94	434
(2875)*	78/79	77/78	83/84	87/88	148
	80/81	79/80	85/86	89/90	38
	82/83	85/86		95/96	7
	84/85	89/90		93/94	2
OCT	76/77	77/78		79/80	5
(3646)*					

*Total number of observations in indicated month.

#Month(s) with most frequent occurrence of high dew points - AUG.

CHIANG MAI, THAILAND

CUMULATIVE FREQUENCIES OF TEMPERATURES AND DEW POINTS

January, April, July, October

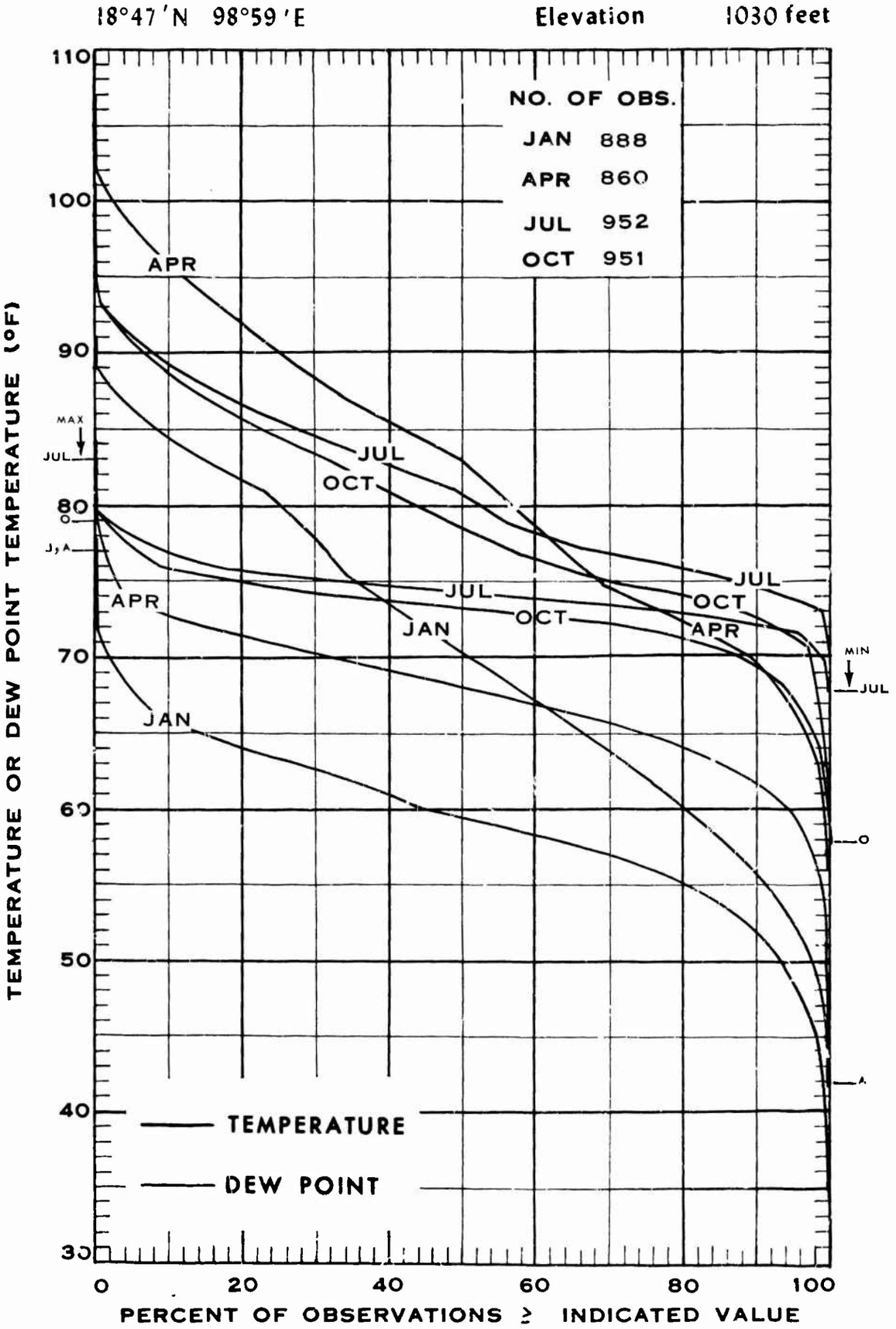


Figure 1.14

CHIANG MAI, THAILAND

TEMPERATURE-DEW POINT RELATIONSHIPS FOR DEW POINTS ≥ 76°F#

MONTH	DEW POINT CLASS	TEMPERATURE CLASS			NUMBER OF OBSERVATIONS
		LOWEST	MEDIAN	HIGHEST	
JAN	76/77		81/82		1
(888)*					
APR	76/77	79/80		91/92	10
(860)*					
JUL	76/77	75/76	85/86	97/98	145
(952)*	78/79	79/80	85/86	95/96	26
	80/81		87/88		1
	82/83	85/86		89/90	2
OCT	76/77	75/76	84/85	97/98	82
(951)*	78/79	81/82	83/84	93/94	13
	80/81	83/84		87/88	2

*Total number of observations in indicated month.

#Month(s) with most frequent occurrence of high dew points - AUG.

CHIHKIANG, CHINA
CUMULATIVE FREQUENCIES OF TEMPERATURES AND DEW POINTS

January, April, July, October

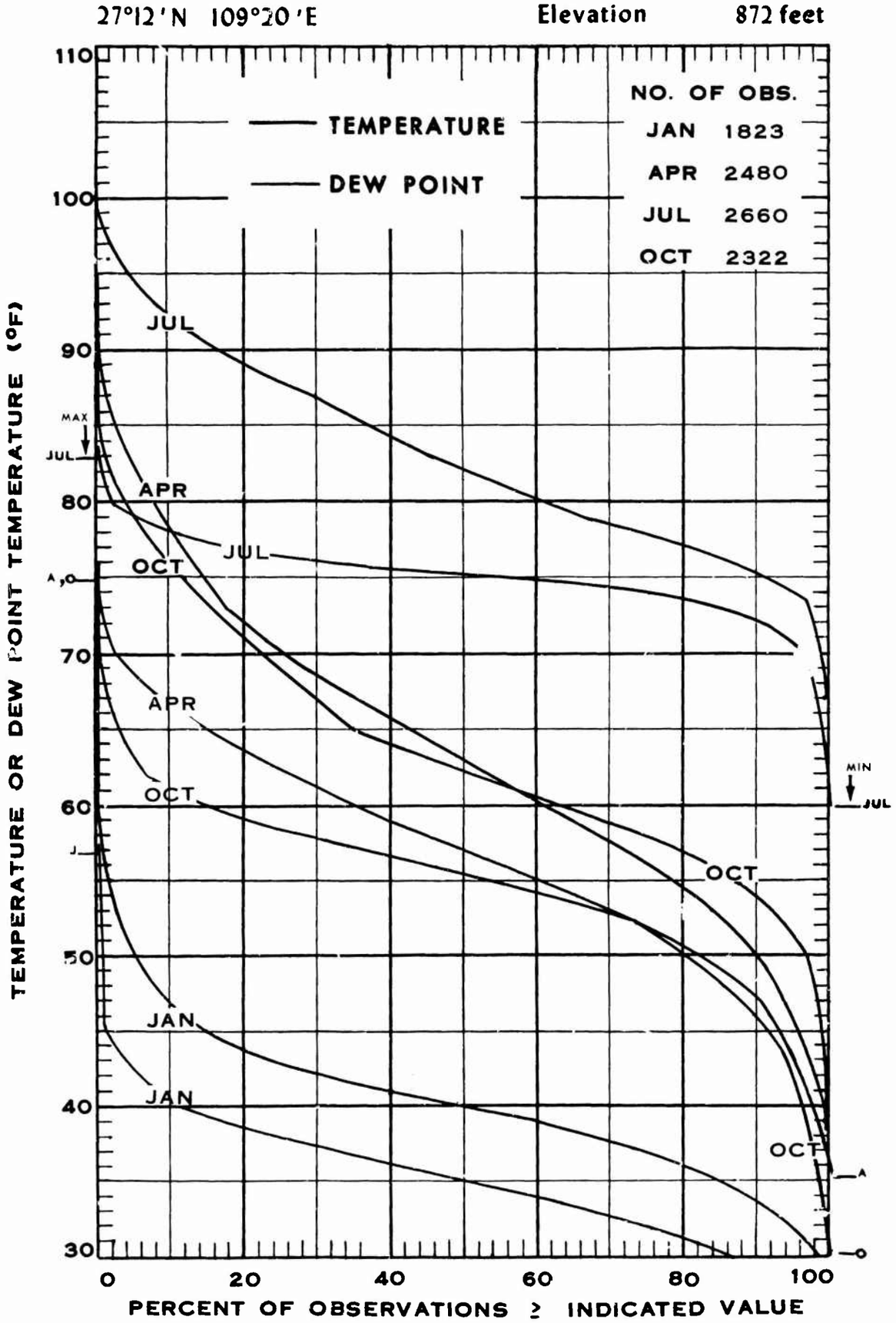


Figure 1.15

CHIHKIANG, CHINA

TEMPERATURE-DEW POINT RELATIONSHIPS FOR DEW POINTS ≥ 76°F#

MONTH	DEW POINT CLASS	TEMPERATURE CLASS			NUMBER OF OBSERVATIONS
		LOWEST	MEDIAN	HIGHEST	
JAN	None				
(1823)*					
APR	None				
(2480)*					
JUL	76/77	75/76	81/82	99/100	692
(2660)*	78/79	77/78	85/86	95/96	244
	80/81	81/82	89/90	95/96	56
	82/83	87/88		95/96	5
OCT	None				
(2322)*					

*Total number of observations in indicated month.

#Month(s) with most frequent occurrence of high dew points - JUL.

CHINHAE, KOREA

CUMULATIVE FREQUENCIES OF TEMPERATURES AND DEW POINTS

January, April, July, October

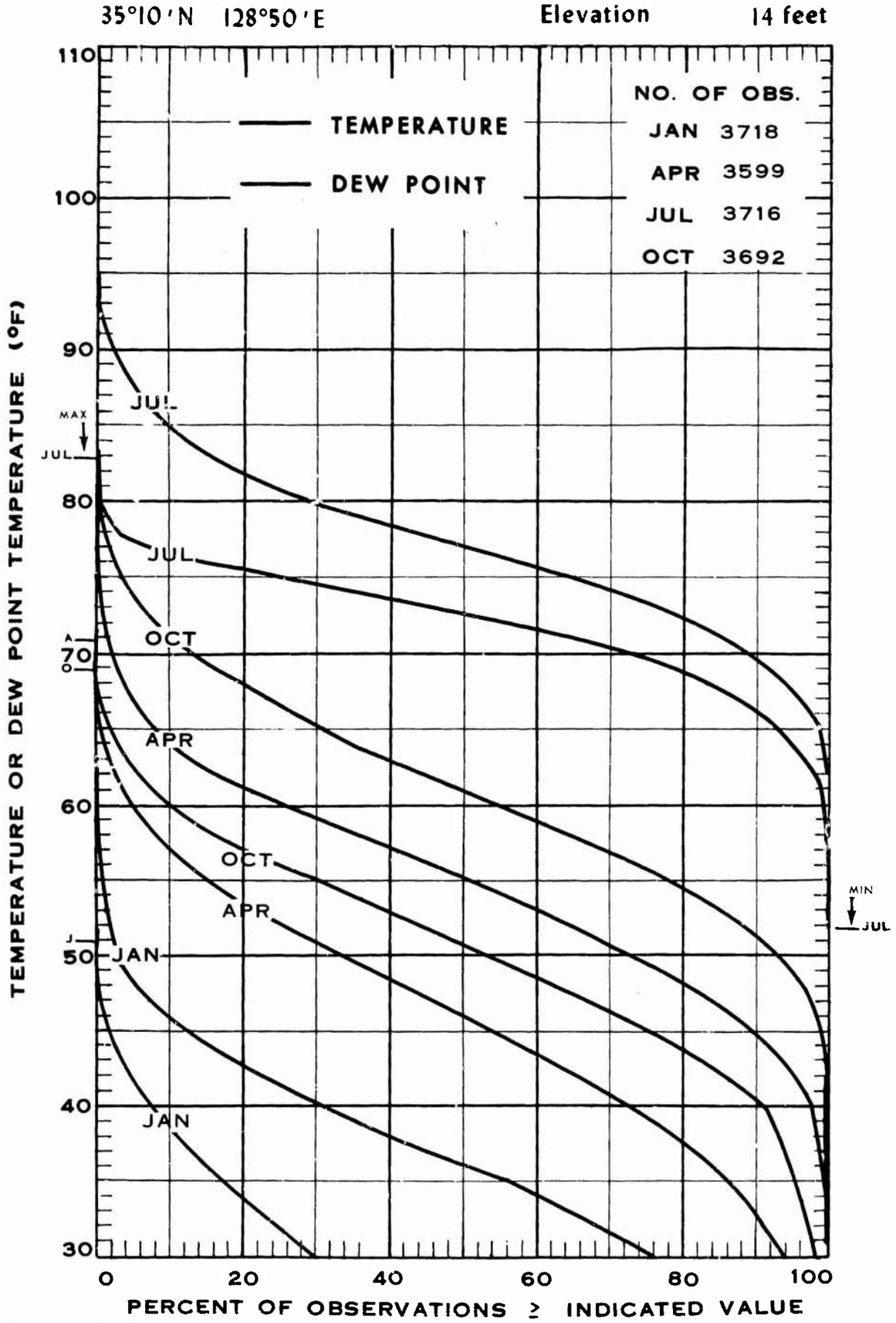


Figure 1.16

CHINHAE, KOREA

TEMPERATURE-DEW POINT RELATIONSHIPS FOR DEW POINTS ≥ 76°F

MONTH	DEW POINT CLASS	TEMPERATURE CLASS			NUMBER OF OBSERVATIONS
		LOWEST	MEDIAN	HIGHEST	
JAN	None				
(3718)*					
APR	None				
(3599)*					
JUL	76/77	75/76	81/82	91/92	579
(3716)*	78/79	79/80	83/84	89/90	118
	80/81	81/82		85/86	3
OCT	None				
(3692)*					

*Total number of observations in indicated month.

#Month(s) with most frequent occurrence of high dew points - JUL.

CHRISTMAS ISLAND, LINE ISLANDS
CUMULATIVE FREQUENCIES OF TEMPERATURES AND DEW POINTS
January, April, July, October

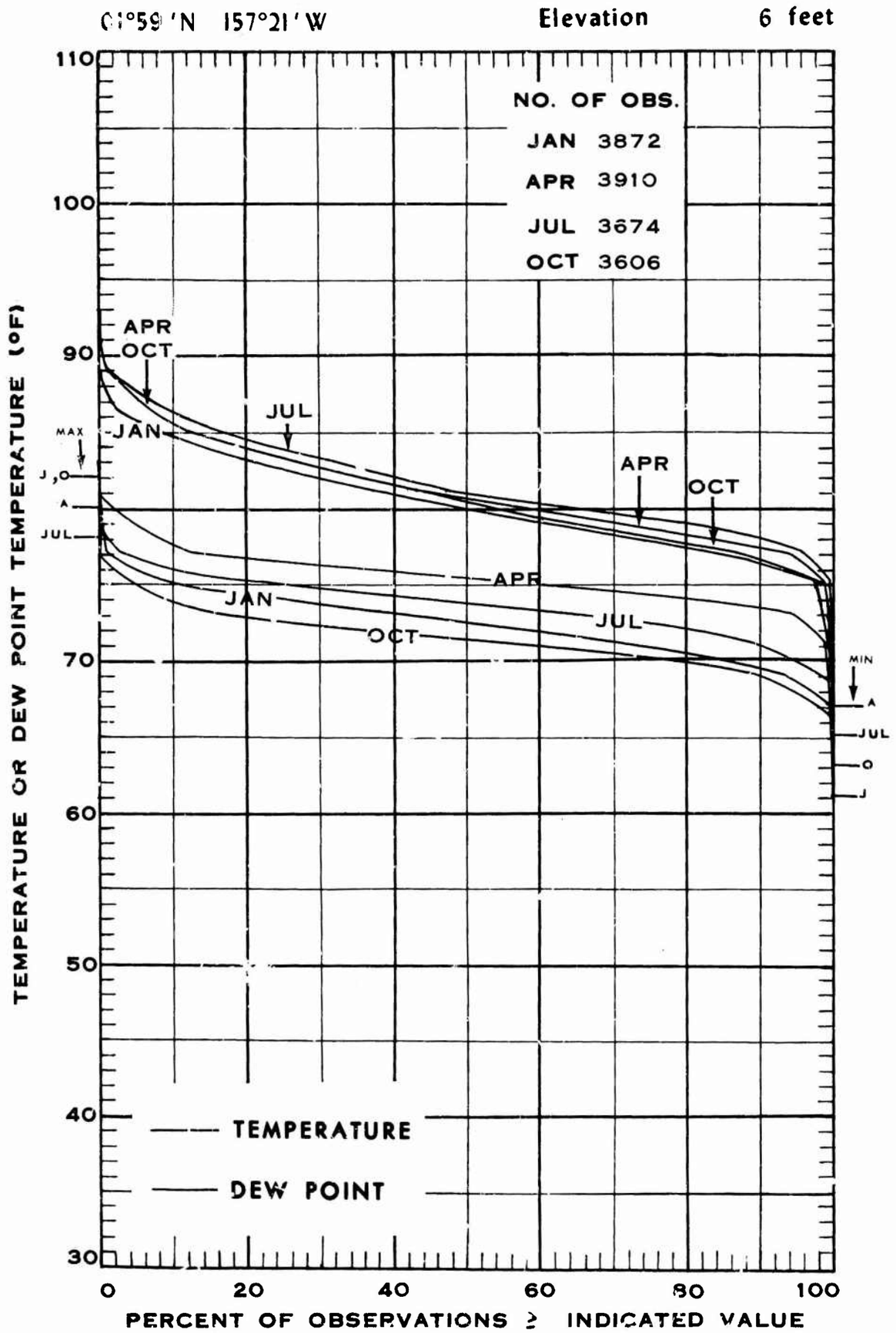


Figure 1.17

CHRISTMAS ISLAND, LINE ISLANDS

TEMPERATURE-DEW POINT RELATIONSHIPS FOR DEW POINTS ≥ 76°F#

MONTH	DEW POINT CLASS	TEMPERATURE CLASS			NUMBER OF OBSERVATIONS
		LOWEST	MEDIAN	HIGHEST	
JAN	76/77	75/76	81/82	87/88	77
(3872)*	78/79	83/84	84/85	87/88	11
	80/81	83/84		87/88	4
	82/83		85/86		1
APR	76/77	75/76	81/82	87/88	667
(3910)*	78/79	79/80	83/84	87/88	62
	80/81		83/84		2
JUL	76/77	75/76	83/84	87/88	232
(3674)*	78/79	77/78	85/86	87/88	38
	80/81		85/86		1
OCT	76/77	75/76	83/84	89/90	58
(3606)*	78/79	81/82		87/88	7
	80/81	85/86		87/88	3
	82/83		87/88		1

*Total number of observations in indicated month.

#Month(s) with most frequent occurrence of high dew points - APR.

COCO SOLO, CANAL ZONE

CUMULATIVE FREQUENCIES OF TEMPERATURES AND DEW POINTS

January, April, July, October

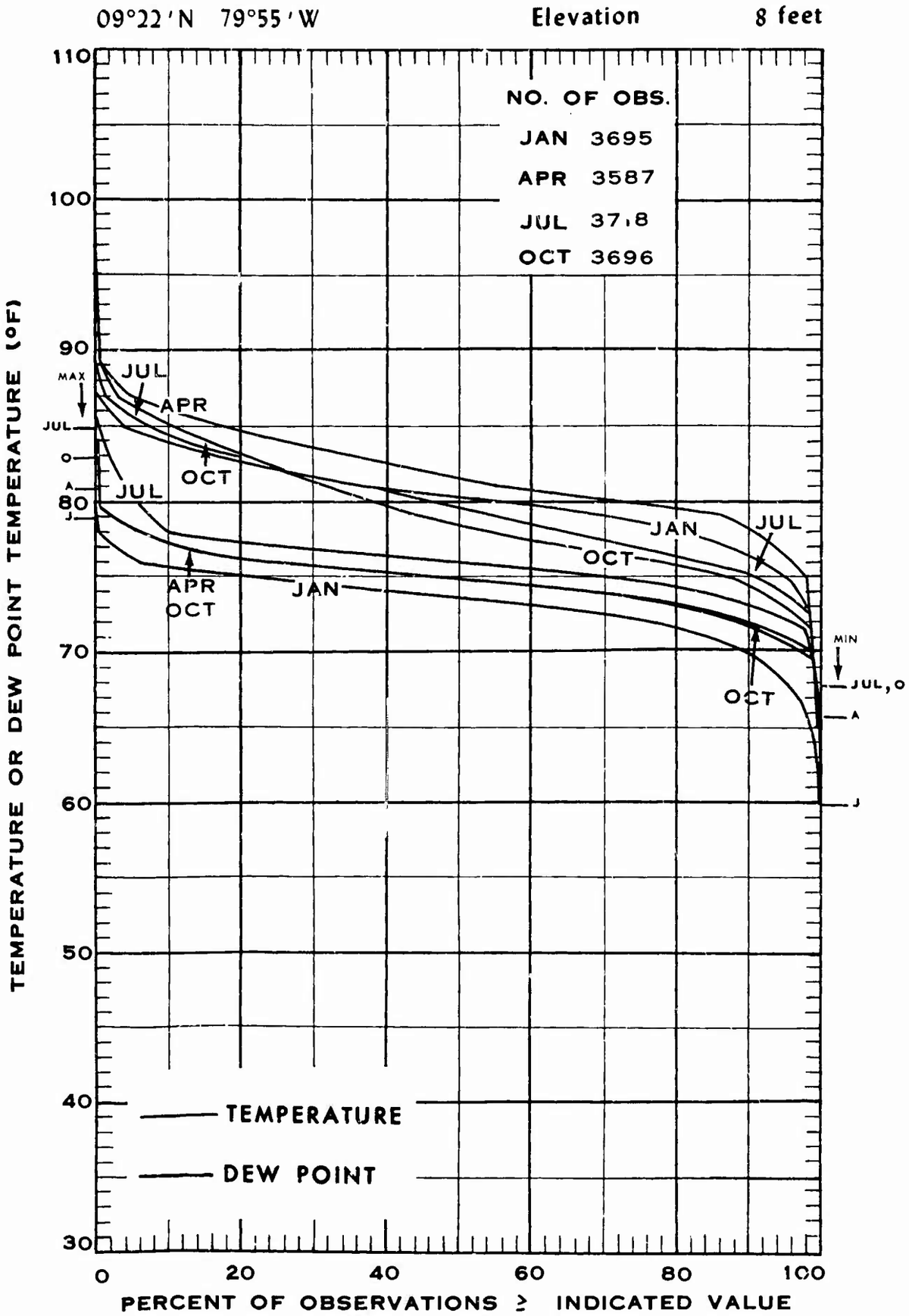


Figure 1.18

COCO SOLO, CANAL ZONE

TEMPERATURE-DEW POINT RELATIONSHIPS FOR DEW POINTS ≥ 76°F#

MONTH	DEW POINT CLASS	TEMPERATURE CLASS			NUMBER OF OBSERVATIONS
		LOWEST	MEDIAN	HIGHEST	
JAN	76/77	75/76	81/82	85/86	228
(3695)*	78/79	79/80	81/82	85/86	21
APR	76/77	75/76	81/82	93/94	778
(3587)*	78/79	77/78	83/84	87/88	176
	80/81	79/80	85/86	87/88	13
JUL	76/77	75/76	79/80	91/92	1323
(3718)*	78/79	77/78	81/82	87/88	368
	80/81	81/82	84/85	87/88	34
	84/85		83/84		1
OCT	76/77	75/76	81/82	91/92	761
(3696)*	78/79	77/78	83/84	91/92	201
	80/81	79/80	83/84	85/86	13
	82/83		83/84		1

*Total number of observations in indicated month.

#Month(s) with most frequent occurrence of high dew points - JUL

DHAHRAN, SAUDI ARABIA

CUMULATIVE FREQUENCIES OF TEMPERATURES AND DEW POINTS

January, April, July, October

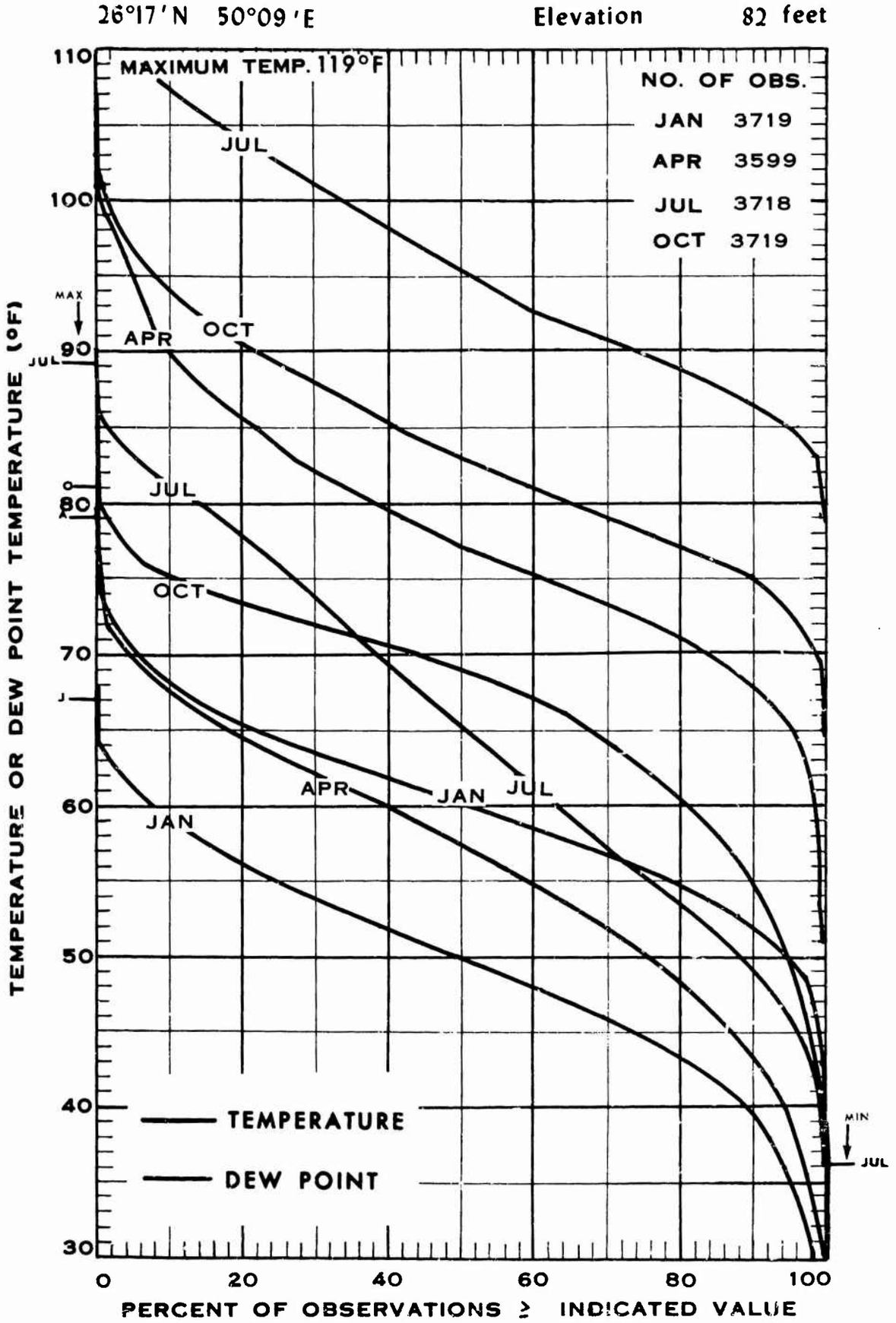


Figure 1.19

DHAHRAN, SAUDI ARABIA

TEMPERATURE-DEW POINT RELATIONSHIPS FOR DEW POINTS ≥ 76°F#

MONTH	DEW POINT CLASS	TEMPERATURE CLASS			NUMBER OF OBSERVATIONS
		LOWEST	MEDIAN	HIGHEST	
JAN	None				
(3719)*					
APR	76/77	83/84		89/90	3
(3599)*	78/79		83/84		2
JUL	76/77	81/82	91/92	107/108	185
(3718)*	78/79	81/82	91/92	107/108	233
	80/81	83/84	89/90	105/106	270
	82/83	83/84	91/92	103/104	179
	84/85	85/86	90/91	101/102	65
	86/87	89/90	93/94	101/102	19
	88/89	91/92		101/102	2
OCT	76/77	77/78	83/84	97/98	175
(3719)*	78/79	79/80	83/84	95/96	73
	80/81	85/86		89/90	6

*Total number of observations in indicated month.

#Month(s) with most frequent occurrence of high dew points - AUG

DJAKARTA. INDONESIA

CUMULATIVE FREQUENCIES OF TEMPERATURES AND DEW POINTS

January, April, July, October

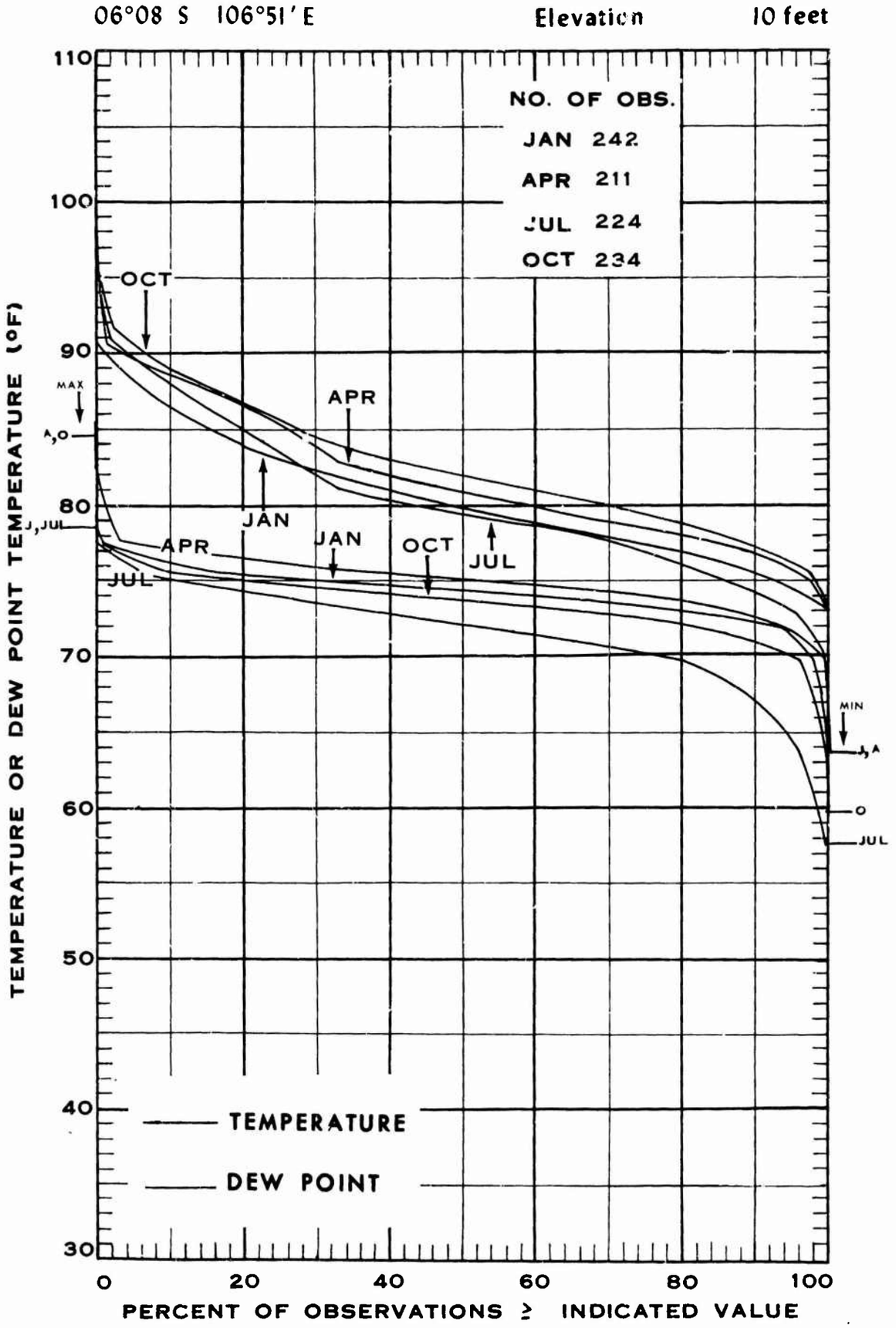


Figure 1.20

DJAKARTA, INDONESIA

TEMPERATURE-DEW POINT RELATIONSHIPS FOR DEW POINTS ≥ 76°F#

MONTH	DEW POINT CLASS	TEMPERATURE CLASS			NUMBER OF OBSERVATIONS
		LOWEST	MEDIAN	HIGHEST	
JAN	76/77	75/76	81/82	89/90	36
(242)*	78/79	79/80		85/86	3
APR	76/77	77/78	83/84	91/92	61
(211)*	78/79	81/82		87/88	7
	84/85		87/88		1
JUL	76/77	77/78	79/80	89/90	13
(224)*	78/79				1
OCT	76/77	75/76		89/90	22
(234)*	78/79		79/80		1
	82/83		91/92		1
	84/85		89/90		1

*Total number of observations in indicated month.

#Month(s) with most frequent occurrence of high dew points - APR, MAY.

DOBODURA, PAPUA (NEW GUINEA)

CUMULATIVE FREQUENCIES OF TEMPERATURES AND DEW POINTS

January, April, July, October

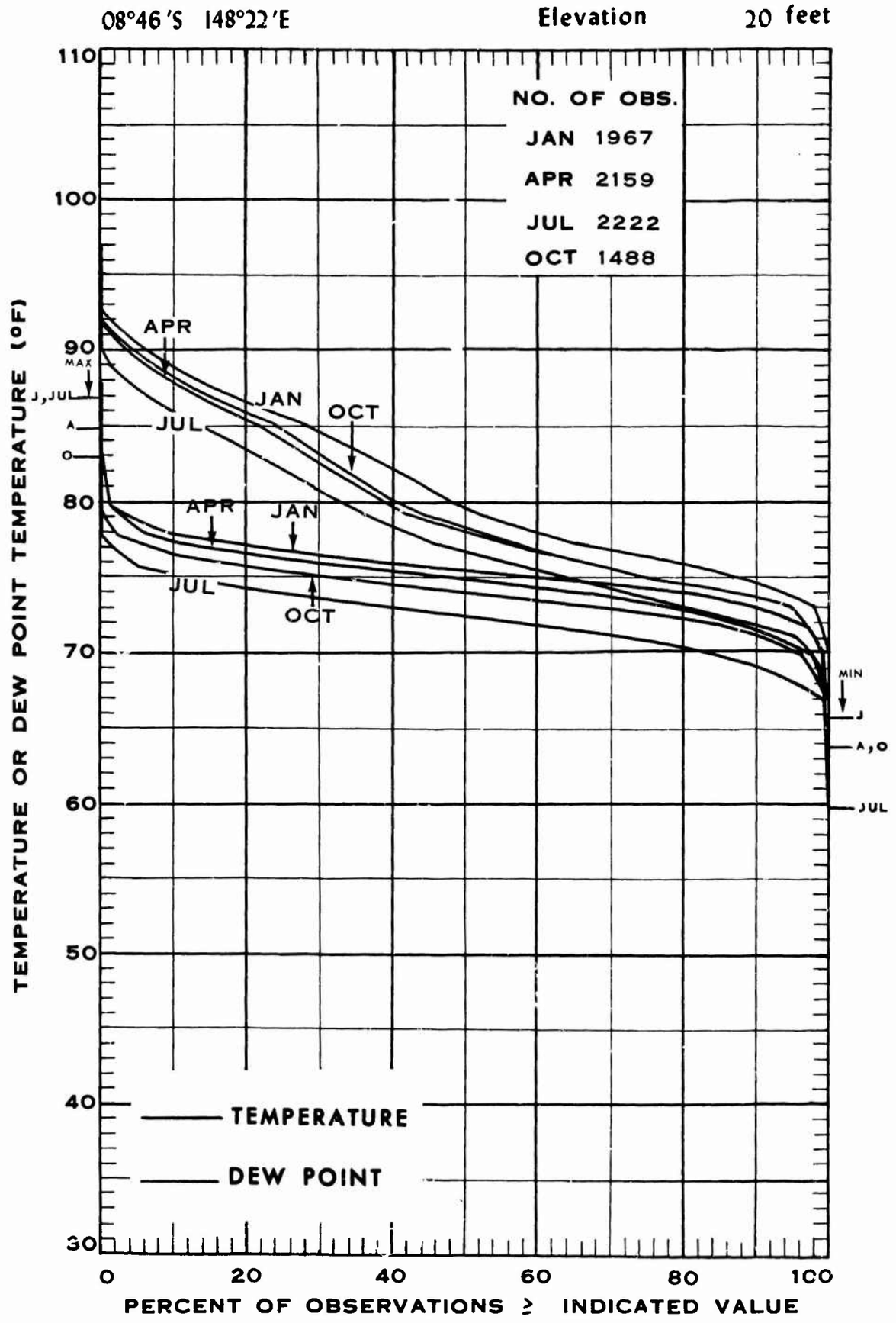


Figure 1.21

DOBODURA, PAPUA(NEW GUINEA)

TEMPERATURE-DEW POINT RELATIONSHIPS FOR DEW POINTS ≥ 76°F

MONTH	DEW POINT CLASS	TEMPERATURE CLASS			NUMBER OF OBSERVATIONS
		LOWEST	MEDIAN	HIGHEST	
JAN	76/77	75/76	81/82	91/92	619
(1967)*	78/79	77/78	83/84	91/92	178
	80/81	79/80	84/85	89/90	33
	82/83	85/86		89/90	5
	84/85	87/88		89/90	4
	86/87		89/90		1
APR	76/77	75/76	79/80	91/92	510
(2159)*	78/79	77/78	83/84	95/96	143
	80/81	79/80	86/87	93/94	27
	82/83		91/92		1
	84/85		87/88		2
JUL	76/77	75/76	79/80	87/88	95
(2222)*	78/79		81/82		1
	80/81		83/84		1
	82/83		83/84		1
	86/87		85/86		1
OCT	76/77	75/76	79/80	91/92	233
(1488)*	78/79	79/80	87/88	91/92	23
	80/81	85/86		91/92	8
	82/83		89/90		1

*Total number of observations in indicated month.

#Month(s) with most frequent occurrence of high dew points - JAN, FEB.

ENIWETOK ATOLL, MARSHALL ISLANDS

CUMULATIVE FREQUENCIES OF TEMPERATURES AND DEW POINTS

January, April, July, October

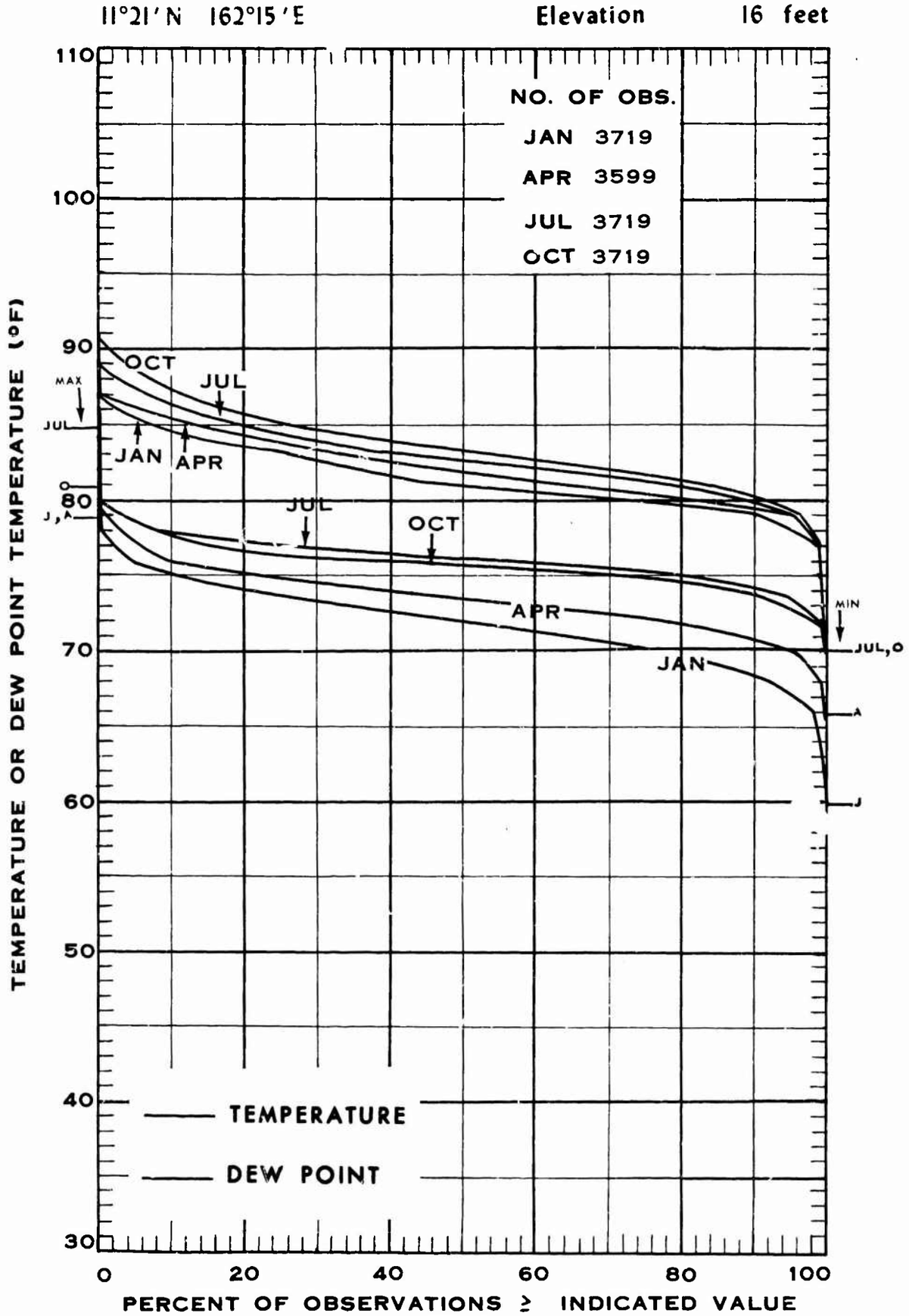


Figure 1.22

ENIWETOK ATOLL, MARSHALL ISLANDS

TEMPERATURE-DEW POINT RELATIONSHIPS FOR DEW POINTS ≥ 76°F#

MONTH	DEW POINT CLASS	TEMPERATURE CLASS			NUMBER OF OBSERVATIONS
		LOWEST	MEDIAN	HIGHEST	
JAN	76/77	77/78	81/82	87/88	154
(3719)*	78/79	81/82		87/88	7
APR	76/77	75/76	81/82	87/88	358
(3599)*	78/79	81/82	84/85	89/90	14
JUL	76/77	75/76	81/82	89/90	1661
(3719)*	78/79	77/78	85/86	87/88	278
	30/81	83/84	85/86	87/88	16
	82/83		87/88		1
	84/85		85/86		1
OCT	76/77	75/76	83/84	89/90	1442
(3719)*	78/79	79/80	85/86	89/90	293
	80/81	81/82	85/86	89/90	13

*Total number of observations in indicated month.

#Month(s) with most frequent occurrence of high dew points - AUG.

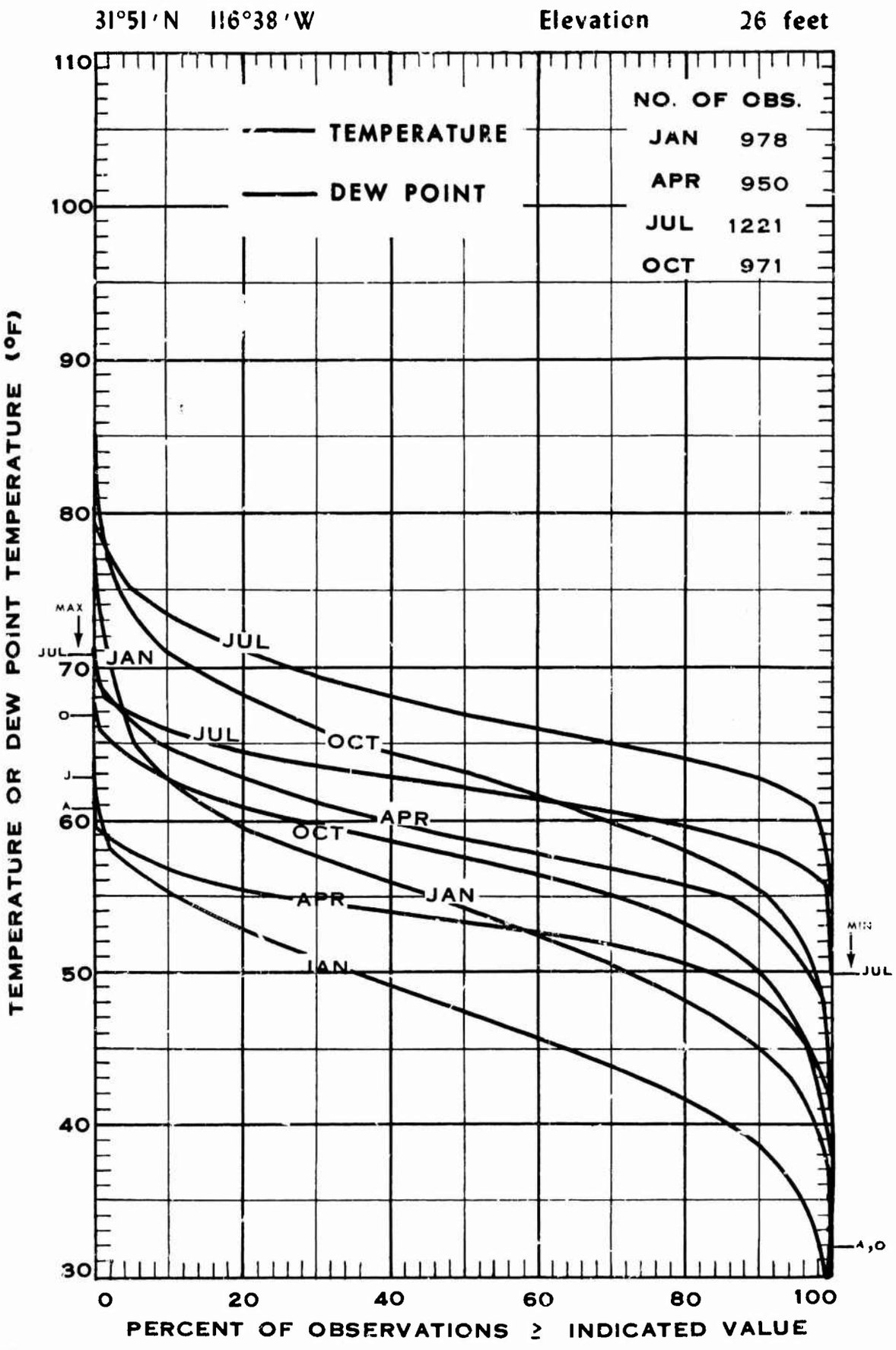

ENSENADA, MEXICO
CUMULATIVE FREQUENCIES OF TEMPERATURES AND DEW POINTS
January, April, July, October
31°51' N 116°38' W
Elevation 26 feet
TEMPERATURE
DEW POINT
NO. OF OBS.
JAN 978
APR 950
JUL 1221
OCT 971
TEMPERATURE OR DEW POINT TEMPERATURE (°F)
PERCENT OF OBSERVATIONS ≥ INDICATED VALUE
MAX
JUL
JAN
JUL
OCT
APR
OCT
JAN
APR
JAN
MIN
JUL
A,O
110
100
90
80
70
60
50
40
30
0
20
40
60
80
100

Figure 1.23

ENSENADA, MEXICO

TEMPERATURE-DEW POINT RELATIONSHIPS FOR DEW POINTS ≥ 76°F#

MONTH	DEW POINT CLASS	TEMPERATURE CLASS			NUMBER OF OBSERVATIONS
		LOWEST	MEDIAN	HIGHEST	
JAN	None				
(978)*					
APR	None				
(950)*					
JUL	None				
(1221)*					
OCT	None				
(971)*					

*Total number of observations in indicated month.

#Month(s) with most frequent occurrence of high dew points - AUG.

GALAPAGOS ISLANDS, ECUADOR

CUMULATIVE FREQUENCIES OF TEMPERATURES AND DEW POINTS

January, April, July, October

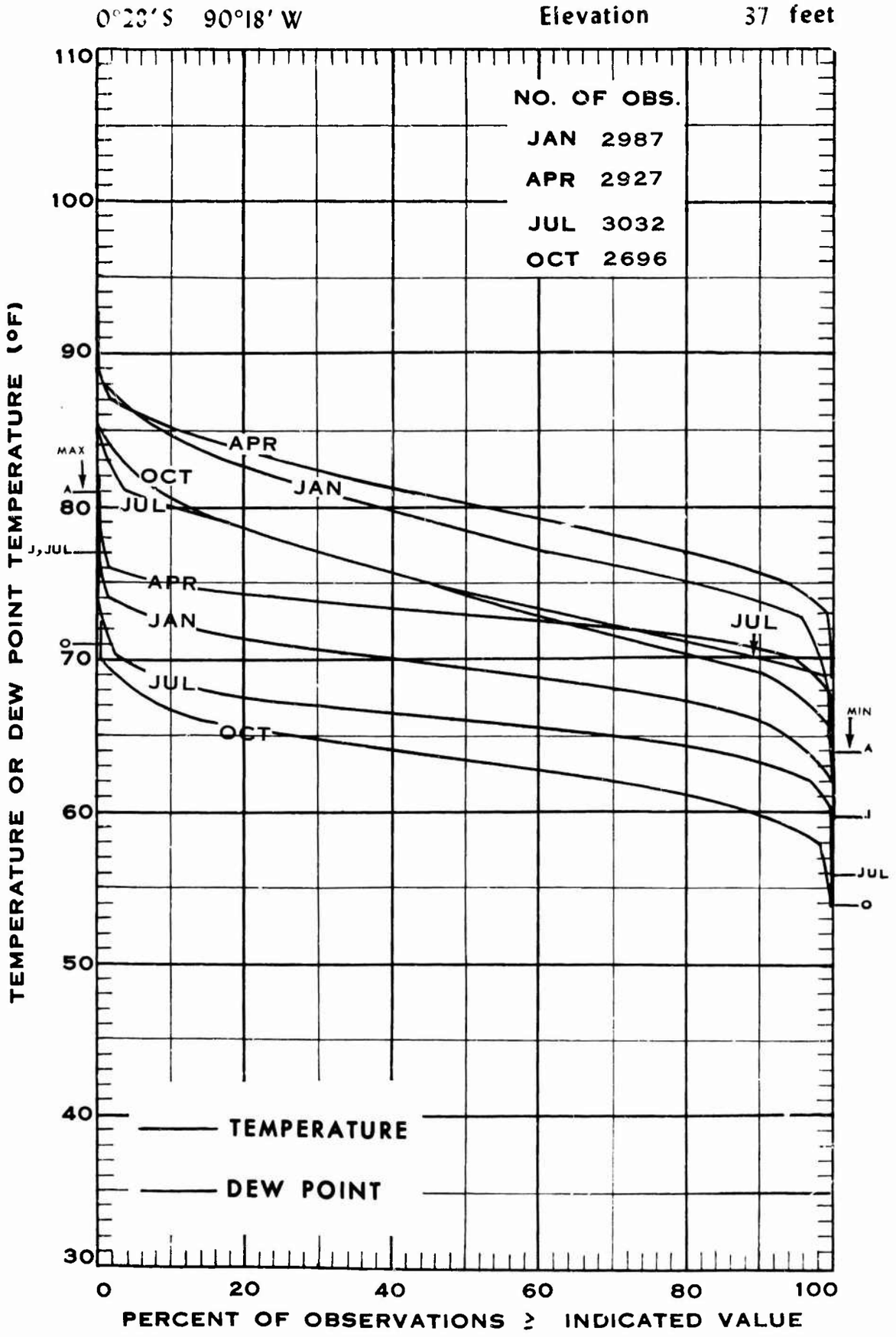


Figure 1.24

GALAPAGOS ISLANDS, ECUADOR

TEMPERATURE-DEW POINT RELATIONSHIPS FOR DEW POINTS ≥ 76°F#

MONTH	DEW POINT CLASS	TEMPERATURE CLASS			NUMBER OF OBSERVATIONS
		LOWEST	MEDIAN	HIGHEST	
JAN	76/77	77/78		83/84	2
(2987)*					
APR	76/77	77/78	83/84	87/88	29
(2927)*	78/79		79/80		1
	80/81		83/84		1
JUL	76/77		83/84		1
(3032)*					
OCT	None				
(2696)*					

*Total number of observations in indicated month.

#Month(s) with most frequent occurrence of high dew points - FEB.

GAYA, INDIA
CUMULATIVE FREQUENCIES OF TEMPERATURES AND DEW POINTS
January, April, July, October

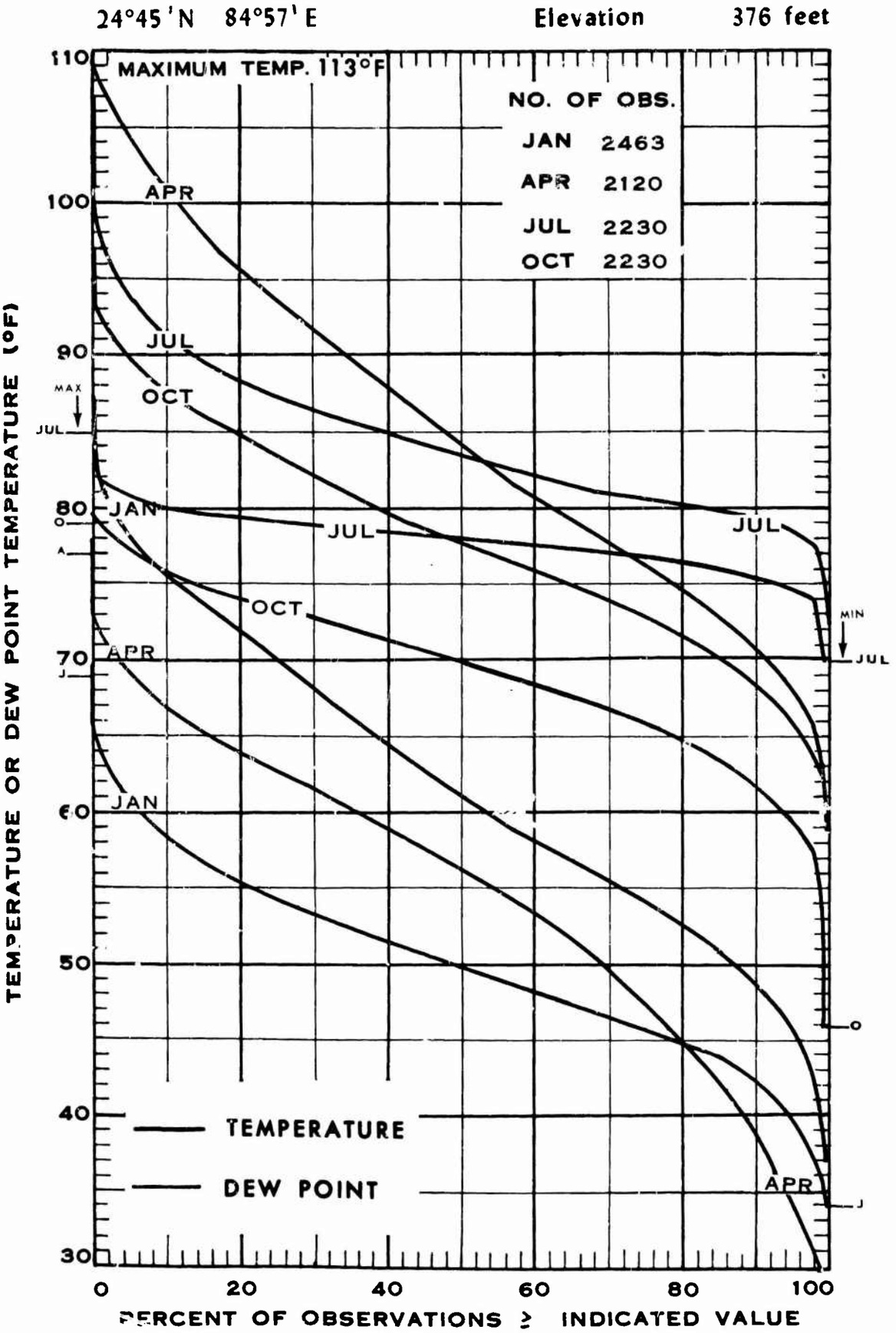


Figure 1.25

GAYA, INDIA

TEMPERATURE-DEW POINT RELATIONSHIPS FOR DEW POINTS ≥ 76°F#

MONTH	DEW POINT CLASS	TEMPERATURE CLASS			NUMBER OF OBSERVATIONS
		LOWEST	MEDIAN	HIGHEST	
JAN	None				
(2463)*					
APR	76/77	81/82		83/84	2
(2120)*					
JUL	76/77	75/76	79/80	99/100	729
(2230)*	78/79	77/78	83/84	97/98	998
	80/81	79/80	85/86	97/98	266
	82/83	81/82	87/88	95/96	35
	84/85		89/90		2
OCT	76/77	75/76	79/80	91/92	221
(2230)*	78/79	79/80	83/84	89/90	66

*Total number of observations in indicated month.

#Month(s) with most frequent occurrence of high dew points - JUL.

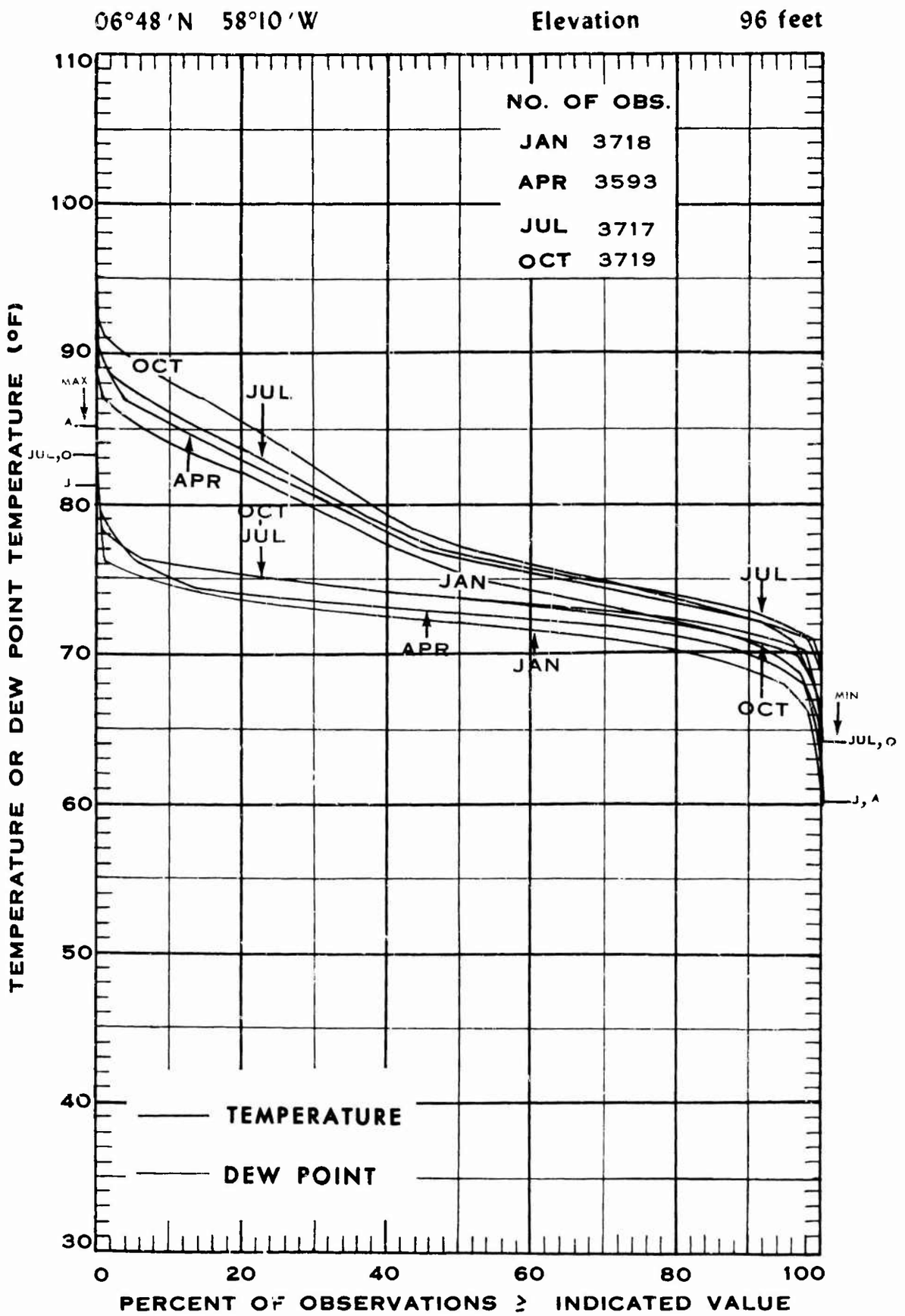

GEORGETOWN, GUYANA
CUMULATIVE FREQUENCIES OF TEMPERATURES AND DEW POINTS
January, April, July, October
06°48'N 58°10'W
Elevation 96 feet
NO. OF OBS.
JAN 3718
APR 3593
JUL 3717
OCT 3719
TEMPERATURE OR DEW POINT TEMPERATURE (°F)
PERCENT OF OBSERVATIONS ≥ INDICATED VALUE
TEMPERATURE
DEW POINT
MAX
MIN
OCT
JUL
APR
JAN
110
100
90
80
70
60
50
40
30
0
20
40
60
80
100

Figure 1.26

GEORGETOWN, GUYANA

TEMPERATURE-DEW POINT RELATIONSHIPS FOR DEW POINTS ≥ 76°F#

MONTH	DEW POINT CLASS	TEMPERATURE CLASS			NUMBER OF OBSERVATIONS
		LOWEST	MEDIAN	HIGHEST	
JAN	76/77	77/78	79/80	87/88	51
(3718)*	78/79	79/80	81/82	85/86	10
	80/81	83/84		85/86	4
APR	76/77	75/76	81/82	89/90	150
(3593)*	78/79	77/78	83/84	89/90	52
	80/81	81/82	85/86	89/90	15
	82/83	83/84		93/94	4
	84/85		93/94		1
JUL	76/77	77/78	81/82	91/92	206
(3717)*	78/79	79/80	85/86	91/92	35
	80/81	83/84		87/88	8
	82/83		85/86		1
OCT	76/77	75/76	81/82	91/92	287
(3719)*	78/79	79/80	85/86	95/96	40
	80/81		87/88		1
	82/83	85/86		93/94	3

*Total number of observations in indicated month.

#Month(s) with most frequent occurrence of high dew points - SEP, OCT.

GOLD ROCK CREEK, BAHAMAS
CUMULATIVE FREQUENCIES OF TEMPERATURES AND DEW POINTS
January, April, July, October

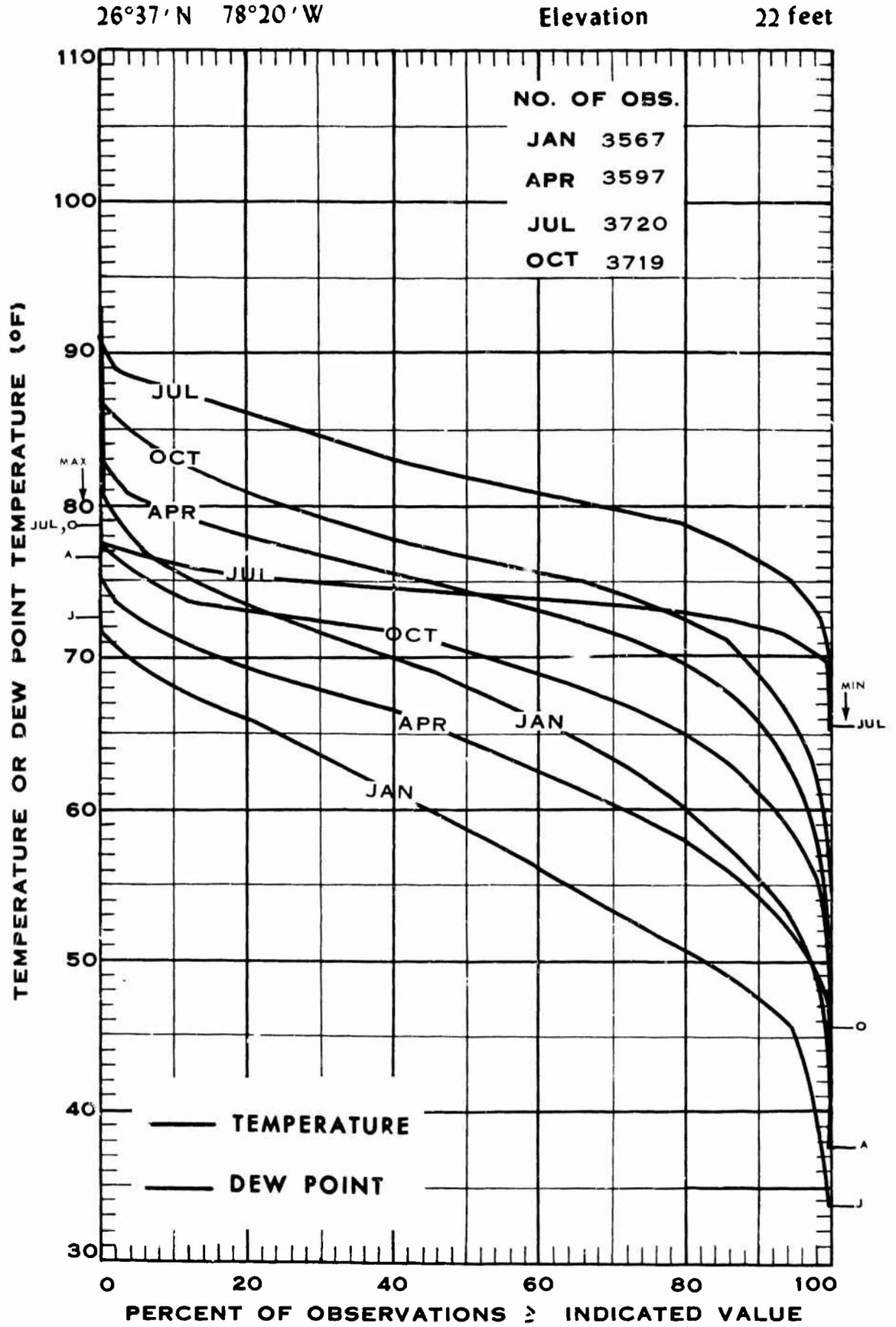


Figure 1.27

GOLD ROCK CREEK, BAHAMAS

TEMPERATURE-DEW POINT RELATIONSHIPS FOR DEW POINTS ≥ 76°F#

MONTH	DEW POINT CLASS	TEMPERATURE CLASS			NUMBER OF OBSERVATIONS
		LOWEST	MEDIAN	HIGHEST	
JAN	None				
(3567)*					
APR	76/77	79/80		83/84	7
(3597)*					
JUL	76/77	75/76	83/84	91/92	589
(3720)*	78/79	77/78	85/86	87/88	36
OCT	76/77	75/76	81/82	87/88	151
(3719)*	78/79	81/82		87/88	9

*Total number of observations in indicated months.

#Month(s) with most frequent occurrence of high dew points - AUG.

GUADALCANAL, SOLOMON ISLANDS

CUMULATIVE FREQUENCIES OF TEMPERATURES AND DEW POINTS

January, April, July, October

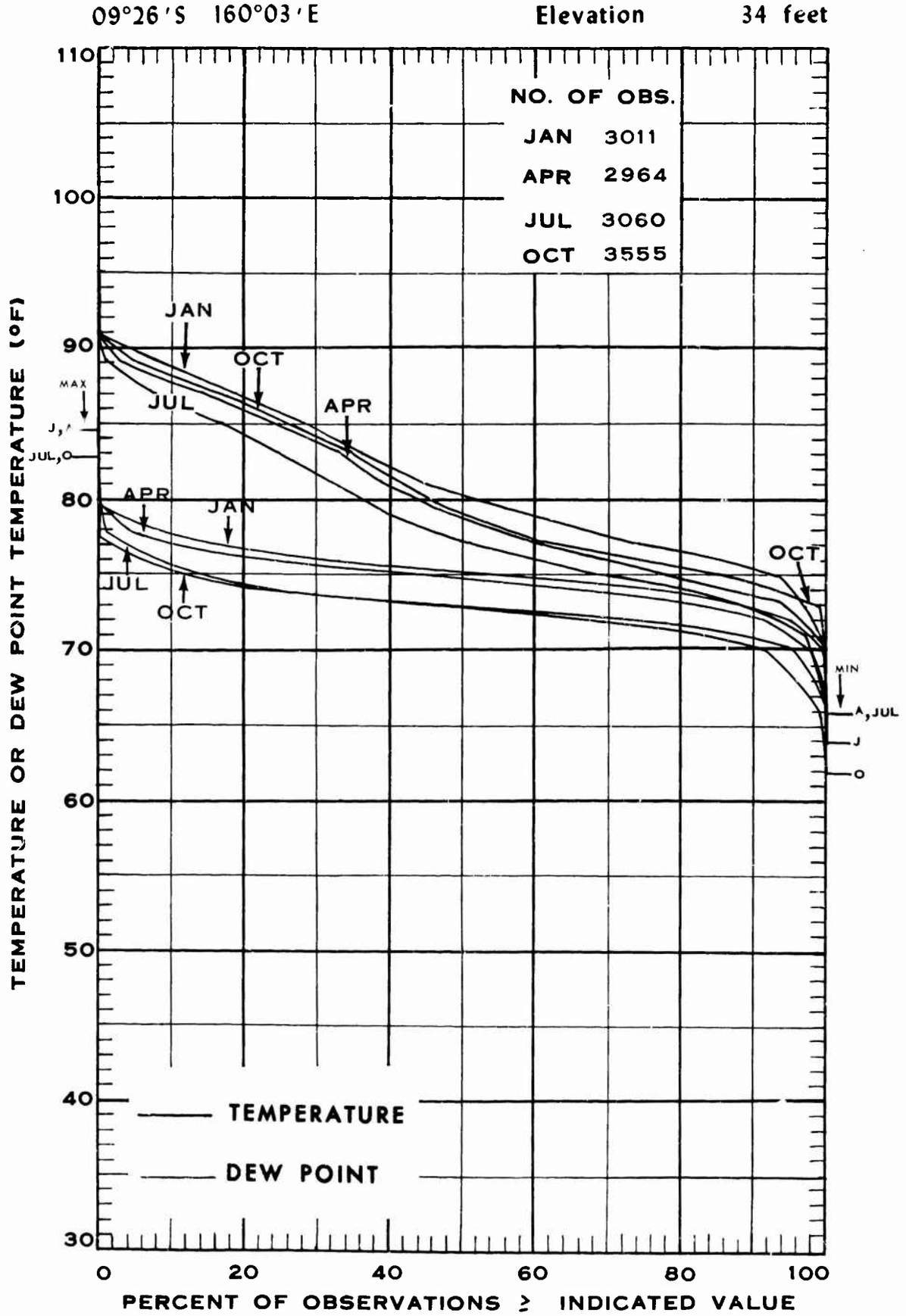


Figure 1.28

GUADALCANAL, SOLOMON ISLANDS

TEMPERATURE-DEW POINT RELATIONSHIPS FOR DEW POINTS ≥ 76°F#

MONTH	DEW POINT CLASS	TEMPERATURE CLASS			NUMBER OF OBSERVATIONS
		LOWEST	MEDIAN	HIGHEST	
JAN	76/77	75/76	83/84	91/92	675
(3011)*	78/79	77/78	85/86	91/92	119
	80/81	79/80		89/90	10
	82/83		81/82		1
	84/85		85/86		1
APR	76/77	75/76	81/82	91/92	739
(2964)*	78/79	77/78	85/86	89/90	219
	80/81	79/80	89/90	89/90	20
	82/83		87/88		4
	84/85		91/92		1
JUL	76/77	75/76	81/82	91/92	256
(3060)*	78/79	77/78	85/86	89/90	37
	80/81	83/84		89/90	6
	82/83		87/88		1
OCT	76/77	75/76	85/86	93/94	193
(3555)*	78/79	81/82	85/86	91/92	25
	80/81	79/80		89/90	6
	82/83		83/84		1

*Total number of observations in indicated month.
Month (s) with most frequent occurrence of high dew points - APR.

GUAM, MARIANA ISLANDS
CUMULATIVE FREQUENCIES OF TEMPERATURES AND DEW POINTS
January, April, July, October

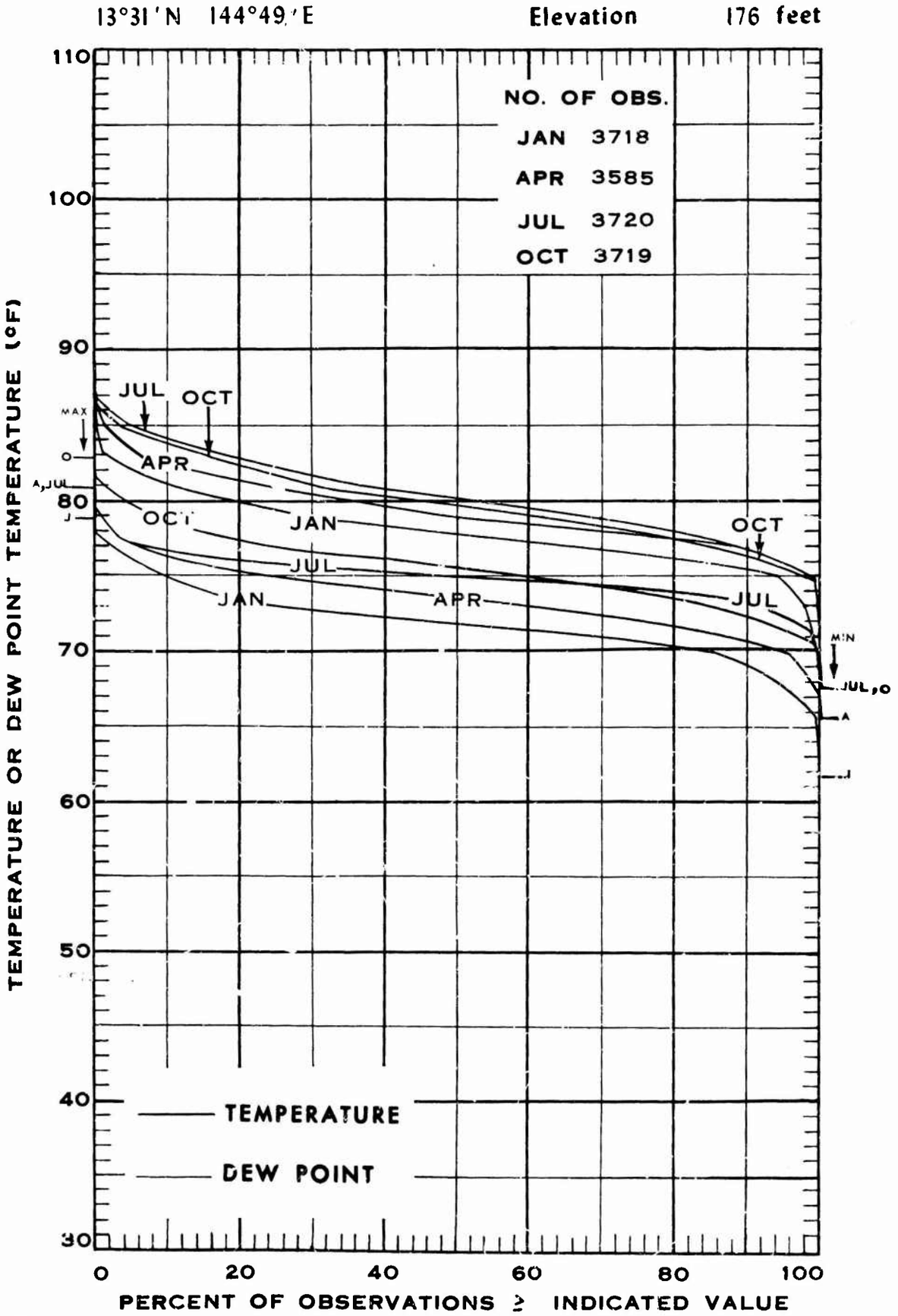


Figure 1.29

GUAM, MARIANA ISLANDS

TEMPERATURE-DEW POINT RELATIONSHIPS FOR DEW POINTS ≥ 76°F#

MONTH	DEW POINT CLASS	TEMPERATURE CLASS			NUMBER OF OBSERVATIONS
		LOWEST	MEDIAN	HIGHEST	
JAN	76/77	75/76	79/80	83/84	235
(3718)*	78/79	77/78	81/82	83/84	14
APR	76/77	75/76	81/82	85/86	407
(3585)*	78/79	77/78	81/82	87/88	120
	80/81	81/82	85/86	85/86	11
JUL	76/77	75/76	81/82	87/88	1233
(3720)*	78/79	77/78	83/84	87/88	119
	80/81	81/82		85/86	6
OCT	76/77	75/76	79/80	85/86	1220
(3719)*	78/79	77/78	81/82	85/86	486
	80/81	79/80	83/84	87/88	137
	82/83	81/82	85/86	87/88	21

*Total number of observations in indicated month.

#Month(s) with most frequent occurrence of high dew points - AUG, SEP.

GUANTÁNAMO BAY, CUBA

CUMULATIVE FREQUENCIES OF TEMPERATURES AND DEW POINTS

January, April, July, October

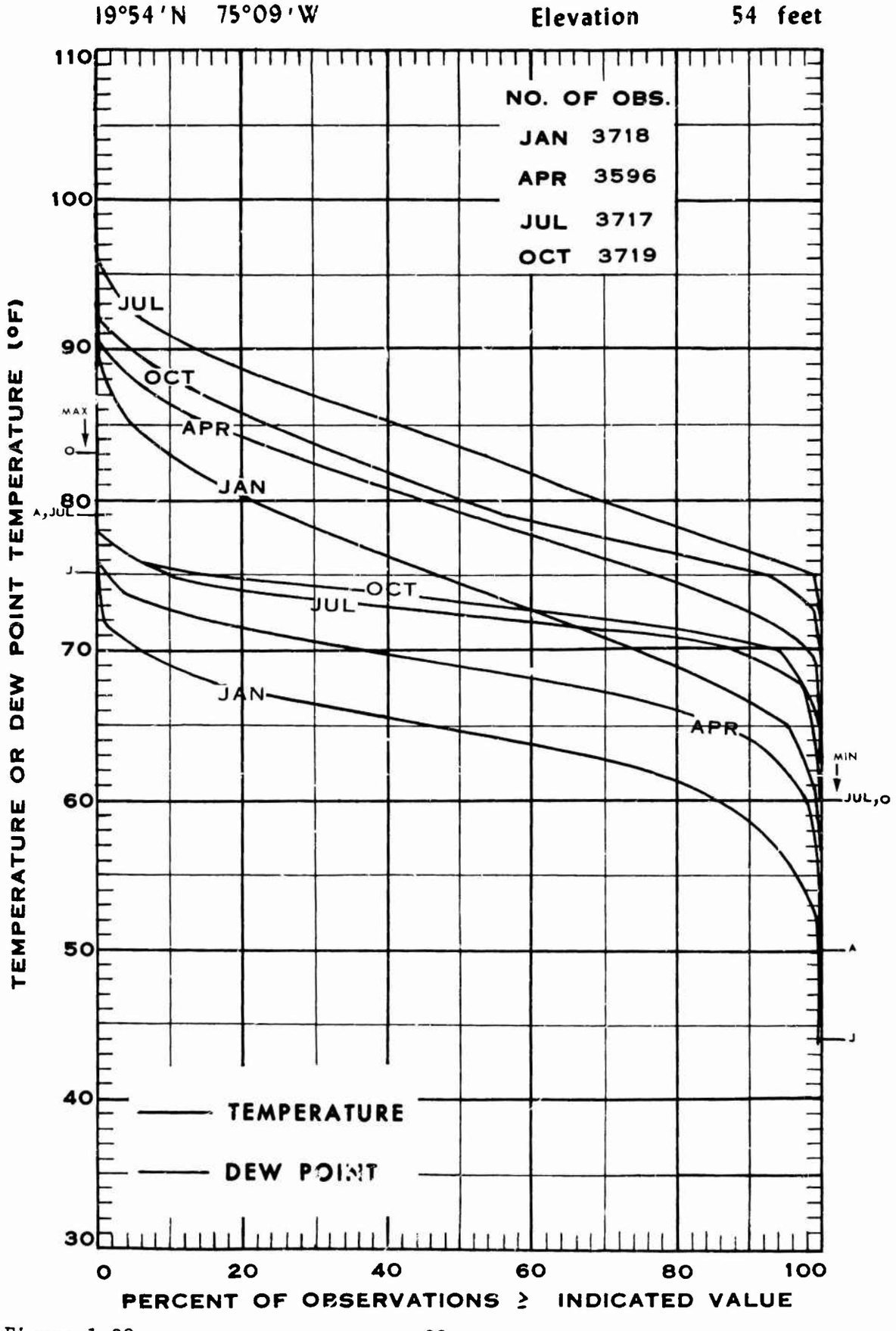


Figure 1.30

GUANTÁNAMO BAY, CUBA

TEMPERATURE-DEW POINT RELATIONSHIPS FOR DEW POINTS ≥ 76°F#

MONTH	DEW POINT CLASS	TEMPERATURE CLASS			NUMBER OF OBSERVATIONS
		LOWEST	MEDIAN	HIGHEST	
JAN	None				
(3718)*					
APR	76/77	79/80	83/84	87/88	16
(3596)*	78/79	85/86		87/88	4
JUL	76/77	79/80	87/88	93/94	193
(3717)*	78/79	83/84	89/90	93/94	21
OCT	76/77	77/78	83/84	91/92	197
(3719)*	78/79	77/78	86/87	89/90	15

*Total number of observations in indicated month.

#Month(s) with most frequent occurrence of high dew points - AUG, SEP.

HANOI. NORTH VIETNAM

CUMULATIVE FREQUENCIES OF TEMPERATURES AND DEW POINTS

January, April, July, October

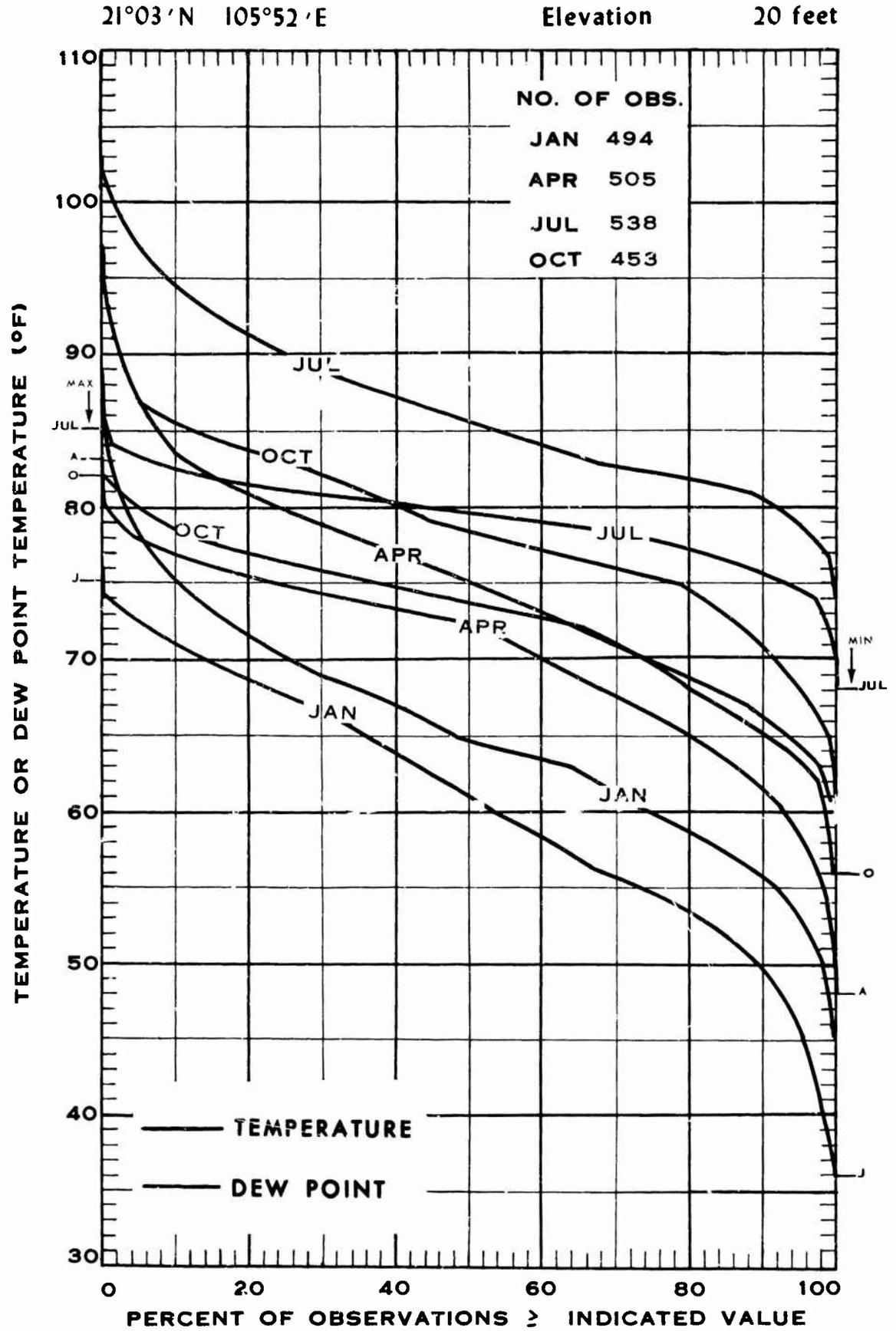


Figure 1.31

HANOI, NORTH VIETNAM

TEMPERATURE-DEW POINT RELATIONSHIPS FOR DEW POINTS ≥ 76°F#

MONTH	DEW POINT CLASS	TEMPERATURE CLASS			NUMBER OF OBSERVATIONS
		LOWEST	MEDIAN	HIGHEST	
JAN	None				
(494)*					
APR	76/77	77/78	81/82	93/94	61
(505)*	78/79	81/82	85/86	95/96	18
	80/81	83/84		85/86	3
	82/83		87/88		1
JUL	76/77	77/78	82/83	99/100	94
(538)*	78/79	79/80	83/84	99/100	165.
	80/81	81/82	85/86	101/102	148
	82/83	83/84	87/88	97/98	67
	84/85	85/86		93/94	6
OCT	76/77	77/78	81/82	89/90	72
(453)*	78/79	79/80	81/82	93/94	34
	80/81	81/82	81/82	89/90	12
	82/83	83/84		87/88	4

*Total number of observations in indicated month.

#Month(s) with most frequent occurrence of high dew points - AUG, SEP.

HONG KONG
CUMULATIVE FREQUENCIES OF TEMPERATURES AND DEW POINTS

January, April, July, October

22°18'N 114°10'E Elevation 109 feet

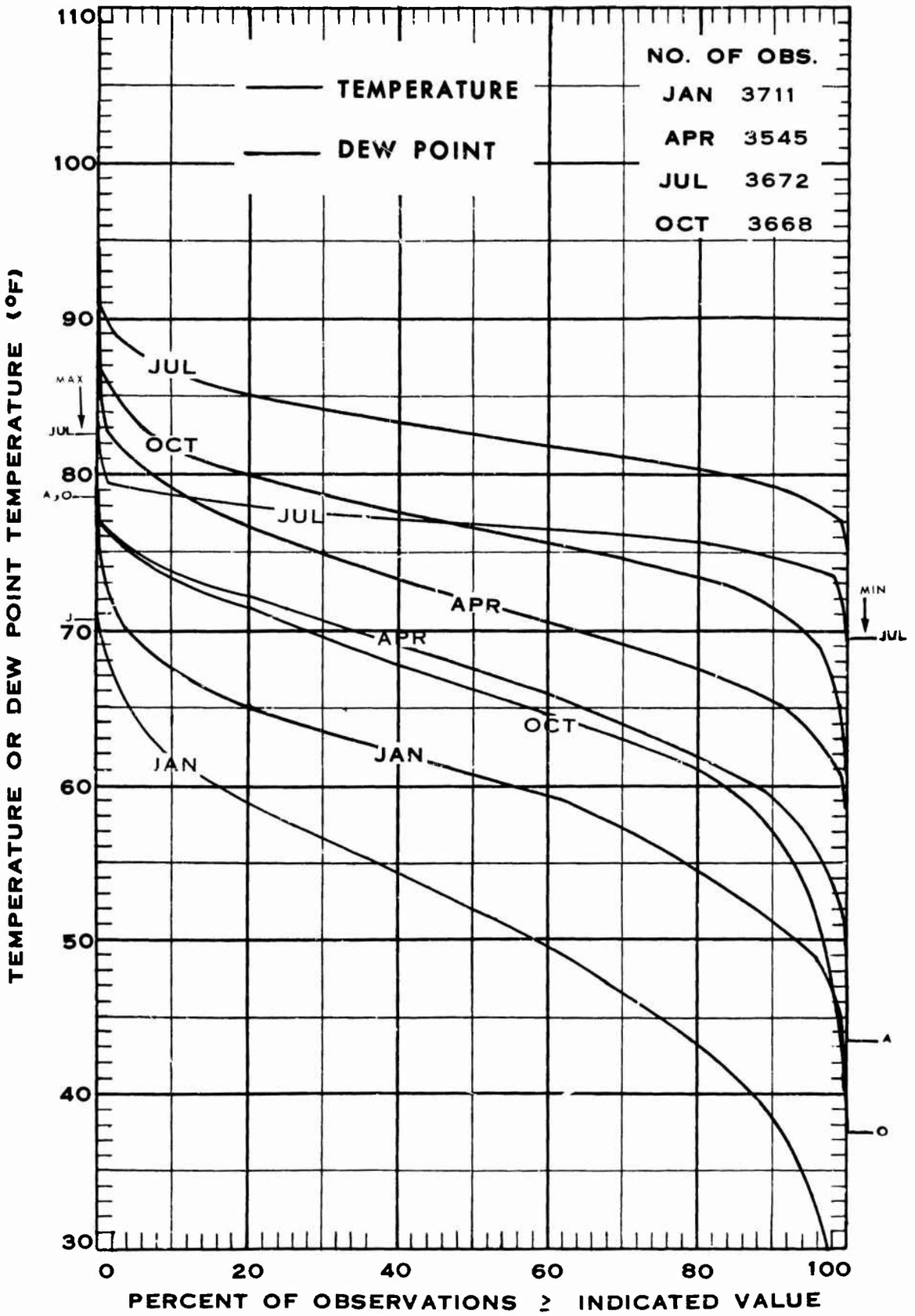


Figure 1.32

HONG KONG

TEMPERATURE-DEW POINT RELATIONSHIPS FOR DEW POINTS ≥ 76°F#

MONTH	DEW POINT CLASS	TEMPERATURE CLASS			NUMBER OF OBSERVATIONS
		LOWEST	MEDIAN	HIGHEST	
JAN	None				
(3711)*					
APR	76/77	75/76	79/80	85/86	122
(3545)*	78/79	81/82		85/86	3
JUL	76/77	75/76	81/82	91/92	1943
(3672*	78/79	77/78	83/84	91/92	980
	80/81	81/82	85/86	91/92	61
	82/83		85/86		1
OCT	76/77	77/78	81/82	87/88	120
(3668)*	78/79	79/80	85/86	87/88	20

*Total number of observations in indicated month.

#Month(s) with most frequent occurrence of high dew points - JUL, AUG.

HONOLULU, HAWAII

CUMULATIVE FREQUENCIES OF TEMPERATURES AND DEW POINTS

January, April, July, October

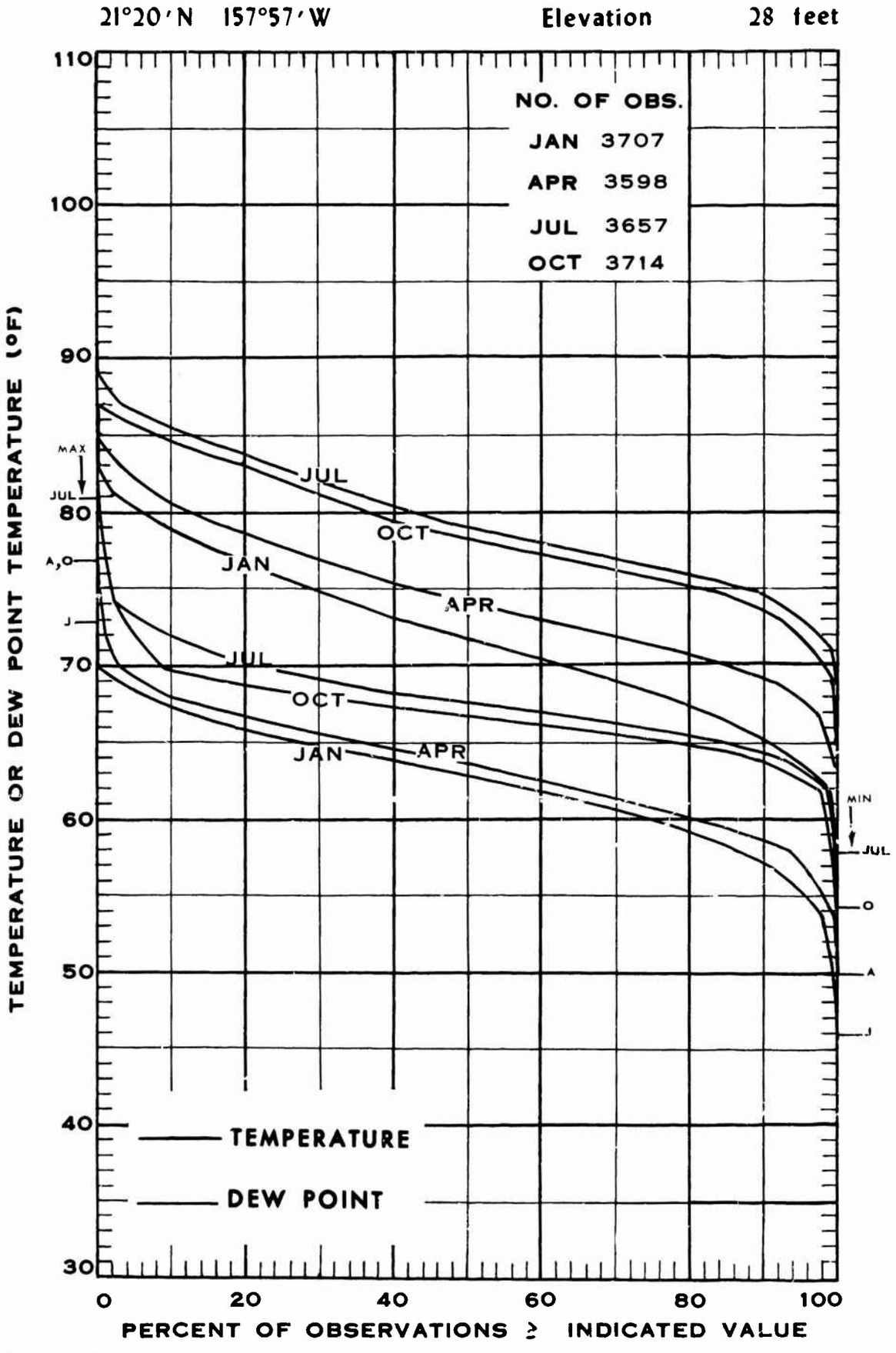


Figure 1.33

HONOLULU, HAWAII

TEMPERATURE-DEW POINT RELATIONSHIPS FOR DEW POINTS ≥ 76°F#

MONTH	DEW POINT CLASS	TEMPERATURE CLASS			NUMBER OF OBSERVATIONS
		LOWEST	MEDIAN	HIGHEST	
JAN	None				
(3707)*					
APR	76/77		81/82		1
(3598)*					
JUL	76/77	75/76		83/84	4
(3657)*					
OCT	76/77	83/84		87/88	7
(3714)*					

* Total number of observations in indicated month.

Month(s) with most frequent occurrence of high dew points - JUL, AUG.

ISTANBUL, TURKEY
CUMULATIVE FREQUENCIES OF TEMPERATURES AND DEW POINTS

January, April, July, October

40°28′ N 28°49′ E Elevation 62 feet

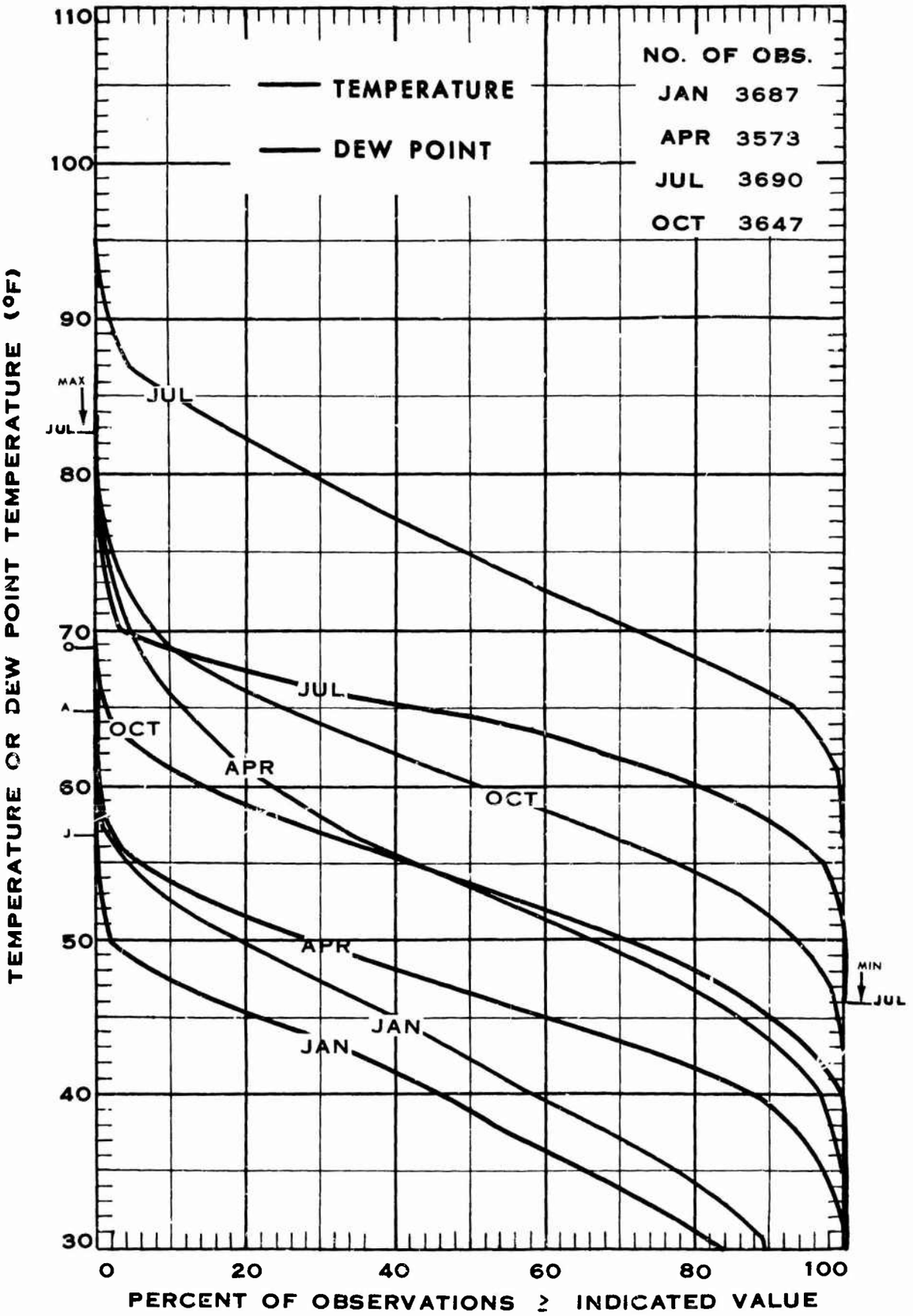


Figure 1.34

ISTANBUL,TURKEY

TEMPERATURE-DEW POINT RELATIONSHIPS FOR DEW POINTS ≥ 76°F

MONTH	DEW POINT CLASS	TEMPERATURE CLASS			NUMBER OF OBSERVATIONS
		LOWEST	MEDIAN	HIGHEST	
JAN	None				
(3687)*					
APR	None				
(3573)*					
JUL	76/77	81/82		83/84	3
(3690)*	82/83		83/84		1
OCT	None				
(3647)*					

*Total number of observations in indicated month.

#Month(s) with most frequent occurrence of high dew points - JUL, AUG.

IWO JIMA, VOLCANO ISLANDS

CUMULATIVE FREQUENCIES OF TEMPERATURES AND DEW POINTS

January, April, July, October

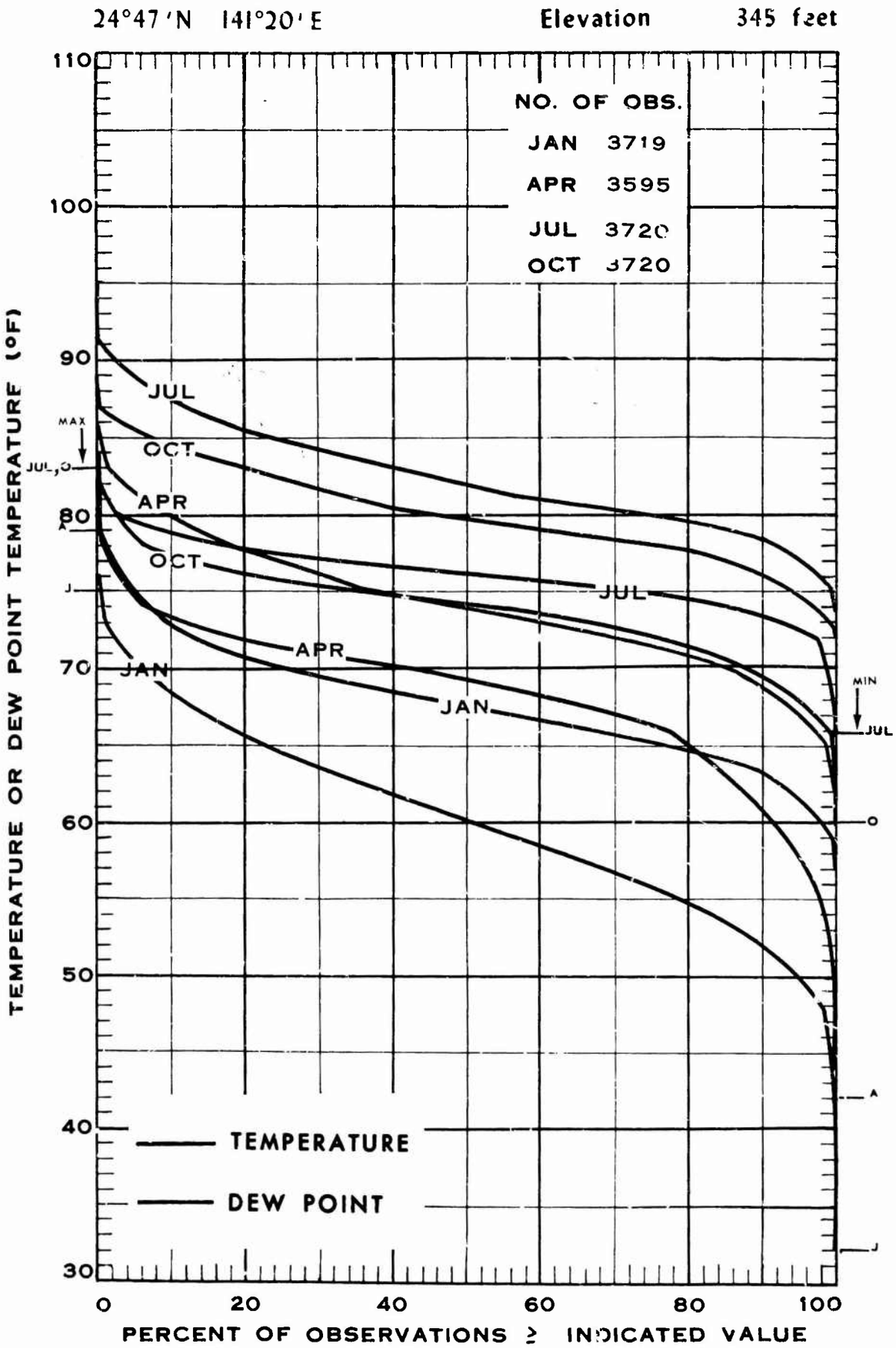


Figure 1.35

IWO JIMA, VOLCANO ISLANDS

TEMPERATURE-DEW POINT RELATIONSHIPS FOR DEW POINTS ≥ 76°F

MONTH	DEW POINT CLASS	TEMPERATURE CLASS			NUMBER OF OBSERVATIONS
		LOWEST	MEDIAN	HIGHEST	
JAN	None				
(3719)*					
APR	76/77		79/80		4
(3595)*					
JUL	76/77	75/76	81/82	91/92	1368
(3720)*	78/79	77/78	83/84	91/92	495
	80/81	79/80	85/86	89/90	52
	82/83	83/84		89/90	7
OCT	76/77	75/76	81/82	87/88	590
(3720)*	78/79	77/78	83/84	87/88	205
	80/81	81/82	83/84	87/88	39
	82/83		83/84		3

*Total number of observations in indicated month.

#Month(s) with most frequent occurrence of high dew points - JUL, AUG.

JOHNSTON ISLAND

CUMULATIVE FREQUENCIES OF TEMPERATURES AND DEW POINTS

January, April, July, October

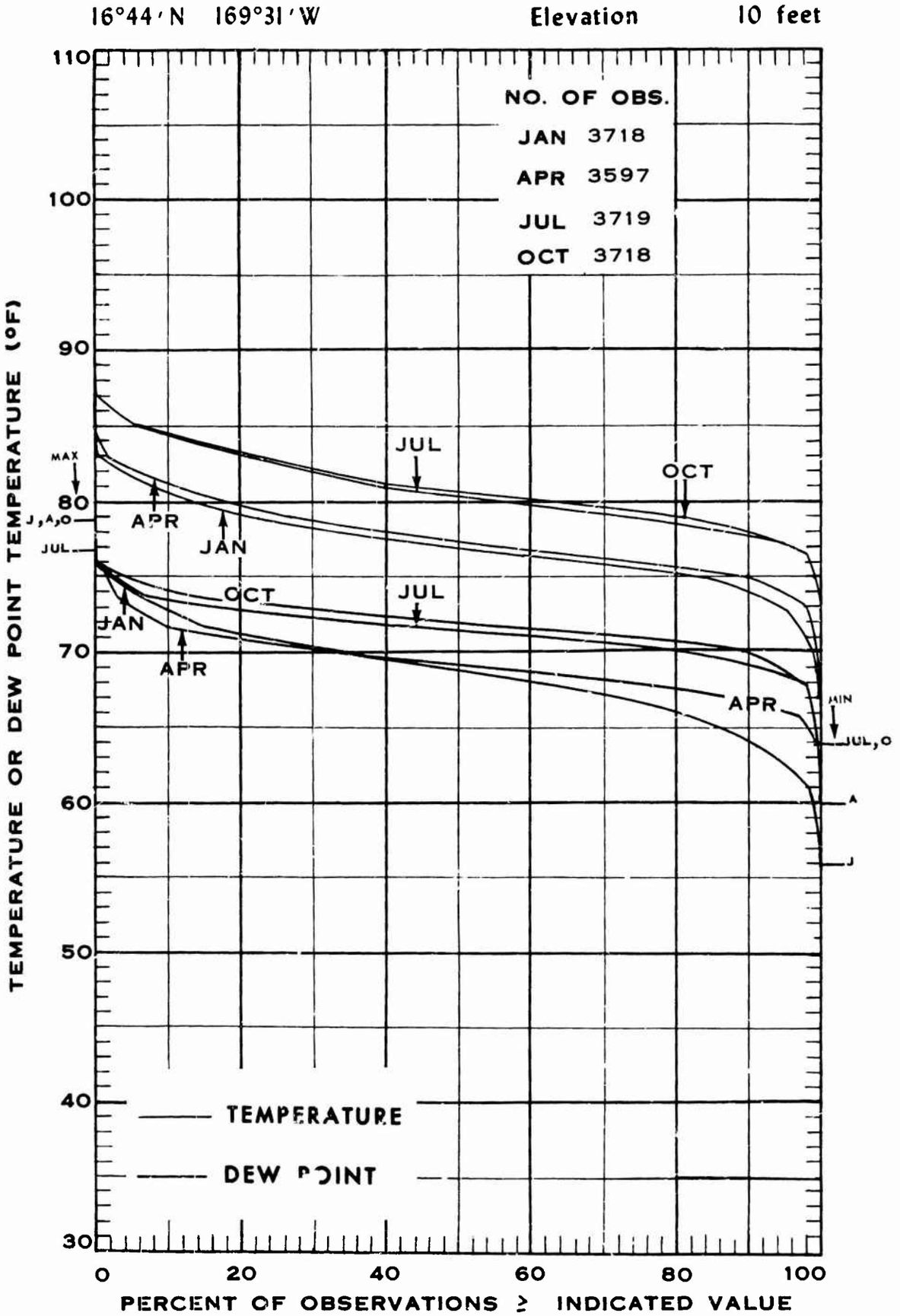


Figure 1.36

JOHNSTON ISLAND

TEMPERATURE-DEW POINT RELATIONSHIPS FOR DEW POINTS ≥ 76°F#

MONTH	DEW POINT CLASS	TEMPERATURE CLASS			NUMBER OF OBSERVATIONS
		LOWEST	MEDIAN	HIGHEST	
JAN	76/77	77/78	79/80	83/84	17
(3718)*	78/79	79/80		81/82	4
APR	76/77	79/80	81/82	83/84	28
(3597)*	78/79	81/82		83/84	6
JUL	76/77	77/78	81/82	85/86	13
(3719)*					
OCT	76/77	77/78	81/82	85/86	27
(3718)*					

*Total number of observations in indicated month.

#Month(s) with most frequent occurrence of high dew points - APR.

KADENA, OKINAWA

CUMULATIVE FREQUENCIES OF TEMPERATURES AND DEW POINTS

January, April, July, October

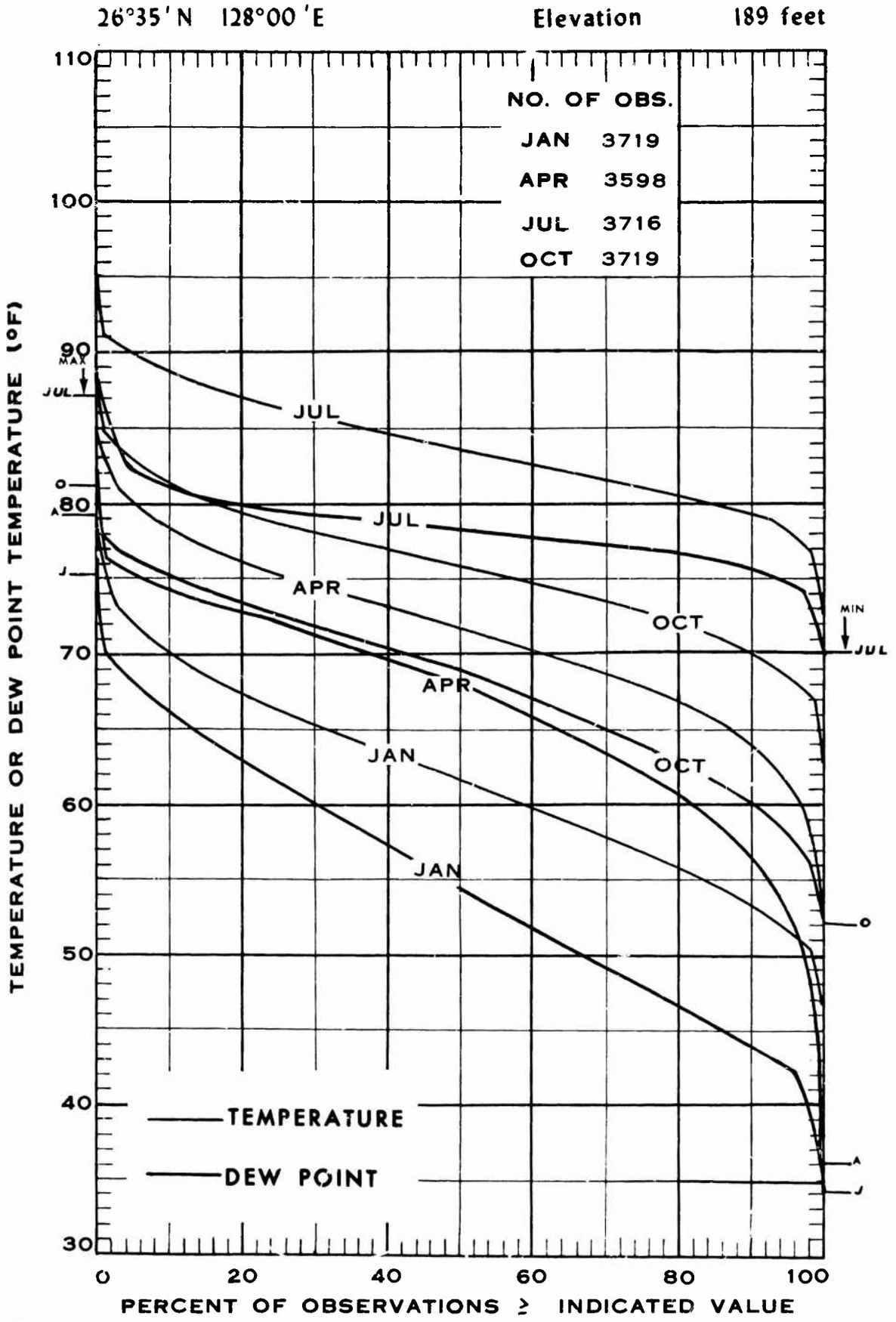


Figure 1.37

KADENA, OKINAWA

TEMPERATURE-DEW POINT RELATIONSHIPS FOR DEW POINTS ≥ 76°F#

MONTH	DEW POINT CLASS	TEMPERATURE CLASS			NUMBER OF OBSERVATIONS
		LOWEST	MEDIAN	HIGHEST	
JAN	None				
( )*					
APR	76/77	77/78	79/80	83/84	61
	78/79		81/82		1
JUL	76/77	75/76	81/82	93/94	1273
	78/79	77/78	83/84	93/94	1387
	80/81	79/80	85/86	93/94	390
	82/83	83/84	87/88	91/92	113
	84/85	85/86	87/88	91/92	41
	86/87		87/88		
OCT	76/77	77/78	81/82	85/86	130
	78/79	77/78	83/84	87/86	17
	80/81		85/86		1

* Number of observations not available.

Month(s) with most frequent occurrence of high dew points - JUL.

KAGOSHIMA, JAPAN

CUMULATIVE FREQUENCIES OF TEMPERATURES AND DEW POINTS

January, April, July, October

31°36'N 130°33'E Elevation 18 feet

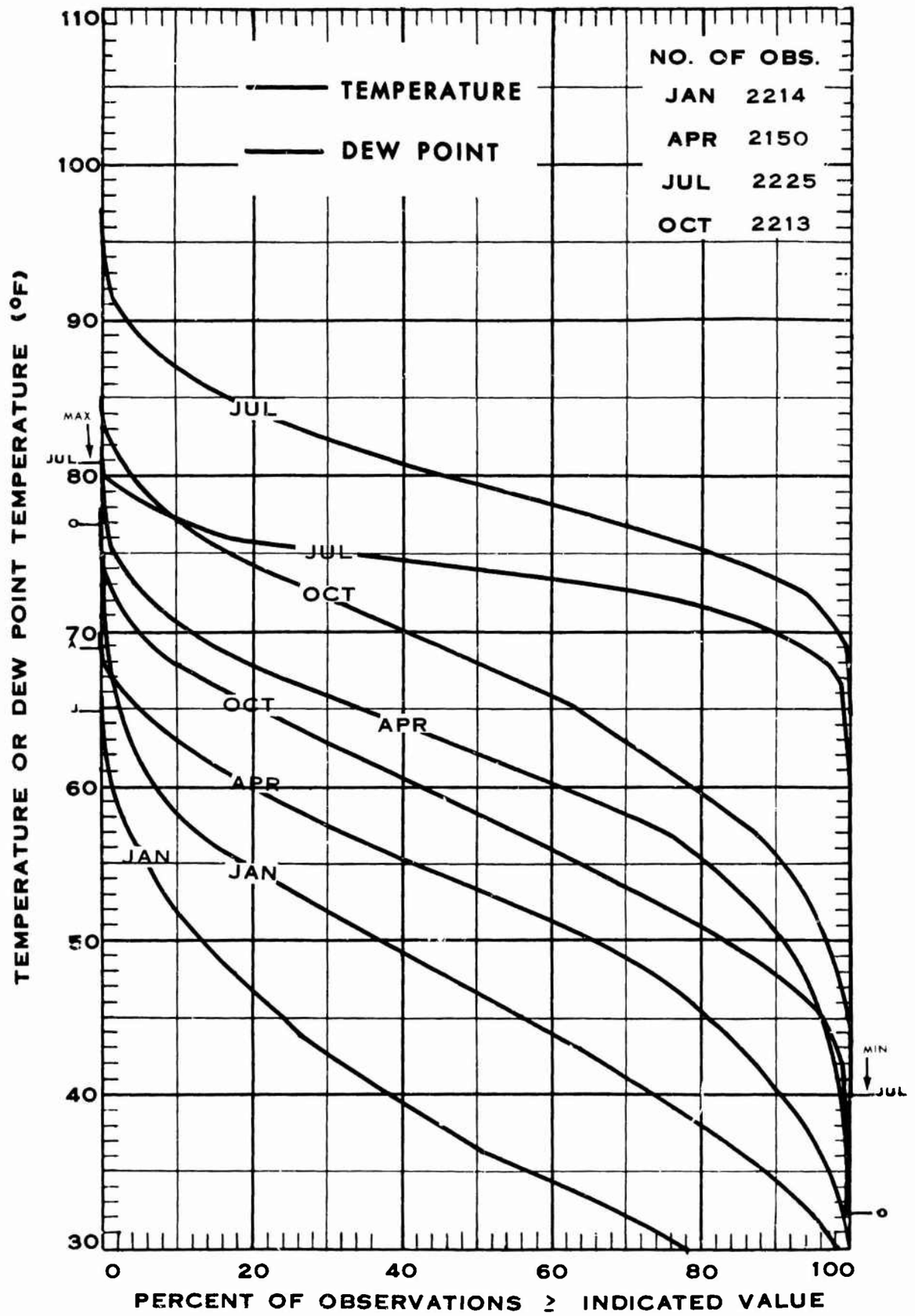


Figure 1.38

KAGOSHIMA, JAPAN

TEMPERATURE-DEW POINT RELATIONSHIPS FOR DEW POINTS ≥ 76°F#

MONTH	DEW POINT CLASS	TEMPERATURE CLASS			NUMBER OF OBSERVATIONS
		LOWEST	MEDIAN	HIGHEST	
JAN	None				
(2214)*					
APR	None				
(2150)*					
JUL	76/77	75/76	81/82	91/92	324
(2225)*	78/79	77/78	83/84	89/90	48
	80/81		89/90		1
OCT	76/77	77/78		79/80	2
(2213)*					

*Total number of observations in indicated month.

#Month(s) with most frequent occurrence of high dew points - AUG.

KARACHI, WEST PAKISTAN
CUMULATIVE FREQUENCIES OF TEMPERATURES AND DEW POINTS
January, April, July, October

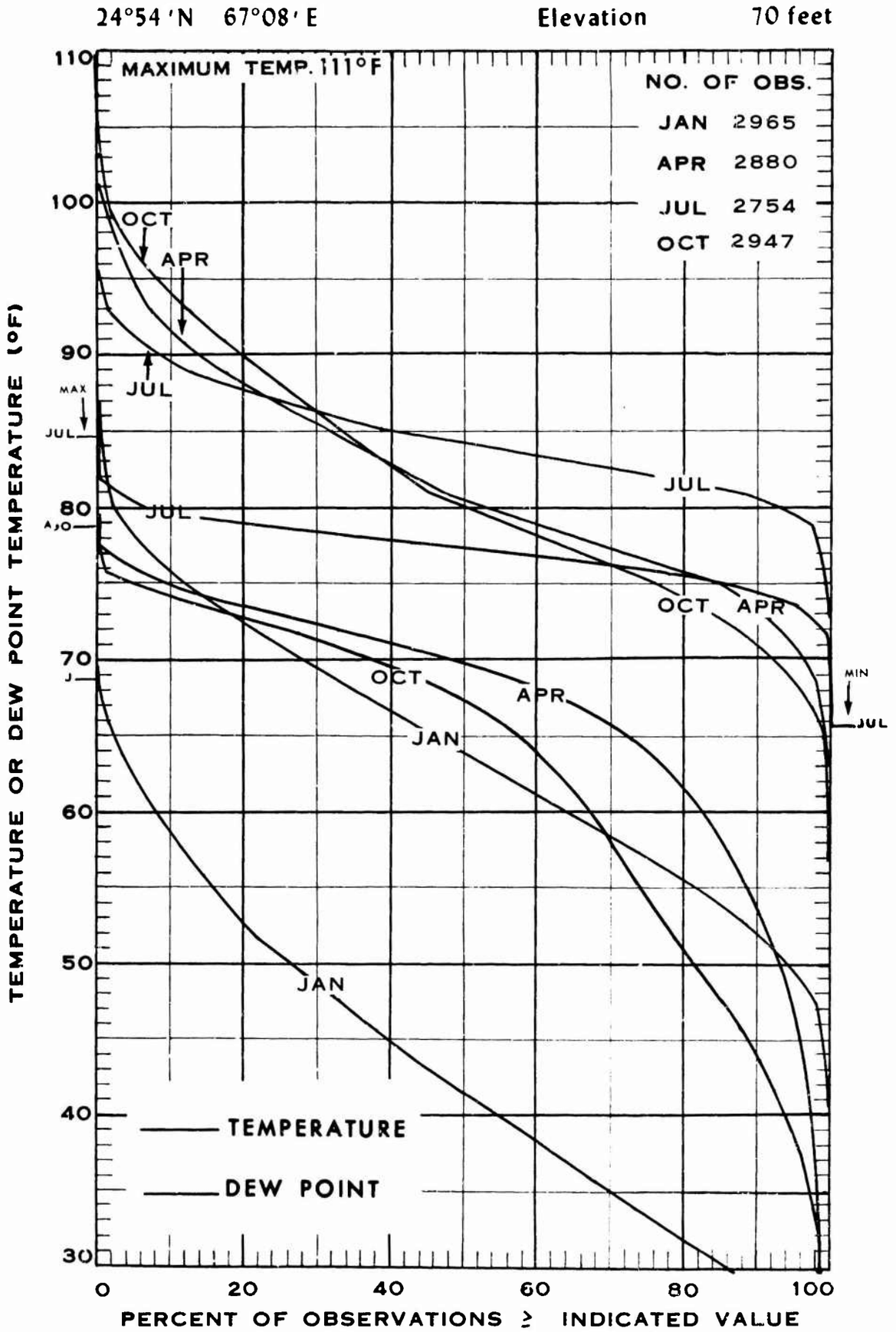


Figure 1.39

KARACHI, WEST PAKISTAN

TEMPERATURE-DEW POINT RELATIONSHIPS FOR DEW POINTS ≥ 76°F

MONTH	DEW POINT CLASS	TEMPERATURE CLASS			NUMBER OF OBSERVATIONS
		LOWEST	MEDIAN	HIGHEST	
JAN	None				
(2965)*					
APR	76/77	75/76	79/80	91/92	144
(2880)*	78/79	79/80	83/84	93/94	14
JUL	76/77	75/76	83/84	95/96	899
(2754)*	78/79	77/78	83/84	95/96	1022
	80/81	79/80	83/84	91/92	211
	82/83	81/82	83/84	91/92	16
	84/85	83/84		87/88	2
OCT	76/77	75/76	79/80	89/90	55
(2947)*	78/79	79/80		83/84	4

*Total number of observations in indicated month.

#Month (s) with most frequent occurrence of high dew points - JUN, JUL.

KHARTOUM, SUDAN

CUMULATIVE FREQUENCIES OF TEMPERATURES AND DEW POINTS

January, April, July, October

15°36' N 32°33' E Elevation 1247 feet

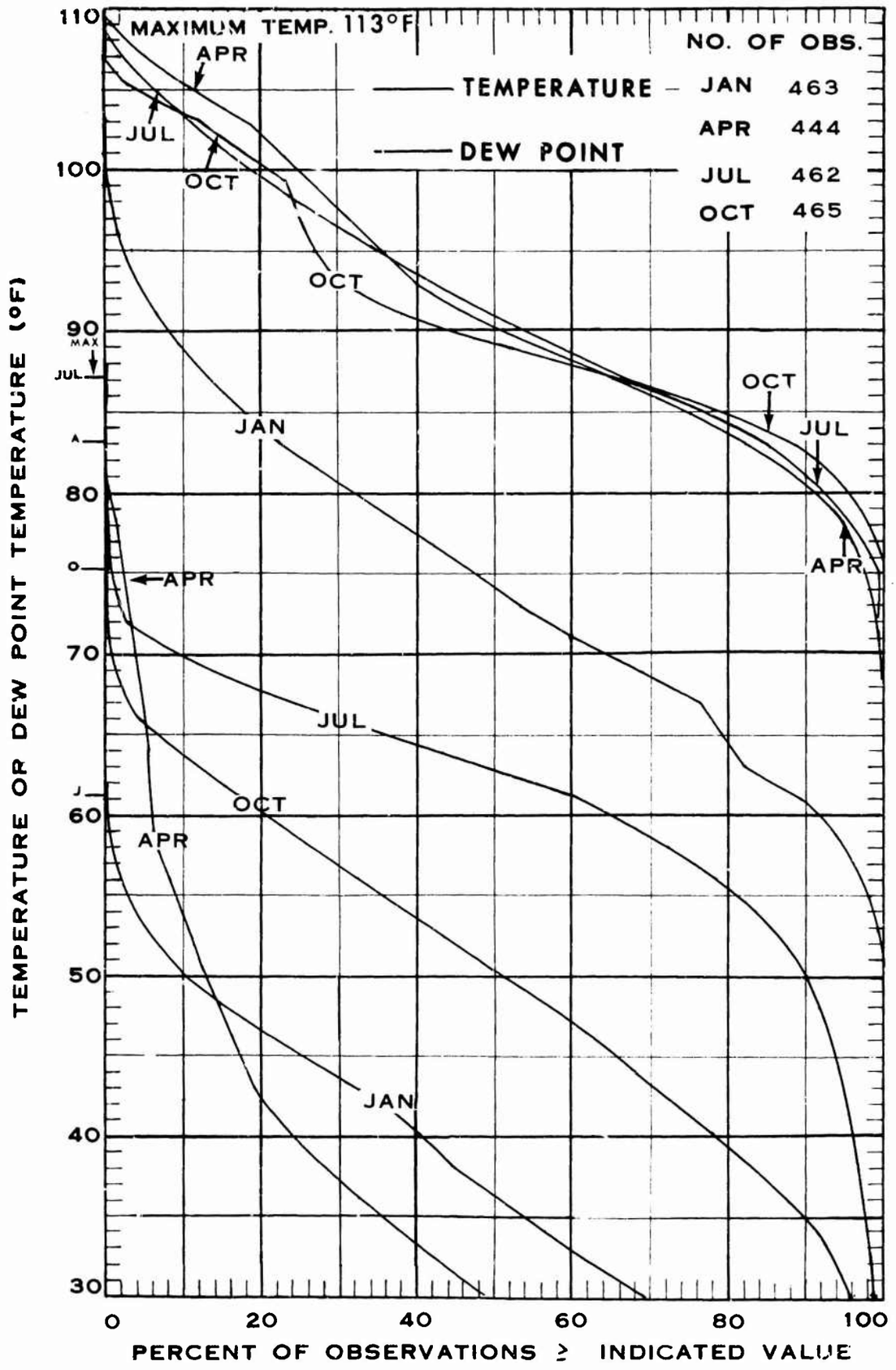


Figure 1.40

KHARTOUM, SUDAN

TEMPERATURE-DEW POINT RELATIONSHIPS FOR DEW POINTS ≥ 76°F#

MONTH	DEW POINT CLASS	TEMPERATURE CLASS			NUMBER OF OBSERVATIONS
		LOWEST	MEDIAN	HIGHEST	
JAN	None				
(463)*					
APR					
(444)*	78/79	101/102		103/104	4
	80/81	103/104		109/110	3
	82/83		97/98		1
JUI	76/77		79/80		1
(462)*	80/81		103/104		1
	86/87		87/88		1
OCT	None				
(465)*					

*Total number of observations in indicated month.

#Month(s) with most frequent occurrence or high dew points - APR.

KINGSTON, JAMAICA

CUMULATIVE FREQUENCIES OF TEMPERATURES AND DEW POINTS

January, April, July, October

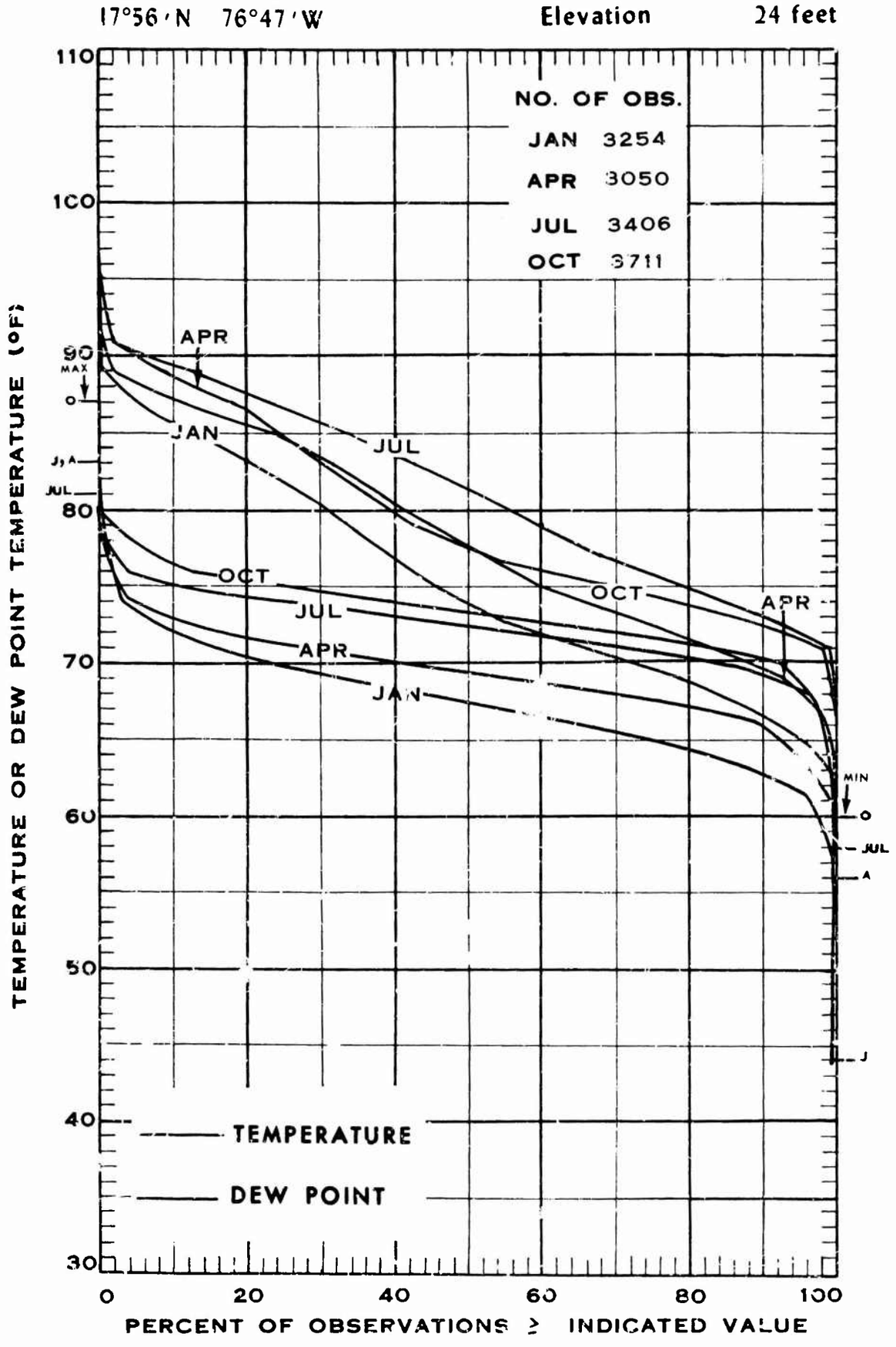


Figure 1.41

KINGSTON, JAMAICA

TEMPERATURE-DEW POINT RELATIONSHIPS FOR DEW POINTS ≥ 76°F#

MONTH	DEW POINT CLASS	TEMPERATURE CLASS			NUMBER OF OBSERVATIONS
		LOWEST	MEDIAN	HIGHEST	
JAN	76/77	79/80	83/84	89/90	17
(3254)*	78/79	81/82	83/84	87/88	23
	80/81	83/84	85/86	87/88	12
	82/83	81/82		87/88	3
APR	76/77	77/78	87/88	89/90	28
(3050)*	78/79	77/78	85/86	87/88	18
	80/81		85/86		1
	82/83	85/86		89/90	4
JUL	76/77	75/76	83/84	91/92	127
(3406)*	78/79	79/80	85/86	89/90	14
	80/81	87/88		89/90	5
OCT	76/77	75/76	83/84	93/94	361
(3711)*	78/79	79/80	85/86	91/92	92
	80/81	79/80	87/88	89/90	25
	82/83	85/86		89/90	7
	84/85		87/88		1
	86/87		89/90		1

*Total number of observations in indicated month.

#Month(s) with most frequent occurrence of high dew points - OCT

LALMANIRHAT, EAST PAKISTAN

CUMULATIVE FREQUENCIES OF TEMPERATURES AND DEW POINTS

January, April, July, October

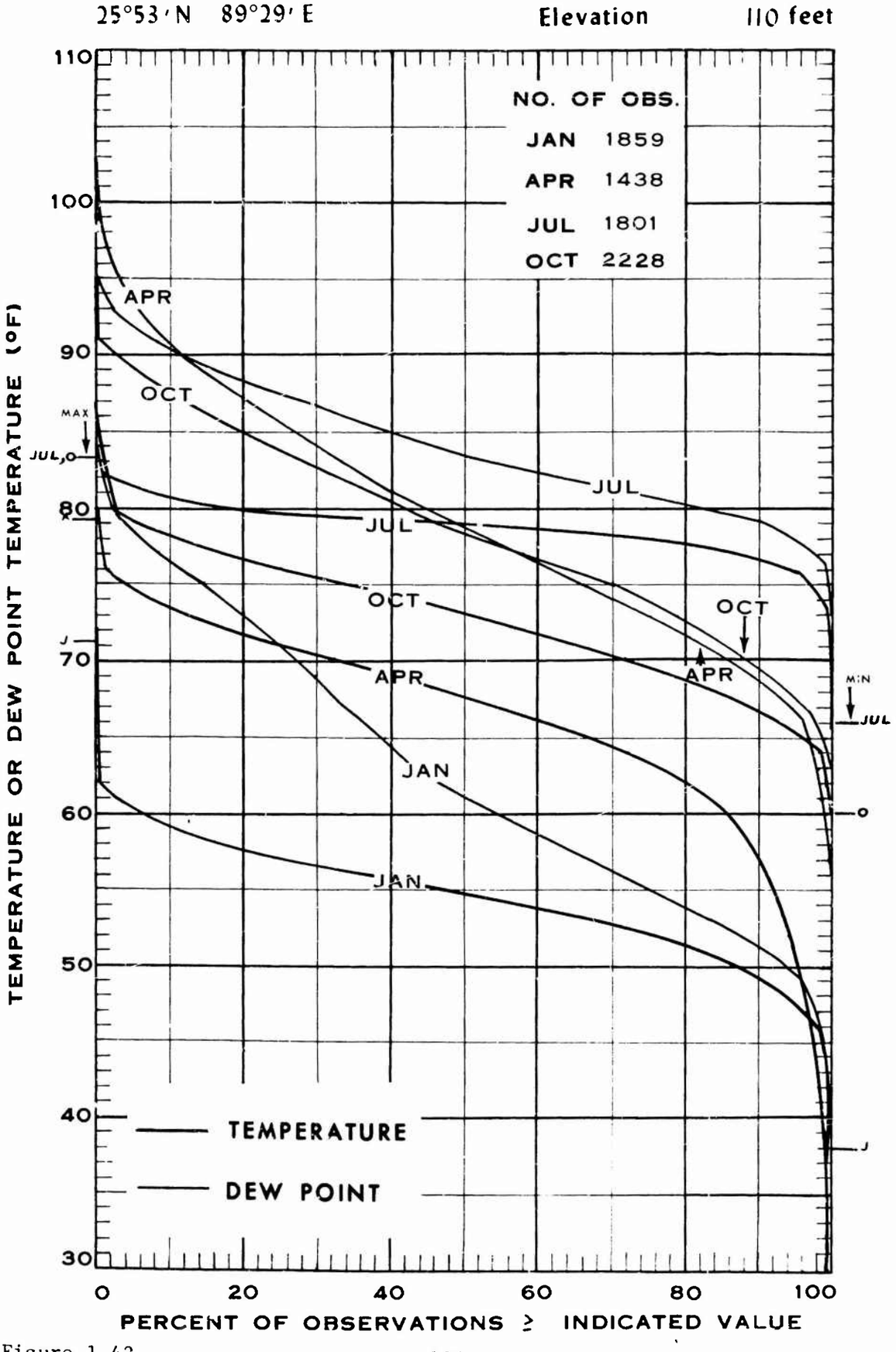


Figure 1.42

LALMANIRHAT, EAST PAKISTAN

TEMPERATURE-DEW POINT RELATIONSHIPS FOR DEW POINTS ≥ 76°F#

MONTH	DEW POINT CLASS	TEMPERATURE CLASS			NUMBER OF OBSERVATIONS
		LOWEST	MEDIAN	HIGHEST	
JAN	None				
(1859)*					
APR	76/77	77/78	83/84	87/88	17
(1438)*	78/79	85/86		87/88	2
JUL	76/77	75/76	81/82	95/96	479
(1801)*	78/79	77/78	83/84	95/96	915
	80/81	79/80	83/84	95/96	297
	82/83	83/84	85/86	95/96	20
OCT	76/77	75/76	79/80	91/92	302
(2228)*	78/79	77/78	79/80	93/94	204
	80/81	79/80	83/84	93/94	48
	82/83		85/86		1

*Total number of observations in indicated month.

#Month(s) with most frequent occurrence of high dew points - AUG.

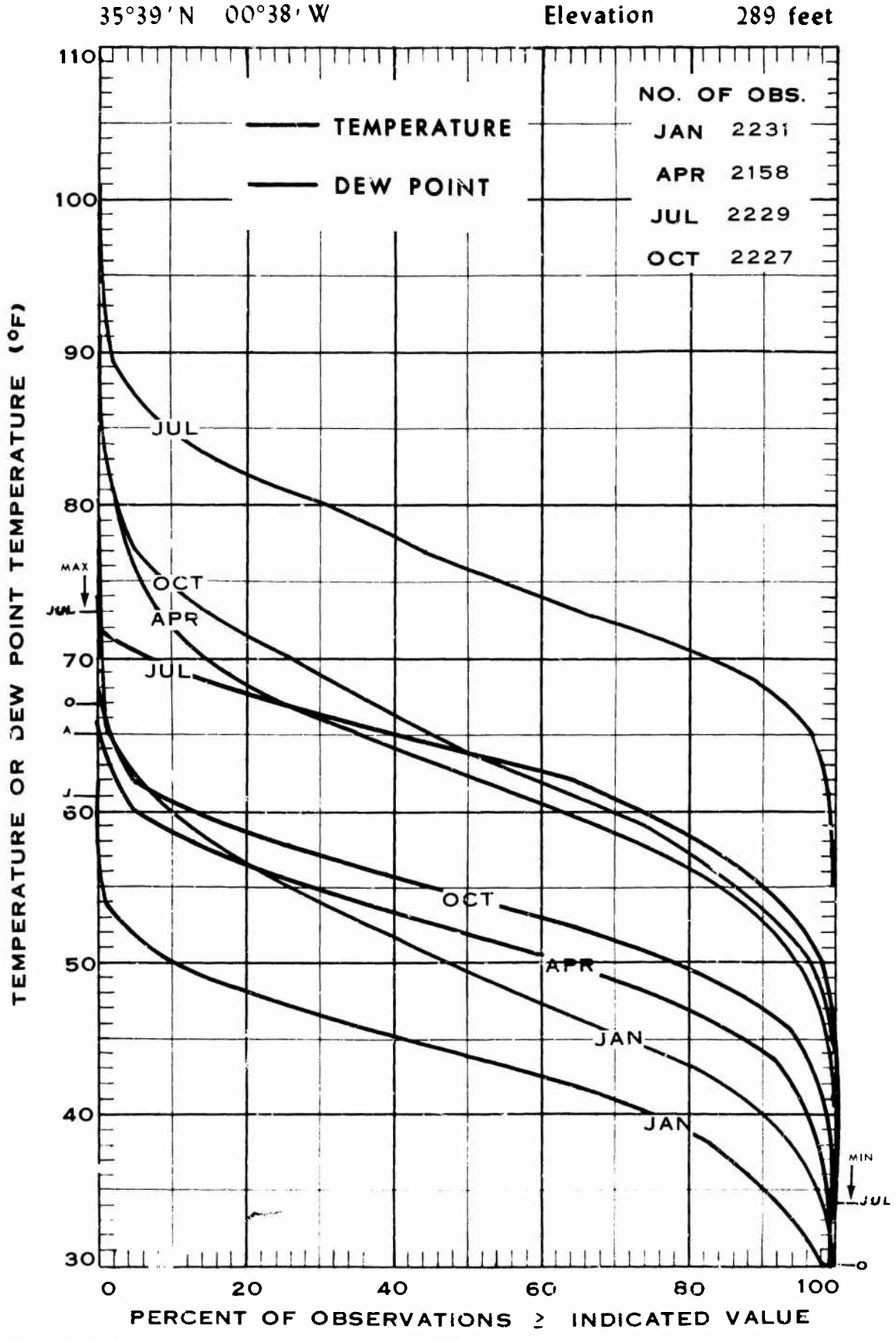

LA SENIA, ALGERIA
CUMULATIVE FREQUENCIES OF TEMPERATURES AND DEW POINTS
January, April, July, October
35°39' N 00°38' W
Elevation 289 feet
NO. OF OBS.
JAN 2231
APR 2158
JUL 2229
OCT 2227
TEMPERATURE
DEW POINT
TEMPERATURE OR DEW POINT TEMPERATURE (°F)
PERCENT OF OBSERVATIONS ≥ INDICATED VALUE
MAX
MIN
JUL
OCT
APR
JAN

Figure 1.43

LA SENIA, ALGERIA

TEMPERATURE-DEW POINT RELATIONSHIPS FOR DEW POINTS ≥ 76°F#

MONTH	DEW POINT CLASS	TEMPERATURE CLASS			NUMBER OF OBSERVATIONS
		LOWEST	MEDIAN	HIGHEST	
JAN	None				
(2231)*					
APR	None				
(2158)*					
JUL	None				
(2229)*					
OCT	None				
(2227)*					

*Total number of observations in indicated month.

#Month(s) with most frequent occurrence of high dew points - JUL, AUG.

LUANDA, ANGOLA

CUMULATIVE FREQUENCIES OF TEMPERATURES AND DEW POINTS

January, April, July, October

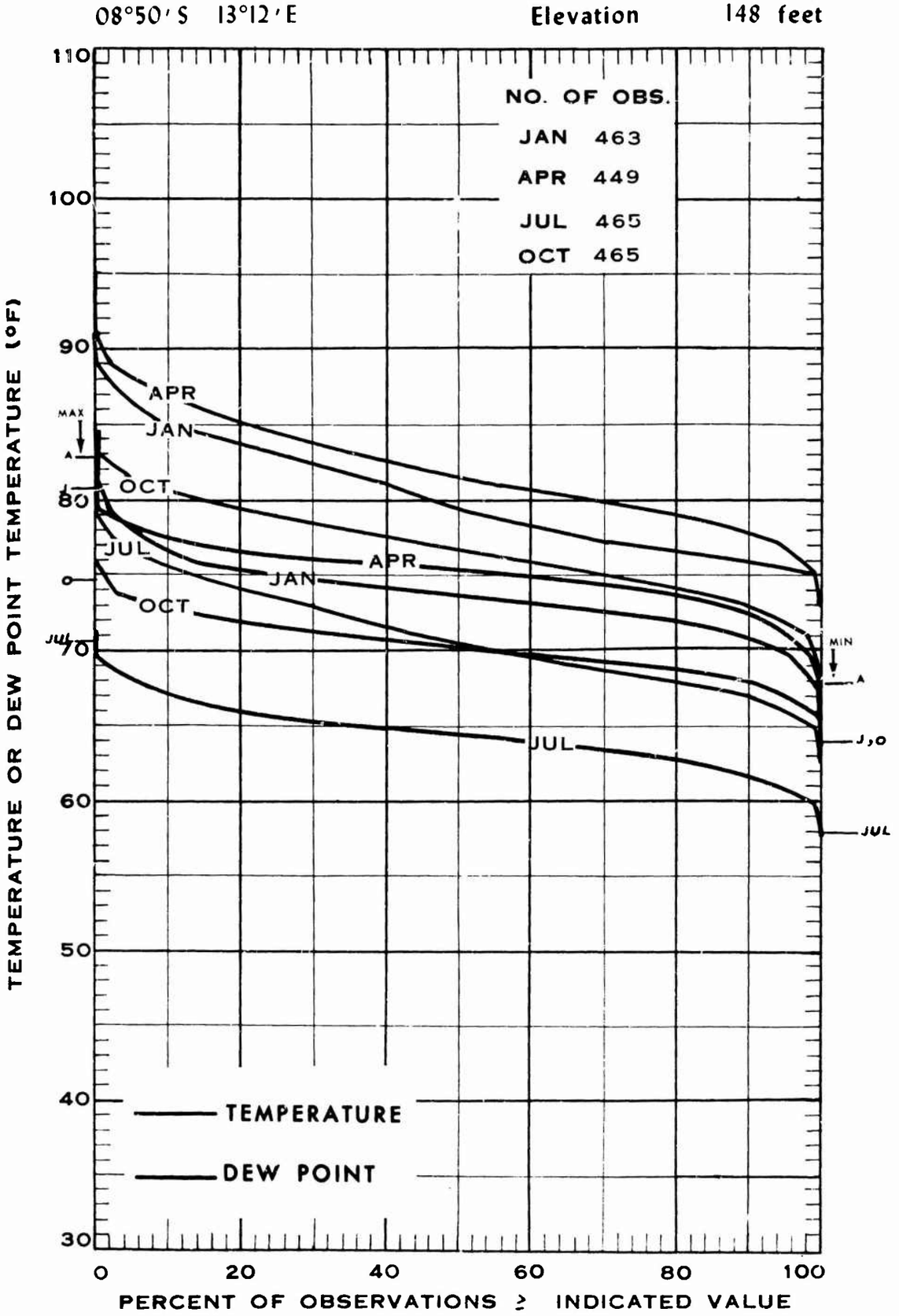


Figure 1.44

LUANDA, ANGOLA

TEMPERATURE-DEW POINT RELATIONSHIPS FOR DEW POINTS ≥ 76°F#

MONTH	DEW POINT CLASS	TEMPERATURE CLASS			NUMBER OF OBSERVATIONS
		LOWEST	MEDIAN	HIGHEST	
JAN	76/77	77/78	81/82	89/90	44
(463)*	78/79	79/80	83/84	85/86	18
	80/81	85/86		87/88	5
APR	76/77	77/78	81/82	89/90	132
(449)*	78/79	79/80	85/86	87/88	29
	80/81		87/88		1
	82/83		85/86		1
JUL	None				
(465)*					
OCT	None				
(465)*					

*Total number of observations in indicated month.

#Month(s) with most frequent occurrence of high dew points - APR.

MADRID, SPAIN

CUMULATIVE FREQUENCIES OF TEMPERATURES AND DEW POINTS

January, April, July, October

40°24' N 03°41' W Elevation 2188 feet

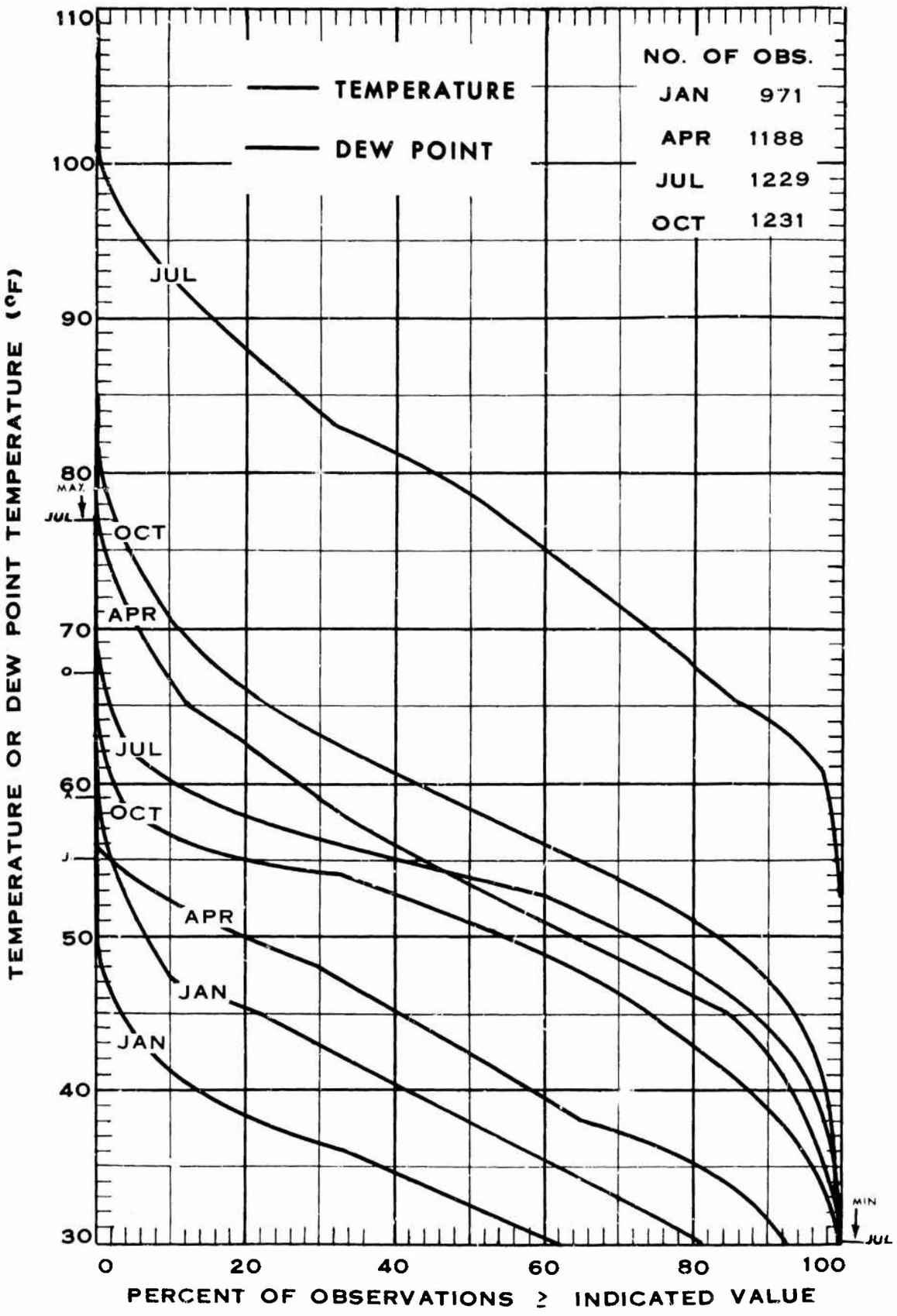


Figure 1.45

MADRID, SPAIN

TEMPERATURE-DEW POINT RELATIONSHIPS FOR DEW POINTS ≥ 76°F#

MONTH	DEW POINT CLASS	TEMPERATURE CLASS			NUMBER OF OBSERVATIONS
		LOWEST	MEDIAN	HIGHEST	
JAN	None				
(971)*					
APR	None				
(1188)*					
JUL	76/77		77/78		1
(1229)*					
OCT	None				
(1231)*					

*Total number of observations in indicated month.

#Month(s) with most frequent occurrence of high dew points - JUL.

MANAGUA, NICARAGUA

CUMULATIVE FREQUENCIES OF TEMPERATURES AND DEW POINTS

January, April, July, October

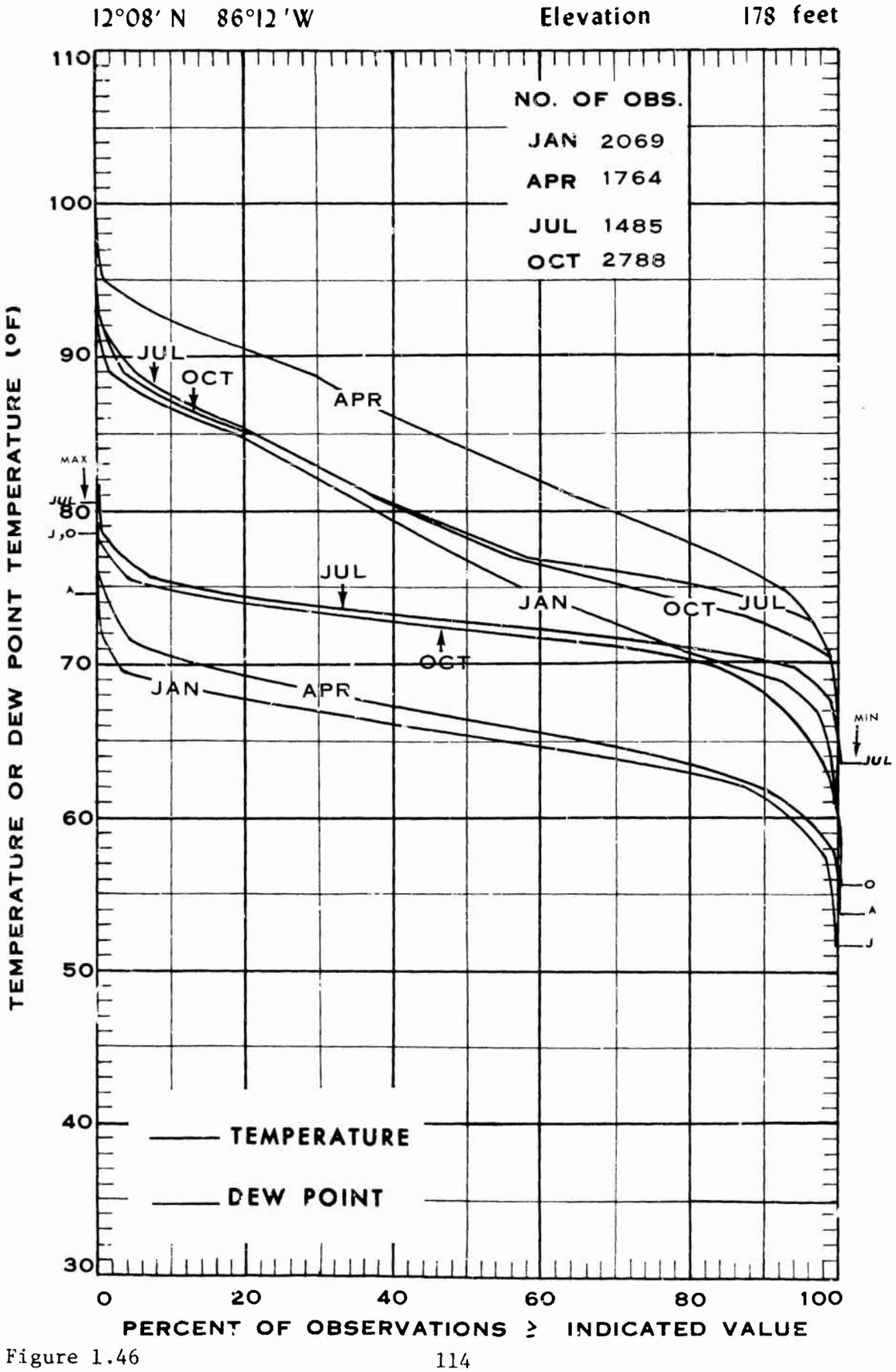


Figure 1.46

MANAGUA, NICARAGUA

TEMPERATURE-DEW POINT RELATIONSHIPS FOR DEW POINTS ≥ 76°F#

MONTH	DEW POINT CLASS	TEMPERATURE CLASS			NUMBER OF OBSERVATIONS
		LOWEST	MEDIAN	HIGHEST	
JAN	76/77		87/88		1
(2069)*	78/79	85/86		87/88	2
APR	None				
(1764)*					
JUL	76/77	75/76	79/80	89/90	85
(1485)*	78/79	79/80	83/84	87/88	22
	80/81	81/82		89/90	4
OCT	76/77	77/78	79/80	91/92	115
(2788)*	78/79	79/80	83/84	87/88	16

*Total number of observations in indicated month.

#Month(s) with most frequent occurrence of high dew points - AUG, SEP.

MANILA, PHILIPPINE ISLANDS
CUMULATIVE FREQUENCIES OF TEMPERATURES AND DEW POINTS
January, April, July, October

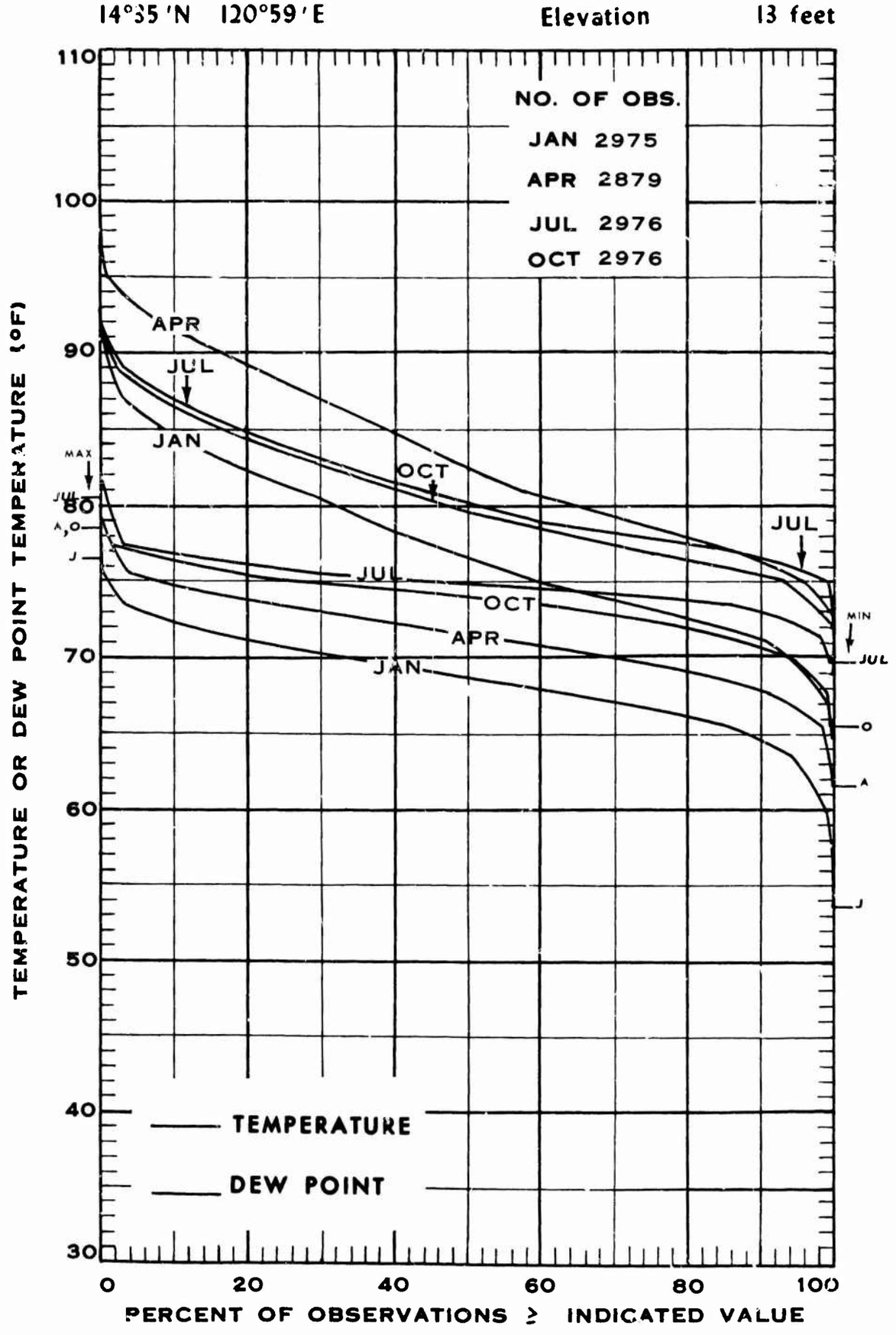


Figure 1.47

MANILA, PHILIPPINE ISLANDS

TEMPERATURE-DEW POINT RELATIONSHIPS FOR DEW POINTS ≥ 76°F#

MONTH	DEW POINT CLASS	TEMPERATURE CLASS			NUMBER OF OBSERVATIONS
		LOWEST	MEDIAN	HIGHEST	
JAN	76/77	79/80		85/86	6
(2975)*					
APR	76/77	77/78	87/88	93/94	114
(2879)*	78/79	87/88		93/94	4
JUL	76/77	77/78	83/84	91/92	805
(2976)*	78/79	79/80	85/86	91/92	102
	80/81	81/82		87/88	7
OCT	76/77	77/78	81/82	91/92	578
(2976)*	78/79	79/80	85/86	91/92	42

*Total number of observations in indicated month.

#Month(s) with most frequent occurrence of high dew points - JUL.

MARSHALL, LIBERIA

CUMULATIVE FREQUENCIES OF TEMPERATURES AND DEW POINTS

January, April, July, October

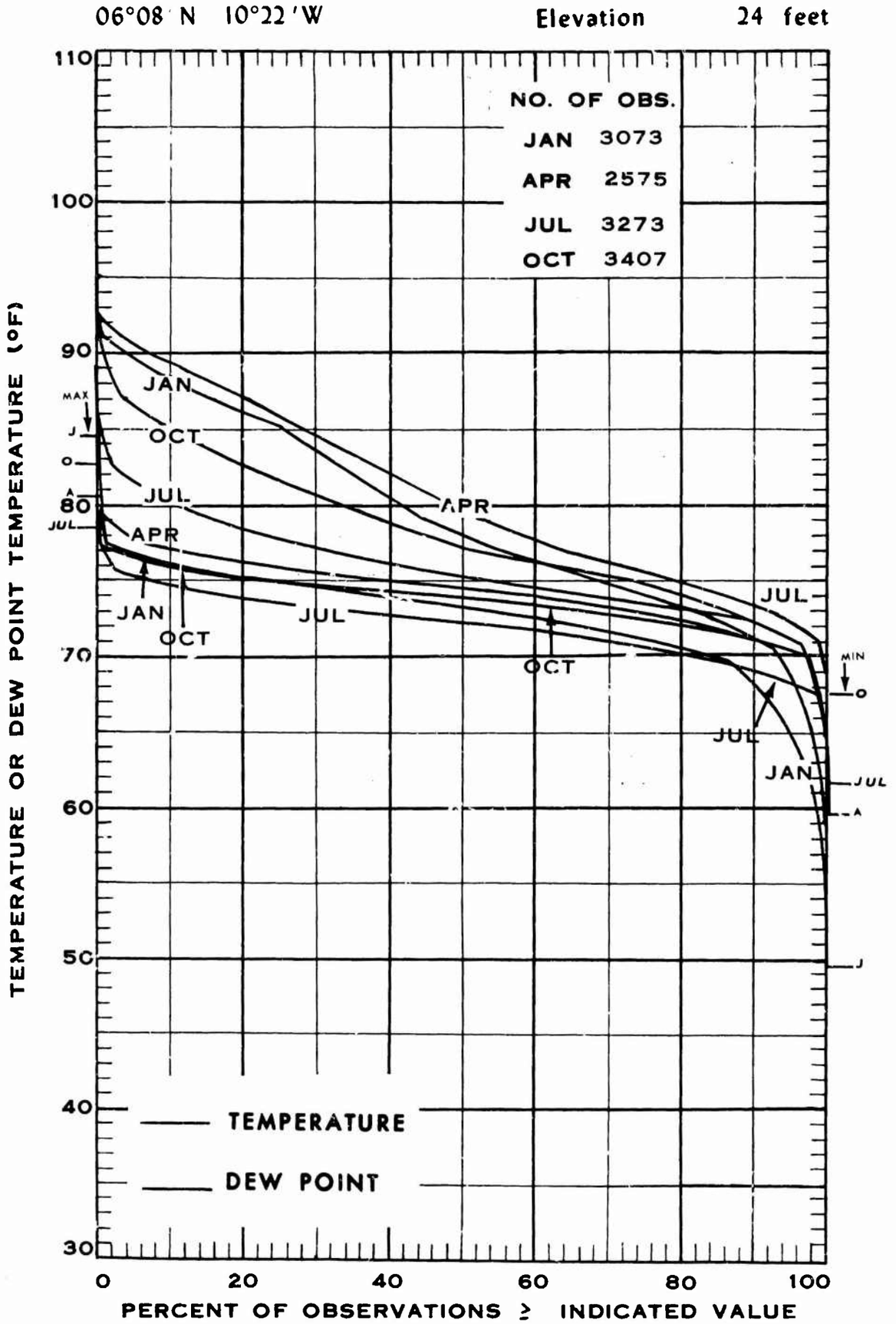


Figure 1.48

MARSHALL, LIBERIA

TEMPERATURE-DEW POINT RELATIONSHIPS FOR DEW POINTS ≥ 76°F

MONTH	DEW POINT CLASS	TEMPERATURE CLASS			NUMBER OF OBSERVATIONS
		LOWEST	MEDIAN	HIGHEST	
JAN	76/77	75/76	83/84	91/92	399
( )*	78/79	79/80	83/84	91/92	40
	80/81		83/84		1
	84/85		85/86		1
APR	76/77	75/76	81/82	93/94	634
	78/79	77/78	85/86	93/94	127
	80/81	85/86		91/92	6
JUL	76/77	75/76	79/80	87/88	79
	78/79	79/80		83/84	5
OCT	76/77	75/76	81/82	97/98	447
	78/79	77/78	83/84	89/90	71
	80/81	81/82	85/86	89/90	11
	82/83		87/88		2

*Number of observations not available.

#Month(s) with most frequent occurrence of high dew points - APR, MAY.

MESHED, IRAN

CUMULATIVE FREQUENCIES OF TEMPERATURES AND DEW POINTS

January, April, July, October

36°17'N 59°36'E Elevation 3104 feet

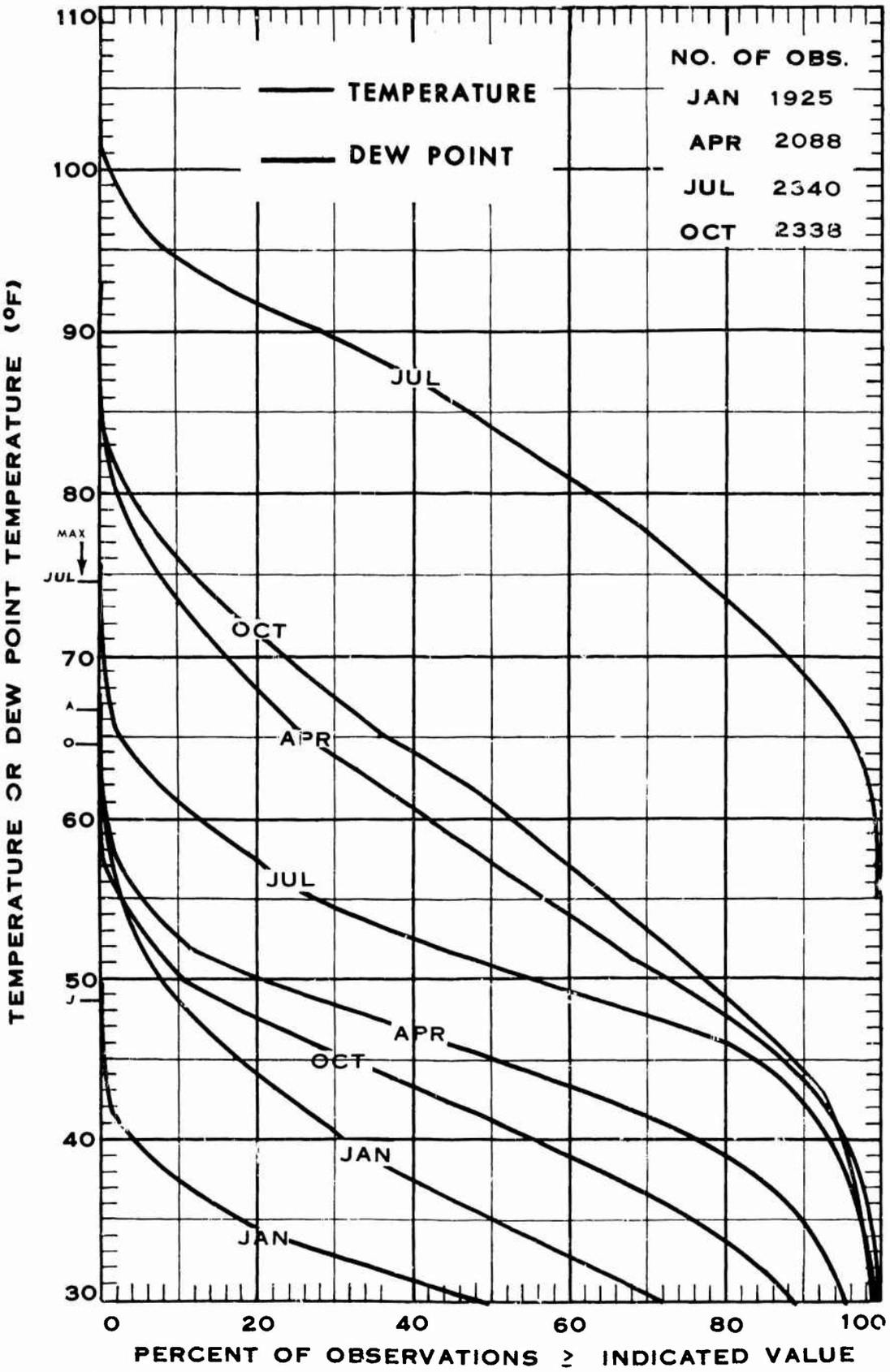


Figure 1.49

MESHED, IRAN

TEMPERATURE-DEW POINT RELATIONSHIPS FOR DEW POINTS ≥ 76°F#

MONTH	DEW POINT CLASS	TEMPERATURE CLASS			NUMBER OF OBSERVATIONS
		LOWEST	MEDIAN	HIGHEST	
JAN	None				
(1925)*					
APR	None				
(2088)*					
JUL	None				
(2340)*					
OCT	None				
(2338)*					

*Total number of observations in indicated month.

#Month(s) with most frequent occurrence of high dew points - JUL.

MIAMI, FLORIDA
CUMULATIVE FREQUENCIES OF TEMPERATURES AND DEW POINTS
January, April, July, October

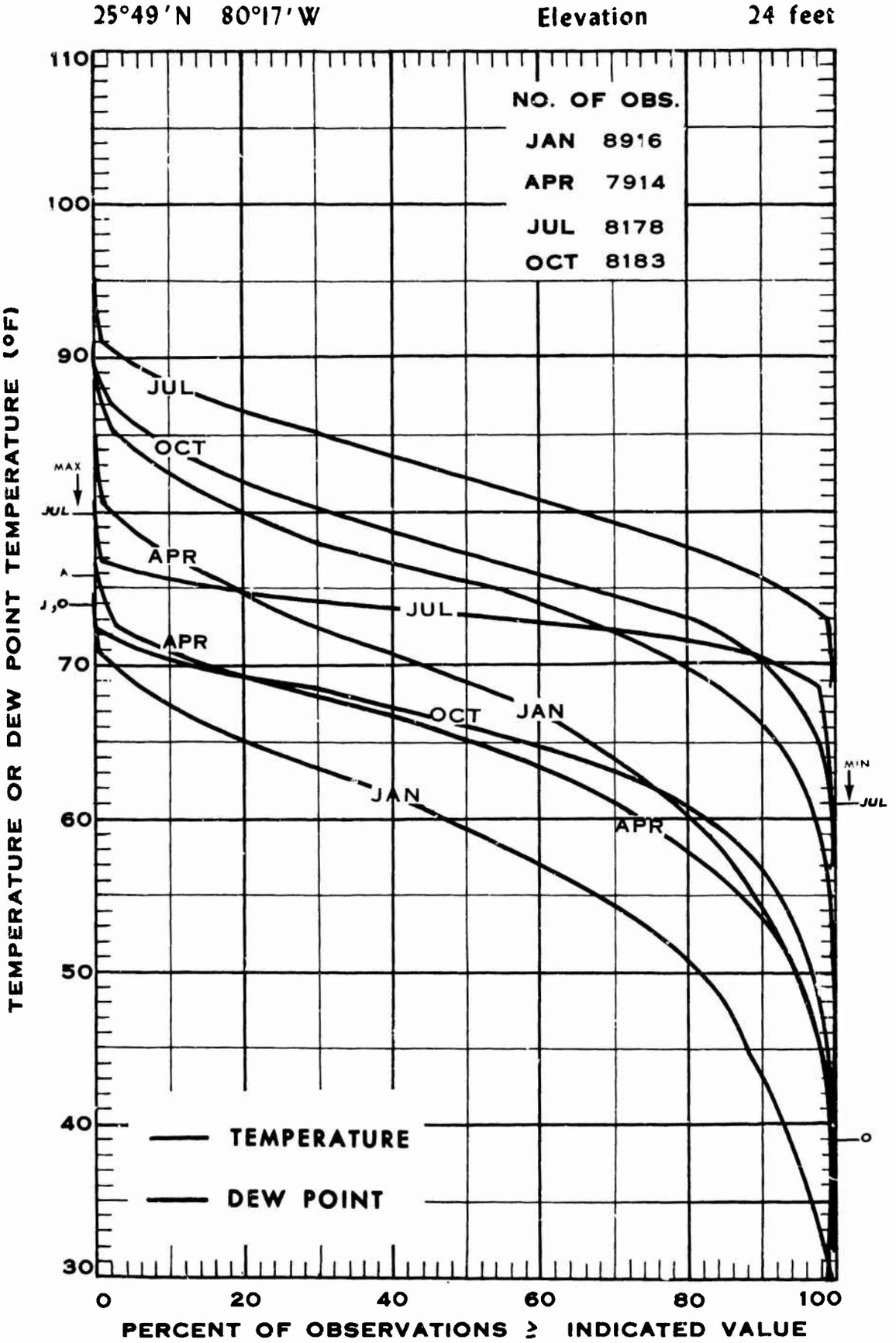


Figure 1.50

MIAMI, FLORIDA

Data not available

(See p 6 for explanation)

MILNE BAY, PAPUA (NEW GUINEA)

CUMULATIVE FREQUENCIES OF TEMPERATURES AND DEW POINTS

January, April, July, October

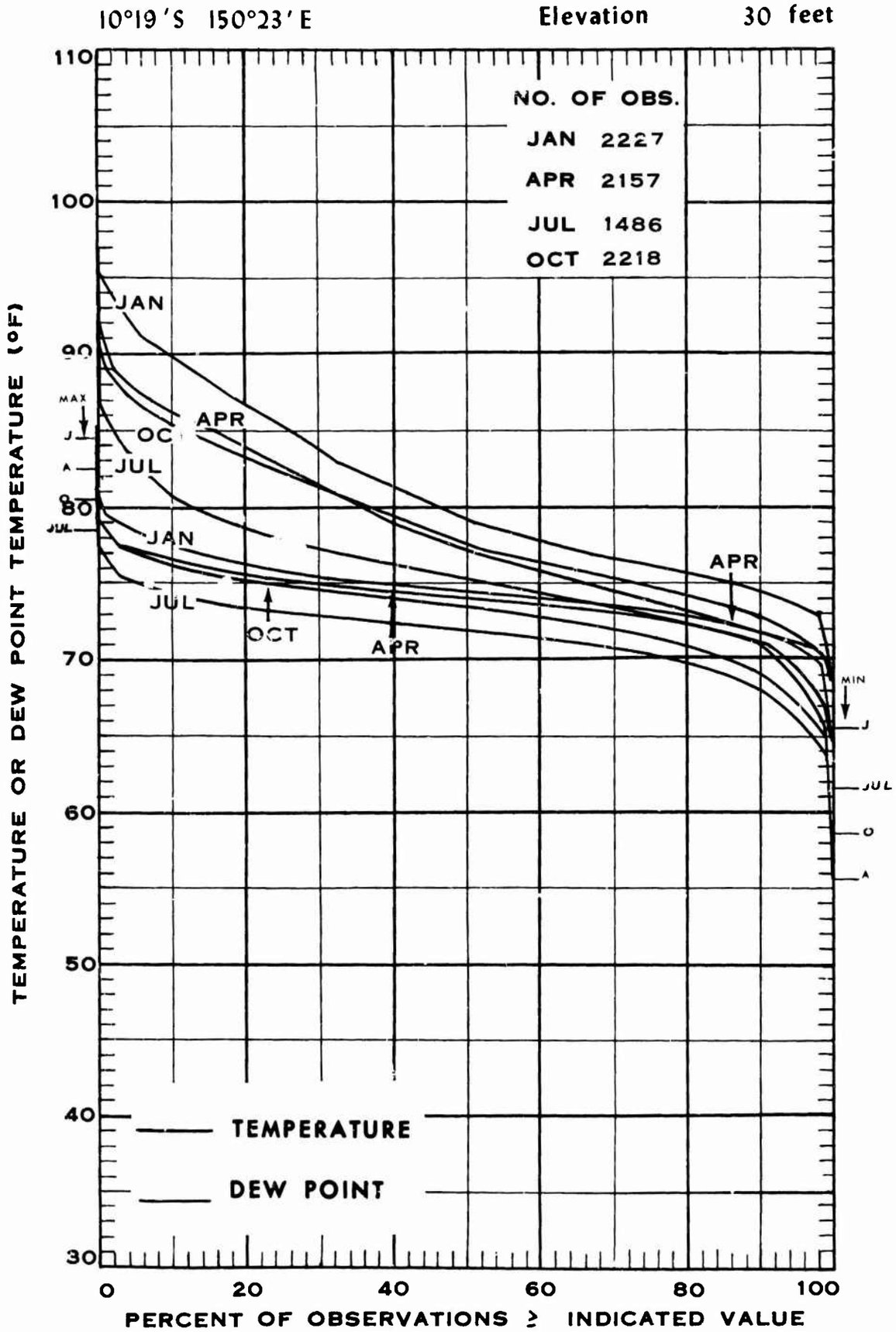


Figure 1.51

MILNE BAY, PAPUA(NEW GUINEA)

TEMPERATURE-DEW POINT RELATIONSHIPS FOR DEW POINTS ≥ 76°F

MONTH	DEW POINT CLASS	TEMPERATURE CLASS			NUMBER OF OBSERVATIONS
		LOWEST	MEDIAN	HIGHEST	
JAN	76/77	75/76	81/82	95/96	476
(2227)*	78/79	79/80	85/86	95/96	203
	80/81	81/82	89/90	93/94	27
	82/83	87/88		95/96	2
	84/85	87/88		95/96	2
APR	76/77	75/76	81/82	91/92	421
(2157)*	78/79	77/78	85/86	91/92	72
	80/81	81/82		87/88	4
	82/83	85/86		89/90	3
JUL	76/77	75/76	79/80	87/88	54
(1486)*	78/79	81/82			3
OCT	76/77	75/76	81/82	89/90	
(2218)*	78/79	77/78	85/86	89/90	
	80/81	81/82		89/90	

* Total number of observations in indicated month.

Month(s) with most frequent occurrence of high dew points - JAN, FEB.

MOBILE, ALABAMA
CUMULATIVE FREQUENCIES OF TEMPERATURES AND DEW POINTS

January, April, July, October

30°38'N 88°04'W Elevation 26 feet

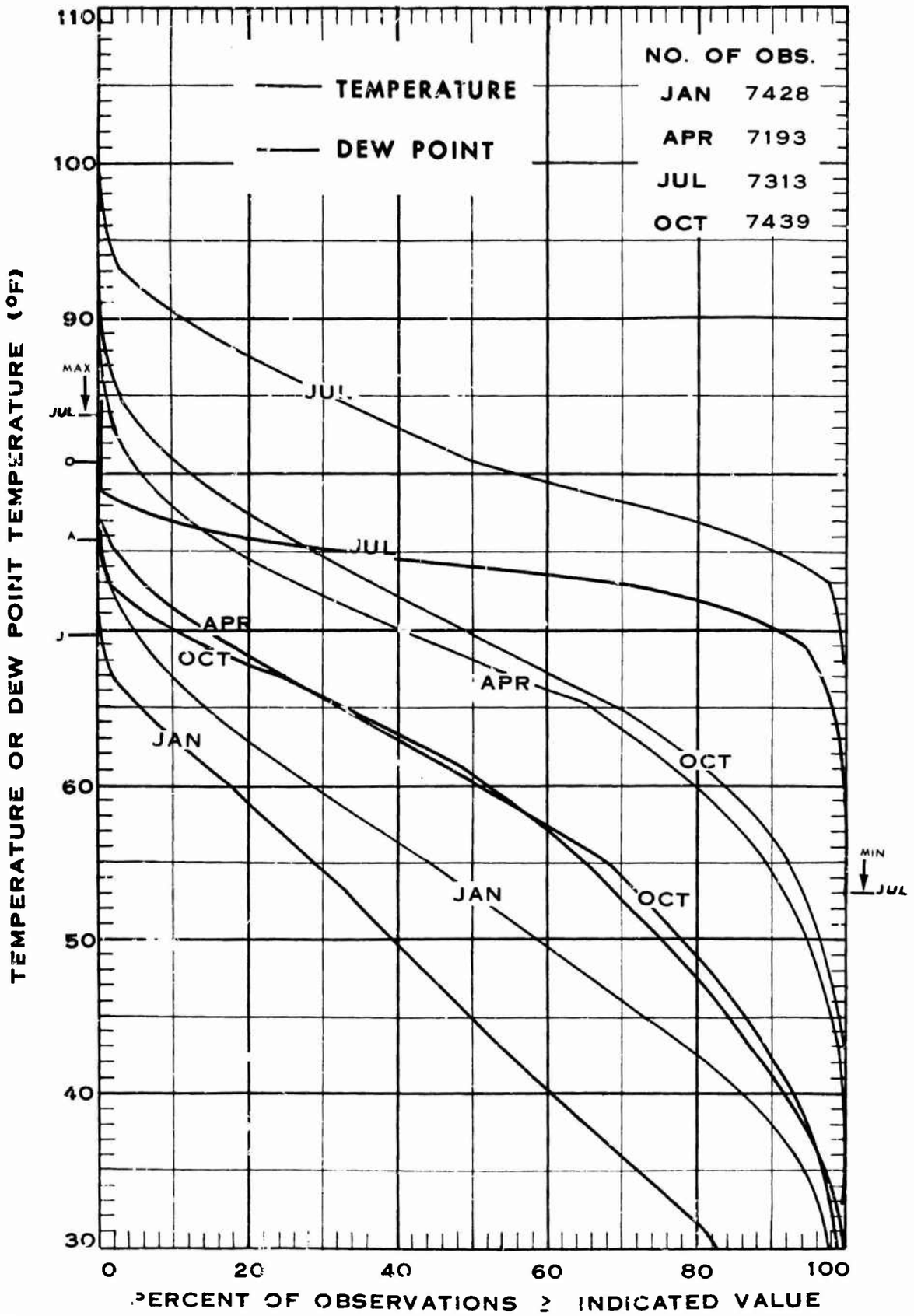


Figure 1.52

MOBILE, ALABAMA

Data not available

(See p 6 for explanation)

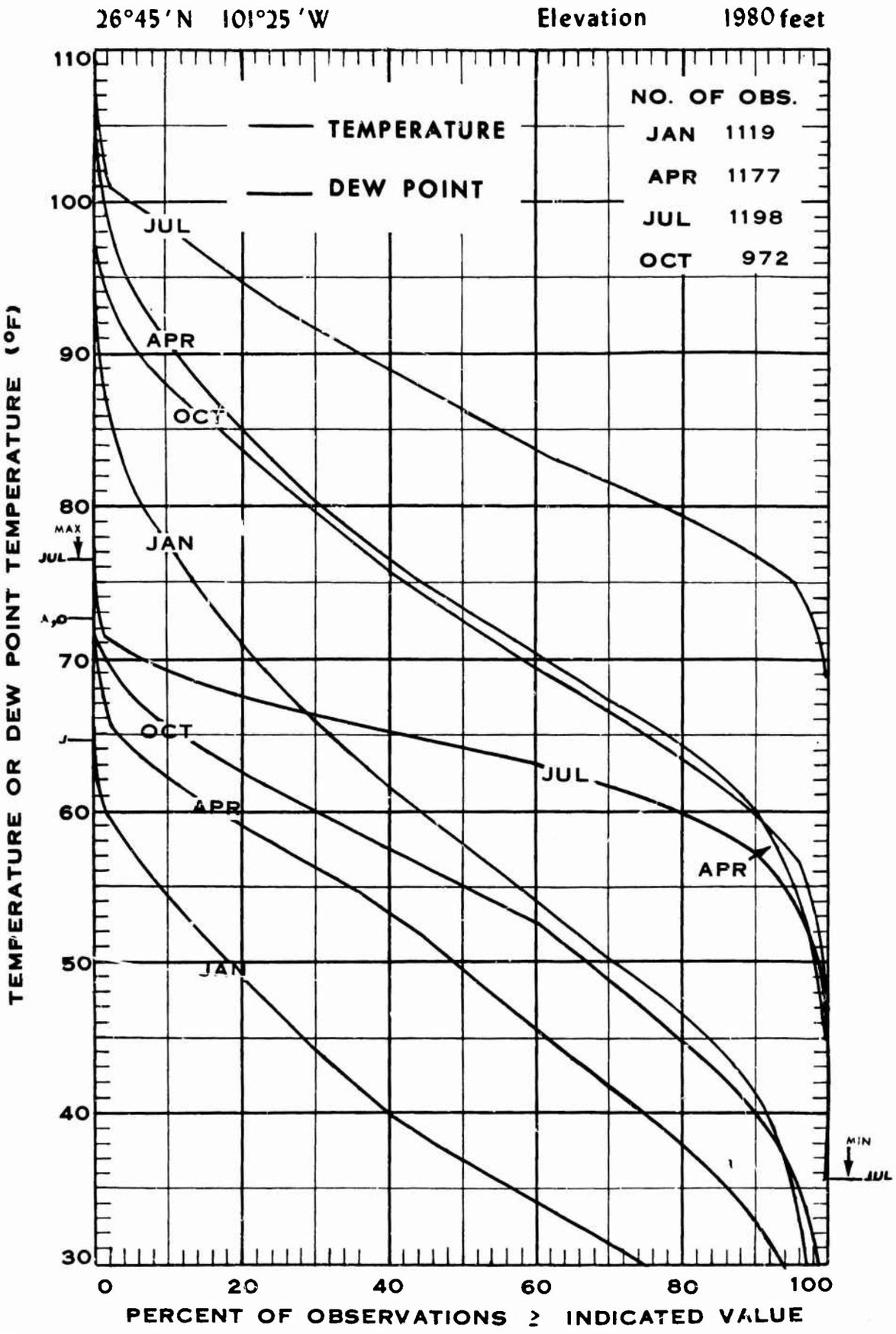

MONCLOVA, MEXICO
CUMULATIVE FREQUENCIES OF TEMPERATURES AND DEW POINTS
January, April, July, October
26°45'N 101°25'W
Elevation 1980 feet
TEMPERATURE
DEW POINT
NO. OF OBS.
JAN 1119
APR 1177
JUL 1198
OCT 972
JUL
APR
OCT
JAN
MAX JUL
MIN JUL
TEMPERATURE OR DEW POINT TEMPERATURE (°F)
PERCENT OF OBSERVATIONS ≥ INDICATED VALUE
110
100
90
80
70
60
50
40
30
0
20
40
60
80
100

Figure 1.53

MONCLOVA, MEXICO

TEMPERATURE-DEW POINT RELATIONSHIPS FOR DEW POINTS ≥ 76°F

MONTH	DEW POINT CLASS	TEMPERATURE CLASS			NUMBER OF OBSERVATIONS
		LOWEST	MEDIAN	HIGHEST	
JAN	None				
(1119)*					
APR	None				
(1177)*					
JUL	76/77	79/80		87/88	3
(1198)*					
OCT	None				
(972)*					

*Total number of observations in indicated month.

#Month(s) with most frequent occurrence of high dew points - JUL, AUG.

NANDI, VITI LEVU (FIJI ISLANDS)
CUMULATIVE FREQUENCIES OF TEMPERATURES AND DEW POINTS
January, April, July, October

17°45'S 177°27'E Elevation 51 feet

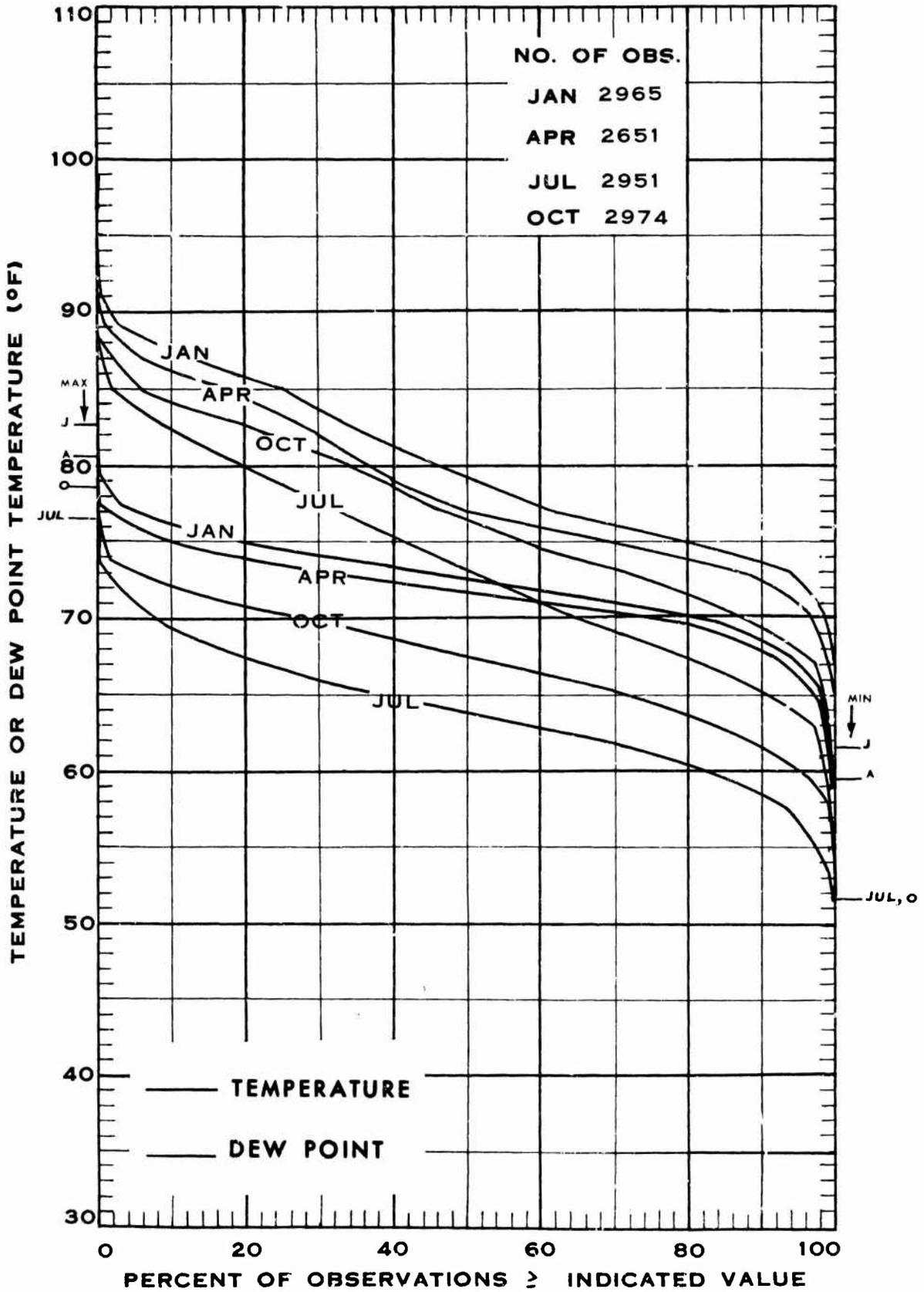


Figure 1.54

NANDI, VITI LEVU(FIJI ISLANDS)

TEMPERATURE-DEW POINT RELATIONSHIPS FOR DEW POINTS ≥ 76°F#

MONTH	DEW POINT CLASS	TEMPERATURE CLASS			NUMBER OF OBSERVATIONS
		LOWEST	MEDIAN	HIGHEST	
JAN	76/77	75/76	81/82	91/92	307
(2965)*	78/79	77/78	83/84	91/92	79
	80/81				6
	82/83				1
APR	76/77	75/76	81/82	89/90	160
(2651)*	78/79	79/80	83/84	87/88	19
	80/81		81/82		1
JUL	76/77		83/84		1
(2951)*					
OCT	76/77	77/78		85/86	4
(2974)*	78/79		79/80		1

*Total number of observations in indicated month.

#Month(s) with most frequent occurrence of high dew points - JAN, FEB.

NANKING, CHINA

CUMULATIVE FREQUENCIES OF TEMPERATURES AND DEW POINTS

January, April, July, October

32°05'N 118°45'E Elevation 82 feet

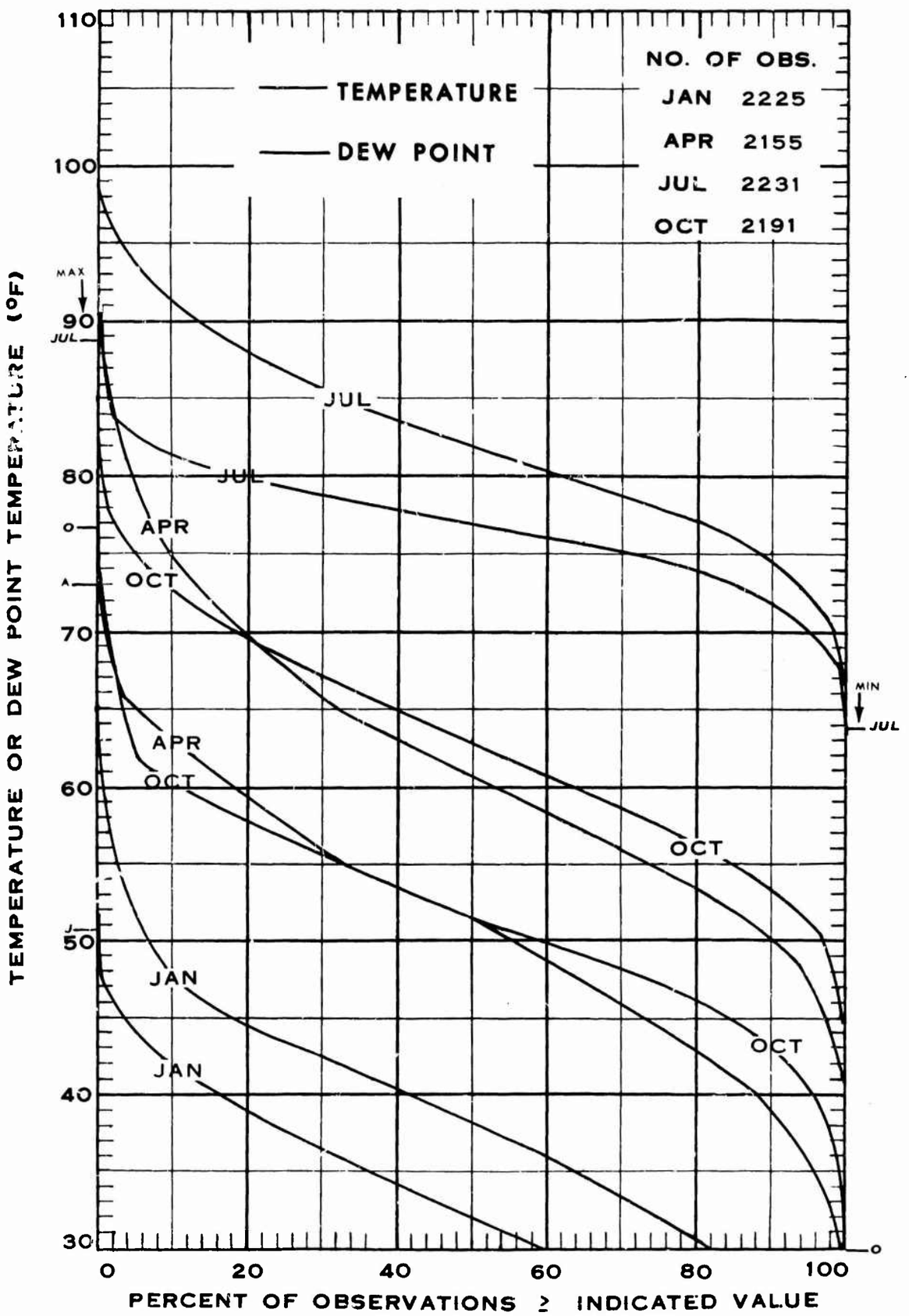


Figure 1.55

NANKING, CHINA

TEMPERATURE-DEW POINT RELATIONSHIPS FOR DEW POINTS ≥ 76°F

MONTH	DEW POINT CLASS	TEMPERATURE CLASS			NUMBER OF OBSERVATIONS
		LOWEST	MEDIAN	HIGHEST	
JAN	None				
(2225)*					
APR	None				
(2155)*					
JUL	76/77	75/76	79/80	97/98	551
(2231)*	78/79	77/78	83/84	97/98	468
	80/81	79/80	85/86	97/98	276
	82/83	81/82	87/88	97/98	128
	84/85	85/86	89/90	95/96	41
	86/87		95/96		2
	88/89		93/94		1
OCT	76/77	83/84		87/88	2
(2191)*					

*Total number of observations in indicated month.

#Month(s) with most frequent occurrence of high dew points - JUL, AUG.

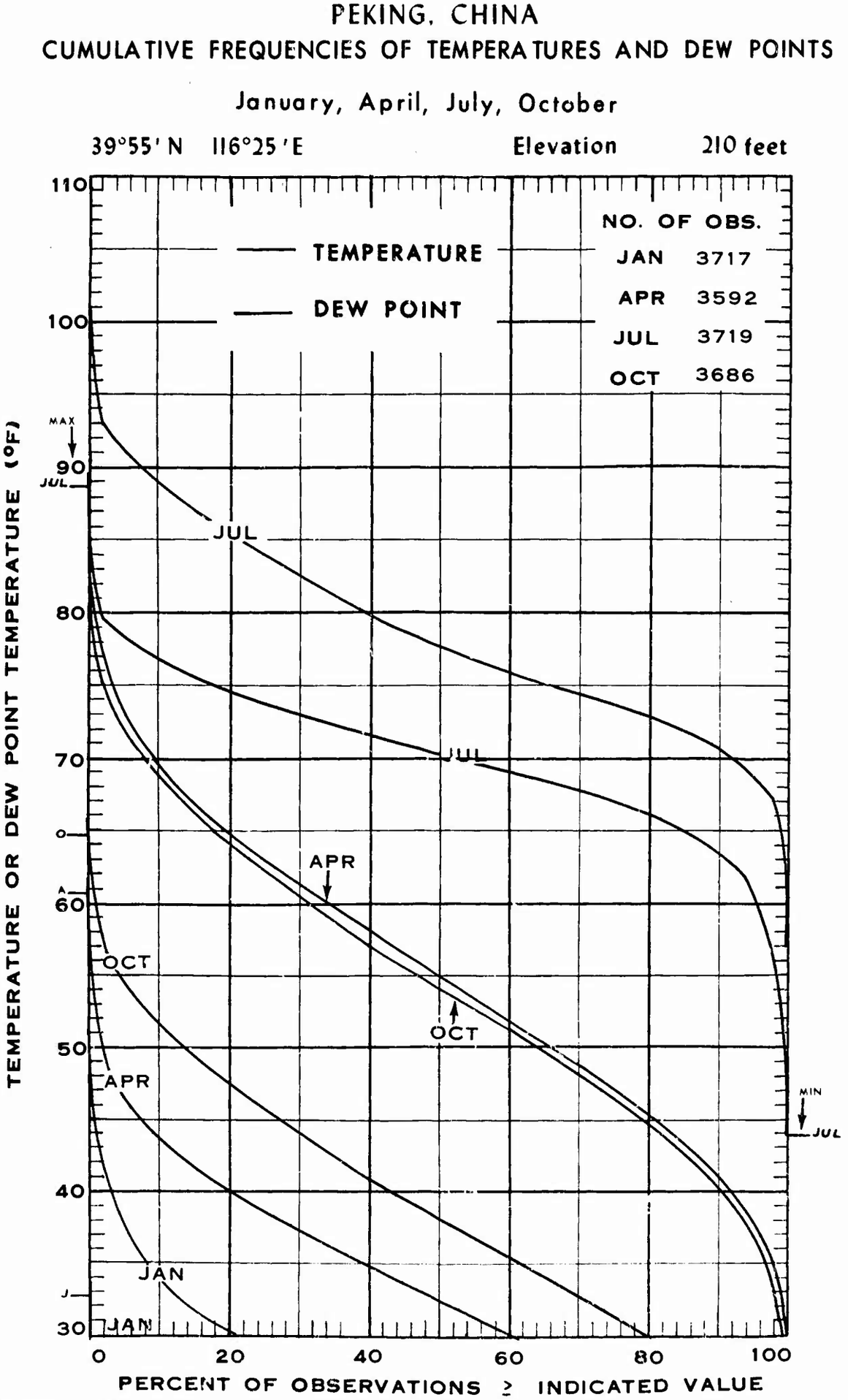

PEKING, CHINA
CUMULATIVE FREQUENCIES OF TEMPERATURES AND DEW POINTS
January, April, July, October
39°55' N 116°25' E
Elevation 210 feet
NO. OF OBS.
JAN 3717
APR 3592
JUL 3719
OCT 3686
TEMPERATURE
DEW POINT
TEMPERATURE OR DEW POINT TEMPERATURE (°F)
PERCENT OF OBSERVATIONS ≥ INDICATED VALUE
MAX
MIN
JUL
APR
OCT
JAN
110
100
90
80
70
60
50
40
30
0
20
40
60
80
100

Figure 1.56

PEKING, CHINA

TEMPERATURE-DEW POINT RELATIONSHIPS FOR DEW POINTS ≥ 76°F#

MONTH	DEW POINT CLASS	TEMPERATURE CLASS			NUMBER OF OBSERVATIONS
		LOWEST	MEDIAN	HIGHEST	
JAN	None				
(3717)*					
APR	None				
(3592)*					
JUL	76/77	75/76	83/84	97/98	283
(3719)*	78/79	79/80	83/84	97/98	127
	80/81	81/82	85/86	97/98	44
	82/83	83/84	88/89	93/94	20
	84/85	85/86		93/94	4
	86/87	89/90		91/92	2
	88/89		91/92		3
OCT	None				
(3686)*					

*Total number of observations in indicated month.

#Month(s) with most frequent occurrence of high dew points - JUL.

POEMBUT, NEW CALEDONIA
CUMULATIVE FREQUENCIES OF TEMPERATURES AND DEW POINTS
January, April, July, October

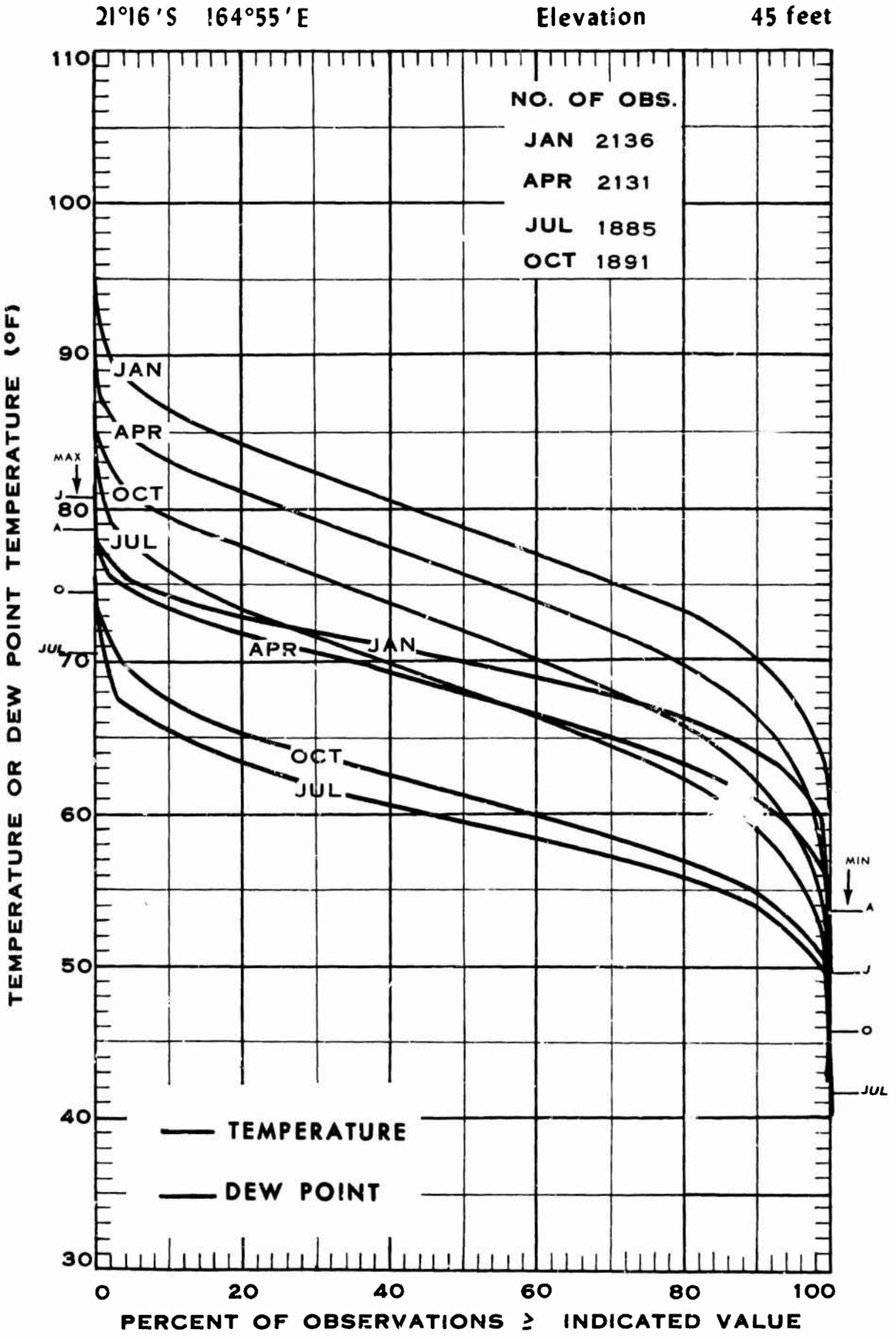


Figure 1.57

POEMBUT, NEW CALEDONIA

TEMPERATURE-DEW POINT RELATIONSHIPS FOR DEW POINTS ≥ 76°F

MONTH	DEW POINT CLASS	TEMPERATURE CLASS			NUMBER OF OBSERVATIONS
		LOWEST	MEDIAN	HIGHEST	
JAN	76/77	75/76	81/82	93/94	70
(2136)*	78/79	79/80	79/80	89/90	18
	80/81		83/84		1
APR	76/77	77/78	77/78	87/88	36
(2131)*	78/79	79/80		83/84	6
JUL	None				
(1885)*					
OCT	None				
(1891)*					

*Total number of observations in indicated month.

#Month(s) with most frequent occurrence of high dew points - JAN.

PORT-AU-PRINCE, HAITI

CUMULATIVE FREQUENCIES OF TEMPERATURES AND DEW POINTS

January, April, July, October

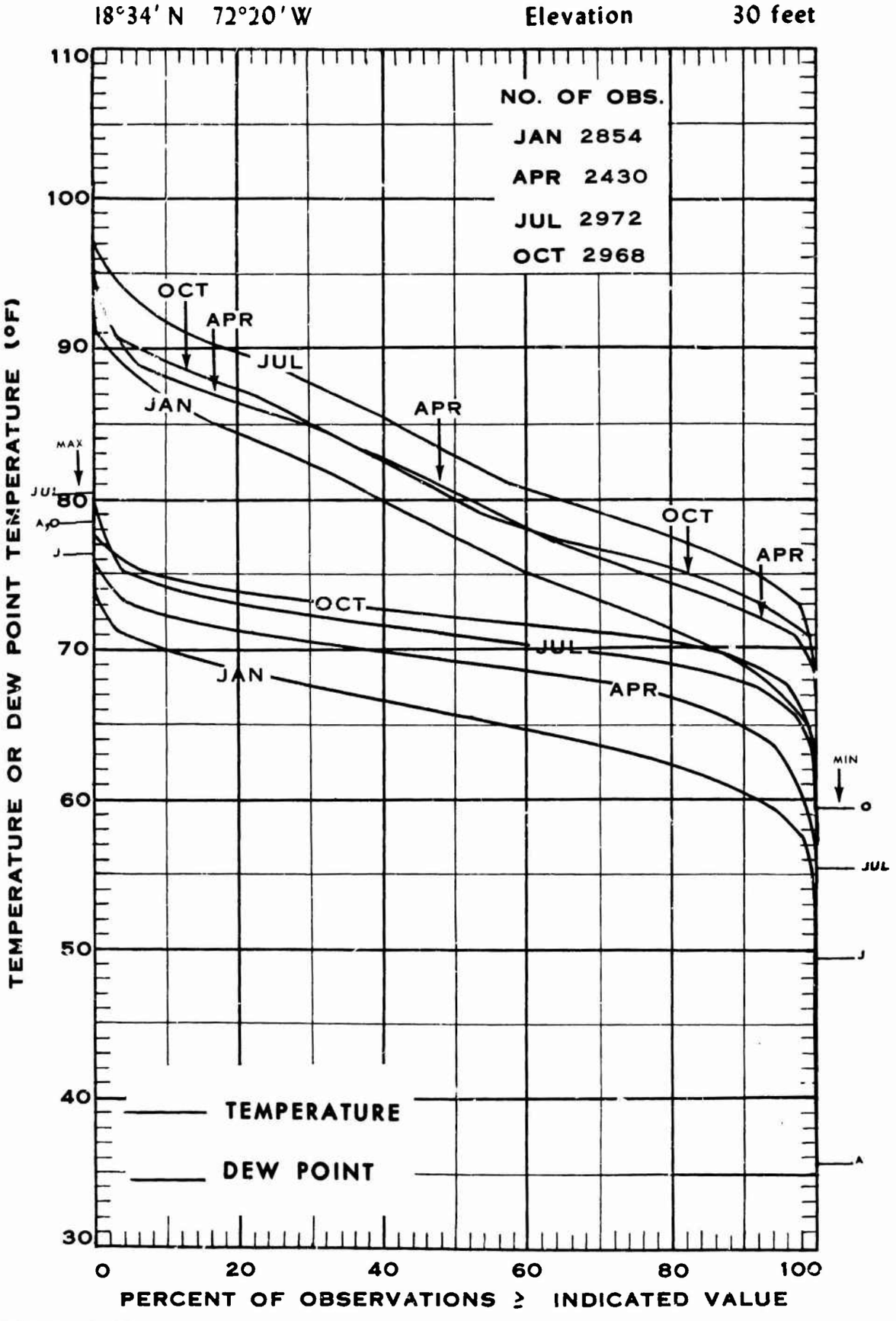


Figure 1.58

PORT-AU-PRINCE, HAITI

TEMPERATURE-DEW POINT RELATIONSHIPS FOR DEW POINTS ≥ 76°F#

MONTH	DEW POINT CLASS	TEMPERATURE CLASS			NUMBER OF OBSERVATIONS
		LOWEST	MEDIAN	HIGHEST	
JAN	76/77		87/88		1
(2854)*					
APR	76/77	79/80		87/88	5
(2430)*	78/79	79/80		85/86	6
JUL	76/77	77/78	87/88	93/94	101
(2972)*	78/79	83/84	85/86	91/92	20
	80/81		87/88		1
OCT	76/77	75/76	85/86	93/94	196
(2968)*	78/79	77/78	87/88	93/94	23

*Total number of observations in indicated month.

#Month(s) with most frequent occurrence of high dew points - OCT.

PUERTO PENASCO, MEXICO

CUMULATIVE FREQUENCIES OF TEMPERATURES AND DEW POINTS

January, April, July, October

31°21'N 113°40'W Elevation unknown

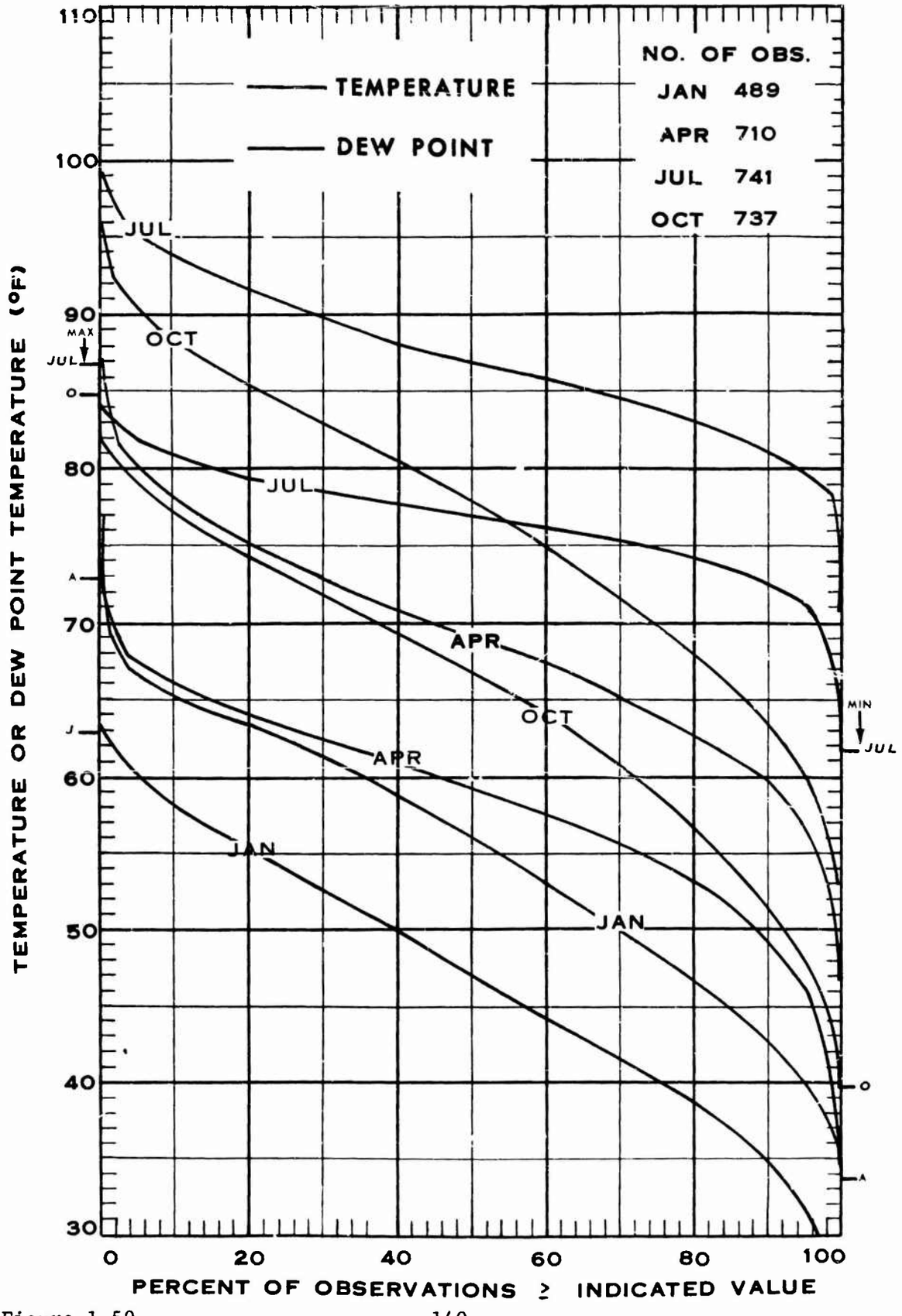


Figure 1.59

PUERTO PENASCO, MEXICO

TEMPERATURE-DEW POINT RELATIONSHIPS FOR DEW POINTS ≥ 76°F

MONTH	DEW POINT CLASS	TEMPERATURE CLASS			NUMBER OF OBSERVATIONS
		LOWEST	MEDIAN	HIGHEST	
JAN	None				
(489)*					
APR	None				
(710)*					
JUL	76/77	79/80	85/86	97/98	194
(741)*	78/79	79/80	87/88	97/98	177
	80/81	83/84	89/90	97/98	84
	82/83	83/84	91/92	97/98	38
	84/85	89/90		97/98	4
	86/87		91/92		1
OCT	76/77	79/80	85/86	93/94	41
(737)*	78/79	77/78	87/88	93/94	49
	80/81	81/82	89/90	95/96	14
	82/83	83/84		91/92	4
	84/85		87/88		1

*Total number of observations in indicated month.

#Month(s) with most frequent occurrence of high dew points - AUG.

RECIFE, BRAZIL

CUMULATIVE FREQUENCIES OF TEMPERATURES AND DEW POINTS

January, April, July, October

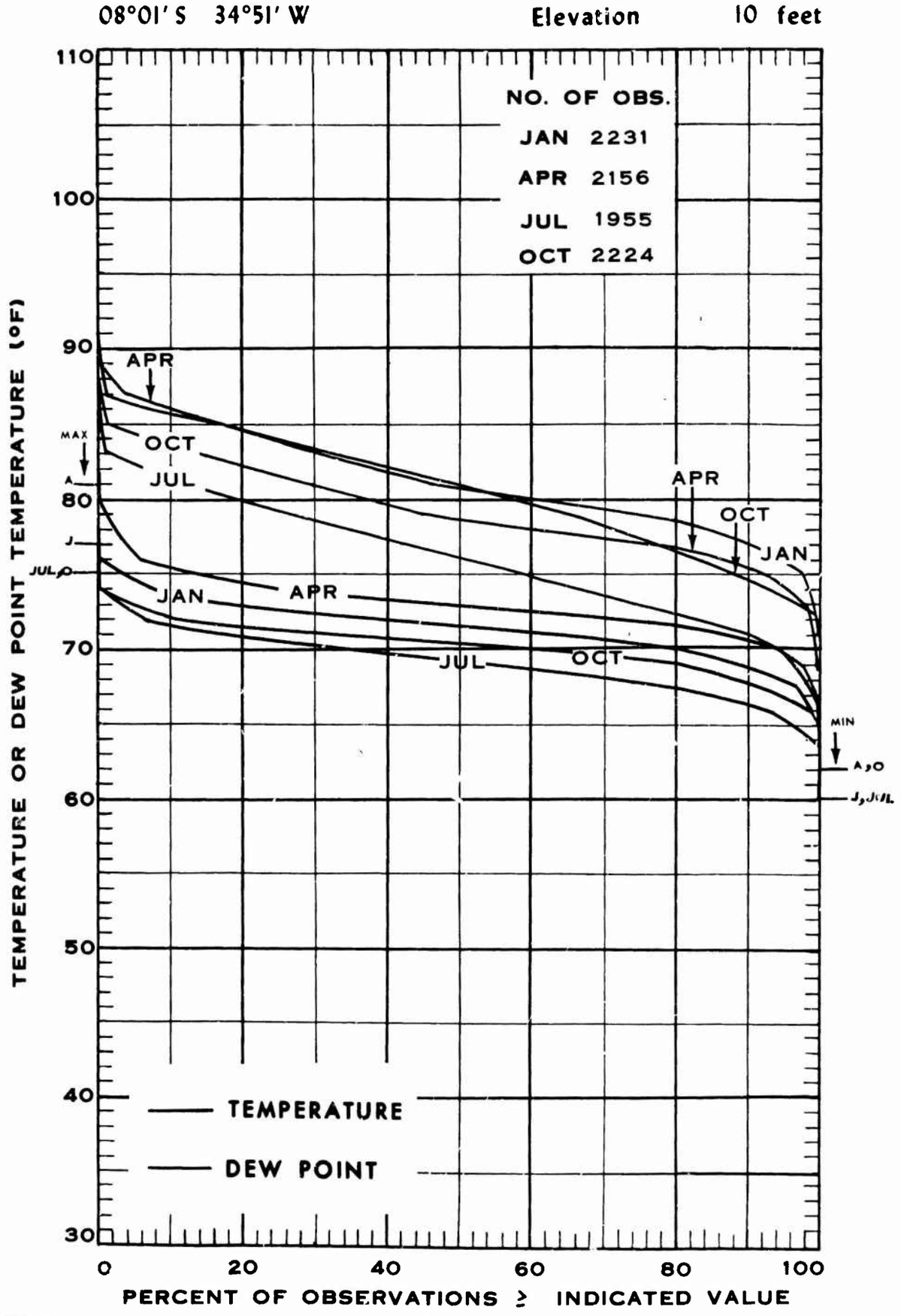


Figure 1.60

RECIFE, BRAZIL

TEMPERATURE-DEW POINT RELATIONSHIPS FOR DEW POINTS ≥ 76°F

MONTH	DEW POINT CLASS	TEMPERATURE CLASS			NUMBER OF OBSERVATIONS
		LOWEST	MEDIAN	HIGHEST	
JAN	76/77	81/82		85/86	6
(2231)*					
APR	76/77	75/76	83/84	89/90	138
(2165)*	78/79	81/82		85/86	4
	80/81		79/80		2
JUL	None				
(1955)*					
OCT	None				
(2224)*					

*Total number of observations in indicated month.

#Month(s) with most frequent occurrence of high dew points - APR.

SAIGON SOUTH VIETNAM

CUMULATIVE FREQUENCIES OF TEMPERATURES AND DEW POINTS

January, April, July, October

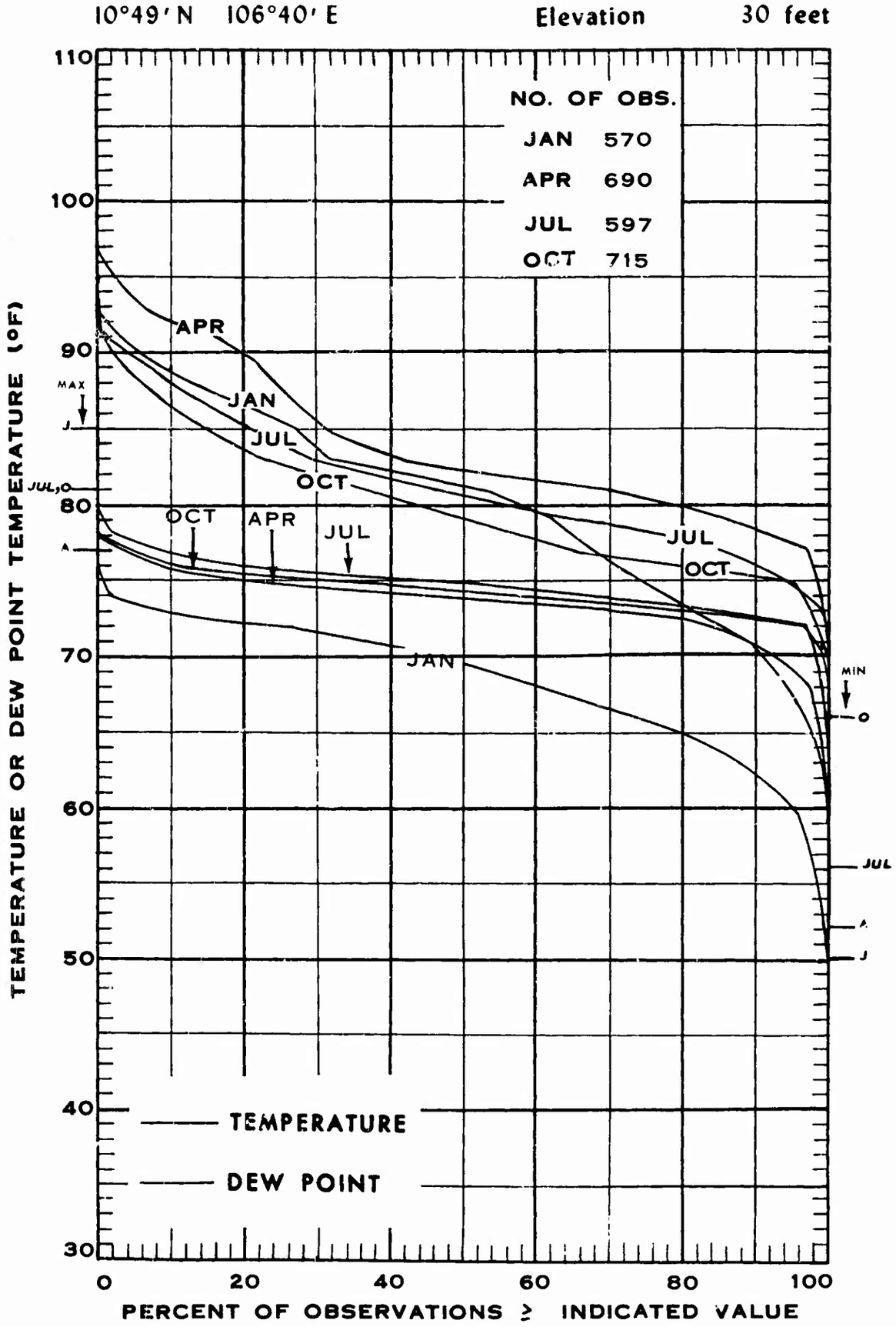


Figure 1.61

SAIGON, SOUTH VIETNAM

TEMPERATURE-DEW POINT RELATIONSHIPS FOR DEW POINTS ≥ 76°F#

MONTH	DEW POINT CLASS	TEMPERATURE CLASS			NUMBER OF OBSERVATIONS
		LOWEST	MEDIAN	HIGHEST	
JAN	76/77	81/82		87/88	2
(570)*	84/85	85/86		89/90	2
APR	76/77	77/78	81/82	95/96	81
(690)*					
JUL	76/77	77/78	81/82	89/90	103
(597)*	78/79	81/82	81/82	85/86	12
	80/81		87/88		1
OCT	76/77	77/78		89/90	93
(715)*	78/79		83/84		1
	80/81		81/82		1

*Total number of observations in indicated month.

#Month(s) with most frequent occurrence of high dew points - JUL.

SAINT GEORGE, BERMUDA

CUMULATIVE FREQUENCIES OF TEMPERATURES AND DEW POINTS

January, April, July, October

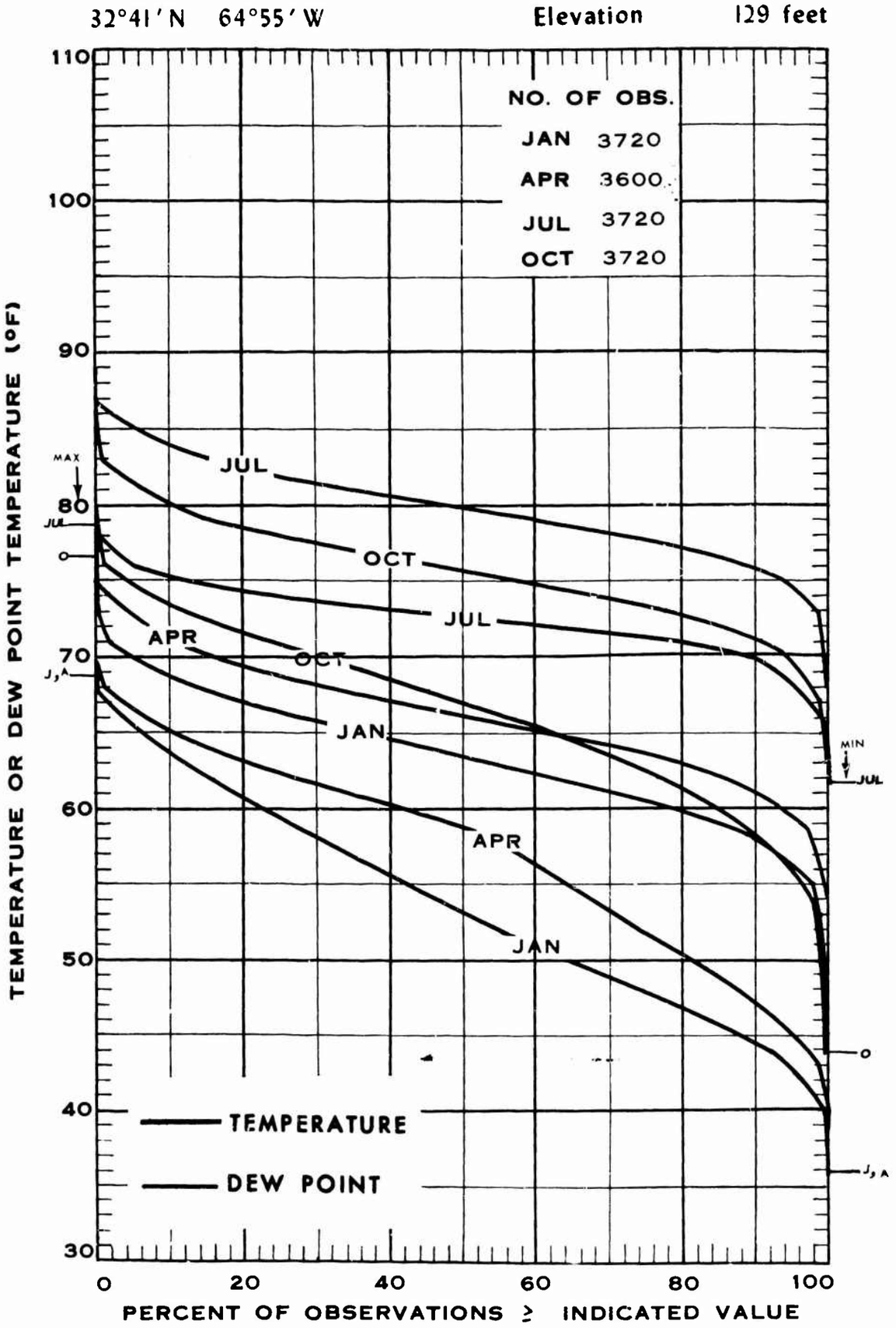


Figure 1.62

SAINT GEORGE, BERMUDA

TEMPERATURE-DEW POINT RELATIONSHIPS FOR DEW POINTS ≥ 76°F#

MONTH	DEW POINT CLASS	TEMPERATURE CLASS			NUMBER OF OBSERVATIONS
		LOWEST	MEDIAN	HIGHEST	
JAN	None				
(3720)*					
APR	None				
(3600)*					
JUL	76/77	75/76	79/80	85/86	187
(3720)*	78/79	77/78	81/82	83/84	14
OCT	76/77				1
(3720)*					

*Total number of observations in indicated month.

#Month(s) with most frequent occurrence of high dew points - JUL., AUG.

ST. JOHN'S, ANTIGUA
CUMULATIVE FREQUENCIES OF TEMPERATURES AND DEW POINTS
January, April, July, October

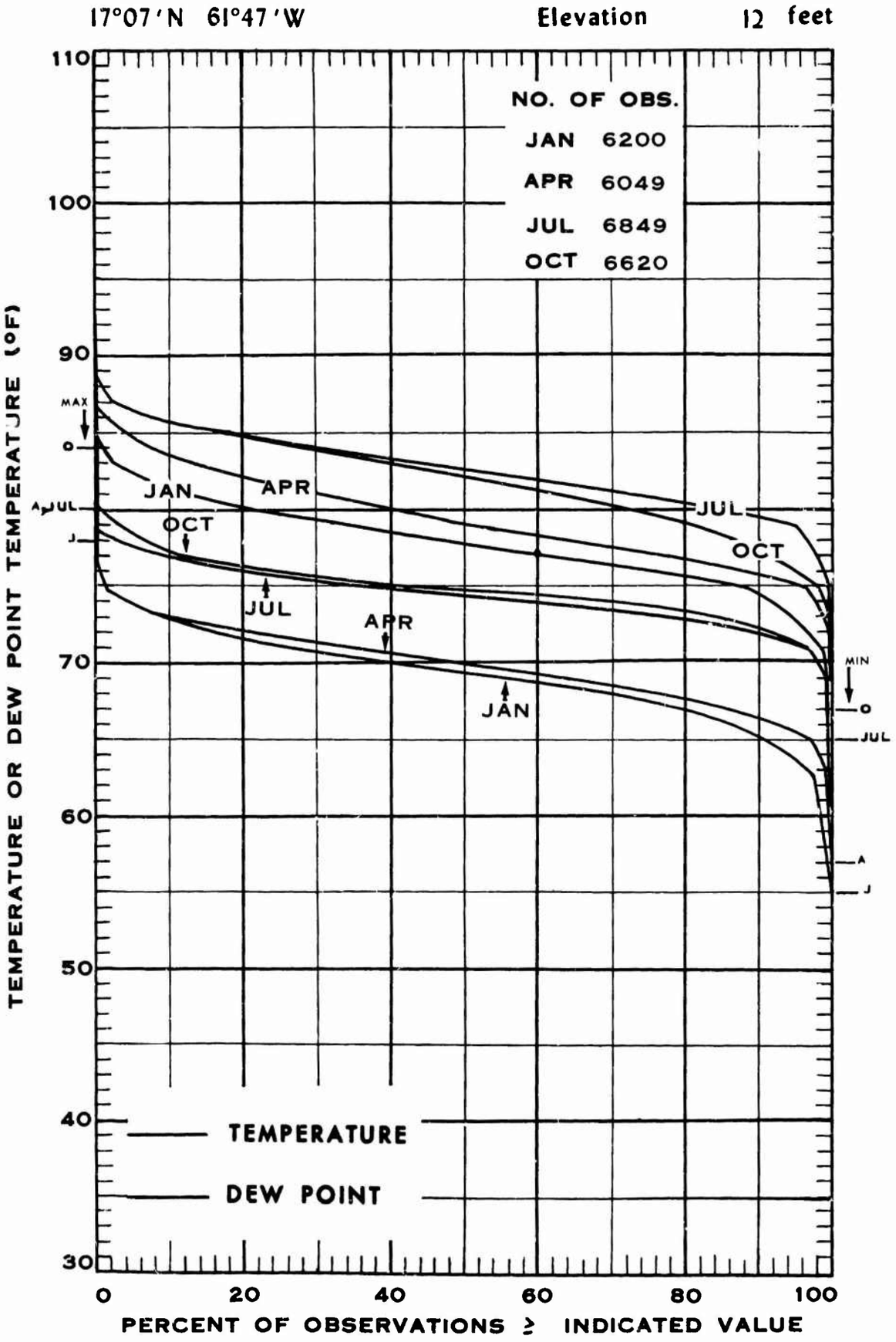


Figure 1.63

ST. JOHN'S, ANTIGUA

TEMPERATURE-DEW POINT RELATIONSHIPS FOR DEW POINTS ≥ 76°F#

MONTH	DEW POINT CLASS	TEMPERATURE CLASS			NUMBER OF OBSERVATIONS
		LOWEST	MEDIAN	HIGHEST	
JAN	76/77	79/80	81/82	83/84	25
(3213)*	78/79		81/82		2
APR	76/77	79/80		83/84	2
(2996)*	78/79		81/82		2
JUL	76/77	77/78	81/82	87/88	354
(2708)*	78/79	79/80	83/84	87/88	53
	80/81	83/84		87/88	6
OCT	76/77	75/76	81/82	91/92	669
(3697)*	78/79	79/80	83/84	89/90	206
	80/81	83/84	85/86	87/88	64
	82/83	83/84	85/86	87/88	23

*Total number of observations in indicated month.

#Month(s) with most frequent occurrence of high dew points - OCT.

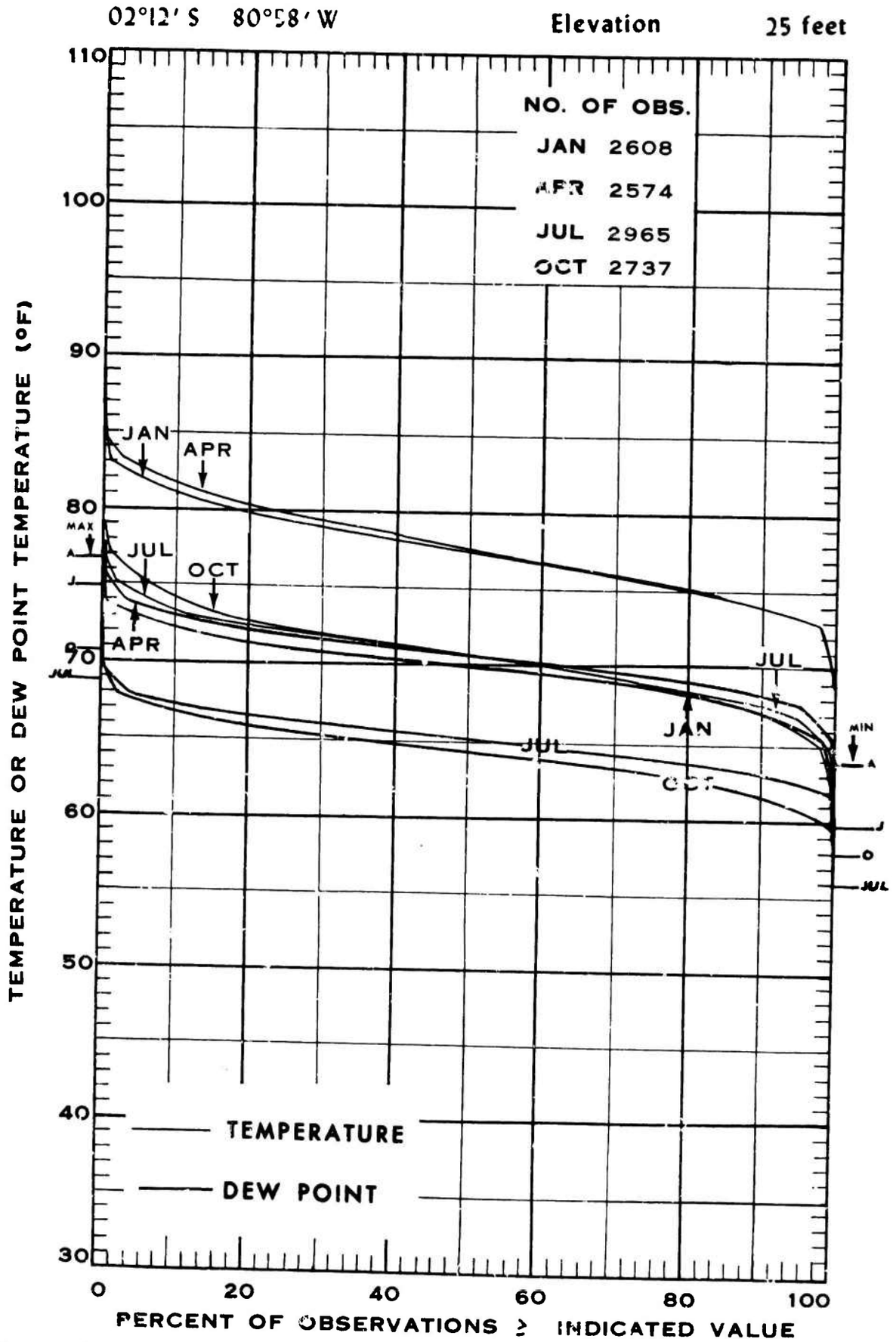

SALINAS. ECUADOR
CUMULATIVE FREQUENCIES OF TEMPERATURES AND DEW POINTS
January, April, July, October
02°12' S 80°58' W
Elevation 25 feet
NO. OF OBS.
JAN 2608
APR 2574
JUL 2965
OCT 2737
TEMPERATURE OR DEW POINT TEMPERATURE (°F)
PERCENT OF OBSERVATIONS ≥ INDICATED VALUE
TEMPERATURE
DEW POINT
JAN
APR
JUL
OCT
MAX
MIN

Figure 1.64

SALINAS, ECUADOR

TEMPERATURE-DEW POINT RELATIONSHIPS FOR DEW POINTS ≥ 76°F

MONTH	DEW POINT CLASS	TEMPERATURE CLASS			NUMBER OF OBSERVATIONS
		LOWEST	MEDIAN	HIGHEST	
JAN	None				
(2664)*					
APR	76/77	77/78		81/82	3
(2243)*					
JUL	None				
(2060)*					
OCT	None				
(2184)*					

*Total number of observations in indicated month.

#Month(s) with most frequent occurrence of high dew points - FEB.

SAN JOSÉ. GUATEMALA

CUMULATIVE FREQUENCIES OF TEMPERATURES AND DEW POINTS

January, April, July, October

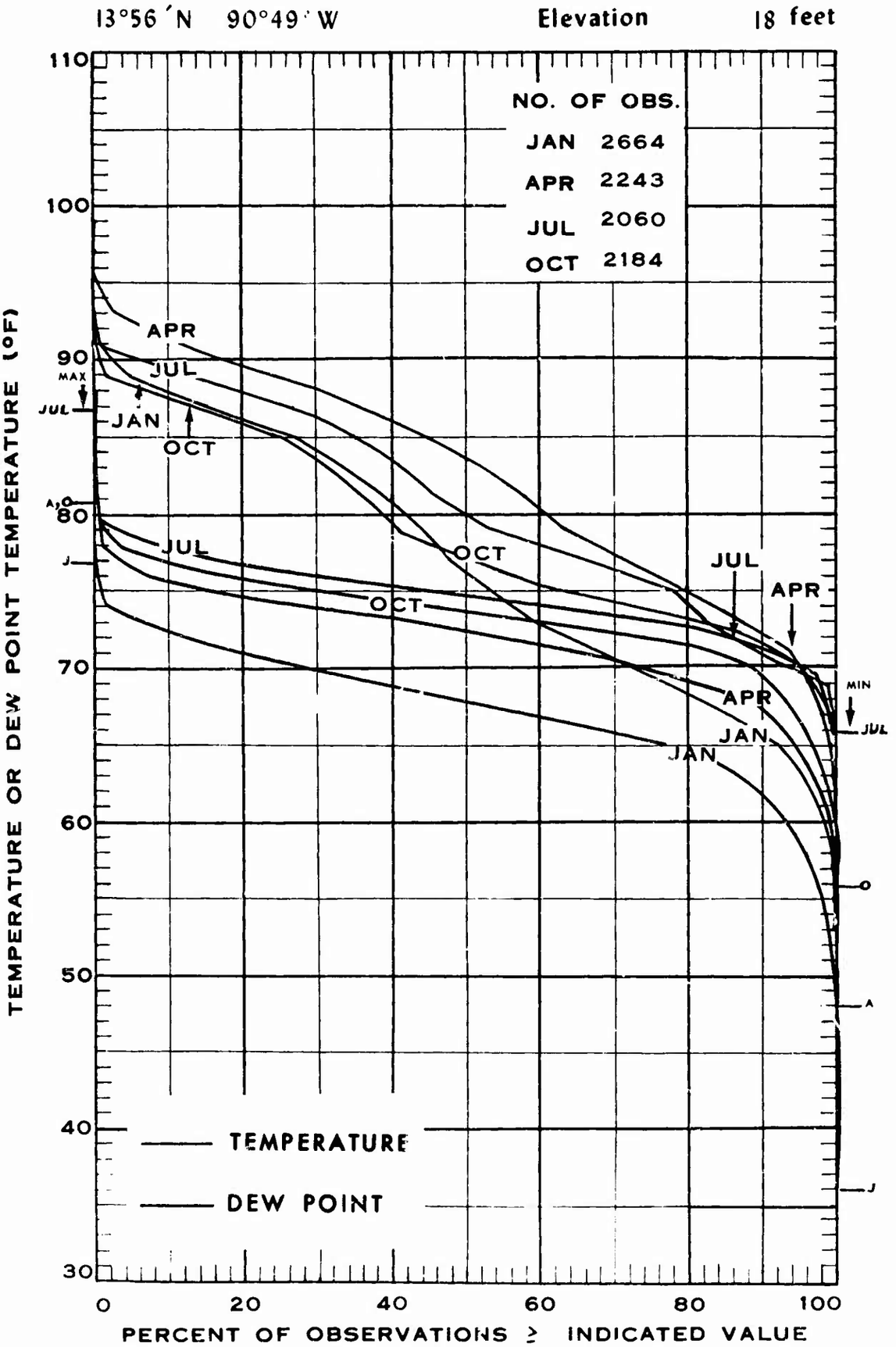


Figure 1.65

SAN JOSÉ, GUATEMALA

TEMPERATURE-DEW POINT RELATIONSHIPS FOR DEW POINTS ≥ 76°F

MONTH	DEW POINT CLASS	TEMPERATURE CLASS			NUMBER OF OBSERVATIONS
		LOWEST	MEDIAN	HIGHEST	
JAN	76/77	83/84		87/88	7
(2664)*					
APR	76/77	77/78	87/88	93/94	136
(2243)*	78/79	81/82	87/88	93/94	31
	80/81		87/88		1
	82/83	83/84		85/86	3
JUL	76/77	75/76	85/86	91/92	460
(2060)*	78/79	79/80	87/88	91/92	159
	80/81	83/84	87/88	89/90	15
OCT	76/77	75/76	85/86	91/92	363
(2184)*	78/79	77/78	87/88	89/90	60
	80/81	87/88		89/90	8

* Total number of observations in indicated month.

Month(s) with most frequent occurrence of high dew points - JUL, OCT.

SAN JUAN, PUERTO RICO

CUMULATIVE FREQUENCIES OF TEMPERATURES AND DEW POINTS

January, April, July, October

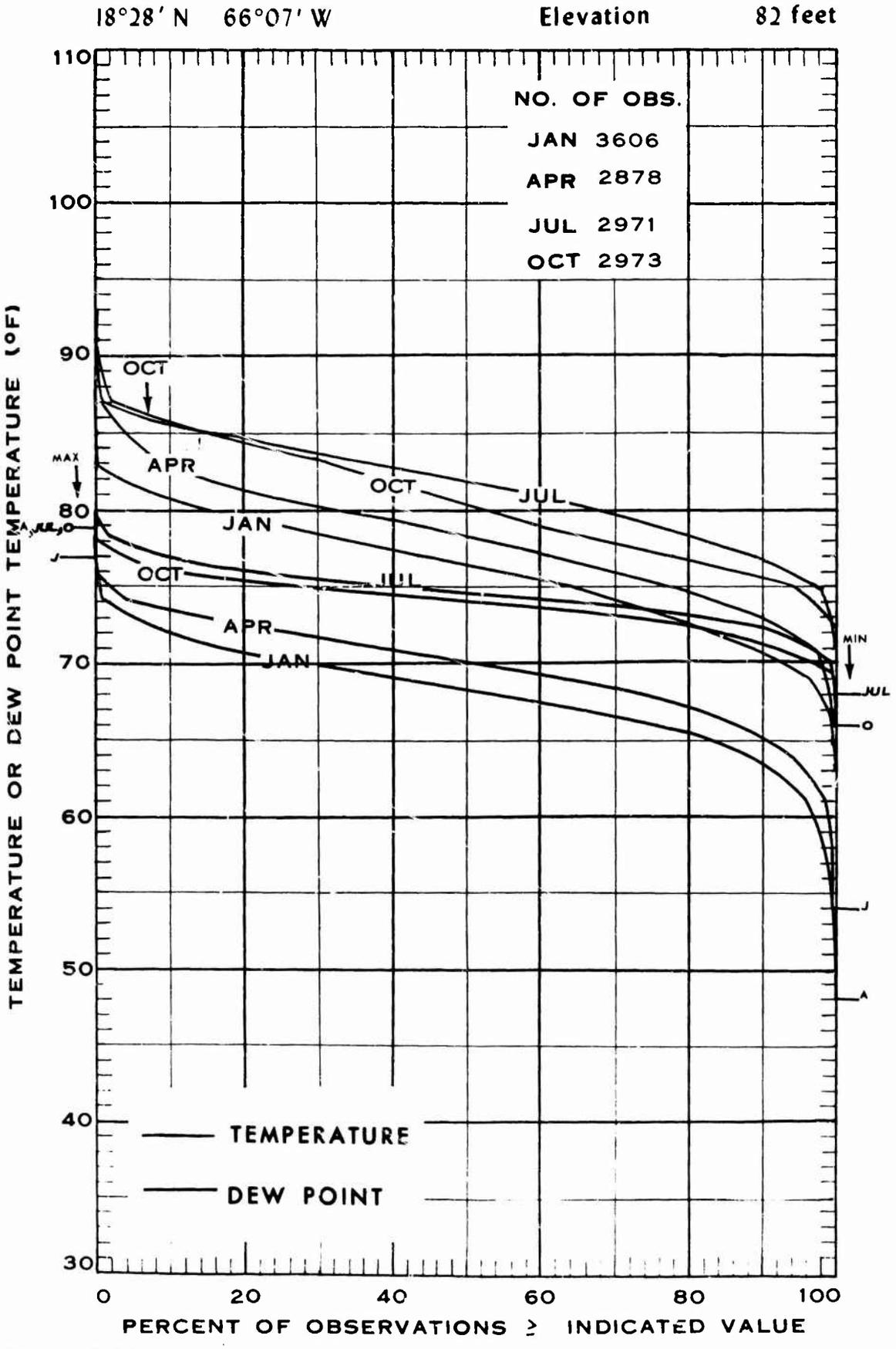


Figure 1.66

SAN JUAN, PUERTO RICO

TEMPERATURE-DEW POINT RELATIONSHIPS FOR DEW POINTS ≥ 76°F#

MONTH	DEW POINT CLASS	TEMPERATURE CLASS			NUMBER OF OBSERVATIONS
		LOWEST	MEDIAN	HIGHEST	
JAN	76/77	77/78		79/80	6
(3606)*					
APR	76/77	77/78		83/84	9
(2878)*	78/79		79/80		1
JUL	76/77	77/78	83/84	87/88	552
(2971)*	78/79	79/80	83/84	87/88	61
OCT	76/77	77/78	83/84	87/88	232
(2973)*	78/79	79/80	84/85	87/88	14

*Total number of observations in indicated month.

#Month(s) with most frequent occurrence of high dew points - AUG.

SENO, LAOS

CUMULATIVE FREQUENCIES OF TEMPERATURES AND DEW POINTS

January, April, July, October

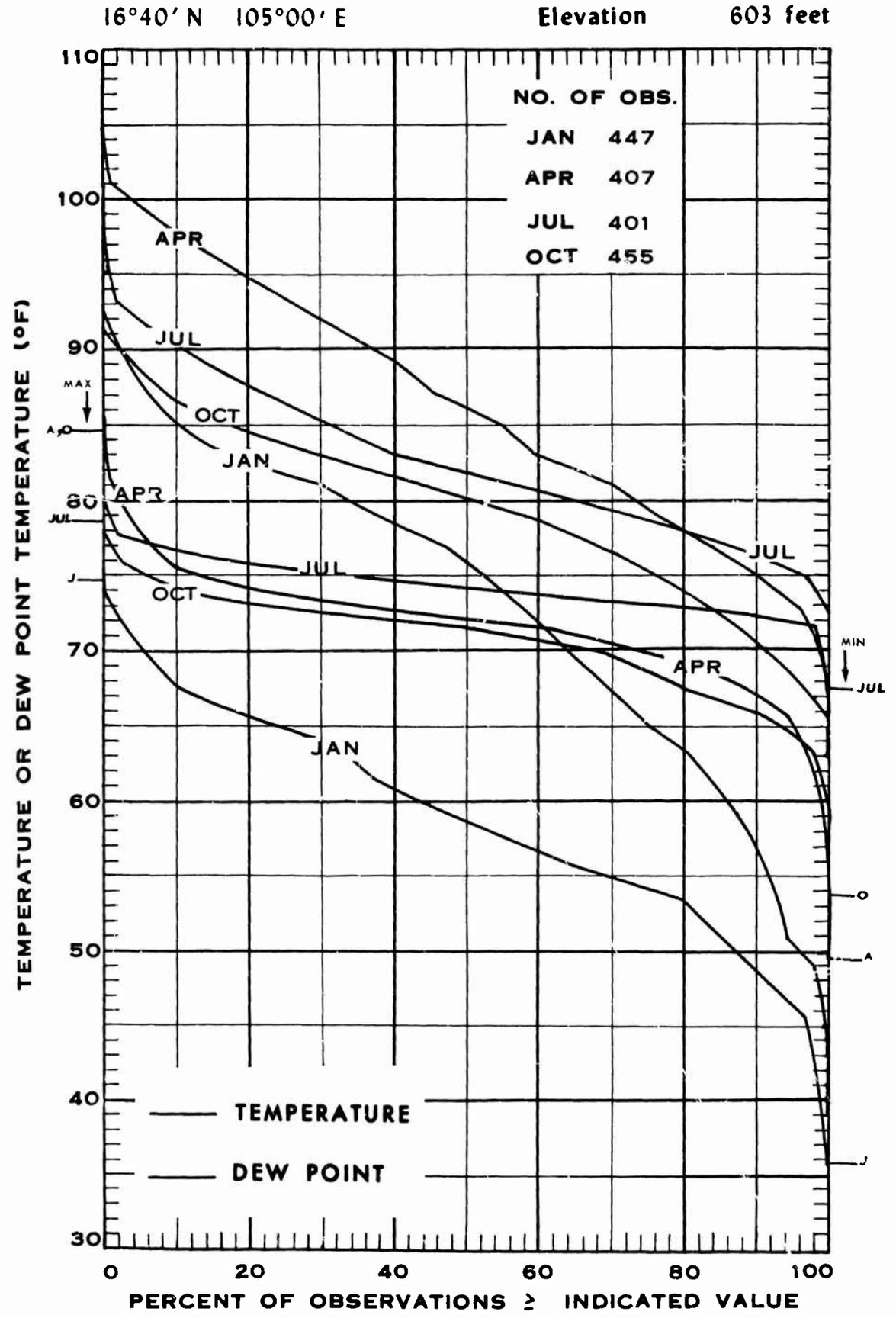


Figure 1.67

SENO, LAOS

TEMPERATURE-DEW POINT RELATIONSHIPS FOR DEW POINTS ≥ 76°F

MONTH	DEW POINT CLASS	TEMPERATURE CLASS			NUMBER OF OBSERVATIONS
		LOWEST	MEDIAN	HIGHEST	
JAN	None				
(447)*					
APR	76/77	79/80	85/86	97/98	16
(407)*	78/79	81/82	93/94	99/100	16
	80/81	81/82		91/92	4
	82/83		93/94		2
	84/85		99/100		2
JUL	76/77	77/78	83/84	91/92	94
(401)*	78/79	79/80		85/86	10
OCT	76/77	81/82	81/82	91/92	11
(455)*			81/82		1
			81/82		1
		83/84		89/90	2

*Total number of observations in indicated month.

#Month(s) with most frequent occurrence of high dew points - JUL, AUG.

SONGKHLA, THAILAND

CUMULATIVE FREQUENCIES OF TEMPERATURES AND DEW POINTS

January, April, July, October

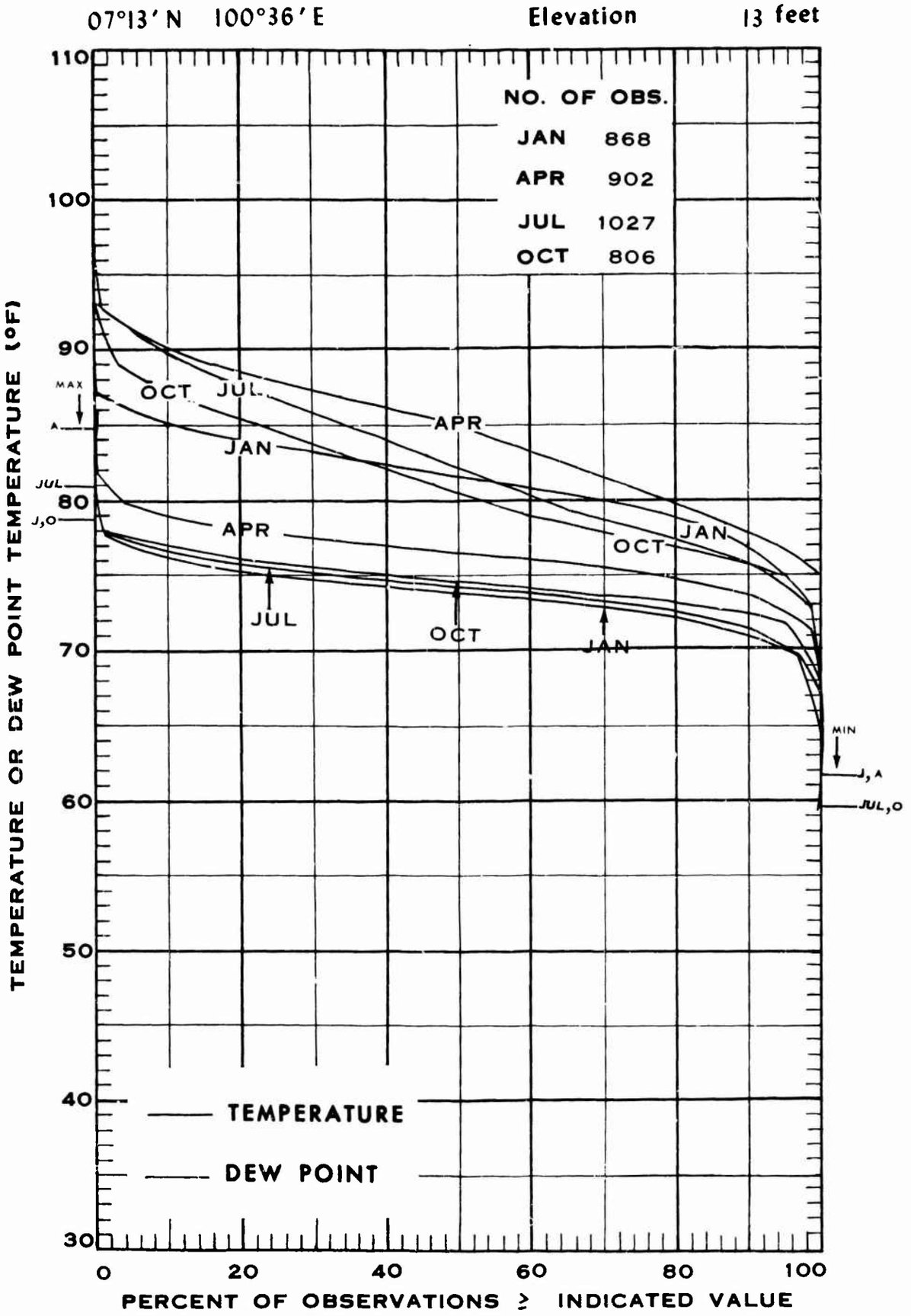


Figure 1.68

SONGKHLA, THAILAND

TEMPERATURE-DEW POINT RELATIONSHIPS FOR DEW POINTS ≥ 76°F#

MONTH	DEW POINT CLASS	TEMPERATURE CLASS			NUMBER OF OBSERVATIONS
		LOWEST	MEDIAN	HIGHEST	
JAN	76/77	75/76	83/84	85/86	115
(868)*	78/79	83/84	85/86	87/88	12
APR	76/77	75/76	83/84	93/94	322
(902)*	78/79	77/78	87/88	95/96	270
	80/81	83/84	87/88	91/92	35
	82/83	87/88		91/92	3
	84/85	85/86		91/92	2
JUL	76/77	77/78	85/86	93/94	174
(1027)*	78/79	79/80	87/88	91/92	15
	80/81		93/94		1
OCT	76/77	75/76	83/84	91/92	166
(806)*	78/79	81/82	85/86	91/92	12

*Total number of observations in indicated month.

#Month(s) with most frequent occurrence of high dew points - MAR, APR.

SYDNEY. AUSTRALIA

CUMULATIVE FREQUENCIES OF TEMPERATURES AND DEW POINTS

January, April, July, October

33°57′ S 151°12′ E Elevation 14 feet

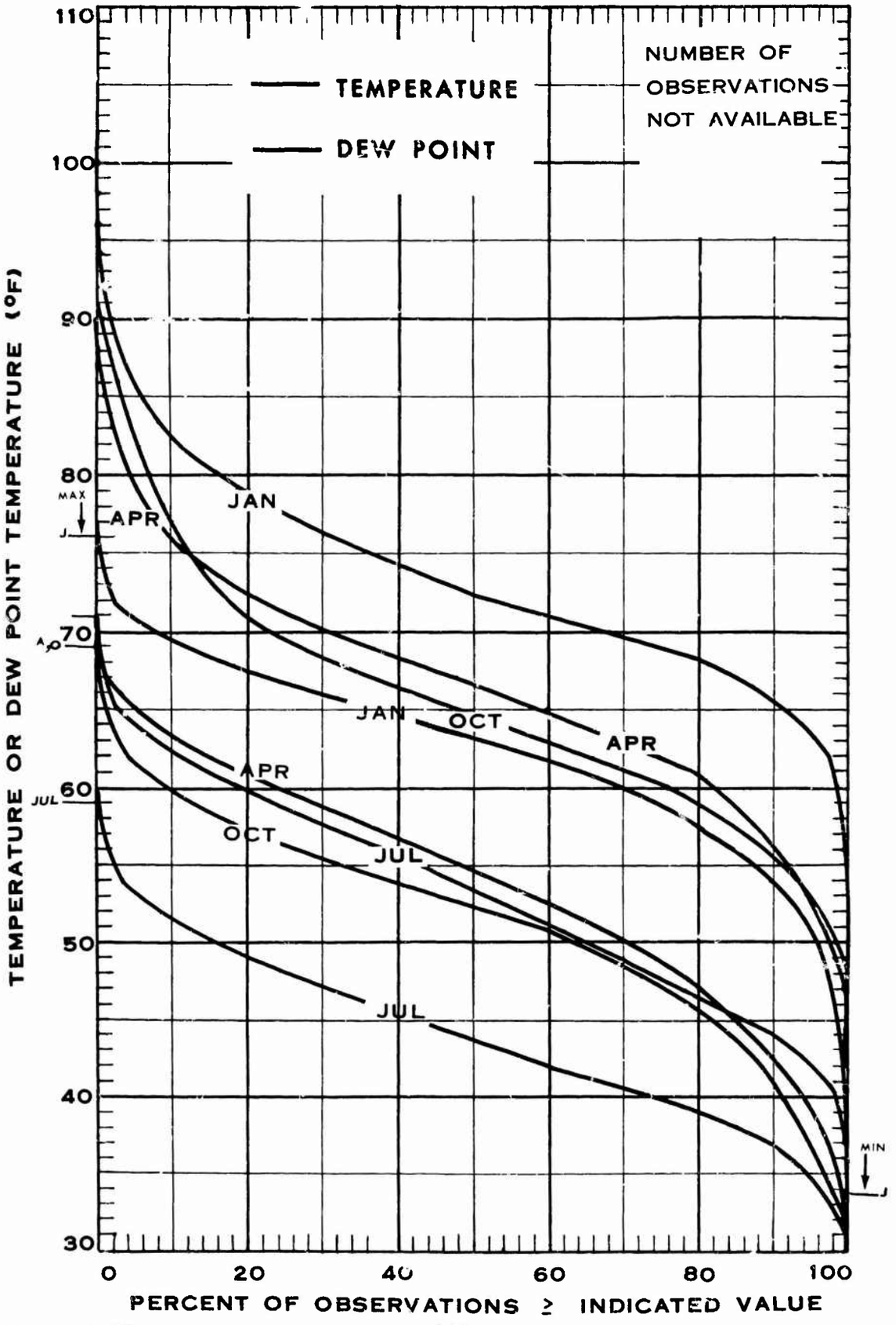


Figure 1.69

SYDNEY, AUSTRALIA

TEMPERATURE-DEW POINT RELATIONSHIPS FOR DEW POINTS ≥ 76°F#

MONTH	DEW POINT CLASS	TEMPERATURE CLASS			PERCENT OF OBSERVATIONS
		LOWEST	MEDIAN	HIGHEST	
JAN	76/77	78/79		82/83	0.2
( )*					
APR	None				0
JUL	None				0
OCT	None				0

*Number of observations not available.

#Month(s) with most frequent occurrence of high dew points - JAN.

TAIPEI, TAIWAN

CUMULATIVE FREQUENCIES OF TEMPERATURES AND DEW POINTS

January, April, July, October

25°00′N 121°30′E Elevation 30 feet

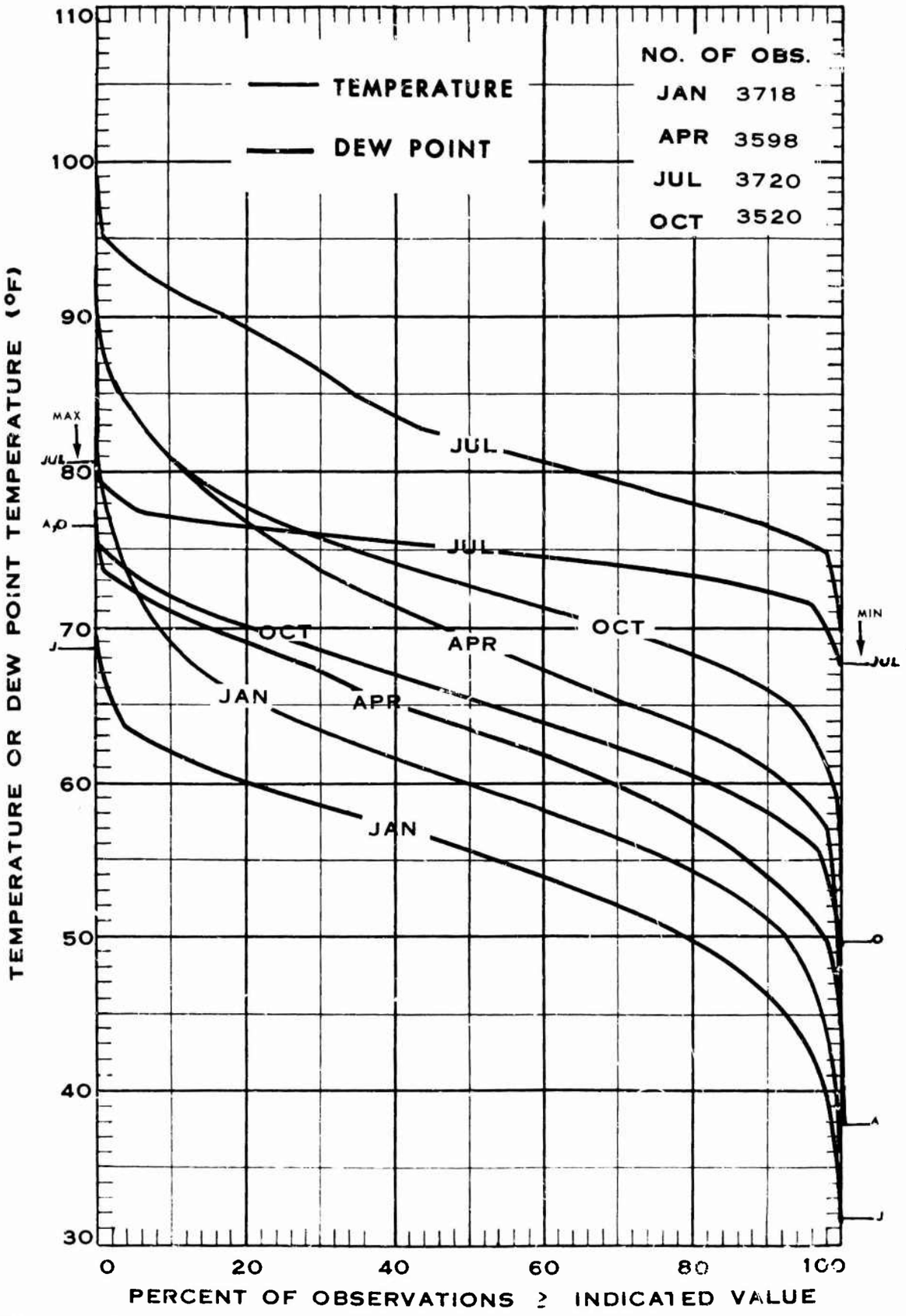


Figure 1.70

TAIPEI, TAIWAN

TEMPERATURE-DEW POINT RELATIONSHIPS FOR DEW POINTS ≥ 76°F

MONTH	DEW POINT CLASS	TEMPERATURE CLASS			NUMBER OF OBSERVATIONS
		LOWEST	MEDIAN	HIGHEST	
JAN	None				
(3718)*					
APR	76/77	79/80		89/90	8
(3598)*					
JUL	76/77	75/76	81/82	97/98	1153
(3720)*	78/79	79/80	82/83	93/94	227
	80/81	83/84	84/85	87/88	12
	82/83		91/92		1
OCT	76/77	75/76	79/80	87/88	27
(3520)*					

*Total number of observations in indicated month.

#Month(s) with most frequent occurrence of high dew points - JUL, AUG.

TAIPINGSZE, CHINA

CUMULATIVE FREQUENCIES OF TEMPERATURES AND DEW POINTS

January, April, July, October

30°40' N 104°40' E Elevation 1640 feet

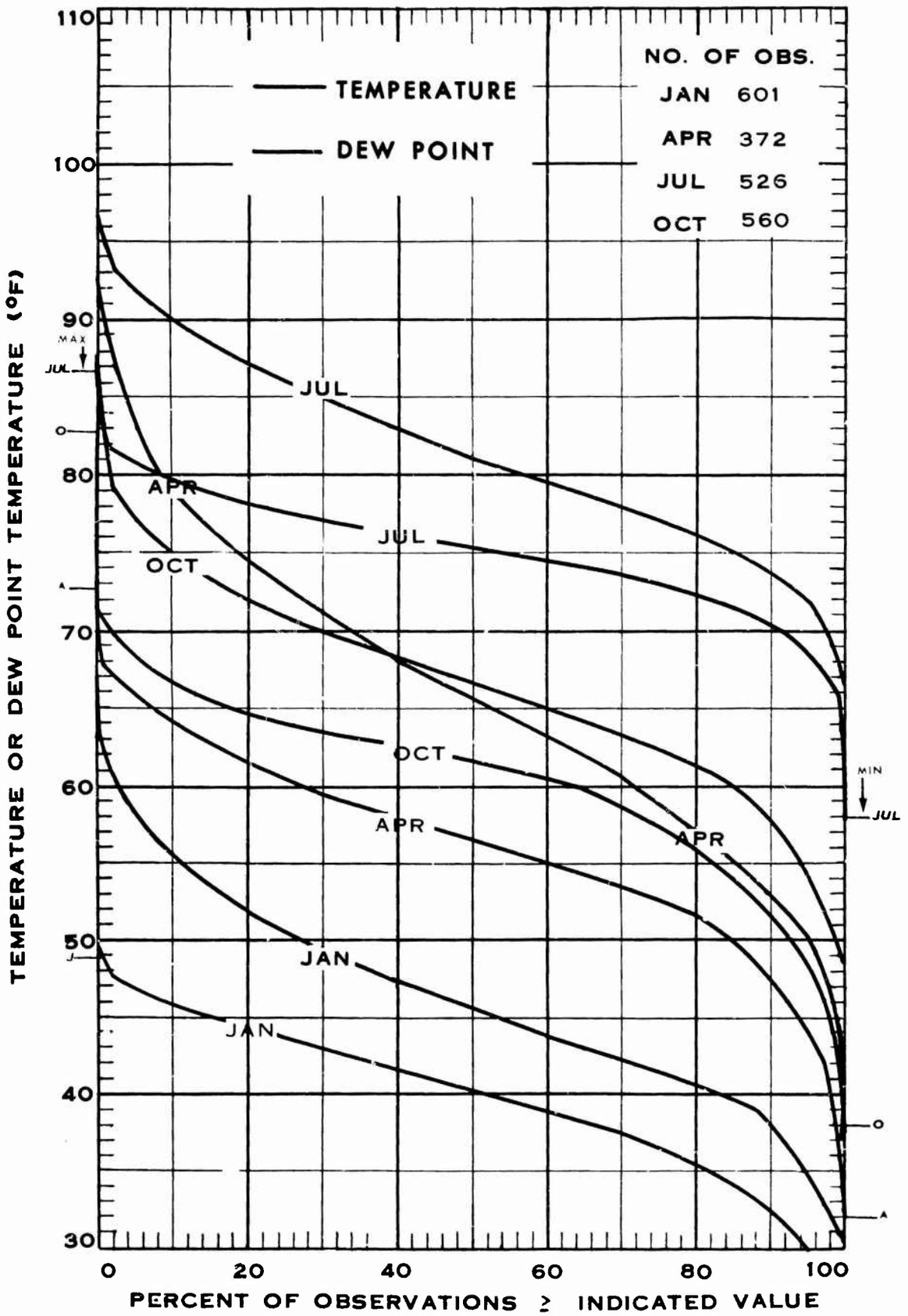


Figure 1.71

TAIPINGSZE, CHINA

TEMPERATURE-DEW POINT RELATIONSHIPS FOR DEW POINTS ≥ 76°F#

MONTH	DEW POINT CLASS	TEMPERATURE CLASS			NUMBER OF OBSERVATIONS
		LOWEST	MEDIAN	HIGHEST	
JAN	None				
(601)*					
APR	None				
(372)*					
JUL	76/77	79/80	83/84	95/96	97
(526)*	78/79	79/80	83/84	95/96	71
	80/81	81/82	87/88	95/96	39
	82/83	85/86		93/94	9
	84/85	83/84		87/88	3
	86/87		89/90		1
OCT	None				
(560)*					

*Total number of observations in indicated month.

#Month(s) with most frequent occurrence of high dew points - JUL, AUG.

TALARA, PERU

CUMULATIVE FREQUENCIES OF TEMPERATURES AND DEW POINTS

January, April, July, October

04°34′S 81°15′W Elevation 249 feet

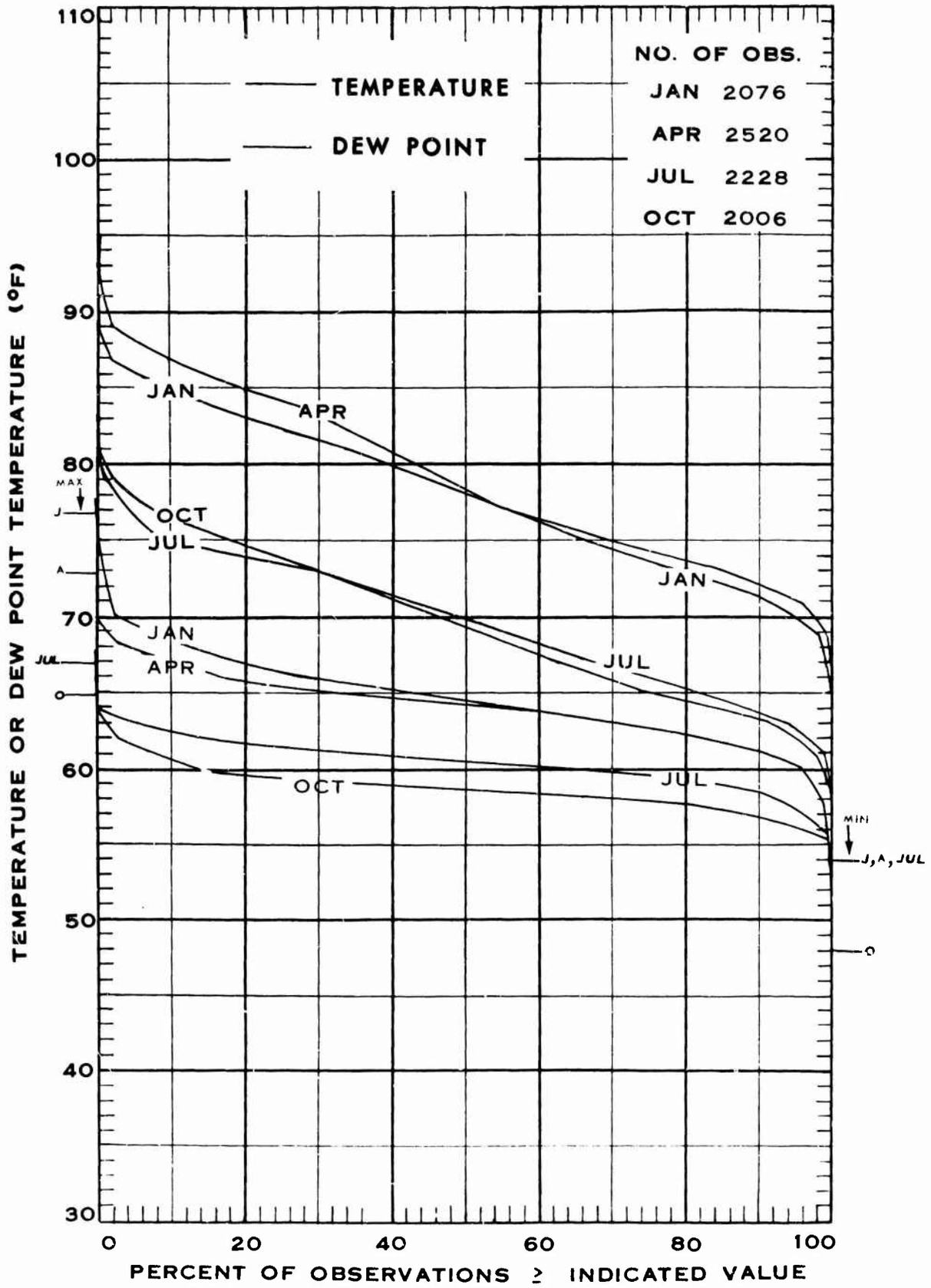


Figure 1.72

TALARA, PERU

TEMPERATURE-DEW POINT RELATIONSHIPS FOR DEW POINTS ≥ 76°F#

MONTH	DEW POINT CLASS	TEMPERATURE CLASS			NUMBER OF OBSERVATIONS
		LOWEST	MEDIAN	HIGHEST	
JAN	76/77		85/86		1
(2076)*					
APR	None				
(2520)*					
JUL	None				
(2228)*					
OCT	None				
(2006)*					

*Total number of observations in indicated month.

#Month(s) with most frequent occurrence of high dew points - JAN.

TERCEIRA. AZORES

CUMULATIVE FREQUENCIES OF TEMPERATURES AND DEW POINTS

January, April, July, October

38°40'N 27°20'W Elevation 174 feet

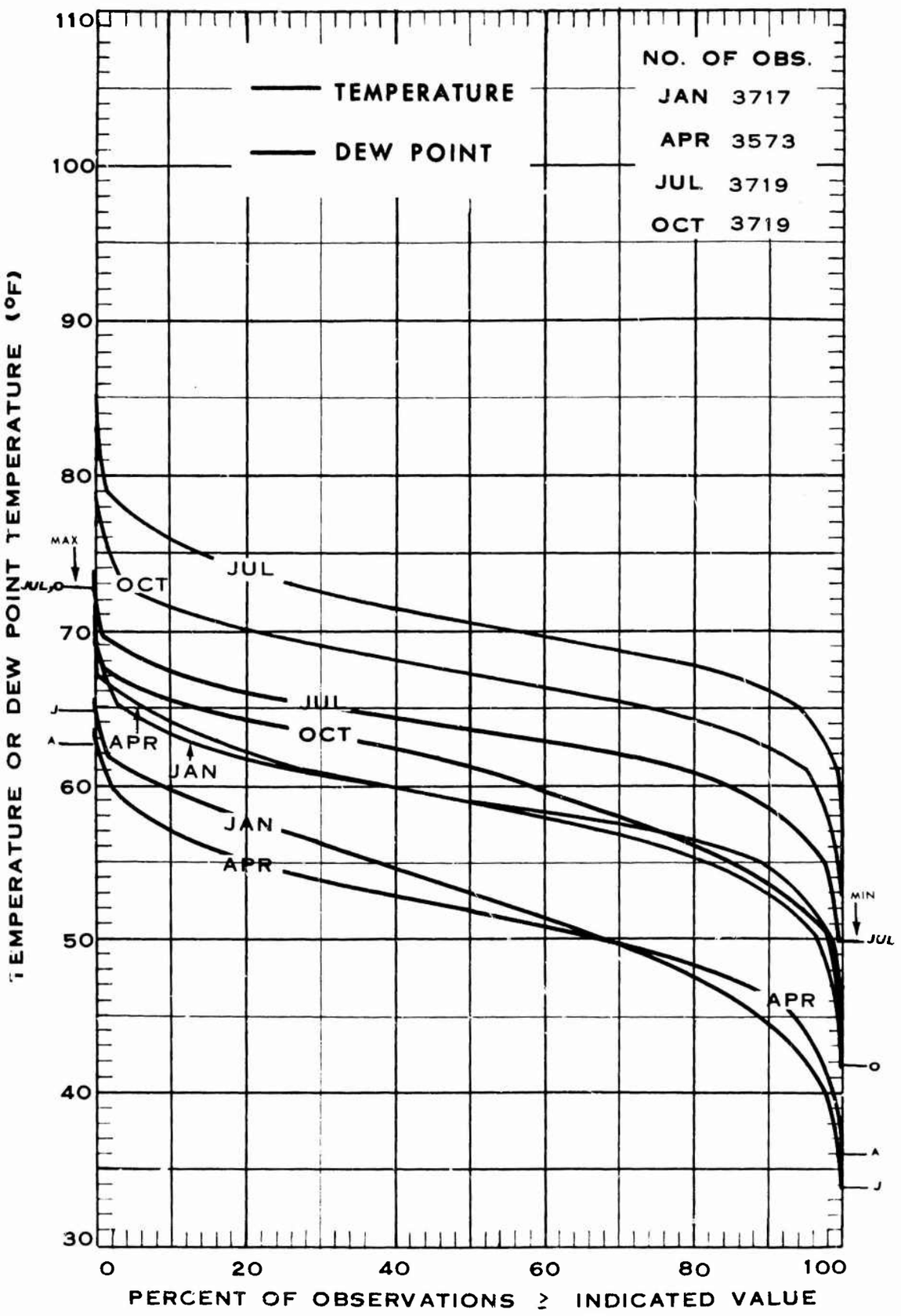


Figure 1.73

TERCEIRA, AZORES

TEMPERATURE-DEW POINT RELATIONSHIPS FOR DEW POINTS ≥ 76°F

MONTH	DEW POINT CLASS	TEMPERATURE CLASS			NUMBER OF OBSERVATIONS
		LOWEST	MEDIAN	HIGHEST	
JAN	None				
(3717)*					
APR	None				
(3573)*					
JUL	None				
(3719)*					
OCT	None				
(3719)*					

*Total number of observations in indicated month.
#Month(s) with most frequent occurrence of high dew points - AUG.

TOKYO. JAPAN

CUMULATIVE FREQUENCIES OF TEMPERATURES AND DEW POINTS

January, April, July, October

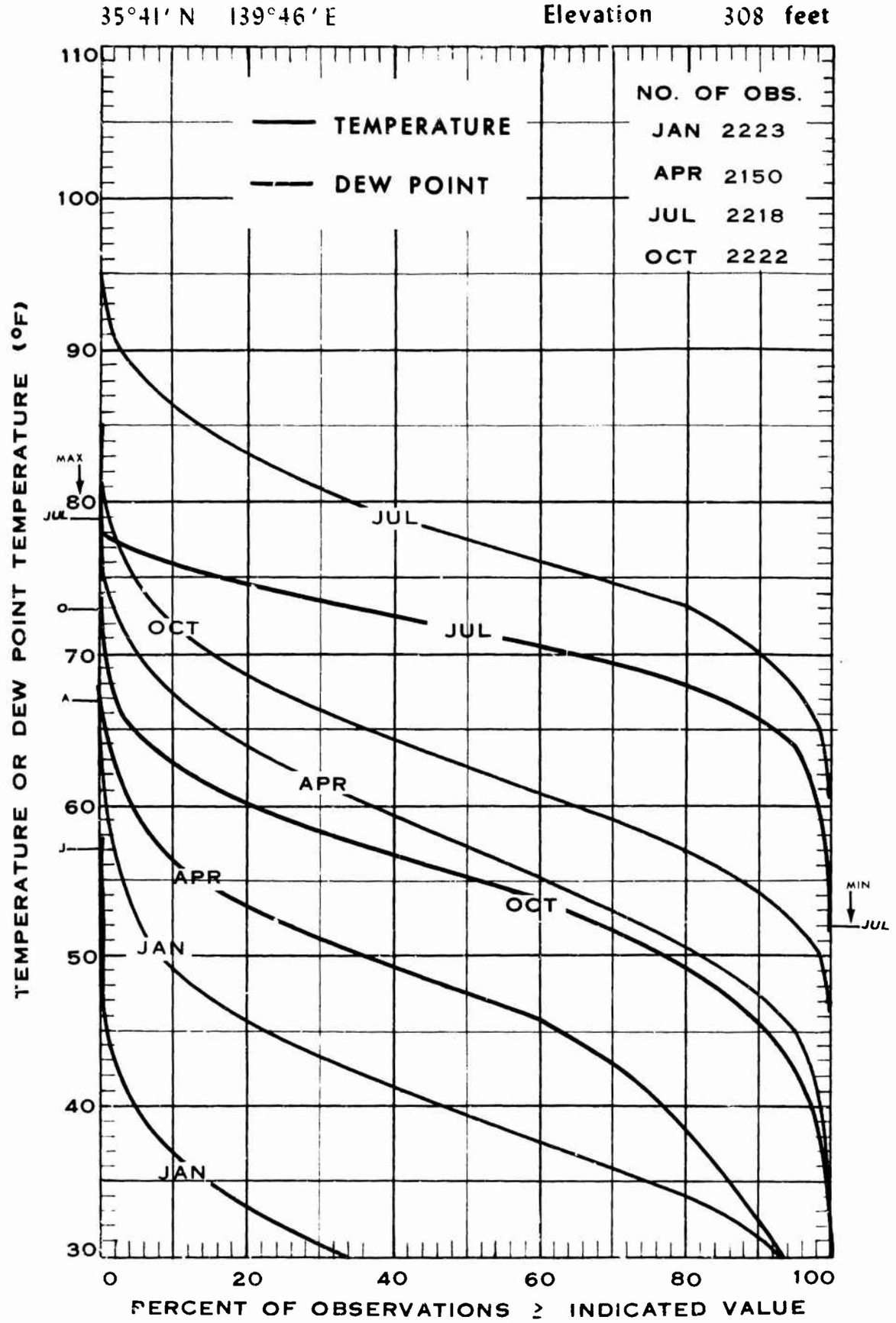


Figure 1.74

TOKYO, JAPAN

TEMPERATURE-DEW POINT RELATIONSHIPS FOR DEW POINTS ≥ 76°F

MONTH	DEW POINT CLASS	TEMPERATURE CLASS			NUMBER OF OBSERVATIONS
		LOWEST	MEDIAN	HIGHEST	
JAN	None				
(2223)*					
APR	None				
(2150)*					
JUL	76/77	75/76	81/82	91/92	149
(2218)*	78/79	79/80	85/86	91/92	11
OCT	None				
(2222)*					

*Total number of observations in indicated month.

#Month(s) with most frequent occurrence of high dew points - AUG.

TRINIDAD (WALLER AIR FORCE BASE)

CUMULATIVE FREQUENCIES OF TEMPERATURES AND DEW POINTS

January, April, July, October

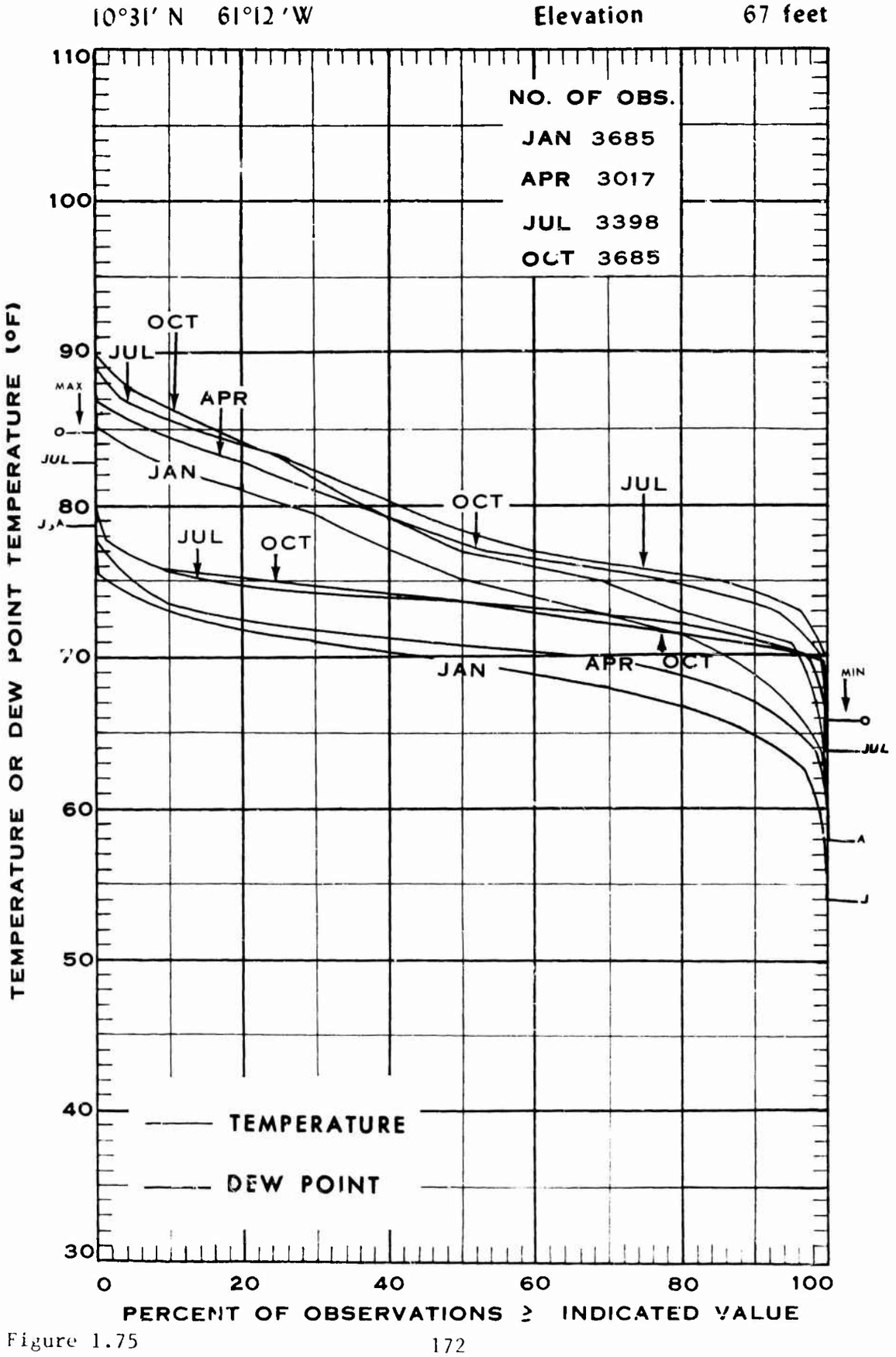


Figure 1.75

TRINIDAD (WALLER AIR FORCE BASE)

TEMPERATURE-DEW POINT RELATIONSHIPS FOR DEW POINTS ≥ 76°F#

MONTH	DEW POINT CLASS	TEMPERATURE CLASS			NUMBER OF OBSERVATIONS
		LOWEST	MEDIAN	HIGHEST	
JAN	76/77	75/76	79/80	83/84	19
(3685)*	78/79	79/80		81/82	3
APR	76/77	77/78	79/79	79/80	16
(3017)*	78/79		79/80		2
JUL	76/77	75/76	79/80	87/88	212
(3398)*	78/79	77/78	81/82	85/86	31
	82/83		85/86		1
OCT	76/77	75/76	81/82	87/88	300
(3685)*	78/79	77/78	83/84	87/88	33

*Total number of observations in indicated month.

#Month(s) with most frequent occurrence of high dew points - OCT.

TRIPOLI. LIBYA

CUMULATIVE FREQUENCIES OF TEMPERATURES AND DEW POINTS

January, April, July, October

32°54 N 13°17' E Elevation 82 feet

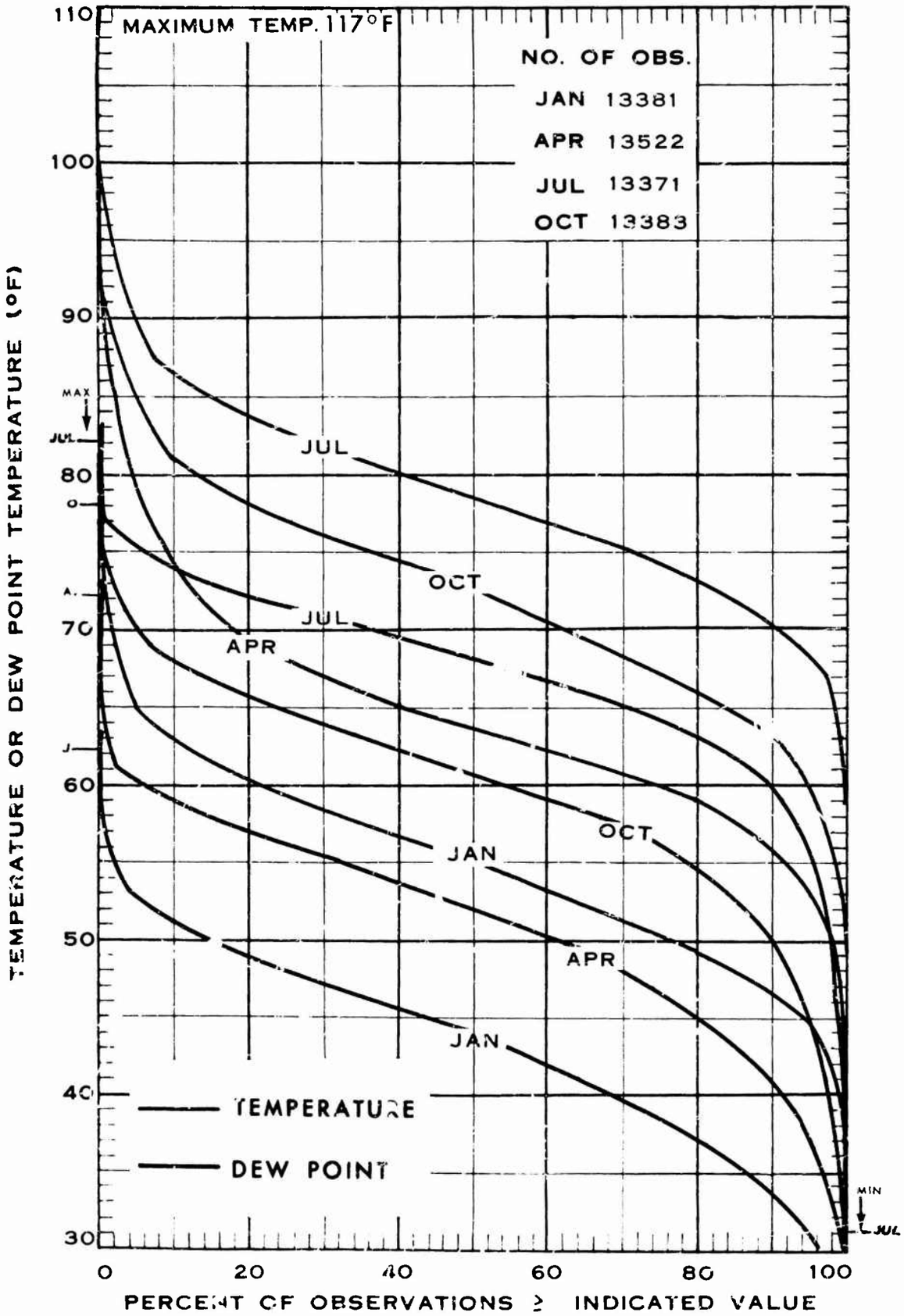


Figure 1.76

TRIPOLI, LIBYA

TEMPERATURE-DEW POINT RELATIONSHIPS FOR DEW POINTS ≥ 76°F

MONTH	DEW POINT CLASS	TEMPERATURE CLASS			NUMBER OF OBSERVATIONS
		LOWEST	MEDIAN	HIGHEST	
JAN	None				
(3719)*					
APR	None				
(3589)*					
JUL	76/77	75/76	81/82	91/92	66
(3705)*	78/79	85/86		87/88	3
	80/81		89/90		2
OCT	76/77		83/84		2
(3719)*	78/79		85/86		1

*Total number of observations in indicated month.

#Month(s) with most frequent occurrence of high dew points - AUG.

WASHINGTON, DISTRICT OF COLUMBIA

CUMULATIVE FREQUENCIES OF TEMPERATURES AND DEW POINTS

January, April, July, October

38°50′ N 77°01′ W Elevation 29 feet

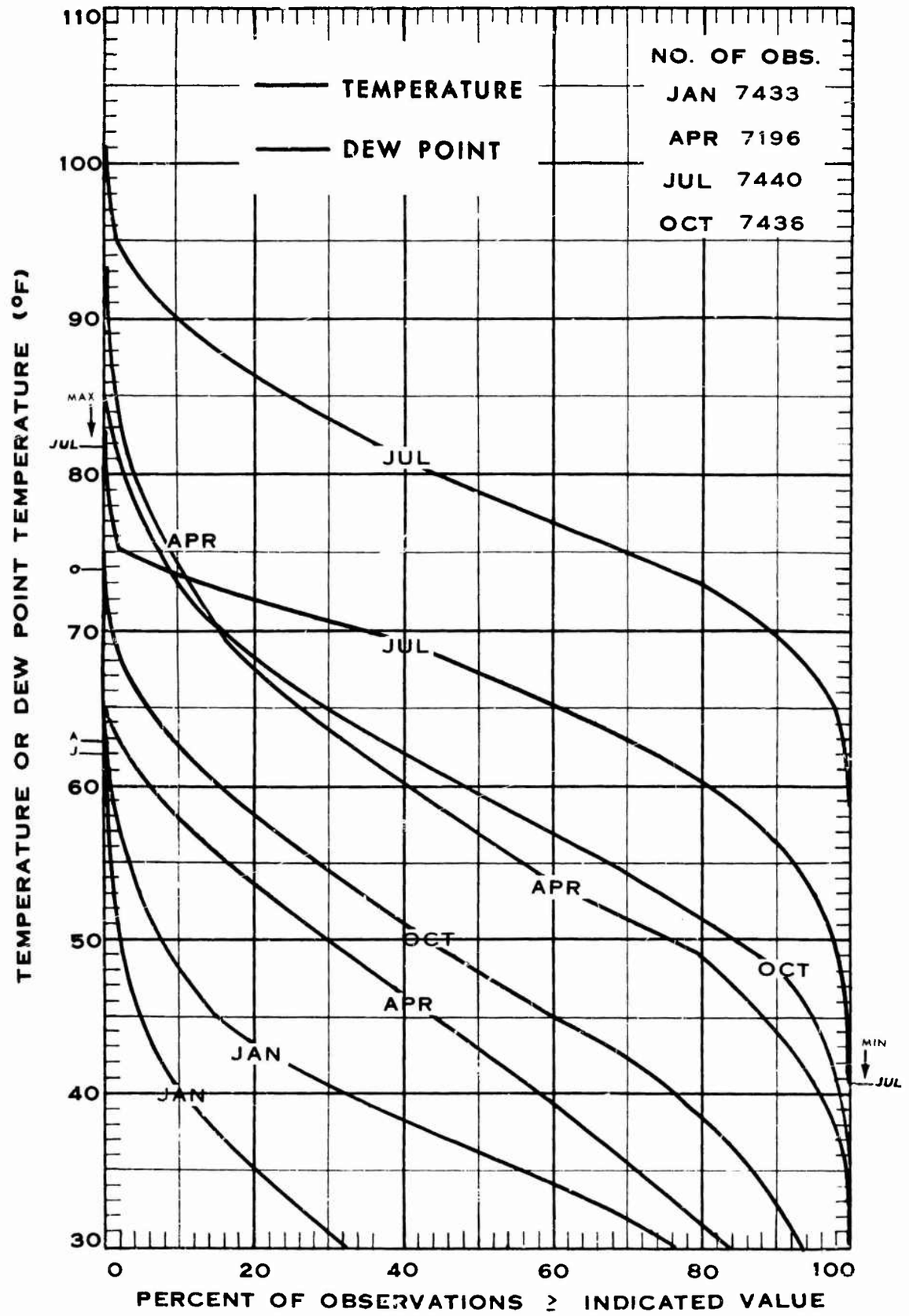


Figure 1.77

WASHINGTON, D.C.

Data not available

(See p 6 for explanation)

ZAMBOANGA, PHILIPPINE ISLANDS

CUMULATIVE FREQUENCIES OF TEMPERATURES AND DEW POINTS

January, April, July, October

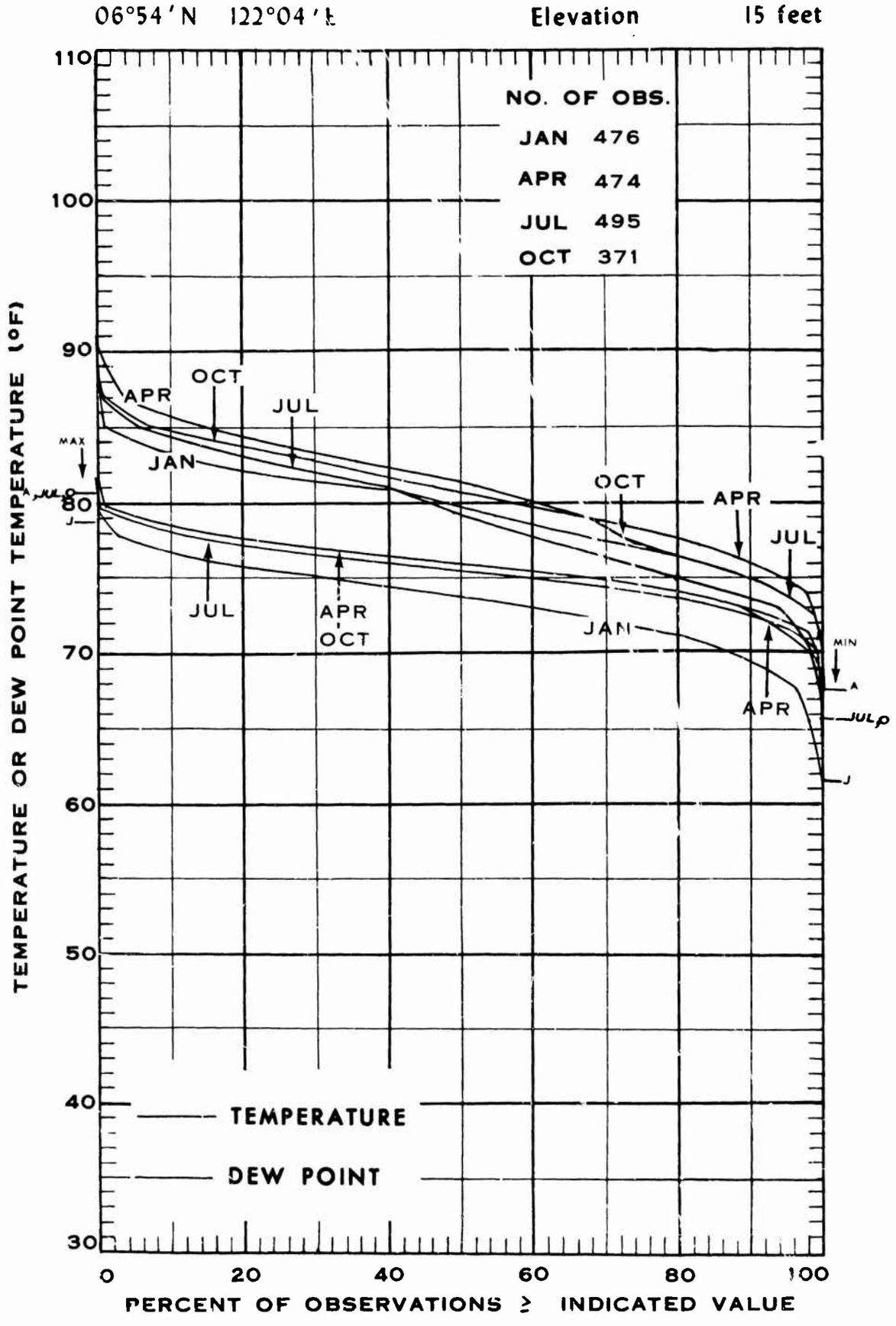


Figure 1.78

ZAMBOANGA, PHILIPPINE ISLANDS

TEMPERATURE-DEW POINT RELATIONSHIPS FOR DEW POINTS ≥ 76°F

MONTH	DEW POINT CLASS	TEMPERATURE CLASS			NUMBER OF OBSERVATIONS
		LOWEST	MEDIAN	HIGHEST	
JAN	76/77	77/78	81/82	85/86	88
(476)*	78/79	79/80	81/82	83/84	14
APR	76/77	77/78	81/82	87/88	172
(474)*	78/79	79/80	83/84	89/90	85
	80/81	83/84		87/88	8
JUL	76/77	77/78	81/82	87/88	165
(495)*	78/79	79/80		87/88	58
	80/81		83/84		2
OCT	76/77	77/78	81/82	87/88	127
(371)*	78/79	79/80	83/84	87/88	69
	80/81	81/82		85/86	4

*Total number of observations in indicated month.

#Month(s) with most frequent occurrence of high dew points - JUL, AUG.

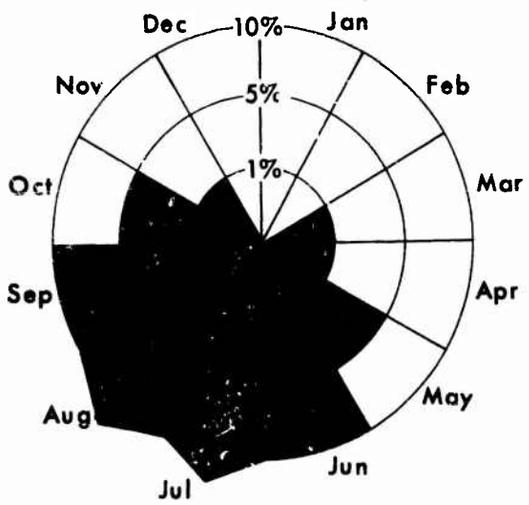
DEW POINT FREQUENCY MAPS

The maps included in this section, except for the overall location map on page 183, are broken down into sections to overcome scale problems. A separate location map faces each Dew Point Frequency Map for convenience. The maps present data from a total of 215 world-wide stations, generally located between latitudes 20° N and 20° S. An expansion and detailed exploration of the legend material on the maps is found on page 182.

MAPS SHOWING DISTRIBUTION OF OCCURRENCE OF HIGH DEW POINTS

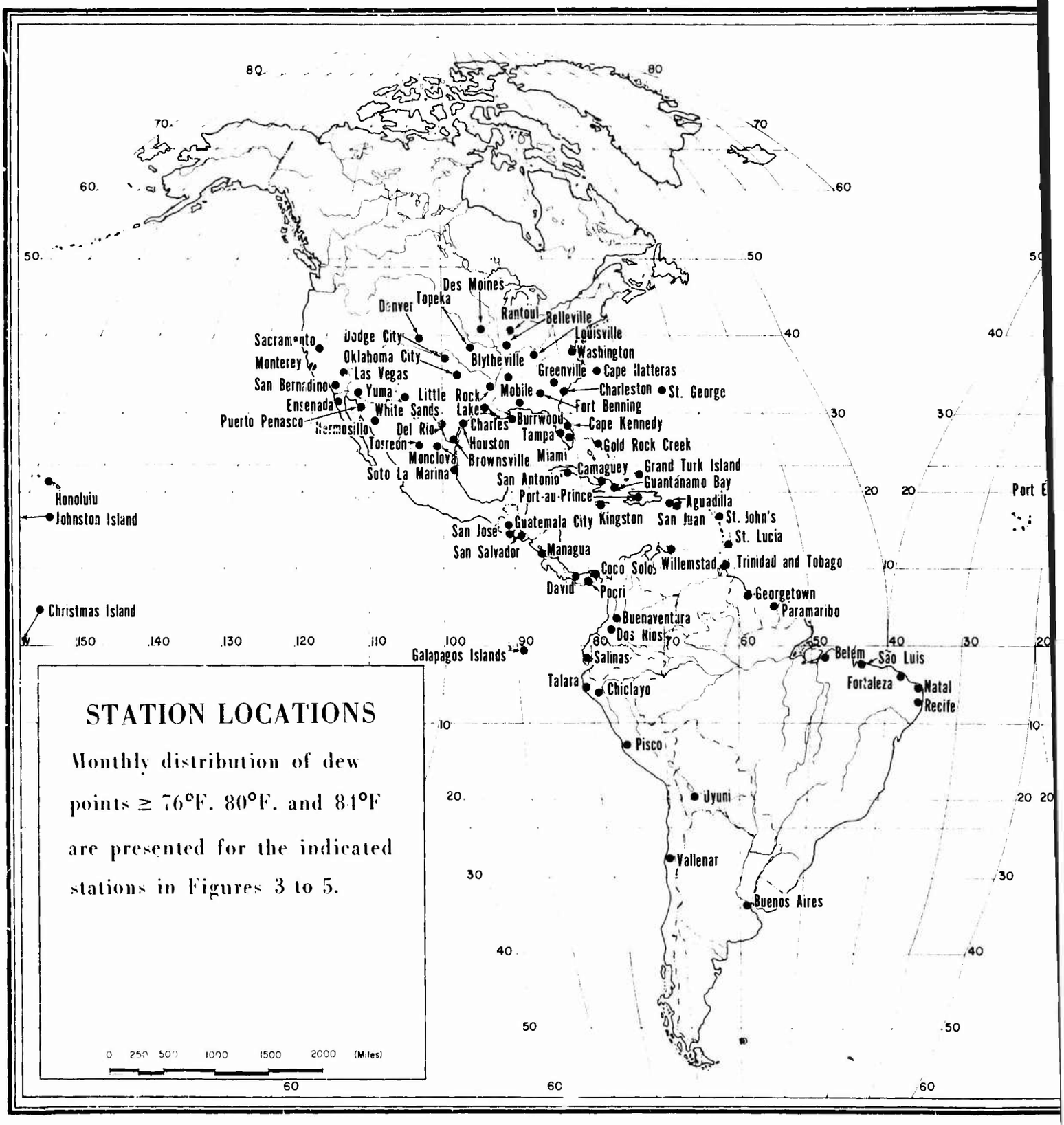
The nine maps (Figs. 3, 4, and 5) on the following pages depict the frequency of occurrence of high dew points by use of circular graphs overprinted on the maps. The maps are presented for three dew point levels, 76°, 80°, and 84°F. Figure 3 shows the monthly frequency of occurrence of dew points equal to or greater than 76°F. Figures 4 and 5 similarly show the frequency of occurrence of dew points equal to or greater than 80°F and 84°F, respectively. Each figure consists of three sections to afford world coverage between latitudes 40° N and 40° S. Section "a" covers Southeastern Asia and Australia; Section "b" covers Southern Europe, Southwestern Asia, and Africa; and Section "c" covers North and South America. An example of the interpretation of the circular graphs is included below.

INTERPRETATION OF CIRCULAR GRAPHS



Dew points at the indicated level on the map (76°, 80°, 84°F) depict five frequency classes. The 12 sections of the graph, one for each month, are further divided so that the frequency class can be depicted for each month. The interpretation of the above sample station graph is as follows:

Dew Point Frequency Class (% of Occurrence)	Month(s) of Occurrence
0	Dec, Jan, Feb
0 - 0.9	Mar, Apr, Nov
1 - 4.9	May, Oct
5 - 9.9	Jun, Sep
≥10	Jul, Aug


Des Moines
Denver
Topeka
Rantoul
Belleville
Louisville
Sacramento
Dodge City
Washington
Monterey
Oklahoma City
Blytheville
Greenville
Cape Hatteras
Las Vegas
San Bernadino
Yuma
Little Rock
Mobile
Charleston
St. George
Ensenada
White Sands
Lake
Fort Benning
Puerto Penasco
Del Rio
Charles
Burrwood
Cape Kennedy
Hermosillo
Tampa
Torreon
Houston
Gold Rock Creek
Monclova
Brownsville
Miami
Camaguey
Grand Turk Island
Soto La Marina
San Antonio
Guantanamo Bay
Port-au-Prince
Aguadilla
Honoluiu
Johnston Island
Guatemala City
Kingston
San Juan
St. John's
San Jose
St. Lucia
San Salvador
Managua
Willemstad
Trinidad and Tobago
Coco Solo
David
Pocri
Georgetown
Christmas Island
Paramaribo
Buenaventara
Dos Rios
Galapagos Islands
Salinas
Belém
São Luis
Talara
Chiclayo
Fortaleza
Natal
Recife
Pisco
Uyuni
Vallenar
Buenos Aires
STATION LOCATIONS
Monthly distribution of dew points ≥ 76°F. 80°F. and 84°F are presented for the indicated stations in Figures 3 to 5.
0 250 500 1000 1500 2000 (Miles)

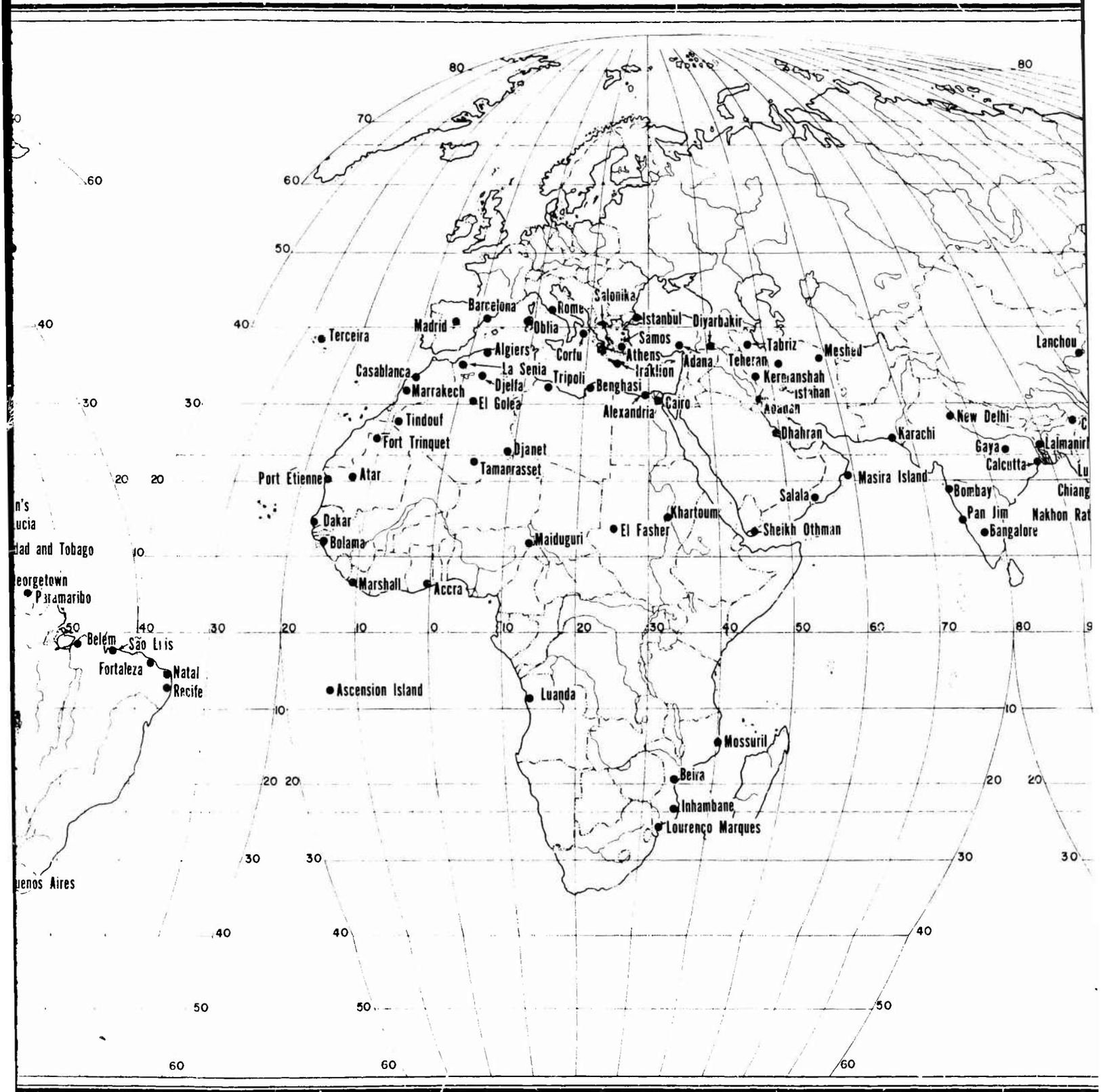
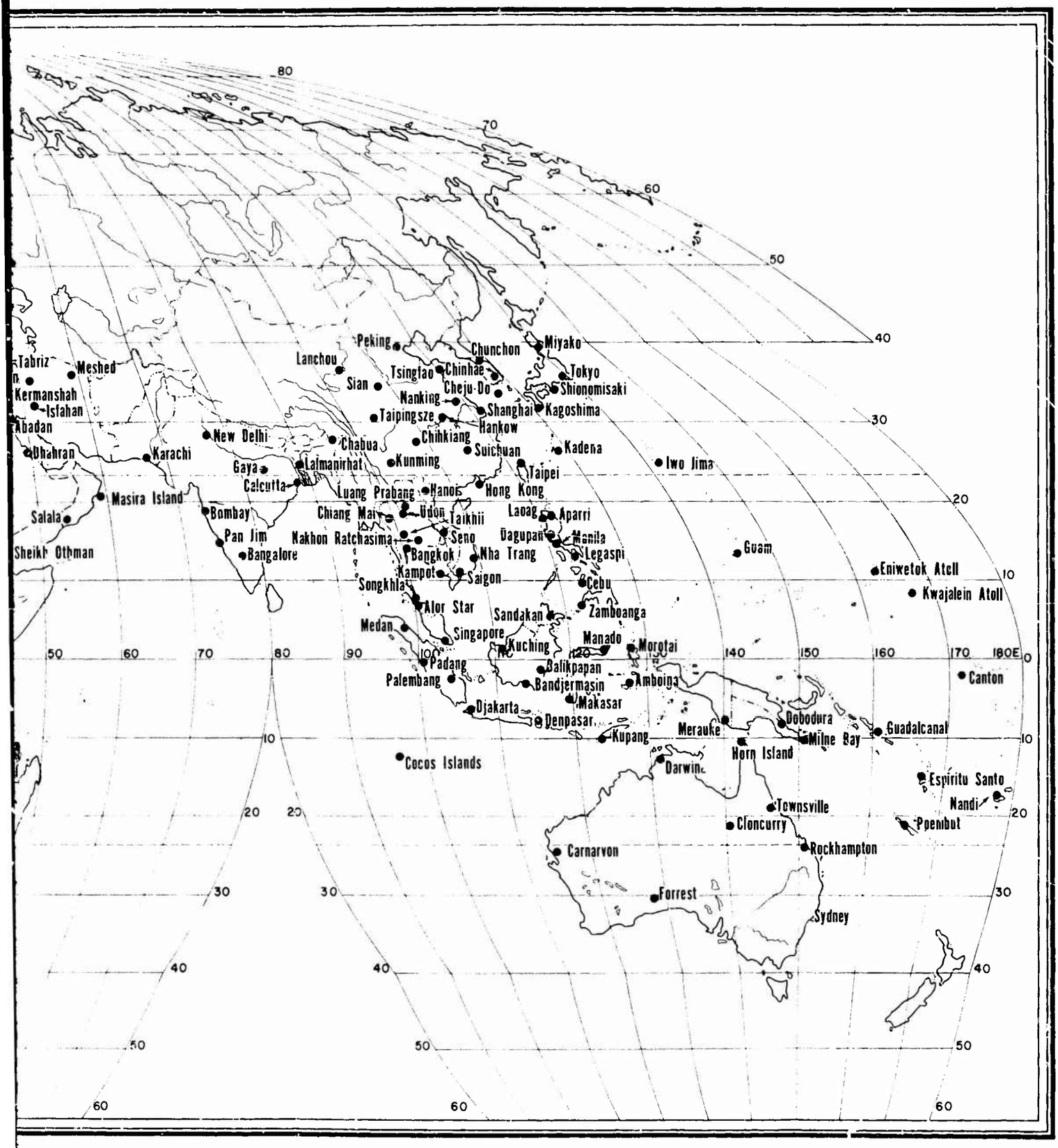
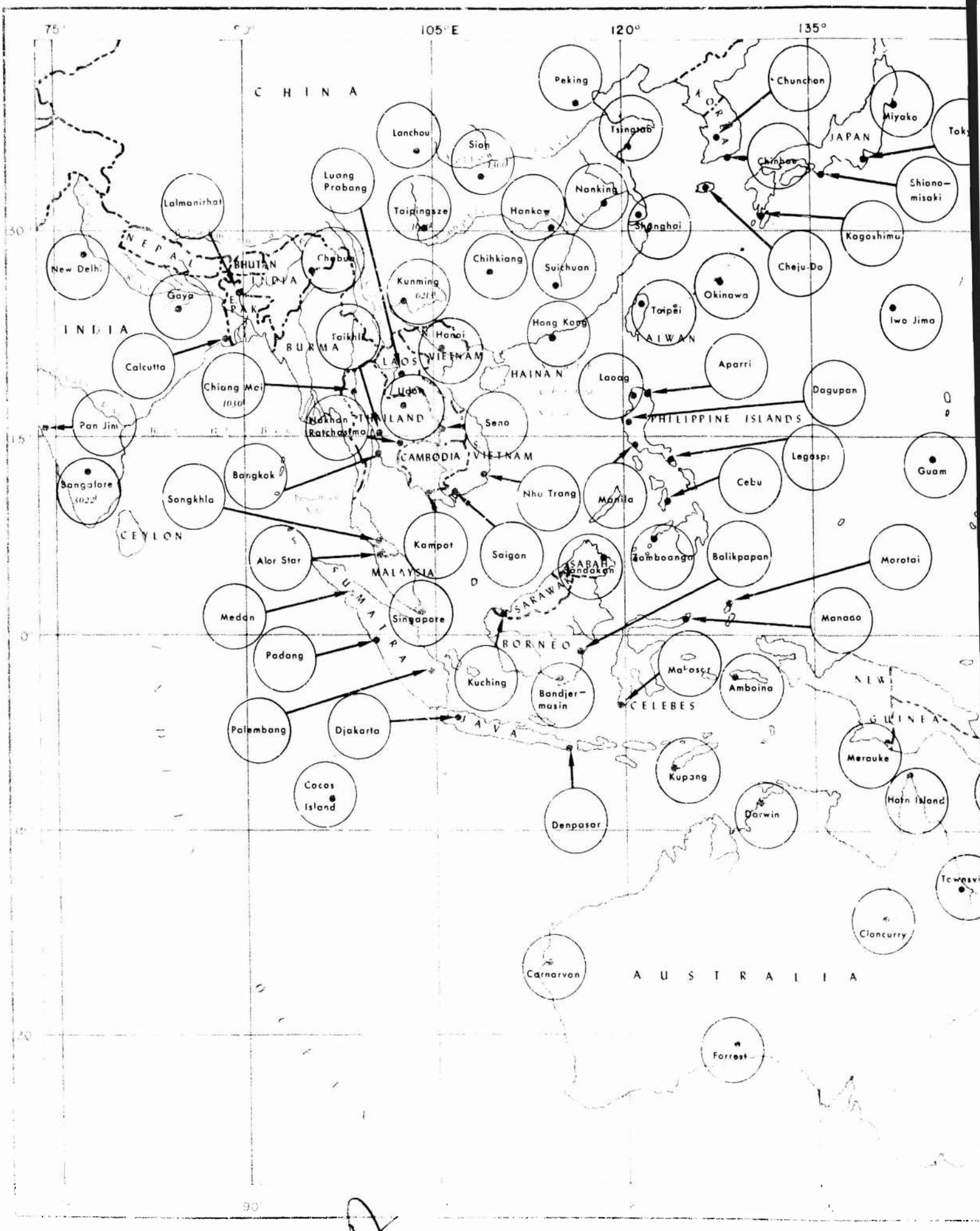
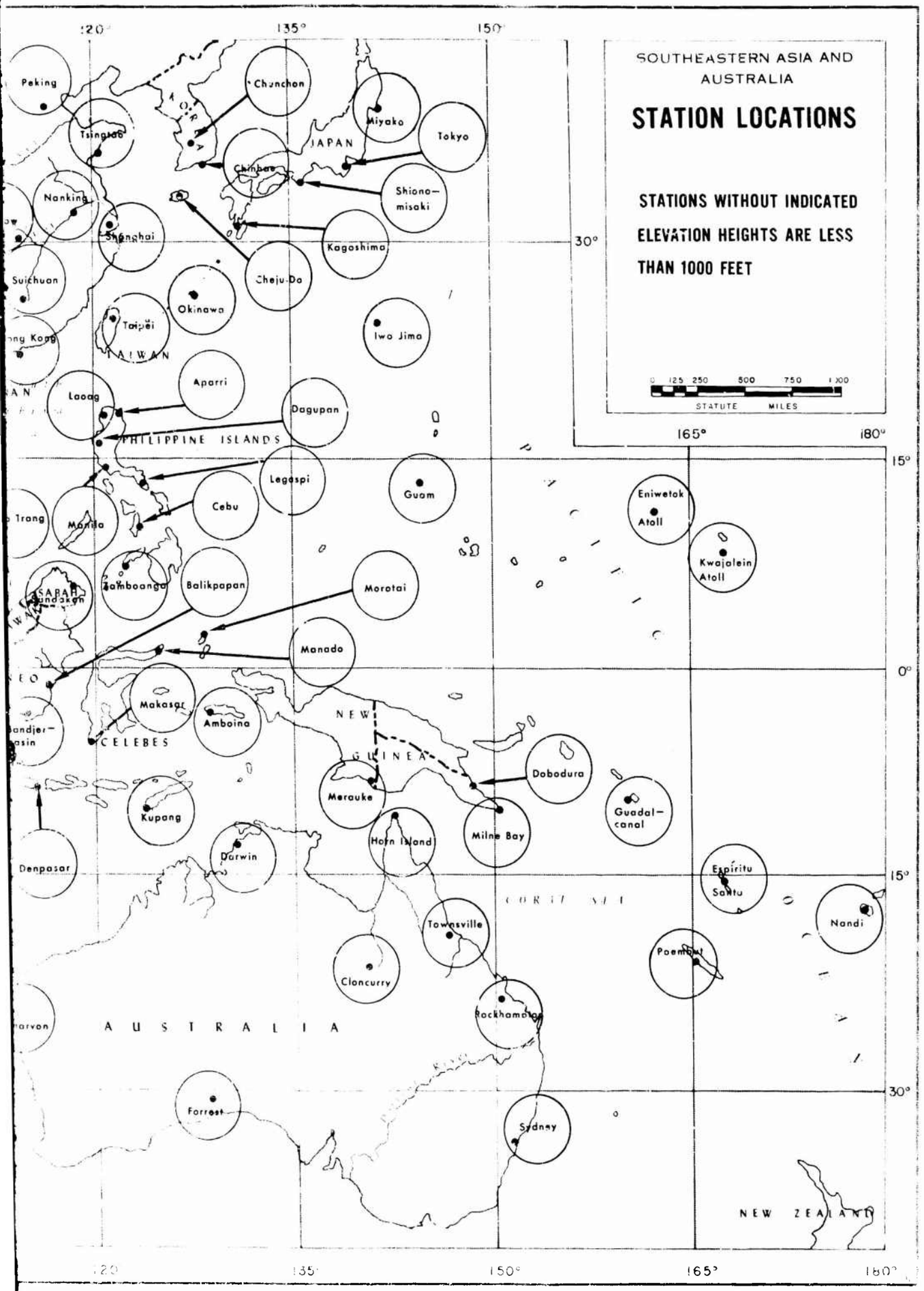

Barcelona
Rome
Salonika
Madrid
Oblia
Istanbul
Diyarbakir
Terceira
Samos
Tabriz
Meshed
Lanchou
Algiers
Corfu
Athens
Adana
Teheran
Casablanca
La Senia
Iraklion
Kermanshah
Djelfa
Tripoli
Benghasi
Marrakech
El Golea
Cairo
Alexandria
Tindouf
New Delhi
Fort Trinquet
Dhahran
Karachi
Djanet
Gaya
Tamanrasset
Calcutta
Port Etienne
Atar
Masira Island
Salala
Bombay
Khartoum
Dakar
Pan Jim
Nakhon Rat
El Fasher
Sheikh Othman
Bangalore
Maiduguri
Bolama
Marshall
Accra
Belém
São Luis
Fortaleza
Natal
Recife
Ascension Island
Luanda
Mossuril
Beira
Inhambane
Lourenço Marques

Figure 2


Peking
Chunchon
Miyako
Lanchou
Tsingtao
Chinhae
Tokyo
Sian
Cheju-Do
Shionomisaki
Nanking
Shanghai
Kagoshima
Taipingsze
Hankow
Tabriz
Meshed
Kermanshah
Isfahan
Abadan
Dhahran
Karachi
New Delhi
Chabua
Chihkiang
Suichuan
Kadena
Kunming
Iwo Jima
Gaya
Laimanirhat
Taipei
Calcutta
Luang Prabang
Hanoi
Hong Kong
Masira Island
Salala
Bombay
Chiang Mai
Udon
Taikhii
Laoag
Aparri
Pan Jim
Nakhon Ratchasima
Seno
Dagupan
Manila
Sheikh Othman
Bangalore
Bangkok
Nha Trang
Legaspi
Guam
Kampot
Saigon
Eniwetok Atoll
Songkhla
Cebu
Kwajalein Atoll
Alor Star
Sandakan
Zamboanga
Medan
Singapore
Kuching
Manado
Morotai
Padang
Balikpapan
Canton
Palembang
Bandjermasin
Amboina
Makasar
Djakarta
Denpasar
Dobodura
Merauke
Guadalcanal
Kupang
Milne Bay
Horn Island
Cocos Islands
Darwin
Espiritu Santo
Townsville
Nandi
Cloncurry
Ppenibut
Carnarvon
Rockhampton
Forrest
Sydney


75°
90°
105° E
120°
135°
CHINA
Peking
Lanchou
Sian
Tsingtao
Chunchon
KOREA
Miyako
JAPAN
Chinhae
Shiono-misaki
Kagoshimu
Cheju-Do
Nanking
Hankow
Shanghai
Taipingsze
Luang Prabang
Lalmanirhat
NEPAL
BHUTAN
INDIA
Gaya
New Delhi
Chabua
Kunming
Chihkiang
Suichuan
Okinawa
Taipei
TAIWAN
Iwo Jima
Hong Kong
Taikhi
BURMA
Hanoi
LAOS
VIETNAM
HAINAN
Aparri
Laoag
Dagupan
Calcutta
Chiang Mai
Udon
THAILAND
Nakhon Ratchasima
Pan Jim
Seno
PHILIPPINE ISLANDS
Legaspi
Guam
CAMBODIA
VIETNAM
Bangkok
Songkhla
Nha Trang
Manila
Cebu
Sangalore
CEYLON
Kampot
Saigon
Alor Star
MALAYSIA
SABAH
Sandakan
Zamboanga
Balikpapan
Morotai
SUMATRA
Medan
Singapore
SARAWAK
Manado
Padang
BORNEO
Kuching
Bandjer-masin
Ma'assr
Amboina
CELEBES
NEW GUINEA
Palembang
Djakarta
JAVA
Merauke
Kupang
Cocos Island
Darwin
Horn Island
Denpasar
Townsvil
Cloncurry
Carnarvon
AUSTRALIA
Forrest


SOUTHEASTERN ASIA AND AUSTRALIA
STATION LOCATIONS
STATIONS WITHOUT INDICATED ELEVATION HEIGHTS ARE LESS THAN 1000 FEET
0 125 250 500 750 1000
STATUTE MILES
120°
135°
150°
165°
180°
30°
15°
0°
15°
30°
Peking
Tsingtao
Chunchon
Miyako
Tokyo
JAPAN
Chinhae
Shiono-misaki
Nanking
Shanghai
Kagoshima
Cheju-Do
Suichuan
Okinawa
Taipei
TAIWAN
Iwo Jima
Aparri
Laoag
Dagupan
PHILIPPINE ISLANDS
Legaspi
Cebu
Manila
Guam
Eniwetok Atoll
Kwajalein Atoll
Zamboanga
Balikpapan
Morotai
Manado
Makasar
Amboina
CELEBES
NEW GUINEA
Dobodura
Merauke
Kupang
Horn Island
Milne Bay
Guadal-canal
Darwin
Denpasar
Espiritu Santu
Nandi
Townsville
Cloncurry
Rockhampton
AUSTRALIA
Forrest
Sydney
NEW ZEALAND

B

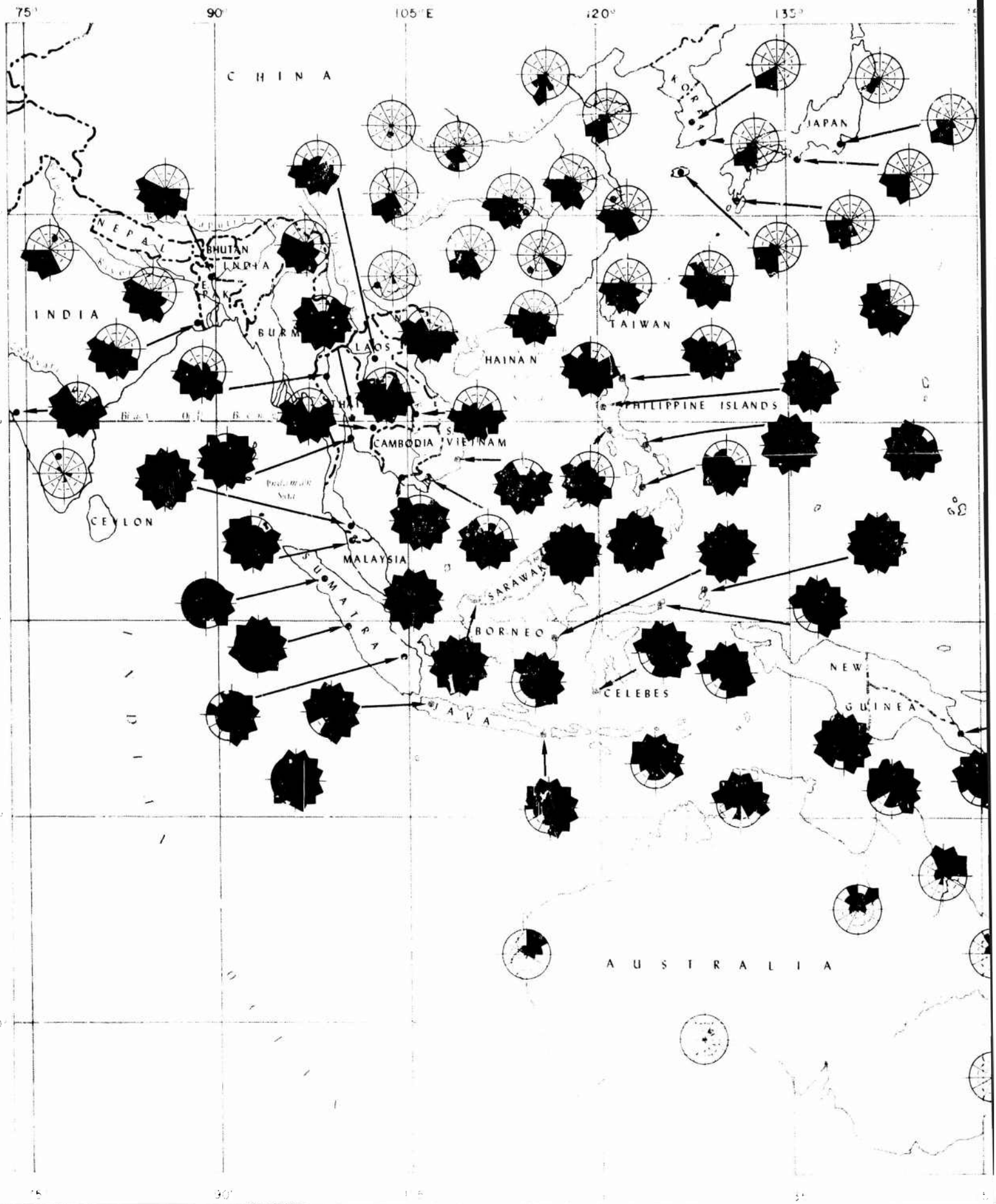

75°
90°
105° E
120°
135°
CHINA
KOREA
JAPAN
NEPAL
BHUTAN
INDIA
INDIA
BURMA
LAOS
TAIWAN
HAINAN
PHILIPPINE ISLANDS
CAMBODIA
VIETNAM
CEYLON
MALAYSIA
SARAWAK
SUMATRA
BORNEO
CELEBES
NEW GUINEA
JAVA
AUSTRALIA

Figure 3a

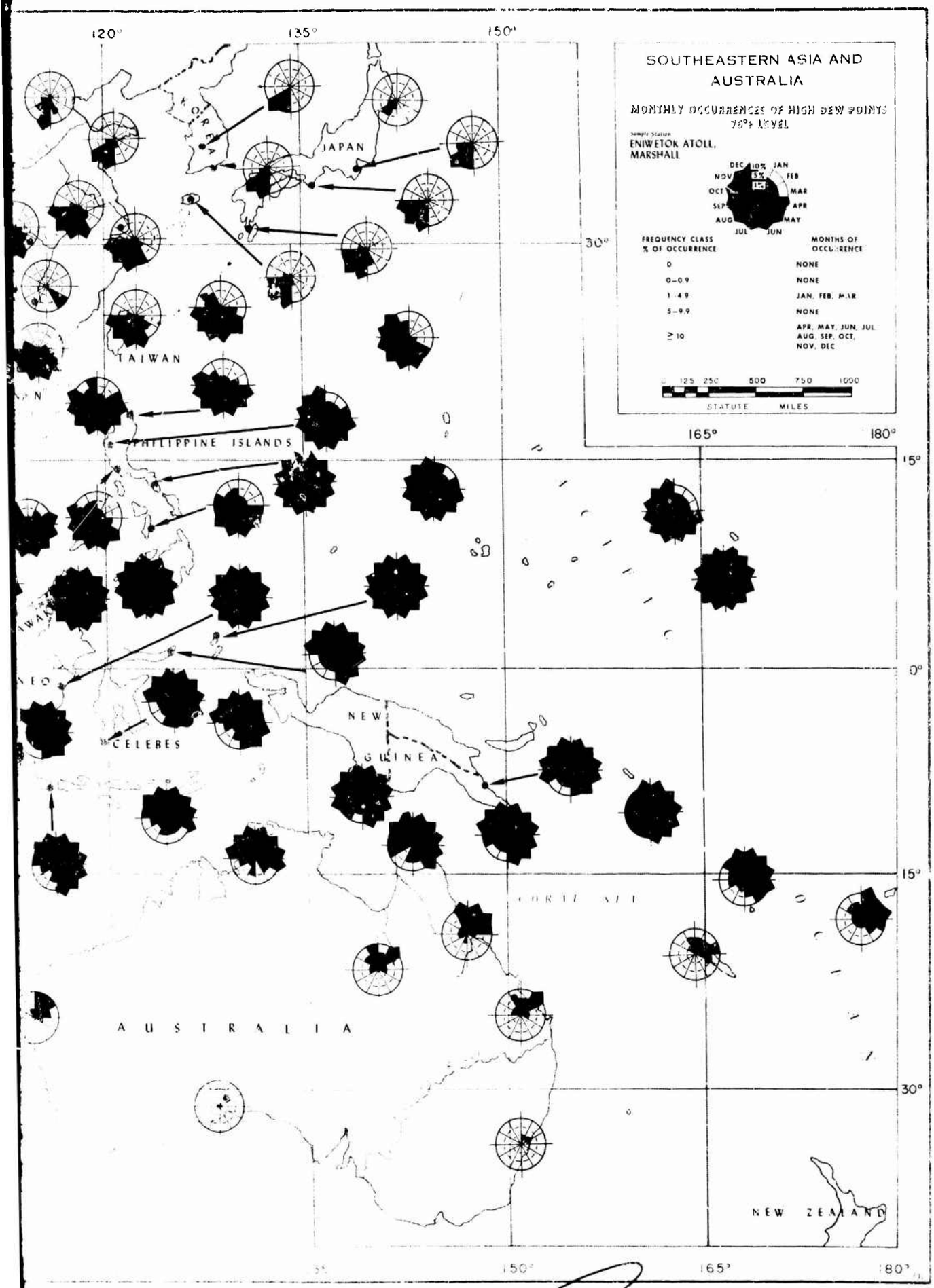
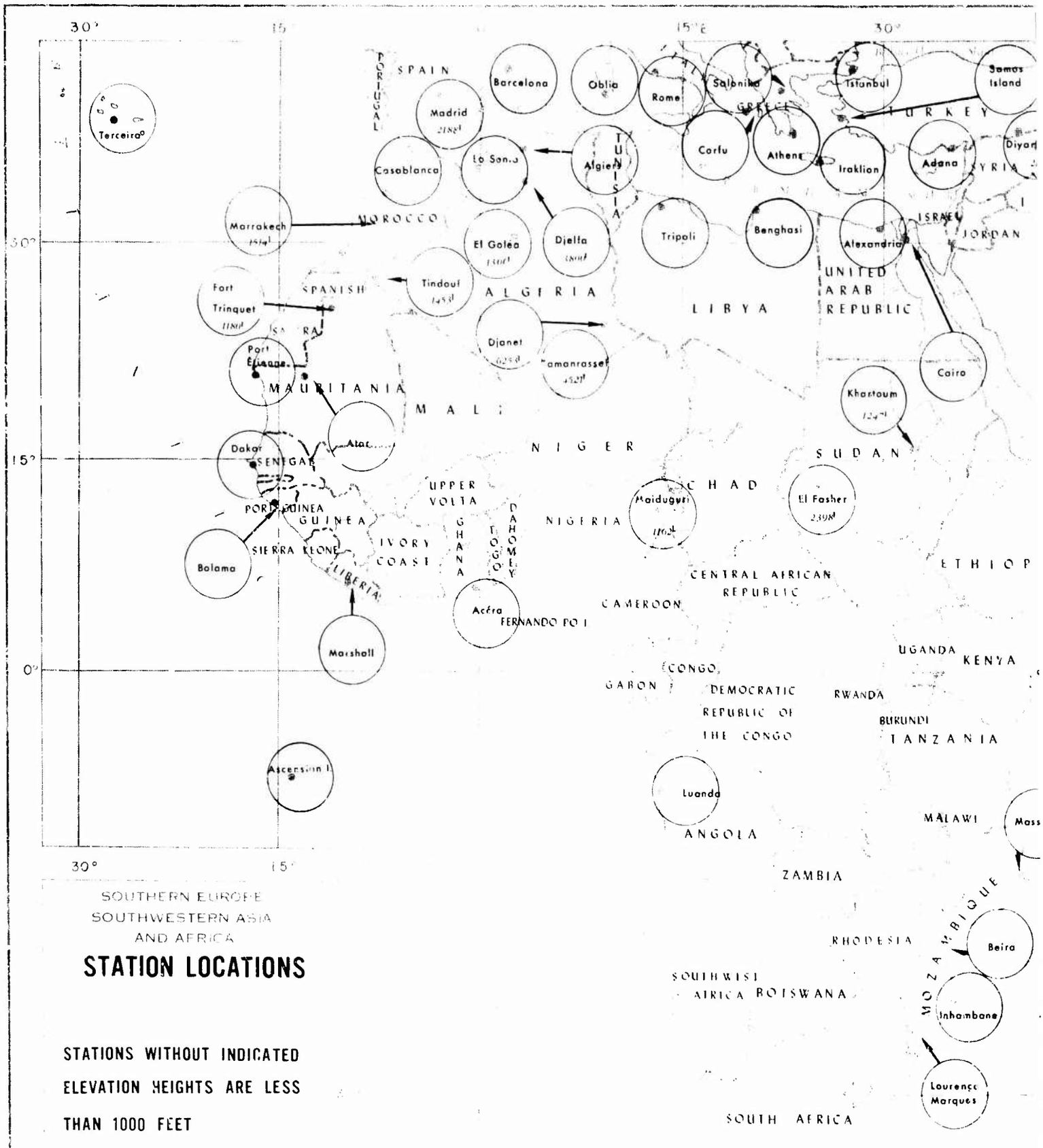

SOUTHEASTERN ASIA AND AUSTRALIA
MONTHLY OCCURRENCES OF HIGH DEW POINTS
Sample Station
ENIWETOK ATOLL, MARSHALL
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
10%
5%
1%
FREQUENCY CLASS % OF OCCURRENCE
MONTHS OF OCCURRENCE
0
NONE
0–0.9
NONE
1–4.9
JAN, FEB, MAR
5–9.9
NONE
≥10
APR, MAY, JUN, JUL, AUG, SEP, OCT, NOV, DEC
0 125 250 500 750 1000
STATUTE MILES
120°
135°
150°
165°
180°
30°
15°
0°
15°
30°
KOREA
JAPAN
TAIWAN
PHILIPPINE ISLANDS
CELEBES
NEW GUINEA
AUSTRALIA
NEW ZEALAND

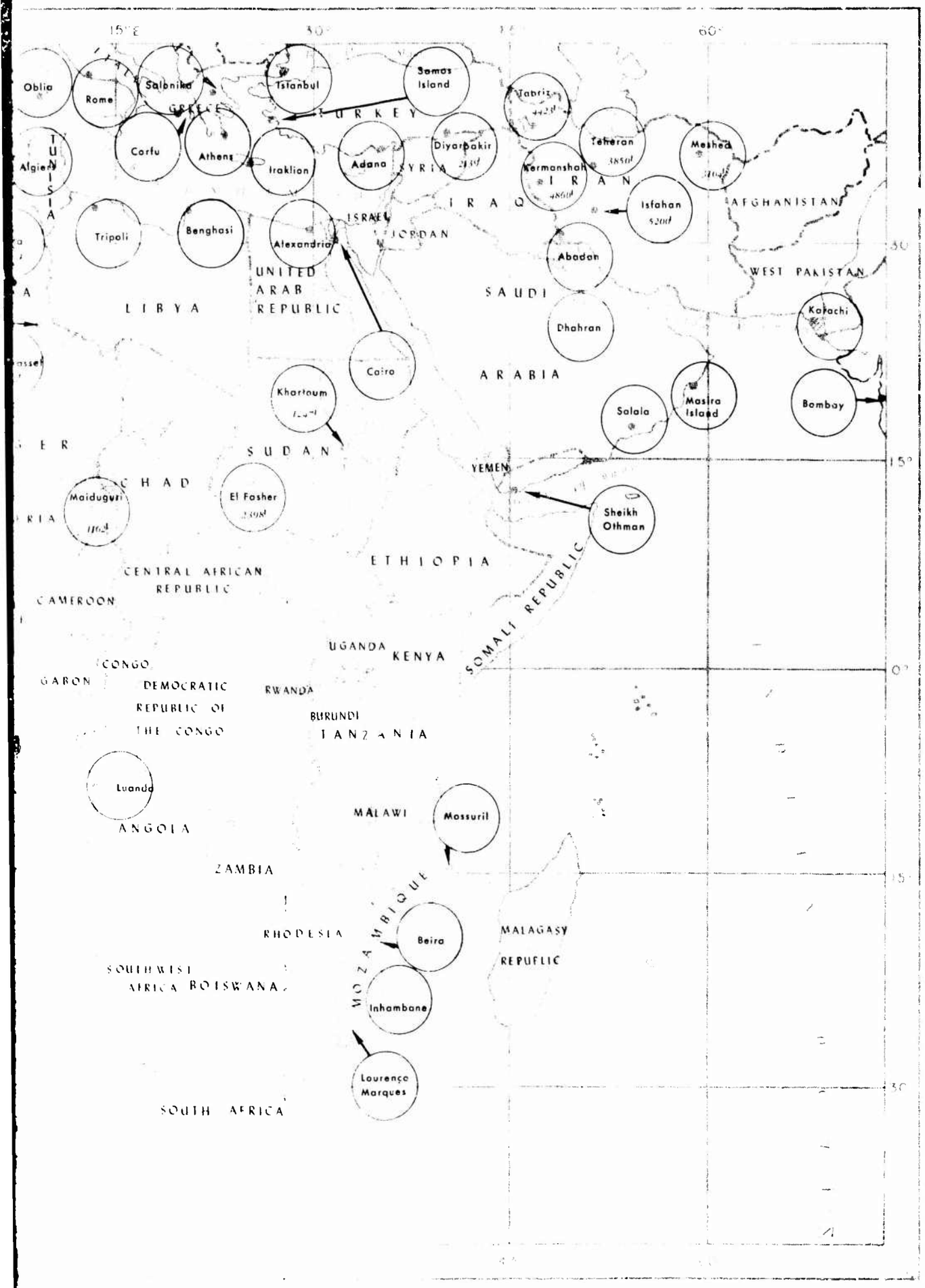
Figure 3a



SOUTHERN EUROPE
SOUTHWESTERN ASIA
AND AFRICA

STATION LOCATIONS

STATIONS WITHOUT INDICATED ELEVATION HEIGHTS ARE LESS THAN 1000 FEET


15°E
30°
60°
Oblia
Rome
Salonika
Istanbul
Samos Island
GREECE
TURKEY
Corfu
Athens
Iraklion
Adana
SYRIA
Diyarbakir
Tabriz
Teheran
Meshed
Kermanshah
IRAN
IRAQ
Isfahan
AFGHANISTAN
Algiers
TUNISIA
Tripoli
Benghasi
Alexandria
ISRAEL
JORDAN
Abadan
WEST PAKISTAN
UNITED ARAB REPUBLIC
LIBYA
SAUDI ARABIA
Dhahran
Karachi
Cairo
Khartoum
Masira Island
Salala
Bombay
SUDAN
YEMEN
CHAD
Maiduguri
El Fasher
Sheikh Othman
ETHIOPIA
CENTRAL AFRICAN REPUBLIC
CAMEROON
SOMALI REPUBLIC
UGANDA
KENYA
CONGO
GABON
DEMOCRATIC REPUBLIC OF THE CONGO
RWANDA
BURUNDI
TANZANIA
Luanda
ANGOLA
MALAWI
Massuril
ZAMBIA
RHODESIA
MOZAMBIQUE
Beira
MALAGASY REPUFLIC
SOUTHWEST AFRICA
BOTSWANA
Inhambane
Lourenço Marques
SOUTH AFRICA
30°
15°
0°
15°
30°

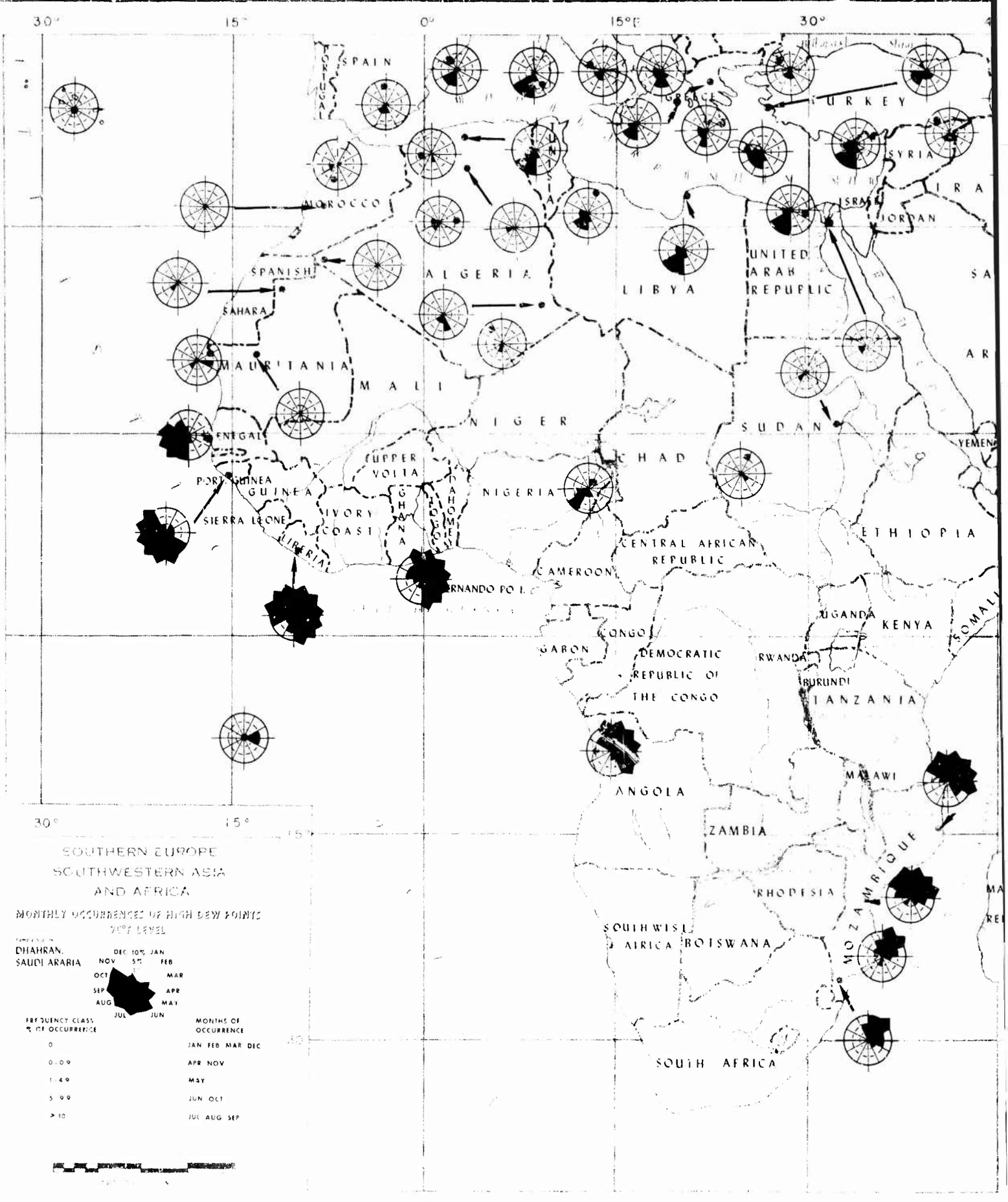

30°
15°
0°
15°E
30°
SPAIN
PORTUGAL
MOROCCO
SPANISH SAHARA
ALGERIA
LIBYA
TUNISIA
GREECE
TURKEY
SYRIA
IRAQ
ISRAEL
JORDAN
UNITED ARAB REPUBLIC
MAURITANIA
MALI
NIGER
SUDAN
CHAD
SENEGAL
PORTUGUESE GUINEA
GUINEA
SIERRA LEONE
LIBERIA
IVORY COAST
UPPER VOLTA
GHANA
TOGO
DAHOMEY
NIGERIA
CAMEROON
FERNANDO PO I.
CENTRAL AFRICAN REPUBLIC
ETHIOPIA
UGANDA
KENYA
SOMALI
CONGO
GABON
DEMOCRATIC REPUBLIC OF THE CONGO
RWANDA
BURUNDI
TANZANIA
ANGOLA
MALAWI
ZAMBIA
RHODESIA
MOZAMBIQUE
SOUTH WEST AFRICA
BOTSWANA
SOUTH AFRICA
SOUTHERN EUROPE
SOUTHWESTERN ASIA
AND AFRICA
MONTHLY OCCURRENCES OF HIGH DEW POINTS
70°F LEVEL
DHAHRAN, SAUDI ARABIA
DEC 10% JAN
NOV 5% FEB
OCT MAR
SEP APR
AUG MAY
JUL JUN
FREQUENCY CLASS % OF OCCURRENCE
MONTHS OF OCCURRENCE
0 JAN FEB MAR DEC
0.0-0.9 APR NOV
1.0-4.9 MAY
5.0-9.9 JUN OCT
>10 JUL AUG SEP

Figure 3b

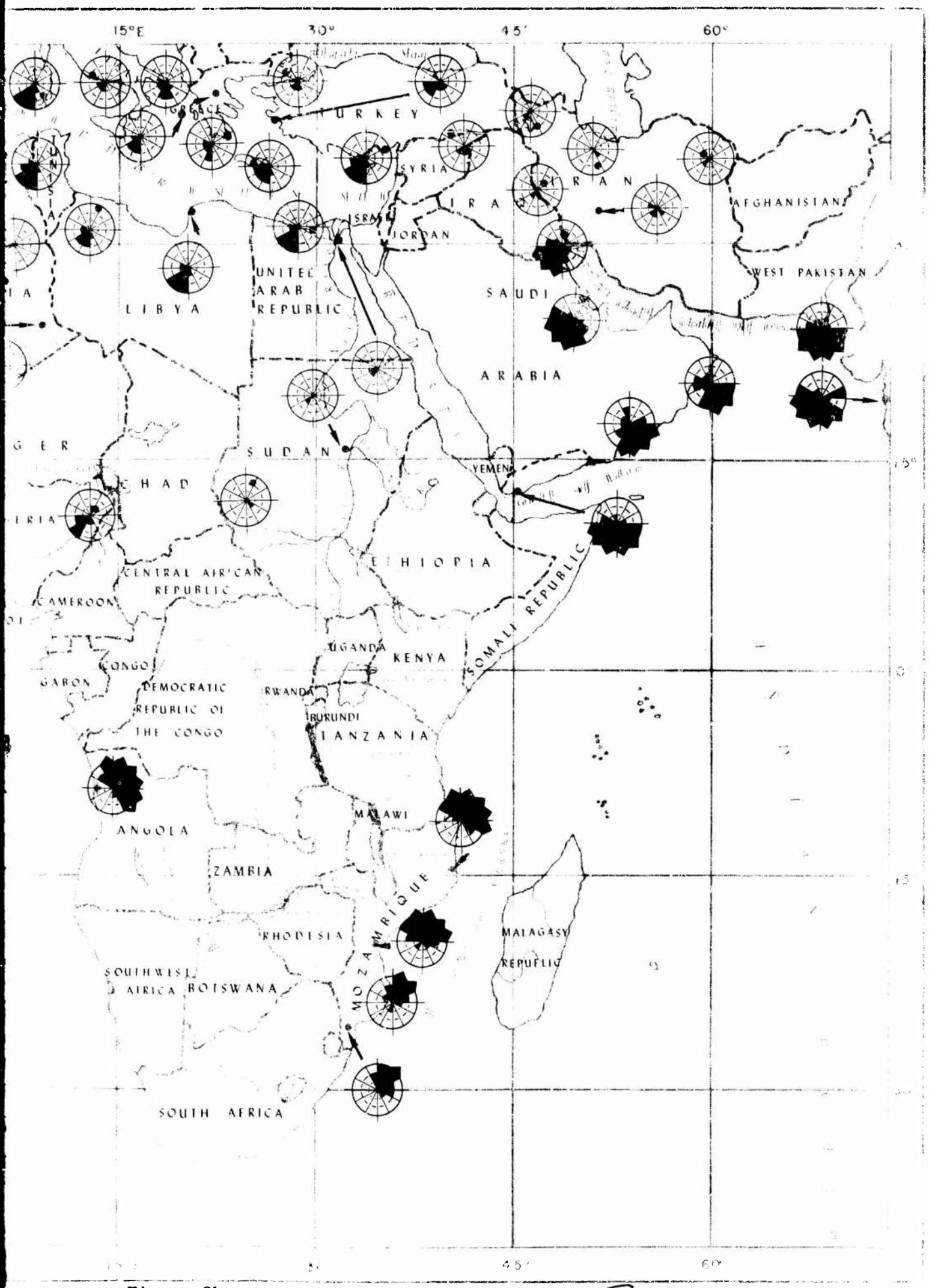
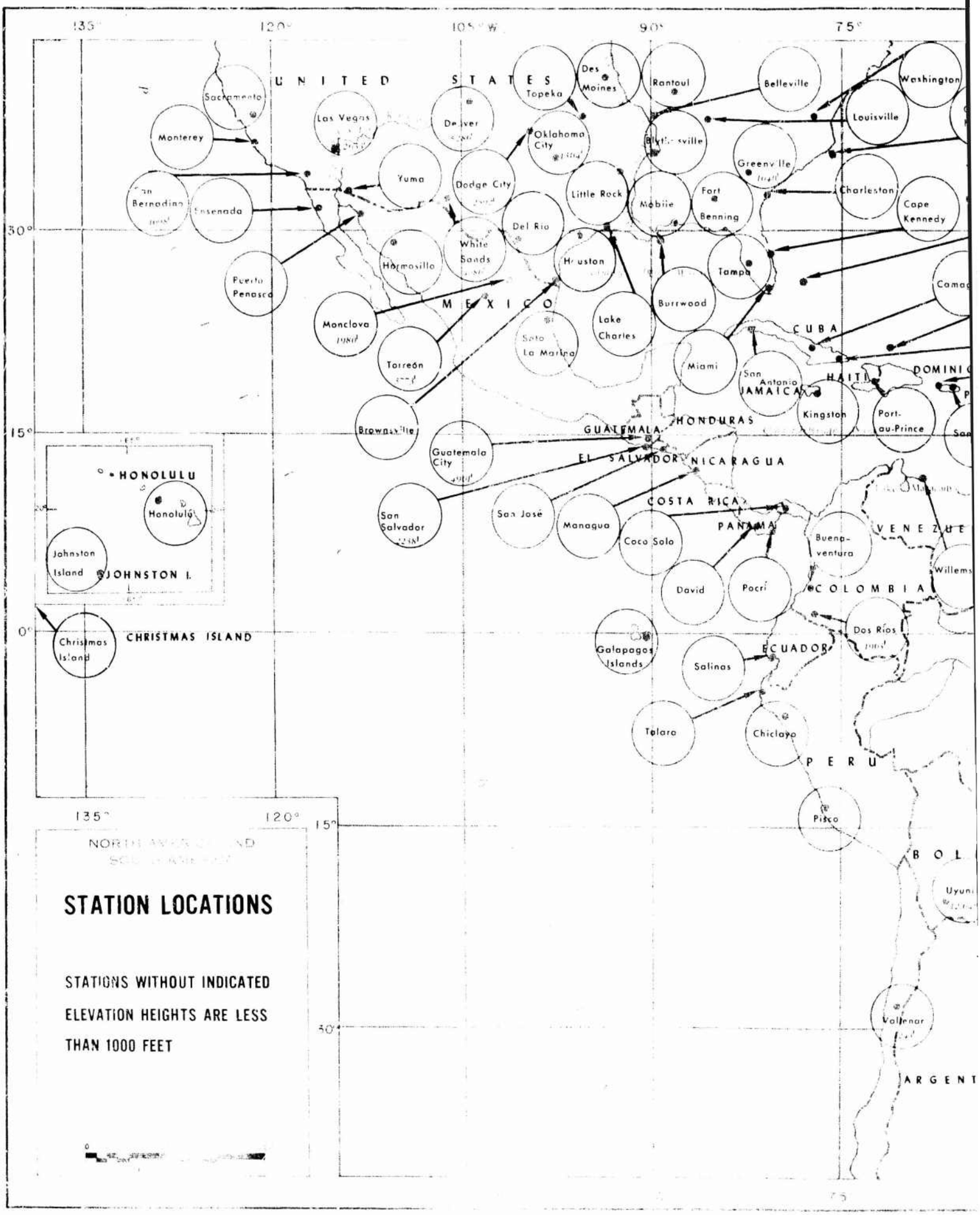
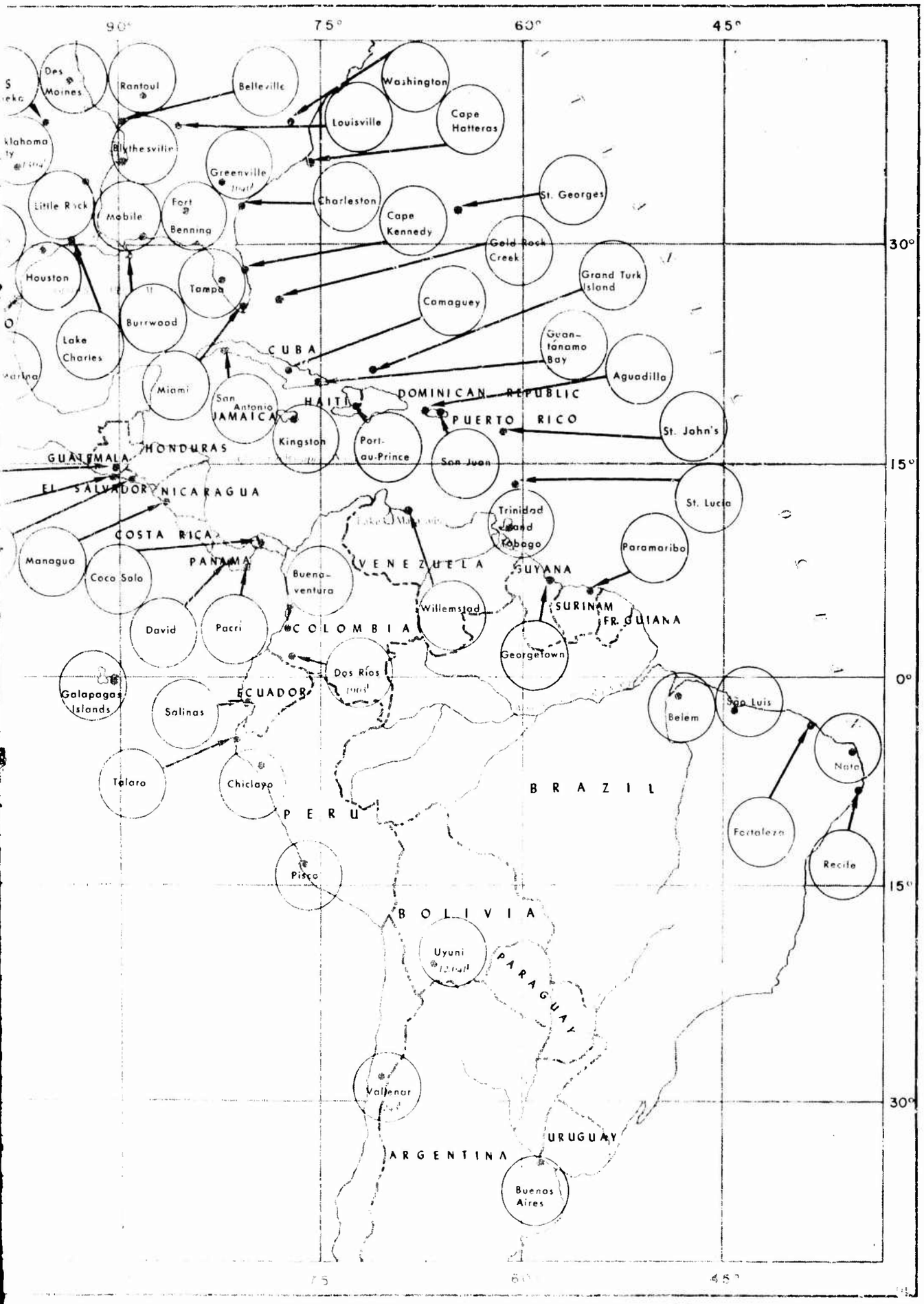

15°E
30°
45°
60°
GREECE
TURKEY
SYRIA
IRAN
IRAQ
ISRAEL
JORDAN
AFGHANISTAN
WEST PAKISTAN
SAUDI
ARABIA
UNITED
ARAB
REPUBLIC
LIBYA
SUDAN
CHAD
YEMEN
ETHIOPIA
CENTRAL AFRICAN
REPUBLIC
CAMEROON
SOMALI REPUBLIC
UGANDA
KENYA
CONGO
GABON
DEMOCRATIC
REPUBLIC OF
THE CONGO
RWANDA
BURUNDI
TANZANIA
MALAWI
ANGOLA
ZAMBIA
MOZAMBIQUE
RHODESIA
MALAGASY
REPUBLIC
SOUTHWEST
AFRICA
BOTSWANA
SOUTH AFRICA

Figure 3b

B


135°
120°
105° W
90°
75°
30°
15°
0°
UNITED STATES
MEXICO
CUBA
JAMAICA
HAITI
GUATEMALA
HONDURAS
EL SALVADOR
NICARAGUA
COSTA RICA
PANAMA
COLOMBIA
ECUADOR
PERU
VENEZUE
BOL
ARGENT
Sacramento
Monterey
Las Vegas
Denver
Topeka
Des Moines
Rantoul
Belleville
Washington
Louisville
Oklahoma City
Yuma
Dodge City
Little Rock
Mobile
Fort Benning
Greenville
Charleston
Cape Kennedy
San Bernadino
Ensenada
Del Rio
Hermosillo
White Sands
Houston
Tampa
Puerto Penasco
Monclova
Burrwood
Lake Charles
Soto La Marina
Miami
Torreón
San Antonio
Kingston
Port-au-Prince
Brownsville
Guatemala City
San Salvador
San José
Managua
Coco Solo
Buenaventura
David
Pocri
Dos Ríos
Galapagos Islands
Salinas
Talara
Chiclayo
Pisco
Vallenar
HONOLULU
Honolulu
Johnston Island
JOHNSTON I.
Christmas Island
CHRISTMAS ISLAND
STATION LOCATIONS
STATIONS WITHOUT INDICATED ELEVATION HEIGHTS ARE LESS THAN 1000 FEET

A


90°
75°
60°
45°
30°
15°
0°
15°
30°
Des Moines
Rantoul
Belleville
Washington
Louisville
Cape Hatteras
Blythesville
Greenville
Charleston
St. Georges
Cape Kennedy
Little Rock
Mobile
Fort Benning
Gold Rock Creek
Houston
Tampa
Grand Turk Island
Camaguey
Burrwood
Lake Charles
Guantanamo Bay
CUBA
Aguadilla
Miami
San Antonio
HAITI
DOMINICAN REPUBLIC
JAMAICA
PUERTO RICO
St. John's
Kingston
Port-au-Prince
San Juan
HONDURAS
GUATEMALA
EL SALVADOR
NICARAGUA
St. Lucia
Trinidad and Tobago
COSTA RICA
Managua
Paramaribo
PANAMA
Coco Solo
Buena-ventura
VENEZUELA
GUYANA
Willemstad
SURINAM
FR. GUIANA
David
Pacri
COLOMBIA
Georgetown
Dos Ríos
Galapagos Islands
ECUADOR
Salinas
Belem
São Luis
Natal
Talara
Chiclayo
BRAZIL
PERU
Fortaleza
Recife
Pisco
BOLIVIA
Uyuni
PARAGUAY
Vallenar
URUGUAY
ARGENTINA
Buenos Aires

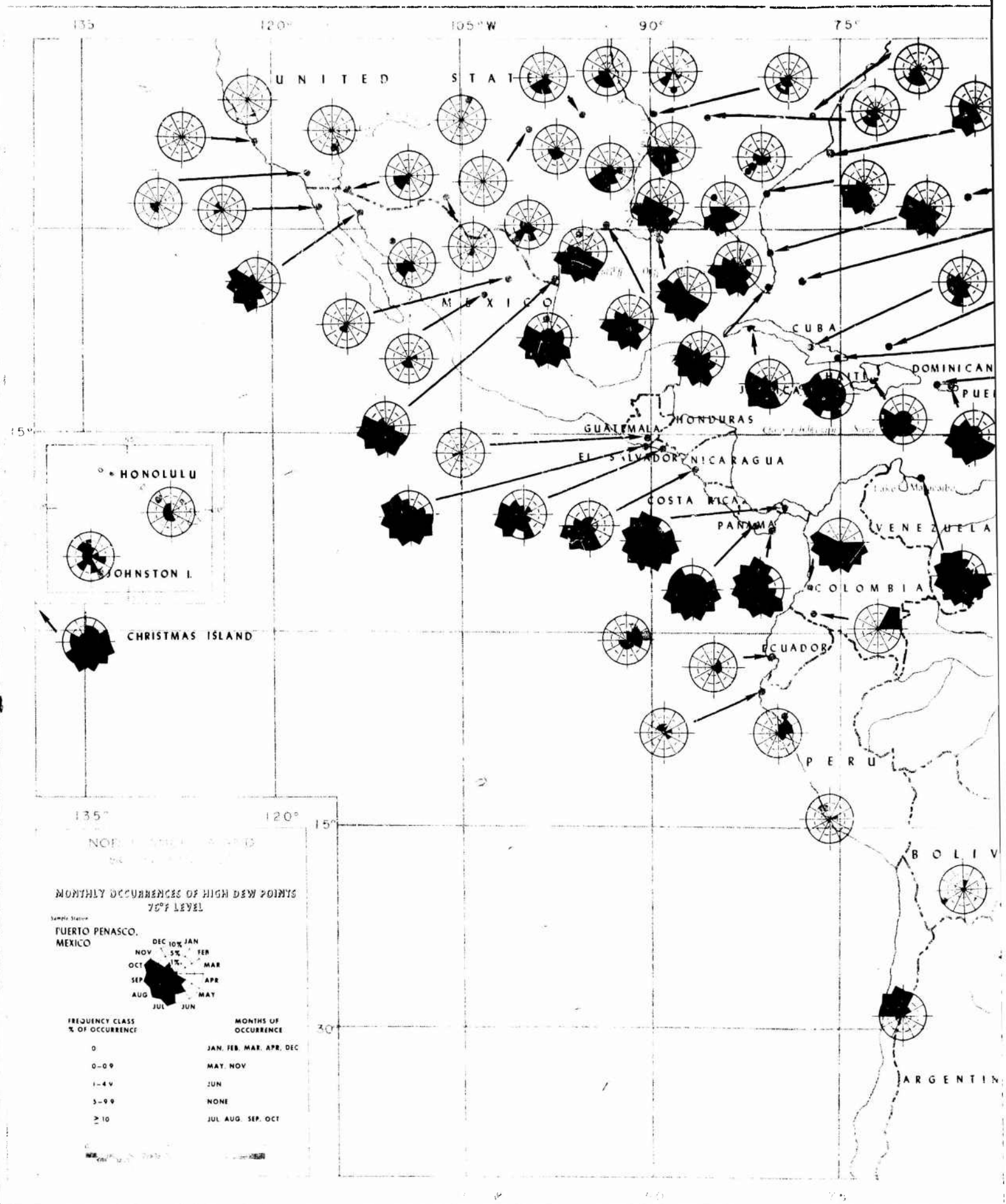

135
120°
105° W
90°
75°
UNITED STATES
MEXICO
CUBA
DOMINICAN
HONDURAS
GUATEMALA
EL SALVADOR
NICARAGUA
COSTA RICA
PANAMA
VENEZUELA
COLOMBIA
ECUADOR
PERU
BOLIV
ARGENTIN
15°
30°
HONOLULU
JOHNSTON I.
CHRISTMAS ISLAND
MONTHLY OCCURRENCES OF HIGH DEW POINTS
75°F LEVEL
Sample Station
PUERTO PENASCO,
MEXICO
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
10%
5%
1%
FREQUENCY CLASS
% OF OCCURRENCE
MONTHS OF
OCCURRENCE
0
JAN, FEB, MAR, APR, DEC
0-0.9
MAY, NOV
1-4.9
JUN
5-9.9
NONE
≥10
JUL, AUG, SEP, OCT

Figure 3c

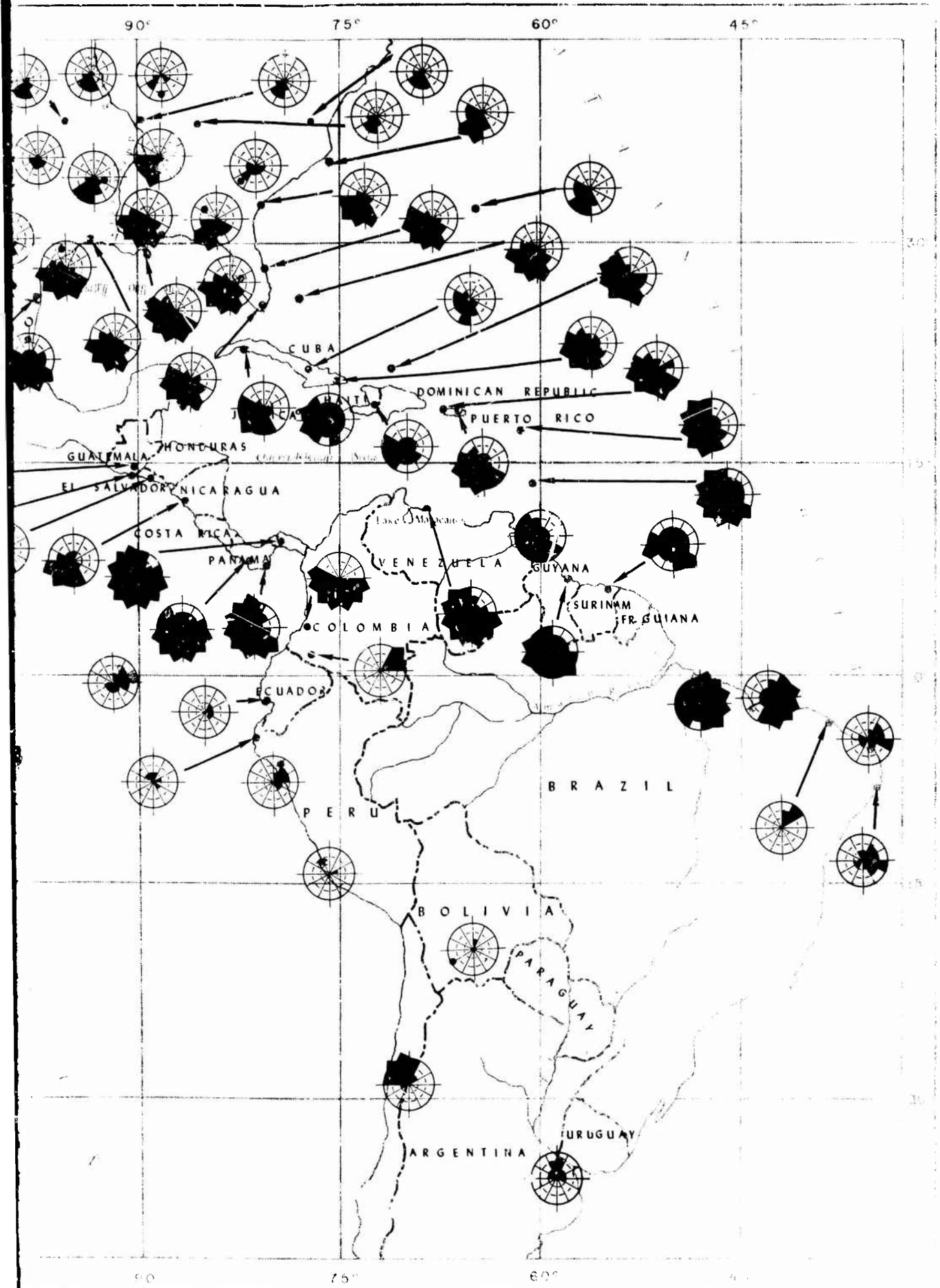
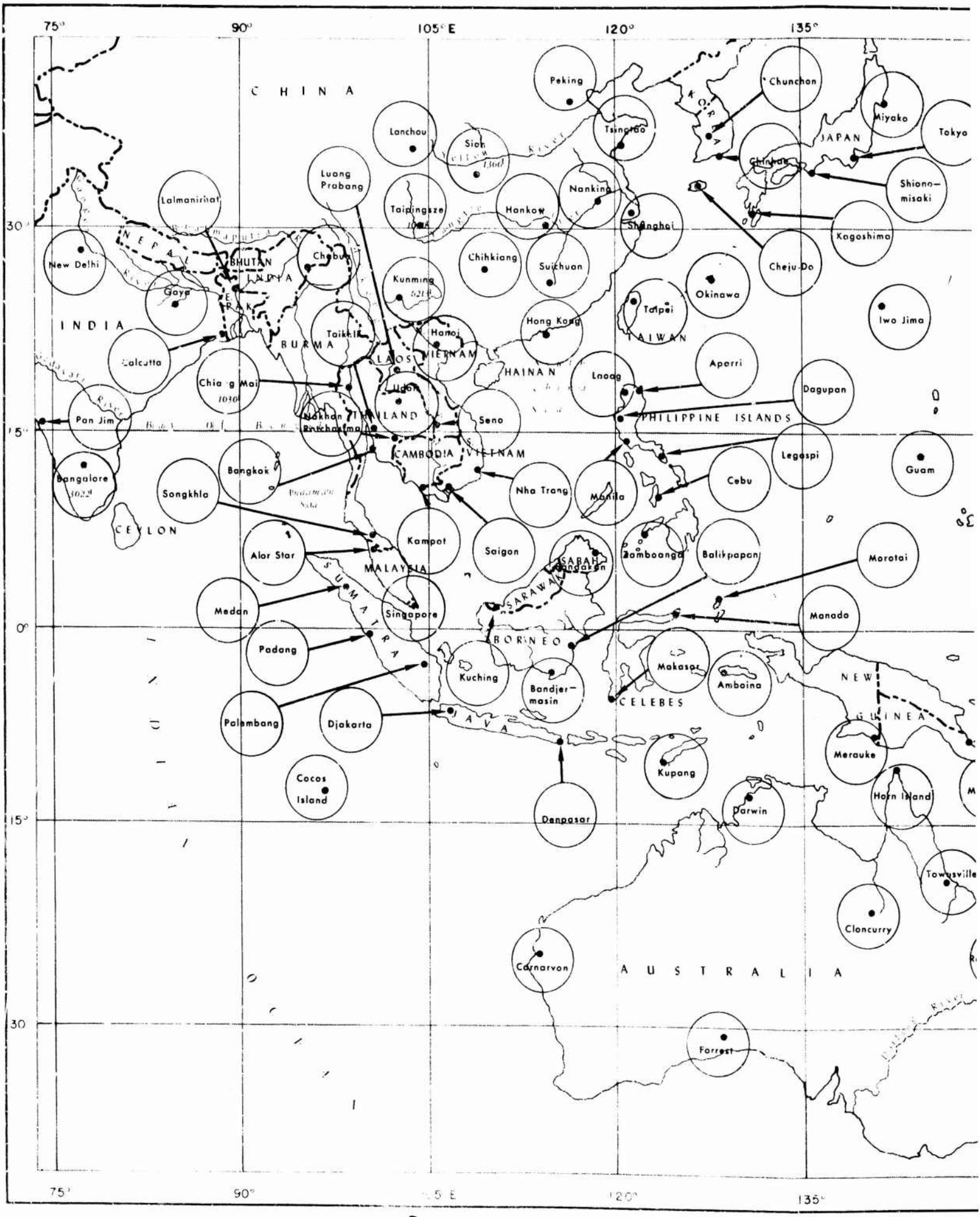
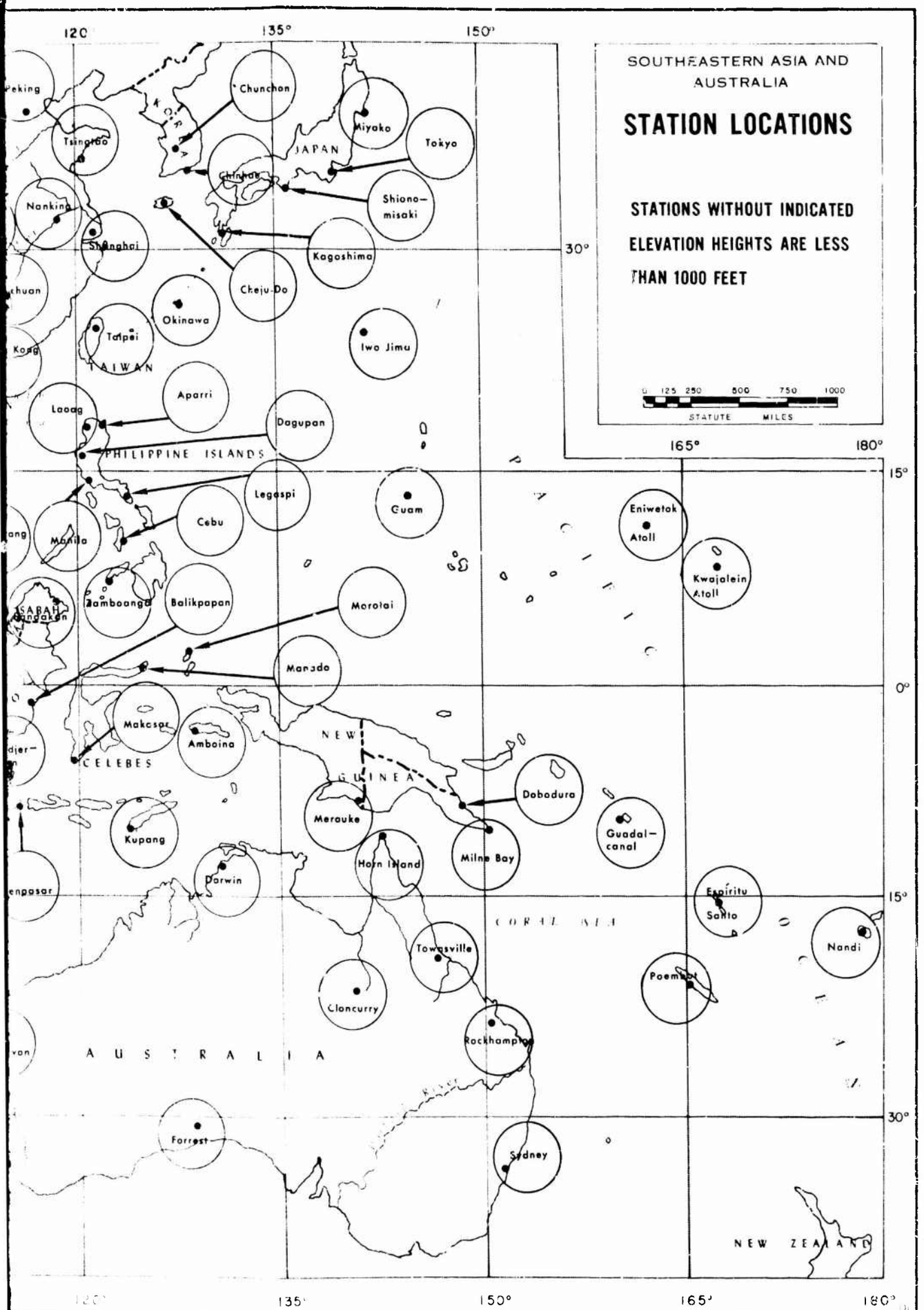

90°
75°
60°
45°
CUBA
DOMINICAN REPUBLIC
PUERTO RICO
HONDURAS
GUATEMALA
EL SALVADOR
NICARAGUA
COSTA RICA
PANAMA
VENEZUELA
GUYANA
SURINAM
FR. GUIANA
COLOMBIA
ECUADOR
PERU
BRAZIL
BOLIVIA
PARAGUAY
URUGUAY
ARGENTINA

Figure 3c


75°
90°
105° E
120°
135°
30°
15°
0°
15°
30
CHINA
Peking
Chunchon
Miyako
Tokyo
Tsingtao
Lanchou
Sian
Luang Prabang
Taipingsze
Hankow
Nanking
Shanghai
Lalmanirhat
Chinhae
JAPAN
Shiono-misaki
Kagoshima
Cheju-Do
NEPAL
BHUTAN
INDIA
Chebua
New Delhi
Gaya
Chihkiang
Suichuan
Kunming
Okinawa
Iwo Jima
Taipei
TAIWAN
INDIA
Calcutta
Taikkit
BURMA
Hanoi
LAOS
VIETNAM
Hong Kong
HAINAN
Aparri
Chia g Mai
Laoag
Dagupan
Pan Jim
Nakhon Ratchasima
THAILAND
Seno
PHILIPPINE ISLANDS
Bangalore
CAMBODIA
VIETNAM
Bangkok
Songkhla
Nha Trang
Manila
Cebu
Legaspi
Guam
CEYLON
Kampot
Alor Star
Saigon
Zamboanga
Balikpapan
Morotai
MALAYSIA
SABAH
SARAWAK
Medan
Singapore
Manado
Padang
BORNEO
Kuching
Bandjer-masin
Makasar
Amboina
NEW GUINEA
CELEBES
Palembang
Djakarta
JAVA
Merauke
Kupang
Cocos Island
Darwin
Horn Island
Townsville
Denpasar
Cloncurry
Carnarvon
AUSTRALIA
Forrest


SOUTHEASTERN ASIA AND AUSTRALIA
STATION LOCATIONS
STATIONS WITHOUT INDICATED ELEVATION HEIGHTS ARE LESS THAN 1000 FEET
0 125 250 500 750 1000
STATUTE MILES
120°
135°
150°
165°
180°
15°
0°
30°
Peking
Tsingtao
Chunchon
KOREA
Miyako
Tokyo
JAPAN
Chinhae
Shiono-misaki
Nanking
Shanghai
Kagoshima
Cheju-Do
Okinawa
Taipei
TAIWAN
Iwo Jima
Aparri
Laoag
Dagupan
PHILIPPINE ISLANDS
Legaspi
Guam
Cebu
Manila
Eniwetok Atoll
Kwajalein Atoll
Zamboanga
Balikpapan
Morotai
Manado
Makasar
Amboina
CELEBES
NEW GUINEA
Dobodura
Merauke
Kupang
Guadal-canal
Horn Island
Milne Bay
Darwin
Espiritu Santo
CORAL SEA
Nandi
Townsville
Cloncurry
Rockhampton
AUSTRALIA
Forrest
Sydney
NEW ZEALAND

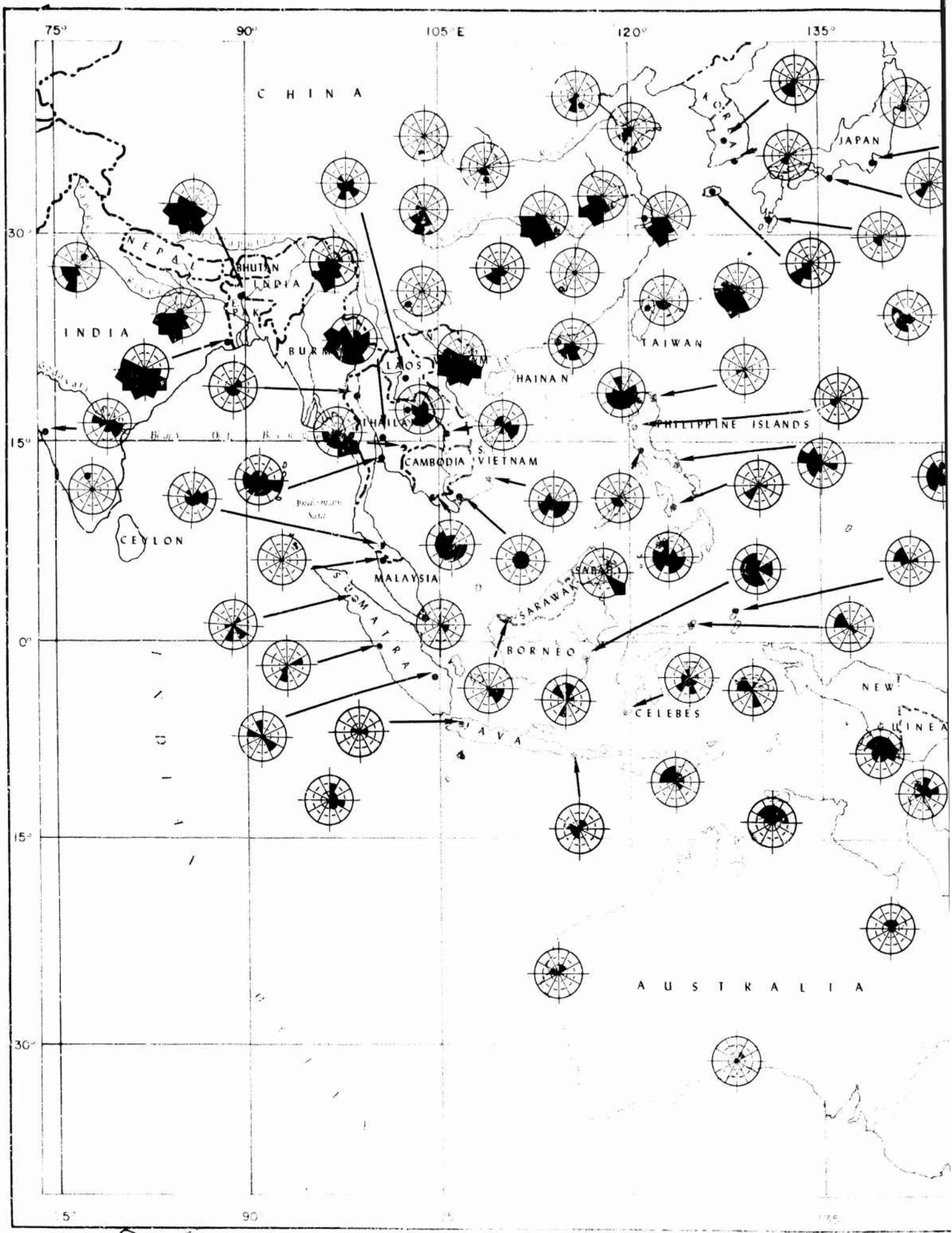

75°
90°
105° E
120°
135°
CHINA
KOREA
JAPAN
NEPAL
BHUTAN
INDIA
INDIA
BURMA
LAOS
THAILAND
HAINAN
TAIWAN
PHILIPPINE ISLANDS
CAMBODIA
VIETNAM
CEYLON
MALAYSIA
SARAWAK
SABAH
SUMATRA
BORNEO
CELEBES
JAVA
NEW GUINEA
AUSTRALIA
30°
15°
0°
15°
30°

Figure 4a

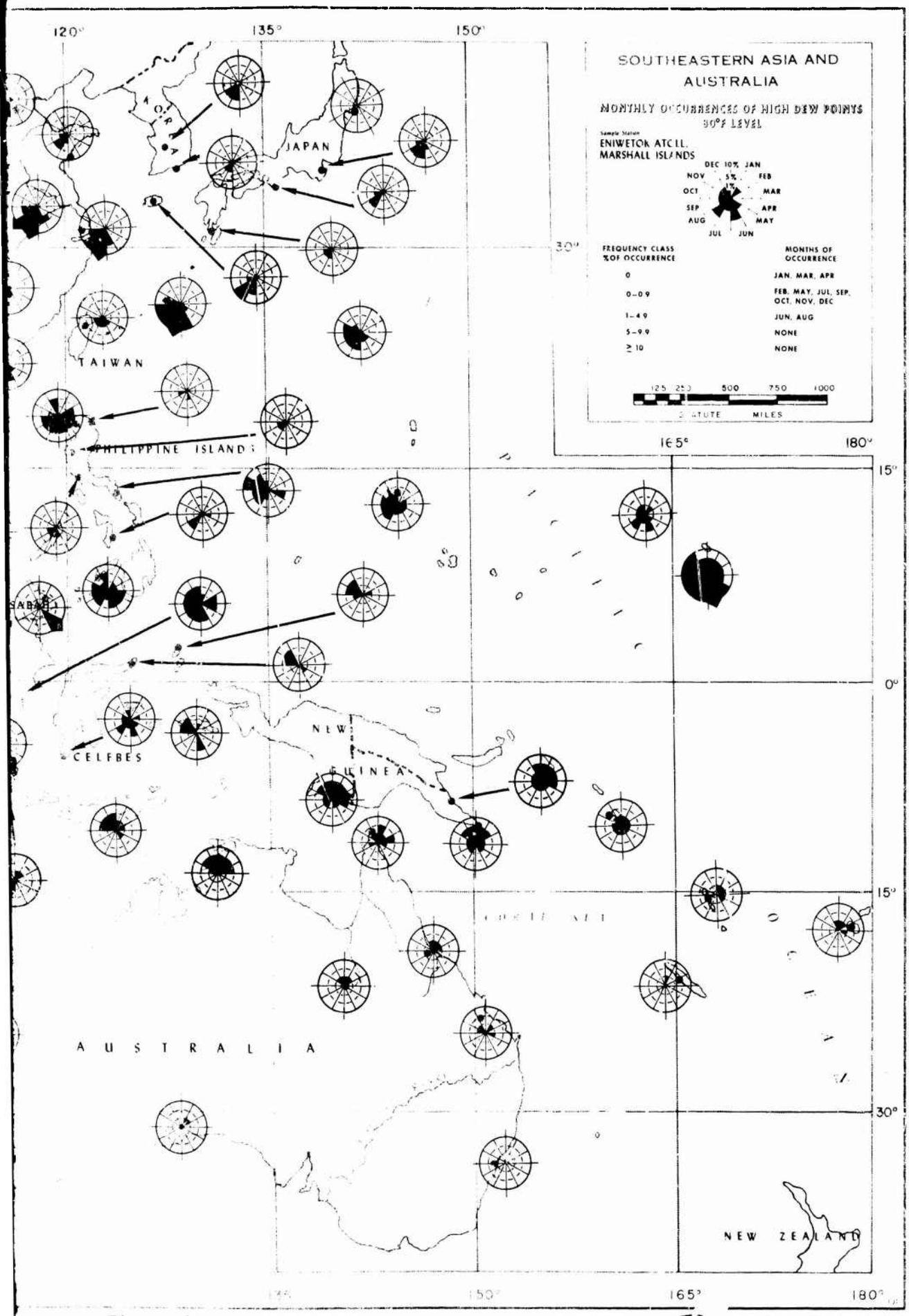
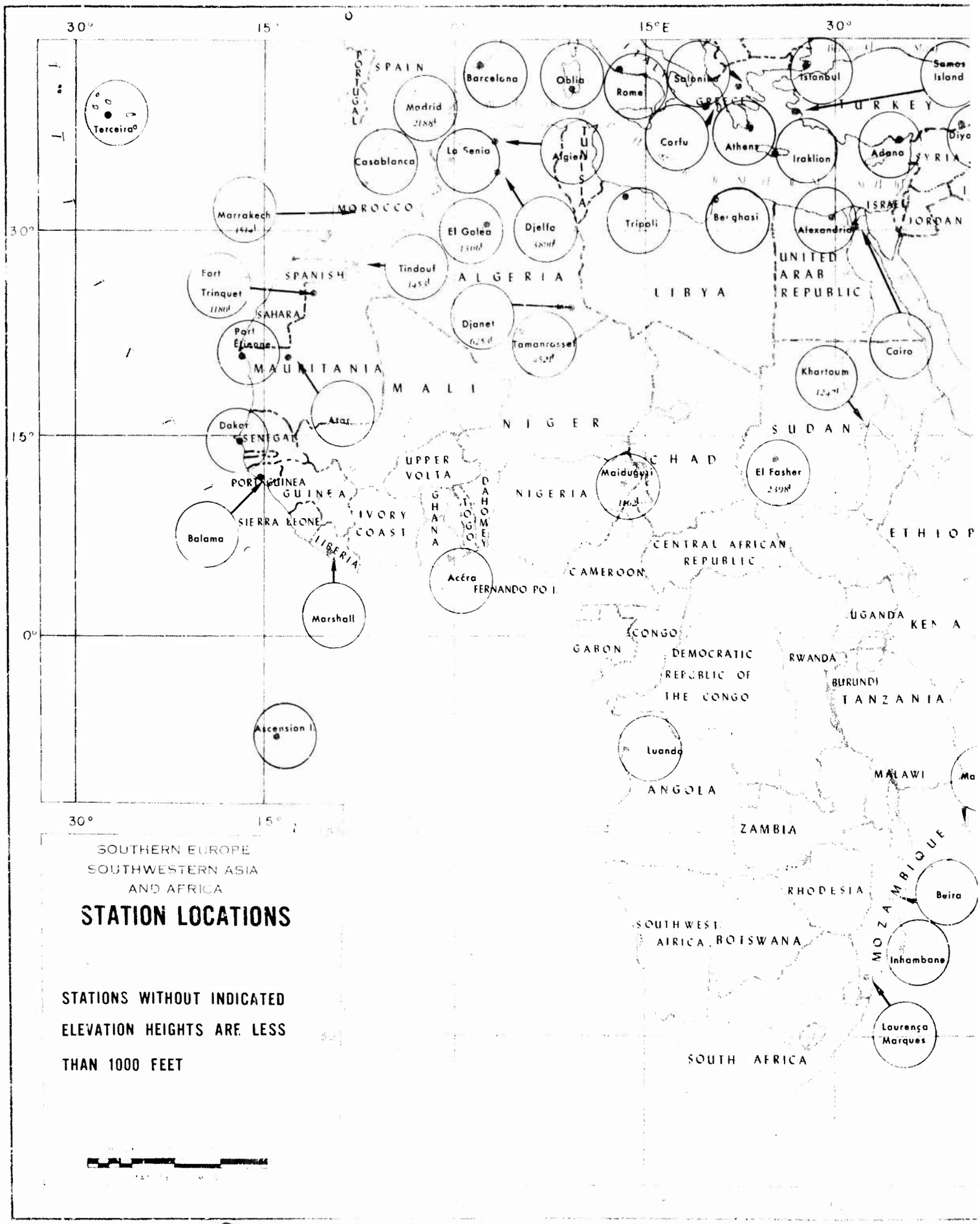

SOUTHEASTERN ASIA AND AUSTRALIA
MONTHLY OCCURRENCES OF HIGH DEW POINTS
90°F LEVEL
Sample Station
ENIWETOK ATOLL,
MARSHALL ISLANDS
DEC 10% JAN
NOV 5% FEB
OCT 1% MAR
SEP APR
AUG MAY
JUL JUN
FREQUENCY CLASS %OF OCCURRENCE
MONTHS OF OCCURRENCE
0 JAN, MAR, APR
0-0.9 FEB, MAY, JUL, SEP, OCT, NOV, DEC
1-4.9 JUN, AUG
5-9.9 NONE
≥ 10 NONE
125 250 500 750 1000
STATUTE MILES
120°
135°
150°
165°
180°
15°
0°
30°
JAPAN
TAIWAN
PHILIPPINE ISLANDS
CELEBES
NEW GUINEA
AUSTRALIA
NEW ZEALAND

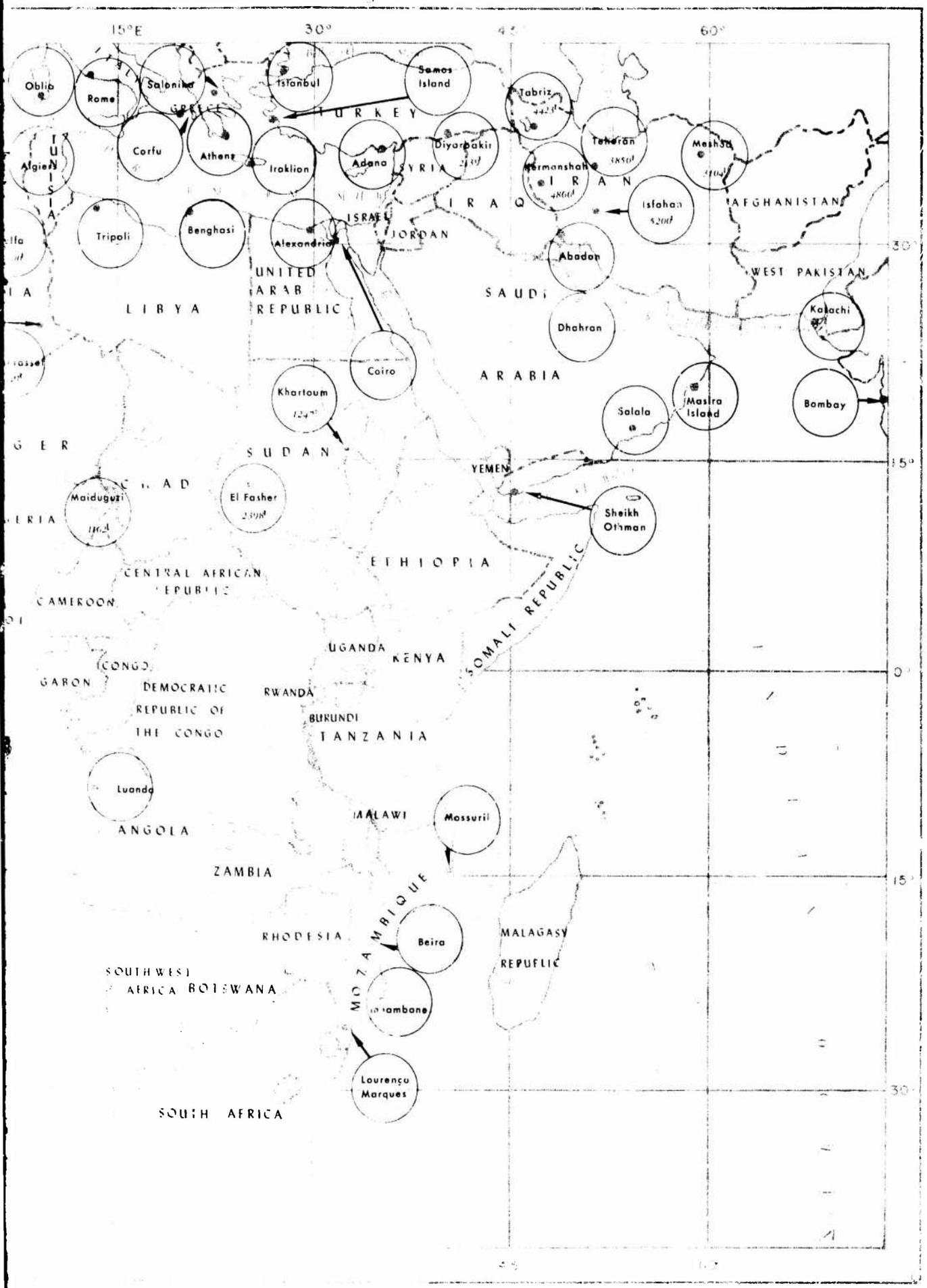
Figure 4a



SOUTHERN EUROPE
SOUTHWESTERN ASIA
AND AFRICA

STATION LOCATIONS

STATIONS WITHOUT INDICATED ELEVATION HEIGHTS ARE LESS THAN 1000 FEET


15°E
30°
60°
Oblib
Rome
Salonika
Istanbul
Samos Island
Tabriz
GREECE
TURKEY
Corfu
Athens
Iraklion
Adana
Diyarbakir
Teheran
Meshed
Algiers
TUNISIA
SYRIA
Kermanshah
IRAN
IRAQ
Isfahan
AFGHANISTAN
Tripoli
Benghasi
Alexandria
ISRAEL
JORDAN
Abadan
WEST PAKISTAN
UNITED ARAB REPUBLIC
LIBYA
SAUDI ARABIA
Dhahran
Karachi
Cairo
Khartoum
Masira Island
Salala
Bombay
SUDAN
YEMEN
CHAD
Maiduguri
El Fasher
Sheikh Othman
ETHIOPIA
CENTRAL AFRICAN REPUBLIC
CAMEROON
SOMALI REPUBLIC
UGANDA
KENYA
CONGO
GABON
DEMOCRATIC REPUBLIC OF THE CONGO
RWANDA
BURUNDI
TANZANIA
Luanda
ANGOLA
MALAWI
Massuril
ZAMBIA
MOZAMBIQUE
RHODESIA
Beira
MALAGASY REPUFLIC
SOUTH WEST AFRICA
BOTSWANA
Lourenço Marques
SOUTH AFRICA
30°
15°
0°
15°
30°

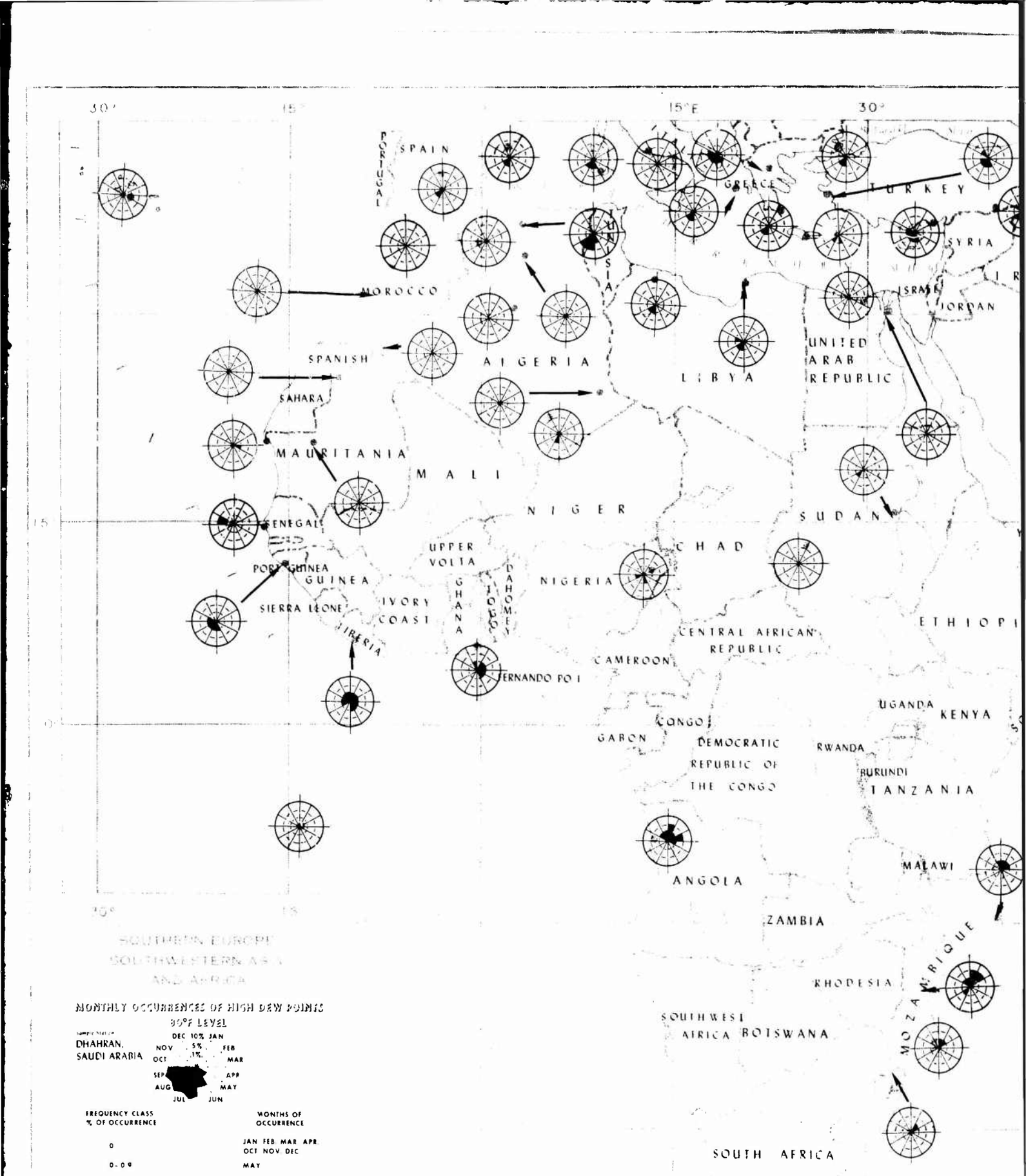

30°
15°
15°E
30°
PORTUGAL
SPAIN
GREECE
TURKEY
SYRIA
MOROCCO
ALGERIA
LIBYA
UNITED ARAB REPUBLIC
SPANISH SAHARA
MAURITANIA
MALI
NIGER
SUDAN
SENEGAL
UPPER VOLTA
CHAD
PORTUGUESE GUINEA
GUINEA
NIGERIA
SIERRA LEONE
IVORY COAST
GHANA
TOGO
DAHOMEY
LIBERIA
FERNANDO PO I
CENTRAL AFRICAN REPUBLIC
CAMEROON
UGANDA
KENYA
CONGO
GABON
DEMOCRATIC REPUBLIC OF THE CONGO
RWANDA
BURUNDI
TANZANIA
ANGOLA
MALAWI
ZAMBIA
RHODESIA
MOZAMBIQUE
SOUTHWEST AFRICA
BOTSWANA
SOUTH AFRICA
MONTHLY OCCURRENCES OF HIGH DEW POINTS
90°F LEVEL
DHAHRAN, SAUDI ARABIA
DEC 10% JAN
NOV 5% FEB
OCT 1% MAR
SEP APR
AUG MAY
JUL JUN
FREQUENCY CLASS % OF OCCURRENCE
MONTHS OF OCCURRENCE
0 JAN FEB MAR APR OCT NOV DEC
0-0.9 MAY
1-4.9 JUN
5-9.9 NONE
≥10 JUL AUG SEP

Figure 4b

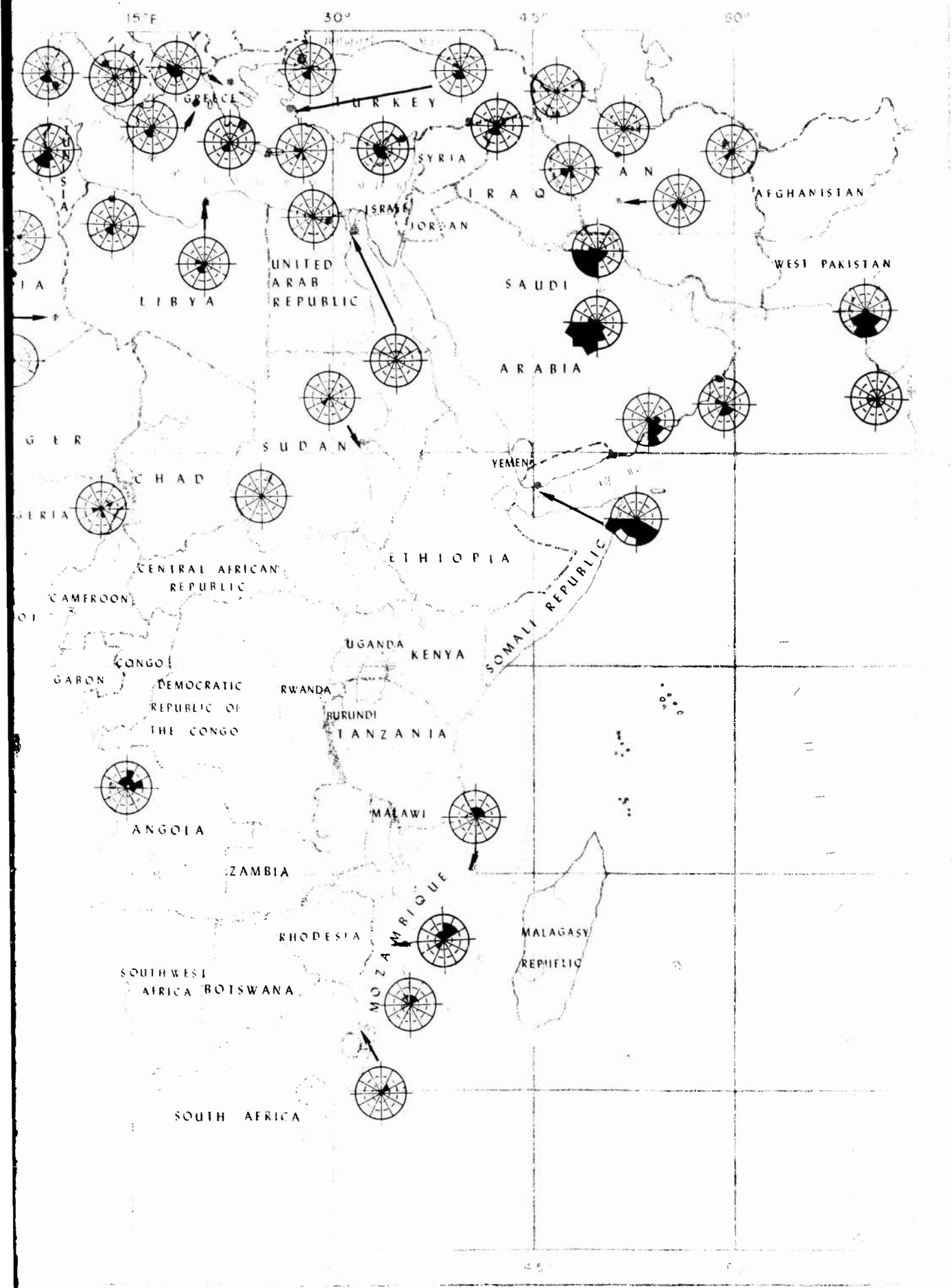
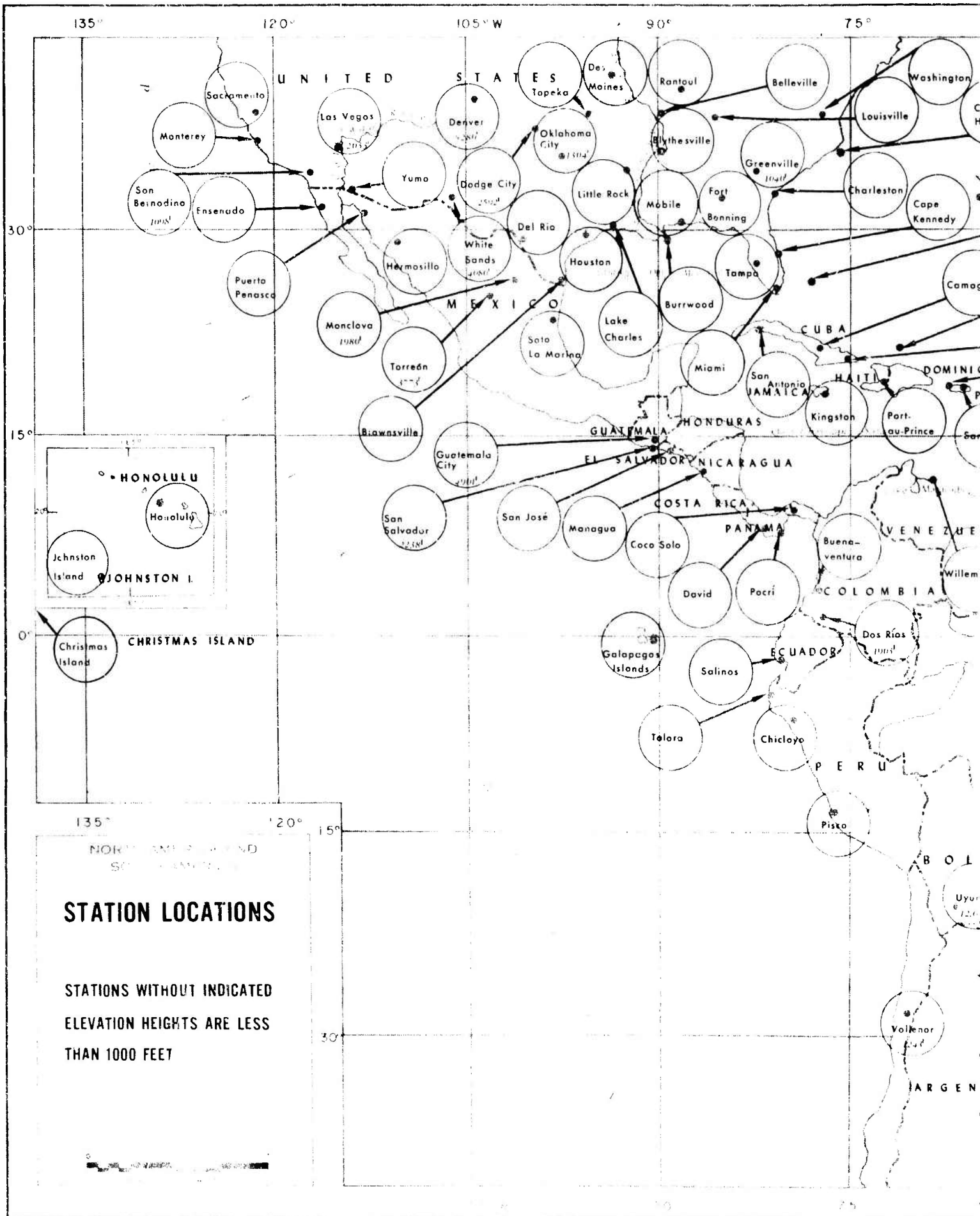
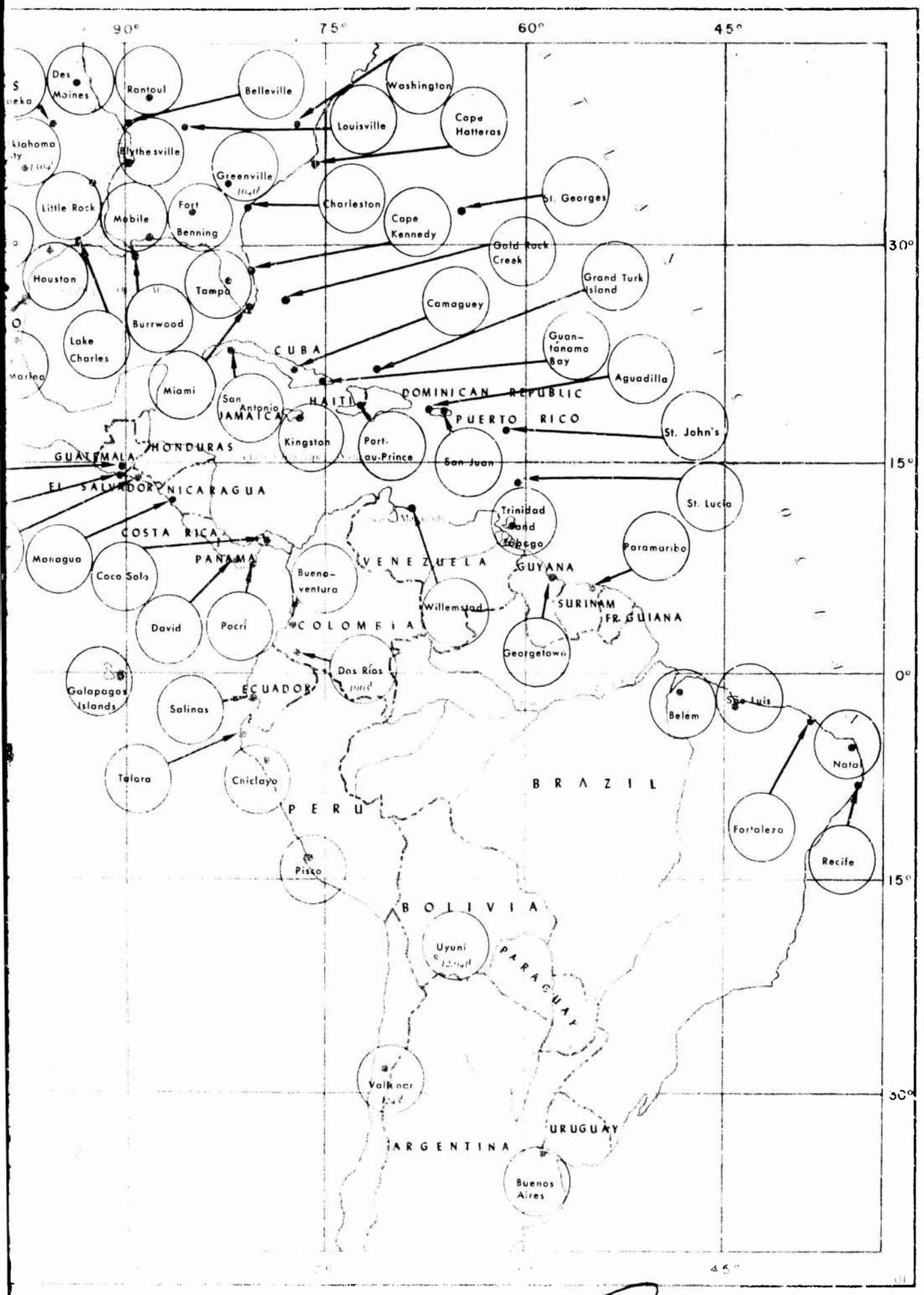

15°E
30°
45°
60°
GREECE
TURKEY
SYRIA
IRAQ
IRAN
AFGHANISTAN
ISRAEL
JORDAN
UNITED ARAB REPUBLIC
LIBYA
SAUDI ARABIA
WEST PAKISTAN
SUDAN
YEMEN
CHAD
ETHIOPIA
CENTRAL AFRICAN REPUBLIC
CAMEROON
SOMALI REPUBLIC
UGANDA
KENYA
CONGO
GABON
DEMOCRATIC REPUBLIC OF THE CONGO
RWANDA
BURUNDI
TANZANIA
MALAWI
ANGOLA
ZAMBIA
MOZAMBIQUE
RHODESIA
MALAGASY REPUBLIC
SOUTHWEST AFRICA
BOTSWANA
SOUTH AFRICA

Figure 4b


135°
120°
105° W
90°
75°
30°
15°
0°
UNITED STATES
MEXICO
CUBA
HAITI
JAMAICA
GUATEMALA
HONDURAS
EL SALVADOR
NICARAGUA
COSTA RICA
PANAMA
COLOMBIA
VENEZUE
ECUADOR
PERU
BOL
ARGEN
Sacramento
Monterey
Las Vegas
Denver
Topeka
Des Moines
Rantoul
Belleville
Washington
Louisville
Oklahoma City
Blythesville
Greenville
Charleston
Cape Kennedy
Yuma
Dodge City
Little Rock
Mobile
Fort Benning
San Bernodino
Ensenado
Del Rio
White Sands
Houston
Tampa
Hermosillo
Puerto Penasco
Monclova
Torreón
Burrwood
Lake Charles
Soto La Marina
Miami
San Antonio
Kingston
Port-au-Prince
Brownsville
Guatemala City
San Salvador
San José
Managua
Coco Solo
Buena-ventura
David
Pocrí
Dos Ríos
Galapagos Islands
Salinos
Tolora
Chicloyo
Pisco
Volleнar
HONOLULU
Honolulu
Johnston Island
JOHNSTON I.
Christmas Island
CHRISTMAS ISLAND
STATION LOCATIONS
STATIONS WITHOUT INDICATED ELEVATION HEIGHTS ARE LESS THAN 1000 FEET


90°
75°
60°
45°
30°
15°
0°
15°
30°
45°
Des Moines
Rantoul
Belleville
Washington
Louisville
Cape Hatteras
Blythesville
Greenville
Charleston
St. Georges
Cape Kennedy
Little Rock
Mobile
Fort Benning
Gold Rock Creek
Grand Turk Island
Houston
Tampa
Camaguey
Burrwood
Lake Charles
CUBA
Guantanamo Bay
Aguadilla
Miami
San Antonio
HAITI
DOMINICAN REPUBLIC
JAMAICA
PUERTO RICO
St. John's
Kingston
Port-au-Prince
San Juan
GUATEMALA
HONDURAS
EL SALVADOR
NICARAGUA
St. Lucia
Trinidad and Tobago
COSTA RICA
Managua
Paramaribo
Coco Solo
PANAMA
VENEZUELA
GUYANA
Buenaventura
Willemstad
SURINAM
FR. GUIANA
David
Pocri
COLOMBIA
Georgetown
Galapagos Islands
Das Rios
ECUADOR
Belém
São Luis
Salinas
Talara
Chiclayo
Nata
BRAZIL
PERU
Fortaleza
Recife
Pisco
BOLIVIA
Uyuni
PARAGUAY
Valknar
URUGUAY
ARGENTINA
Buenos Aires

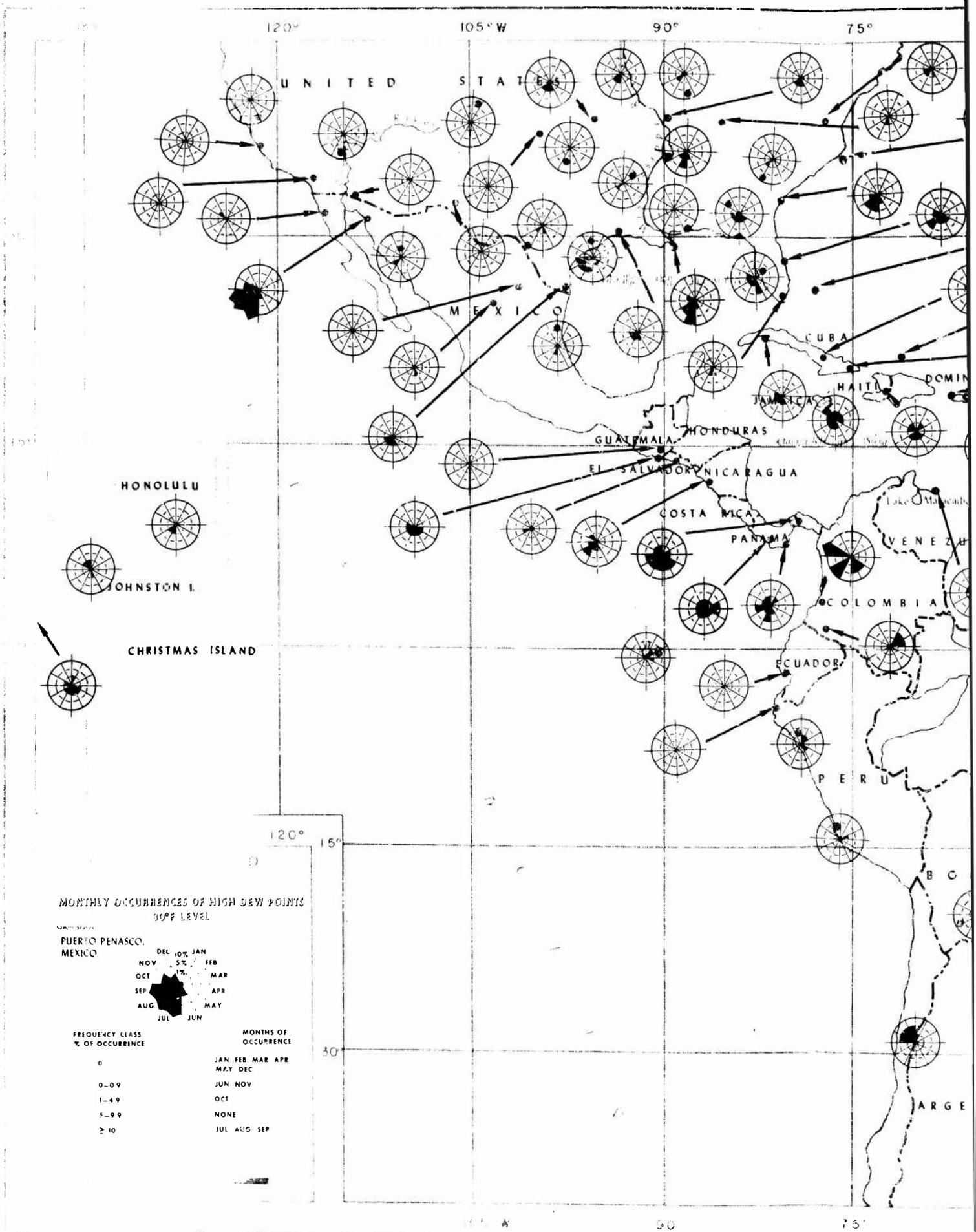

120°
105° W
90°
75°
UNITED STATES
MEXICO
CUBA
HAITI
JAMAICA
GUATEMALA
HONDURAS
EL SALVADOR
NICARAGUA
COSTA RICA
PANAMA
COLOMBIA
ECUADOR
PERU
HONOLULU
JOHNSTON I.
CHRISTMAS ISLAND
15°
30°
MONTHLY OCCURRENCES OF HIGH DEW POINTS
90°F LEVEL
PUERTO PENASCO,
MEXICO
DEC
JAN
NOV
FEB
OCT
MAR
SEP
APR
AUG
MAY
JUL
JUN
10%
5%
1%
FREQUENCY CLASS
% OF OCCURRENCE
MONTHS OF
OCCURRENCE
0
JAN FEB MAR APR MAY DEC
0-0.9
JUN NOV
1-4.9
OCT
5-9.9
NONE
≥ 10
JUL AUG SEP

Figure 4c

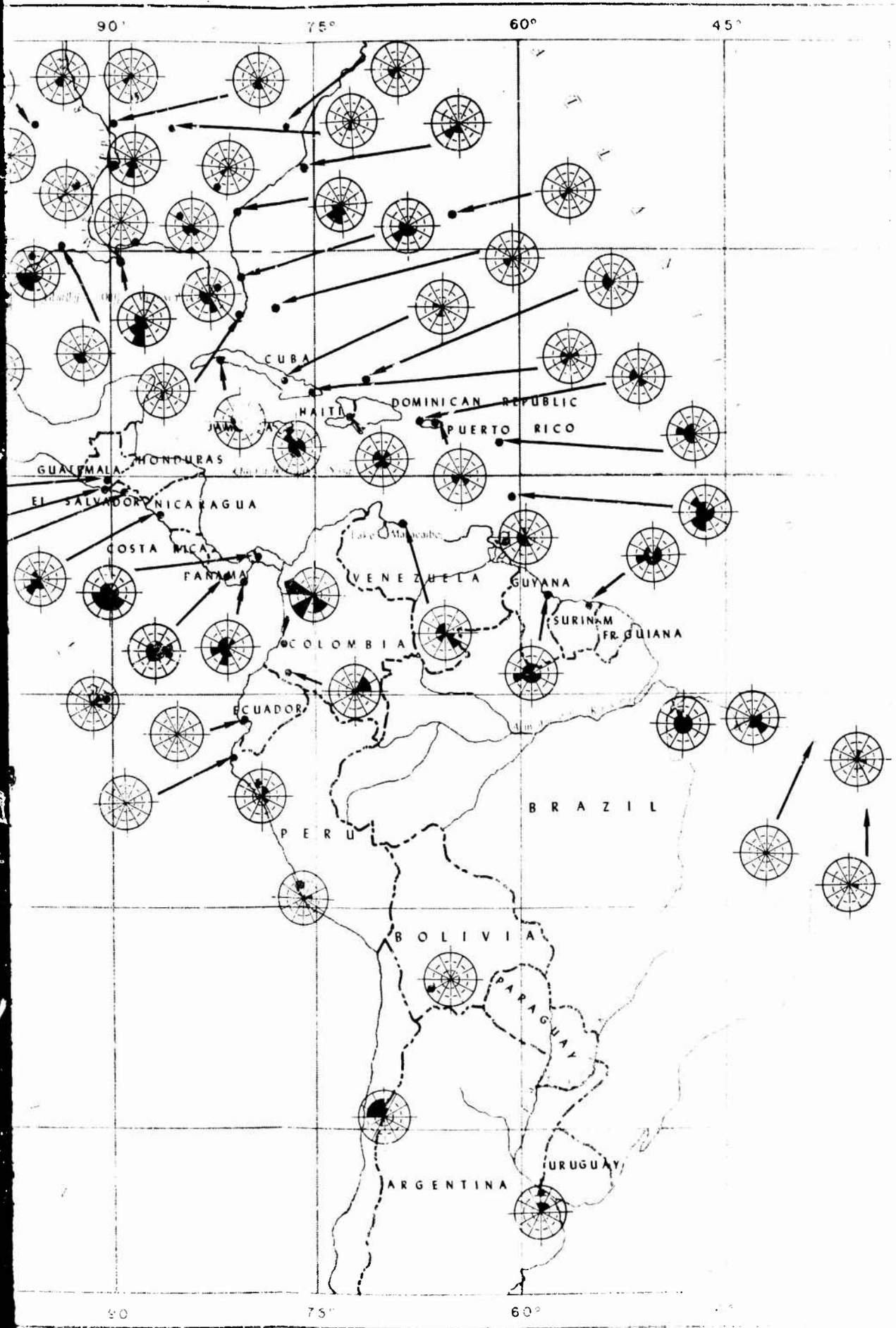
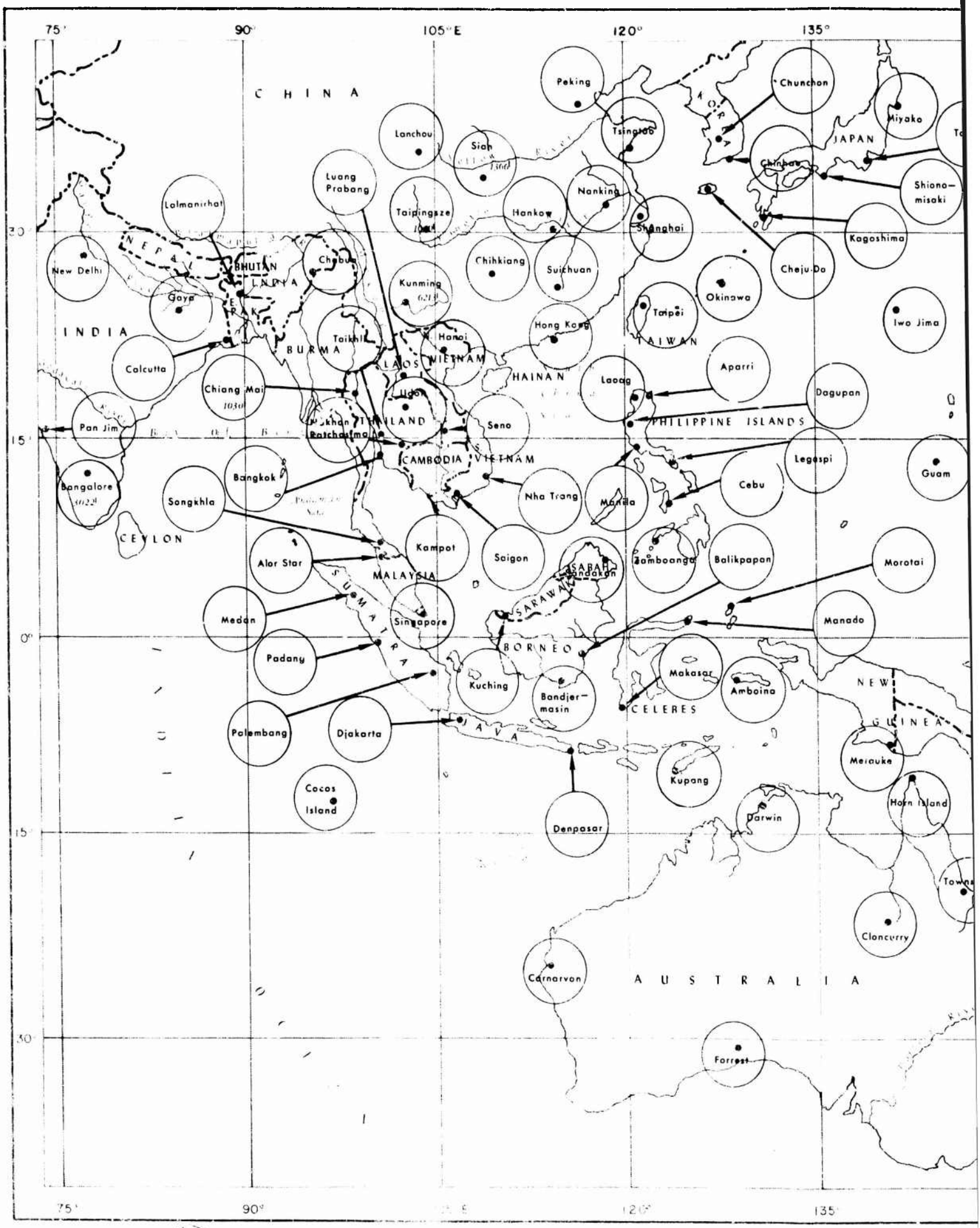
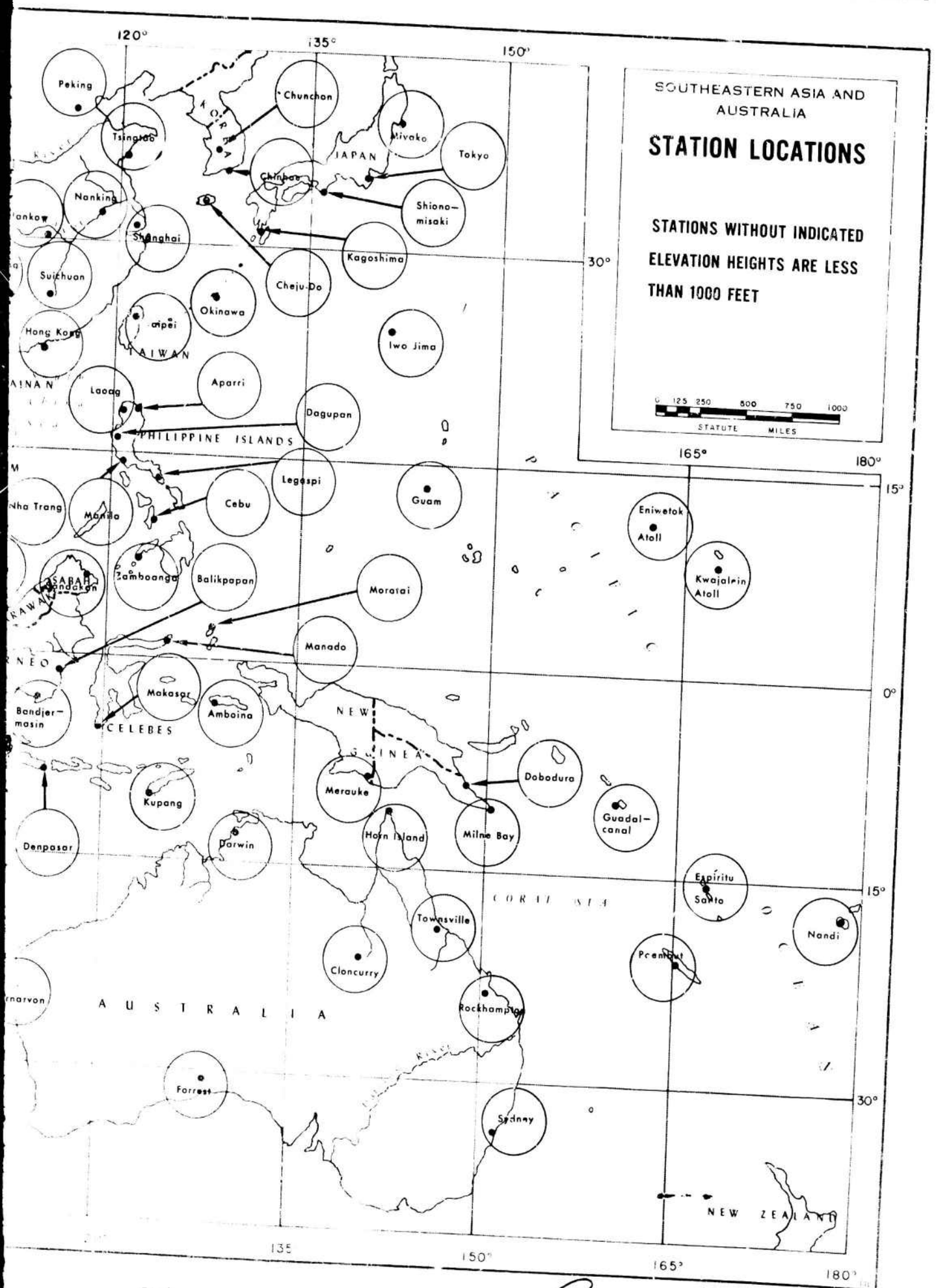

90°
75°
60°
45°
CUBA
HAITI
DOMINICAN REPUBLIC
PUERTO RICO
JAMAICA
HONDURAS
GUATEMALA
EL SALVADOR
NICARAGUA
COSTA RICA
PANAMA
Lake Maracaibo
VENEZUELA
GUYANA
SURINAM
FR. GUIANA
COLOMBIA
ECUADOR
PERU
BRAZIL
BOLIVIA
PARAGUAY
URUGUAY
ARGENTINA
90
75°
60°

Figure 4c


75°
90°
105° E
120°
135°
30°
15°
0°
15°
30°
CHINA
Peking
Chunchon
Miyako
JAPAN
Tsingtao
Lanchou
Sian
Nanking
Chinhae
Shiono-misaki
Luang Prabang
Taipingsze
Hankow
Shanghai
Kagoshima
Lalmanirhat
Cheju-Do
NEPAL
BHUTAN
INDIA
Chebua
Chihkiang
Suichuan
Okinawa
New Delhi
Kunming
Gaya
Taipei
Iwo Jima
INDIA
Taikhi
Hong Kong
TAIWAN
BURMA
Hanoi
LAOS
VIETNAM
Calcutta
Aparri
HAINAN
Laoag
Chiang Mai
Udon
Dagupan
Pan Jim
THAILAND
Seno
PHILIPPINE ISLANDS
Ratchaburi
CAMBODIA
VIETNAM
Legaspi
Guam
Bangalore
Bangkok
Nha Trang
Manila
Cebu
Songkhla
CEYLON
Kampot
Saigon
Zamboanga
Balikpapan
Morotai
Alor Star
MALAYSIA
SABAH
Kandakan
SARAWAK
SUMATRA
Medan
Singapore
Manado
Padang
BORNEO
Kuching
Makasar
Amboina
Bandjer-masin
CELEBES
NEW GUINEA
Palembang
Djakarta
JAVA
Merauke
Kupang
Cocos Island
Horn Island
Darwin
Denpasar
Townsville
Cloncurry
Carnarvon
AUSTRALIA
Forrest


SOUTHEASTERN ASIA AND AUSTRALIA
STATION LOCATIONS
STATIONS WITHOUT INDICATED ELEVATION HEIGHTS ARE LESS THAN 1000 FEET
0 125 250 500 750 1000
STATUTE MILES
120°
135°
150°
165°
180°
15°
30°
0°
Peking
Tsingtao
Chunchon
Chinhae
Miyako
Tokyo
Shiono-misaki
Kagoshima
Cheju-Do
Nanking
Shanghai
Suichuan
Okinawa
Taipei
TAIWAN
Hong Kong
Iwo Jima
Laoag
Aparri
Dagupan
PHILIPPINE ISLANDS
Legaspi
Cebu
Guam
Eniwetok Atoll
Kwajalein Atoll
Nha Trang
Manila
Zamboanga
Balikpapan
Moratai
Manado
Bandjermasin
Makasar
Amboina
CELEBES
NEW GUINEA
Dobodura
Merauke
Kupang
Guadalcanal
Horn Island
Milne Bay
Denpasar
Darwin
Espiritu Santo
Townsville
Nandi
Cloncurry
Rockhampton
AUSTRALIA
Forrest
Sydney
NEW ZEALAND

B

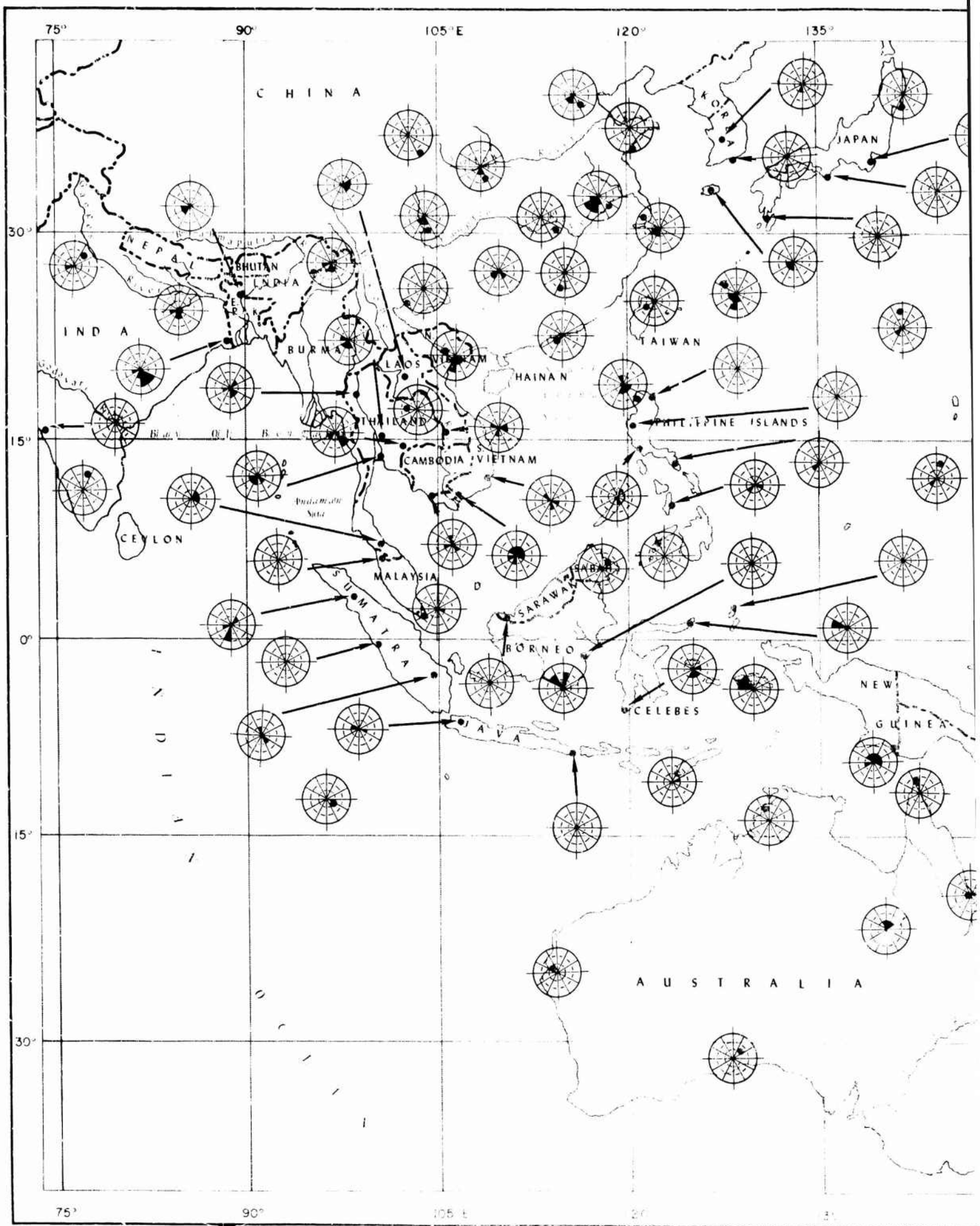

75°
90°
105° E
120°
135°
30°
15°
0°
15°
30°
CHINA
KOREA
JAPAN
NEPAL
BHUTAN
INDIA
INDIA
BURMA
LAOS
VIETNAM
HAINAN
TAIWAN
THAILAND
PHILIPPINE ISLANDS
CAMBODIA
S. VIETNAM
Andaman Sea
CEYLON
MALAYSIA
SUMATRA
SARAWAK
SABAH
BORNEO
CELEBES
JAVA
NEW GUINEA
AUSTRALIA
INDIAN OCEAN

Figure 5a

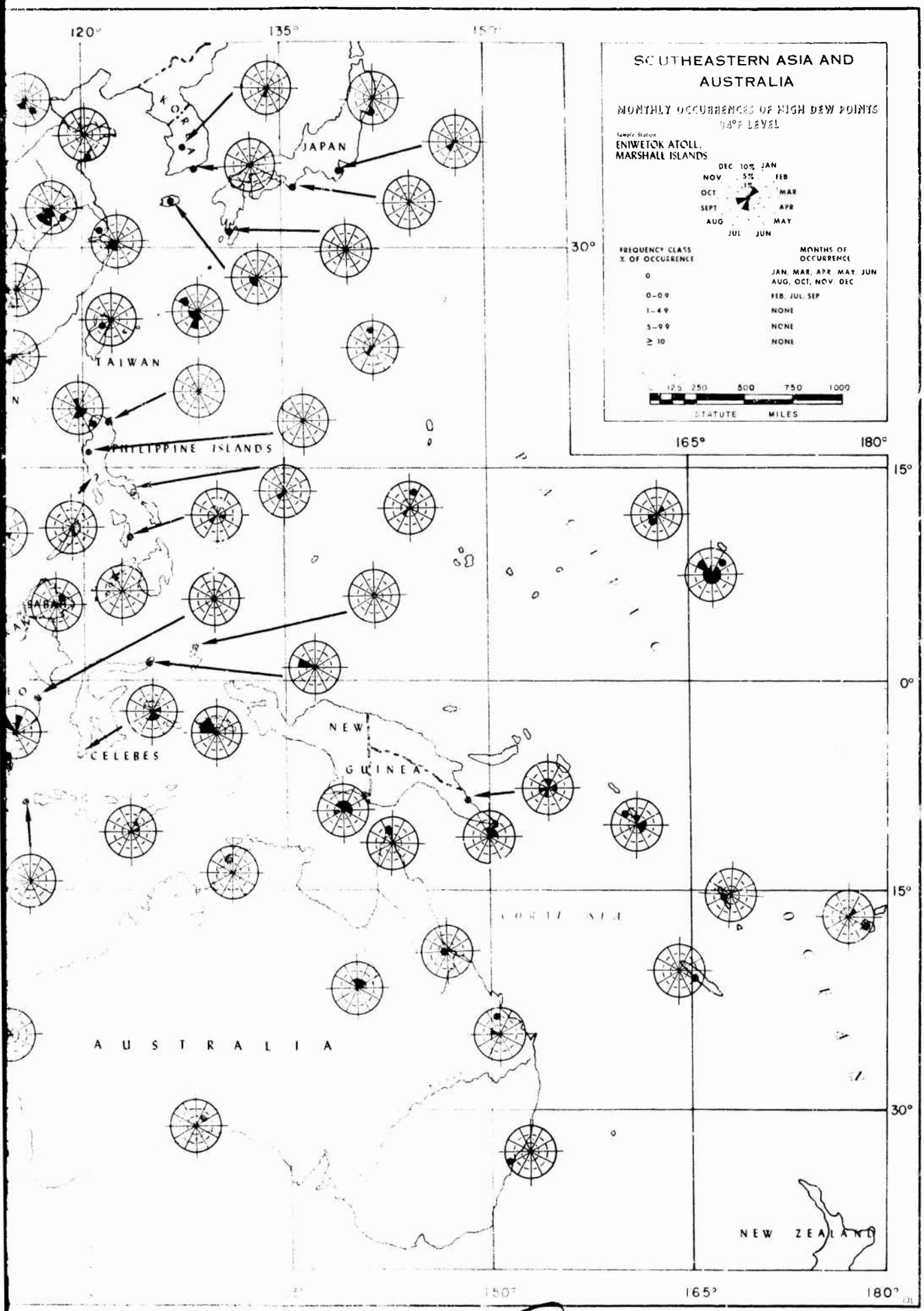
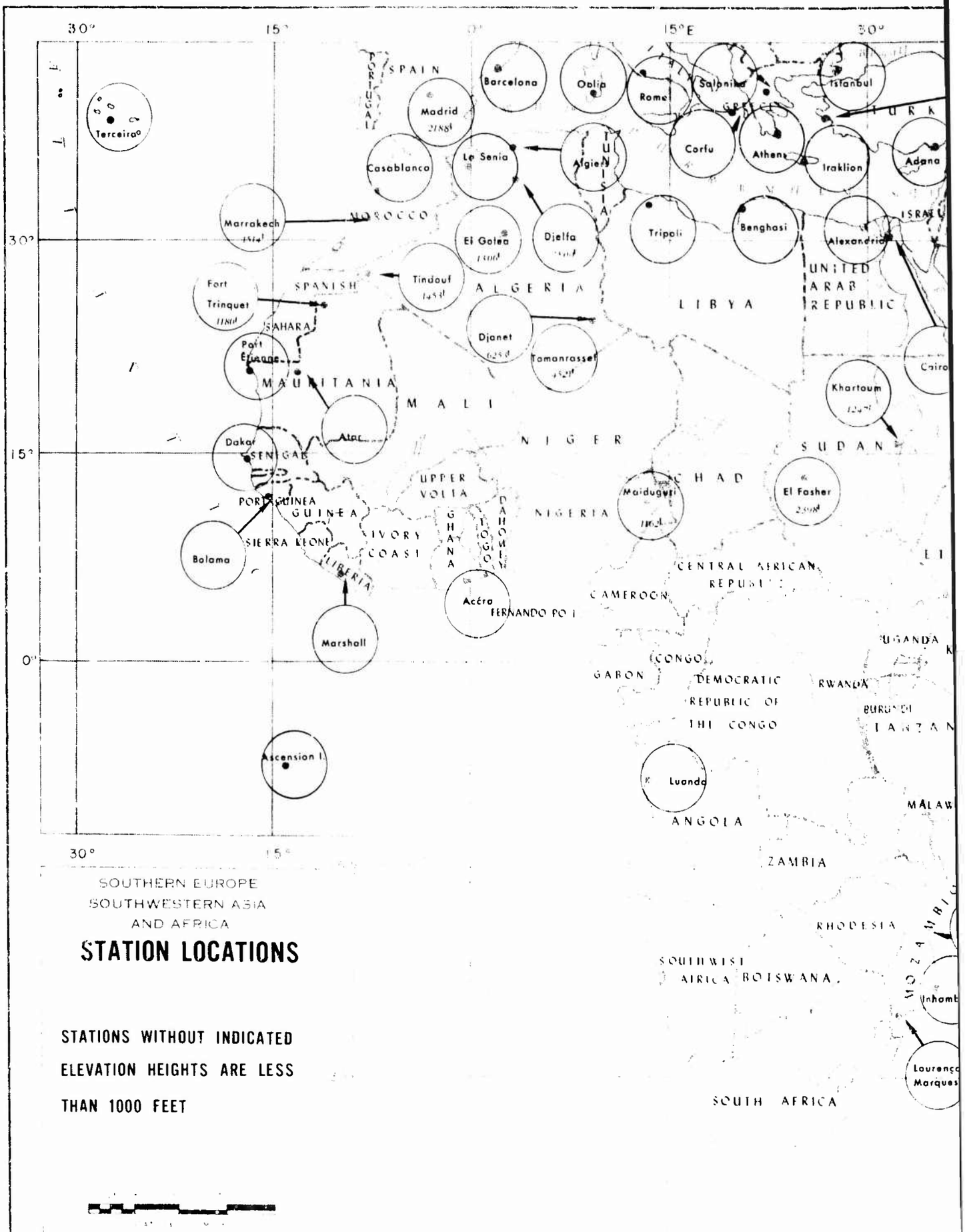

SOUTHEASTERN ASIA AND AUSTRALIA
MONTHLY OCCURRENCES OF HIGH DEW POINTS
Sample Station
ENIWETOK ATOLL, MARSHALL ISLANDS
DEC 10% JAN
NOV 5% FEB
OCT MAR
SEPT APR
AUG MAY
JUL JUN
FREQUENCY CLASS % OF OCCURRENCE
MONTHS OF OCCURRENCE
0
JAN, MAR, APR, MAY, JUN AUG, OCT, NOV, DEC
0-0.9
FEB, JUL, SEP
1-4.9
NONE
5-9.9
NONE
≥ 10
NONE
125 250 500 750 1000
STATUTE MILES
JAPAN
TAIWAN
PHILIPPINE ISLANDS
CELEBES
NEW GUINEA
AUSTRALIA
NEW ZEALAND
120°
135°
150°
165°
180°
30°
15°
0°
15°
30°

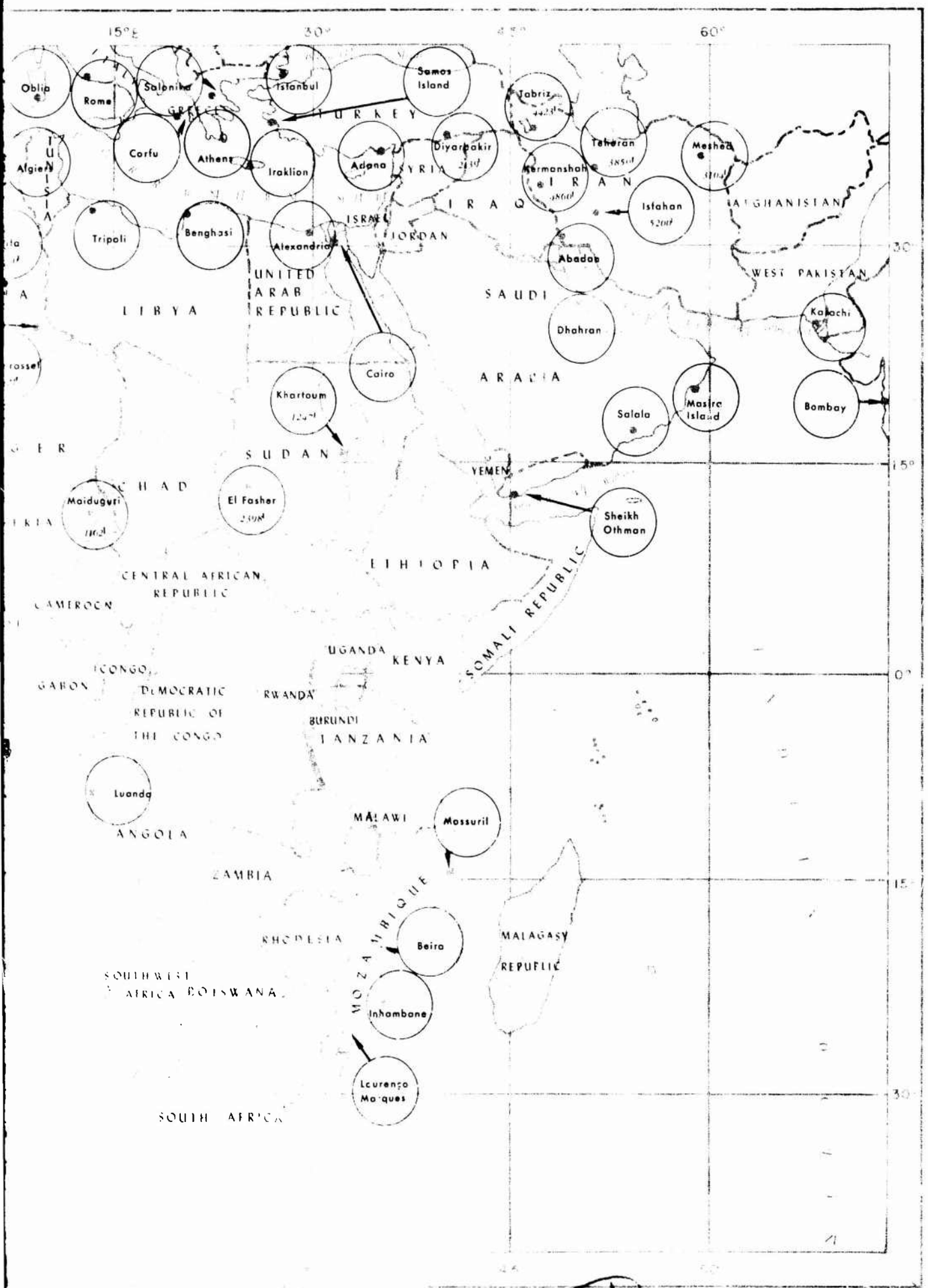
Figure 5a



SOUTHERN EUROPE
SOUTHWESTERN ASIA
AND AFRICA

STATION LOCATIONS

STATIONS WITHOUT INDICATED ELEVATION HEIGHTS ARE LESS THAN 1000 FEET


15°E
30°
45°
60°
Oblia
Rome
Salonika
Istanbul
Samos Island
Tabriz
GREECE
TURKEY
Corfu
Athens
Iraklion
Adana
Diyarbakir
Teheran
Meshed
SYRIA
Kermanshah
IRAN
Algiers
TUNISIA
IRAQ
Isfahan
AFGHANISTAN
Tripoli
Benghasi
Alexandria
ISRAEL
JORDAN
Abadan
WEST PAKISTAN
UNITED ARAB REPUBLIC
LIBYA
SAUDI
Dhahran
Karachi
Cairo
ARABIA
Khartoum
Masira Island
Salala
Bombay
SUDAN
YEMEN
CHAD
Maiduguri
El Fasher
Sheikh Othman
ETHIOPIA
CENTRAL AFRICAN REPUBLIC
CAMEROON
SOMALI REPUBLIC
UGANDA
KENYA
CONGO
GABON
DEMOCRATIC REPUBLIC OF THE CONGO
RWANDA
BURUNDI
TANZANIA
Luanda
ANGOLA
MALAWI
Massuril
ZAMBIA
MOZAMBIQUE
RHODESIA
Beira
MALAGASY REPUBLIC
SOUTH WEST AFRICA BOTSWANA
Inhambane
Lourenço Marques
SOUTH AFRICA
30°
15°
0°
15°
30°
45°
60°

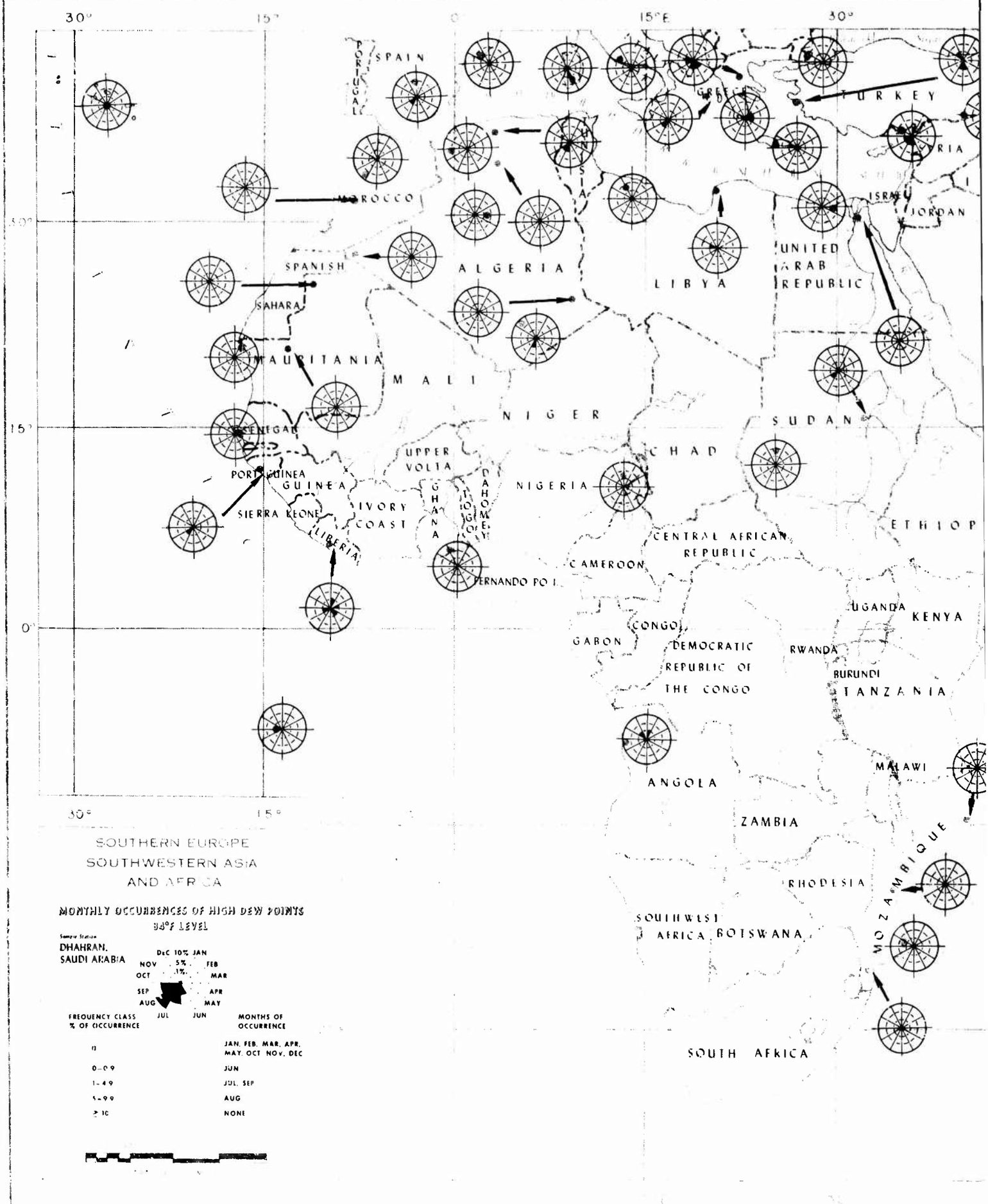

30°
15°
0°
15°E
30°
15°
0°
PORTUGAL
SPAIN
MOROCCO
SPANISH SAHARA
ALGERIA
TUNISIA
LIBYA
GREECE
TURKEY
SYRIA
ISRAEL
JORDAN
UNITED ARAB REPUBLIC
MAURITANIA
MALI
NIGER
SUDAN
SENEGAL
PORTUGUESE GUINEA
GUINEA
SIERRA LEONE
LIBERIA
IVORY COAST
UPPER VOLTA
GHANA
TOGO
DAHOMEY
NIGERIA
CHAD
CENTRAL AFRICAN REPUBLIC
CAMEROON
FERNANDO PO I.
ETHIOPIA
GABON
CONGO
DEMOCRATIC REPUBLIC OF THE CONGO
UGANDA
KENYA
RWANDA
BURUNDI
TANZANIA
ANGOLA
MALAWI
ZAMBIA
MOZAMBIQUE
RHODESIA
SOUTHWEST AFRICA
BOTSWANA
SOUTH AFRICA
SOUTHERN EUROPE
SOUTHWESTERN ASIA
AND AFRICA
MONTHLY OCCURRENCES OF HIGH DEW POINTS
84°F LEVEL
Sample Station
DHAHRAN, SAUDI ARABIA
DEC 10% JAN
NOV 5% FEB
OCT 1% MAR
SEP APR
AUG MAY
JUL JUN
FREQUENCY CLASS % OF OCCURRENCE
MONTHS OF OCCURRENCE
0 JAN, FEB, MAR, APR, MAY, OCT, NOV, DEC
0-0.9 JUN
1-4.9 JUL, SEP
5-9.9 AUG
≥ 10 NONE

Figure 5b

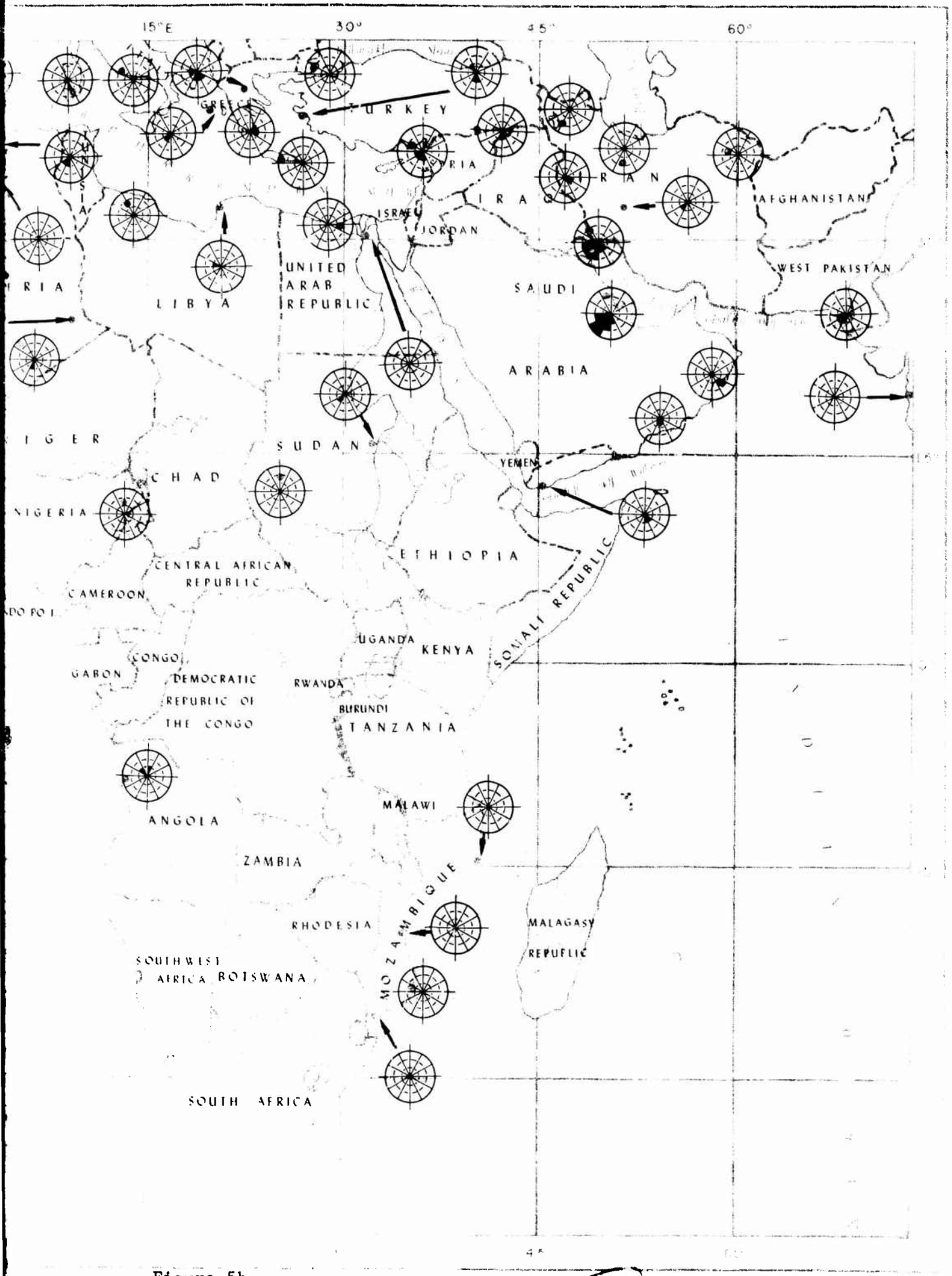
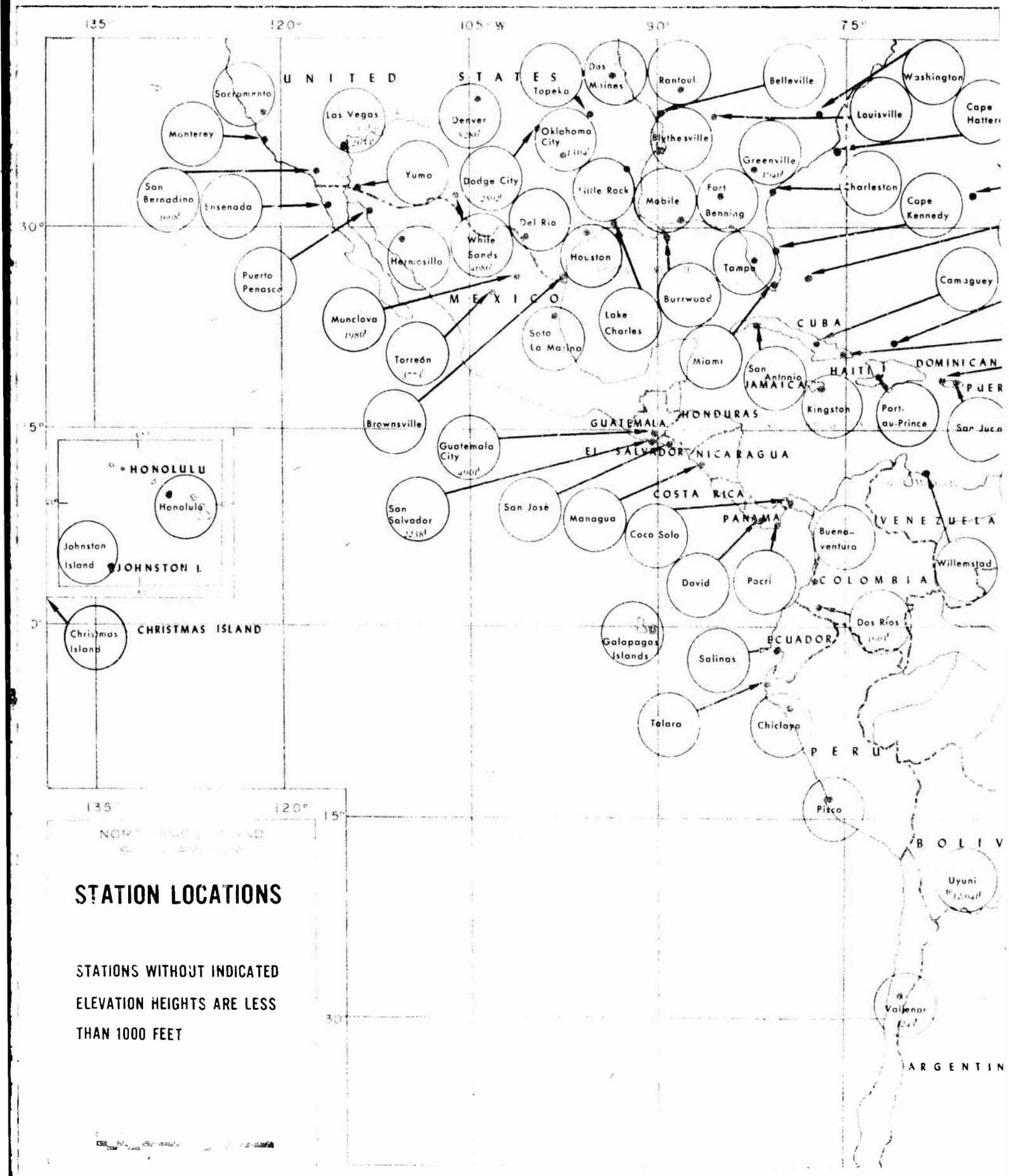
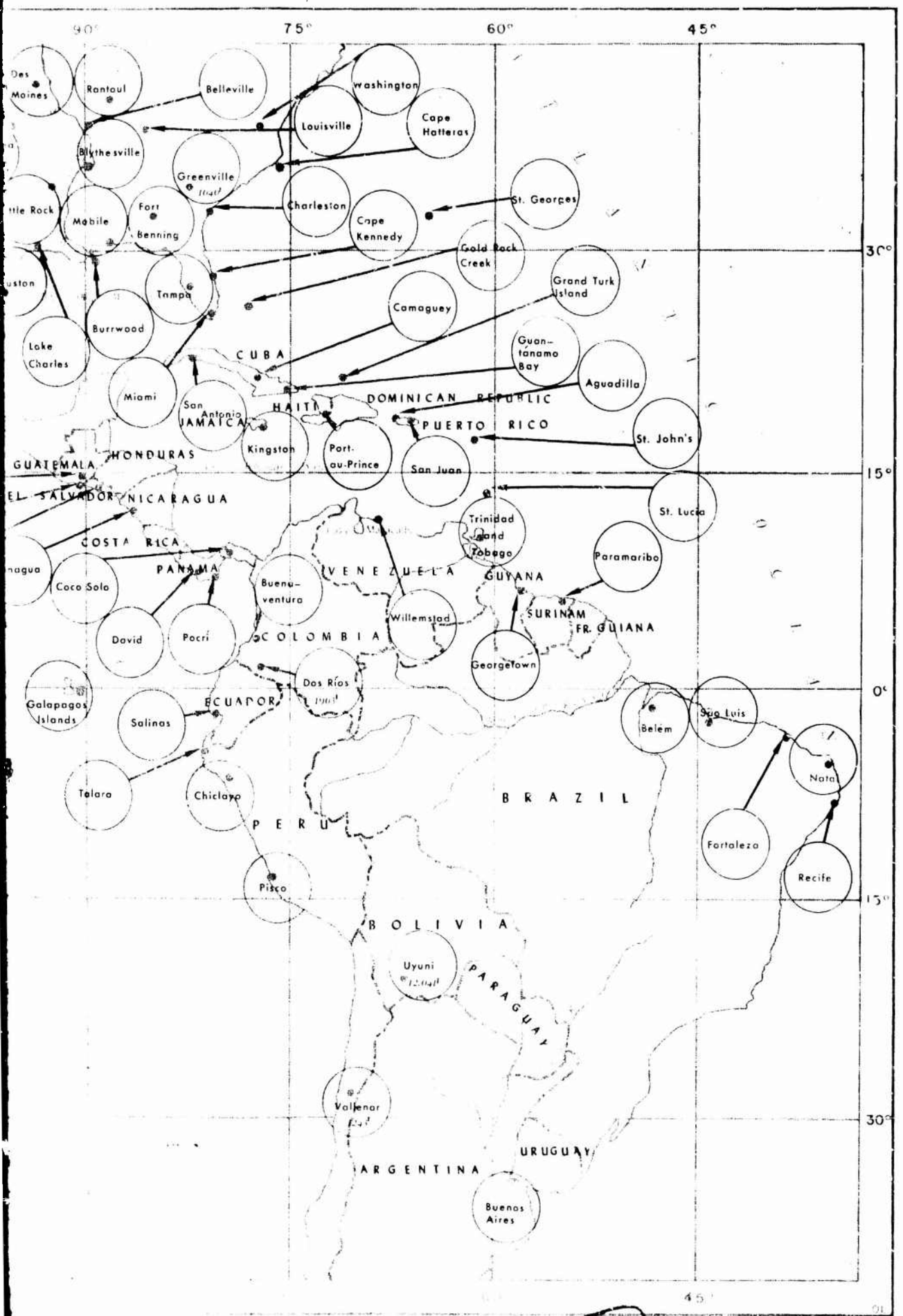

15°E
30°
45°
60°
TURKEY
GREECE
SYRIA
IRAN
IRAQ
AFGHANISTAN
ISRAEL
JORDAN
LIBYA
UNITED ARAB REPUBLIC
SAUDI ARABIA
WEST PAKISTAN
SUDAN
CHAD
NIGERIA
YEMEN
ETHIOPIA
CENTRAL AFRICAN REPUBLIC
CAMEROON
SOMALI REPUBLIC
UGANDA
KENYA
GABON
CONGO
DEMOCRATIC REPUBLIC OF THE CONGO
RWANDA
BURUNDI
TANZANIA
ANGOLA
MALAWI
ZAMBIA
MOZAMBIQUE
RHODESIA
MALAGASY REPUBLIC
SOUTHWEST AFRICA
BOTSWANA
SOUTH AFRICA

Figure 5b



STATION LOCATIONS

STATIONS WITHOUT INDICATED ELEVATION HEIGHTS ARE LESS THAN 1000 FEET


90°
75°
60°
45°
30°
15°
0°
15°
30°
Des Moines
Rantoul
Belleville
Washington
Louisville
Cape Hatteras
Blythesville
Greenville
Charleston
St. Georges
Cape Kennedy
Fort Benning
Mobile
Gold Rock Creek
Grand Turk Island
Tampa
Camaguey
Burrwood
Lake Charles
CUBA
Guantanamo Bay
Aguadilla
Miami
San Antonio
JAMAICA
HAITI
DOMINICAN REPUBLIC
PUERTO RICO
St. John's
Kingston
Port-au-Prince
San Juan
HONDURAS
GUATEMALA
EL SALVADOR
NICARAGUA
St. Lucia
Trinidad and Tobago
COSTA RICA
PANAMA
VENEZUELA
GUYANA
Paramaribo
Coco Solo
Buenaventura
Willemstad
SURINAM
FR. GUIANA
David
Pocri
COLOMBIA
Georgetown
Dos Ríos
Galapagos Islands
ECUADOR
Salinas
Belem
São Luis
Natal
Talara
Chiclayo
BRAZIL
PERU
Fortaleza
Recife
Pisco
BOLIVIA
Uyuni
PARAGUAY
Vallenar
URUGUAY
ARGENTINA
Buenos Aires

B

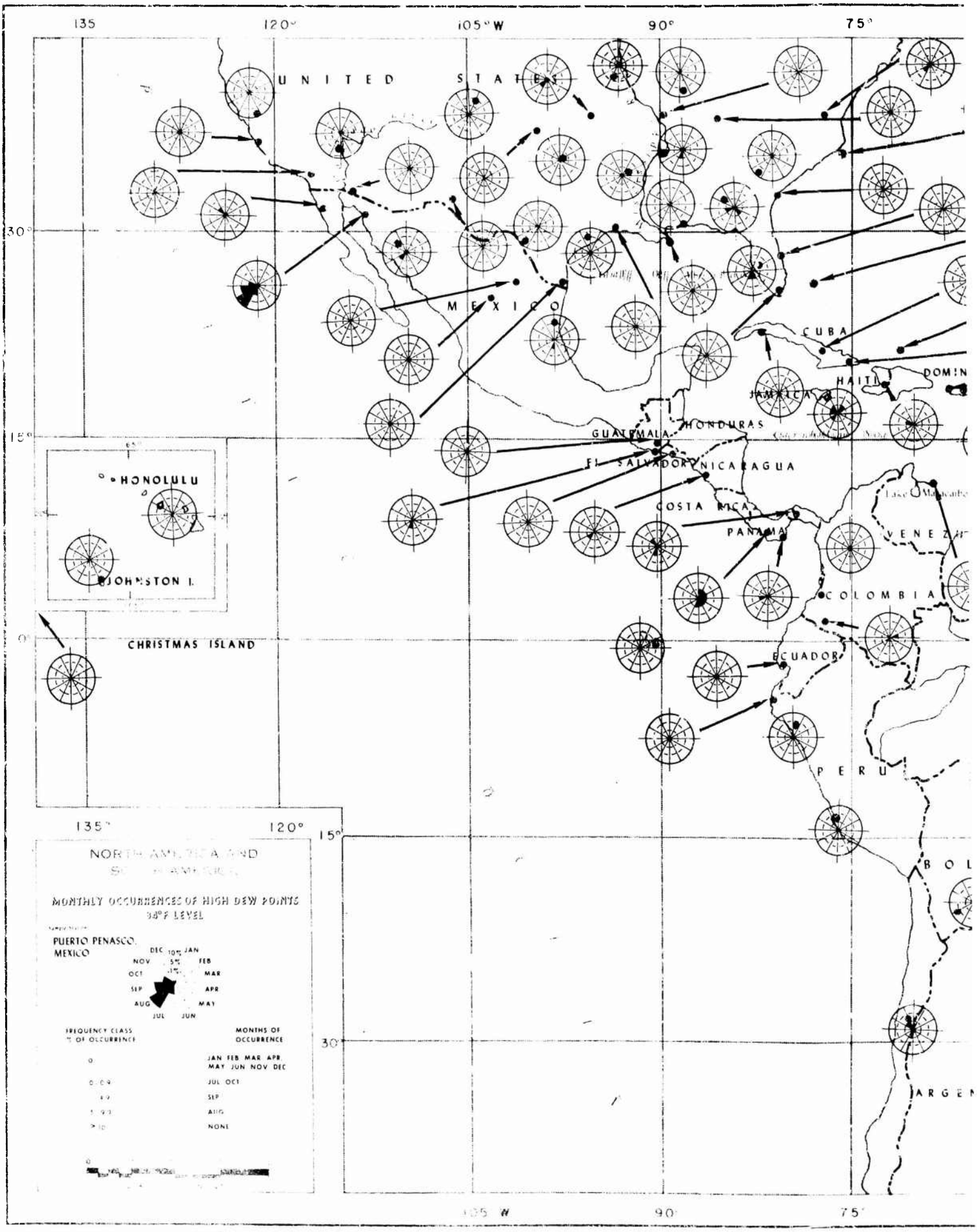

135
120°
105°W
90°
75°
UNITED STATES
MEXICO
CUBA
HAITI
DOMIN
JAMAICA
GUATEMALA
HONDURAS
EL SALVADOR
NICARAGUA
COSTA RICA
PANAMA
VENEZ
COLOMBIA
ECUADOR
PERU
BOL
ARGEN
30°
15°
0°
HONOLULU
JOHNSTON I.
CHRISTMAS ISLAND
NORTH AMERICA AND
MONTHLY OCCURRENCES OF HIGH DEW POINTS
86°F LEVEL
PUERTO PENASCO,
MEXICO
DEC
JAN
NOV
FEB
OCT
MAR
SEP
APR
AUG
MAY
JUL
JUN
FREQUENCY CLASS
% OF OCCURRENCE
MONTHS OF
OCCURRENCE
JAN FEB MAR APR
MAY JUN NOV DEC
JUL OCT
SEP
AUG
NONE

Figure 5c

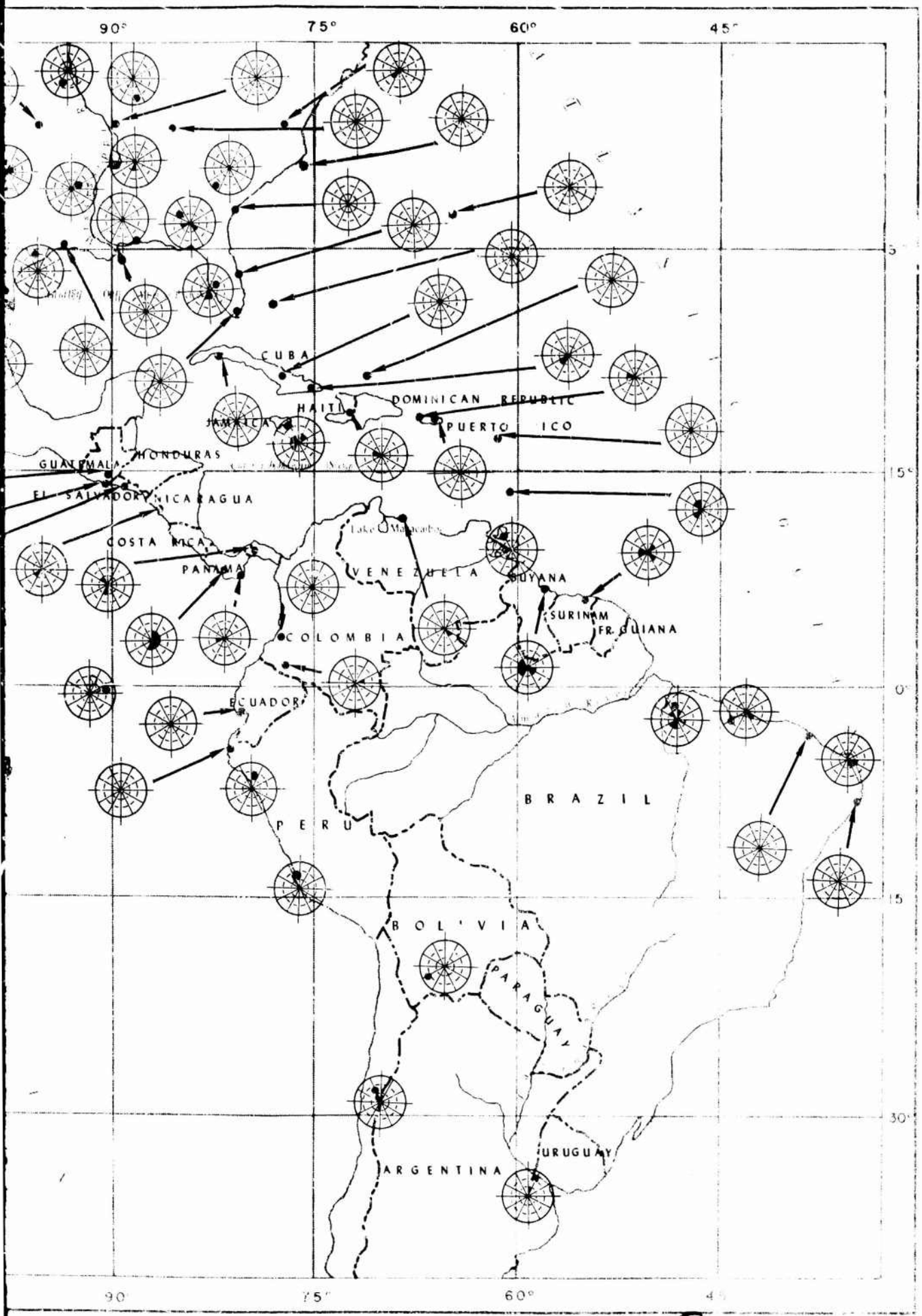

90°
75°
60°
45°
5°
15°
0°
15
30°
CUBA
HAITI
DOMINICAN REPUBLIC
PUERTO ICO
JAMAICA
GUATEMALA
HONDURAS
EL SALVADOR
NICARAGUA
COSTA RICA
PANAMA
VENEZUELA
GUYANA
SURINAM
FR. GUIANA
COLOMBIA
ECUADOR
PERU
BRAZIL
BOLIVIA
PARAGUAY
URUGUAY
ARGENTINA

Figure 5c

APPENDIX

APPENDIX

High Temperatures and Associated High Humidities in AR 70-38 (formerly AR 705-15), "RESEARCH, DEVELOPMENT, TEST AND EVALUATION OF MATERIEL IN EXTREME CLIMATIC CONDITIONS"

I. Introduction

Army Regulation 705-15, "Operation of Materiel under Extreme Conditions of Environment," prepared in 1963, sets forth several categories of extreme climatic conditions which should be considered in the development and testing of materiel. It is the Army implementation document for Military Standard 210A, "Climatic Extremes for Military Equipment," which lists climatic extremes not to be exceeded in the Department of Defense specifications. Before 1962 the principal function of AR 705-15 was to delimit high and low temperatures which should be considered in the development of Army materiel, but the need for elaboration of the environmental conditions which materiel might actually encounter has necessitated revision of the document three times since 1962.

The latest revision of the Regulation, designated AR 70-38, was published 1 July 1969 (1)*. An earlier revision has been discussed elsewhere (2, 3). The purpose of this Appendix is to present the background for the expanded treatment of high temperatures and associated high humidities in the new regulation. Much of the basic data collated and interpreted in this report has been available at the U.S. Army Natick Laboratories for several years. These data, along with data prepared in the United Kingdom, were basic to the preparation of the temperature-humidity recommendations in the Regulation. Similar recommendations were set forth in a Quadripartite Standardization Agreement which serves the same purpose as AR 70-38. The Quadripartite Standardization Agreement (QSTAG 200 "Climatic Factors Affecting Design Criteria") was prepared by the United Kingdom, based on recommendations of a Quadripartite Ad Hoc Working Group which met in London in 1964 (4, 5).

The need for additional consideration of the joint occurrence of high temperature and high humidity has been recognized by the U. S. Army and United Kingdom authorities (6). In 1959 a United Kingdom War Office Working Party undertook a study of temperature and humidity extremes which

---

*References used in the Appendix are located in Reference section at the end of the Appendix.

should be considered in the development of equipment, and in 1961 this group published the first recommendations for specification of climatic extremes in diurnal cycles (7). The work of this group is reflected in the provisions of AR 70-38, although some of the British Working Party recommendations were modified by the Quadripartite Ad Hoc Working Group.

II. Delimitation of the High Temperature-High Humidity Categories

Figure A1 is a copy of the map included in AR 70-38. The map shows the areas where the eight climatic categories set forth in the Regulation apply. Only Categories 1, 2, and 3 which involve consideration of high temperatures and concurrent high humidities are discussed in this Appendix. The areas where Categories 1 and 2 apply are the wet tropical regions of the world. Category 3 applies in very limited desert areas on the coasts of the Persian Gulf and Red Sea. It is the area with the highest water vapor content in the air near the ground. Categories 1 and 2 have been delimited on the basis of a modified Koeppen climatic classification. In much of the area with wet-warm and wet-hot conditions throughout the year (nonseasonal areas) the natural vegetation is tropical rainforest. In the areas of seasonal occurrence of wet-warm and wet-hot conditions, natural vegetation varies from savanna grassland type to forest, depending mainly upon the length of the dry season and the amount of rainfall.

One common criterion for delimiting tropical climates is the occurrence of relatively high temperatures throughout the year. Areas with a definite cool season are not considered to be tropical. This principle was adhered to in delimiting the wet-warm and wet-hot areas in Figure A1. Cool-season temperatures generally average higher than 60°F throughout the areas of application of Categories 1 and 2. Some areas which have a relatively short season with high temperatures and high humidities are not included in the area of application of Categories 1 and 2, because these same areas experience relatively cold winters. On the basis of the distribution of high temperatures and associated high humidities demonstrated in this report, an argument can be made that the area of application of Categories 1 and 2 should be enlarged to include the areas where these conditions occur only during a short summer season (e.g., in southern China). This was not done, because one stress of hot and humid conditions is their persistence throughout much or all of the year. Many of the adverse effects of joint heat and humidity are cumulative; where the season of occurrence is short, the effects are not as severe.

1. Wet-Warm (Table I)

The wet-warm conditions depicted in Table I occur under the canopy of tropical rainforests. The extreme aspect of this condition is the long duration of relative humidities above 90 percent. The United Kingdom

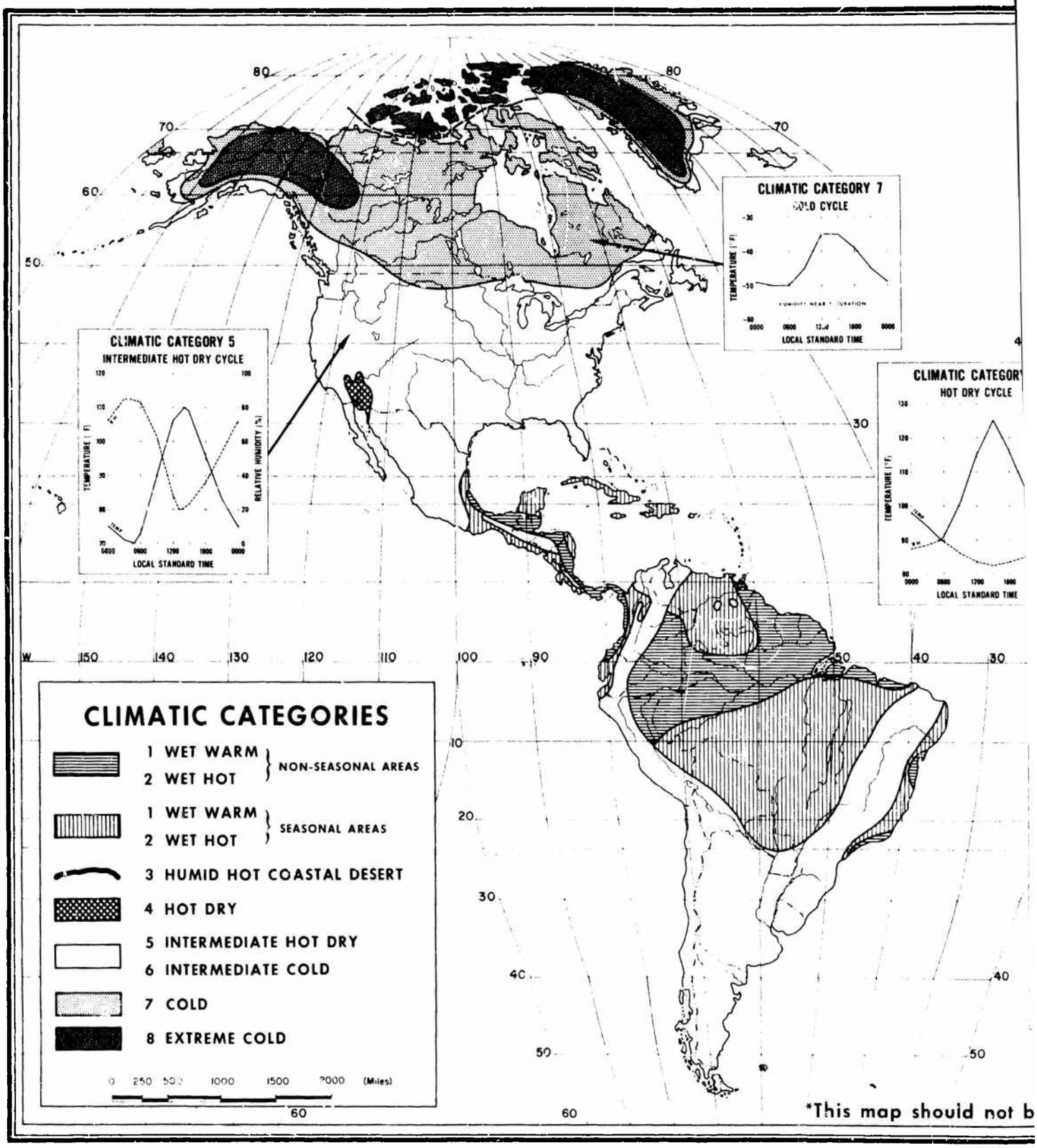
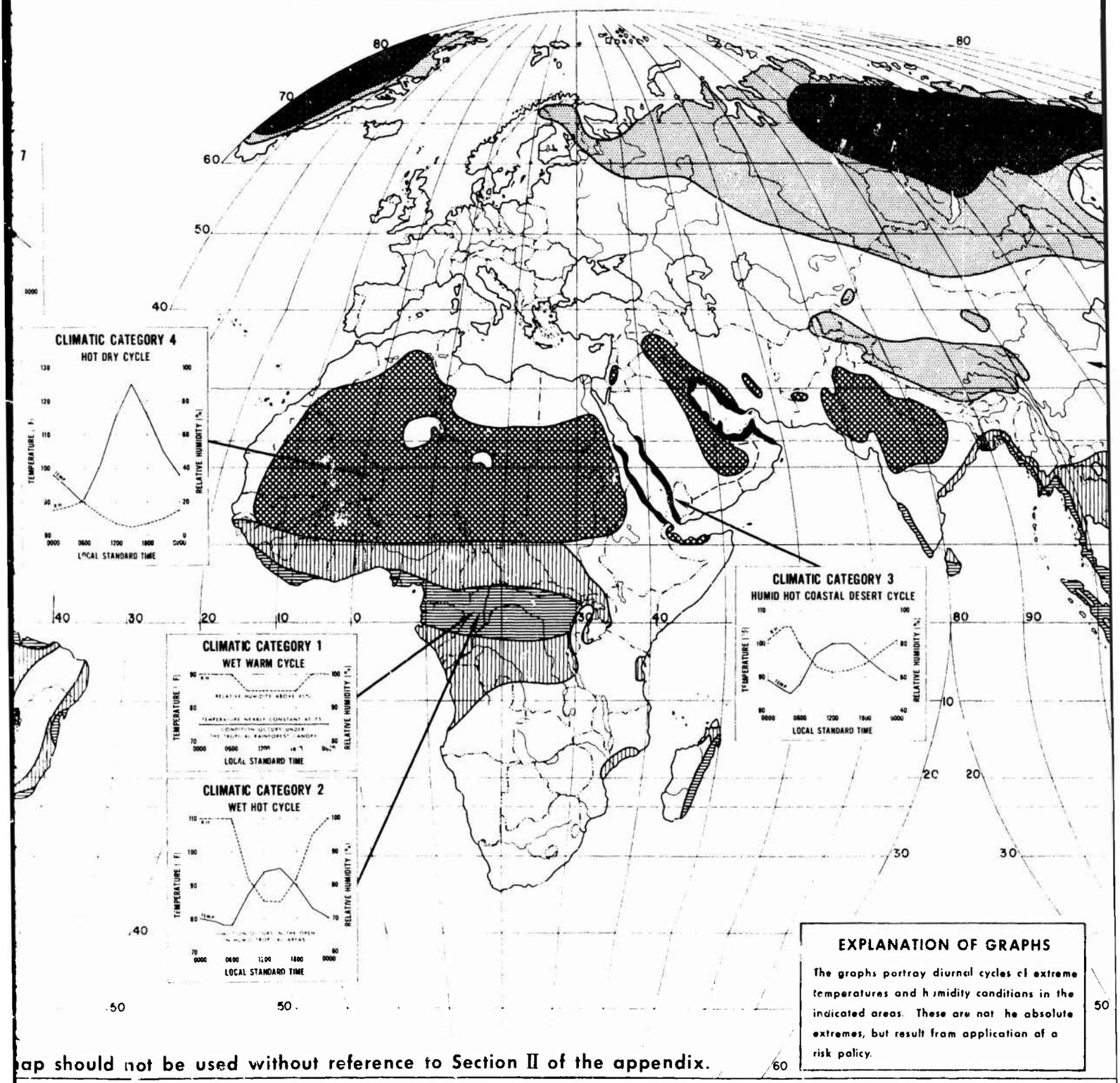
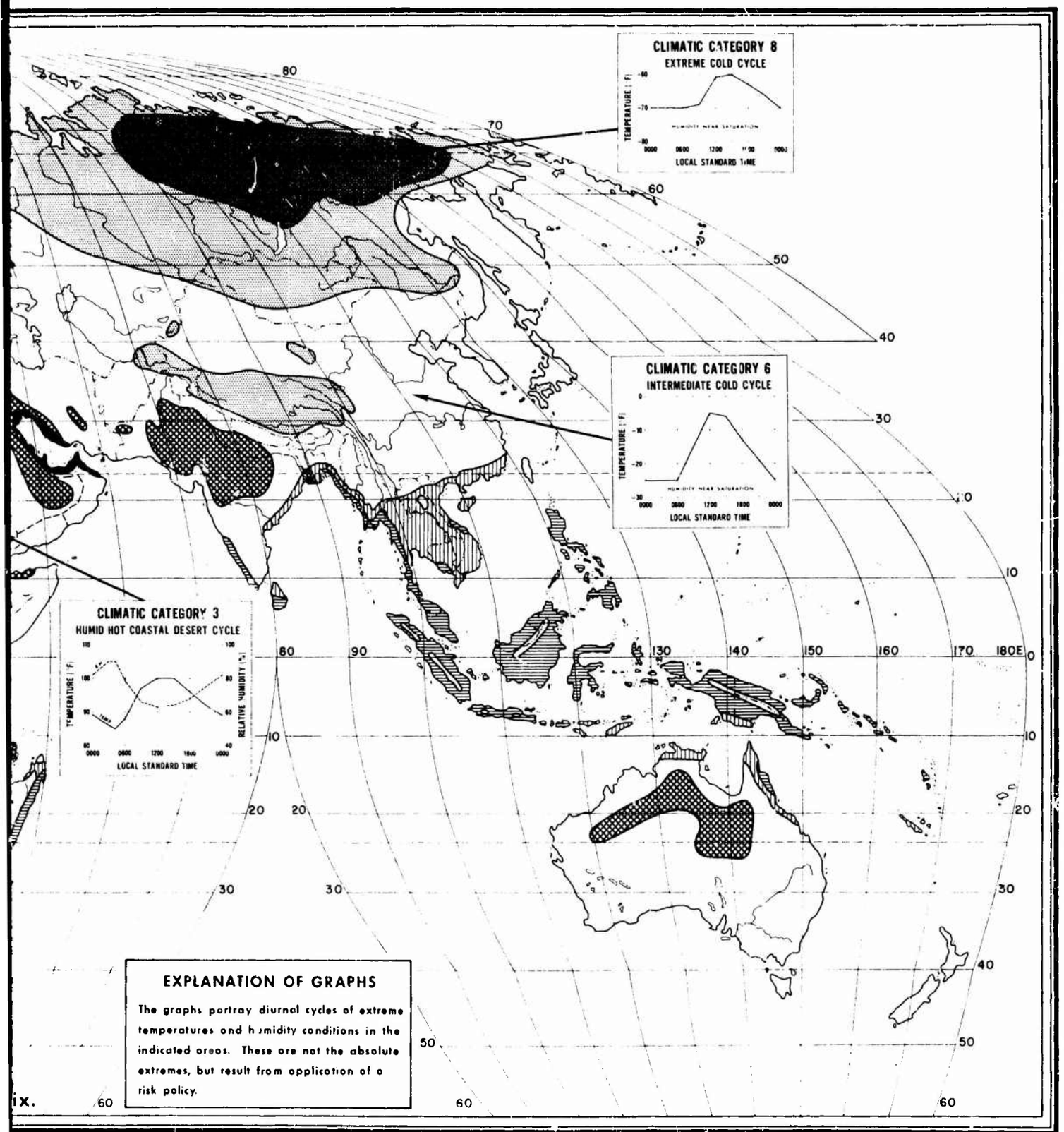


Figure A1. AREAS OF



ap should not be used without reference to Section II of the appendix.

REAS OF OCCURRENCE OF CLIMATIC CATEGORIES (AR 70-38*)



NLABS - ESL - 1969

ix.

EGORIES (AR 70-38 *)

T A B L E I

TEMPERATURE, SOLAR RADIATION, AND HUMIDITY DIURNAL CYCLE
FOR WET-WARM CONDITIONS*

OPERATING CONDITIONS				STORAGE AND TRANSIT EXTREME CONDITIONS	
Local Time	Temperature °F	Solar Radiation Btu/ft^2/hr	Relative Humidity %	Temperature °F	Relative Humidity %
0300					
0600	nearly		varying	nearly	varying
0900	constant	negli-	between	constant	between
1200	at 75°F	gible	95%	at 80°F	95%
1500	through-		and	through-	and
1800	out		100%	out	100%
2100	the 24			the 24	
2400	hours			hours	
Max			100		100
Min			95		95

* Wet-warm is Category 1 in AR 70-38.

Working Party measured temperatures and humidities similar to those in Table I at a forest site near Singapore, and similar conditions have been observed at the Army Tropic Test Center in the Canal Zone (8). Normally, weather observations are taken in ventilated instrument shelters located in open areas. Therefore, a data base for forest temperatures and humidities does not exist in the same sense that it does for open areas, and it has been recognized that further studies of environment within the tropical rainforest are necessary.*

2. Wet-Hot (Table II)

The wet-hot conditions depicted in Table II are found in open portions of the same tropical areas where wet-warm conditions occur in the forest. These areas are indicated in Figure A1. The Wet-hot Category is the most important of the three High Temperature-High Humidity Categories, since the other categories apply under rather specialized circumstances. The diurnal cycle includes a temperature variation from 78° to 95°F, a relative humidity variation from 75 percent to 100 percent, and a dew point variation from 78° to 85°F. The extreme aspect of the Category is the joint occurrence of a temperature of 95°F and a dew point of 85°F. In much of the wet-hot area in Figure A1, neither a temperature as high as 95°F nor a dew point as high as 85°F is experienced. In some areas temperatures or dew points at those levels may occur sometimes but not concurrently at these stations. From the data available in the main portion of this report and presented in Figure A1, nonseasonal wet-warm and wet-hot conditions apparently occur thoughout the area. Stations such as Belém (Brazil), Christmas Island, San Juan (Puerto Rico), and many others did not experience temperatures as high as 95°F during the periods of record available for this study. There are stations, however, which do occasionally experience a combination of temperatures near 95°F and concurrent dew points near 85°F. These stations are located in the area of seasonal occurrence of wet-hot and wet-warm conditions. Examples of stations with such extremes are Calcutta (India), Seno (Laos), Kampot (Cambodia), Hanoi (North Vietnam), Nanking (China), Kwajalein Atoll, Paramaribo (Surinam) and Georgetown (Guyana). If a better data base were available, there undoubtedly would be other locations reporting comparable, simultaneous high temperatures and high dew points.

The diurnal cycle presented in Table II is considered typical. Study of dew point variations at many stations around the world has indicated that on clear days, daytime dew points normally are higher than nighttime

---

*The Quadripartite Ad Hoc Working Group which made the basic recommendation incorporated in QSTAG 200 specifically recommended "that further investigation be continued into tropical rainforest environments including, as necessary, the establishment of short-term measuring sites."

T A B L E II

TEMPERATURE, SOLAR RADIATION, AND HUMIDITY DIURNAL CYCLE
FOR WET-HOT CONDITIONS*

	OPERATING CONDITIONS				STORAGE AND TRANSIT EXTREME CONDITIONS	
Local Time	Temperature °F	Solar Radiation** Btu/ft^2/hr	Humidity Rel. %	Humidity Dew Pt. °F	Temperature*** °F	Relative Humidity %
0300	79	0	100	79	94	80
0600	78	70	100	78	91	84
0900	87	290	82	81	117	74
1200	94	360	75	84	150	30
1500	95	290	75	85	160	10
1800	90	70	82	84	142	35
2100	83	0	95	82	105	59
2400	80	0	100	80	98	75
Max	95	360	100	85	160	85
Min	78	0	75	78	90	10

*Wet-hot is Category 2 in AR 70-38

**To remain at 360 Btu/ft^2/hr for not more than 4 hours

***To exceed 155°F for not more than 4 hours and to remain at 160°F for not more than 1 hour

dew points if there is moisture available for transpiration from the lush vegetation. Dew points during the cycle in Table II therefore are higher during the day than at night. A diurnal temperature variation of 17 degrees from 78°F to 95°F is larger than the normal tropical variation, but nevertheless is considered typical of conditions during hot clear weather. A variation in dew point of 7 degrees from 78°F to 85°F is larger than normally experienced in the tropics, but again it may occur and in some situations will cause condensation problems which should be considered.

3. Humid-Hot Coastal Desert (Table III)

Coastal areas of the Persian Gulf and the Red Sea are well known for the occurrence of an extreme combination of high temperature and high humidity (Table III). Records in this report for Dhahran (Saudi Arabia) and Abadan (Iran) indicate the frequency of occurrence of these conditions. Recent summaries for Red Sea coastal stations in Eritrea and Saudi Arabia indicate the frequent occurrence of high dew points on those coasts. Dew points above 90°F have been reported from Persian Gulf and Red Sea coastal stations in conjunction with temperatures near or above 100°F. Whether these extreme values resulted from faulty observations, or whether they actually occurred, is a matter of judgment. The available evidence justifies the humid-hot coastal desert diurnal cycle set forth in Table III, with a maximum dew point of 86°, well below the highest reported, and a concurrent temperature of 100°F.

The best analog of humid-hot coastal desert conditions in North America is probably found on the coast of the Gulf of California, and on the basis of the Puerto Penasco record, a small sector of the northern coast of the Gulf of California might have been indicated as being subject to the extreme conditions at Category 3 in Figure A1. However, temperatures of 100°F were not reported at Puerto Penasco in July and August, and therefore the Puerto Penasco record does not indicate quite as severe a condition as occasionally occurs on the Persian Gulf and Red Sea coasts. Because the area where high dew points occur along the coast of the Gulf of California is small, and because temperatures are below 100°F in the area where dew points are high, it was decided not to indicate an area of humid-hot coastal desert on the northern coast of the Gulf of California.

III. Storage and Transit Extreme Conditions

The storage and transit temperature and humidity cycles set forth in Tables I, II, and III represent conditions in storage situations where the combination of intense solar radiation and poor ventilation induces temperatures considerably higher than those in the ambient environment. Examples of this situation are: unventilated field storage shelters, tents, stores covered by tarpaulins, and railway boxcars. There have been a

T A B L E III

TEMPERATURE, SOLAR RADIATION, AND HUMIDITY DIURNAL CYCLE
FOR HUMID-HOT COASTAL DESERT

	OPERATING CONDITIONS				STORAGE AND TRANSIT EXTREME CONDITIONS	
Local Time	Temperature °F	Solar Radiation Btu/ft^2/hr**	Humidity Rel. %	Humidity Dew Pt. °F	Temperature*** °F	Relative Humidity %
0300	86	0	90	83	94	80
0600	88	70	79	80	91	84
0900	97	290	66	84	117	74
1200	100	360	63	85	150	30
1500	100	290	64	86	160	10
1800	96	70	68	84	142	35
2100	92	0	75	83	105	59
2400	89	0	82	83	98	75
Max	100	360	90	86	160	85
Min	85	0	63	80	90	10

*Humid-hot coastal desert is Category 3 in AR 70-38

**To remain at 360 Btu/ft^2/hr for not more than 4 hours

***To exceed 155°F for not more than 4 hours and to remain at 160°F for not more than 1 hour

number of measurements of storage and transit temperatures,* and high and low temperatures in storage and transit based on these measurements are included in AR 70-38 (1).

The storage and transit temperature and humidity cycles in Tables I, II, and III are based primarily on the findings of the British War Office Working Party which supervised temperature and humidity measurements inside empty storage shelters in a number of areas, including hot-desert and wet-tropical sites (7). The British measurements tended to corroborate earlier United States Army findings (9, 10).

There are several important points to be made concerning the storage and transit cycles. In the first place, the extreme temperature of 160°F of the cycles in Tables II and III is the extreme air temperature which might occur at the top of a confined space, and normally the temperatures of materiel in storage will be much lower. If the stores are kept out of the sunshine (as is the case in the wet-warm storage cycle summarized in Table I) storage temperatures will not be as extreme as the temperatures cited in Tables II and III. In all cases, the temperatures are dependent upon the individual circumstances and should be determined from calculation or by actual test.

The British Working Party used hair hygrometers in their measurements of humidities in storage situations. There is considerable lag in these instruments and they are not accurate in situations where temperatures are varying rapidly. Therefore, they furnish only a very general perspective on actual humidity regimes which might be anticipated in storage situations. The measurements were taken in empty shelters, and in actual practice the characteristics of the stores would influence the humidity regime. Placing wet stores in an unventilated shelter subject to intense solar radiation could result in higher absolute humidities than those of the natural environment. The temperature-humidity combinations cited in the Storage and Transit portion of Tables II and III reflect an induced humidity regime where the stores constitute a source of moisture.

The primary factor in the occurrence of high storage air temperatures is solar radiation. Ambient air temperature is also a contributing factor, but the British Working Party found that storage temperatures in wet-tropical locations may be as high as in the hot deserts even though ambient temperatures are lower. Storage humidities in wet-hot locations

---

*Storage and transit temperatures have been summarized in an informal file report available at the Earth Sciences Lab., U.S. Army Natick Labs (11).

are higher, of course, than in desert locations, except in the specialized circumstances of the humid-hot coastal desert areas represented in Table III. Hot-desert areas generally have less cloudiness and more frequent occurrence of intense solar radiation, and high storage temperatures will be induced more frequently. However, extremes of temperatures apparently are not any higher.

Under the forest canopy, temperatures and humidities in storage situations are almost the same as in the operating situation. This is because during the periods of almost constant temperatures and high humidities, skies are cloudy and the forest canopy intercepts what solar radiation is present. The United Kingdom Working Party found some increase in storage temperatures under the canopy, and a temperature of 80°F is specified rather than the 75°F temperature of the operating condition (Table I).

IV. Risk Policy

The extreme values of the climatic categories set forth in the Wet-Hot and Humid-Hot Coastal Desert Categories (Tables II and III) are not the absolute extremes which have been observed, but are extremes which may be expected to be exceeded approximately 1 percent of the time in the most extreme month. Considerable judgment is necessary in applying this risk policy because dependable and representative data are not available from some areas of extremes, and because the occurrence of extreme conditions does not always follow patterns which allow meaningful simplification.

The extreme feature of the Wet-Warm Category (Table I) is the long duration of high humidities at moderate temperatures. The risk policy stated above is not applicable to this type of an extreme condition.

V. Coincident Humidity and Dry Bulb Temperatures

For some applications, particularly the design and testing of environmental control equipment, it is useful to designate concurrent temperatures and humidities which constitute an extreme occurrence of total heat content of the air. Figure A2 is included in AR 70-38 for this purpose. Figure A2 is a psychrometric chart on which two lines are plotted to illustrate the relationship between high temperature and high humidity, when their combined occurrence causes an extreme condition. Line "A" shows this occurrence for areas of extreme conditions. One point on this line, (a), showing the occurrence of 100°F temperature and 64 percent relative humidity, is the extreme condition of the Humid-Hot Coastal Desert Category (Table III). Another point on this line, (b), showing the occurrence of 125°F temperature and 5 percent relative humidity, is the extreme

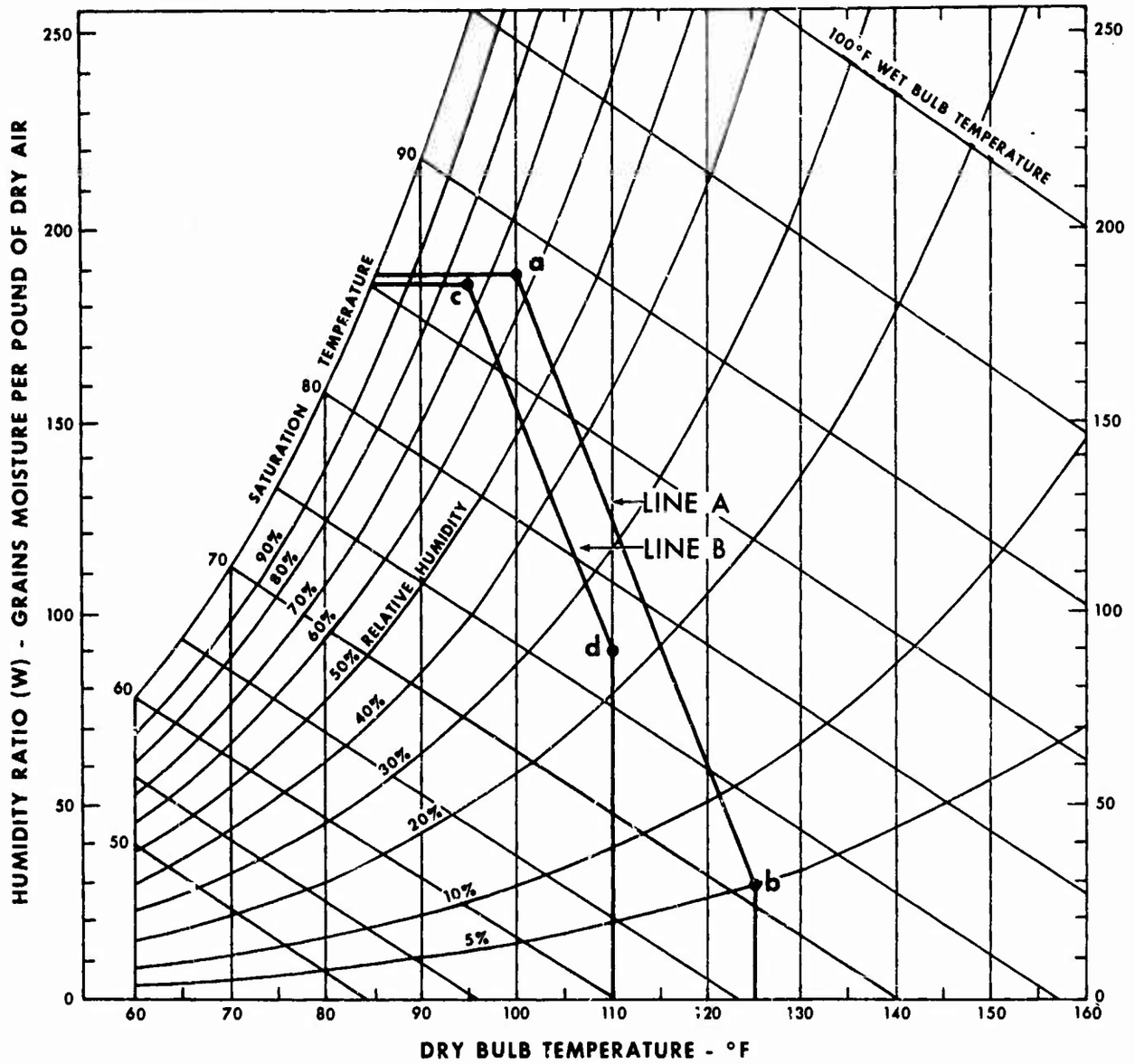


Figure A2. SIMULTANEOUS OCCURRENCE OF HIGH TEMPERATURE AND HIGH HUMIDITY.

(PSYCHROMETRIC CHART BASED ON A BAROMETRIC PRESSURE OF 29.92 INCHES OF MERCURY.)

Point a. Extreme temperature and relative humidity combination of Category 3, HUMID-HOT COASTAL DESERT.

Point b. Extreme temperature and relative humidity combination of Category 4, HOT-DRY.

Point c. Extreme temperature and relative humidity combingtion of Category 2, WET-HOT.

Point d. Extreme temperature and relative humidity combination of Category 5, INTERMEDIATE HOT-DRY.

Figure A-2

condition of the Hot-Dry Category in AR 70-38. (The hot-dry diurnal cycle is graphed in Fig. A1.) The conditions represented by line "A" are limited in areal extent and frequency of occurrence, and it is a matter of judgment how broadly they should be applied. One purpose of this report is to furnish information on the areal distribution of high temperatures and high humidities so that this judgment can be made realistically.

Line "B" of Figure A2 shows a more general occurrence of high temperatures and high humidities. One point on line "B", (d), showing the occurrence of 110°F temperature and 23 percent relative humidity, is the extreme condition of the Intermediate Hot-Dry Category in AR 70-38. (The intermediate hot-dry diurnal cycle also is graphed in Fig. A1). Another point on line "B", (c), showing the occurrence of a temperature of 95°F and a relative humidity of 75 percent, is the extreme condition of the Wet-Hot Category (Table II). The conditions represented by line "B" are severe, but they are not as limited in areal extent and frequency of occurrence as the conditions represented by line "A". They are a valid design goal for most Army materiel affected by the joint occurrence of high temperature and high humidity.

The approach to presenting the joint extremes of high temperature and high humidity on a psychrometric diagram was originally proposed by McDonald (6) based on United States Air Force studies and additional data, and has been adapted for use in AR 70-38.

References for the Appendix

1. United States Army. Army Regulation 70-38 (formerly AR 705-15), Research, development, test and evaluation of materiel for extreme climatic conditions. Washington, 1 July 1969.

2. Dodd, Arthur V. Draft regulation outlines design, testing climatic criteria. Army Res and Dev Monthly Newsmagazine, 8(11):6-7. Office of the Chief, Research and Development, Washington, December 1967.

3. Dodd, Arthur V. Considerations in revision of Army climatic criteria. Instit of Env Sci Ann Meeting Proc., St. Louis, April 1968.

4. Ministry of Defence (UK). Report of the ABCA Quadripartite Ad Hoc Working Group on the revision of the ABC-Army Standard No. 14, Temperature limitations agreement. London, 1965.

5. American, British, Canadian, Australian Armies Standardization Program, Quadripartite Standardization Agreement-200. Climatic factors affecting design criteria. March 1969.

6. McDonald, John L. A review of high temperature extremes in AR 705-15 and MIL-STD 210A, as compared to world-wide weather data. U.S. Army Eng Res and Dev Labs, Fort Belvoir, Va, 1964.

7. War Office Working Party (UK). Climatic requirements for Army equipment, Rpt No. 2. The War Office, London, 1961. (RESTRICTED)

8. Parmenter, G. Private communication containing information on temperature and humidities observed under the forest canopy at the U.S. Army Tropic Test Center, Canal Zone, 1965.

9. Porter, W. L. Occurrence of high temperatures in standing boxcars, Tech Rpt EP-27. Env Protection Div, QMR&D Center, Natick, Mass. February 1956.

10. Porter, W. L., and N. H. Roos. Occurrence of high temperatures in Yuma storage dumps, Tech Rpt EP-121. Env Protection Res Div, QMR&E Center, Natick, Mass. November 1959.

11. Brierly, W. (Compiler). Examples of surface and internal air temperatures of materiel exposed to solar insolation and storage and transit temperatures (file report). Earth Sci Lab, U.S. Army Natick Labs, Natick, Mass, October 1967.

UNCLASSIFIED

Security Classification

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author)	2a. REPORT SECURITY CLASSIFICATION
U.S. Army Natick Laboratories Natick, Massachusetts 01760	Unclassified
	2b. GROUP

3. REPORT TITLE

AREAL AND TEMPORAL OCCURRENCE OF HIGH DEW POINTS AND ASSOCIATED TEMPERATURES

4. DESCRIPTIVE NOTES *(Type of report and inclusive dates)*

5. AUTHOR(S) *(First name, middle initial, last name)*

Dodd, Arthur V.

6. REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
August 1969	218	24

8a. CONTRACT OR GRANT NO.	9a. ORIGINATOR'S REPORT NUMBER(S)
b. PROJECT NO. 1T062112A129	70-4-ES
c.	9b. OTHER REPORT NO(S) *(Any other numbers that may be assigned this report)*
d.	

10. DISTRIBUTION STATEMENT

This document has been approved for public release and sale; its distribution is unlimited.

11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY
	U.S. Army Natick Laboratories Natick, Massachusetts 01760

13. ABSTRACT

This report is a condensation of information currently available in the Earth Sciences Laboratory concerning the frequency of occurrence of high dew points and the temperatures that are associated with high dew points.

In the first section of the report, graphs showing the frequency of occurrence of high dew points and temperatures at 78 stations for the midseason months of January, April, July, and October are presented. Tables showing the maximum, minimum, and median temperatures associated with dew points above 75°F supplement the information on the frequency graphs. This information is presented to illustrate the likelihood of occurrence of high dew points and high temperatures.

In the second section of the report, maps showing the frequency of occurrence each month of dew points above 76°F, 80°F, and 84°F at 215 stations between latitudes 40° N and 40° S are presented. Data for each station are presented on circular graphs, making possible quick comprehension of the seasonal pattern of occurrence of high dew points at the individual stations, and the inclusion of the circular graphs on the maps gives some insight into the areal distribution of the occurrence of high dew points.

The information on the association of high temperatures and high dew points and the frequency of occurrence and areal distribution of high dew points is necessary for realistic consideration of humidity extremes and associated temperatures set forth in documents presenting environmental guidance for design of military materiel. The application of the information in this report to a revision of the humidity extremes in the new Army Regulation 70-38 (formerly AR 705-15), "Research, Development, Test and Evaluation of Materiel for Extreme Climatic Conditions," is discussed in the Appendix.

DD FORM 1 NOV 68 1473 REPLACES DD FORM 1473, 1 JAN 64, WHICH IS OBSOLETE FOR ARMY USE.

UNCLASSIFIED

Security Classification

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Dew Point	8					
Temperature	8					
Humidity	8					
Data	0					
Military requirements	4					
Storage	4					
Transportation	4					

AD-707 119

Technical Report 70-4-ES, "Areal and Temporal Occurrence of High Dew Points and Associated Temperatures"(1969):

Page 13, footnote; formula for Lally and Watson index should read

$H = T + h$.