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U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Weather Service

Monthly Climatological Charts of the Behavior of Fog and Low Stratus at Los Angeles International Airport

DONALD M. GALES

Western Region

SALT LAKE CITY, UTAH

July 1972

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U. S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL WEATHER SERVICE

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MONTHLY CLIMATOLOGICAL CHARTS OF THE BEHAVIOR OF FOG AND LOW STRATUS AT LOS ANGELES INTERNATIONAL AIRPORT

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WESTERN REGION
TECHNICAL MEMORANDUM NO. 76

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MONTHLY CLIMATOLOGICAL CHARTS OF THE BEHAVIOR OF FOG AND LOW STRATUS AT LOS ANGELES INTERNATIONAL AIRPORT

ABSTRACT

Coordinates of arrival time and ending time are used to chart the monthly climatology of fog as well as very low stratus clouds at Los Angeles International Airport. Nineteen years of record and special observations are charted by seasons and months in two categories: Fog (less than 200-foot ceiling and/or visibility less than 1/2 mile) and low stratus (ceilings 200 feet through 500 feet and visibilities of 1/2 mile or more). A variety of chart symbols are used for cloud or fog conditions to indicate the origin, how it subsequently changes to another category, its duration, and repetitions within categories. From the 24 monthly charts and 7 seasonal charts which are reproduced, patterns are discernible which should be useful to forecasters and flight operations personnel who have to make decisions about the immediate behavior of these marginal-type weather conditions. Some rather distinct patterns are apparent.

A comparison of fog frequency between the years 1952-1962 and 1963-1971 shows a significant reduction in fog in the recent period. This is tentatively attributed to extensive land development and expansion of the airport westward toward the ocean.

INTRODUCTION

Fog and stratus on the Southern California coast and at Los Angeles International Airport (LAX) have been abundantly documented by many authors. Only a few authors have attempted to derive parameters for objectively forecasting occurrence of fog or stratus, even though they occur, or the potential for their occurrence is present, on most nights of the year.

Even more difficult than a yes-no forecast of whether fog or stratus will occur is the forecast time of its arrival over the terminal. Very little has been written on this subject. The commonly practiced method of timing the event is "modified persistence". This is an evaluation of all available data in comparison with data from the previous day and the forecast trend of pressure systems, gradients, etc. Current data are used to modify the timing and cloud height of the previous day. The forecaster's experience includes variations due to synoptic patterns, seasons of the year, climatology, and many more specific parameters.

Graham (1952) developed an objective technique to predict the arrival time of warm-season stratus using a thickness value, a pressure gradient, and the Catalina Island Airport observation.

Gales (1962) used a pressure gradient and its 24-hour change in a study for fog forecasting, and Gales (1964) used the 1400Z and 1900Z dew-point temperatures in a similar study.

Keith (1957) developed a check list with numerically weighted items for forecasting clear sky, fog, or stratus at the terminal. The sum of the weighted numbers indicated the most probable forecast.

More recently, Eichelberger (1971) developed an objective technique for forecasting the Catalina Eddy using a coastal pressure gradient and the 500-millibar baroclinic vorticity forecast.

With these techniques, stratus forecasting has improved, but subtle parameter changes, often in conflicting directions, make stratus forecasting as much an art as a science.

This paper is concerned with use of fog and low-stratus climatology as an aid to the forecaster or airline flight-operations personnel who have to make decisions when fog has spread onto the airport, or is imminent. The climatology is only applicable to LAX.

DEVELOPMENT

Nineteen years of LAX hourly and special observations were examined for the presence of fog and low stratus. Each case of fog or stratus was charted separately according to time of beginning and ending. Storm conditions were not considered in the study. If it was raining at observation time or if rain had recently been reported, the observations were not considered. Thin broken or thin overcast sky condition was considered as a ceiling.

DEFINITIONS

These categories were arbitrarily selected for their application to aircraft operations:

FOG:	Ceiling $\leq$ 100 ft.	and/or Visibility $<$ 1/2 mi
LOW STRATUS:	Ceiling = 200 to 500 ft	and Visibility $\geq$ 1/2 mi
STRATUS:	Ceiling $\geq$ 600 ft	and Visibility $\geq$ 1/2 mi

Three basic symbols are used in the charting: ●, ×, ▲. Variations of the solid symbols are made by appending arrows. These symbols are intended to be logical, readable descriptions of the behavior of each fog or low stratus event. The symbol describes the recent history and subsequent behavior of the condition within its category. They are described in Table 1. In some cases repetitions can be traced between charts by the symbols.

The charts were plotted by months for both fog and low stratus as defined above. Because 19 years is a short period for monthly stratification of data, seasonal charts are also provided. Seasons were defined by similarity of behavior of fog or low stratus rather than by the calendar. Seasons vary in length from two to four months with a different grouping for fog and low stratus. There is no summer fog season chart, and July fog was not included in any season since it was dissimilar to adjacent months due to short fog durations.

Seasonal charts include only the initial symbols ▲, ✕ , ● , for a date and as such represent no redundancy of data, whereas monthly charts include open symbols for repetitions on a given date. To the casual observer this redundancy would tend to bias the data in favor of more events than actually occurred.

It is important for a study such as this to have observations all taken from the same location on the airport. Heat from the ground and low-level mechanical turbulence tend to lift the leading edge of the fog as it moves inland from the beach, which is about two miles west of the LAX observation site. Farther inland from the immediate coast, higher ceilings are likely to occur within the marine layer. To move the site westward would tend to increase the amount of data observed in the Fog Category as well as to lengthen the duration slightly. The observation site was moved westward 3/4 mile in June 1968. It is felt, however, that the basic presentation is still valid, although perhaps with a slight bias.

An additional factor of significant effect on the data is man-made changes to the environment over the years. Extensive suburban development of formerly agricultural areas, airport paving, building construction, and increased use of the airport and its facilities along with aircraft and motor vehicle emissions probably affect the amount and height of fog and low clouds observed. The westward move may compensate to some degree for the man-made effects.

Figure 1 shows a reduction in frequency of both fog and low stratus for most months since 1962, when airport activities were accelerating. This change in the climatology of fog and low stratus should not affect the validity of the charts, as these are to be used for forecasting arrival times and subsequent behavior of fog and low stratus, not the occurrence of these conditions.

EXAMPLES OF INTERPRETING THE CHARTS

Observations are plotted in two categories, fog and low stratus, using arrival time of the event as abscissa and the ending time of the event as ordinate (Figure 2). Fog ends when it lifts into the low stratus category, when it dissipates, or when it is advected away. In the case of fog lifting to low stratus, the ending time of the fog becomes the beginning time on the low stratus chart; and the reverse occurs when low stratus becomes fog.

Note that the time difference between beginning and ending of an event is the duration of the event. The zero-duration line is a diagonal across the chart upward to the right. All events of the same duration will fall on a line equidistant from the zero-duration line. Though not a chart coordinate, duration is a convenient parameter for comparing monthly patterns of behavior of the fog and low stratus.

Figure 2 shows several examples of fog entries. Note that the diagonal zero-duration line limits all data to the upper left-hand side of the chart. On monthly and seasonal charts the lower-right halves of the charts are deleted and the abscissa labels are placed along the diagonal for ease of reading.

The first example in Figure 2 shows an X on the 4-hour duration line. This indicates a fog began at 2345 GMT and ended at 0345 GMT. The fog did not repeat during that night according to the definition of the X-symbol (Table 1.

Another example (A) shows fog beginning at 0000 GMT and ending at 0100 GMT. The duration was one hour. The solid round symbol indicates this to be the first fog entry of the date, and that it came from the lowering of low stratus to fog. It ended by lifting up to low stratus and repeated again at 0300 GMT by the lowering of stratus to fog (See A^1 in Figure 2). The open symbol shows that the condition is a repetition of an earlier entry on the chart and also shows the fog ending by the visibility increasing to 1/2 mile or more at 0410 GMT. A second repetition (A^2) is indicated by at 0700 GMT when the visibility again decreased to less than 1/2 mile and/or the ceiling became sero or 100 feet, but not by lowering. This condition ended by lifting to low stratus near 0730 GMT. Letters with exponents are used to trace the particular case with subsequent repetitions. Not all cases are so lettered.

A third example has a solid triangular symbol whose appendage indicates the fog came from the lowering of low stratus at 0400 GMT and it lifted back to low stratus at 0700 GMT. The solid triangle means this one event did not repeat in the fog category on this night. The triangle is used rather than the X symbol because of the change into the low stratus category.

APPLICATIONS

In practice the forecaster often has a difficult time describing the variable nature of the anticipated fog or stratus condition. It is hoped that he will find guidance in these charts for improvement of his forecasts. For example, he may not become concerned by report of a fog bank west of the airport at certain hours during a particular month if he checks the chart and find that fog did not move over the airport until some time later in the day; or that in some months or during evening hours, fog duration is never more than a few hours;

or sometimes the forecaster can state with confidence that a certain condition will (or will not) happen, because the 19-year climatology shows the event very frequently (or rarely) occurred at a certain hour in that particular month.

A flight dispatcher of an airline may find the time-behavior charts useful when he has to decide whether an airplane approaching LAX should go to an alternate airport, proceed to LAX, or take a chance on holding aloft in the area until the weather improves to landing conditions during a fog. Such decisions are always a calculated risk, but with the help of the time-behavior charts he has something factual upon which to base his decision. For example, in December it can be safely said that fog (ceiling below 200 feet and/or visibility less than 1/2 mile) is quite unlikely before 2330 GMT; or in March, if the airport is foggy at some time before 0800 GMT, the dispatcher should feel confident that the fog will not last over two hours and that the fog more likely will dissipate than lift. He might decide it unwise to pick up passengers from a flight that landed at a nearby alternate airport because of fog at LAX when the charts show a definite pattern of short-duration fogs (as in March), and that in less time than the bus ride the flight could fly into LAX after the fog lifts.

During changeable fog periods or marginal weather when the trend is uncertain, the time-behavior charts will give objective help to answer such questions as:

- How long is this condition likely to last?
- Now that it has ended, is it likely to repeat?
- How long before it may fog in again?
- Is the stratus likely to lower to fog, or will it stay as low stratus?

For several examples of applications of the data we will assume some representative conditions and follow through the charts to a reasonable forecast.

1. <u>Given</u>: March, ending of a period of dry offshore flow, no fog is reported over the water in the afternoon, but the sea breeze has increased coastal dew-point temperatures and pressure gradients are such that by other means (Gales, 1962, 1964) fog has been decided upon as the likely forecast for the coming night.

   <u>Procedure</u>: Turn to the March Fog Chart or Spring Fogs and note that the majority of fogs prior to 0800 GMT (hereafter noted as 08Z) were caused by lowering of low stratus to the fog condition, and fog never lasted over two hours. Since no fog or clouds are over the water on this hypothetical afternoon, fog is most likely to come from either radiation (rare) or from later advection, but

not from the lowering of advected clouds. (This decision is largely from experience.) The charts indicate the arrival of below-limits fog to be unlikely earlier than 08Z to 10Z. The fog is <u>not</u> likely to be variable (allowing intermittent flight operations) since there are few open circles on the March Fog Chart. The ending time of the fog is usually by 17Z.

<u>Forecast</u>: LAX going below limits (below 2X1/2F) at 10Z and becoming operational between 15Z and 16Z through dissipation of the fog rather than from lifting into low stratus.

2. <u>Given</u>: March, the next night after the above example. Fog and low stratus are over the water and up to the coastline at forecast time (21Z). Pressure gradients are becoming more onshore toward the desert, indicating a trend toward low clouds with possible fog tonight. Daytime temperatures have been fairly warm and sunshine has warmed the ground.

<u>Procedure</u>: Since fog is along the shoreline and should move in with the sea breeze, the forecaster will find on the Spring Fog, Spring Low Stratus, or the two March charts that an arrival time earlier than 22Z is unlikely (Earliest onsets of stratus are about 2130Z; for fog, about 00Z); also, 00Z is a popular beginning time for low stratus. Low stratus is chosen because the warm ground will tend to lift the leading edge of the fog as it moves inland to the airport. However, the charts indicate that quite often a lowering-and-lifting pattern (♉ , ♀)takes place in March with the duration in the low stratus category likely being less than four hours and in the fog category less than one hour during the time prior to about 09Z. Given the pressure gradient trend favoring low clouds, the forecaster may forecast something like the following:

<u>Forecast</u>: Marginal low stratus arriving at 00Z with short periods of fog (less than 2X1/2F) prior to 08Z or 10Z; then varying between low stratus and stratus above 500 feet (♉). This was chosen because of the pressure gradient trend, and March charts show repeat conditions in the low stratus category are most often of this type (♉) after 08Z. (The other choice for repetitions would be continuations between fog and low stratus (♀ ♉) which was rejected because of the pressure gradient trend noted above.) After 14Z the forecast will be for higher stratus and continued lifting (⚲ ▲).

Among the useful information derivable from the charts are:

1. Initial arrival time will rarely be earlier than that shown by the data toward the left side of the charts.

2. Normal ending times for the conditions will be found at the stratifying of the data near the top of the chart.

3. Variability during day or night will be indicated by the number and time-distribution of the open circles. (Caution: Some dates may be represented by several circles, thus lending some bias toward variability.

4. Note the types of variability from the appendages (or lack of) on the symbols. Is it lifting-and lowering (○) or in-and-out (○) conditions?

5. Note the <u>duration</u> pattern, especially from the ✕ and ▲ symbols, which are nonrepeating events during the night.

6. Compare the relative frequency of variable conditions (circles) with the one-time events ✕ , ▲ .

7. Compare the relative frequency of fog and low stratus conditions ending within their categories to the frequency of cases lifting to the next higher category. (Compare symbols without appendages to those with appendages.) For example, on the Fall Fog Chart, prior to 05Z, 31 of 35 initial onsets of fog were due to lowering from low stratus, while on the Winter Fog Chart, prior to 05Z, only 14 of 94 cases were due to the same action.

8. Compare seasonal distributions. Note that an early fog in winter may have a long duration, but spring and fall fogs forming prior to 08Z are mostly of short duration.

9. Use monthly charts in conjunction with seasonal charts for possible refinement, since there is a gradual transition between months as well as between seasons.

10. When the event has already begun, use the trend already established (lift-and-lower or in-and-out) to provide a clue as to which chart symbols to examine for future behavior.

As an example of application of the charts after an event has begun, assume it is an August evening at 02Z. A low stratus (M3 ⊕ 1F) moved over LAX from the west. The Summer Low Stratus Chart shows that (a) evening low stratus usually comes from the lowering of a higher stratus and returns to higher stratus (● , ▲); (b) at or near 02Z low stratus arriving without lowering (as assumed in our example) will in reality much more often continue to lower to fog (●↓) than rise (●↑); (c) it has an almost equal chance to clear out, however, ● , ✕ . Half of those fogs that clear out will not reappear as low stratus (✕).

As to duration, the Summer Low Stratus Chart shows (a) the condition could last into the morning, but more likely (b) it will be variable (circles) and last less than two hours in this category. Looking at the Fall Fog Chart we are assured that (a) nearly every fog in the evening comes from lowering conditions and almost always lifts back up to low stratus (● , ▲); and (b) fog duration is usually under four hours and quite likely less than one hour if it begins between 03Z and

05Z. Additionally, fog repetitions are not common (circles) in August, but low stratus repetitions are common.

The forecaster's conclusion might be that the presently observed low stratus will lower to fog (below 2X1/2F) at about 03Z and lift up again to low stratus within an hour or so. Further conclusions about the behavior would depend upon trends of pressure and wind flow not specified in this example. However, the August Fog Chart gives about an even chance for a second appearance, probably around 10Z and lasting for several hours.

While these data are climatological and statistical, the forecaster can make the historical facts much more useful when incorporated with his knowledge of events transpiring at the moment and using this information with other objective aids to formulate his forecast.

The forecaster can examine the charts and form opinions or "rules" for each month, such as fog is rare at LAX before a certain hour in the afternoon; or fog almost always ends before some particular hour in the morning. Some months have a greater tendency for fogs to develop by lowering from a stratus condition (●↓ or ✕●) and ending by rising into a stratus condition (↑● or ✕●). Other months are more prone to have ground fog without variability (×), while another month may be subject to great short-period variability (↑●, ↑○, ●, ○, ✕○, or ✕●), and long duration fogs are rare.

It was found in working with the data that winter months tend to have low stratus for relatively short times, and that this condition is more often a transitory stage of a changing condition. Also, in spring the diurnal oscillation of ceiling height was greater than in other months. It was not unusual in April and May to have ceilings lower from 1000 feet to 300 feet during the night, a rather large change.

CONCLUDING REMARKS

The climatology of the behavior of fog and low stratus has been charted by months and seasons to give the meteorologist another tool in understanding and forecasting a rather common weather condition at LAX. Many years of observations from one location are necessary to make such a study representative. Future work similar to this could be made less complex by merging periods of brief changes having little or no operational significance. For example, lifting or lowering of fog or stratus for a period lasting only 10 minutes may be considered of little importance except for an aircraft in position for takeoff or already on a landing approach. Also, brief fluctuations between low-stratus and stratus ceilings are of little importance except when part of a trend.

Changes in fog climatology at LAX have taken place over the years.

Fog is less common in recent years, particularly in the warmer months. It is suggested that airport development by paving and construction of buildings, as well as increased utilization of the runways, has had a large influence in this change.

ACKNOWLEDGMENTS

The first ten years of data were assembled while the author was a Senior Forecaster with Trans-World Airlines in Los Angeles. The next five years of data were extracted from microfilm and plotted by Misses Marilyn Torchinsky and Warnie Webster, student assistants in the Techniques Development Laboratory, Silver Spring, Maryland, where the author was a Research Meteorologist.

The manuscript was reviewed by the Staff at Los Angeles Weather Service Forecast Office, and the preliminary draft was typed by Mrs. Frankie Latimer.

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TABLE 1. SYMBOLS USED ON CHARTS

BASIC SYMBOLS:

▲	A solid triangle indicates only one occurrence of the event on that day or night followed by a change in category as shown by the affixed arrows defined below.
● ○	A solid circle indicates more than one occurrence of the event on that day or night. Repetitions are shown by open circles. Arrows affixed to the symbols define changes.
X	Denotes only one occurrence of the event that day or night with no change in category.

CHART SYMBOLS	FOG* CHART	LOW STRATUS* CHART
X ● ○	Began and ended as fog.	Began and ended as low stratus.
	Lowered from low stratus and ended as fog.	Lowered from stratus* and ended as low stratus.
	Lowered to fog from low stratus and raised back up to low stratus.	Lowered from stratus and raised back up to stratus.
	Began as fog and lifted up to low stratus	Began as low stratus and lifted up to stratus.
	None	Stratus lowers to low stratus and then to fog
	None	Raised up from fog and then returns to fog
	None	Raised up from fog and ended as low stratus
	None	Raised up from fog and continues up to stratus
	None	Began as low stratus and lowers to fog.

*For definitions see page 2.

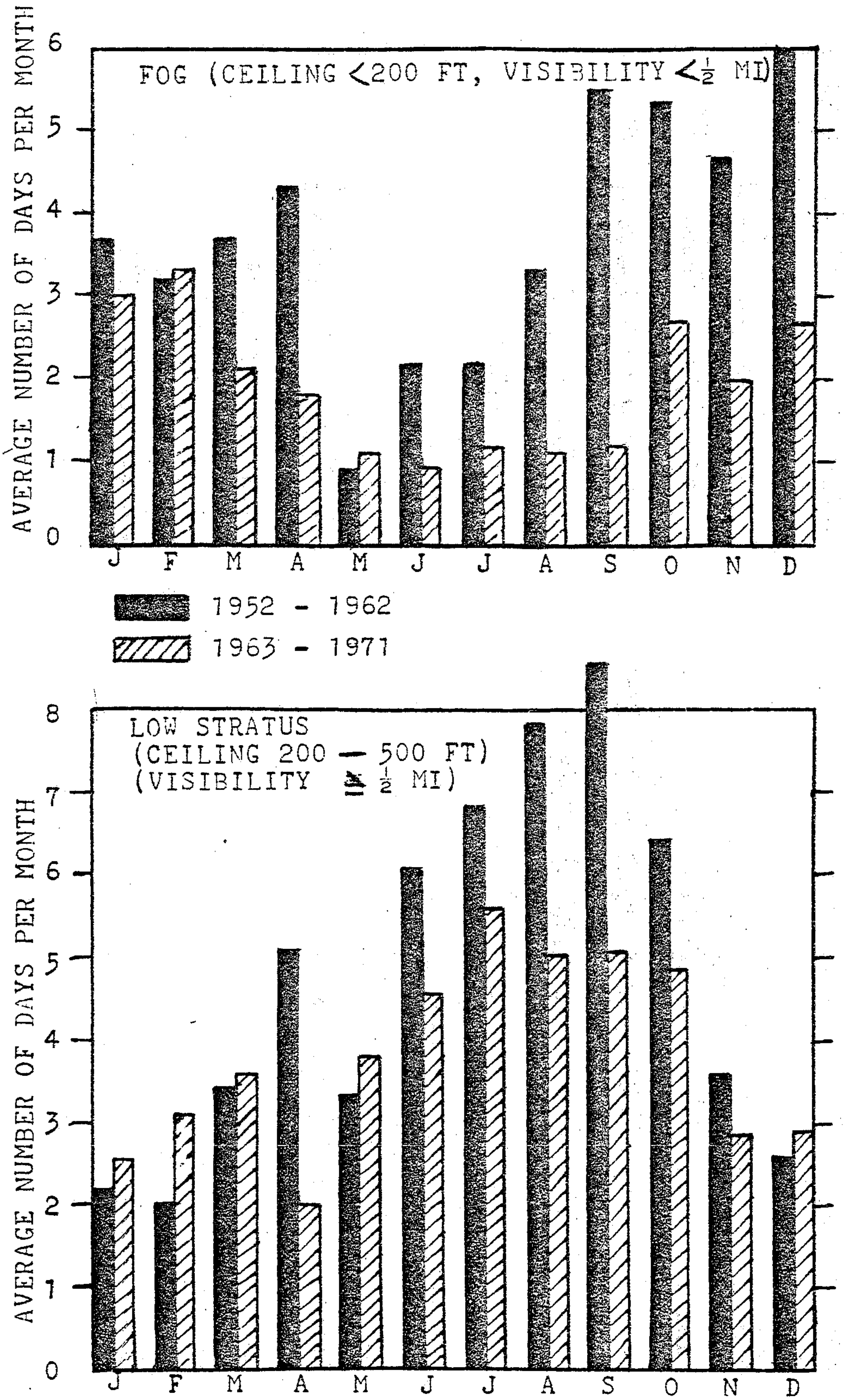


FIGURE 1. AVERAGE NUMBER DAYS PER MONTH OF FOG (TOP) AND LOW STRATUS (BOTTOM) FOR LOS ANGELES INTERNATIONAL AIRPORT, 1952 - 62 AND 1963 - 71.

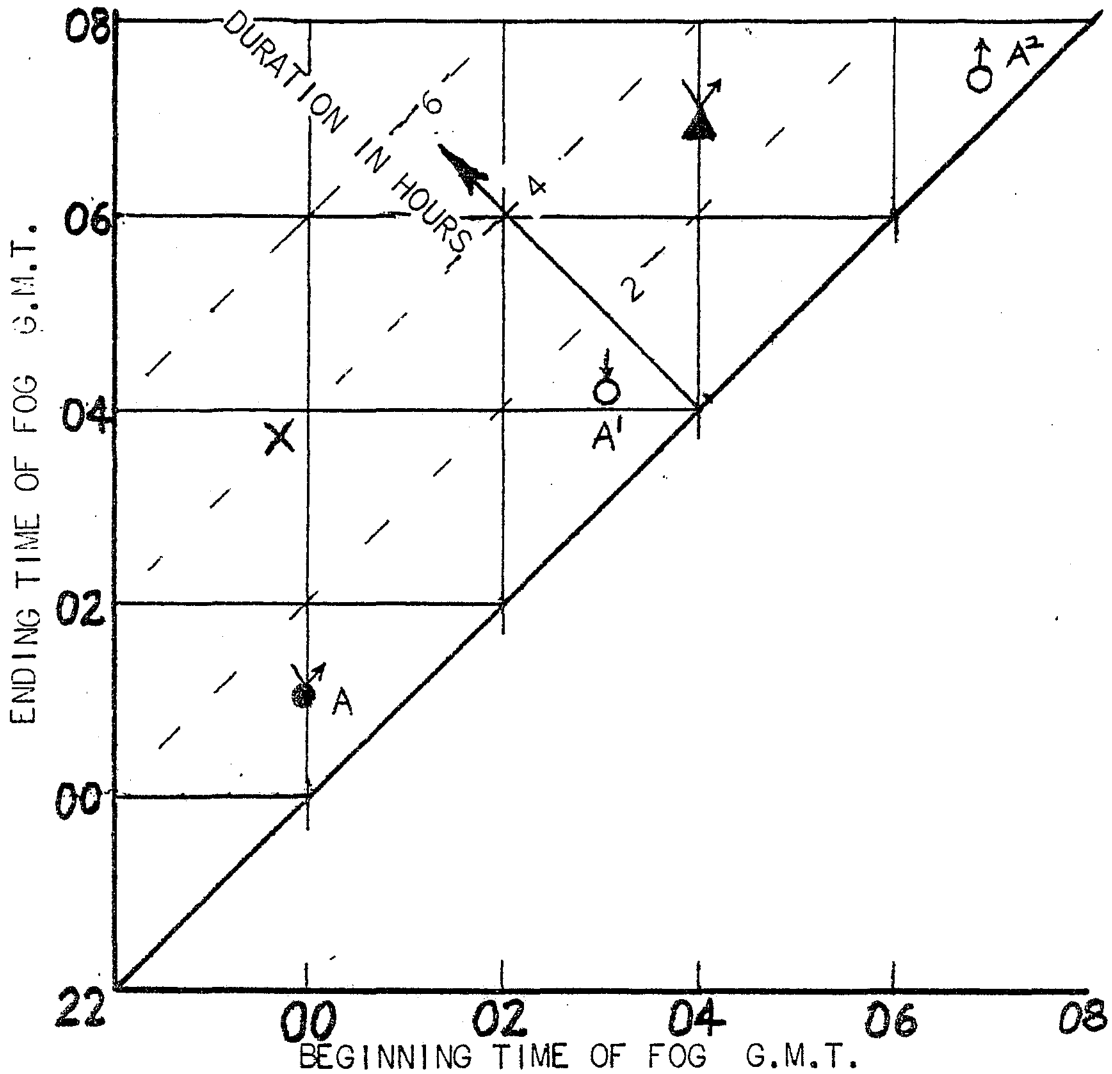


FIGURE 2. EXAMPLES OF DATA ENTRIES ON MONTHLY AND SEASONAL FOG AND STRATUS CHARTS (SEE TEXT FOR FURTHER EXPLANATION).

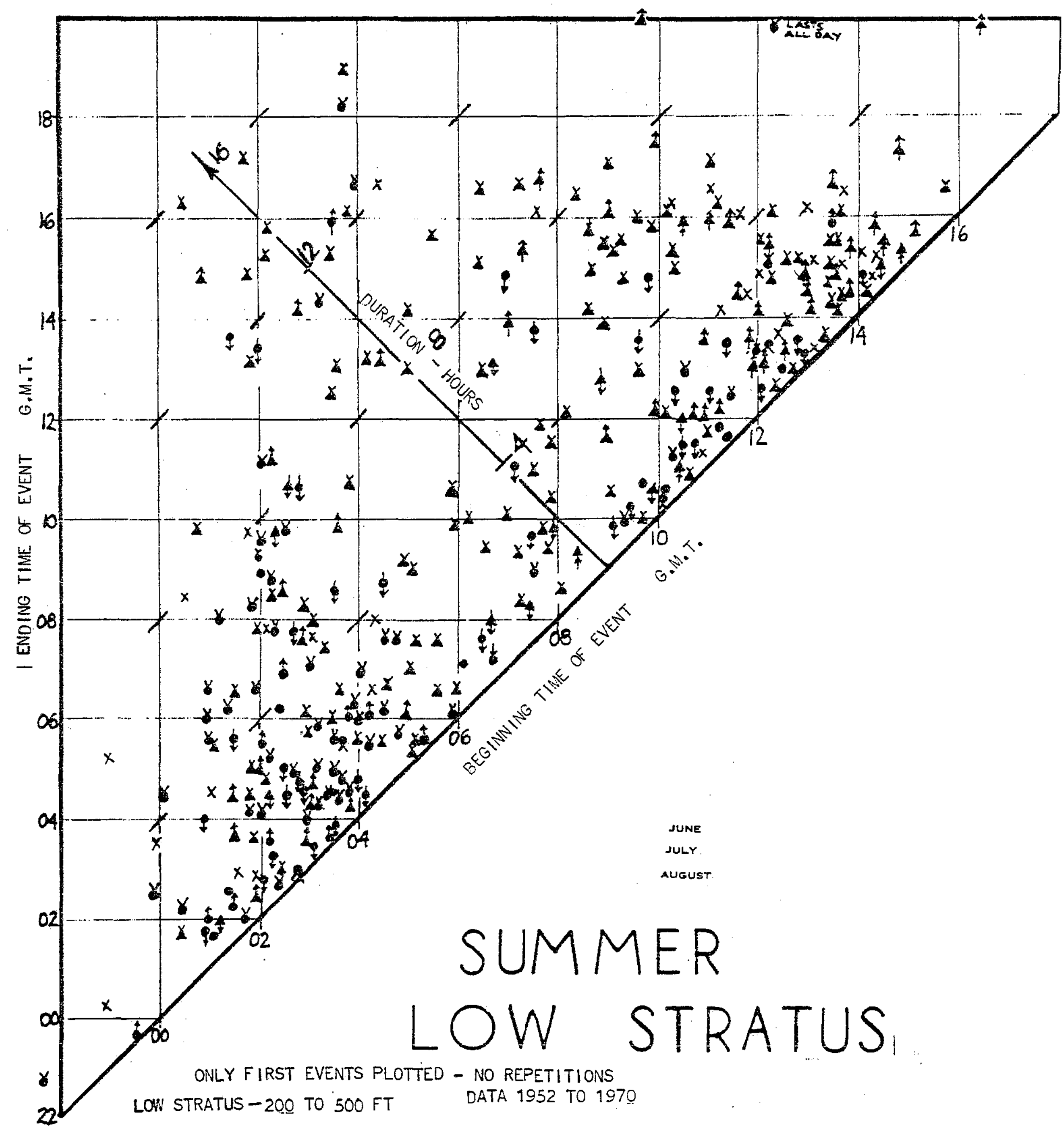

LASTS ALL DAY
ENDING TIME OF EVENT G.M.T.
18
16
14
12
10
08
06
04
02
00
22
DURATION - HOURS
16
12
8
4
BEGINNING TIME OF EVENT G.M.T.
00
02
04
06
08
10
12
14
16
JUNE
JULY
AUGUST
SUMMER
LOW STRATUS
ONLY FIRST EVENTS PLOTTED - NO REPETITIONS
LOW STRATUS - 200 TO 500 FT
DATA 1952 TO 1970

FIGURE 3

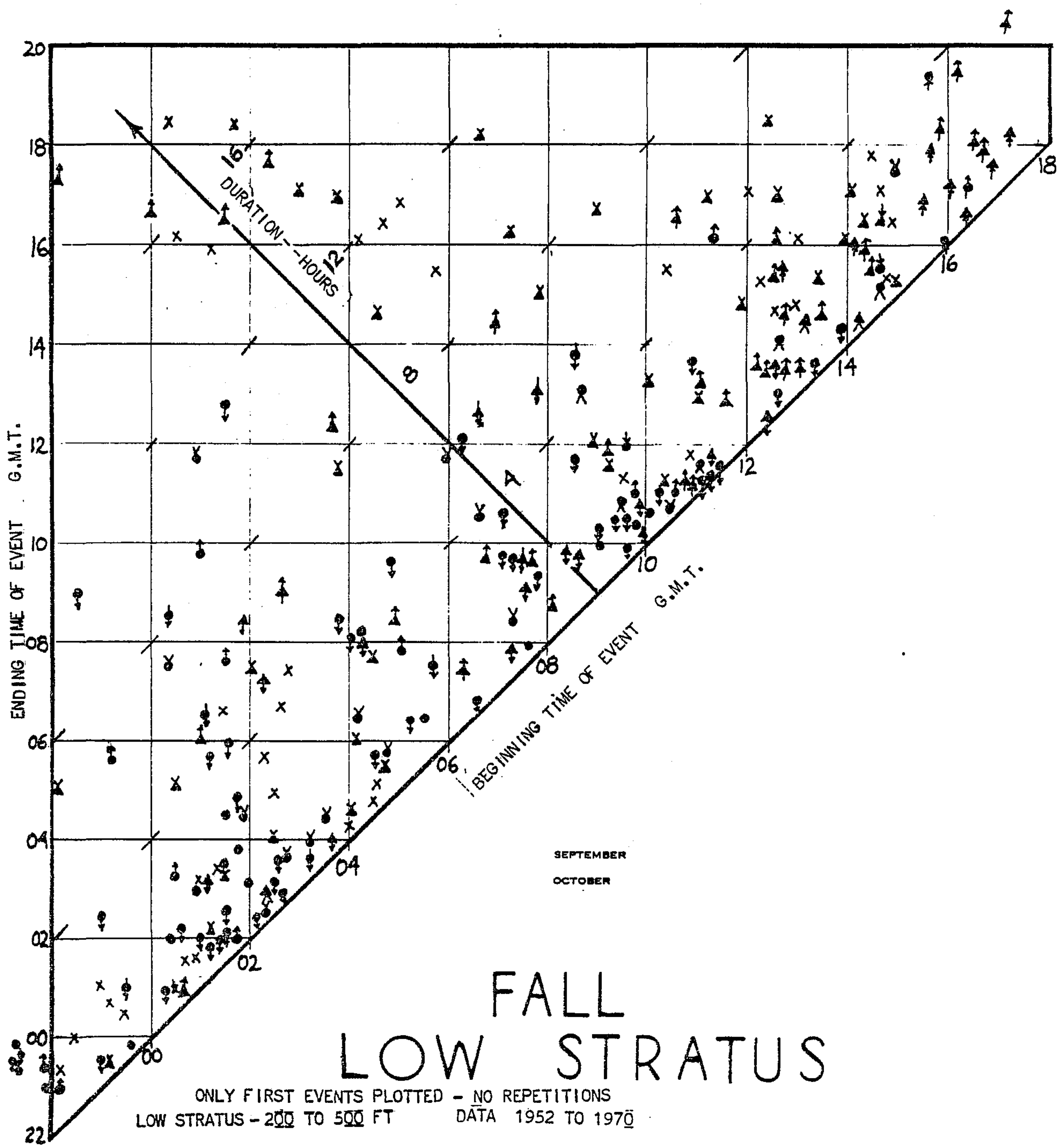
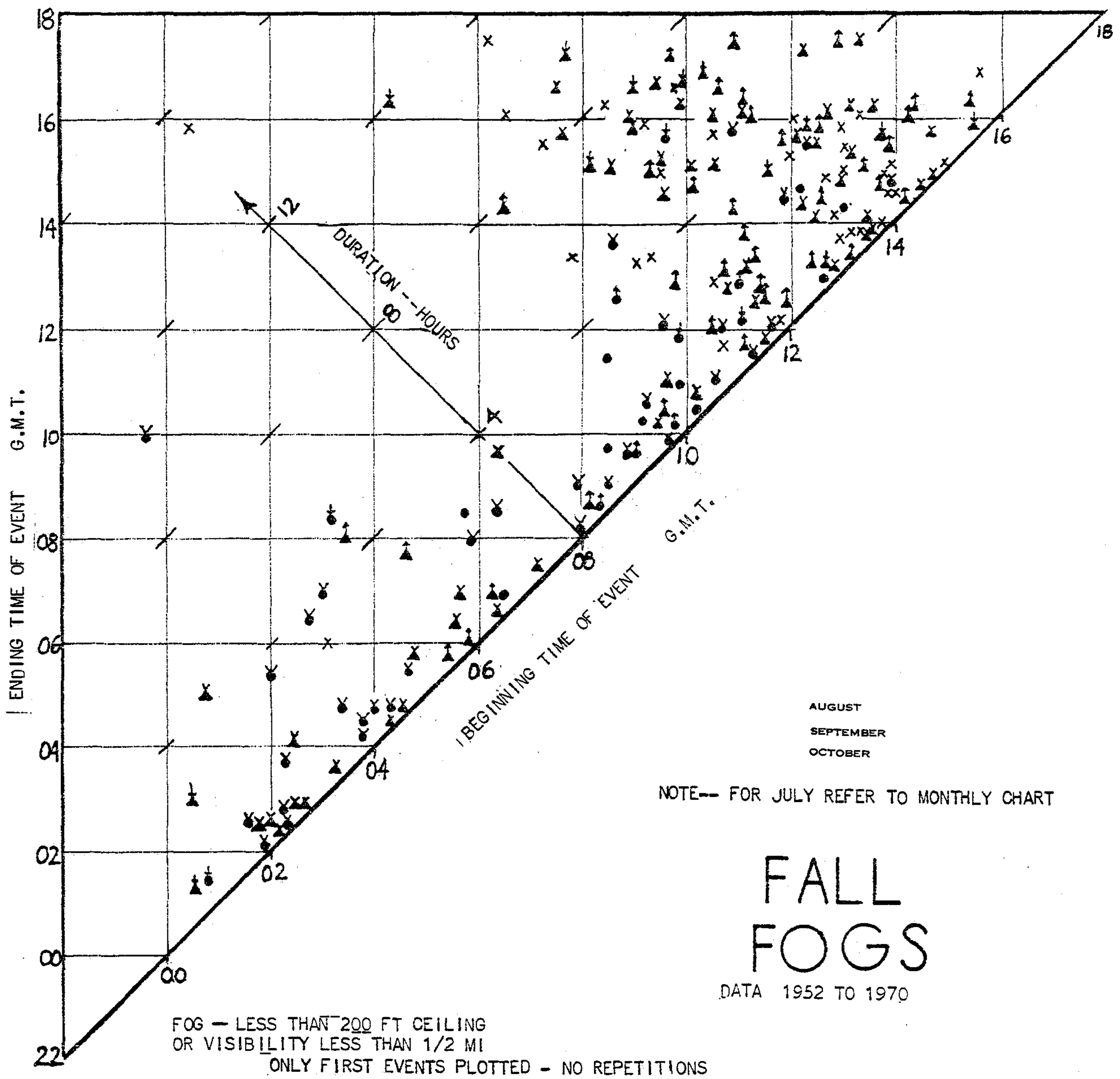
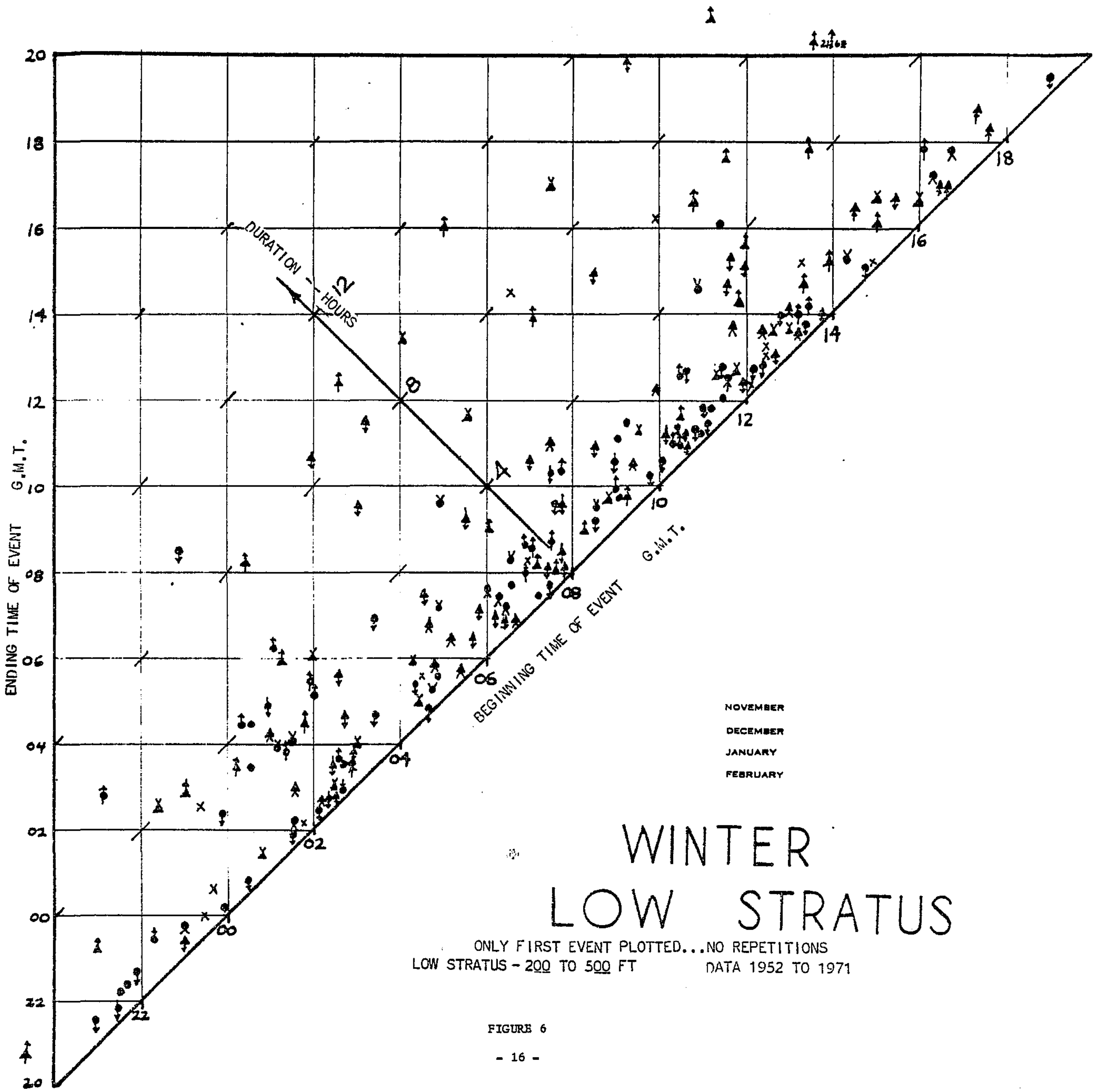

ENDING TIME OF EVENT G.M.T.
BEGINNING TIME OF EVENT G.M.T.
DURATION--HOURS
SEPTEMBER
OCTOBER
FALL
LOW STRATUS
ONLY FIRST EVENTS PLOTTED - NO REPETITIONS
LOW STRATUS - 200 TO 500 FT
DATA 1952 TO 1970

FIGURE 4



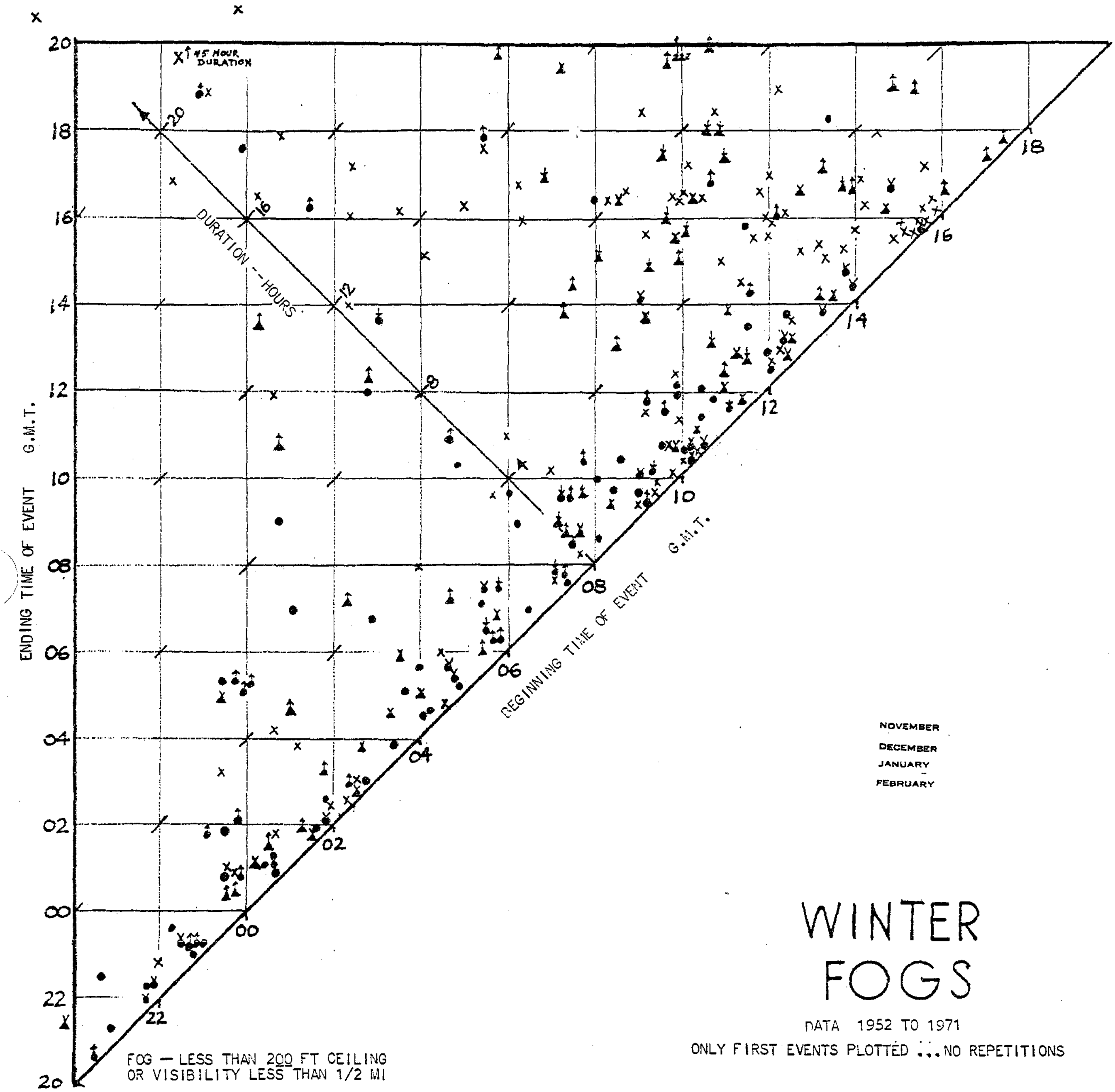
ENDING TIME OF EVENT G.M.T.
BEGINNING TIME OF EVENT G.M.T.
DURATION--HOURS
18
16
14
12
10
08
06
04
02
00
22
AUGUST
SEPTEMBER
OCTOBER
NOTE-- FOR JULY REFER TO MONTHLY CHART
FALL
FOGS
DATA 1952 TO 1970
FOG — LESS THAN 200 FT CEILING
OR VISIBILITY LESS THAN 1/2 MI
ONLY FIRST EVENTS PLOTTED - NO REPETITIONS

FIGURE 5



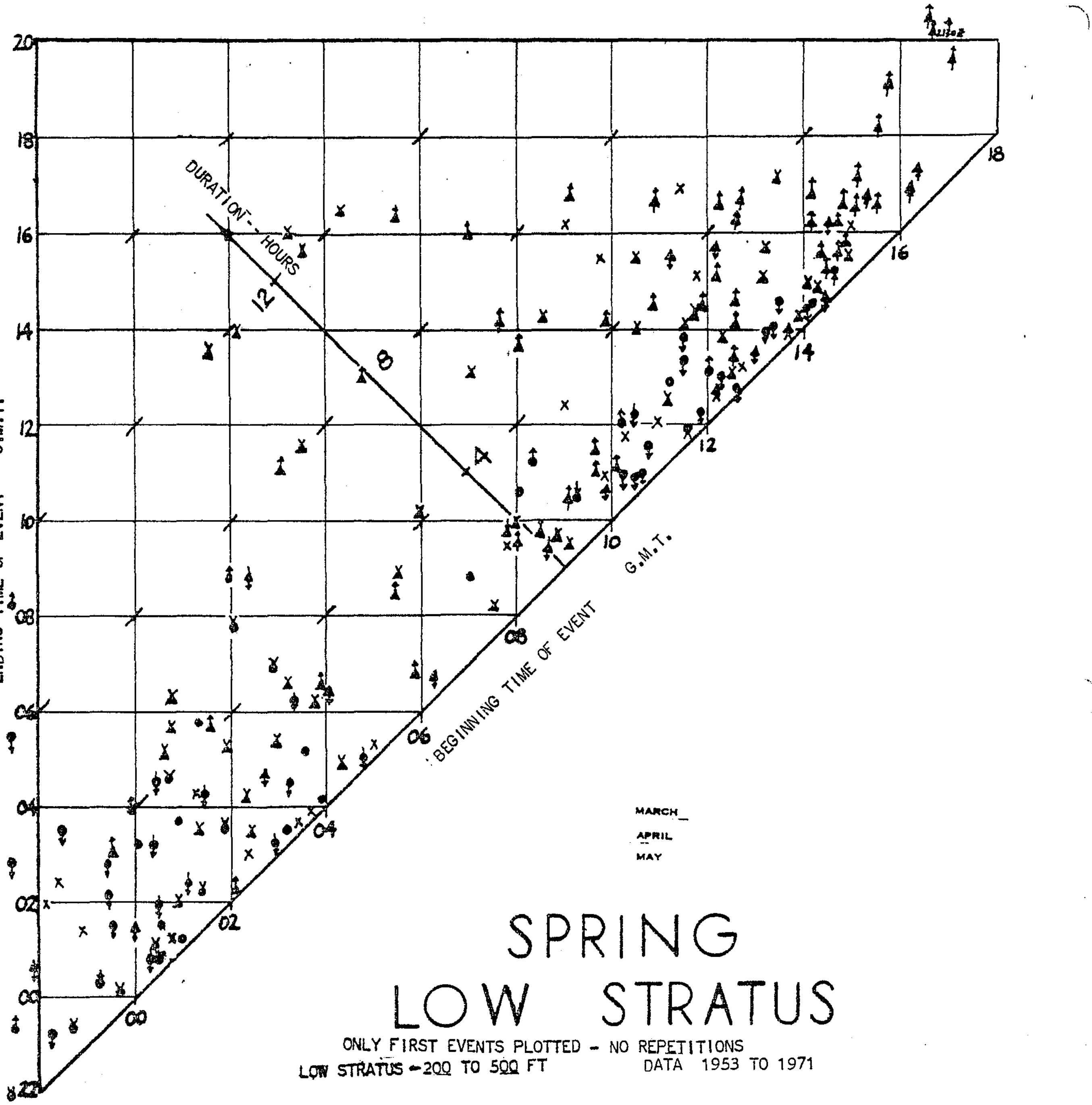
WINTER
LOW STRATUS
ONLY FIRST EVENT PLOTTED...NO REPETITIONS
LOW STRATUS - 200 TO 500 FT
DATA 1952 TO 1971
NOVEMBER
DECEMBER
JANUARY
FEBRUARY
ENDING TIME OF EVENT G.M.T.
BEGINNING TIME OF EVENT G.M.T.
DURATION - HOURS
12
8
4
20
18
16
14
12
10
08
06
04
02
00
22
20

FIGURE 6



WINTER FOGS
DATA 1952 TO 1971
ONLY FIRST EVENTS PLOTTED ... NO REPETITIONS
NOVEMBER
DECEMBER
JANUARY
FEBRUARY
FOG — LESS THAN 200 FT CEILING OR VISIBILITY LESS THAN 1/2 MI
ENDING TIME OF EVENT G.M.T.
BEGINNING TIME OF EVENT G.M.T.
DURATION -- HOURS
45 HOUR DURATION

FIGURE 7



ENDING TIME OF EVENT G.M.T.
BEGINNING TIME OF EVENT G.M.T.
DURATION - HOURS
12
8
4
MARCH
APRIL
MAY
SPRING
LOW STRATUS
ONLY FIRST EVENTS PLOTTED - NO REPETITIONS
LOW STRATUS - 200 TO 500 FT
DATA 1953 TO 1971

FIGURE 8

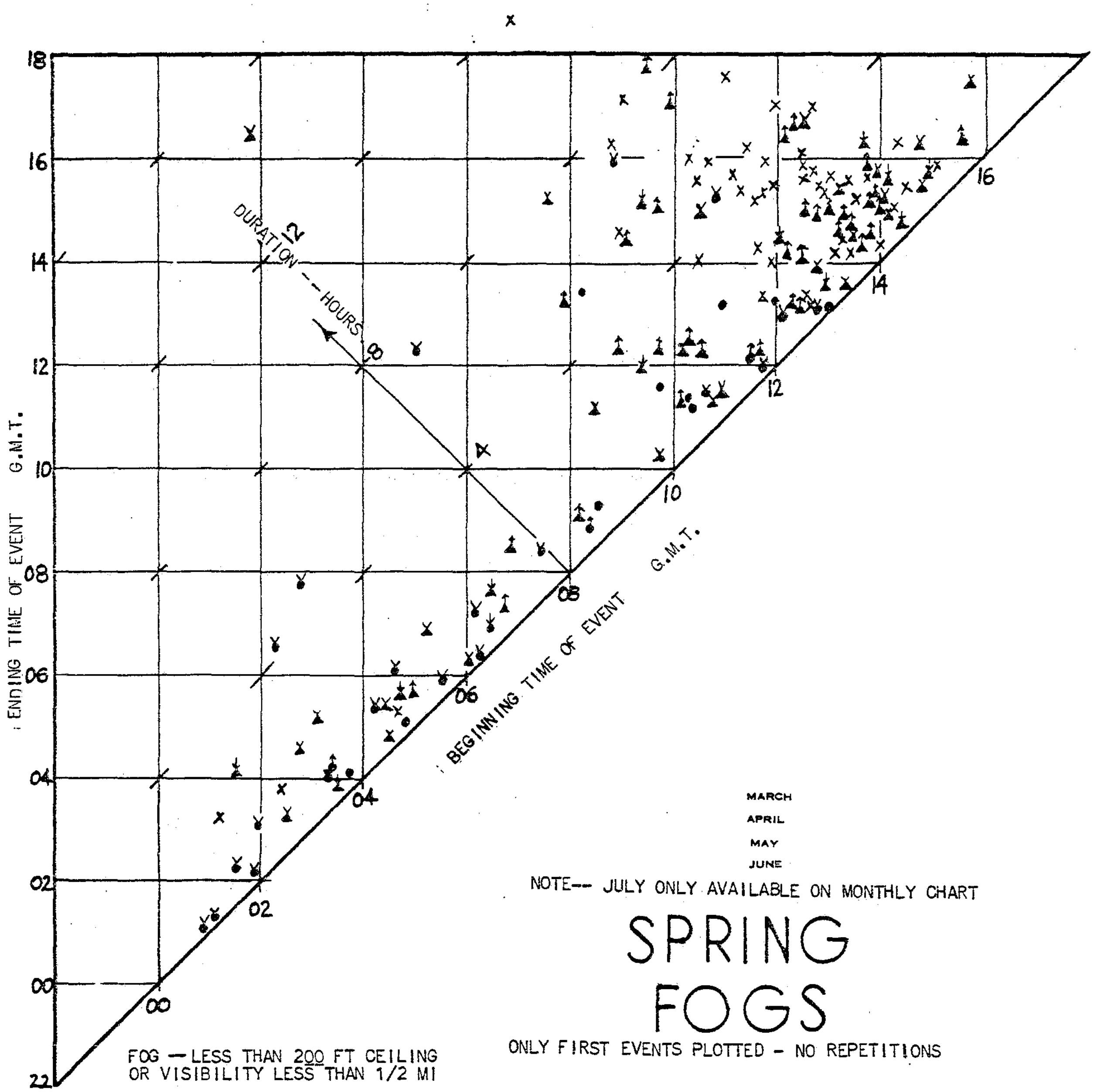

ENDING TIME OF EVENT G.M.T.
BEGINNING TIME OF EVENT G.M.T.
DURATION -- HOURS
MARCH
APRIL
MAY
JUNE
NOTE-- JULY ONLY AVAILABLE ON MONTHLY CHART
SPRING
FOGS
ONLY FIRST EVENTS PLOTTED - NO REPETITIONS
FOG — LESS THAN 200 FT CEILING
OR VISIBILITY LESS THAN 1/2 MI

FIGURE 9

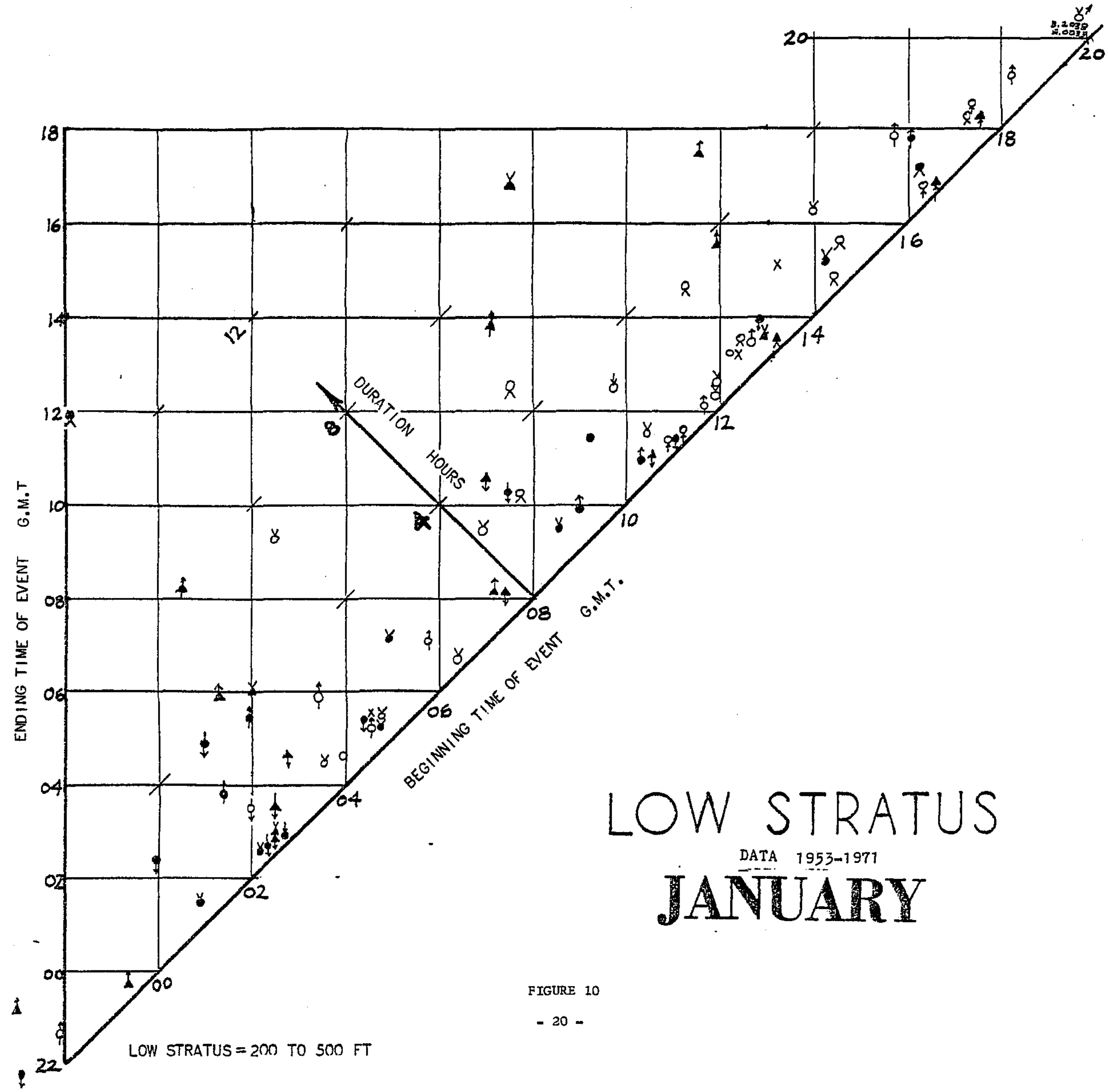
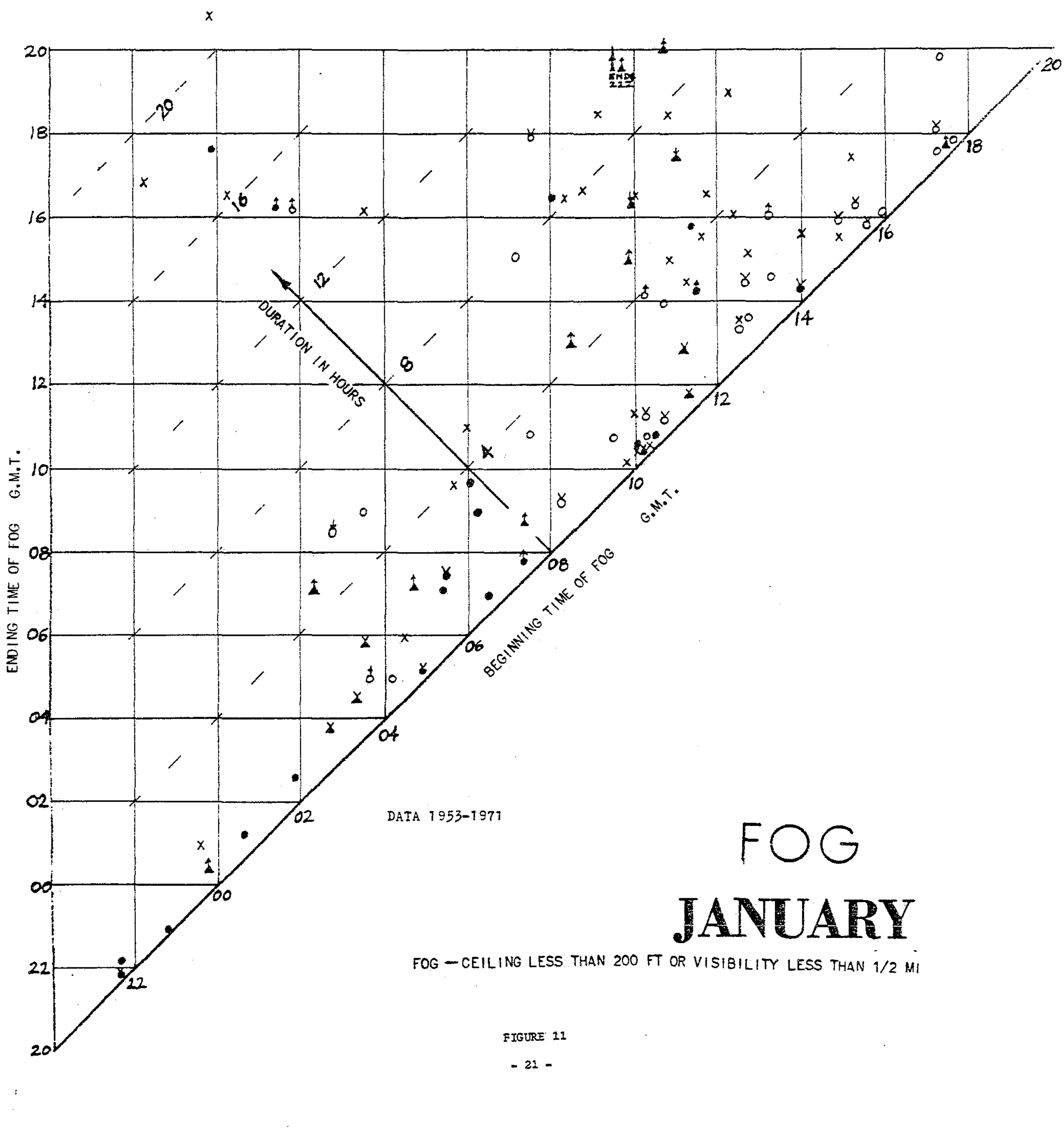

ENDING TIME OF EVENT G.M.T
BEGINNING TIME OF EVENT G.M.T.
DURATION HOURS
LOW STRATUS
DATA 1953-1971
JANUARY
LOW STRATUS = 200 TO 500 FT

FIGURE 10

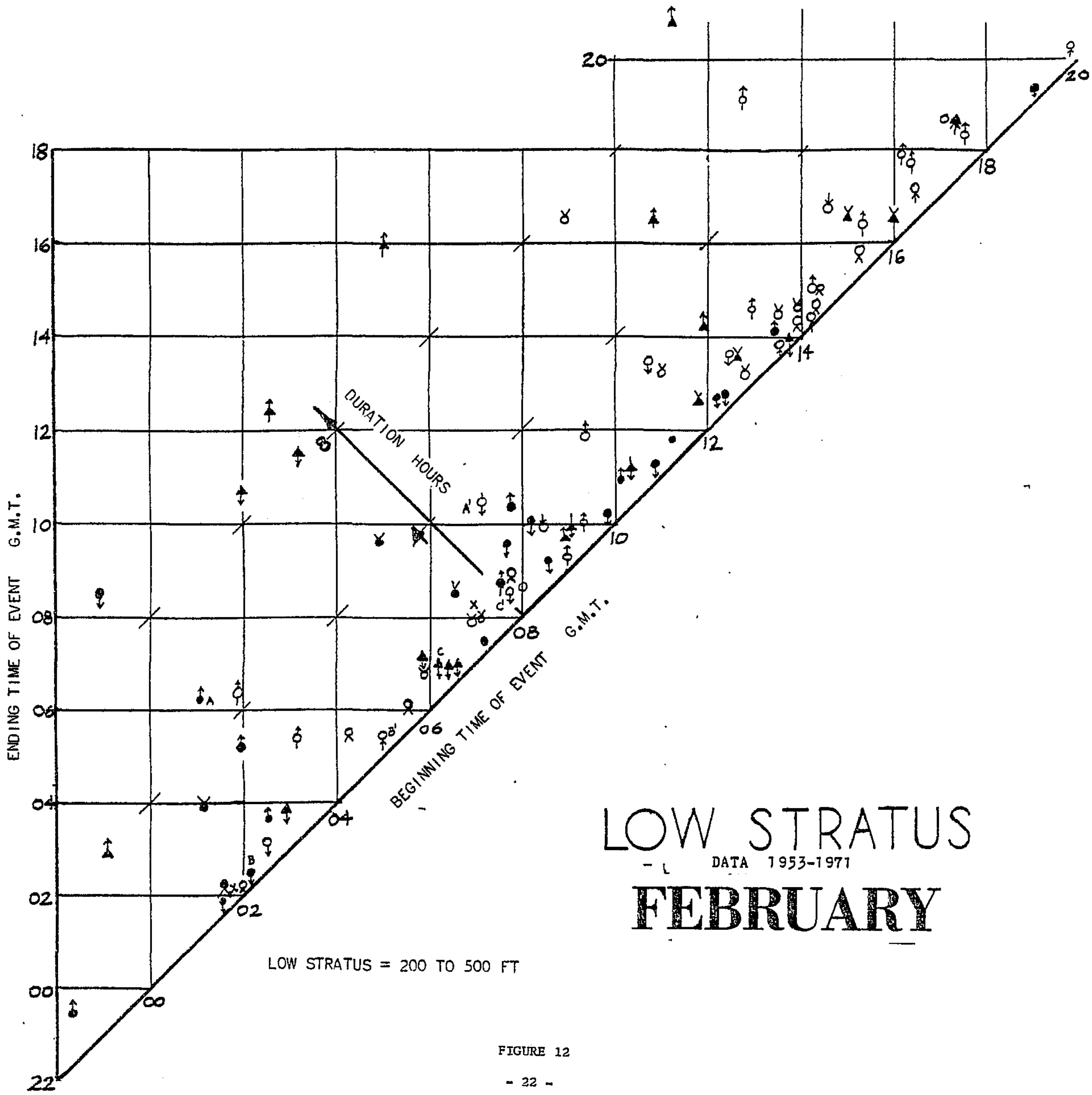


FOG

JANUARY

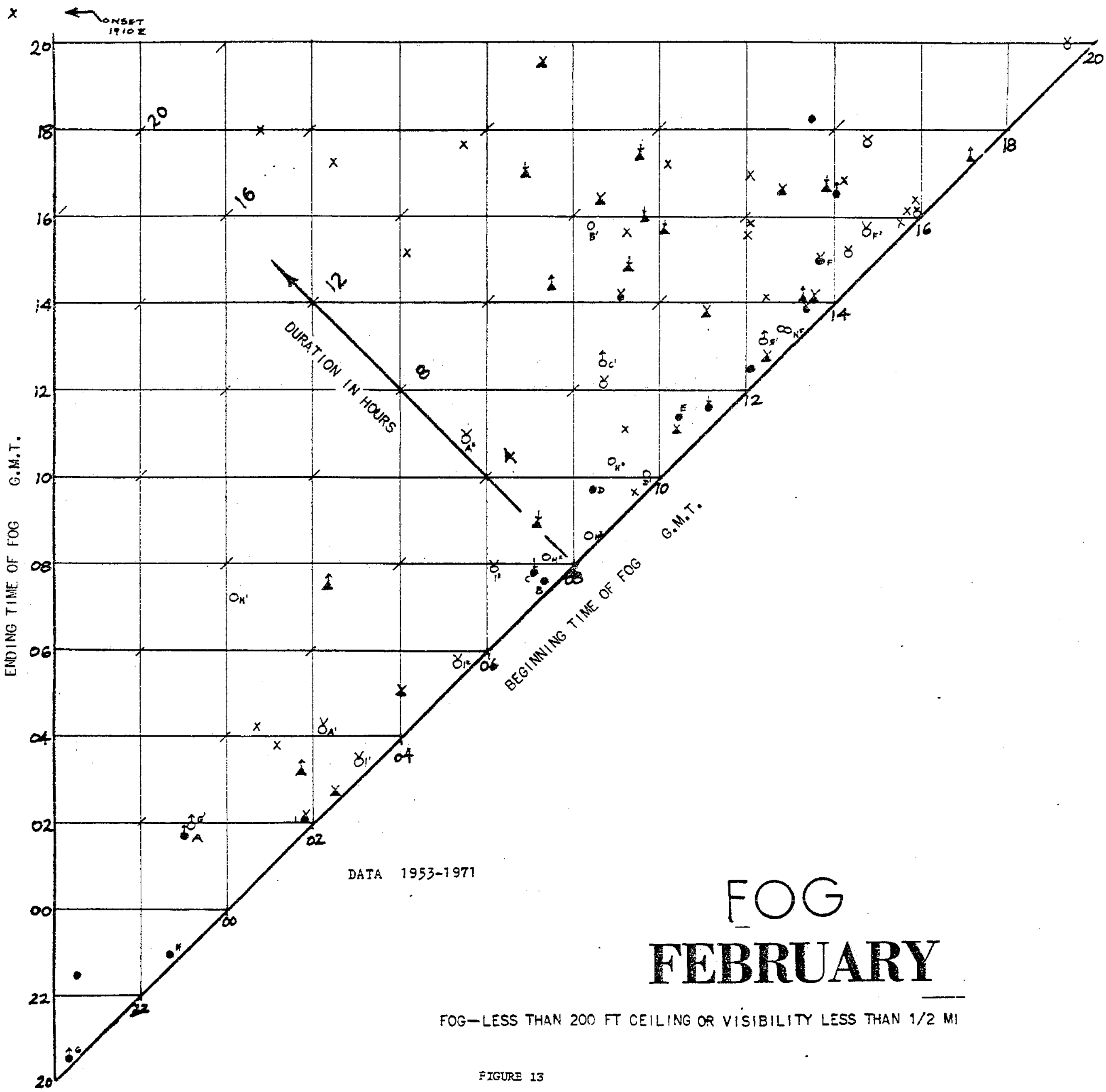
FOG — CEILING LESS THAN 200 FT OR VISIBILITY LESS THAN 1/2 MI

FIGURE 11



LOW STRATUS
DATA 1953-1971
FEBRUARY
LOW STRATUS = 200 TO 500 FT
DURATION HOURS
ENDING TIME OF EVENT G.M.T.
BEGINNING TIME OF EVENT G.M.T.

FIGURE 12



FOG
FEBRUARY

FOG—LESS THAN 200 FT CEILING OR VISIBILITY LESS THAN 1/2 MI

FIGURE 13

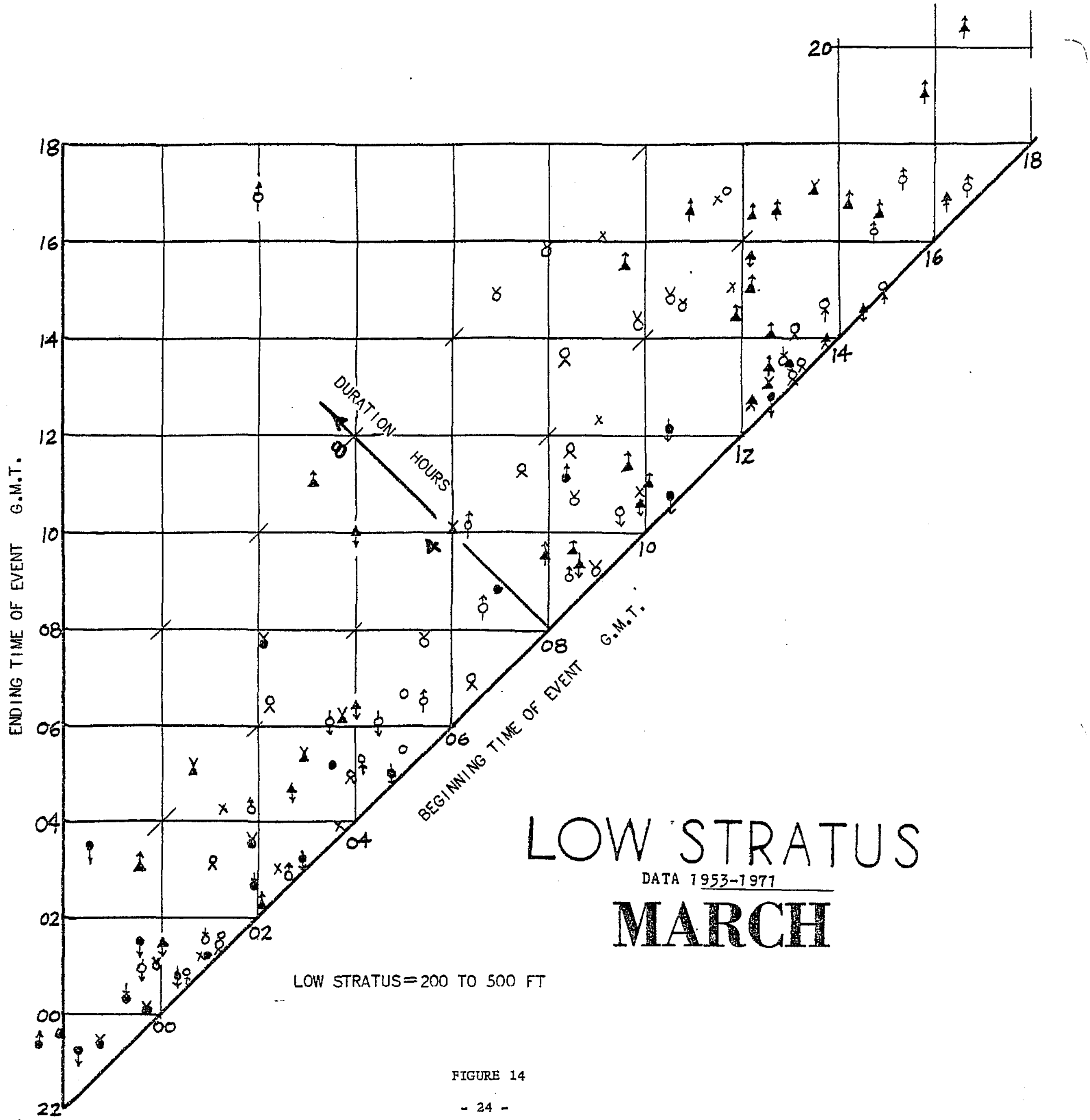

LOW STRATUS
DATA 1953-1971
MARCH
LOW STRATUS = 200 TO 500 FT
ENDING TIME OF EVENT G.M.T.
BEGINNING TIME OF EVENT G.M.T.
DURATION HOURS
18
16
14
12
10
08
06
04
02
00
22
20

FIGURE 14

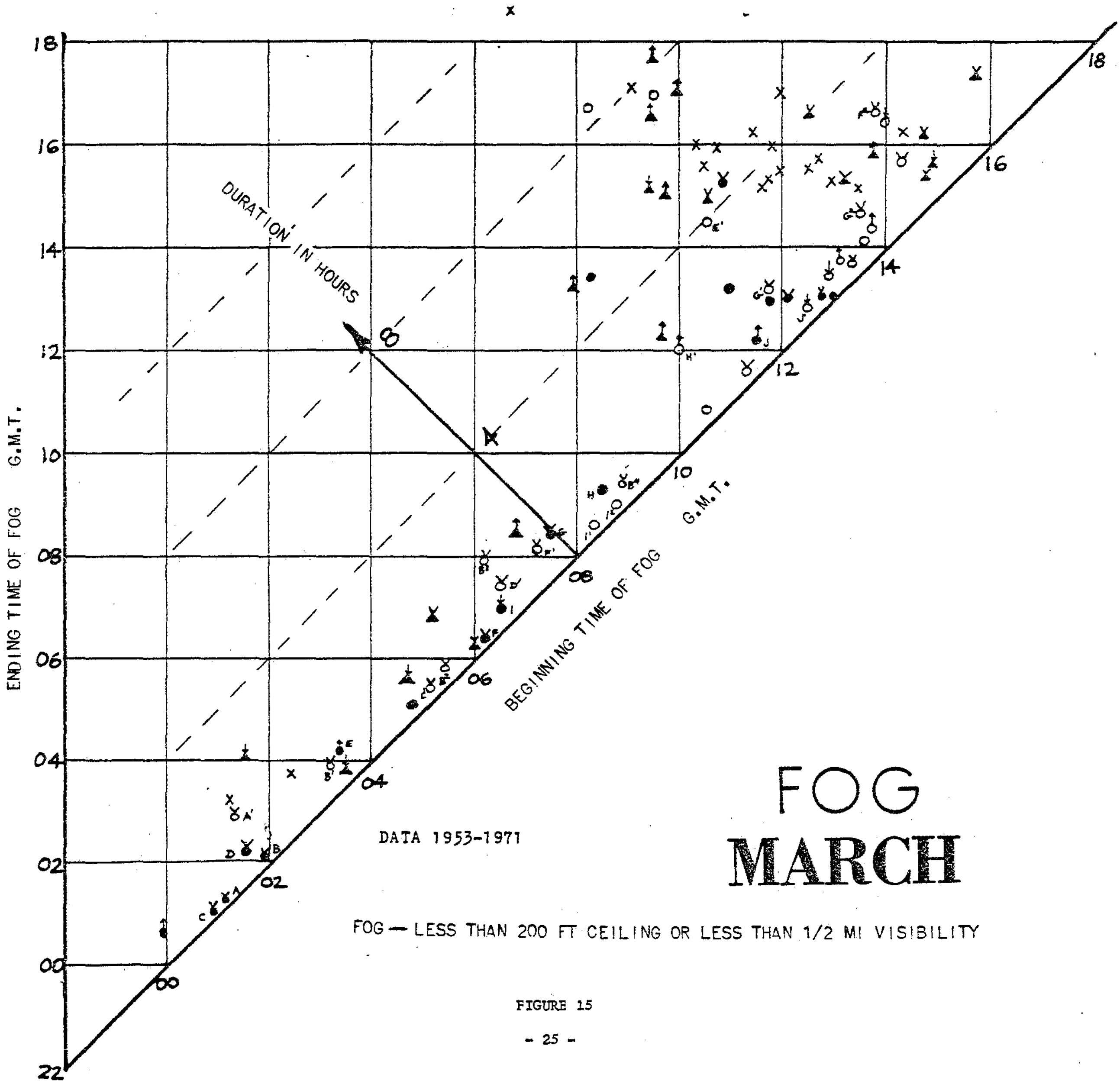
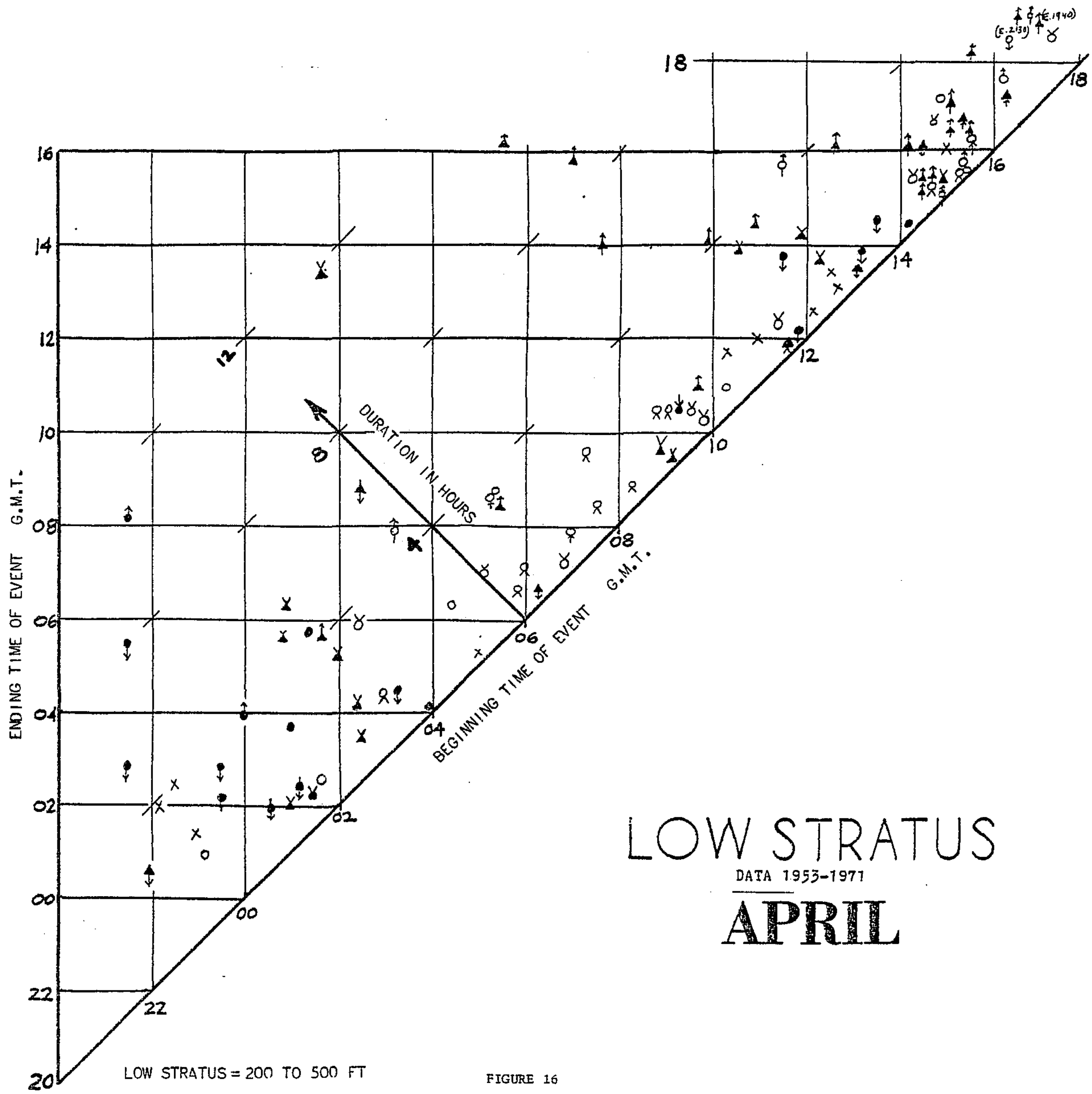

ENDING TIME OF FOG G.M.T.
BEGINNING TIME OF FOG G.M.T.
DURATION IN HOURS
DATA 1953-1971
FOG
MARCH
FOG — LESS THAN 200 FT CEILING OR LESS THAN 1/2 MI VISIBILITY

FIGURE 15



LOW STRATUS

DATA 1953-1971

APRIL

FIGURE 16

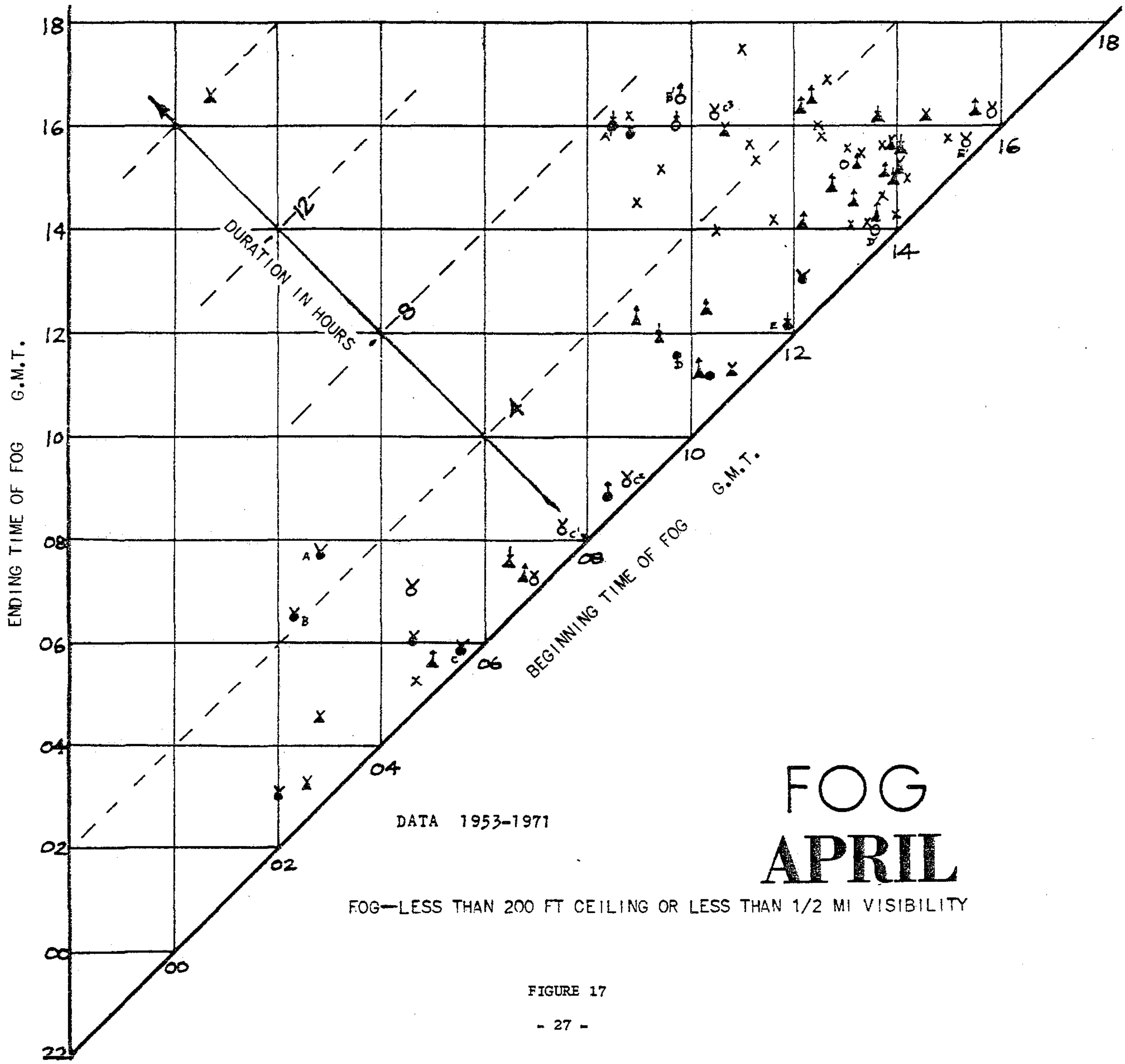

18
16
14
12
10
08
06
04
02
00
22
ENDING TIME OF FOG G.M.T.
DURATION IN HOURS
12
8
BEGINNING TIME OF FOG G.M.T.
DATA 1953-1971
FOG
APRIL
FOG—LESS THAN 200 FT CEILING OR LESS THAN 1/2 MI VISIBILITY

FIGURE 17

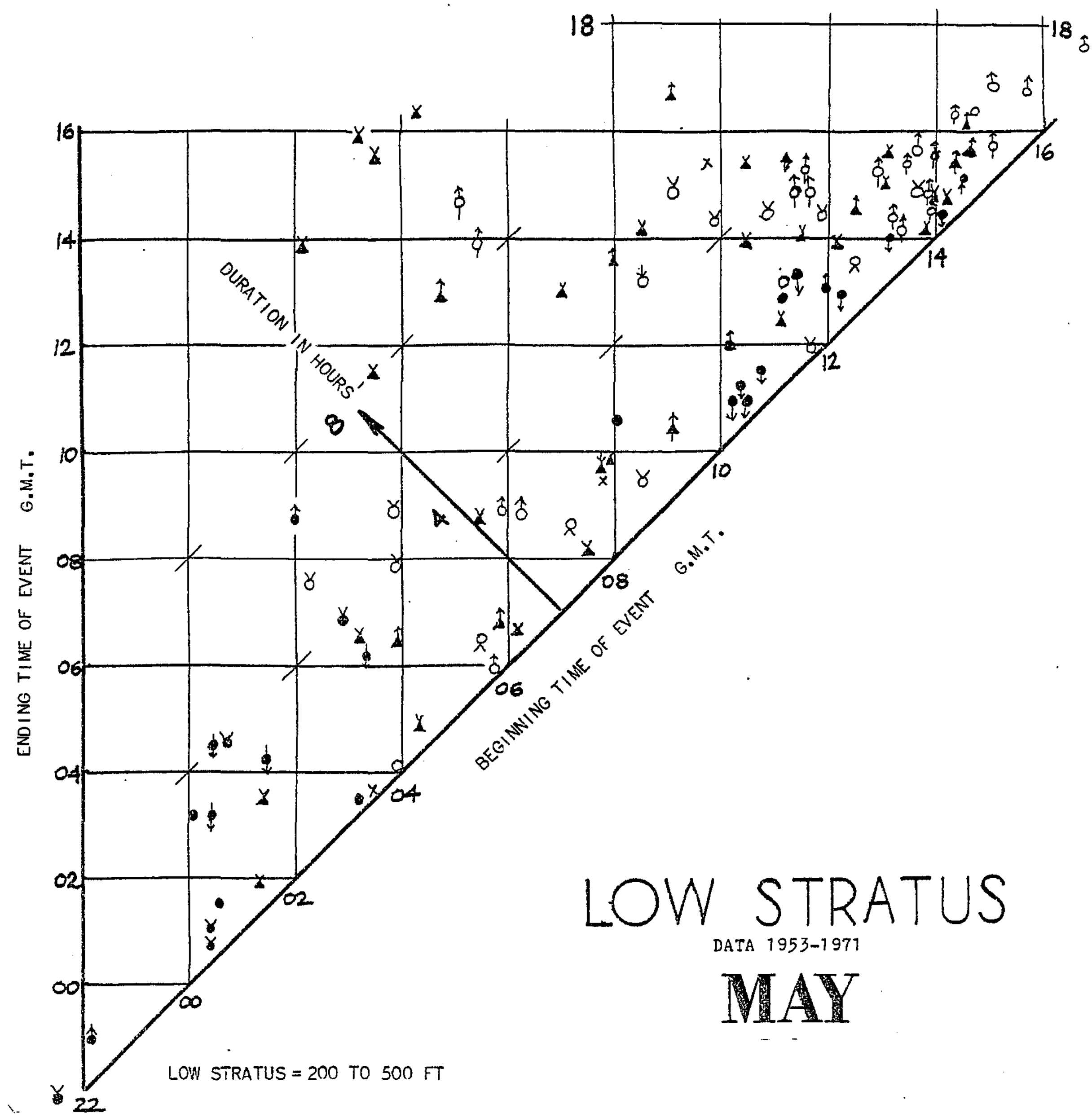
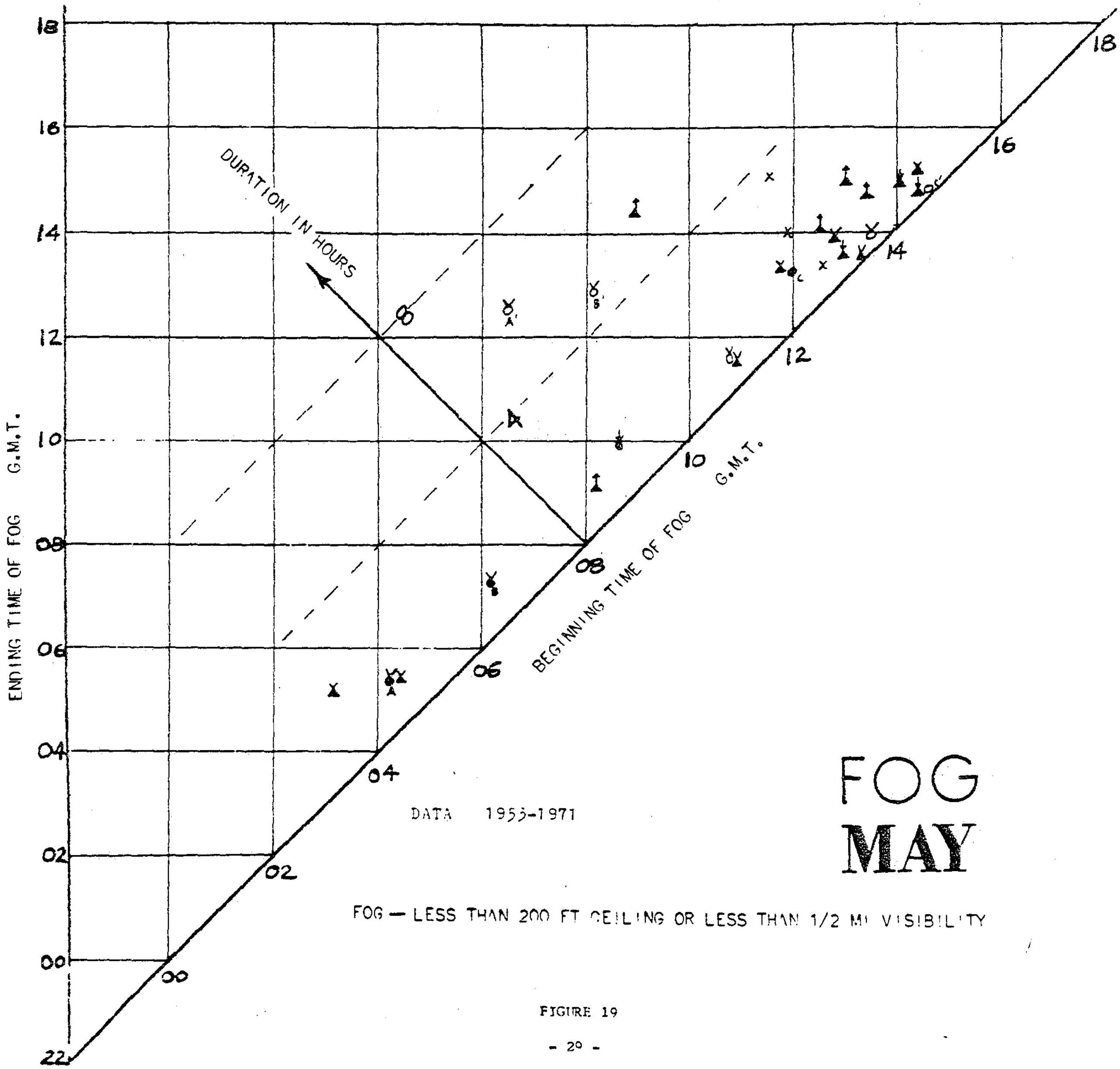

18
18
16
14
12
10
08
06
04
02
00
22
00
02
04
06
08
10
12
14
16
DURATION IN HOURS
8
ENDING TIME OF EVENT G.M.T.
BEGINNING TIME OF EVENT G.M.T.
LOW STRATUS = 200 TO 500 FT
LOW STRATUS
DATA 1953-1971
MAY

FIGURE 18

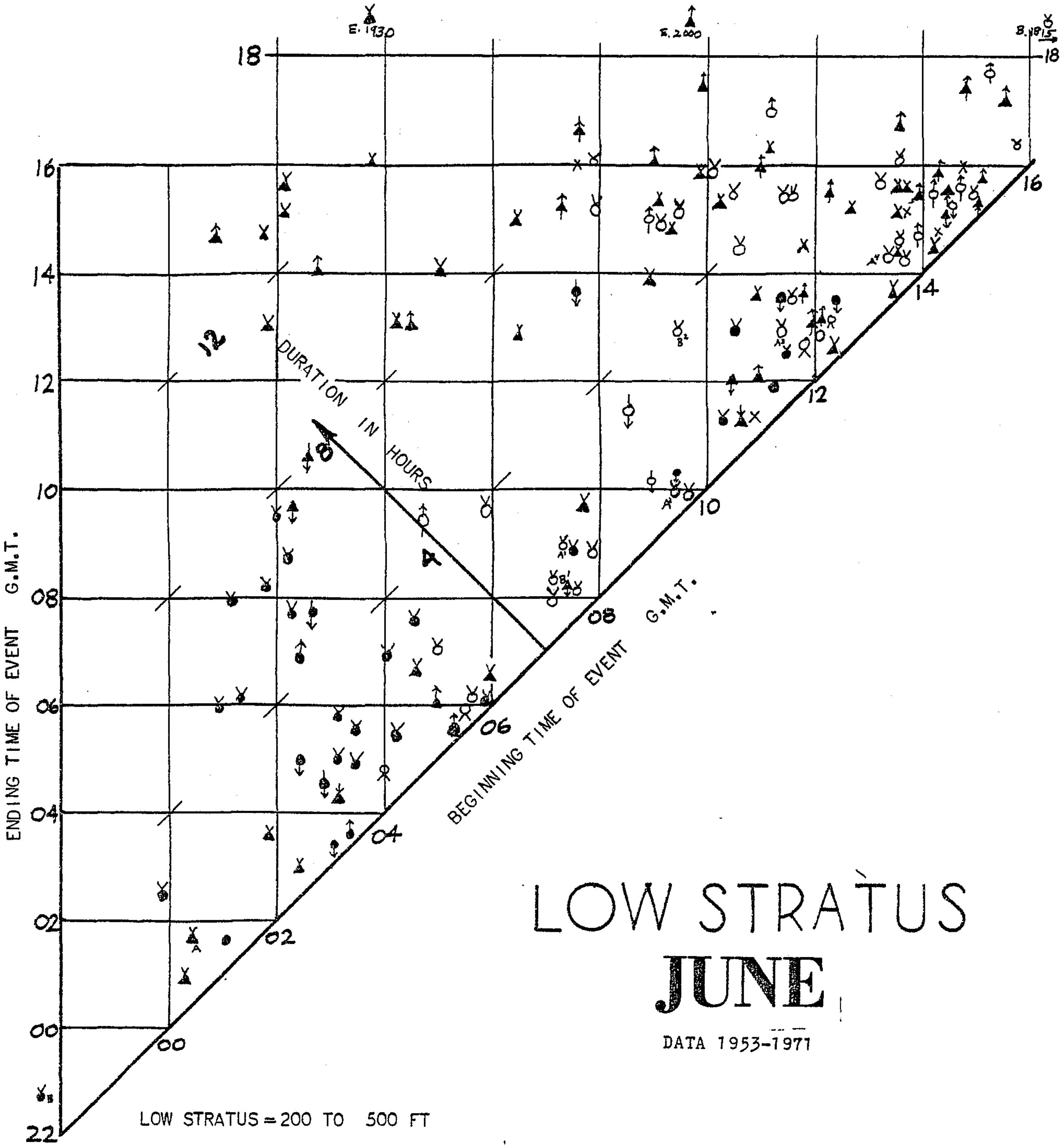


DATA 1955-1971

FOG
MAY

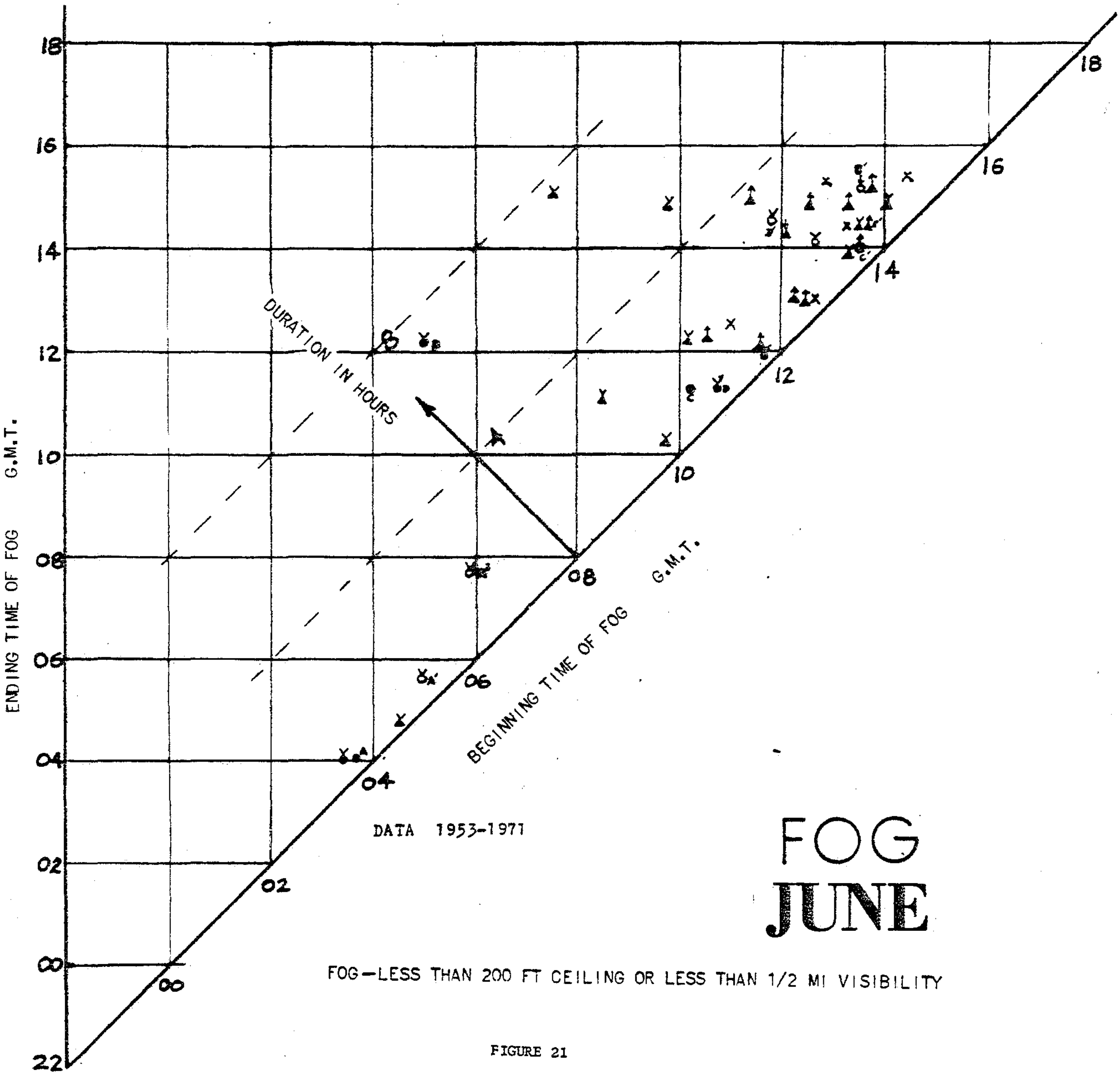
FOG — LESS THAN 200 FT CEILING OR LESS THAN 1/2 MI VISIBILITY

FIGURE 19



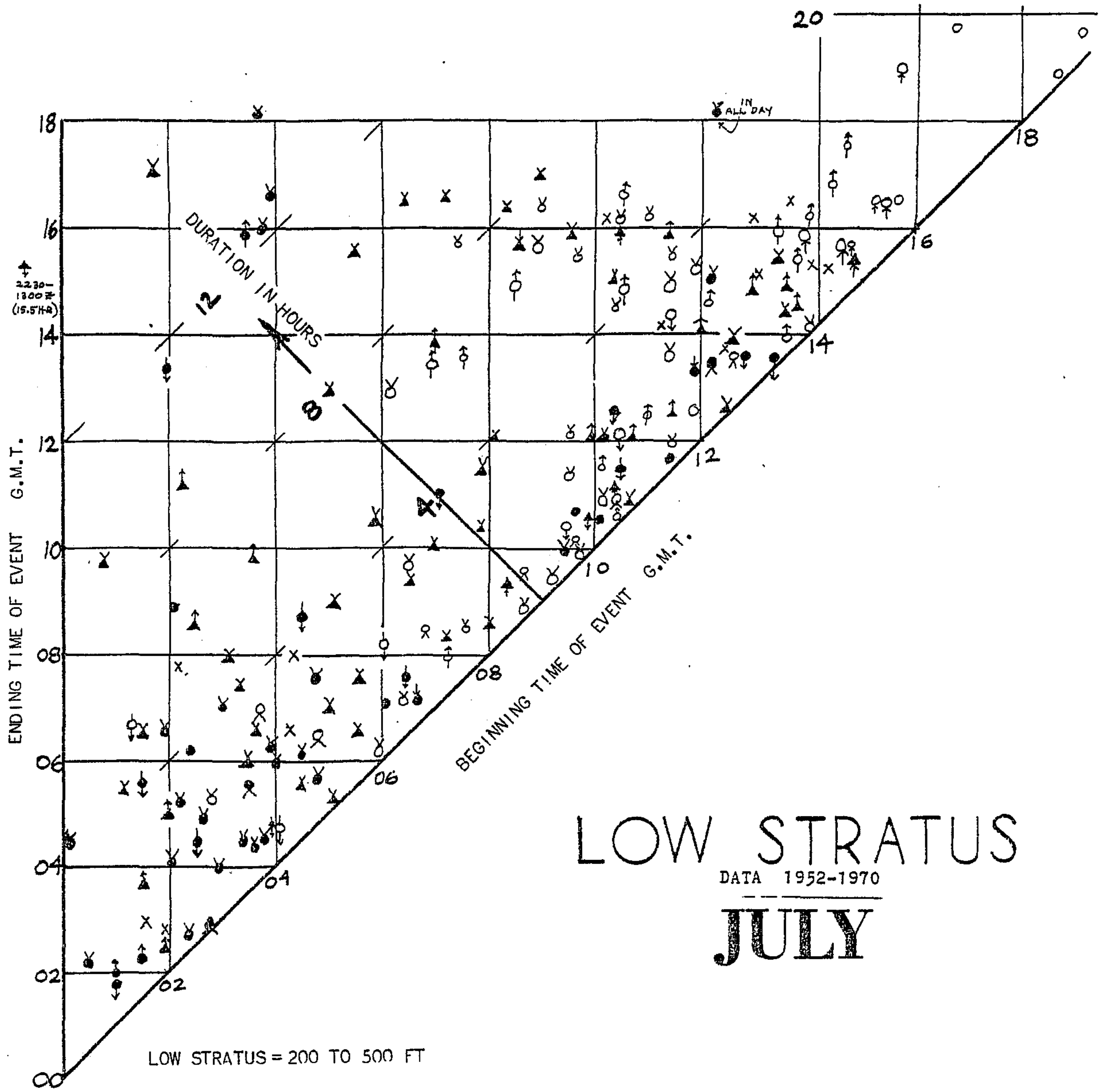
LOW STRATUS
JUNE
DATA 1953-1971
LOW STRATUS = 200 TO 500 FT
ENDING TIME OF EVENT G.M.T.
BEGINNING TIME OF EVENT G.M.T.
DURATION IN HOURS

FIGURE 20



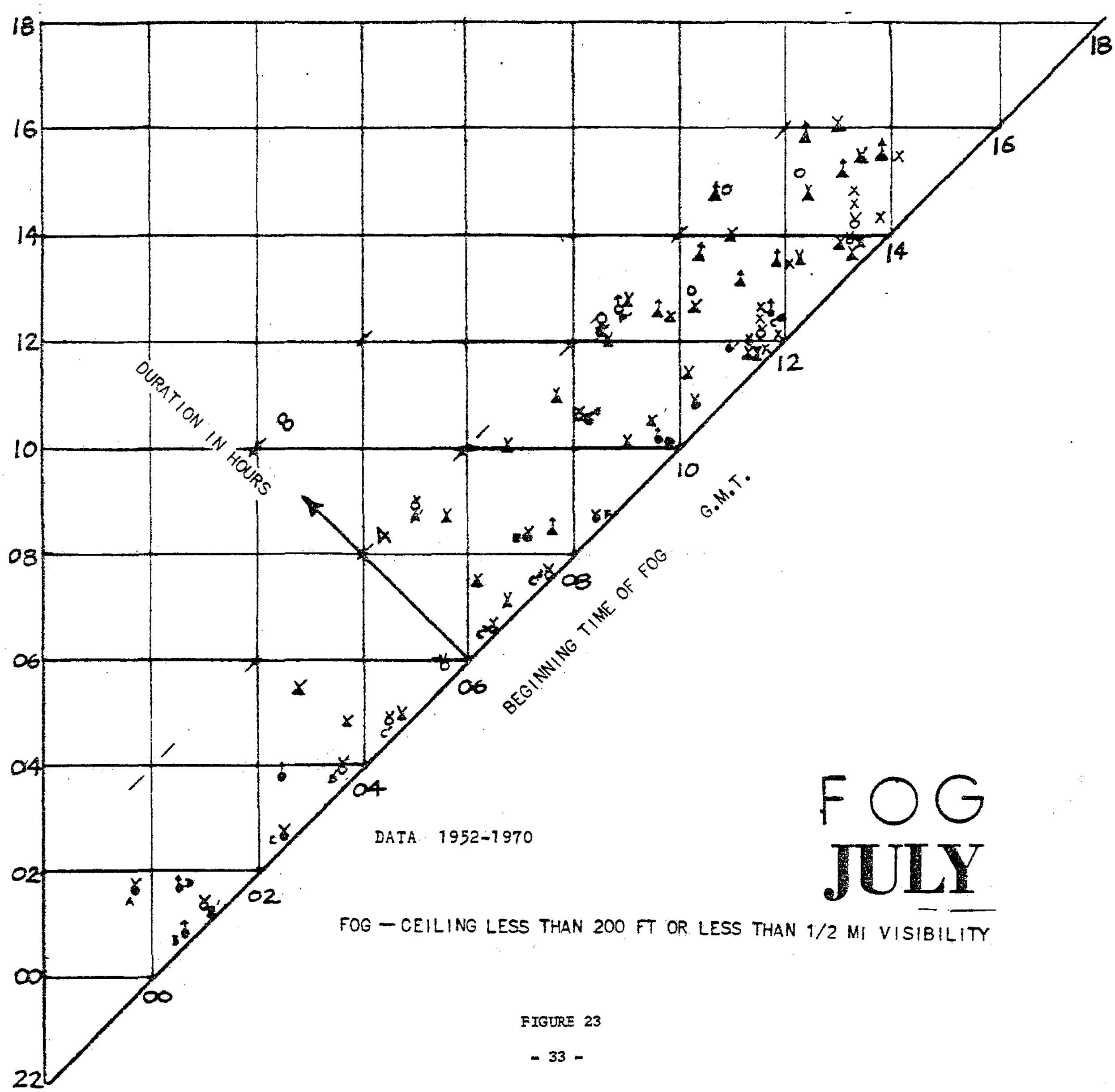
FOG—LESS THAN 200 FT CEILING OR LESS THAN 1/2 MI VISIBILITY

FIGURE 21



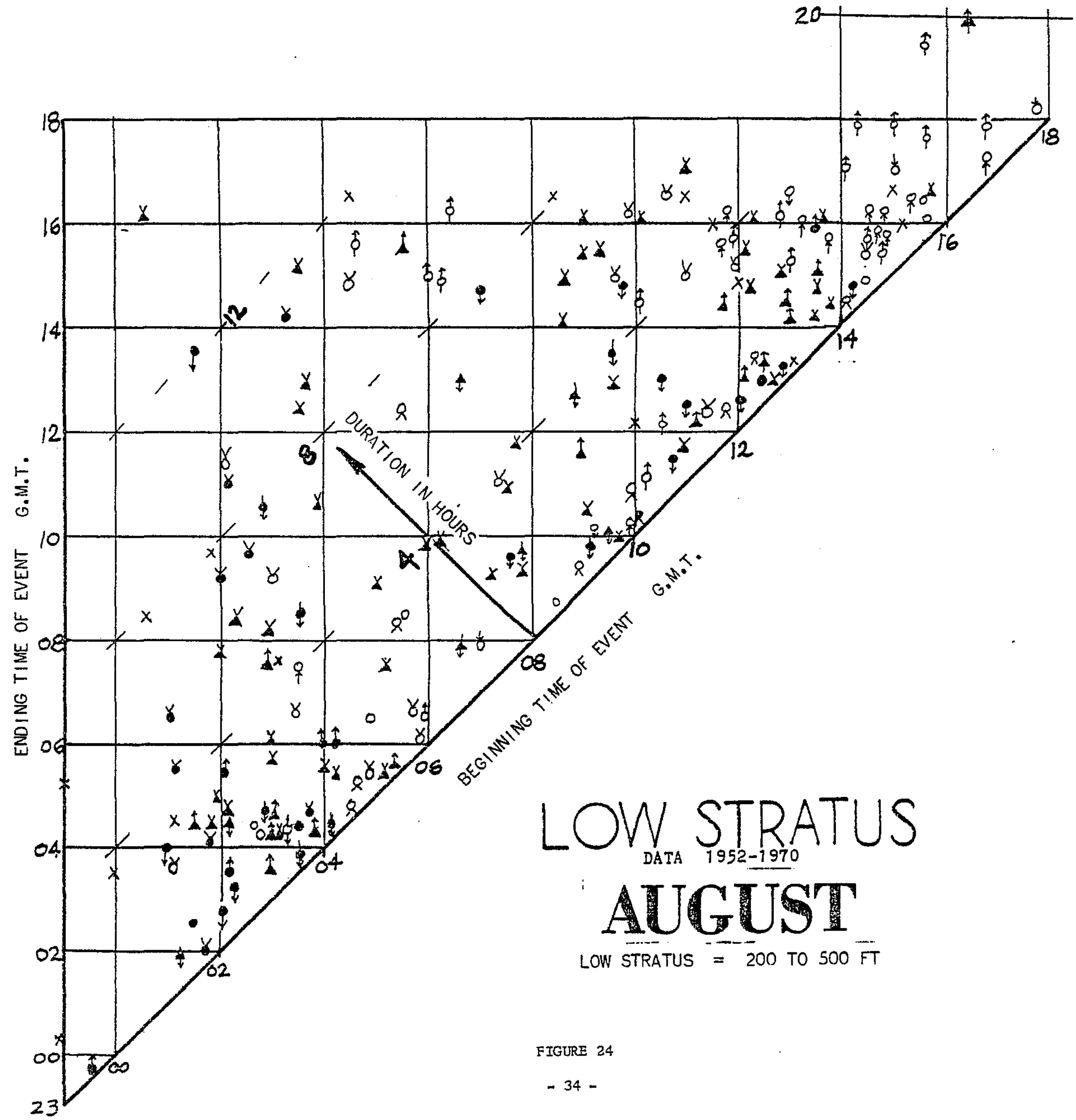
ENDING TIME OF EVENT G.M.T.
BEGINNING TIME OF EVENT G.M.T.
DURATION IN HOURS
12
8
00
02
04
06
08
10
12
14
16
18
20
ALL DAY
LOW STRATUS
DATA 1952-1970
JULY
LOW STRATUS = 200 TO 500 FT

FIGURE 22



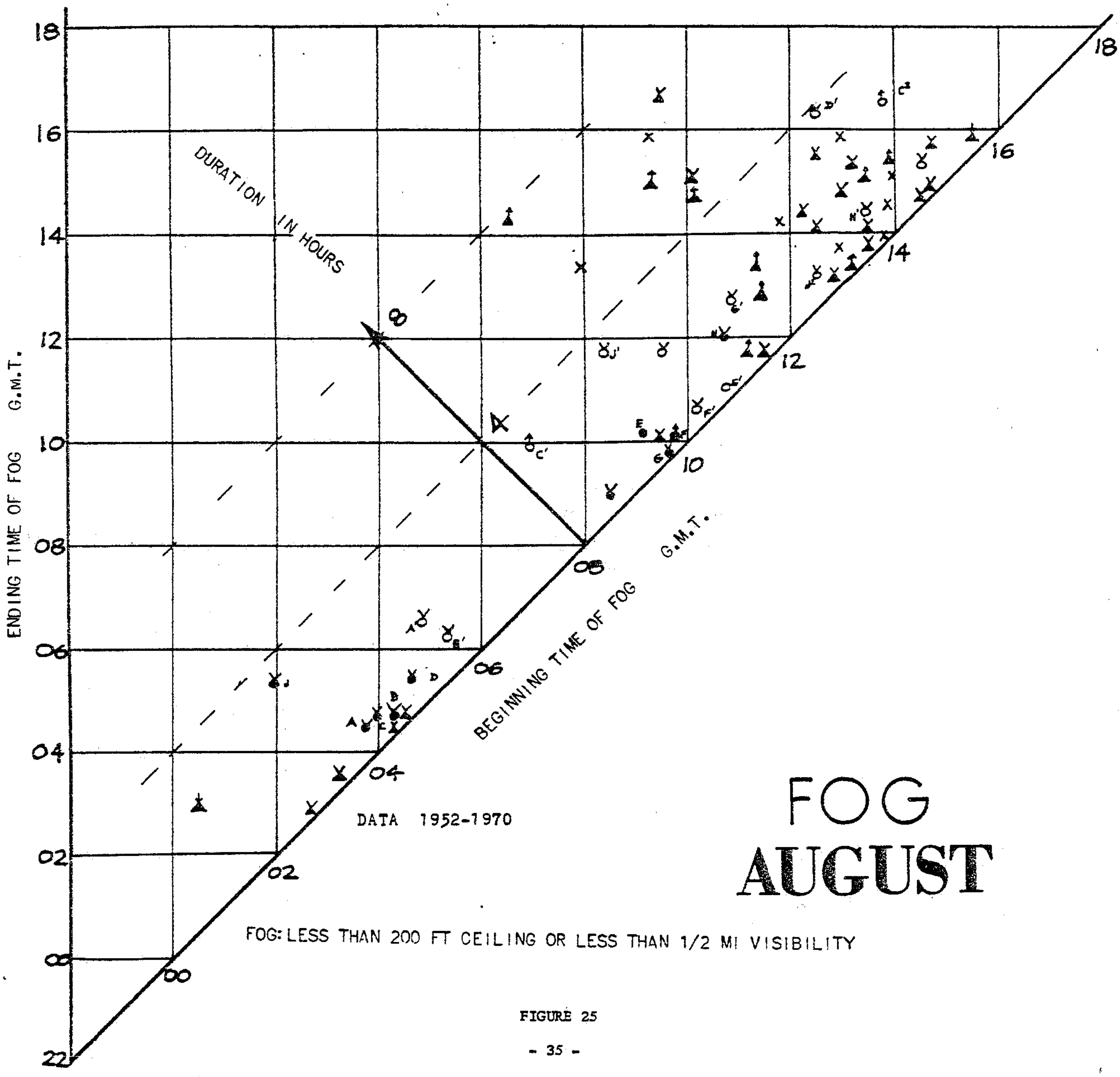
18
16
14
12
10
08
06
04
02
00
22
ENDING TIME OF FOG G.M.T.
DURATION IN HOURS
BEGINNING TIME OF FOG G.M.T.
DATA 1952-1970
FOG
JULY
FOG — CEILING LESS THAN 200 FT OR LESS THAN 1/2 MI VISIBILITY

FIGURE 23



20
18
16
14
12
10
08
06
04
02
00
23
ENDING TIME OF EVENT G.M.T.
BEGINNING TIME OF EVENT G.M.T.
DURATION IN HOURS
LOW STRATUS
DATA 1952-1970
AUGUST
LOW STRATUS = 200 TO 500 FT

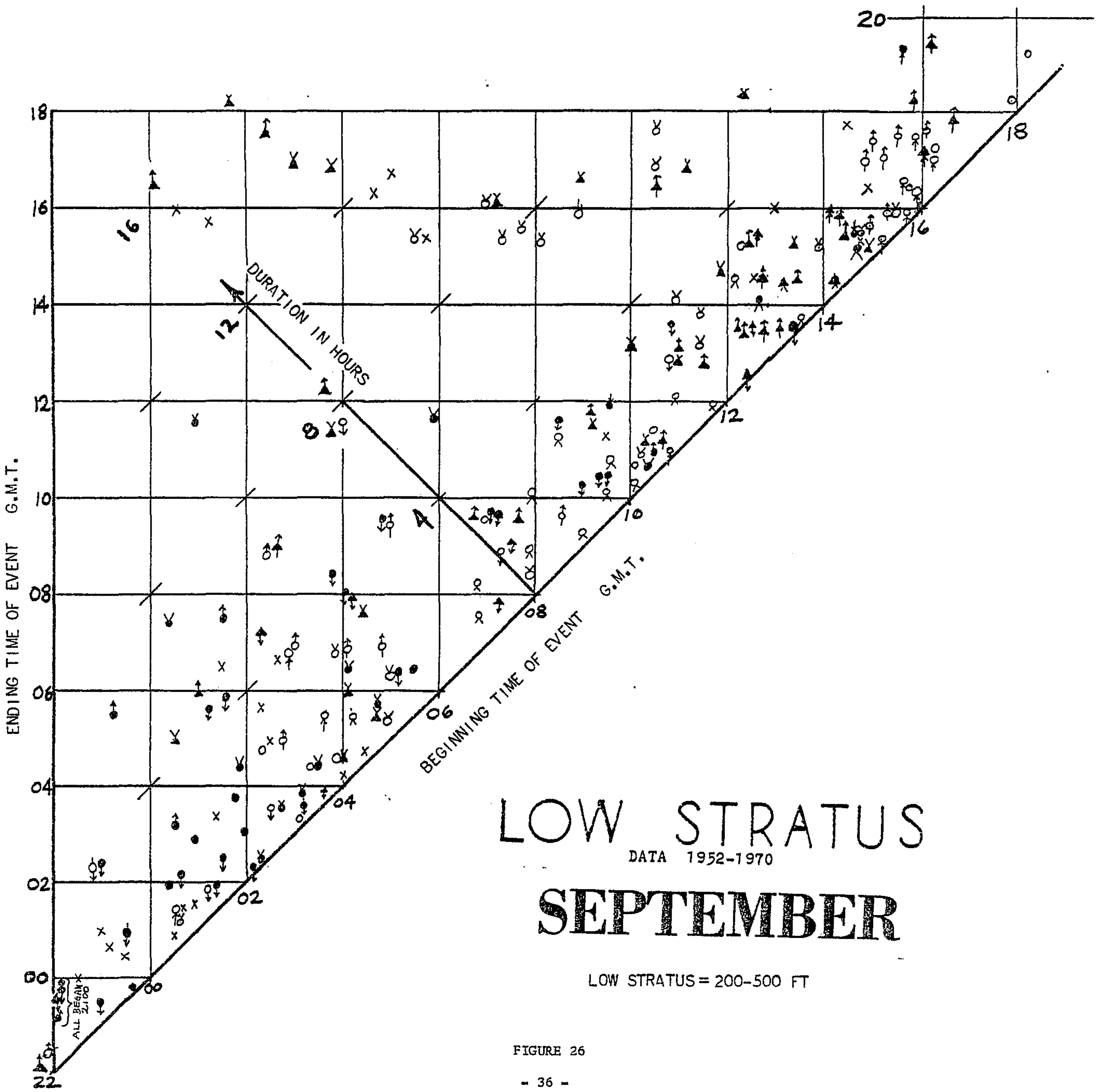
FIGURE 24



FOG
AUGUST

FOG: LESS THAN 200 FT CEILING OR LESS THAN 1/2 MI VISIBILITY

FIGURE 25



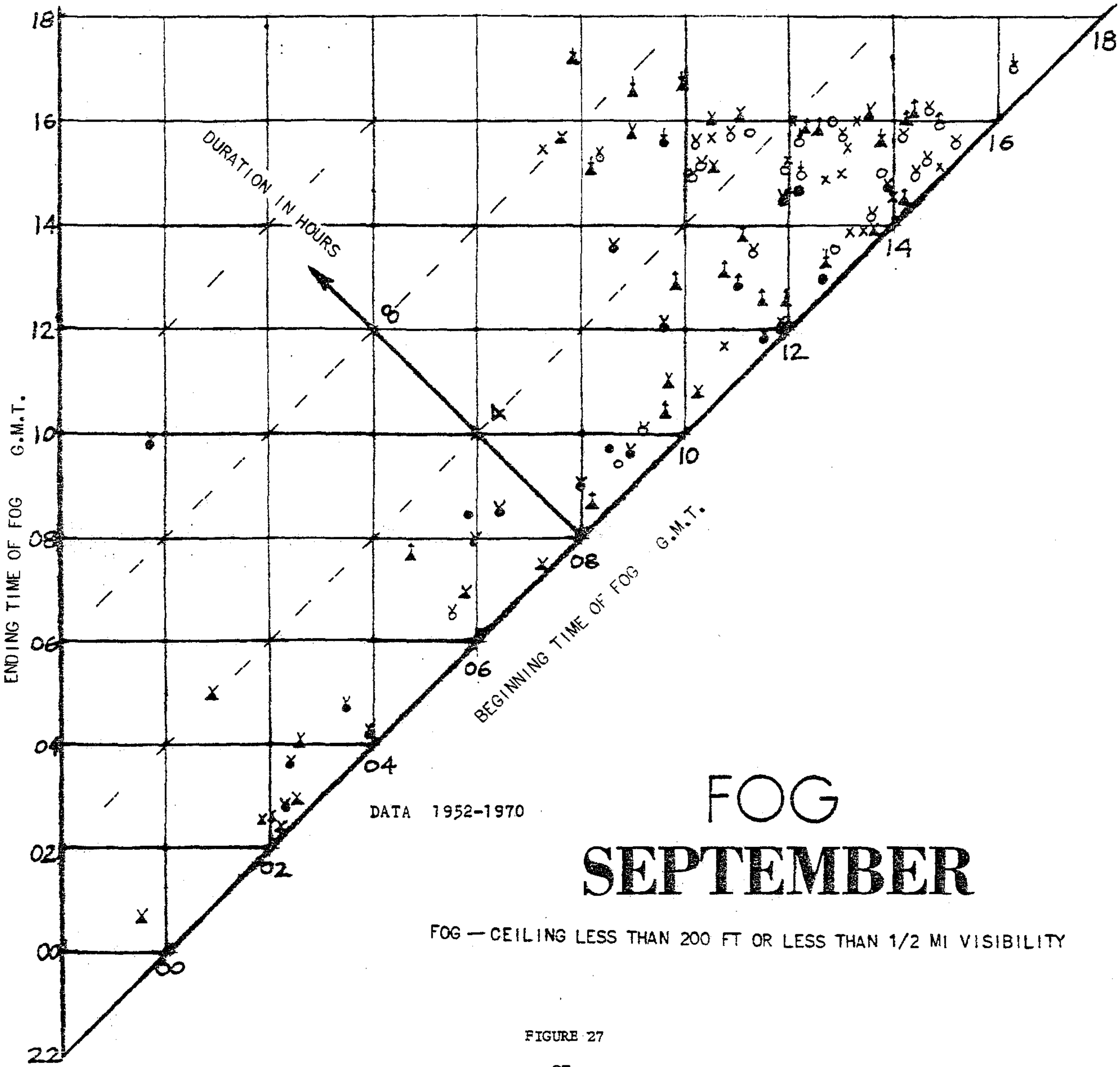
LOW STRATUS

DATA 1952-1970

SEPTEMBER

LOW STRATUS = 200-500 FT

FIGURE 26

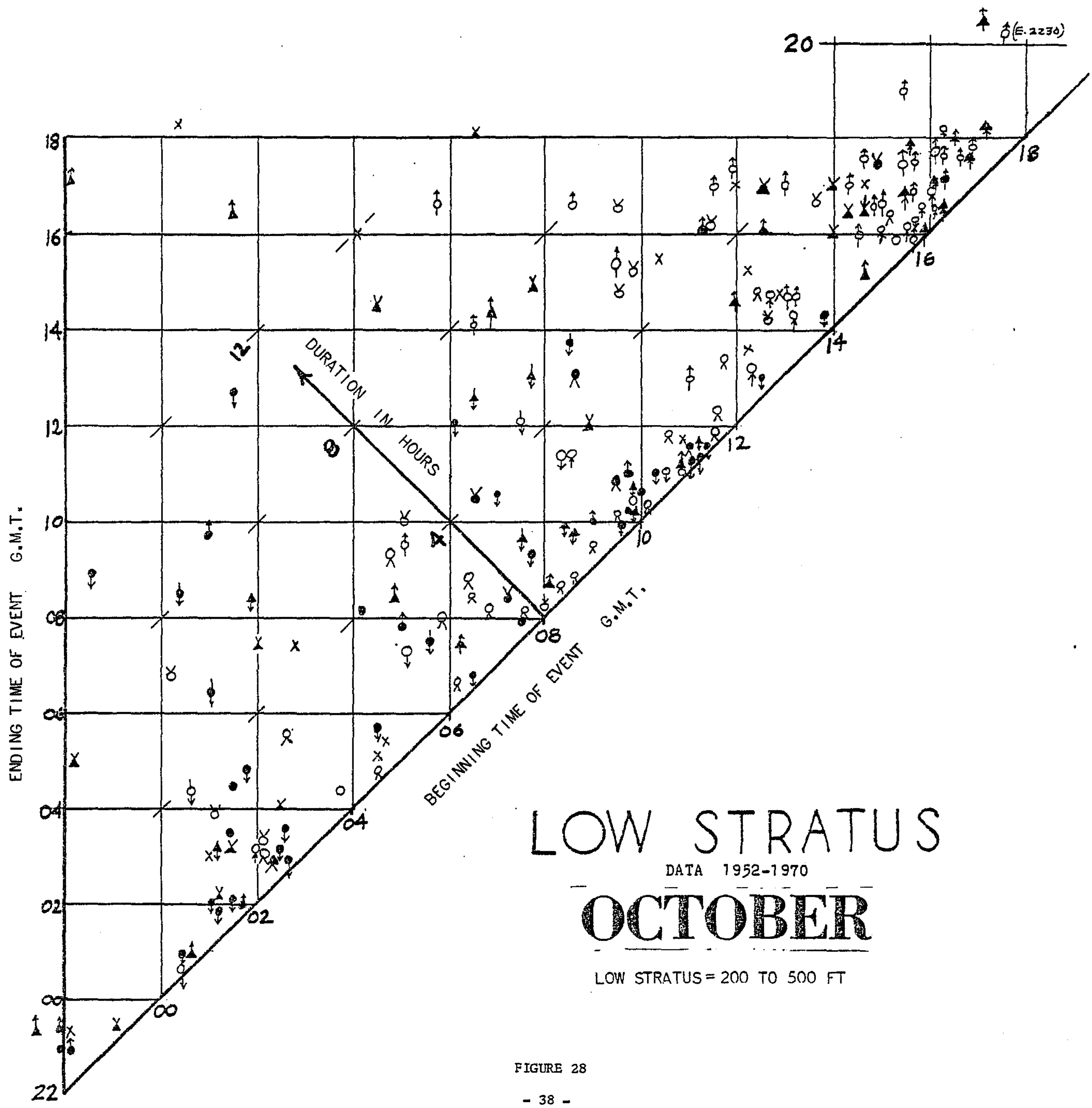


FOG

SEPTEMBER

FOG — CEILING LESS THAN 200 FT OR LESS THAN 1/2 MI VISIBILITY

FIGURE 27



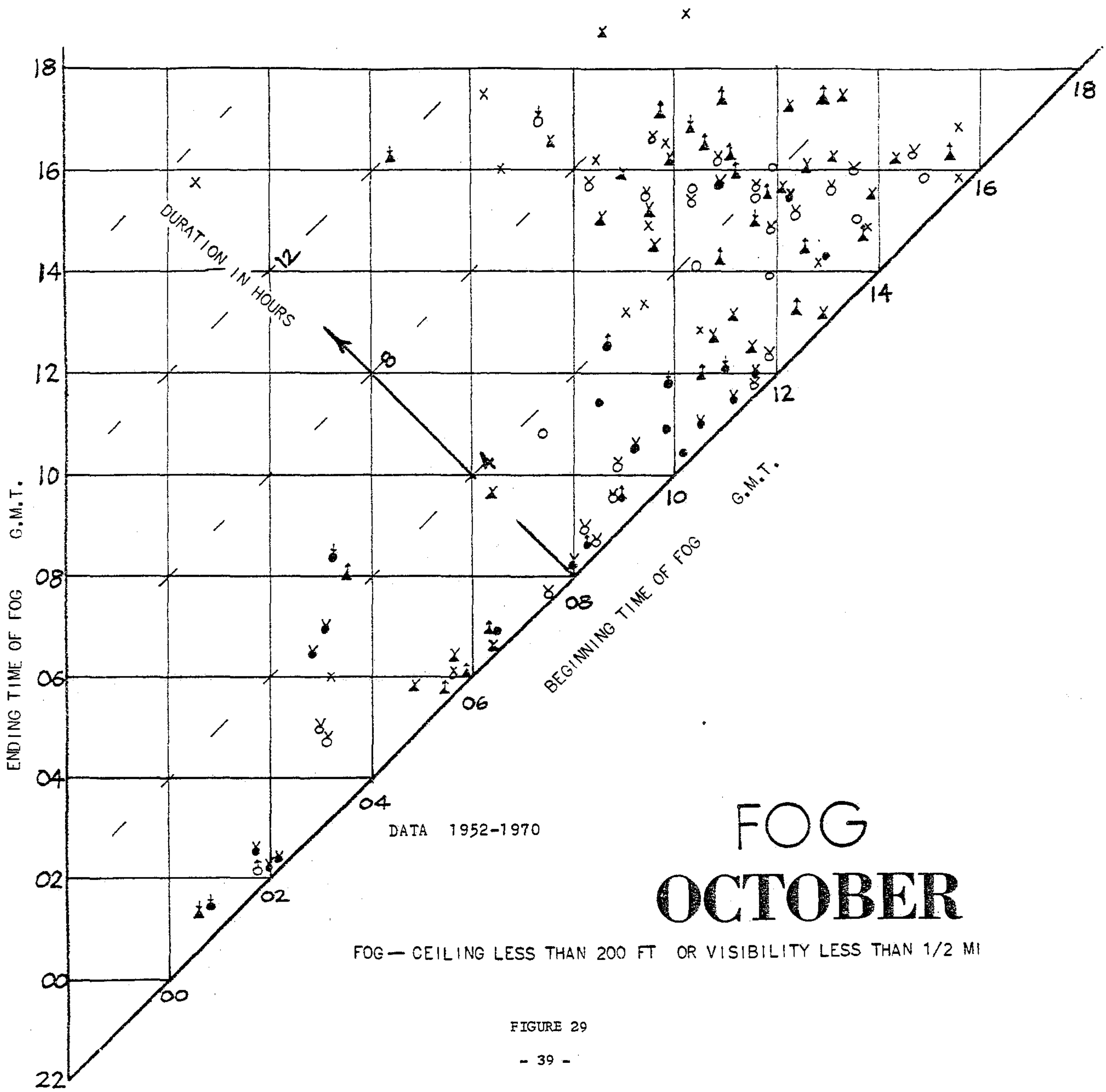
LOW STRATUS

DATA 1952-1970

OCTOBER

LOW STRATUS = 200 TO 500 FT

FIGURE 28



FOG
OCTOBER

FOG — CEILING LESS THAN 200 FT OR VISIBILITY LESS THAN 1/2 MI

FIGURE 29

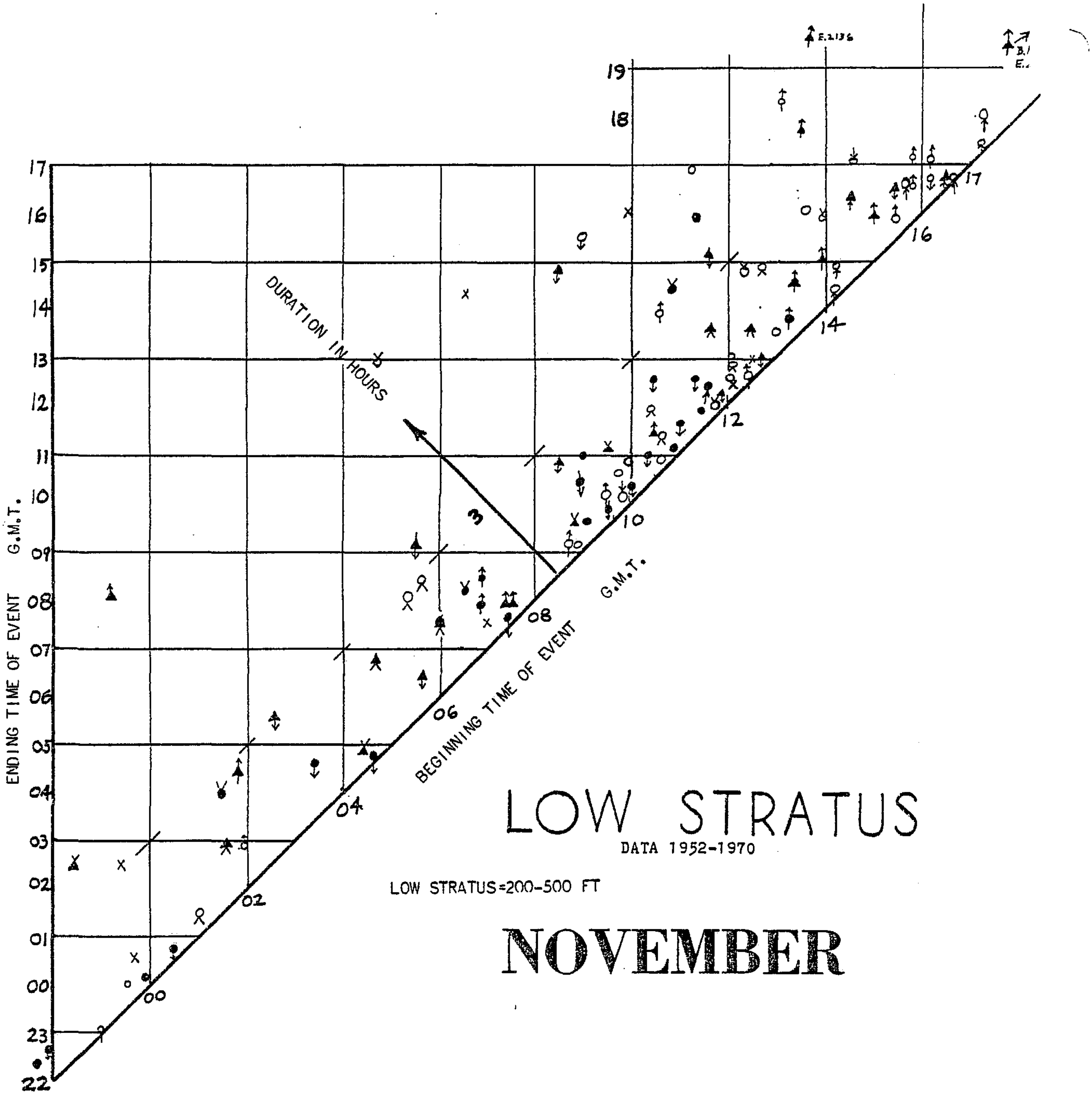
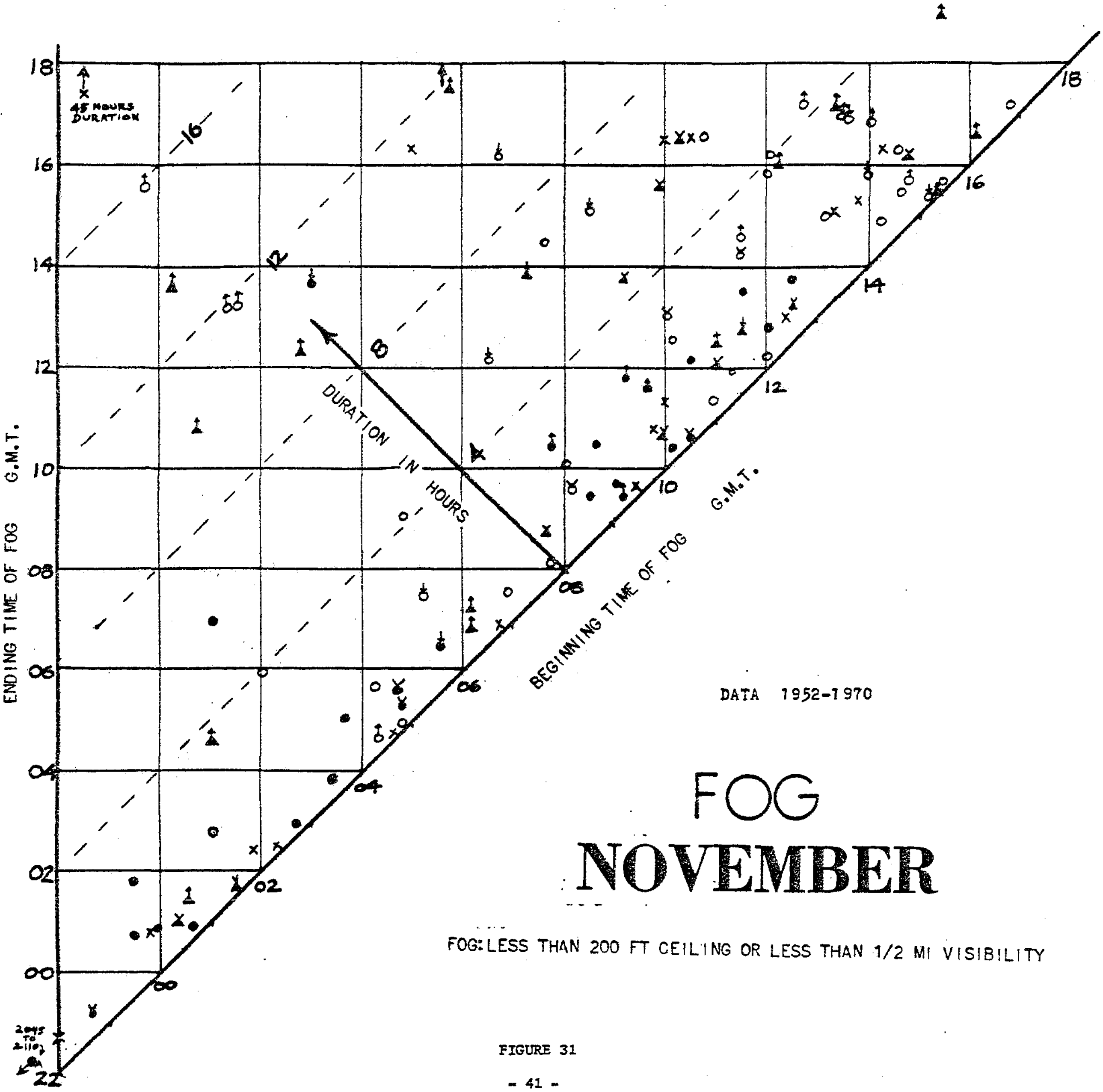
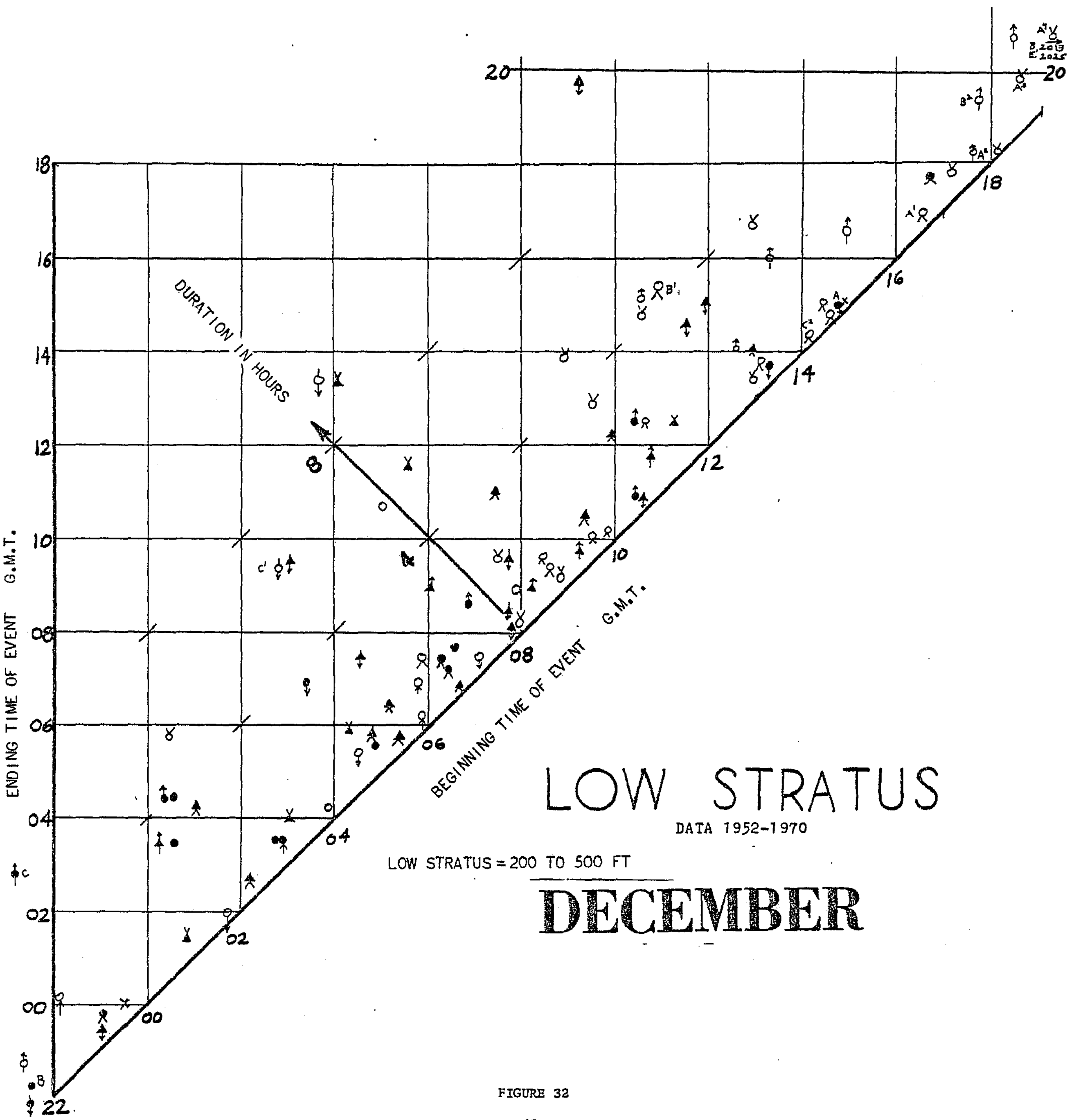

LOW STRATUS
DATA 1952-1970
LOW STRATUS=200-500 FT
NOVEMBER
ENDING TIME OF EVENT G.M.T.
BEGINNING TIME OF EVENT G.M.T.
DURATION IN HOURS
3

FIGURE 30



ENDING TIME OF FOG G.M.T.
BEGINNING TIME OF FOG G.M.T.
DURATION IN HOURS
45 HOURS DURATION
DATA 1952-1970
FOG
NOVEMBER
FOG: LESS THAN 200 FT CEILING OR LESS THAN 1/2 MI VISIBILITY

FIGURE 31



LOW STRATUS

DATA 1952-1970

LOW STRATUS = 200 TO 500 FT

DECEMBER

FIGURE 32

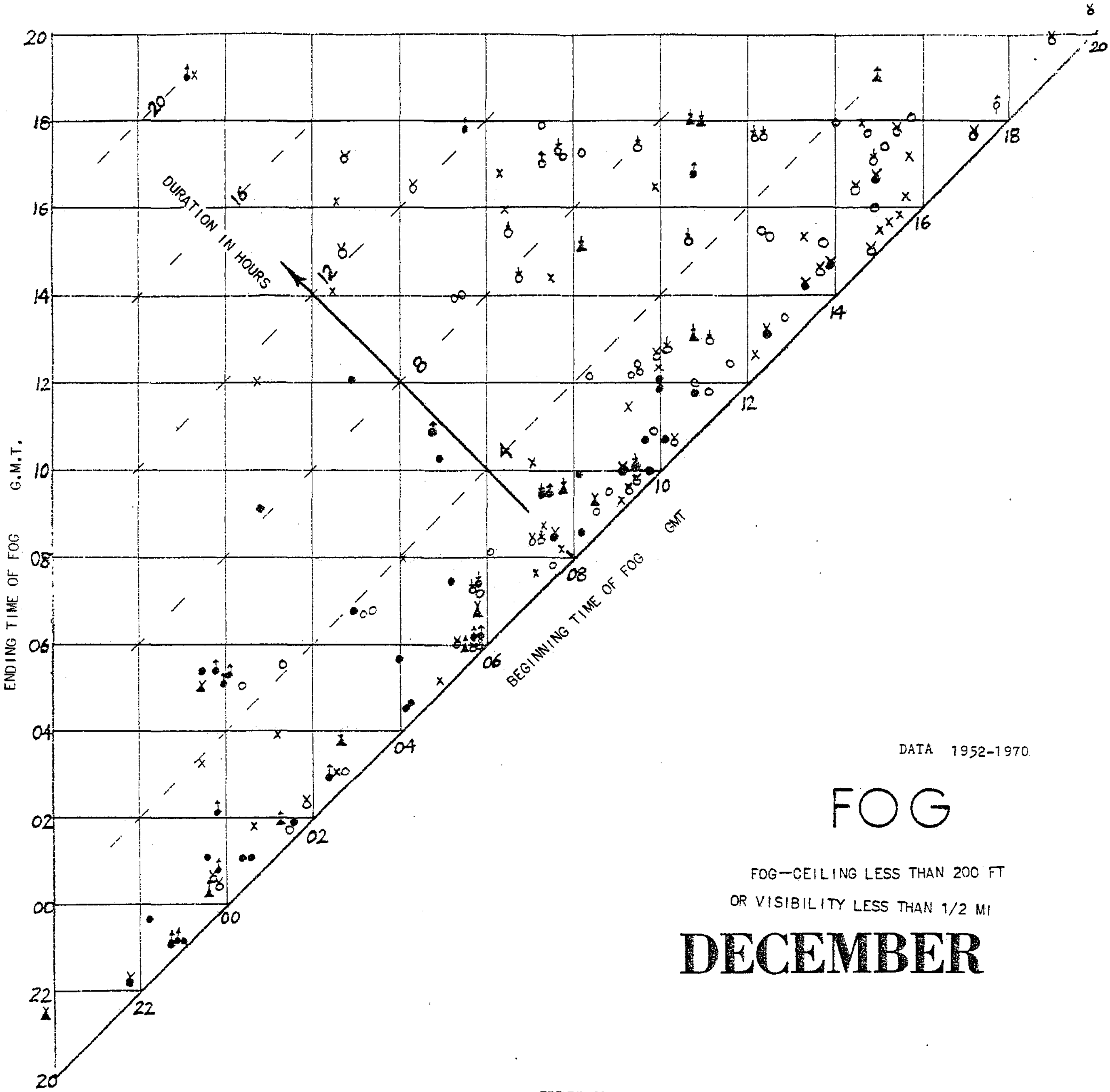

ENDING TIME OF FOG G.M.T.
BEGINNING TIME OF FOG GMT
DURATION IN HOURS
DATA 1952-1970
FOG
FOG—CEILING LESS THAN 200 FT
OR VISIBILITY LESS THAN 1/2 MI
DECEMBER

FIGURE 33

No. 45/2 Precipitation Probabilities in the Western Region Associated with Spring 500-mb Map Types. Richard P. Augulis, January 1970. (PB-189434)
No. 45/3 Precipitation Probabilities in the Western Region Associated with Summer 500-mb Map Types. Richard P. Augulis, January 1970. (PB-189414)
No. 45/4 Precipitation Probabilities in the Western Region Associated with Fall 500-mb Map Types. Richard P. Augulis, January 1970. (PB-189435)
No. 46 Applications of the Net Radiometer to Short-Range Fog and Stratus Forecasting at Eugene, Oregon. L. Yee and E. Bates, December 1969. (PB-190476)
No. 47 Statistical Analysis as a Flood Routing Tool. Robert J. C. Burnash, December 1969. (PB-188744)
No. 48 Tsunami. Richard A. Augulis, February 1970. (PB-190157)
No. 49 Predicting Precipitation Type. Robert J. C. Burnash and Floyd E. Hug, March 1970. (PB-190962)
No. 50 Statistical Report on Aeroallergens (Pollens and Molds) Fort Huachuca, Arizona, 1969. Wayne S. Johnson, April 1970. (PB-191743)
No. 51 Western Region Sea State and Surf Forecaster's Manual. Gordon C. Shields and Gerald B. Burdwell, July 1970. (PB-193102)
No. 52 Sacramento Weather Radar Climatology. R. G. Pappas and C. M. Veliquette, July 1970. (PB-193347)
No. 53 Experimental Air Quality Forecasts in the Sacramento Valley. Norman S. Benes, August 1970. (PB-194128)
No. 54 A Refinement of the Vorticity Field to Delineate Areas of Significant Precipitation. Barry B. Aronovitch, August 1970.
No. 55 Application of the SSARR Model to a Basin Without Discharge Record. Vail Schermerhorn and Donald W. Kuehl, August 1970. (PB-194394)
No. 56 Areal Coverage of Precipitation in Northwestern Utah. Philip Williams, Jr., and Werner J. Heck, September 1970. (PB-194389)
No. 57 Preliminary Report on Agricultural Field Burning vs. Atmosphere Visibility in the Willamette Valley of Oregon. Earl M. Bates and David O. Chilcote, September 1970. (PB-194710)
No. 58 Air Pollution by Jet Aircraft at Seattle-Tacoma Airport. Wallace R. Donaldson, October 1970. (COM-71-00017)
No. 59 Application of P.E. Model Forecast Parameters to Local-Area Forecasting. Leonard W. Snellman, October 1970. (COM-71-00016)

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No. 60 An Aid for Forecasting the Minimum Temperature at Medford, Oregon. Arthur W. Fritz, October 1970. (COM-71-00120)
No. 61 Relationship of Wind Velocity and Stability to SO_2 Concentrations at Salt Lake City, Utah. Werner J. Heck, January 1971. (COM-71-00232)
No. 62 Forecasting the Catalina Eddy. Arthur L. Eichelberger, February 1971. (COM-71-00223)
No. 63 700-mb Warm Air Advection as a Forecasting Tool for Montana and Northern Idaho. Norris E. Woerner, February 1971. (COM-71-00349)
No. 64 Wind and Weather Regimes at Great Falls, Montana. Warren B. Price, March 1971.
No. 65 Climate of Sacramento, California. Wilbur E. Figgins, June 1971. (COM-71-00764)
No. 66 A Preliminary Report on Correlation of ARTCC Radar Echoes and Precipitation. Wilbur K. Hall, June 1971. (COM-71-00829)
No. 67 Precipitation Detection Probabilities by Los Angeles ARTC Radars. Dennis E. Ronne, July 1971. (COM-71-00925)
No. 68 A Survey of Marine Weather Requirements. Herbert P. Benner, July 1971. (COM-71-00889)
No. 69 National Weather Service Support to Soaring Activities. Ellis Burton, August 1971. (COM-71-00956)
No. 70 Predicting Inversion Depths and Temperature Influences in the Helena Valley. David E. Olsen, October 1971. (COM-71-01037)
No. 71 Western Region Synoptic Analysis-Problems and Methods. Philip Williams, Jr., February 1972. (COM-72-10433)
No. 72 A Paradox Principle in the Prediction of Precipitation Type. Thomas J. Weitz, February 1972. (COM-72-10432)
No. 73 A Synoptic Climatology for Snowstorms in Northwestern Nevada. Bert L. Nelson, Paul M. Fransioli, and Clarence M. Sakamoto, February 1972. (COM-72-10338)
No. 74 Thunderstorms and Hail Days Probabilities in Nevada. Clarence M. Sakamoto, April 1972. (COM-72-10554)
No. 75 A Study of the Low Level Jet Stream of the San Joaquin Valley. Ronald A. Willis and Philip Williams, Jr., May 1972.