NOAA Technical Memorandum NWSTM PR-11

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

A CIRRUS CLIMATOLOGY FOR HONOLULU

CLARENCE B. LEE AND WESLEY K. W. YOUNG

PACIFIC REGION
HONOLULU,
HAWAII
April 1974

National Weather Service, Pacific Region Subseries

The Technical Memorandum series provides an informal medium for the documentation and quick dissemination of results not appropriate, or not yet ready, for formal publication in the standard journals. The series is used to report on work in progress, to describe technical procedures and practices, or to report to a limited audience. These Technical Memoranda will report on investigations devoted primarily to regional and local problems of interest mainly to Pacific Region personnel, and hence will not be widely distributed.

Papers 1 and 2 are in the former series, ESSA Technical Memoranda, Pacific Region Technical Memoranda (PRTM); papers 3 to 8 are in the former series, ESSA Technical Memoranda, Weather Bureau Technical Memoranda (WBTM); and papers 9 and 10 are part of the series, NOAA Technical Memoranda NWS.

Papers 1 to 3 are available from the Pacific Region Headquarters, Attention: OPS, P. O. Box 3650, Honolulu, Hawaii 96811. Beginning with 4, the papers are available from the National Technical Information Service, U. S. Dept. of Commerce, Sills Bldg., 5285 Port Royal Road, Springfield, Va. 22151. Price: $3 per copy. Order by accession number shown in parentheses at end of each entry.

ESSA Technical Memoranda

No. 1 The Trade Wind Regime of Central and Western Maui. Carl M. Peterson. January 1966.

No. 2 A Meteorological Glossary of Terms Used by Forecasters in Hawaii (Revised). R. F. Shaw. November 1967.

No. 3 Utilization of Aircraft Meteorological Reports at WBFC Honolulu. E. M. Chadsey, P. R. Moore, R. E. Rush, J. E. Smith, J. Vederman. June 1967.

No. 4 Tropical Numerical Weather Prediction in Hawaii - A Status Report. E. M. Carlstead. November 1967. (PB-183-621)

No. 5 A Computer Method to Generate and Plot Streamlines. Roger A. Davis. February 1969. (PB-183-622)

No. 6 Verification of an Objective Method to Forecast Frontal Passages in the Hawaiian Islands. E. M. Carlstead. September 1969.

No. 7 Meteorological Characteristics of the Cold January 1969 in Hawaii. Richard I. Sasaki. November 1969. (PB-188-040)

No. 8 Giant Waves Hit Hawaii. Jack D. Bottoms. September 1970. (COM-71-00021)

NOAA Technical Memoranda NWS

No. 9 Tropical Numerical Weather Prediction in Hawaii - 1971. E. M. Carlstead. March 1971. (COM-71-00494)

No. 10 Climatology of Rainfall Probabilities for Oahu, Hawaii. A. N. Hull and Jon Pitko. April 1972. (COM-73-10242)

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

NOAA Technical Memorandum NWSTM PR-11

A CIRRUS CLIMATOLOGY FOR HONOLULU

Clarence B. H. Lee and Wesley K. W. Young
Weather Service Forecast Office
Honolulu, Hawaii

March 1974

TABLE OF CONTENTS

LIST OF TABLES AND FIGURES

A CIRRUS CLIMATOLOGY FOR HONOLULU

I. PURPOSE

Climatological input as an aid in operational cirrus forecasting has been a pressing need at WSFO Honolulu for many years. Exacting one- to three-day quantitative forecasts of cirrus-cover over and near the Hawaiian Islands has been an operational requirement levied by several government agencies conducting atmospheric and geophysical research in the Hawaiian area. On a more mundane and routine basis, the need for precise quantitative high cloud data has been a continuing requirement in the formulation of public weather forecasts. This project was undertaken to partially alleviate the paucity of a definitive cirrus climatology heretofore unavailable for the Hawaiian Islands.

II. METHOD

Ten years of data from 1963 through 1972 were gleaned from original copies of WBAN 10A-10B filed at WSFO Honolulu. The occurrence of cirrus and the amount of cirrus observed during the regular three-hourly synoptic times were tabulated for statistical summaries.

III. RESULTS

A. Monthly Occurrence of Cirrus

Figure 1 depicts the annual variation of cirrus observations at Honolulu. Figure 1 is distinctly bimodal with maximum frequencies of cirrus occurrence during the late spring and early fall. Minima occur during the summer and late winter months with the absolute minimum occurring in February.

The pervasiveness of high cloud presence throughout the year is remarkable. Cirrus cover over the Hawaiian Islands has been traditionally thought to be a rather atypical cloud distribution specifically associated with several distinct phenomena such as jet streams and cyclonically related disturbances.

The mean upper-air flow patterns (Weideranders, 1961 and Sadler, 1972) give little information to explain the distribution shown in figure 1.

Table 1, representing the inter-annual variability of cirrus-days, indicates a few instances of substantial variation from the means. In most cases, however, the deviations from the means are limited to relatively narrow ranges. The uniformity of the distributions about the means is shown by the small differences between means and median in each case.

B. Persistence

Table 2 shows the number of cirrus-days which were followed by a succeeding cirrus-day. (A cirrus-day is defined as a day in which an observation or multiple observations of cirrus clouds have been made.) This table shows remarkably high frequencies of two or more successive days of cirrus observation. The mean distribution conforms closely to that of Table 1. Table 2 indicates large-scale, long-lived causative mechanisms in the production of cirrus cloudiness. Subsequent to the initial onset, persistence can be a reliable 24-hour forecast tool for successful cirrus forecasting.

C. Mean Cirrus Cover

Figure 2 depicts the mean amount of observed cirrus, in tenths, during those days in which cirrus is observed. The distribution shown here is enigmatic. The absolute maximum observed mean of more than seven-tenths during May corresponds precisely with the maximum number of cirrus-days shown in figure 1. A minor maximum in figure 2 occurs during July, however, which is represented by a relative minimum of cirrus-days in figure 1. Figure 2 also depicts a secondary minimum of cirrus cloud amount during September whereas a secondary maximum of cirrus-days is observed during September. Another way of stating this is to say that more cirrus-days are observed during September but the observer sees a lesser amount (than during August or October).

Figures 1 and 2 indicate in general that the trend in the annual variability of cirrus cloud cover can be associated with the general trend of cirrus-day occurrences, although some important exceptions exist.

D. Diurnal Cirrus Distribution

1. Qualitative

Figures 3 through 14 are histograms depicting cirrus observations as a function of time-of-day, i.e., observations of cirrus without regard to total amount during the 24-hour period.

Without exception these histograms indicate pronounced maxima during the daylight hours with distinct tendencies toward lesser amounts of cirrus detection during the hours of darkness. This observational bias has long been a basis for conjectural debate among local forecasters but no empirical evidence in support of proponents has been available until now.

2. Quantitative

Figures 15 through 26 depict the amount of cirrus cover as a function of time-of-day for each month. While the absolute amounts range through a substantial interval during the year, the results indicate maxima during the daylight hours and minima at night. Support for observational bias as the rationale for these distributions is further reinforced by the sudden increase in slope from 5 AM to 8 AM and the often precipitous decline and slope reversal after 5 PM.

Figures 3 through 26 clearly outline the limitations of ground-based observations insofar as cirrus cover is concerned. The figures show that not only is the observer less prone to detect cirrus after dark but even if he is reasonably certain of cirrus presence, he is likely to underestimate the total amount significantly.

E. Decadal Cirrus Frequency

Figures 27 through 38 stratify percentage frequencies of cirrus occurrence.

Interpretation of these figures is supported in some respect by figures 3 through 26. The larger frequencies invariably cluster on both ends of the decade with pronounced minima within the interval. In the detection of cirrus the observer generally sees a great deal or very little at all. Perhaps there is an apparent or real limitation of the human eye to successfully discriminate between moderately-high and very-high, or moderately-low and very-low amounts of cirrus concentrations. The suspicion of some observational bias is unavoidable.

IV. SUMMARY

This climatological study was designed to provide an operationally useful basis for the production of cirrus forecasts by WSFO Honolulu.

Cirrus cloudiness over Honolulu has been shown to be a pervasive phenomenon throughout the year. The physical reasoning for the maxima of cirrus activity occurring during late spring and early fall remains obscure. There does not appear to be any significant correlation of the presence of cirrus with any significant features of the mean upper air flow pattern.

Cirrus cloudiness over Honolulu has also been shown to be a highly persistent phenomenon and this fact alone can be successfully applied in the day to day type of cirrus forecasting in which WSFO Honolulu is now actively involved.

The material presented here has posed some very real questions as to the reliability of cirrus observations by ground-based human observers with particular reference to nocturnal observations. Comparisons with improved satellite technology may verify some important restrictions.

Tempered with an understanding of its limitations, the background of material presented here should be an important and useful forecast aid for the operational forecaster. Juxtaposed with future efforts in defining the causative mechanisms this study will provide a deeper understanding of our ability to recognize and predict this important atmospheric phenomenon.

V. ACKNOWLEDGMENTS

The authors would like to extend special thanks to Mr. Roy Matsuda for drafting the diagrams and to Dr. Art Hull for reviewing the final draft.

Table 1. Cirrus-days 1963-1972.

YEAR	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	sum
1972	23	21*	17	29	27	28	27	17	26	24	16	10	265
1971	19	11	22	28	14	22	20	14	19	24	17	26	223
1970	13	11	14	11	21	12	9	16	20	27	23	16	193
1969	10	18	18	23	23	10	22	16	27	18	22	9	216
1968	15	6*	24	26	22	22	28	23	25	22	16	20	249
1967	12	20	20	21	29	18	25	29	29	24	22	18	267
1966	14	14	18	12	24	17	26	23	25	25	23	19	240
1965	15	13	17	27	29	19	17	15	24	20	21	21	238
1964	10	7*	25	22	26	20	15	22	23	22	24	20	236
1963	21	12	26	18	28	17	12	28	13	19	20	14	228
sum	152	133	201	217	243	185	201	203	231	225	204	173	2355
days posb.	310	283*	310	300	310	300	310	310	300	310	300	310	3653
mean	15.2	13.3	20.1	21.7	24.3	18.5	20.1	20.3	23.1	22.5	20.4	17.3	
%	49.0	47.0	64.8	72.3	78.4	62.8	64.8	65.5	77.0	72.6	68.0	55.8	
median	14.5	12.5	19.0	22.5	25.0	18.5	21.0	19.5	24.5	23.0	21.5	18.5	

* due to leap year.

Table 2. Persistence of Cirrus-day Occurrences.

Month	January			February			March			April			May			June		
*Legend	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
YEAR 1972	23	20	87.0	21	17	81.0	17	12	70.6	29	28	96.6	27	24	88.9	28	26	92.9
1971	19	15	78.9	11	7	63.6	22	19	86.4	28	27	96.4	14	10	71.4	22	20	90.9
1970	13	9	69.2	11	7	63.6	14	9	64.3	11	6	54.5	21	17	81.0	12	6	50.0
1969	10	5	50.0	18	15	83.3	18	15	83.3	23	18	78.3	23	19	82.6	10	4	40.0
1968	15	8	53.3	6	1	16.7	24	20	83.3	26	25	96.2	22	18	81.8	22	19	86.4
1967	12	9	75.0	20	15	75.0	20	14	70.0	21	16	76.2	29	24	82.8	18	12	66.7
1966	14	7	50.0	14	9	64.8	18	11	61.1	12	7	58.3	24	20	83.3	17	12	70.6
1965	15	9	60.0	13	7	53.8	17	13	76.5	27	25	92.6	29	25	86.2	19	14	73.7
1964	10	7	70.0	7	5	71.4	25	22	88.0	22	19	86.4	26	23	88.5	20	15	75.0
1963	21	12	57.1	12	6	50.0	26	21	80.8	18	14	77.8	28	26	92.9	17	10	58.8
sum totals	152	101		133	89		188	156		217	186		243	206		185	138	
ave. %			66.4			66.9			83.0			85.7			84.8			74.6
median %			64.6			64.2			78.7			82.4			83.1			72.2

*I Total cirrus-days.
II Consecutive cirrus-days.
III % Occurrence of consecutive cirrus-days.

Table 2. Persistence of Cirrus-day Occurrences, continued.

Month	July			August			September			October			November			December		
*Legend	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
YEAR 1972	27	25	92.6	17	13	76.5	26	22	84.6	24	23	95.8	16	8	50.0	10	5	50.0
1971	20	12	60.0	14	11	78.6	19	16	84.2	24	18	75.0	17	12	70.6	26	22	84.6
1970	9	7	77.8	16	13	81.3	20	15	75.0	27	24	88.9	23	21	91.3	16	11	68.8
1969	22	16	72.7	16	12	75.0	27	23	85.2	18	13	72.2	22	18	81.8	9	4	44.4
1968	28	27	96.4	23	21	91.3	25	21	84.0	22	16	72.7	16	11	68.8	20	14	70.0
1967	25	22	88.0	29	28	96.6	29	28	96.6	24	20	83.3	22	20	90.9	18	14	77.8
1966	26	25	96.2	23	20	87.0	25	22	88.0	25	22	88.0	23	18	78.3	19	15	78.9
1965	17	13	76.5	15	12	80.0	24	20	83.3	20	12	60.0	21	14	66.7	21	17	81.0
1964	15	13	86.7	22	17	77.3	23	19	82.6	22	18	81.8	24	19	79.2	20	14	70.0
1963	12	6	50.0	28	25	89.3	13	6	46.2	19	16	84.2	20	16	80.0	14	6	42.9
sum totals	201	166		203	172		231	192		225	182		204	157		173	122	
ave. %			82.6			84.7			83.1			80.9			77.0			70.5
median %			82.3			80.7			84.1			82.6			78.8			70.0

*I Total cirrus-days
II Consecutive cirrus-days.
III % Occurrence of consecutive cirrus-days.

FIG. 1

DAYS PER MONTH WITH CIRRUS OBSERVED

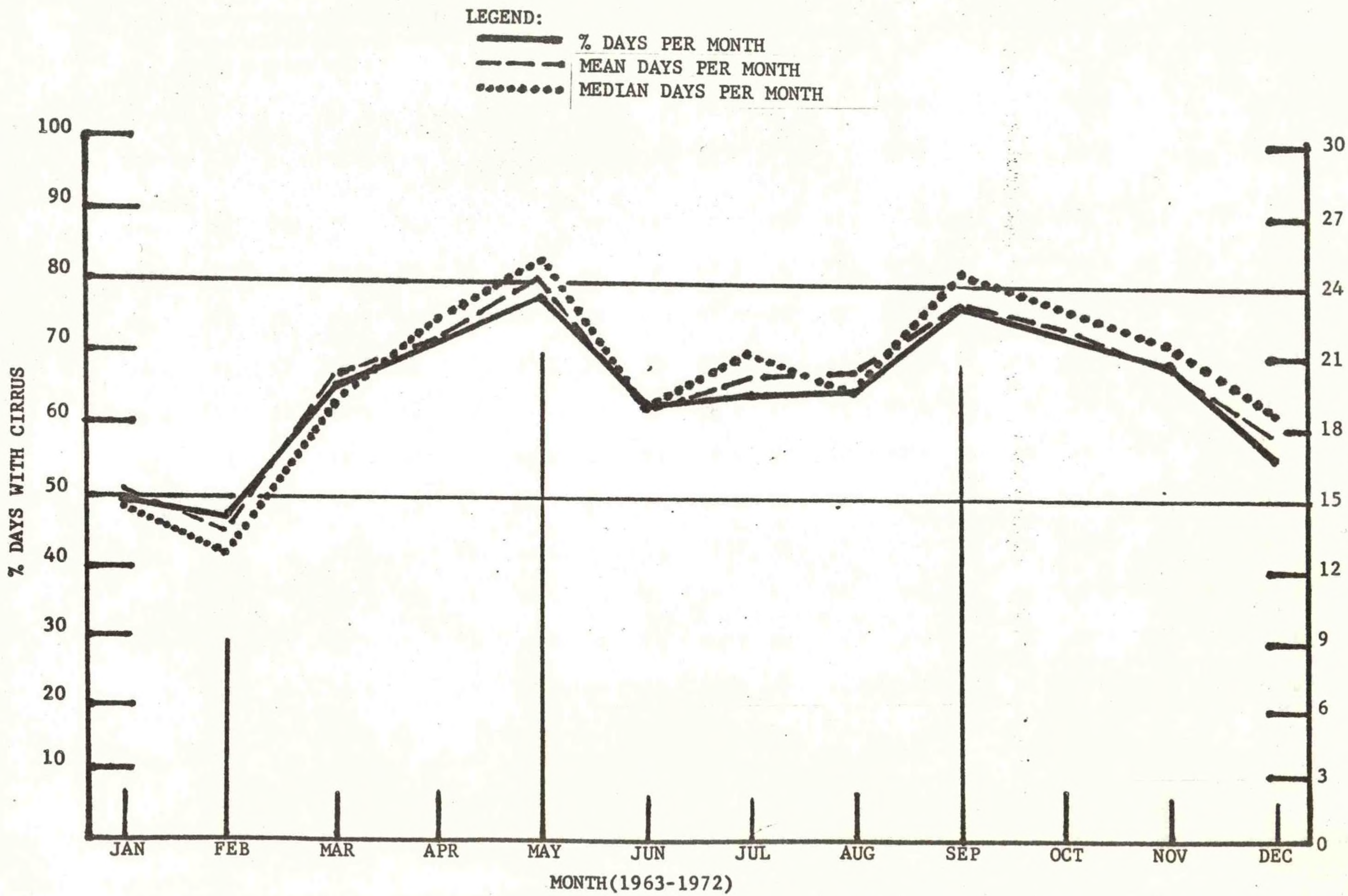


FIG. 2

MEAN MONTHLY CIRRUS COVER

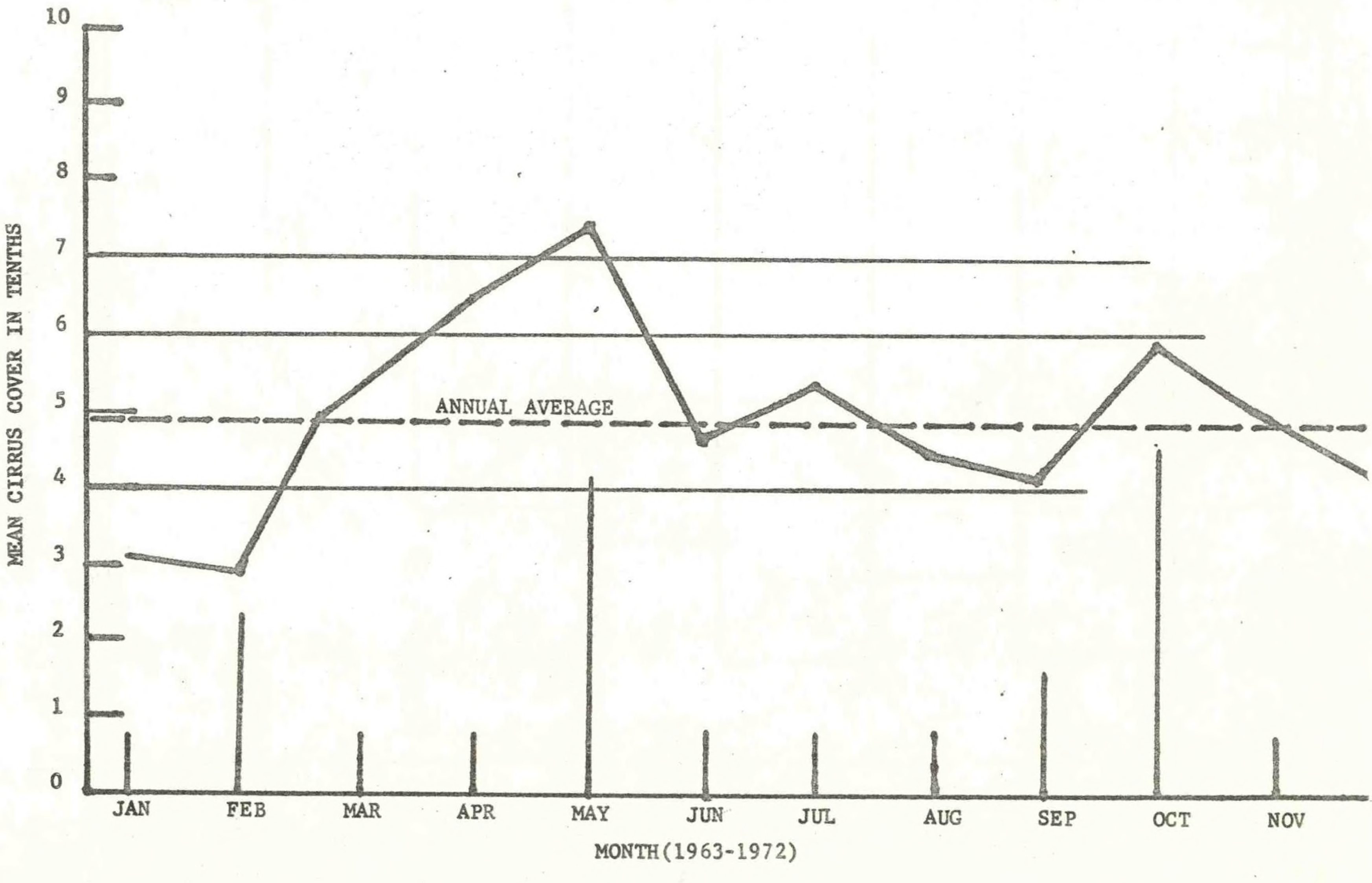


FIG. 3

DIURNAL VARIATION OF CIRRUS FREQUENCY
JANUARY 1963-1972

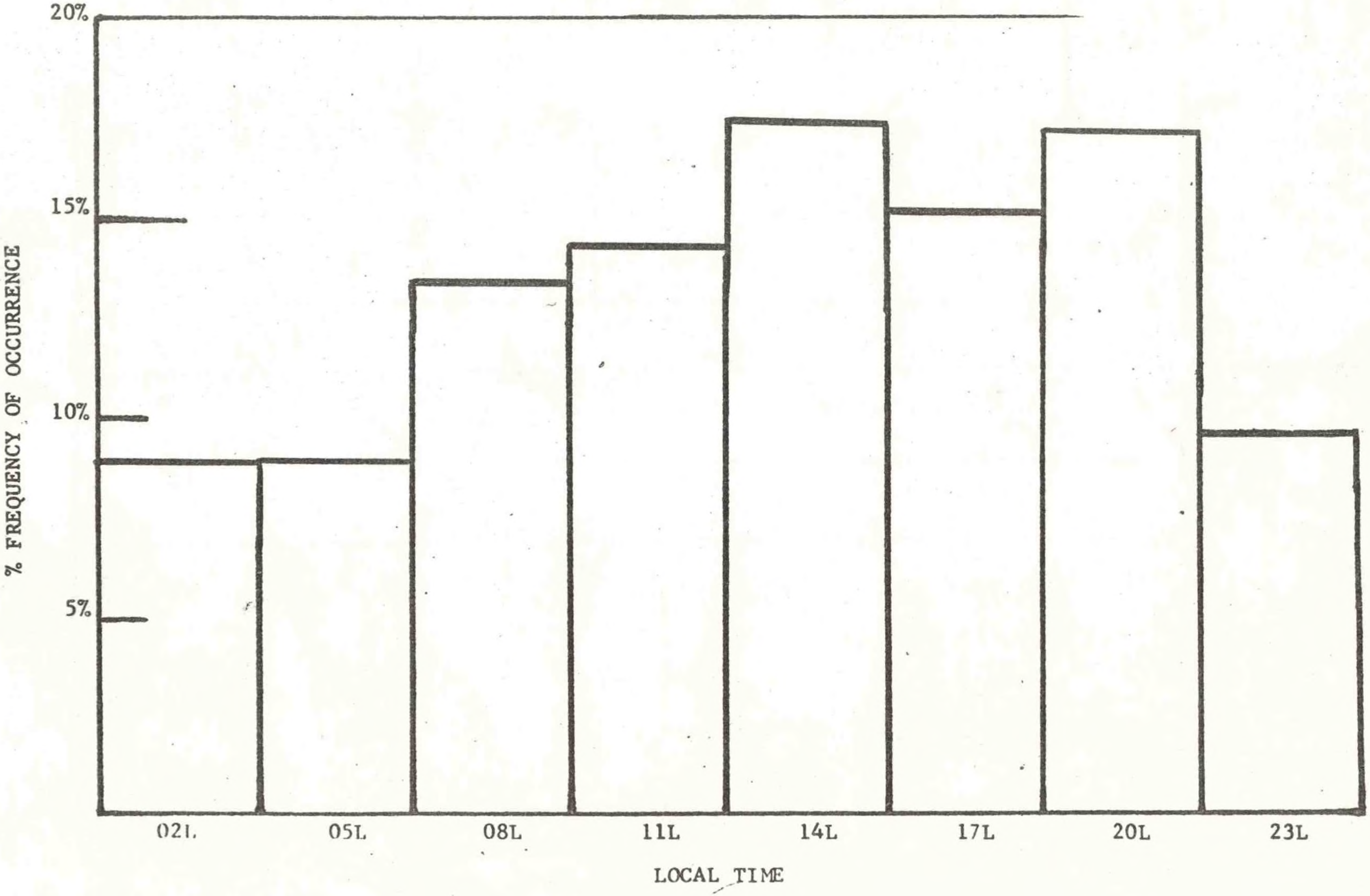


FIG. 4
FEBRUARY 1963-1972
DIURNAL VARIATION OF CIRRUS FREQUENCY

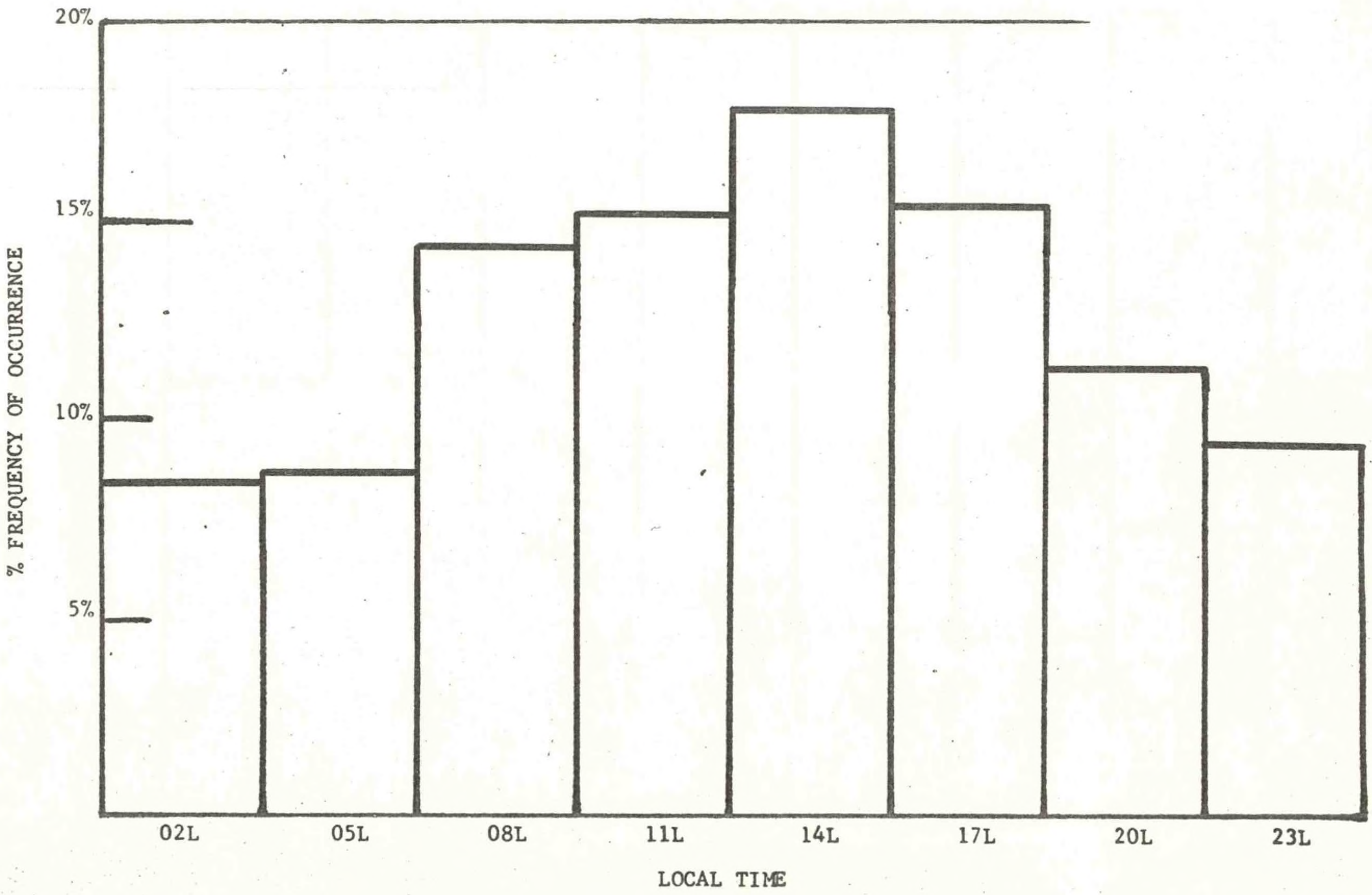


FIG. 5
MARCH 1963-1972
DIURNAL VARIATION OF CIRRUS FREQUENCY

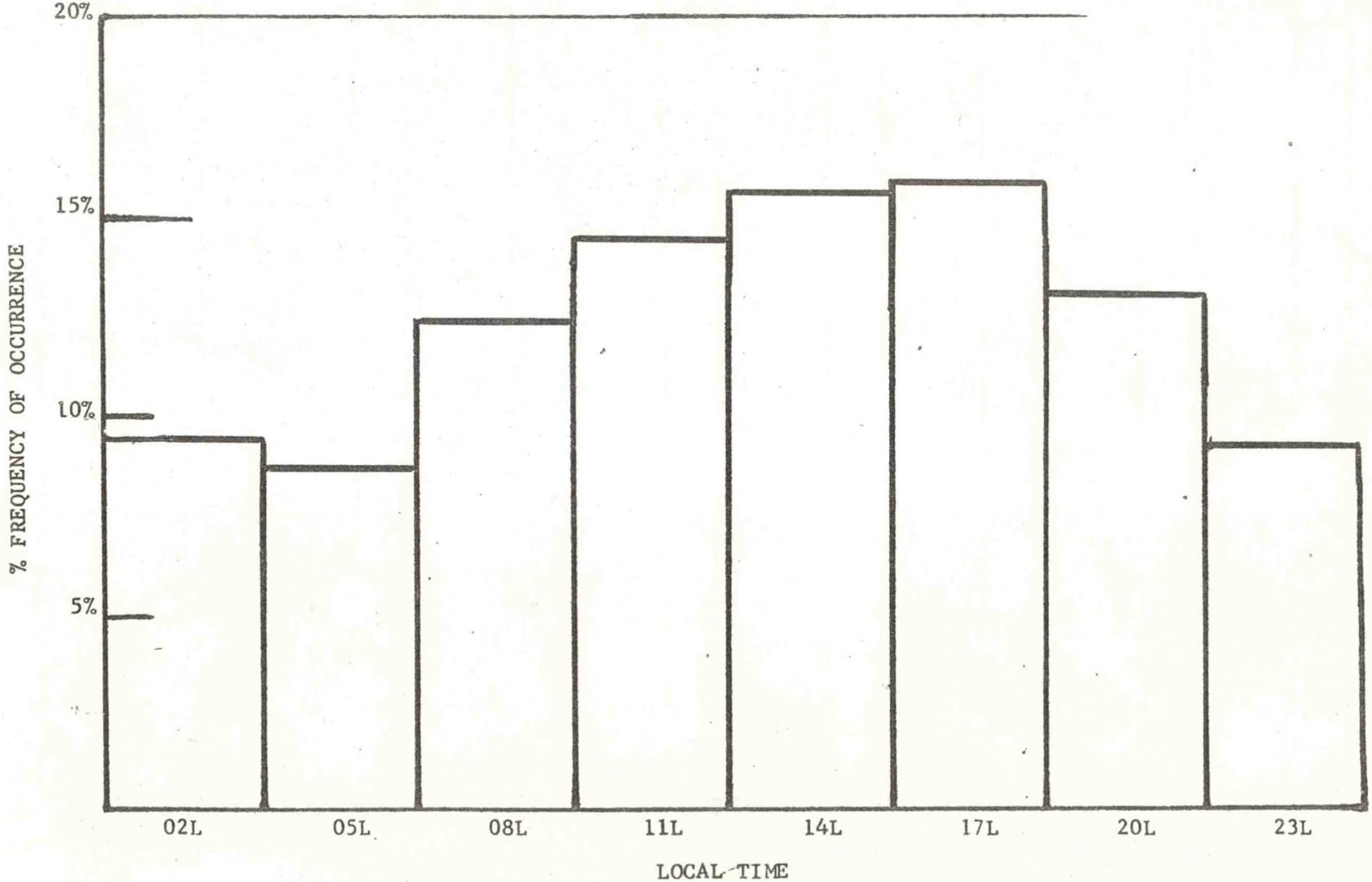


FIG. 6
APRIL 1963-1972
DIURNAL VARIATION OF CIRRUS FREQUENCY

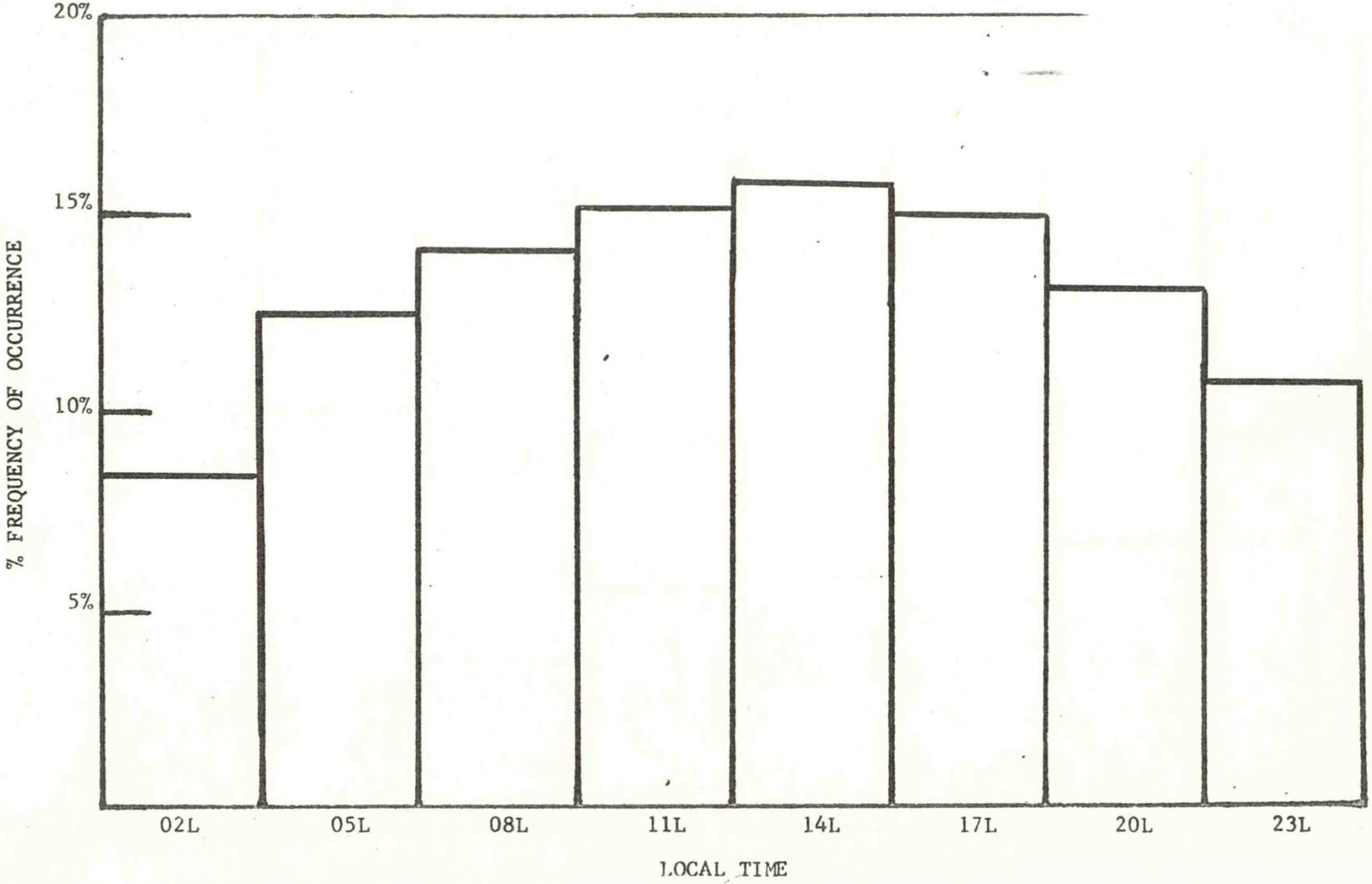


FIG. 7
MAY 1963-1972
DIURNAL VARIATION OF CIRRUS FREQUENCY

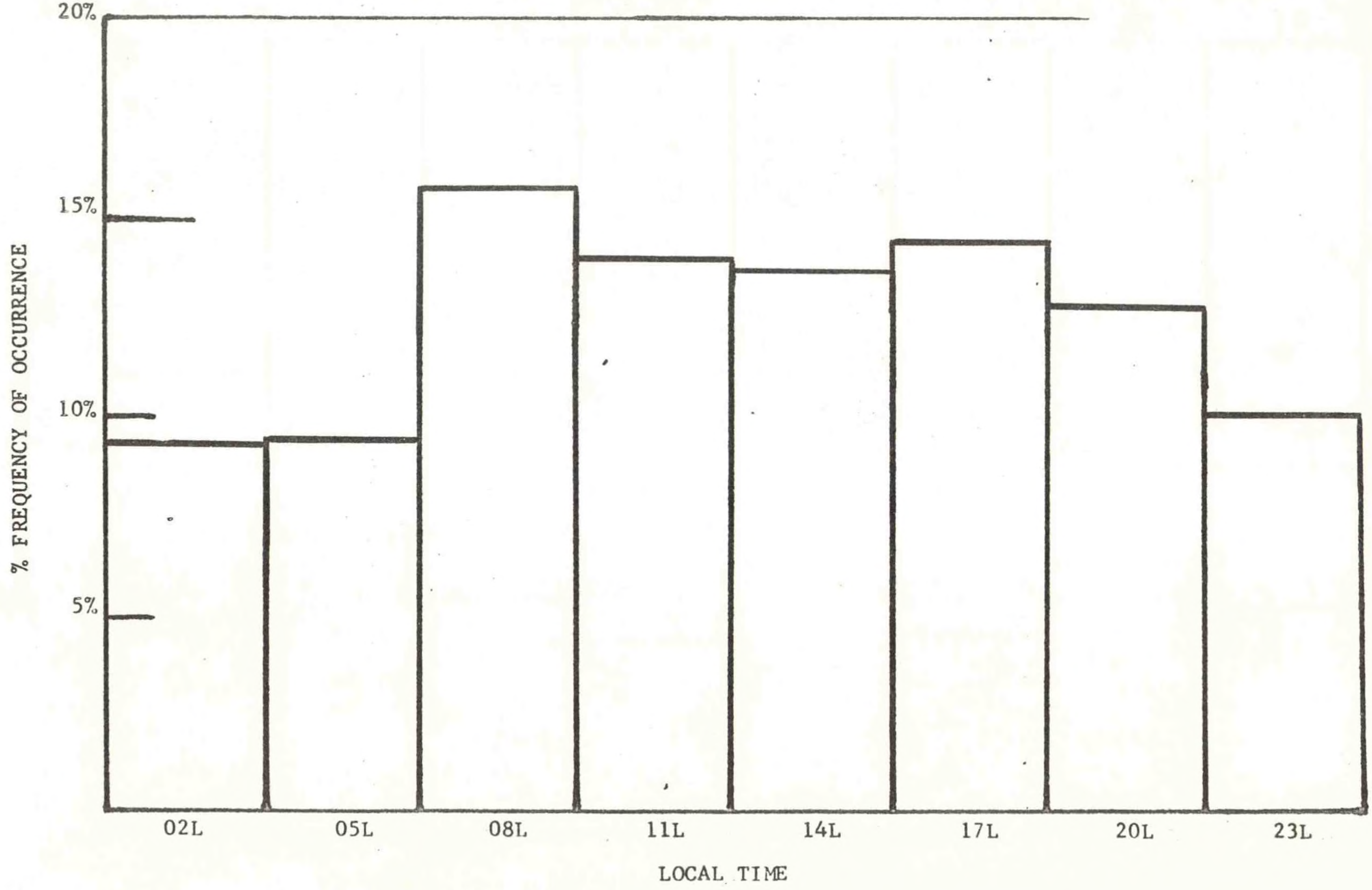


FIG. 8
JUNE 1963-1972
DIURNAL VARIATION OF CIRRUS FREQUENCY

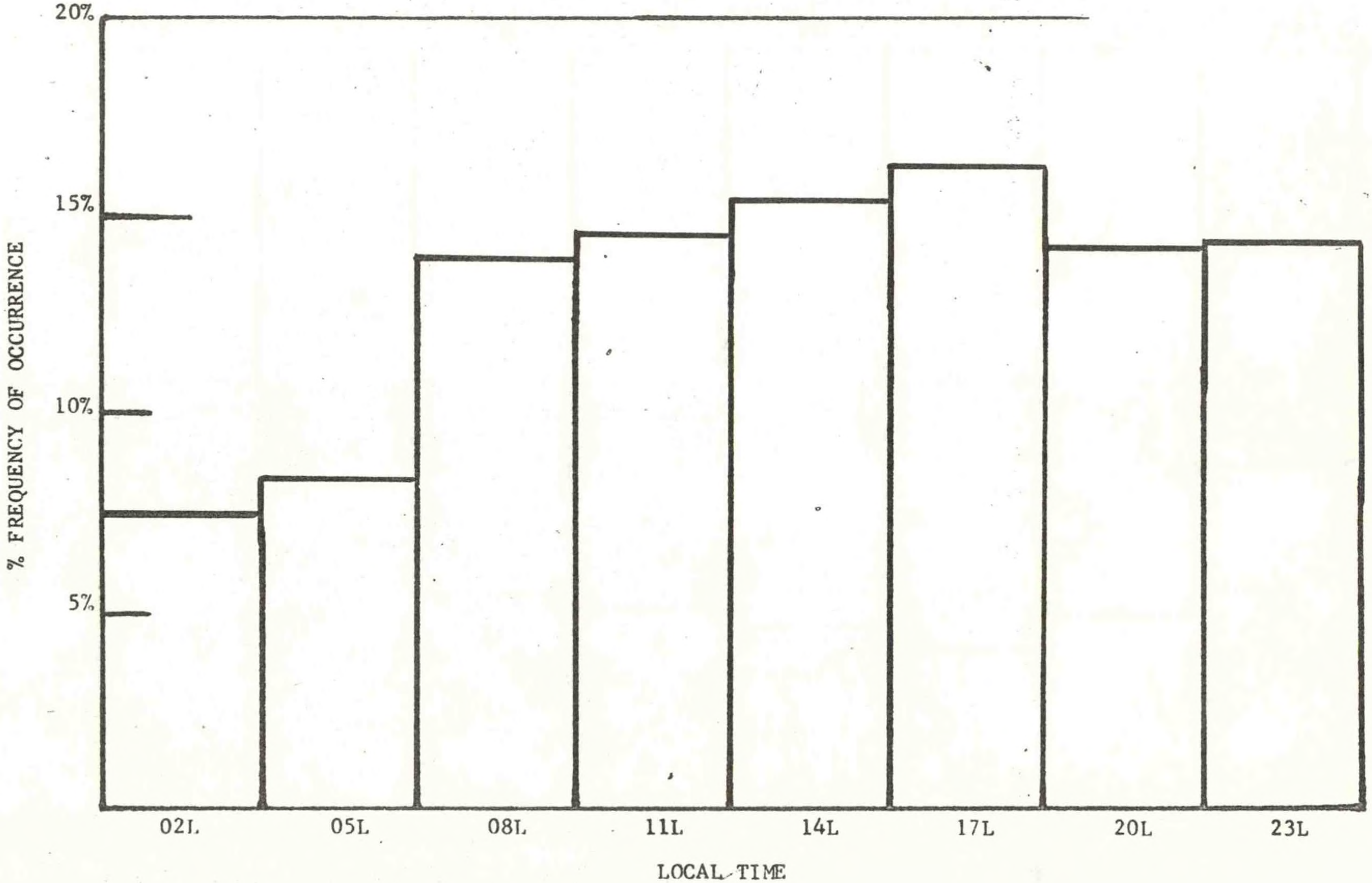


FIG. 9

JULY 1963-1972

DIURNAL VARIATION OF CIRRUS FREQUENCY

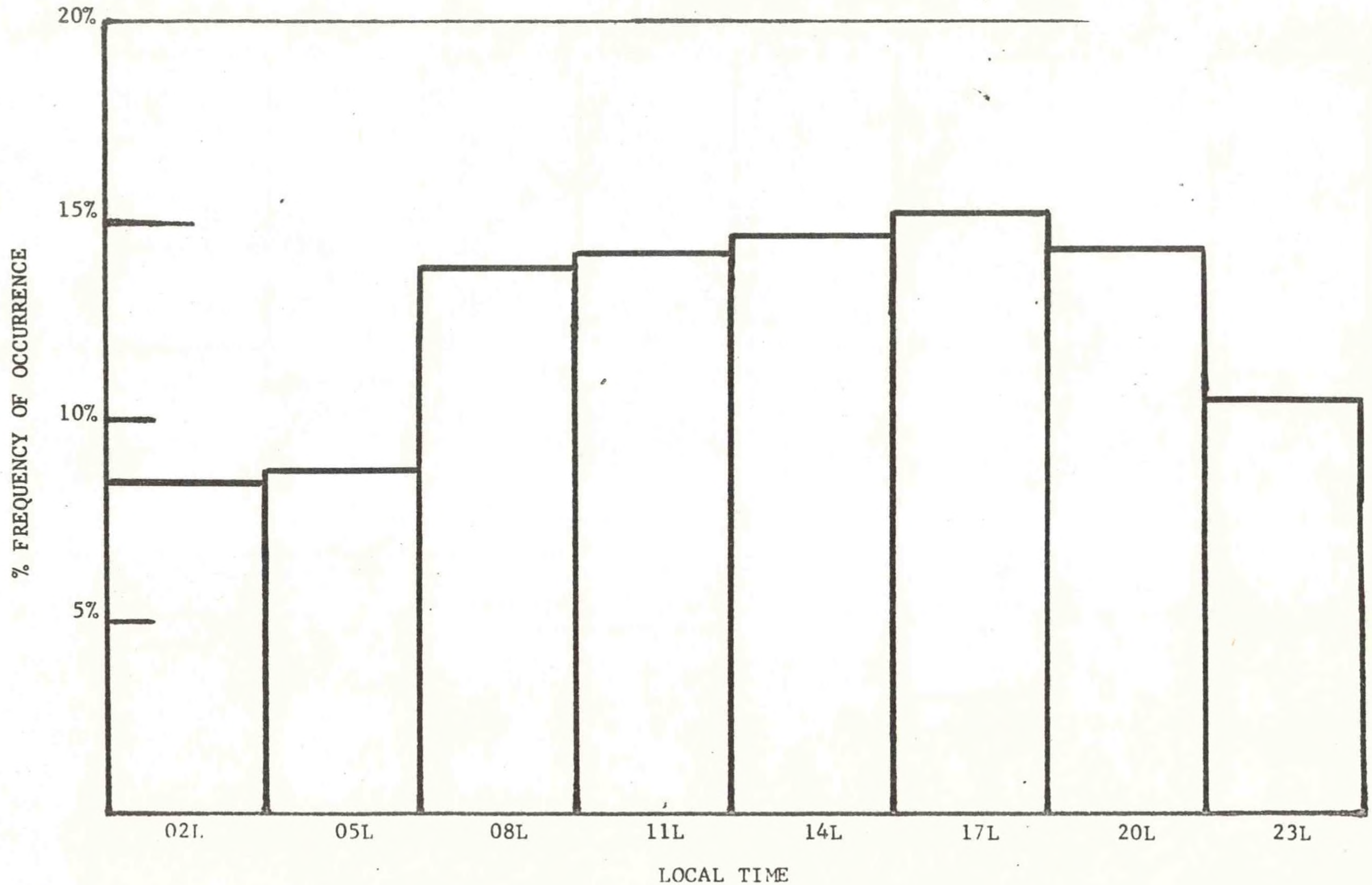


FIG. 10
AUGUST 1963-1972
DIURNAL VARIATION OF CIRRUS FREQUENCY

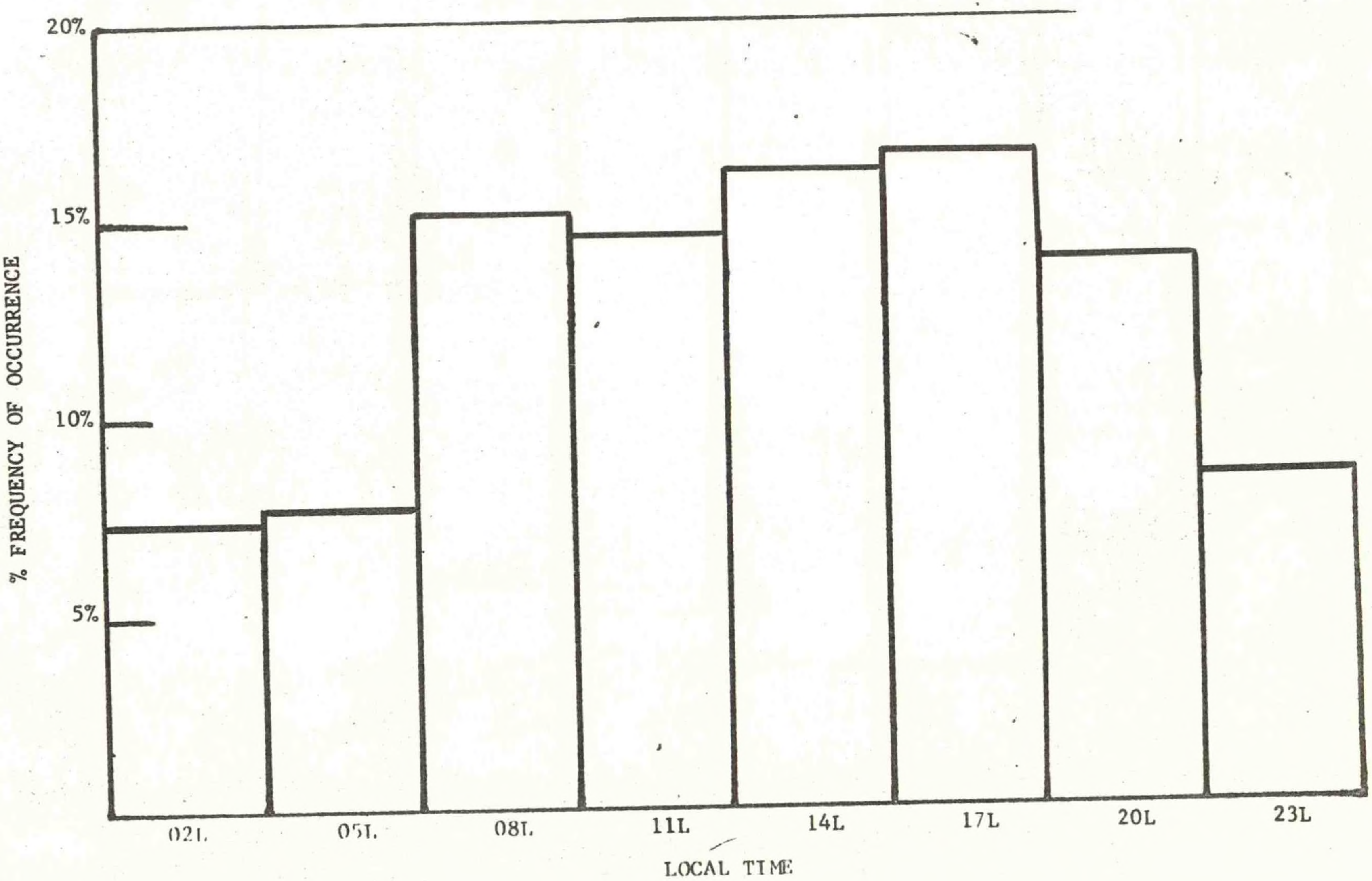


FIG. 11
SEPTEMBER 1963-1972
DIURNAL VARIATION OF CIRRUS FREQUENCY

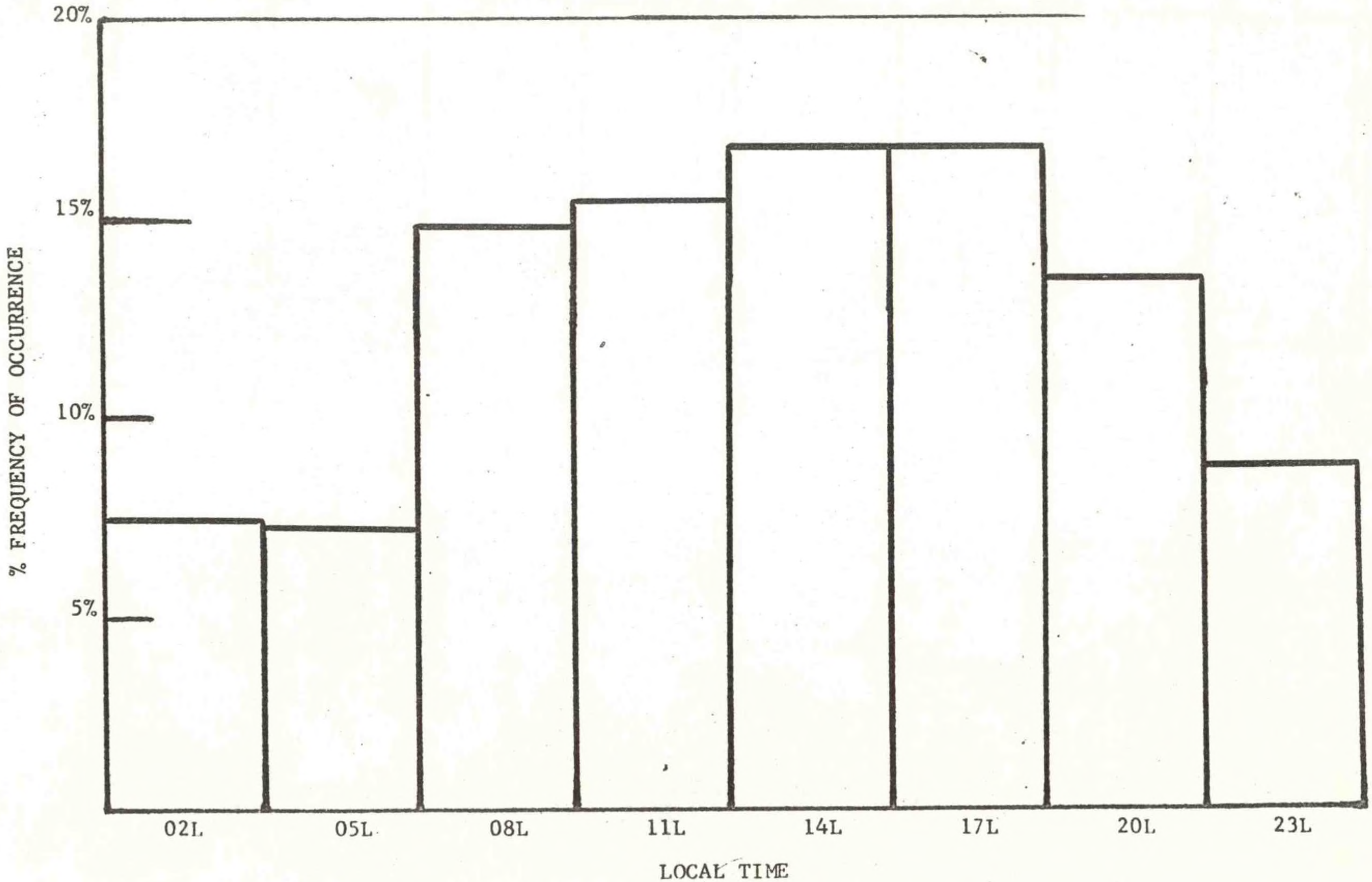


FIG. 12
OCTOBER 1963-1972
DIURNAL VARIATION OF CIRRUS FREQUENCY

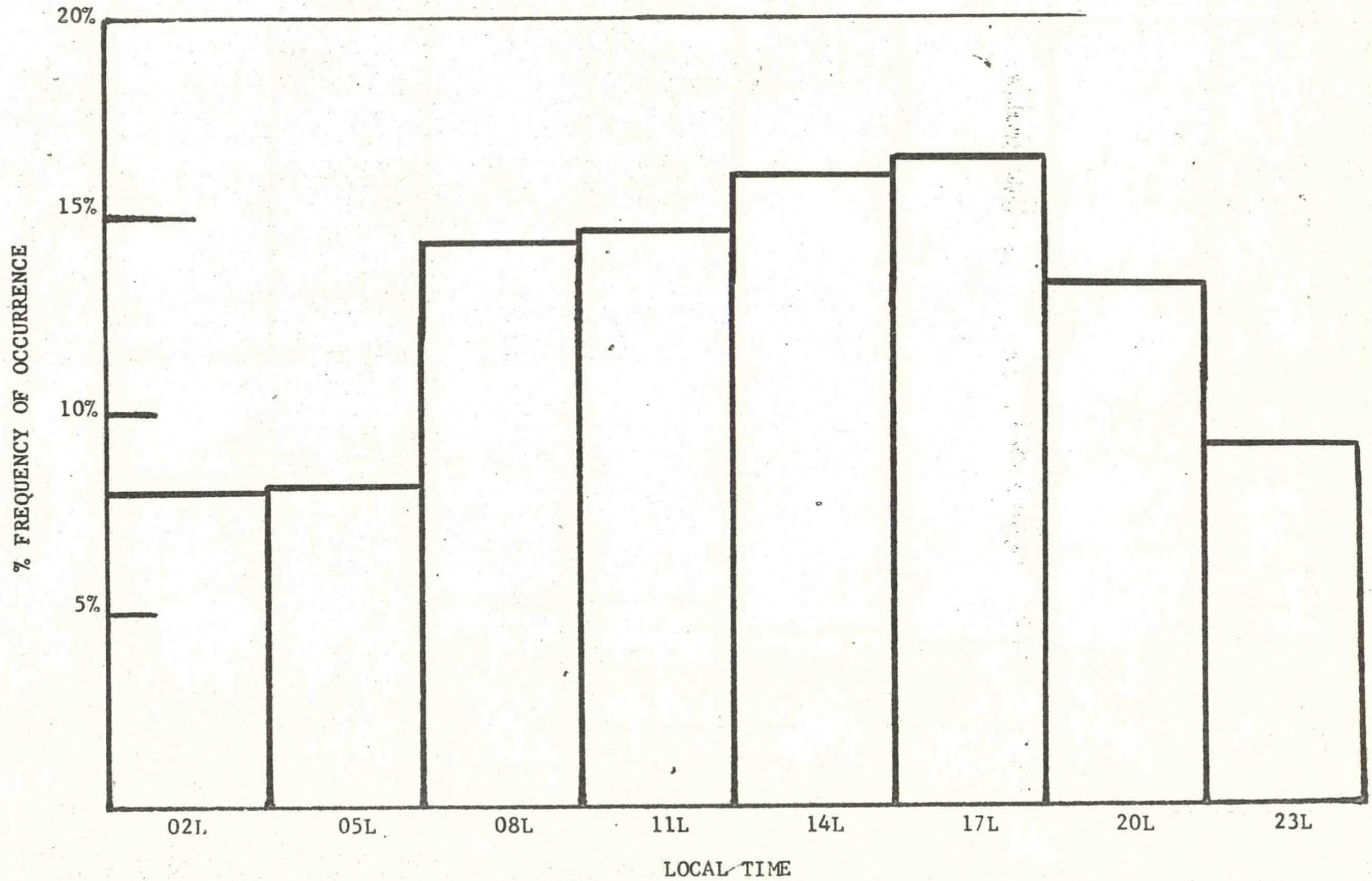


FIG. 13
NOVEMBER 1963-1972
DIURNAL VARIATION OF CIRRUS FREQUENCY

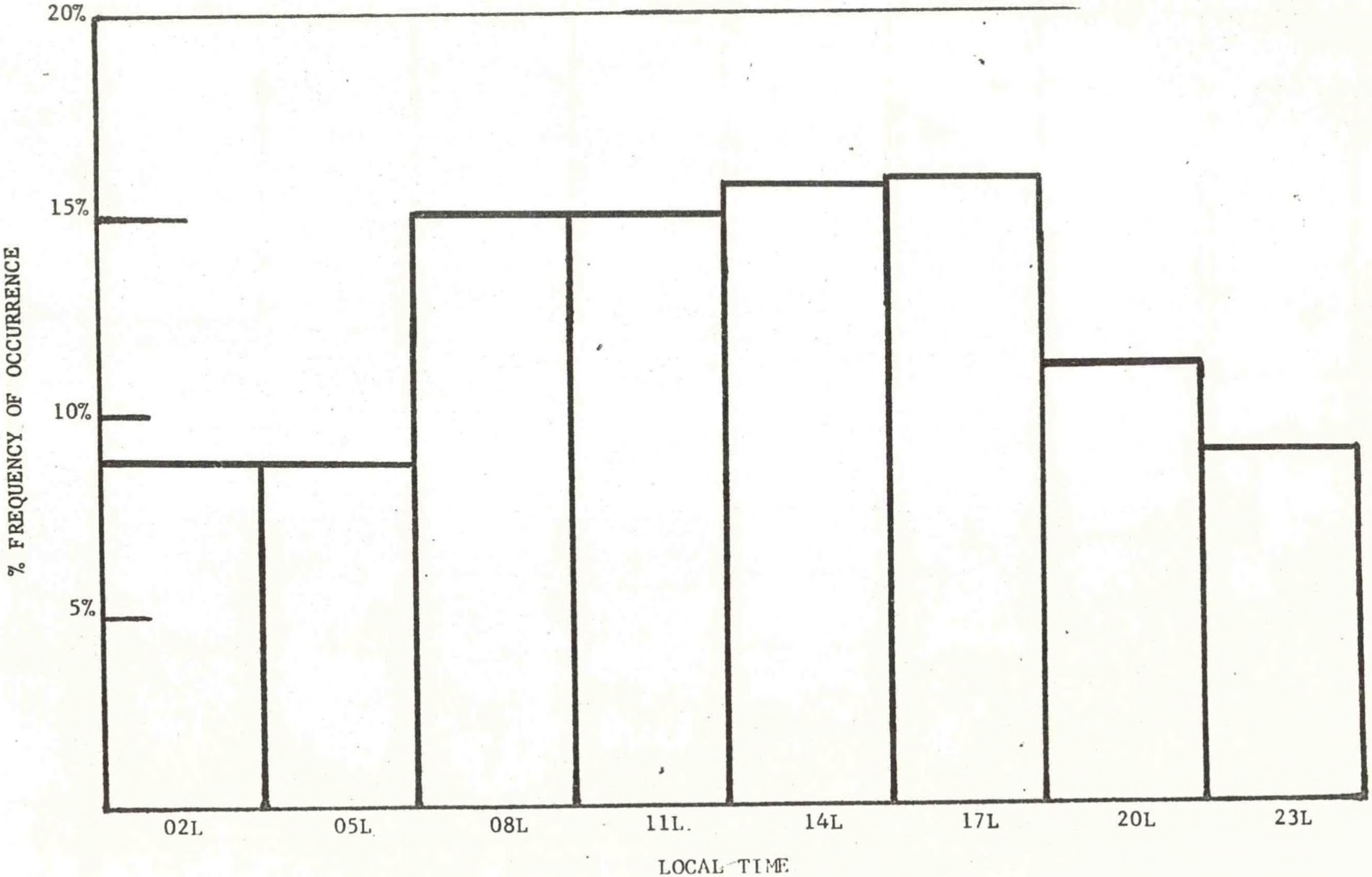


FIG. 14
DECEMBER 1963-1972
DIURNAL VARIATION OF CIRRUS FREQUENCY

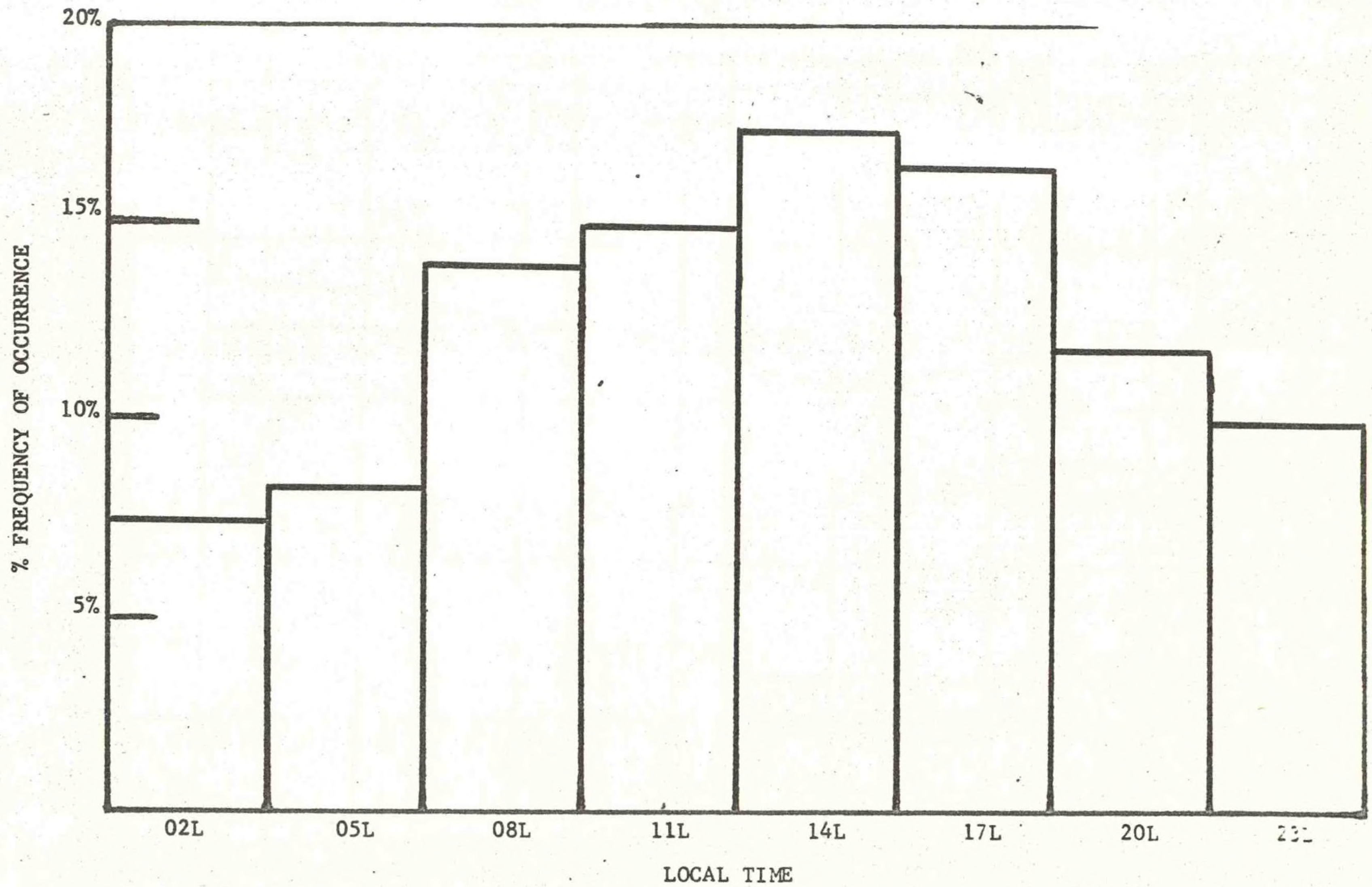


FIG. 15
JANUARY 1963-1972
DIURNAL VARIATION OF CIRRUS (TENTHS)

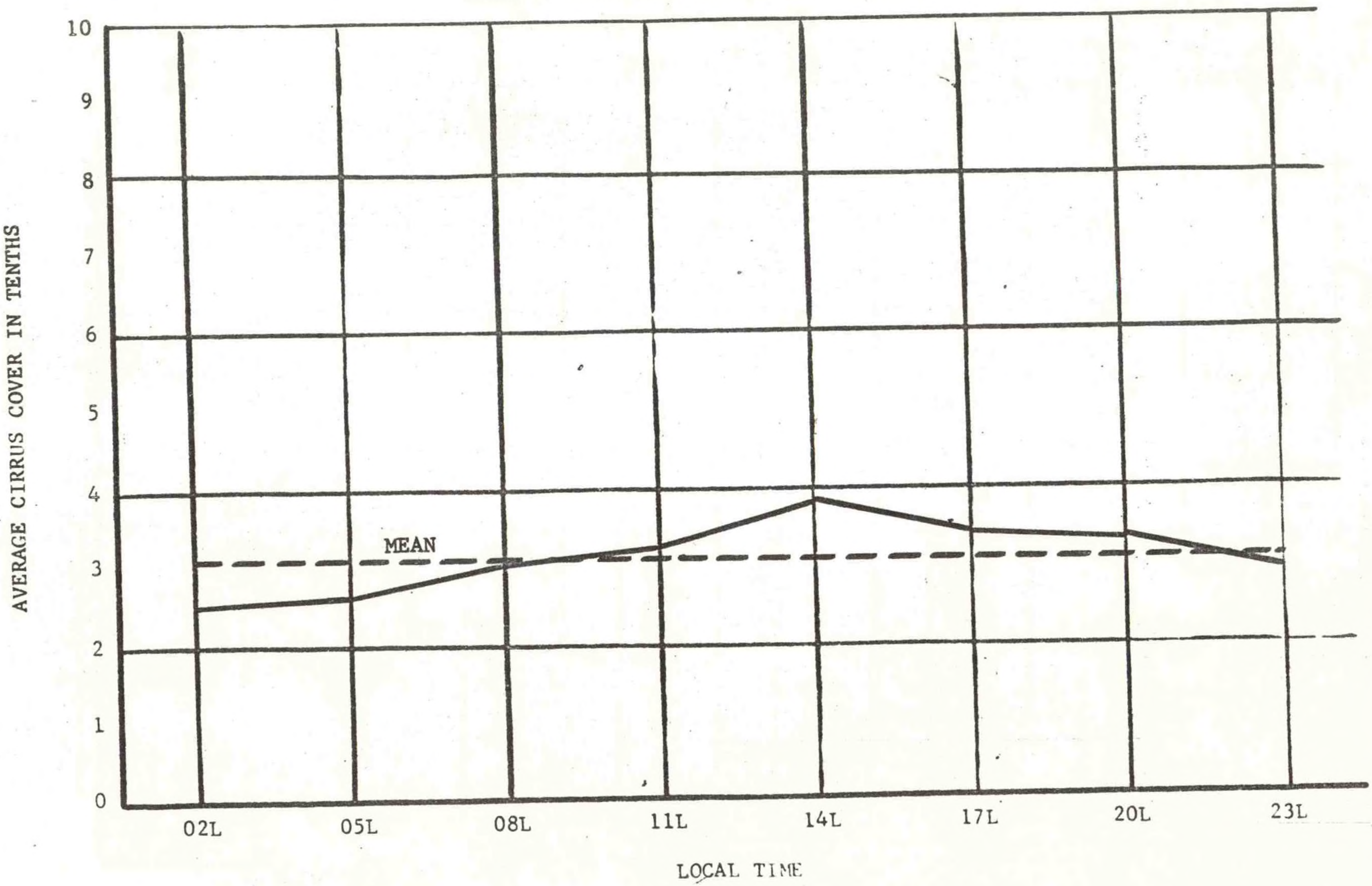


FIG. 16
FEBRUARY 1963-1972
DIURNAL VARIATION OF CIRRUS (TENTHS)

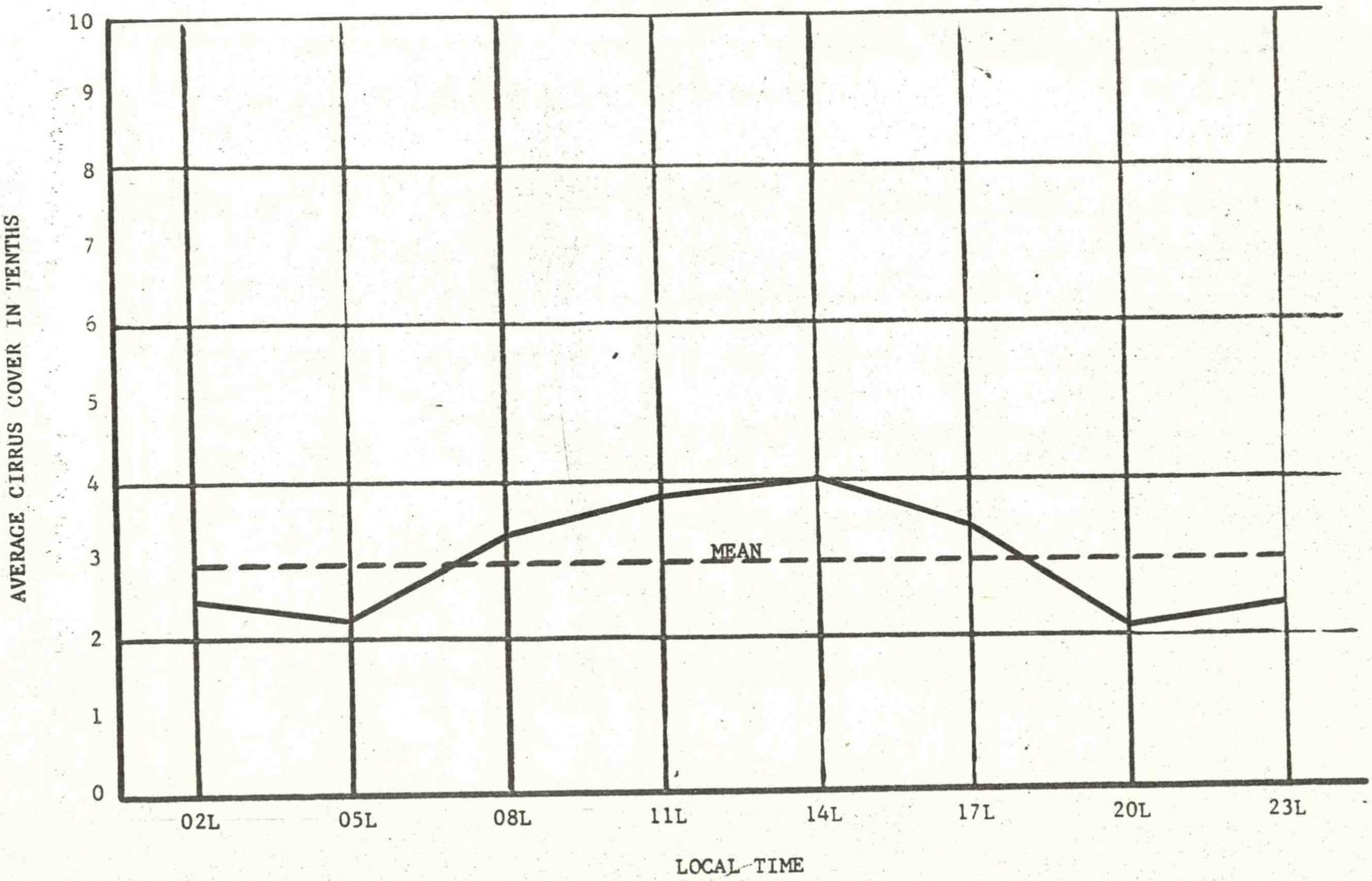


FIG. 17
MARCH 1963-1972
DIURNAL VARIATION OF CIRRUS (TENTHS)

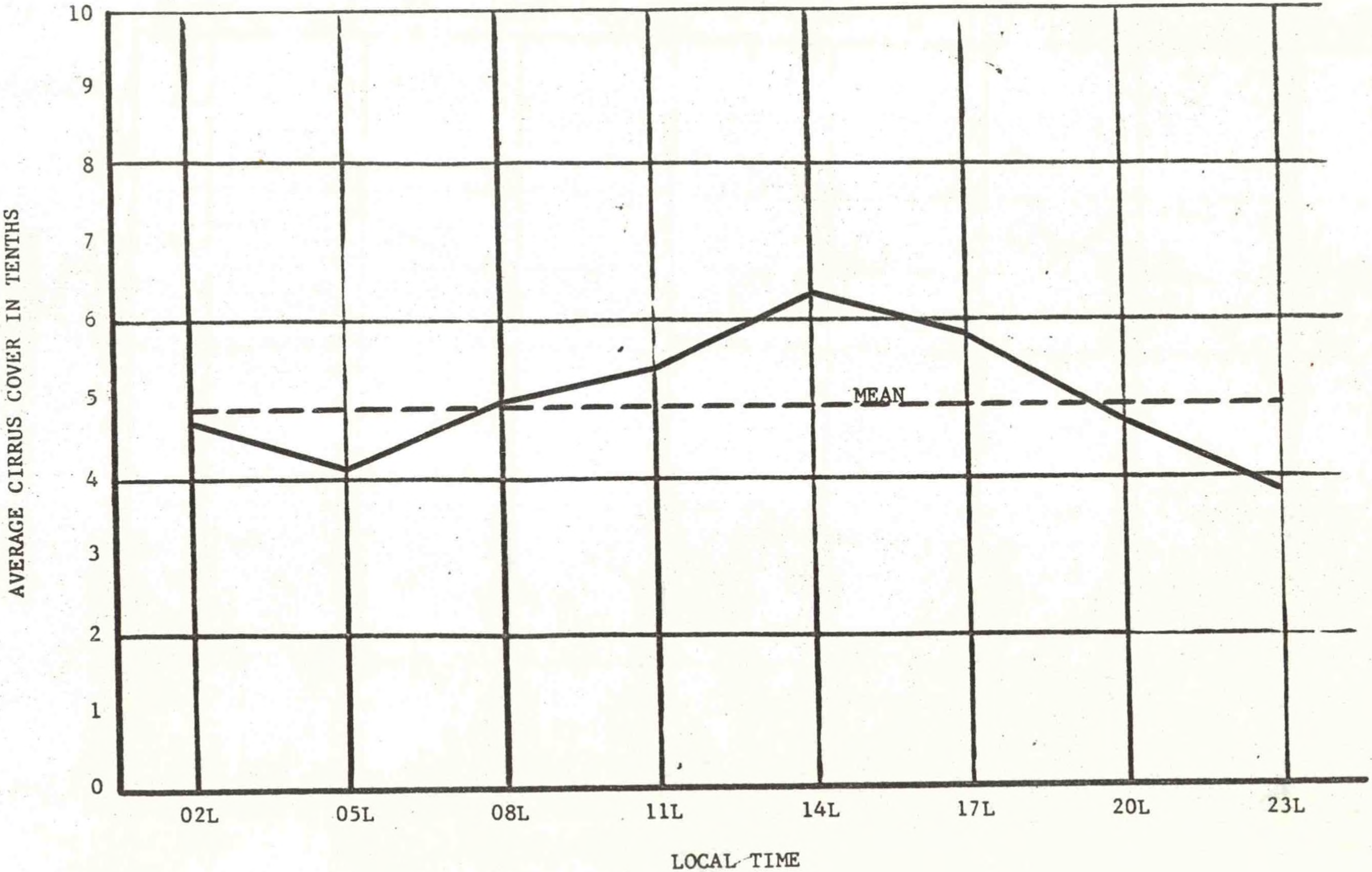


FIG. 18
APRIL 1963-1972
DIURNAL VARIATION OF CIRRUS (TENTHS)

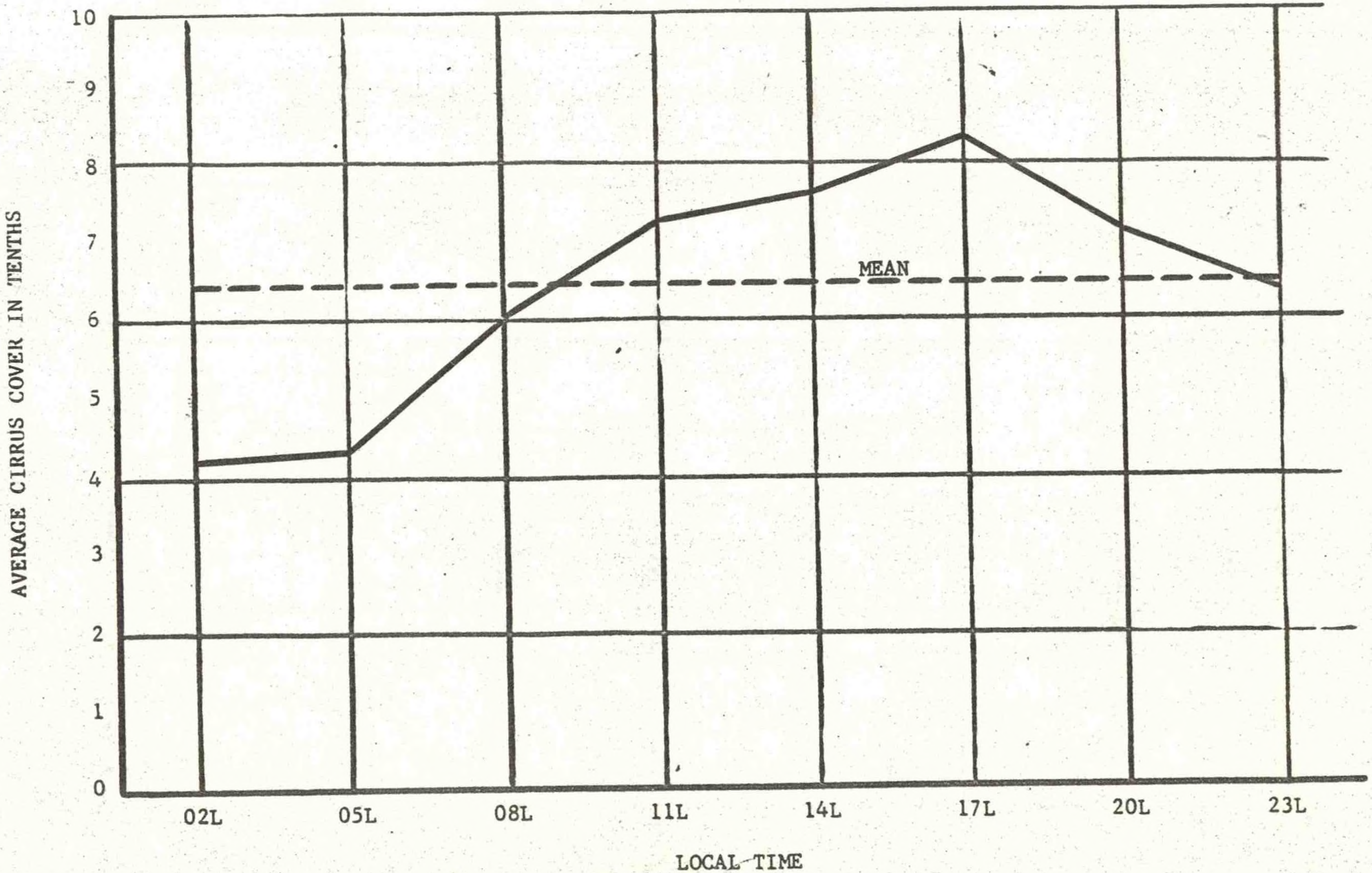


FIG. 19
MAY 1963-1972
DIURNAL VARIATION OF CIRRUS (TENTHS)

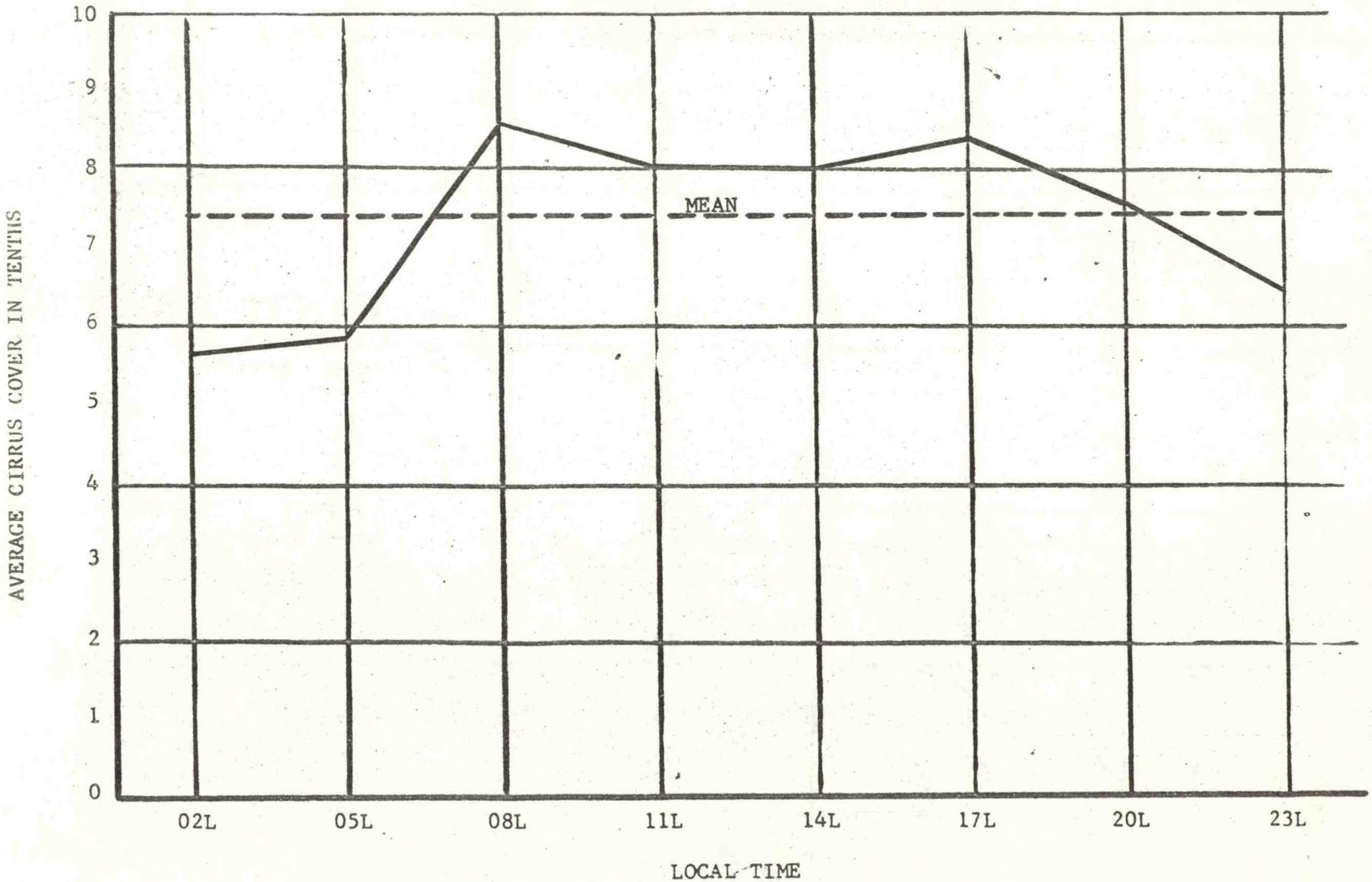


FIG. 20
JUNE 1963-1972
DIURNAL VARIATION OF CIRRUS (TENTHS)

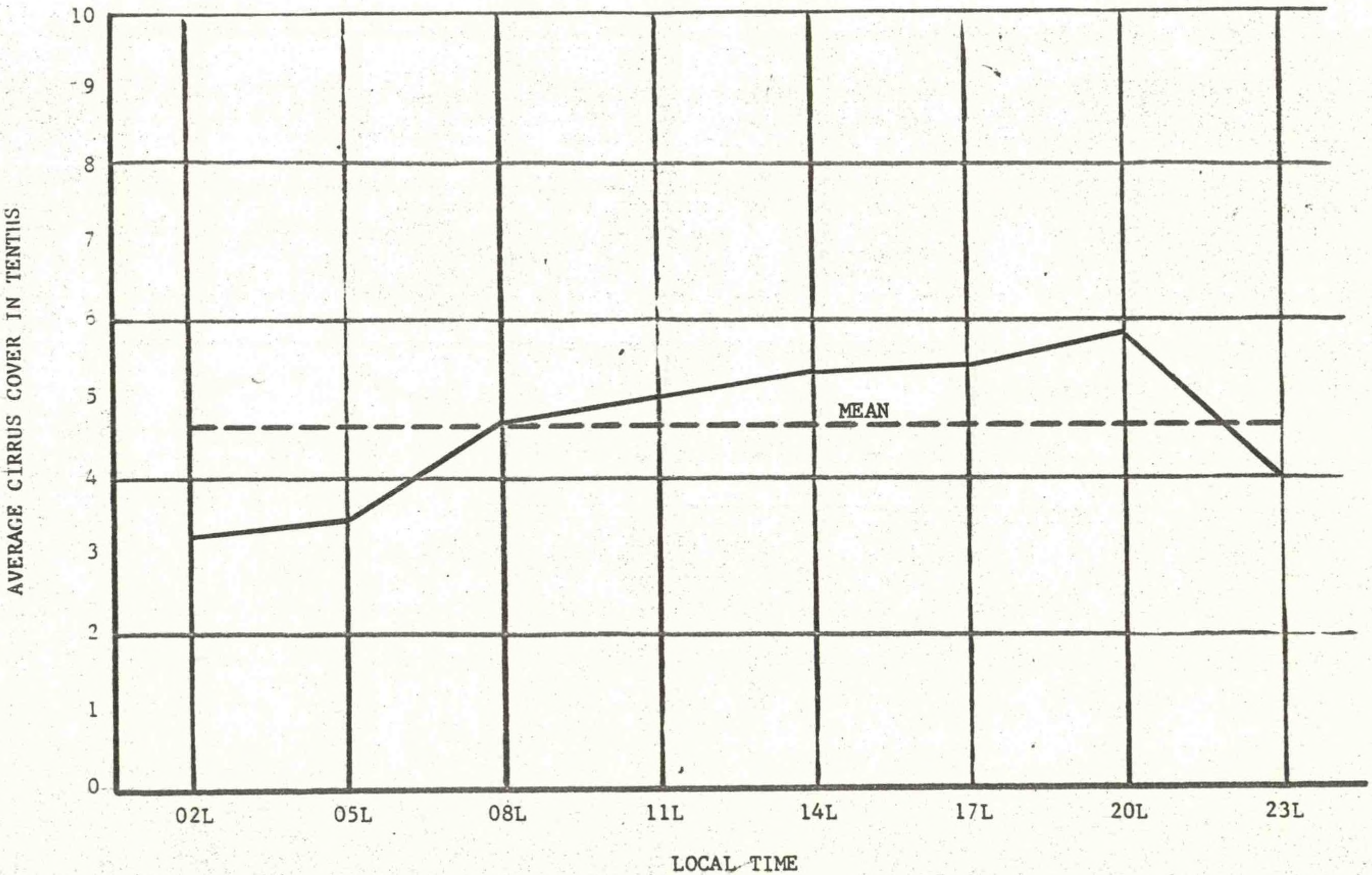


FIG. 21
JULY 1963-1972
DIURNAL VARIATION OF CIRRUS (TENTHS)

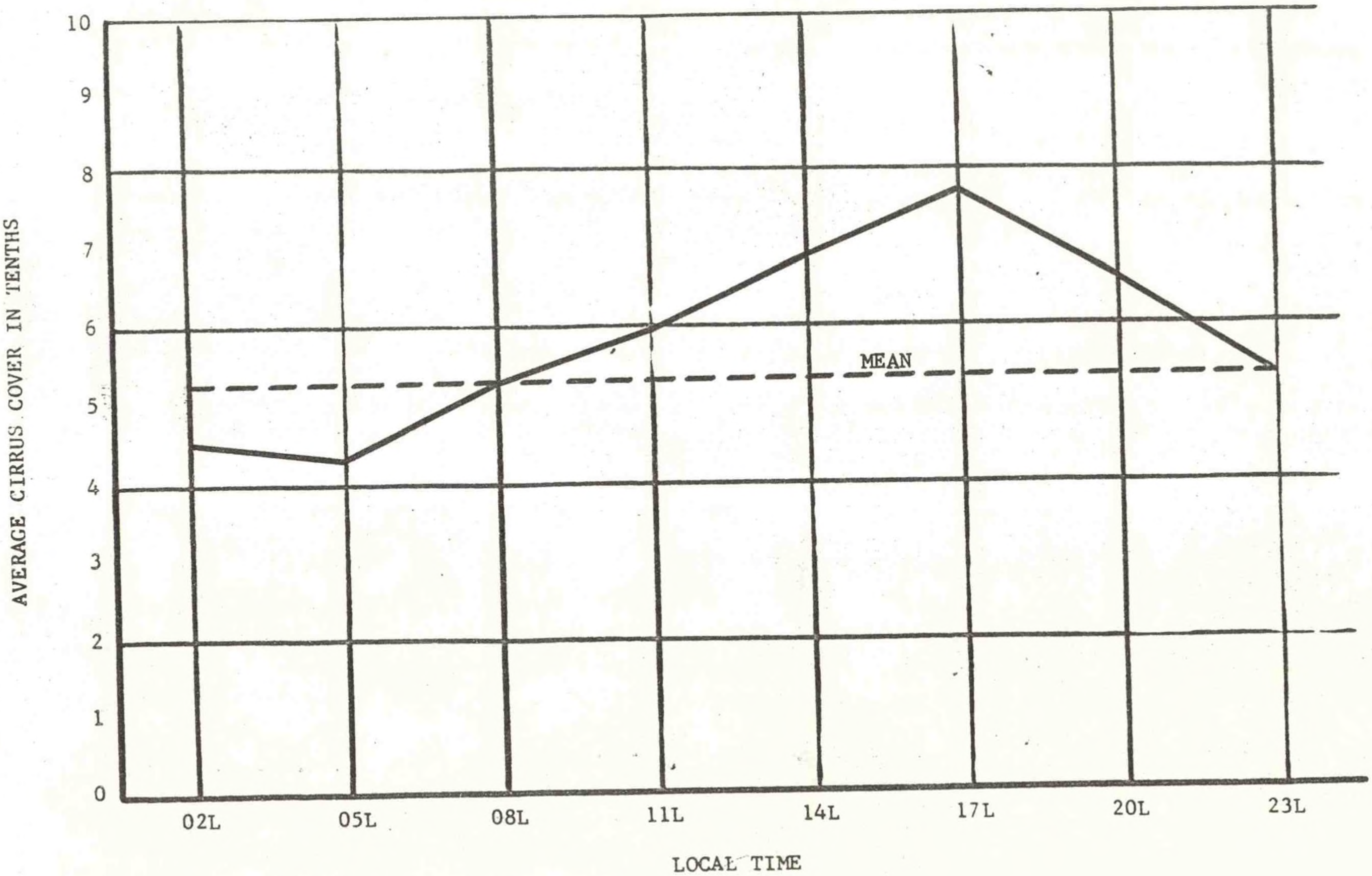


FIG. 22
AUGUST 1963-1972
DIURNAL VARIATION OF CIRRUS (TENTHS)

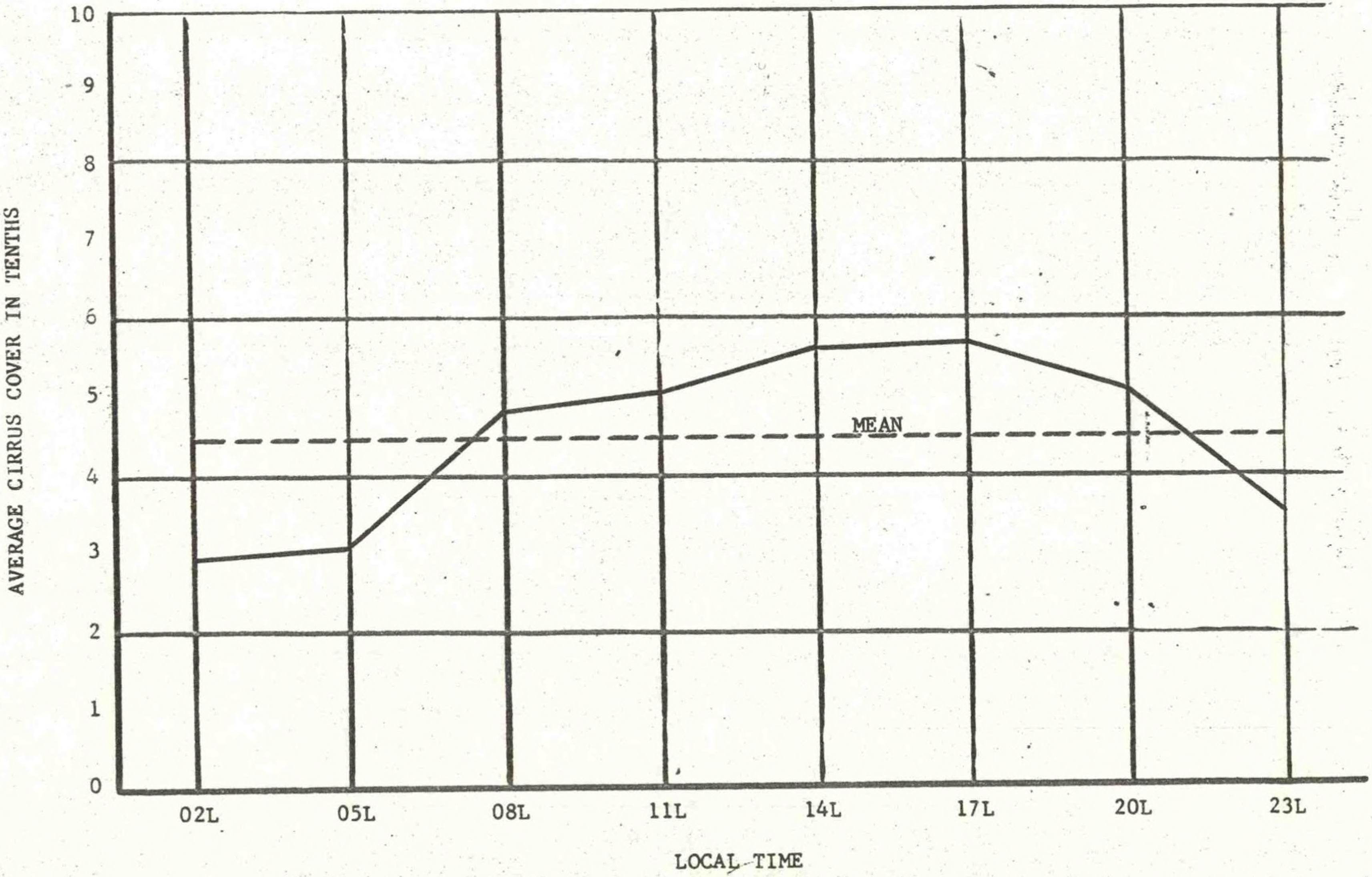


FIG. 23
SEPTEMBER 1963-1972
DIURNAL VARIATION OF CIRRUS (TENTHS)

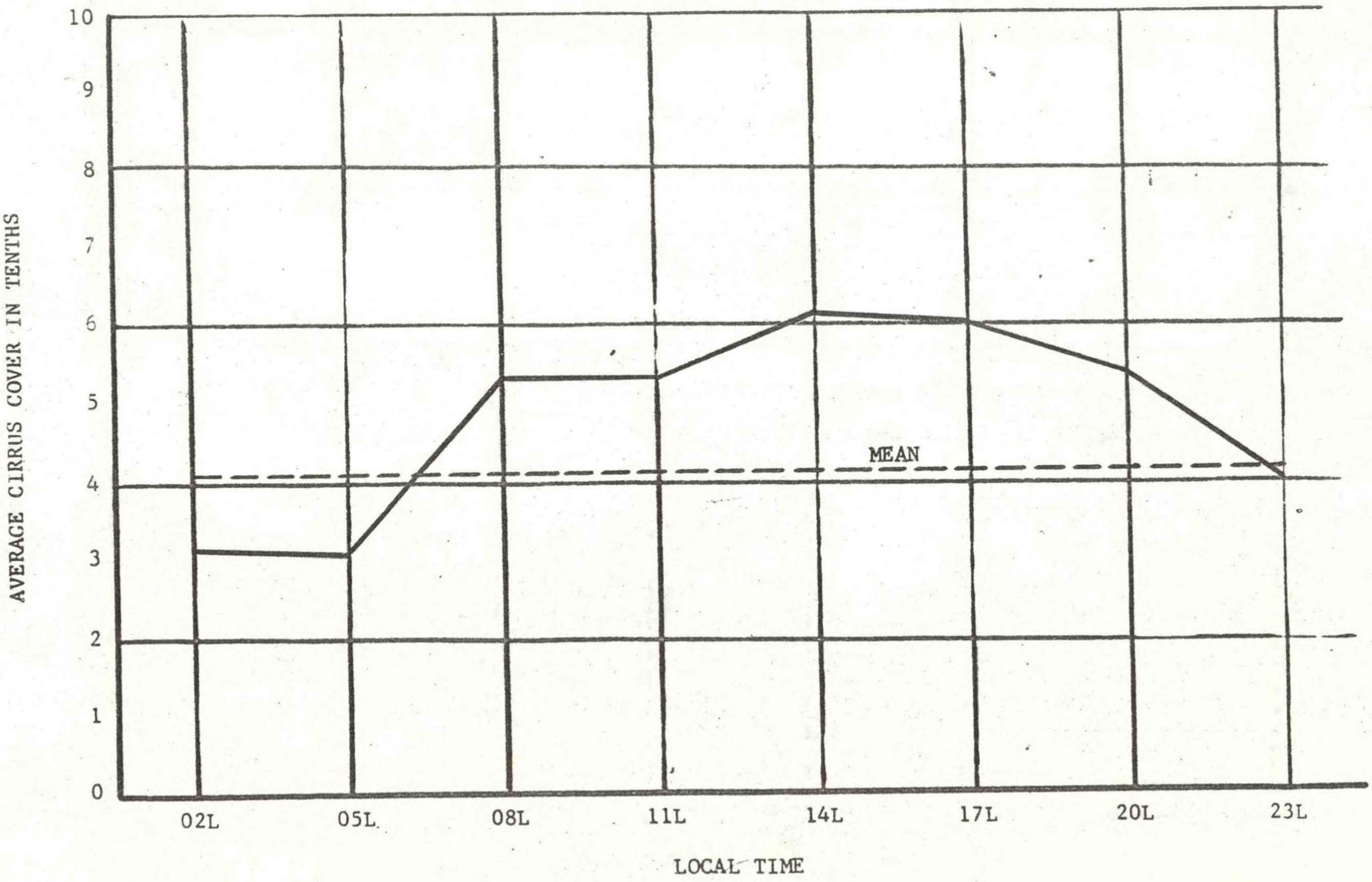


FIG. 24
OCTOBER 1963-1972
DIURNAL VARIATION OF CIRRUS (TENTHS)

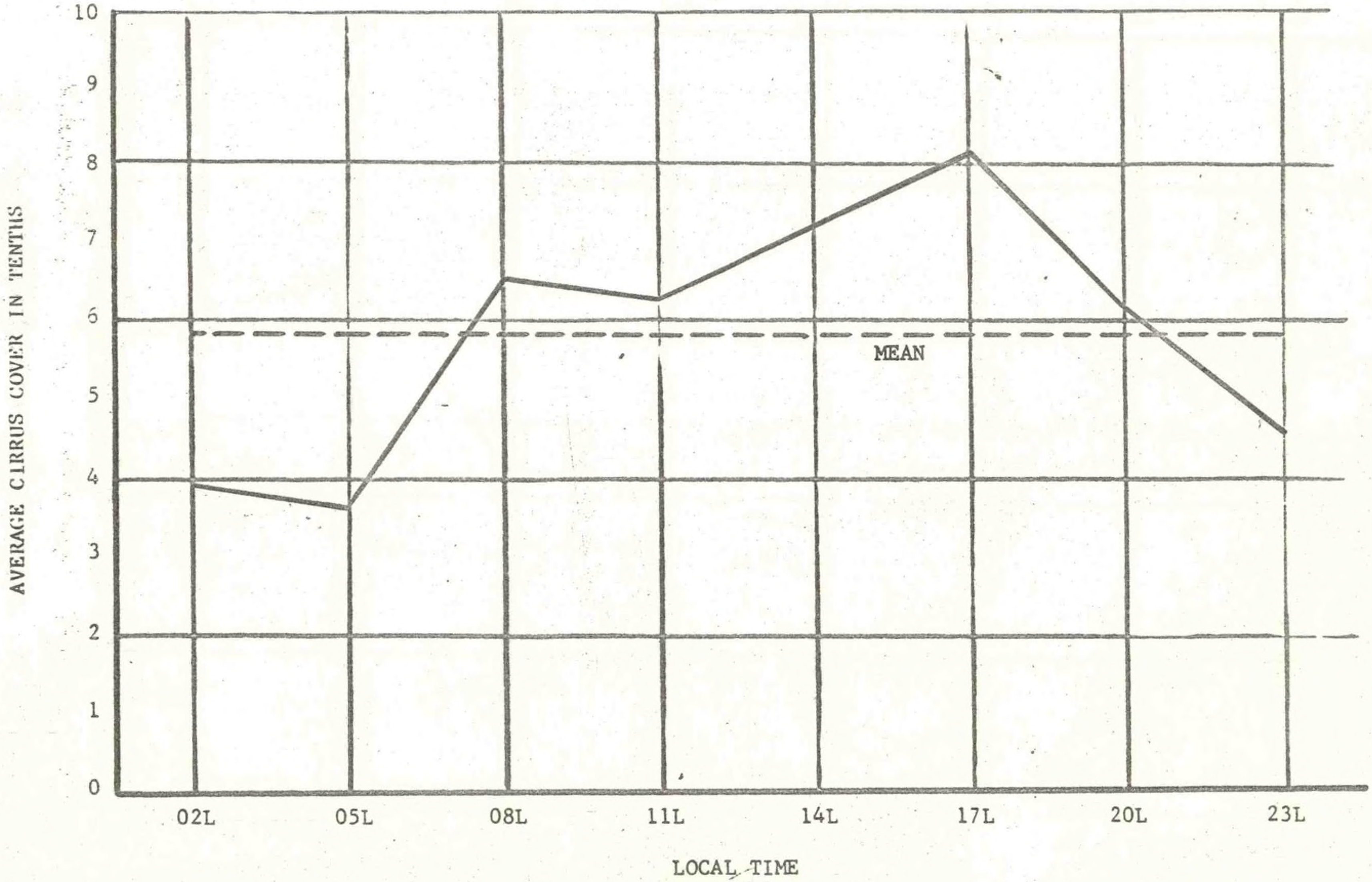


FIG. 25
NOVEMBER 1963-1972
DIURNAL VARIATION OF CIRRUS (TENTHS)

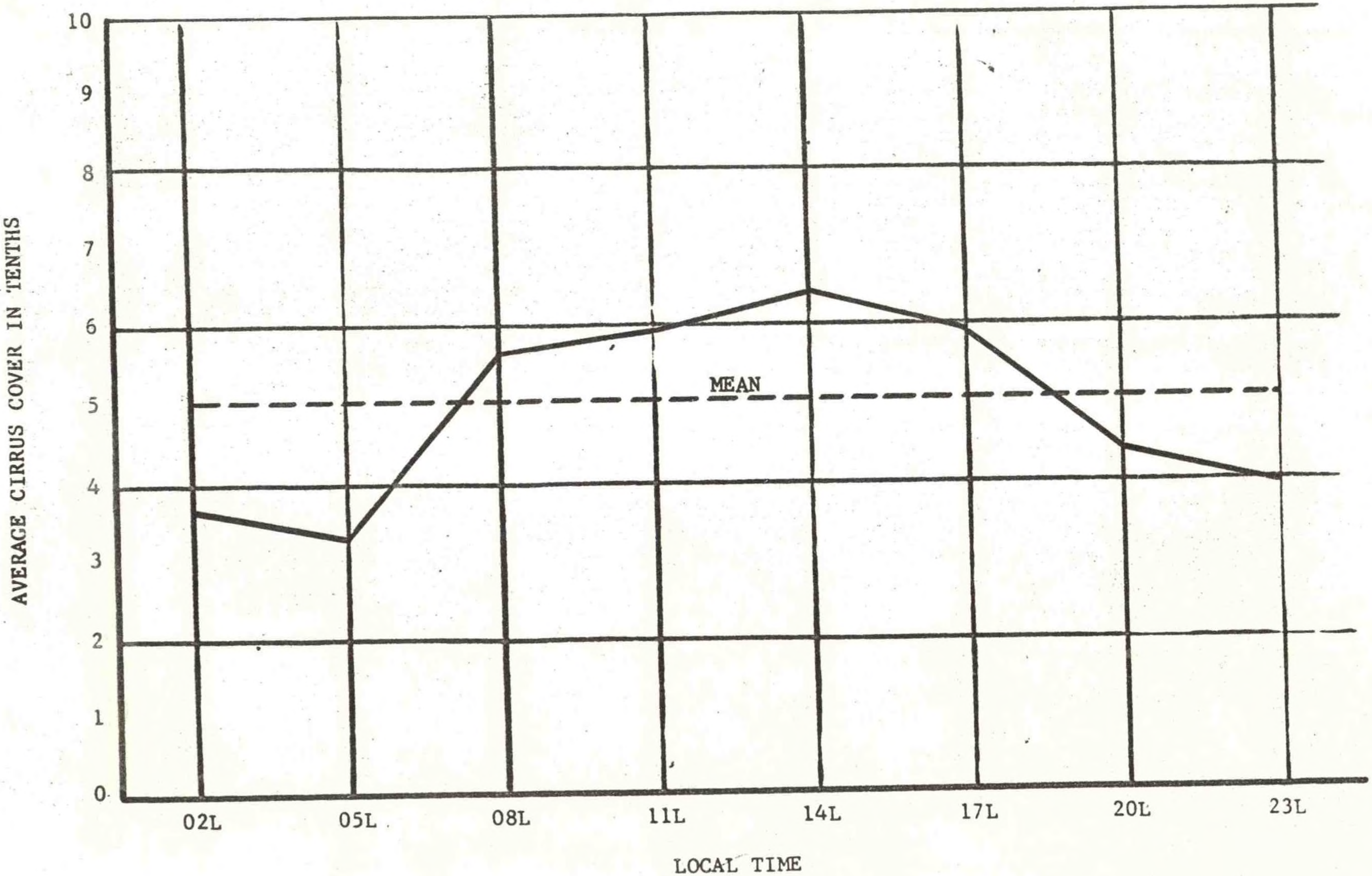
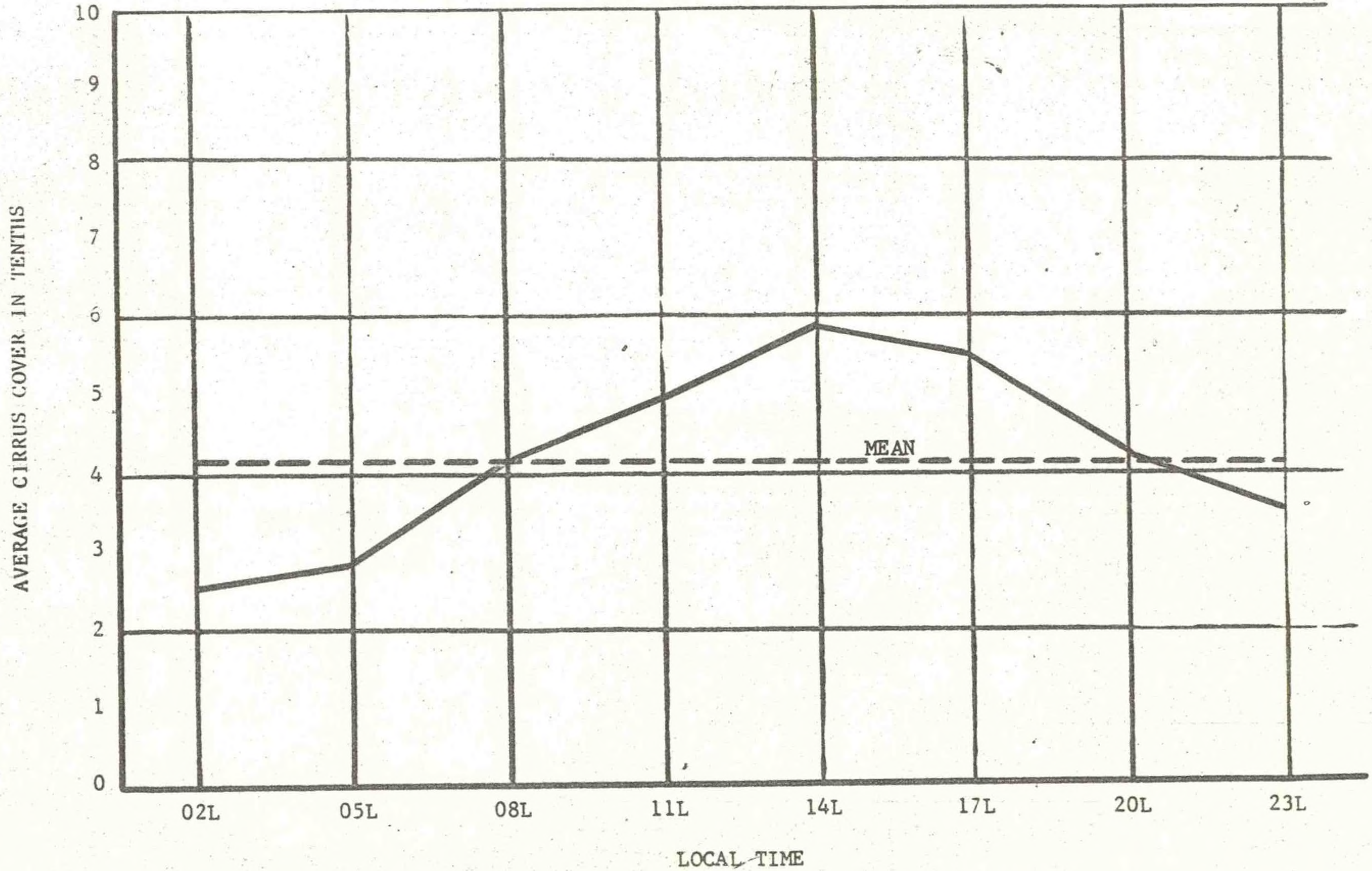


FIG. 26
DECEMBER 1963-1972
DIURNAL VARIATION OF CIRRUS (TENTHS)



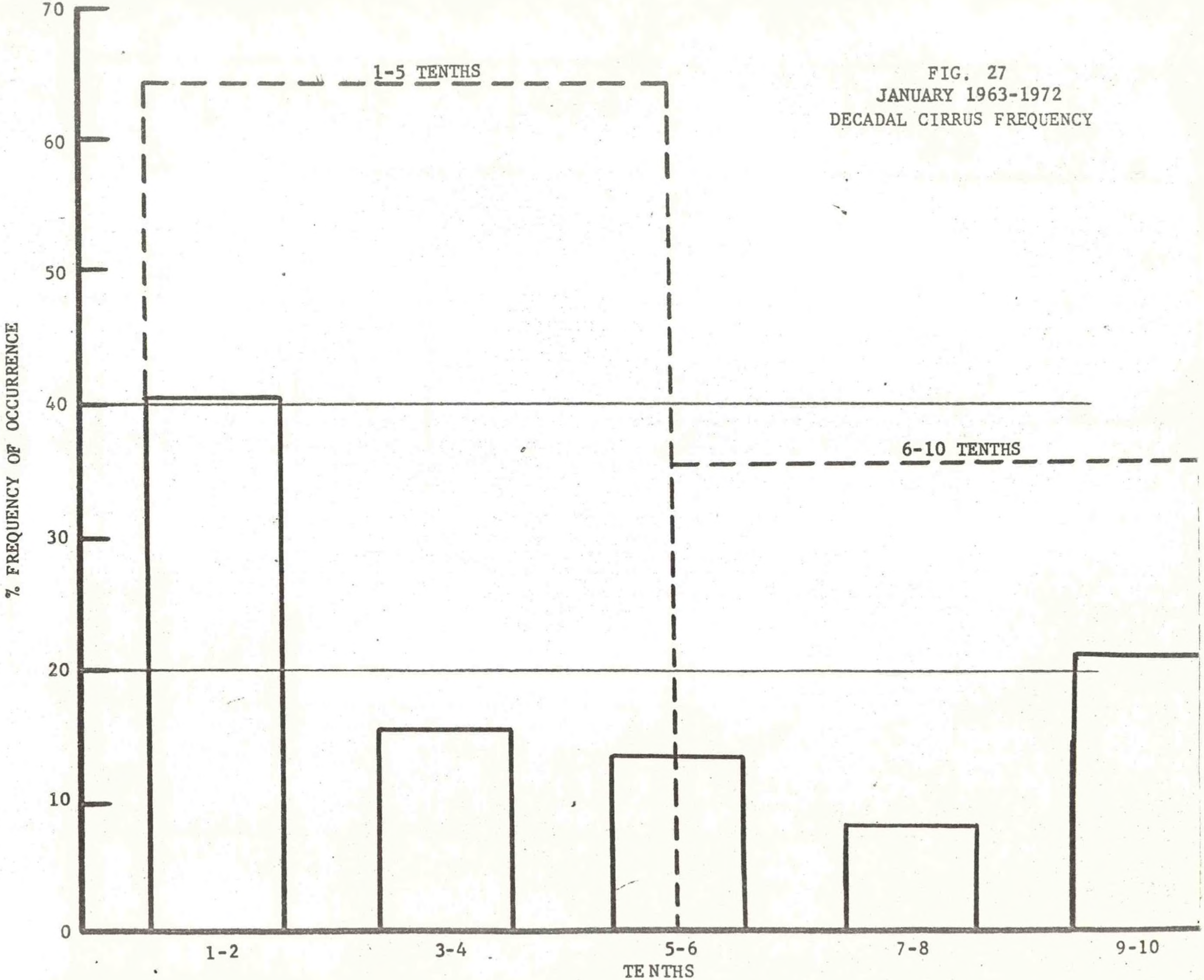


FIG. 27
JANUARY 1963-1972
DECADAL CIRRUS FREQUENCY

FIG. 28
FEBRUARY 1963-1972
DECADAL CIRRUS FREQUENCY

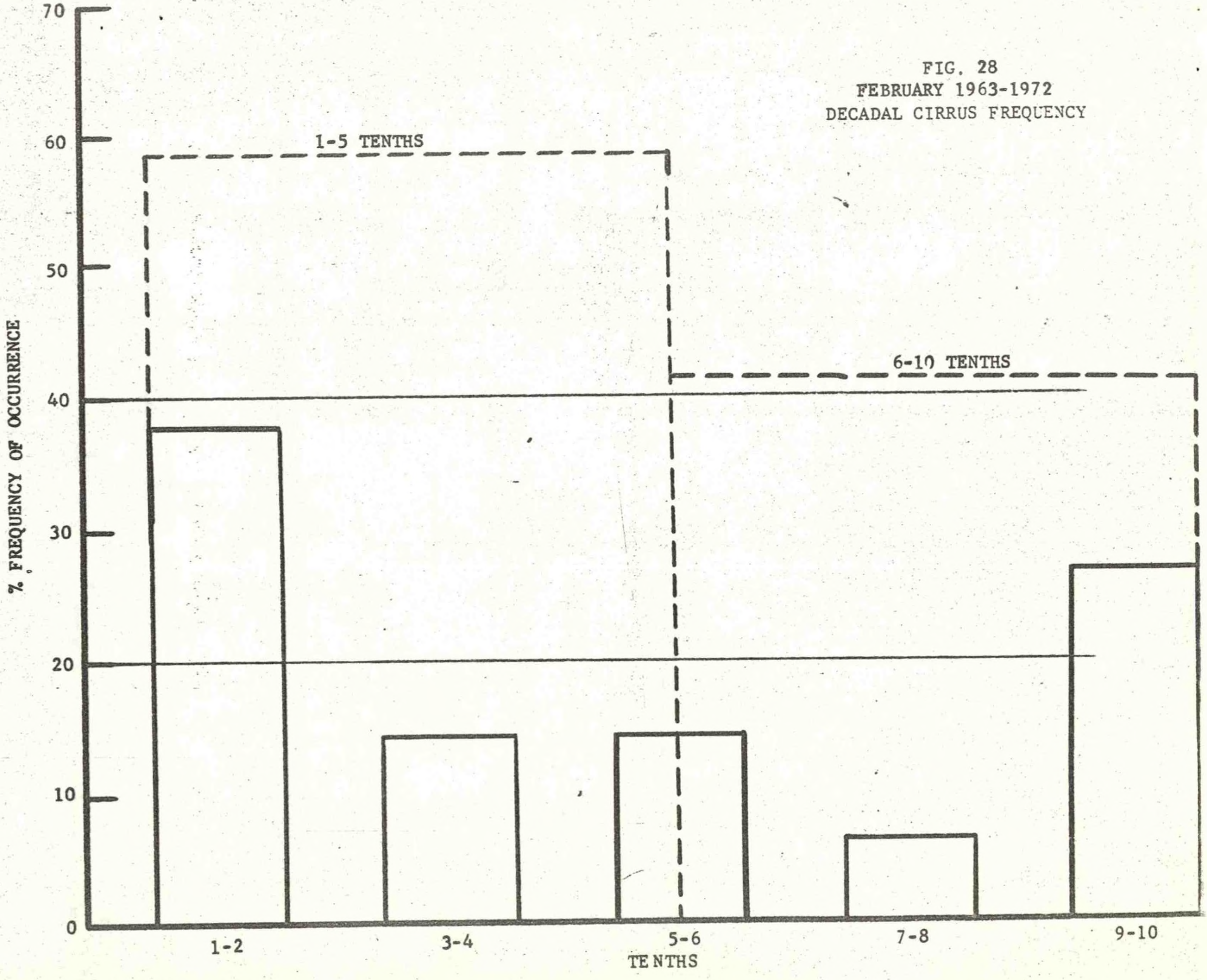


FIG. 29
MARCH 1963-1972
DECADAL CIRRUS FREQUENCY

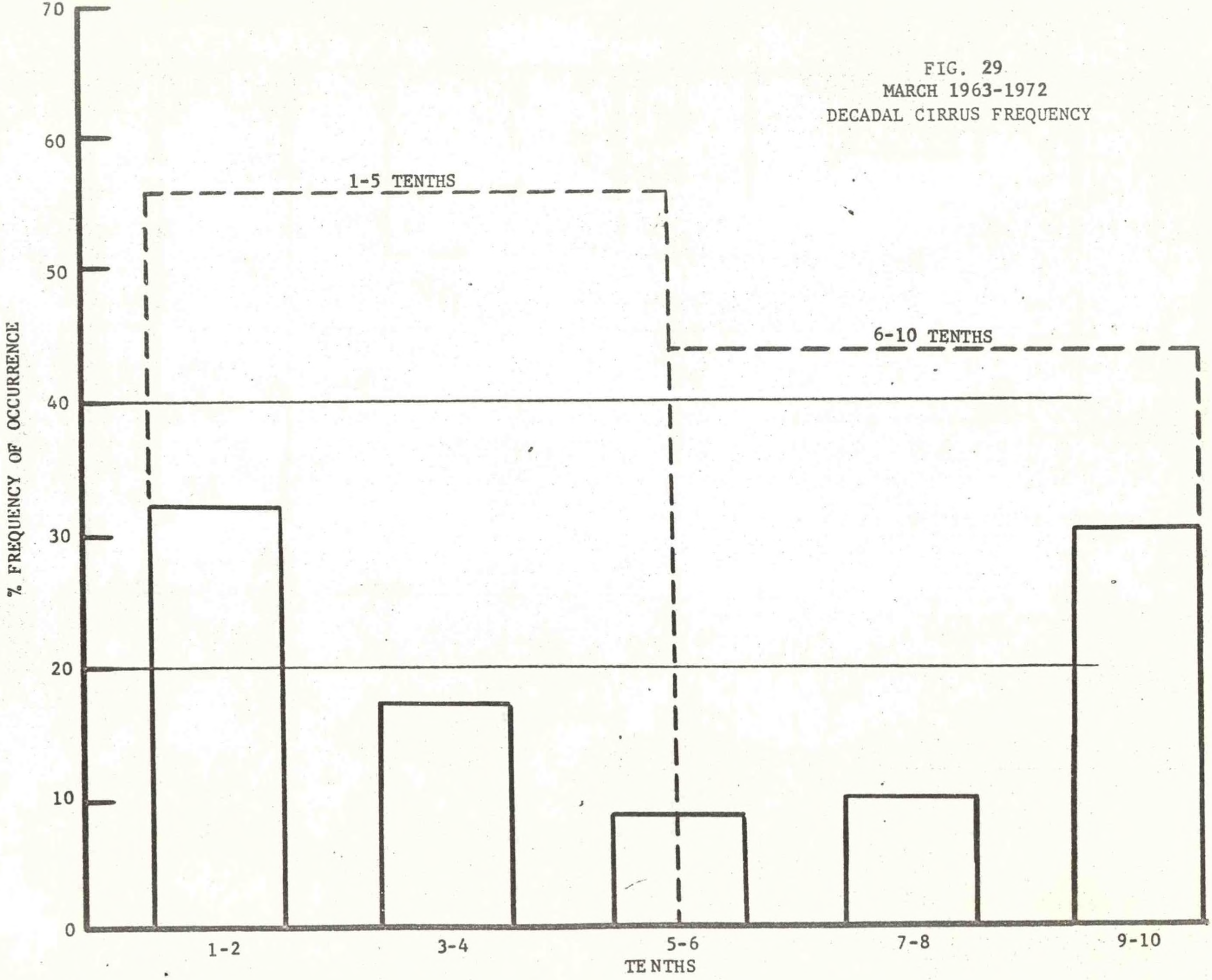


FIG. 30
APRIL 1963-1972
DECADAL CIRRUS FREQUENCY

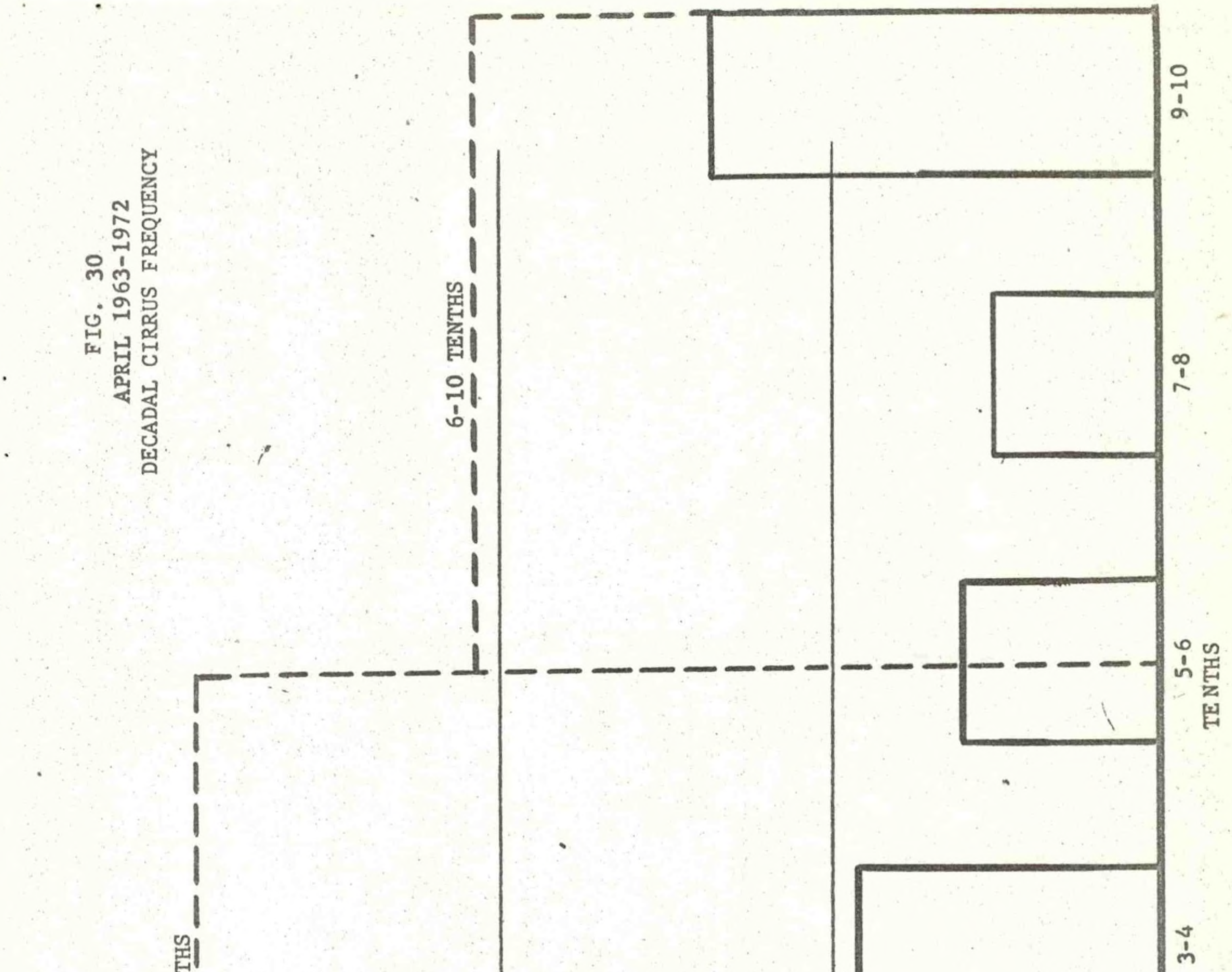


FIG. 31
MAY 1963-1972
DECADAL CIRRUS FREQUENCY

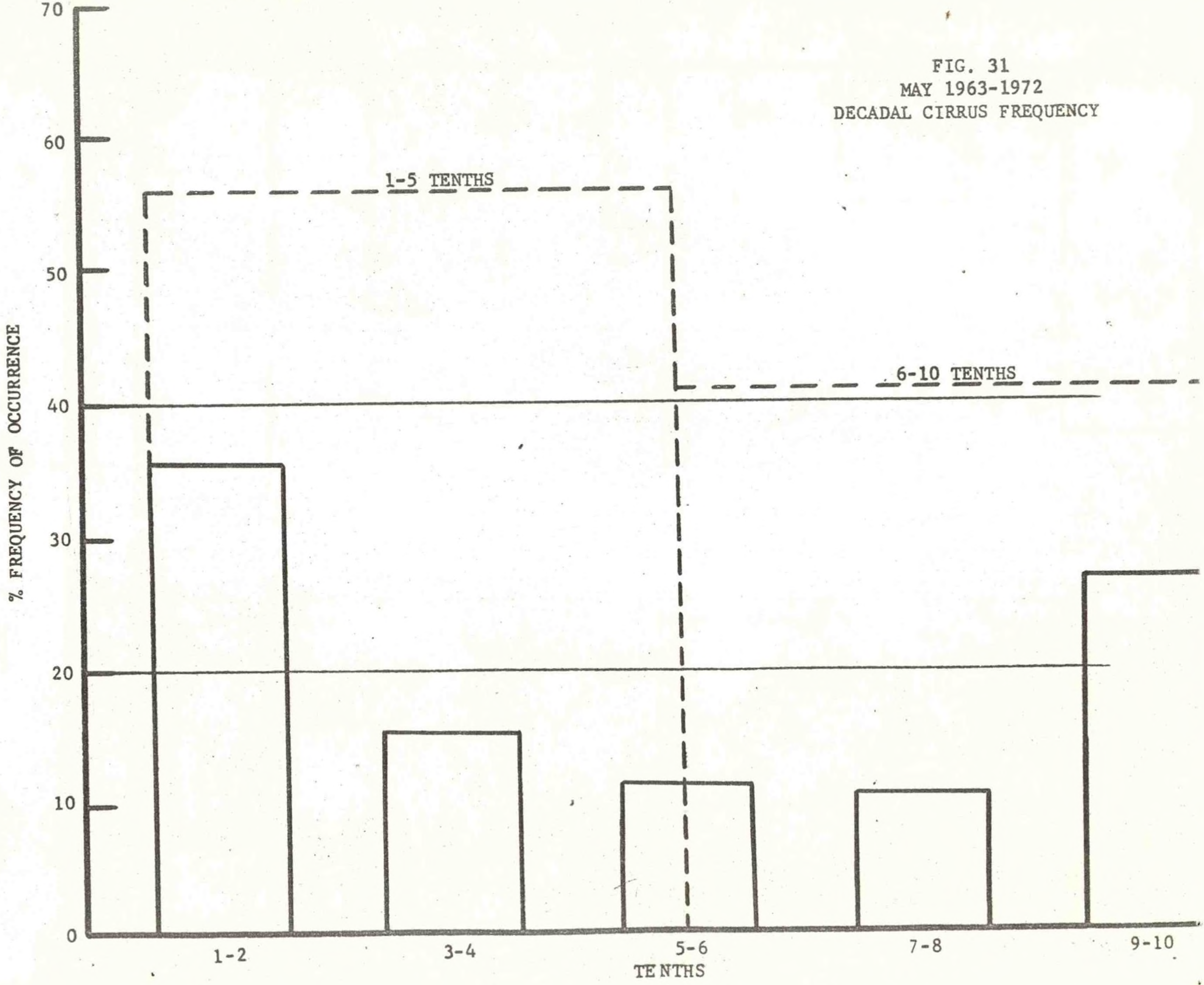


FIG. 32
JUNE 1963-1972
DECADAL CIRRUS FREQUENCY

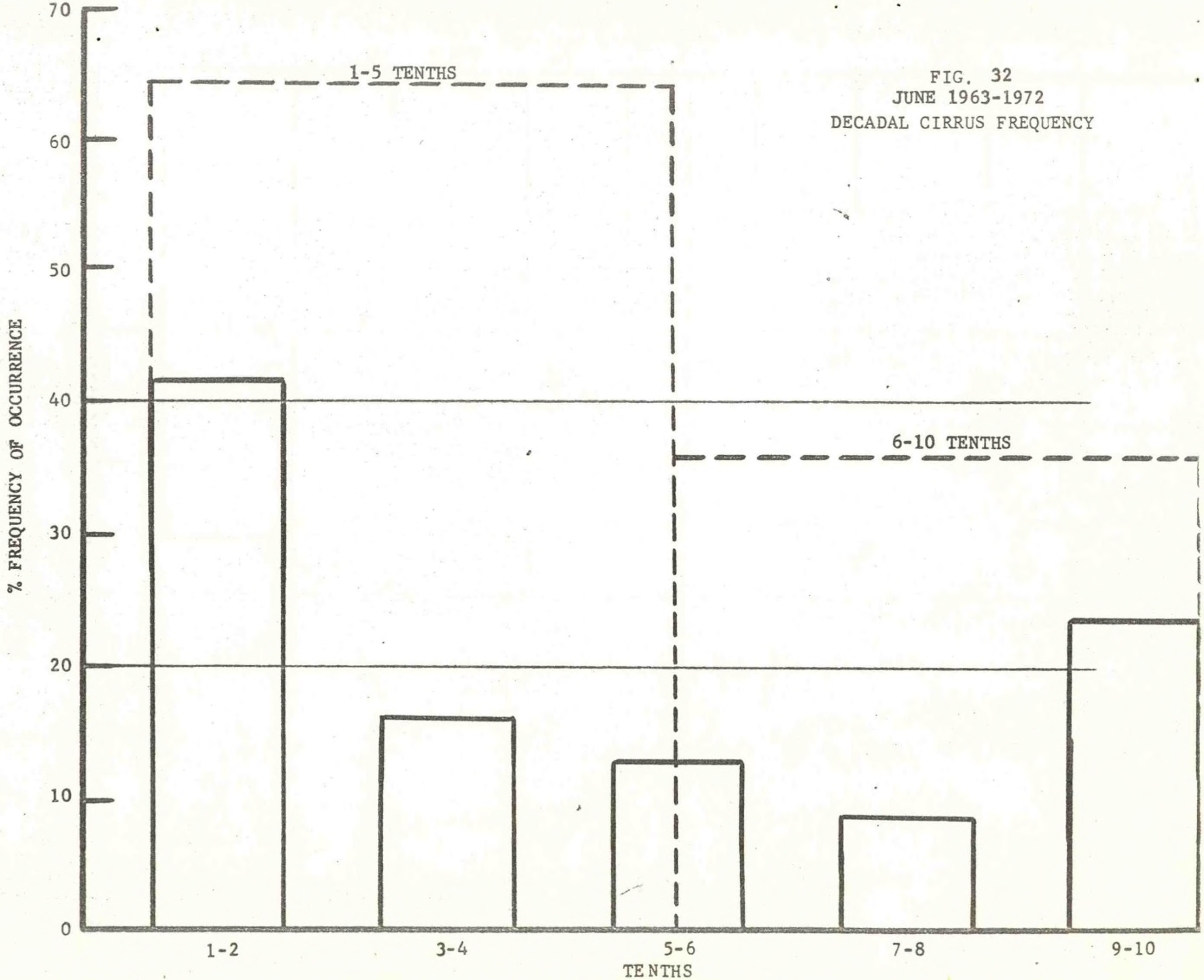
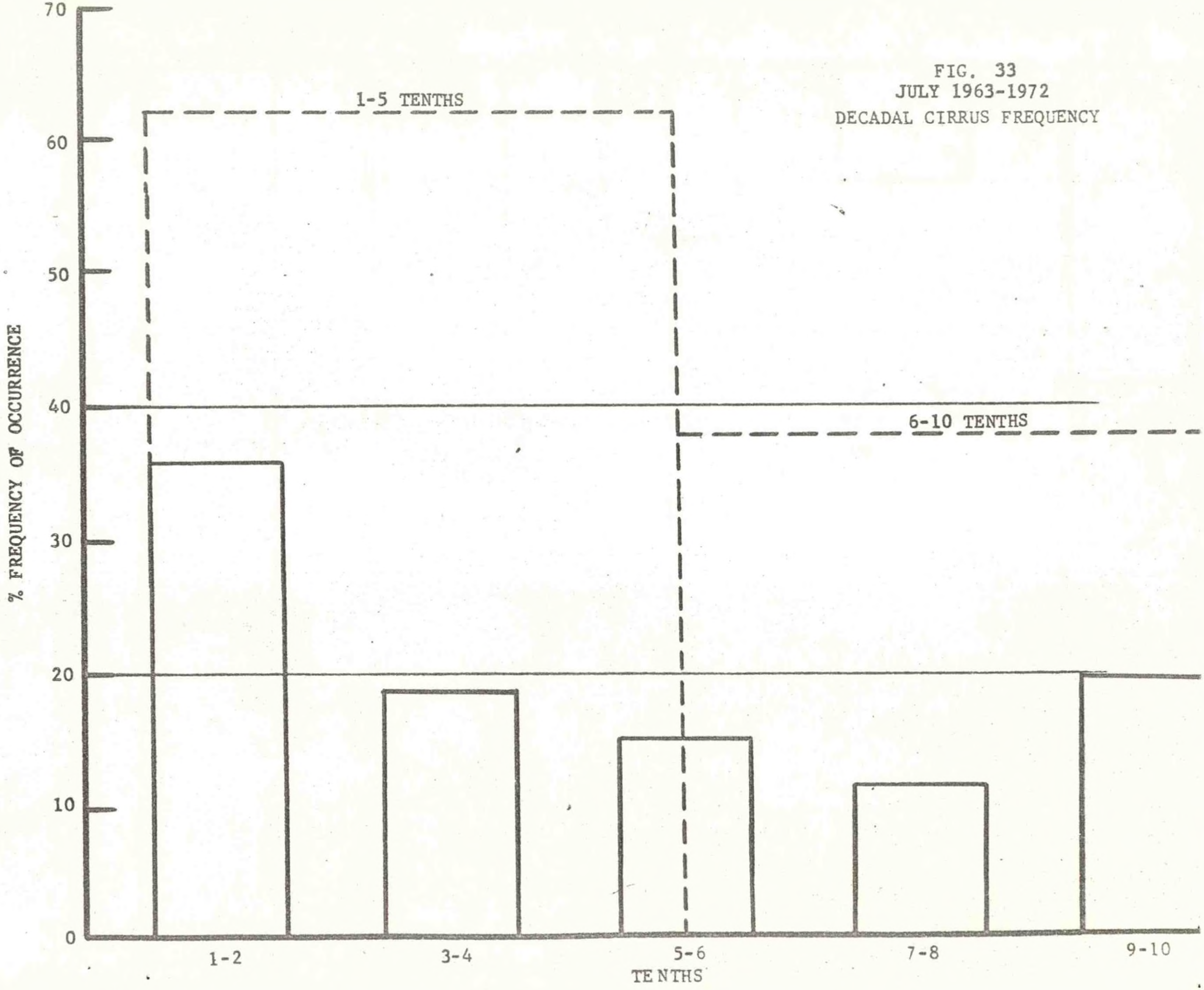


FIG. 33
JULY 1963-1972
DECADAL CIRRUS FREQUENCY



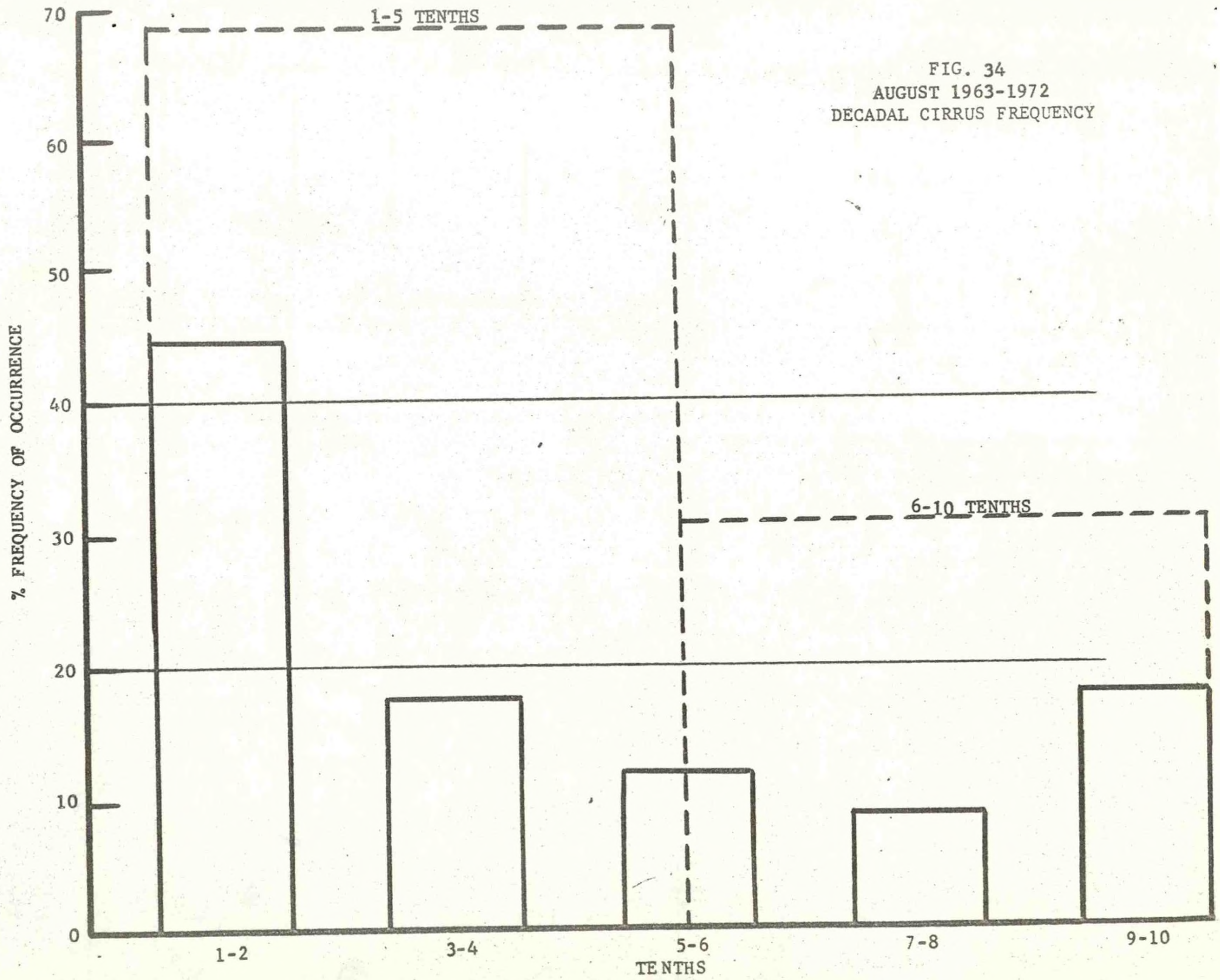


FIG. 34
AUGUST 1963-1972
DECADAL CIRRUS FREQUENCY

FIG. 35
SEPTEMBER 1963-1972
DECADAL CIRRUS FREQUENCY

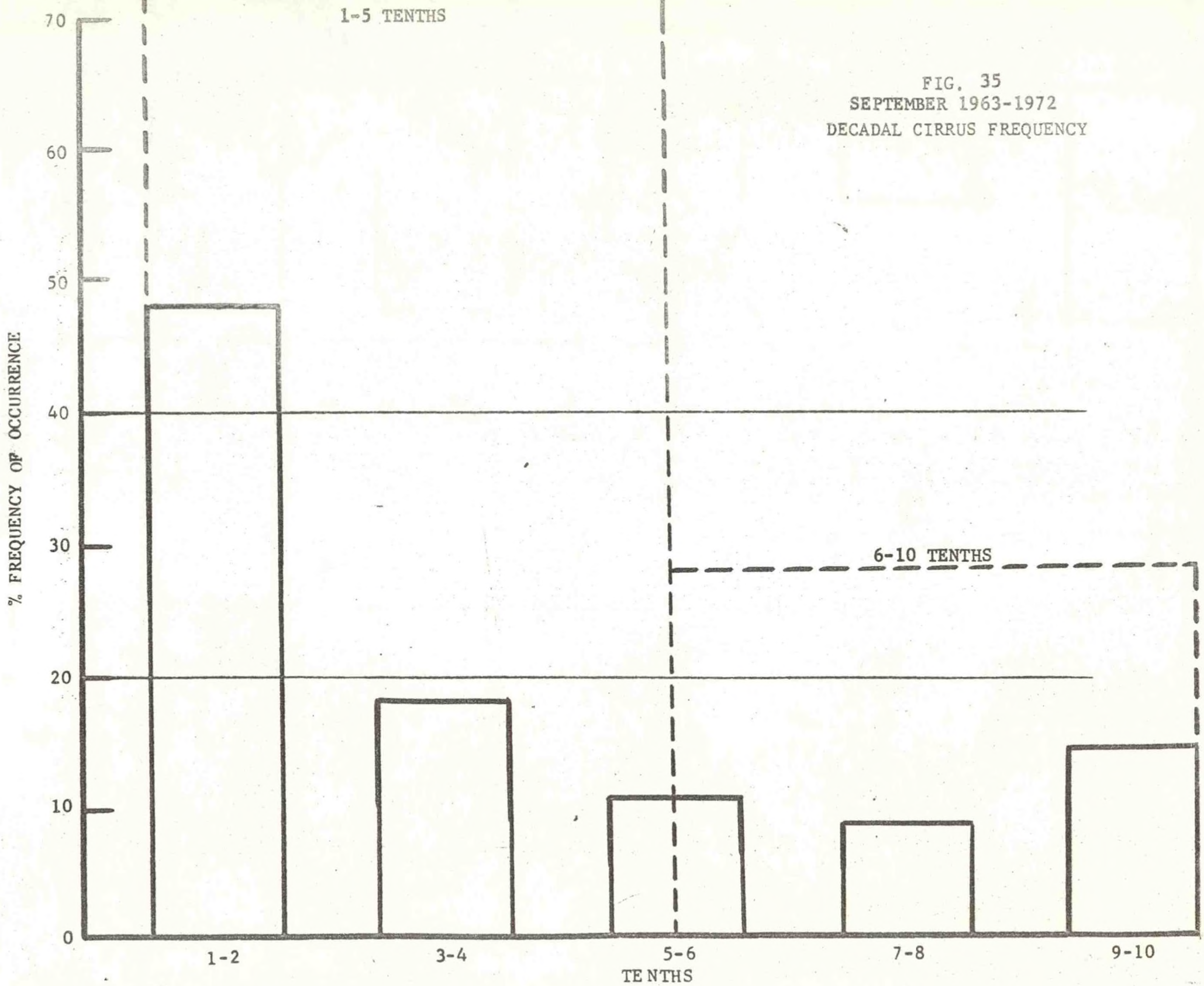


FIG. 36
OCTOBER 1963-1972
DECADAL CIRRUS FREQUENCY

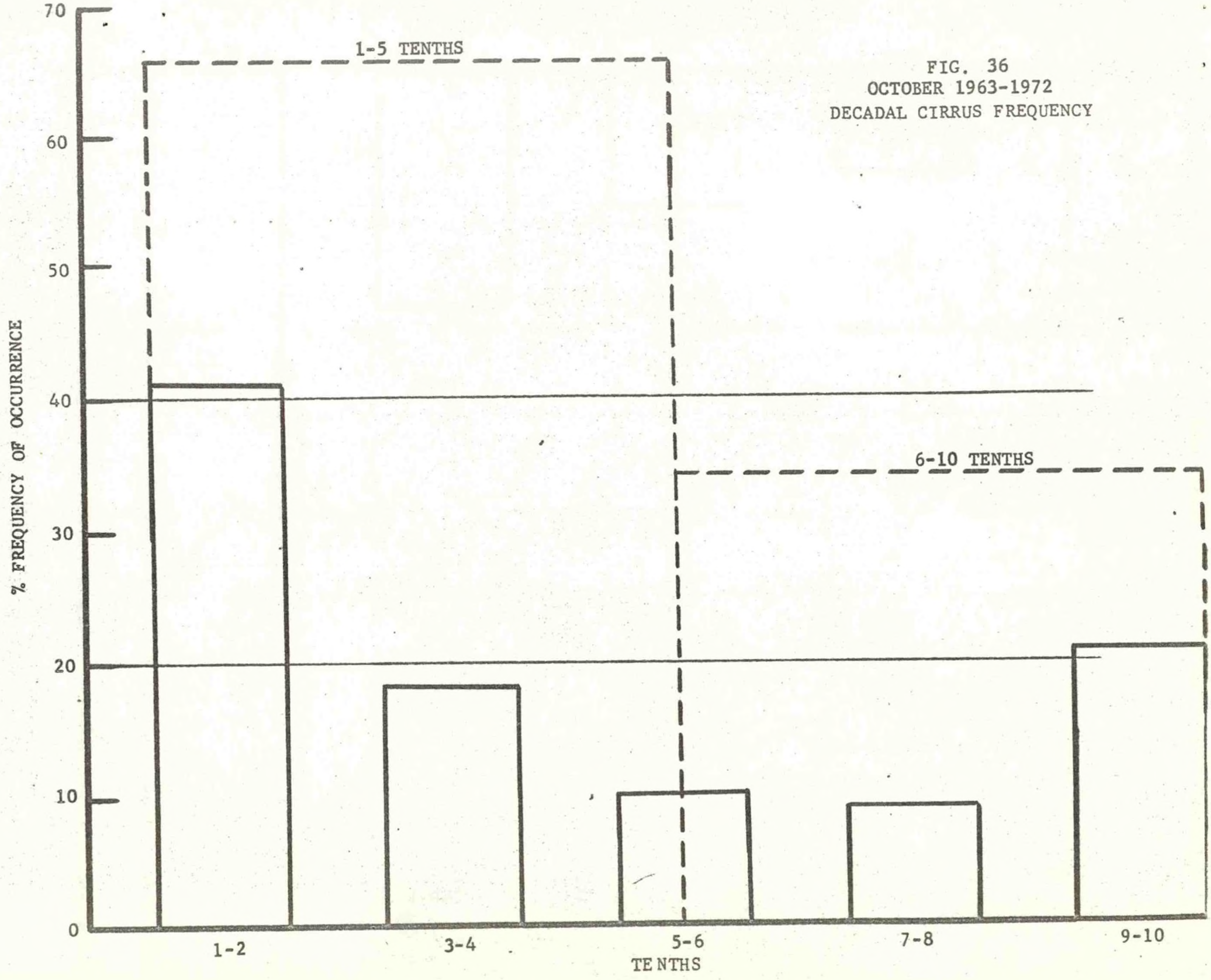


FIG. 37
NOVEMBER 1963-1972
DECADAL CIRRUS FREQUENCY

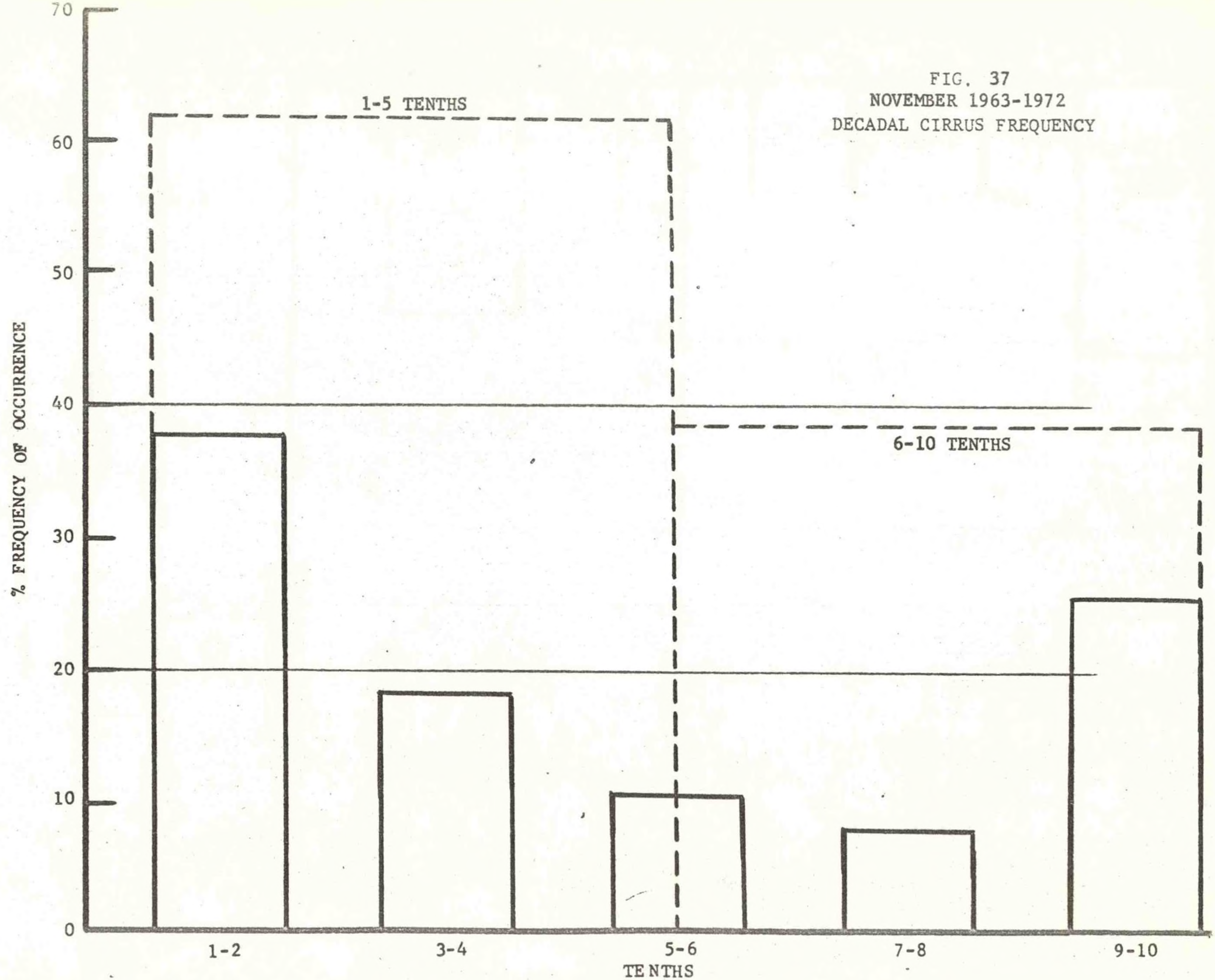
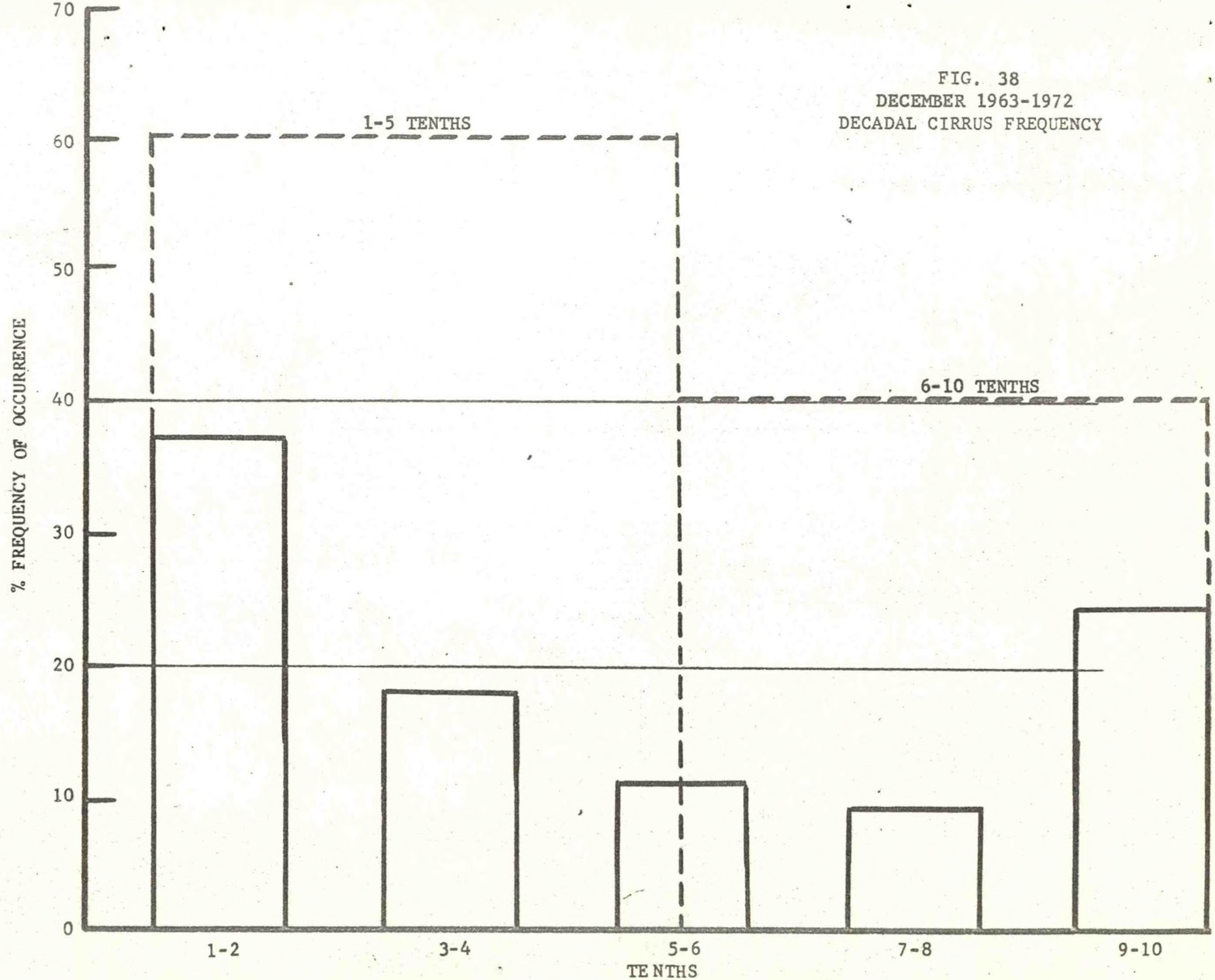


FIG. 38
DECEMBER 1963-1972
DECADAL CIRRUS FREQUENCY



REFERENCES

Sadler, J. C., *The Mean Winds of the Upper Troposphere Over the Central and Eastern Pacific*, Technical Paper No. 8-72, Naval Postgraduate School, Monterey, California, June 1972.

Wiederanders, C. J., *Analyses of Monthly Mean Resultant Winds for Standard Pressure Levels Over the Pacific*, Hawaii Institute of Geophysics, University of Hawaii, March 1961.