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National Bureau of Standards

AUG 22 1947

NOMOGRAPHIC PREDICTIONS OF F<sub>2</sub>-LAYER FREQUENCIESTHROUGHOUT THE SOLAR CYCLE, FOR SEPTEMBER.

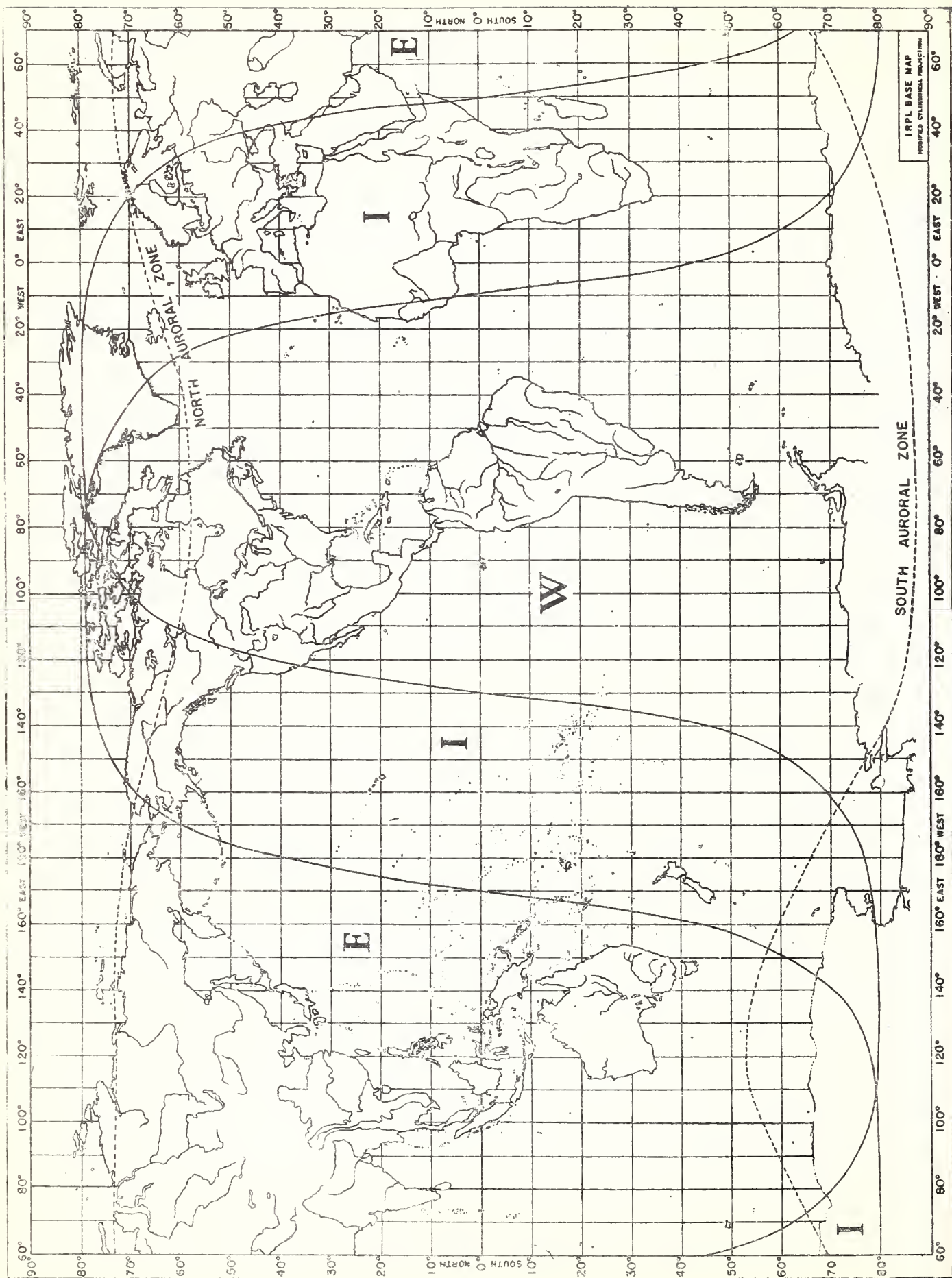
The accompanying nomograms present predictions of  $f^oF_2$  and F2-4000 muf throughout the solar cycle, for each ten degrees of latitude in each of the three zones of Fig. 1.

These were derived in the manner described in the reports IRPL-R11, "A Nomographic Method for Both Prediction and Observation Correlation of Ionosphere Characteristics", and IRPL-R16, "Predicted F2-layer Frequencies Throughout the Solar Cycle, for Summer, Winter, and Equinox Season". The method of their use in obtaining  $f^oF_2$  and F2-4000 muf is illustrated by the example shown on Fig. 6. The use of these quantities in obtaining the muf for high-frequency radio propagation is discussed in the report IRPL-R16, cited above, and in the IRPL Radio Propagation Handbook, Part 1, p.47 et seq. It is to be noted that the values of  $f^oF_2$  and F2-4000 muf obtained by means of these nomograms must be complemented by values of E-layer muf, in the case of transmission paths under 4000 km and by sporadic-E transmission frequencies for all paths, especially those passing near the auroral zones shown in Fig. 1. This is particularly important during times of minimum solar activity.

Values of  $f^oF_2$  obtained by means of these nomograms should be fairly accurate in the proximity of ionosphere observing stations which have been in operation for a long time, such as those at Washington, D.C. Watheroo, W. Australia, and Huancayo, Peru. Inaccuracy of prediction is most likely in equatorial regions, where the latitude gradient of  $f^oF_2$  is particularly high, and in the W zone south of Huancayo, Peru (12°S), where a few ionospheric observations have been made and thus the prediction is based upon observations in other zones.

The small convolutions of the central curves, A, which show the variation of  $f^oF_2$ , are frequently of doubtful significance, since many of them may be less than the error of prediction. No attempt was made to smooth these out, however, because of lack of exact knowledge of the extent of this error.

Values of F2-4000 muf obtained from these nomograms are likely to be slightly too high during periods of high sunspot number, since the values of F2-M4000 used in their computation, the average of all available data, were those obtained during years of low solar activity, and there is a slight decrease in these values with increase of sunspot number. It is estimated that the amount of this error, at a sunspot number of 100, is about 5%.



WORLD MAP SHOWING ZONES COVERED BY PREDICTED CHARTS, AND AURORAL ZONES.

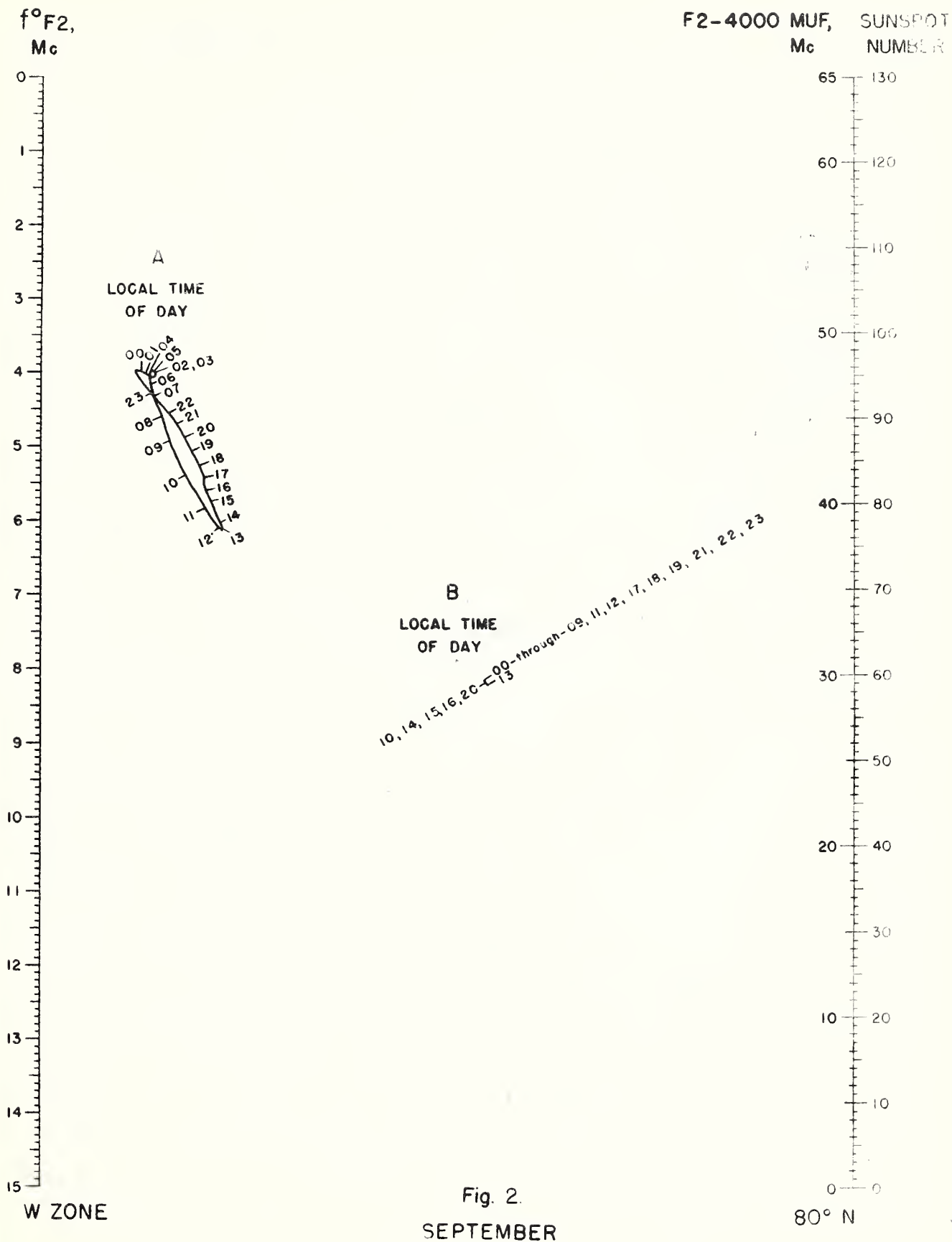
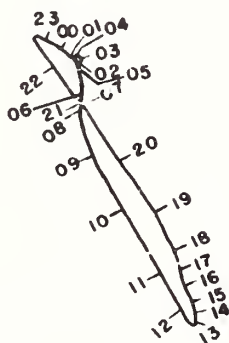


Fig. 2.  
SEPTEMBER

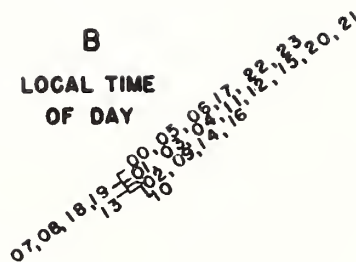
$f^oF_2$ ,  
Mc



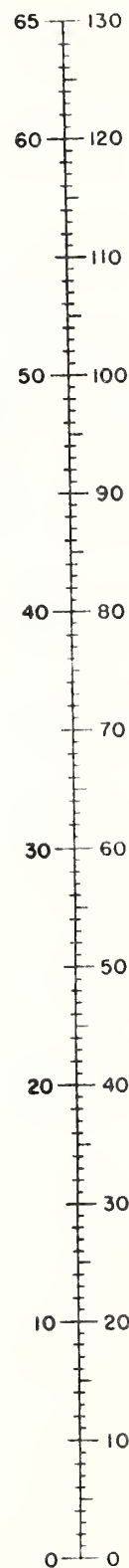
**A**  
LOCAL TIME  
OF DAY



**B**  
LOCAL TIME  
OF DAY



F2-4000 MUF, SUNSPOT  
Mc NUMBER



70° N

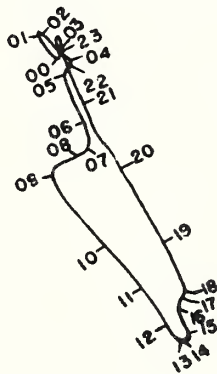
W ZONE

Fig. 3.  
SEPTEMBER

$f^oF_2$ ,  
Mc

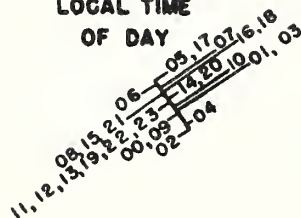


**A**  
LOCAL TIME  
OF DAY

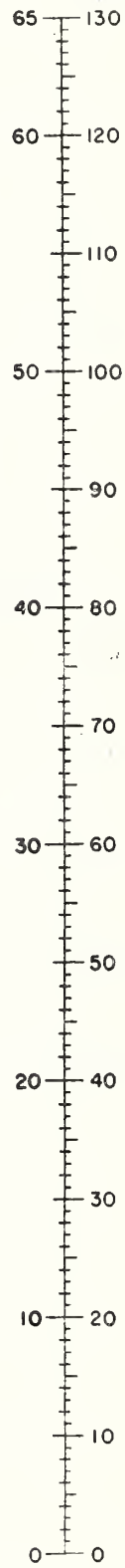


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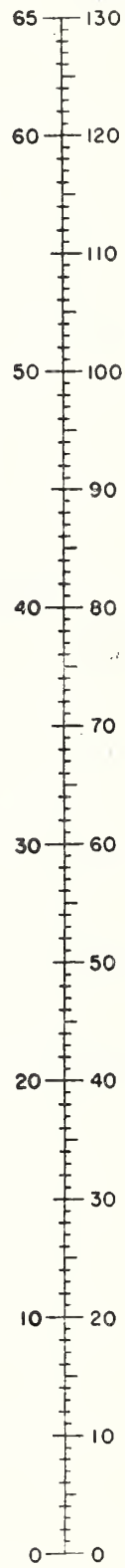
LOCAL TIME  
OF DAY



F2-4000 MUF,  
Mc



SUNSPOT  
NUMBER



W ZONE

Fig. 4.  
SEPTEMBER

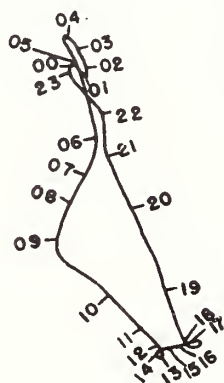
60° N



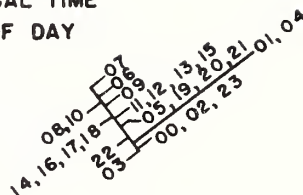
$f^{\circ}F_2$ ,  
Mc



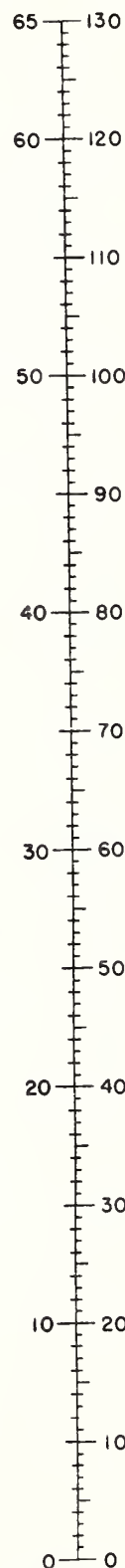
A  
LOCAL TIME  
OF DAY



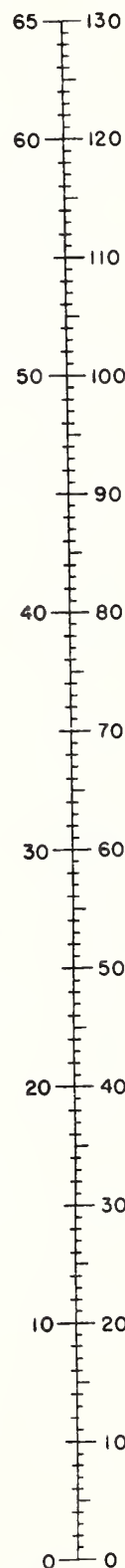
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LOCAL TIME  
OF DAY



F2-4000 MUF,  
Mc

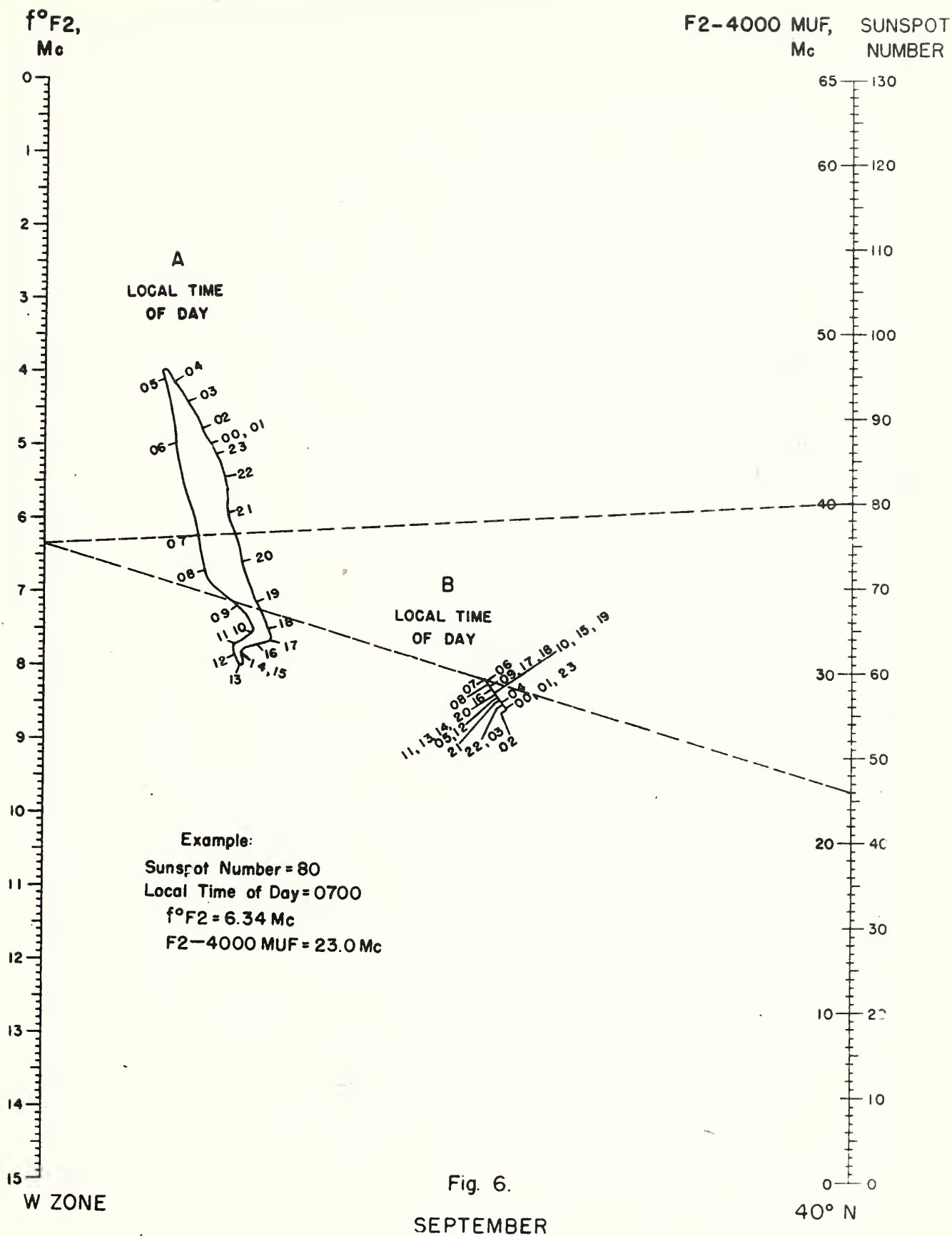


SUNSPOT  
NUMBER



50° N

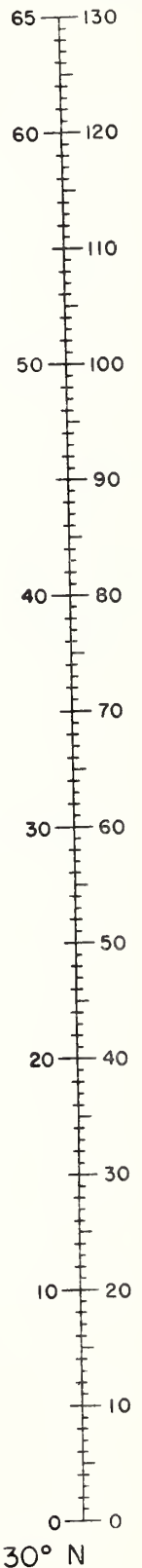
Fig. 5.  
SEPTEMBER





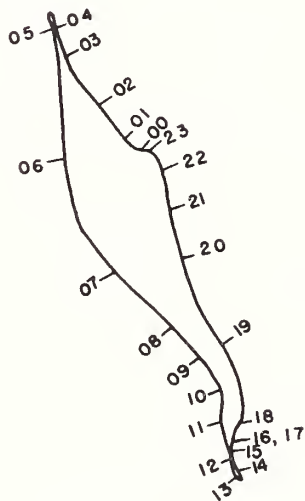
W ZONE

F2-4000 MUF, Mc	SUNSPOT NUMBER
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30° N

A  
LOCAL TIME  
OF DAY



B  
LOCAL TIME  
OF DAY

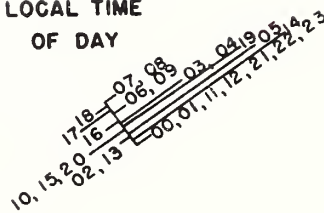
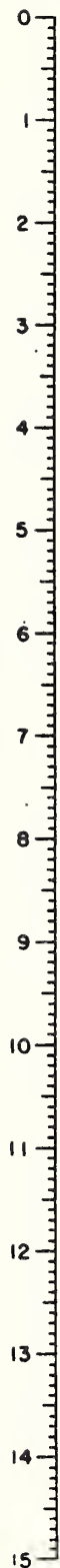


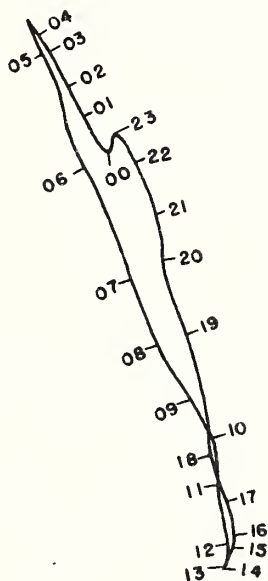
Fig. 7.  
SEPTEMBER



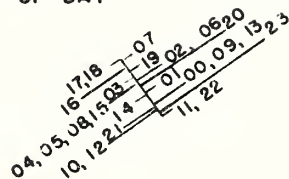
$f^{\circ}F_2$ ,  
Mc



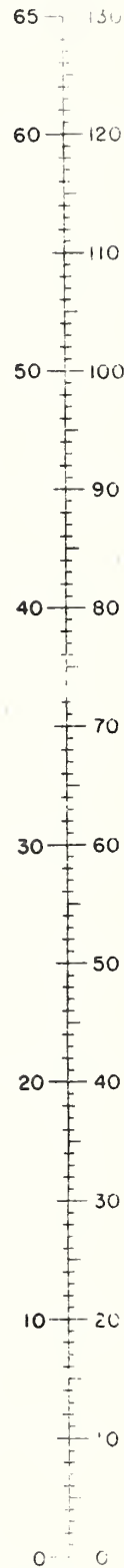
A  
LOCAL TIME  
OF DAY



B  
LOCAL TIME  
OF DAY

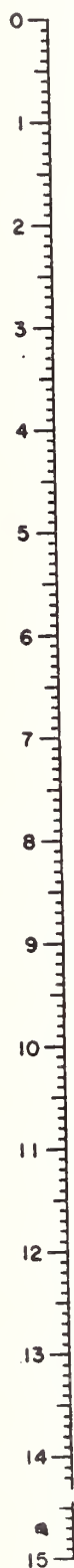


F2-4000 MUF, Mc    SUNSPOT  
NUMBER

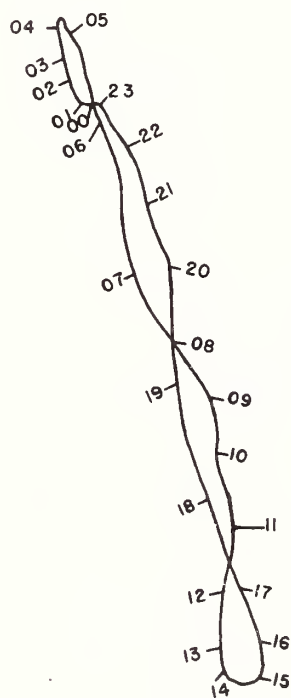


20° N

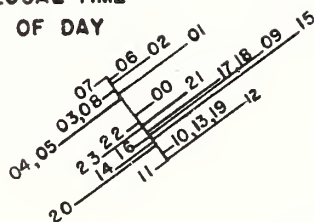
Fig. 8.  
SEPTEMBER



A  
LOCAL TIME  
OF DAY



B  
LOCAL TIME  
OF DAY



F2-4000 MUF, Mc	SUNSPOT NUMBER
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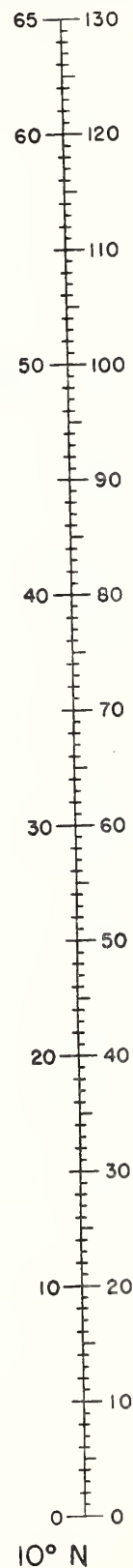


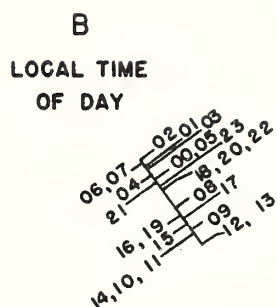
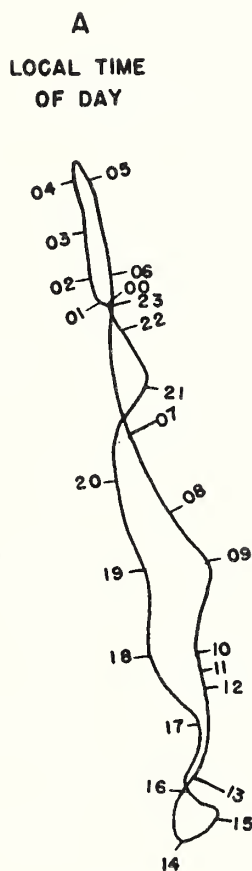
Fig. 9.

SEPTEMBER

$f^{\circ}F_2$ ,  
Mc



W ZONE



F2-4000 MUF, Mc      SUNSPOT  
NUMBER

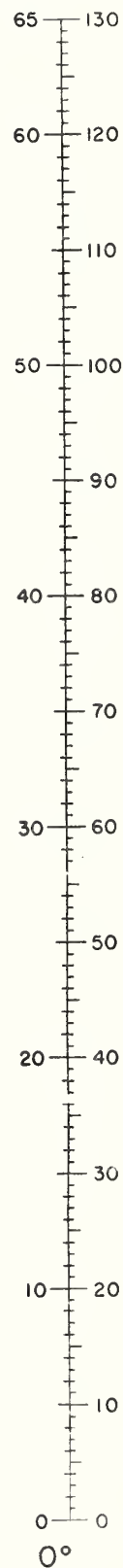


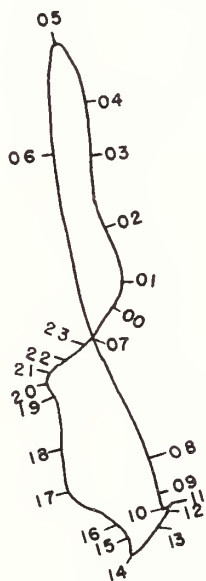
Fig. 10.  
SEPTEMBER

$f^oF_2$ ,  
Mc



W ZONE

A  
LOCAL TIME  
OF DAY



B  
LOCAL TIME  
OF DAY

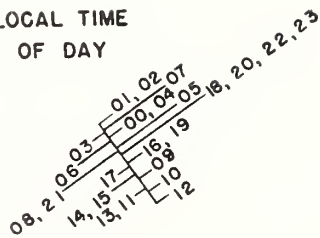
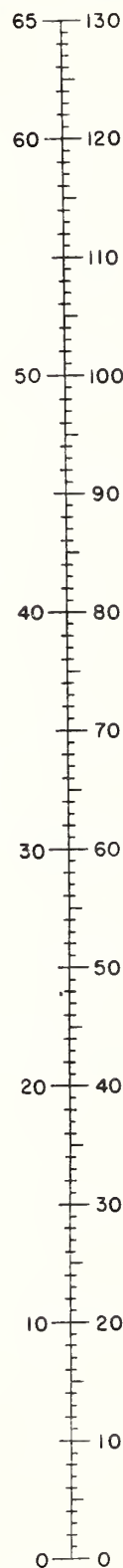


Fig. II.  
SEPTEMBER

F2-4000 MUF,  
Mc SUNSPOT  
NUMBER



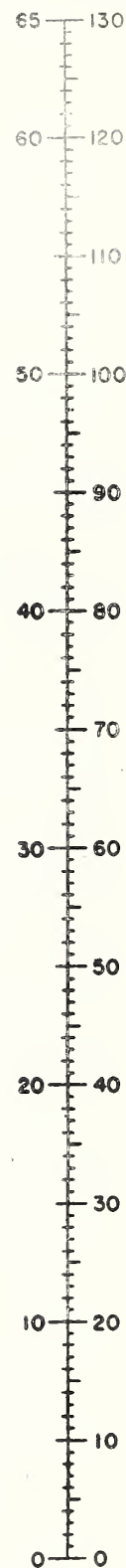
10° S

$f^oF_2$ ,  
Mc



W ZONE

F2-4000 MUF, SUNSPOT  
Mc NUMBER



20° S.

A  
LOCAL TIME  
OF DAY

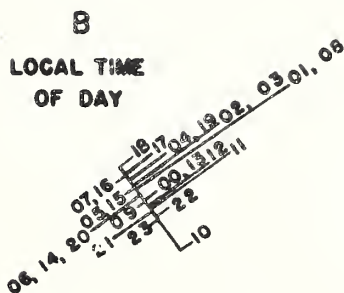
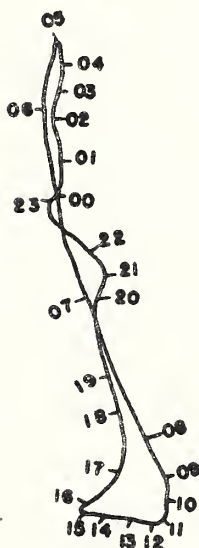
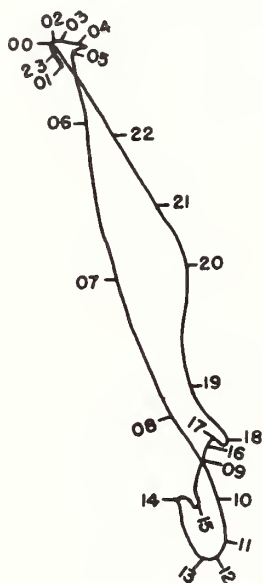


Fig. 12.  
SEPTEMBER

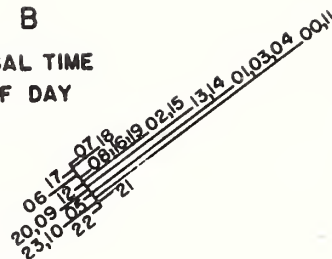
$f^oF_2$ ,  
Mc



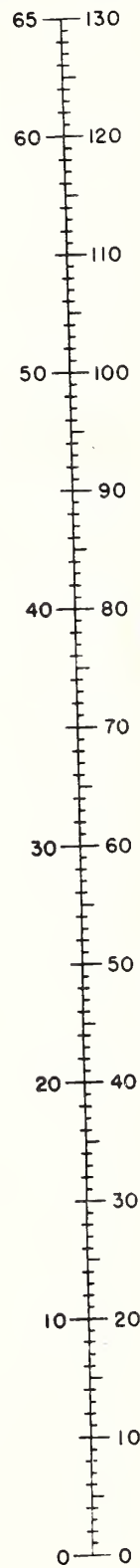
A  
LOCAL TIME  
OF DAY



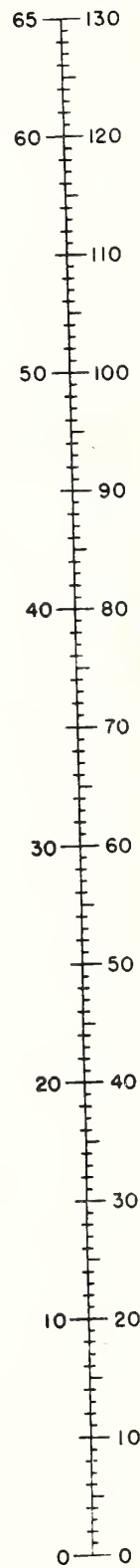
B  
LOCAL TIME  
OF DAY



F2-4000 MUF,  
Mc



SUNSPOT  
NUMBER



W ZONE

Fig. 13  
SEPTEMBER

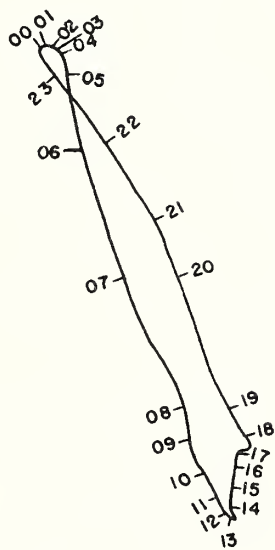
30° S



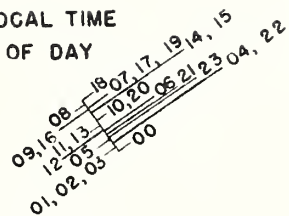
$f^{\circ}F_2$ ,  
Mc



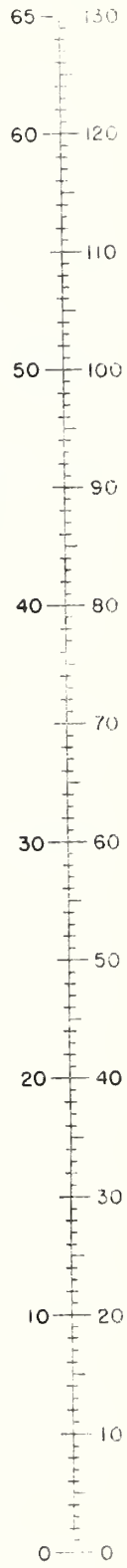
A  
LOCAL TIME  
OF DAY



B  
LOCAL TIME  
OF DAY



F2-4000 MUF, SUNSPOT  
Mc NUMBER

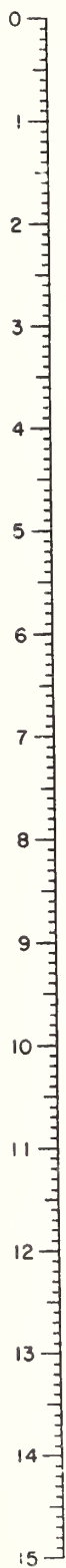


W ZONE

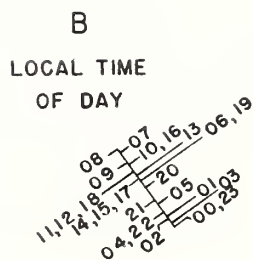
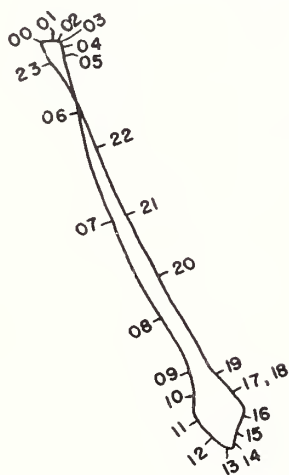
Fig. 14.  
SEPTEMBER

40° S

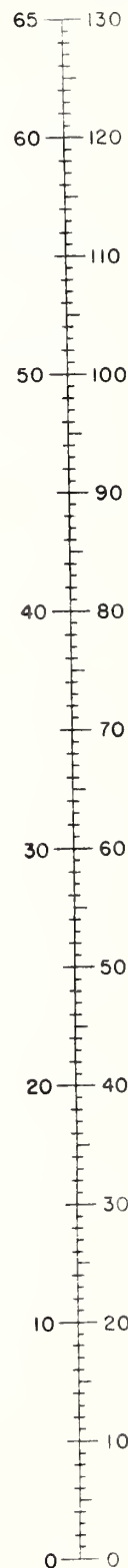
$f^{\circ}F_2$ ,  
Mc



A  
LOCAL TIME  
OF DAY



F2-4000 MUF,  
Mc



SUNSPOT  
NUMBER

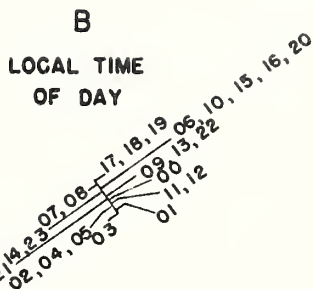
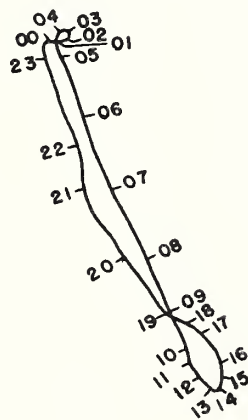
50° S

Fig. 15.  
SEPTEMBER

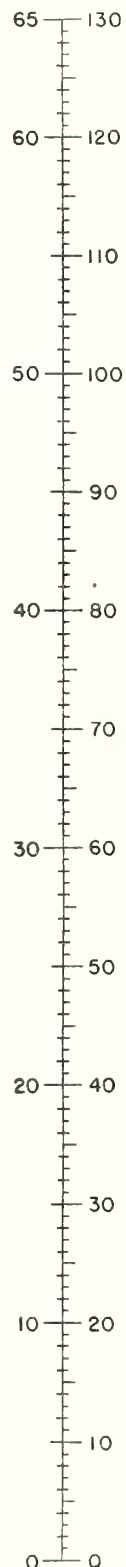
$f^oF_2$ ,  
Mc



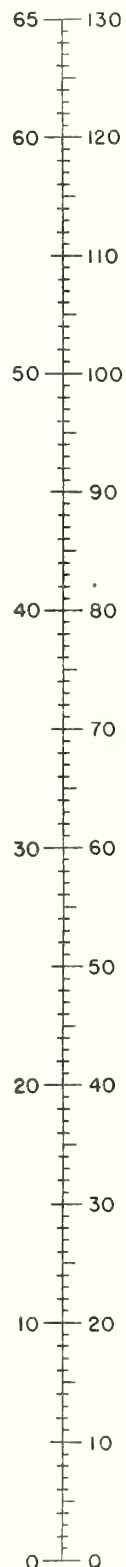
A  
LOCAL TIME  
OF DAY



F2-4000 MUF,  
Mc



SUNSPOT  
NUMBER



60° S

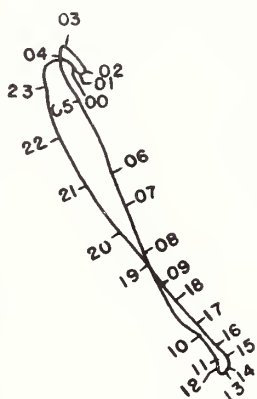
Fig. 16.  
SEPTEMBER

W ZONE

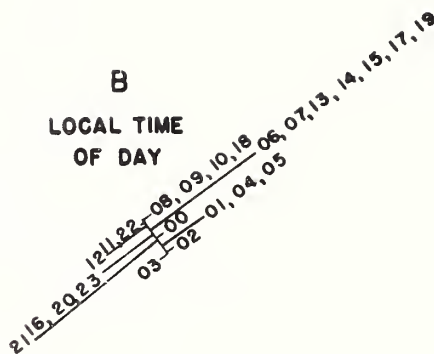
$f^{\circ}F_2$ ,  
Mc



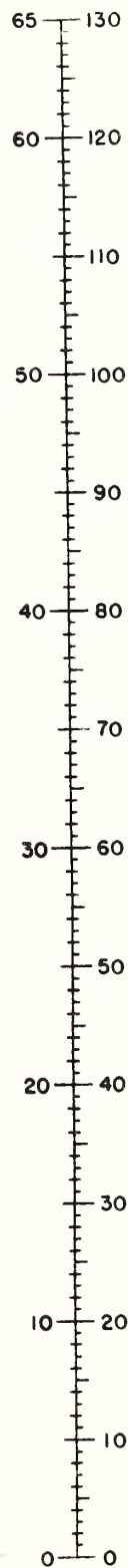
A  
LOCAL TIME  
OF DAY



B  
LOCAL TIME  
OF DAY



F2-4000 MUF, SUNSPOT  
Mc, NUMBER



70° S

Fig. 17.  
SEPTEMBER

W ZONE

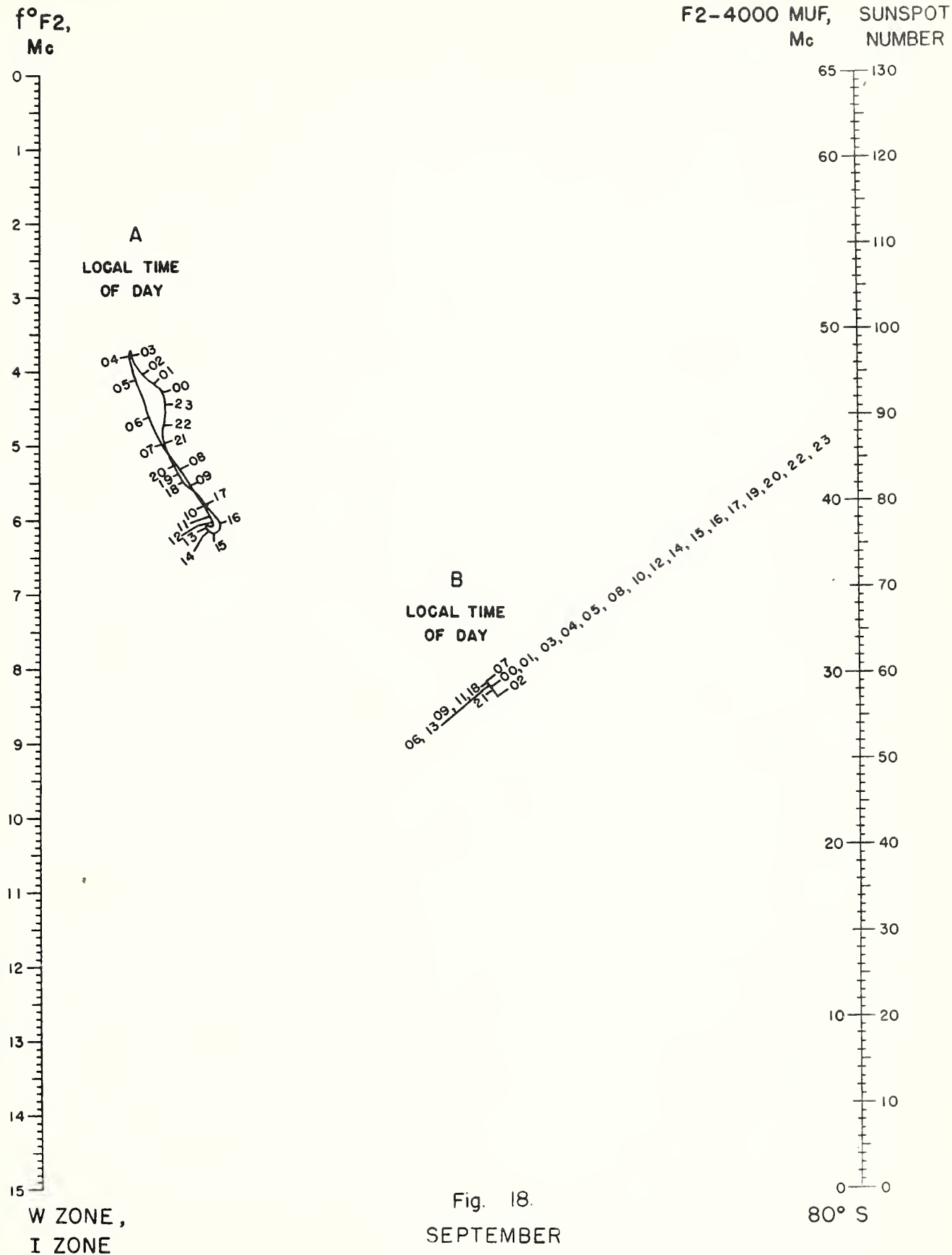
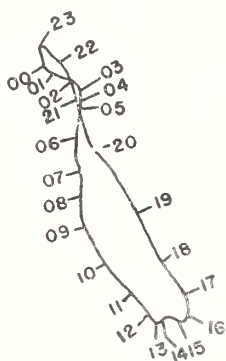


Fig. 18.  
SEPTEMBER

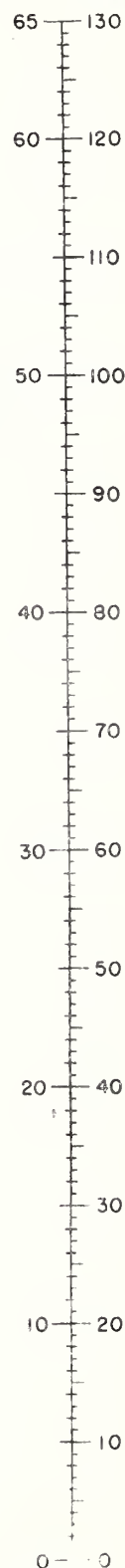
$f^oF_2$ ,  
Mc



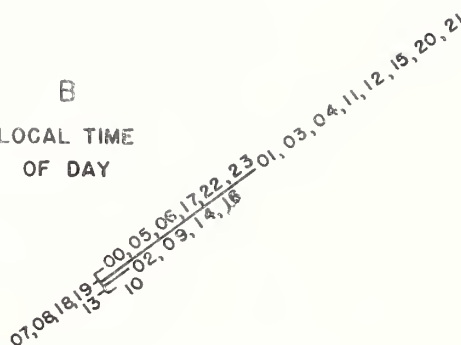
A  
LOCAL TIME  
OF DAY



F2-4000 MUF, SUNSPOT  
Mc NUMBER



B  
LOCAL TIME  
OF DAY



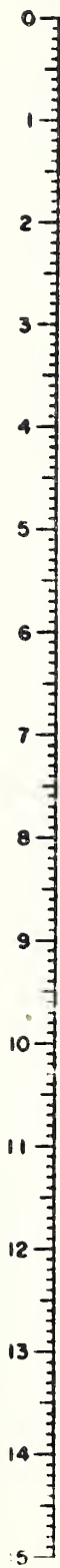
I ZONE

Fig. 19.  
SEPTEMBER

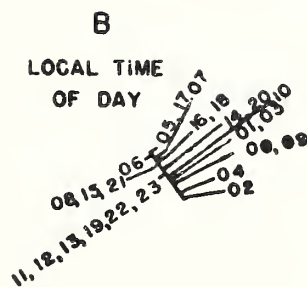
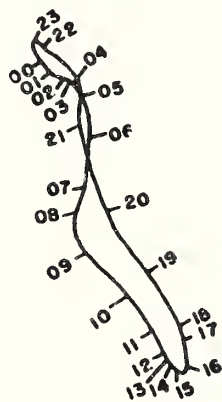
70° N



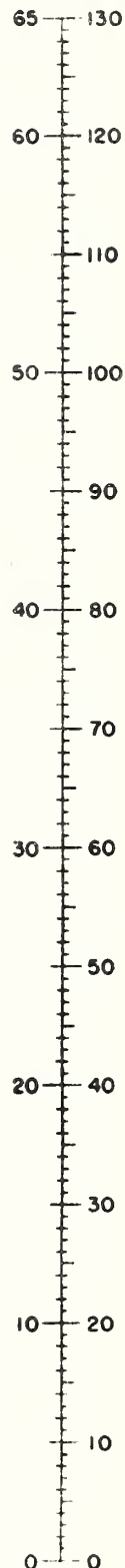
$f^{\circ}F2,$   
 $M_e$



**A**  
LOCAL TIME  
OF DAY



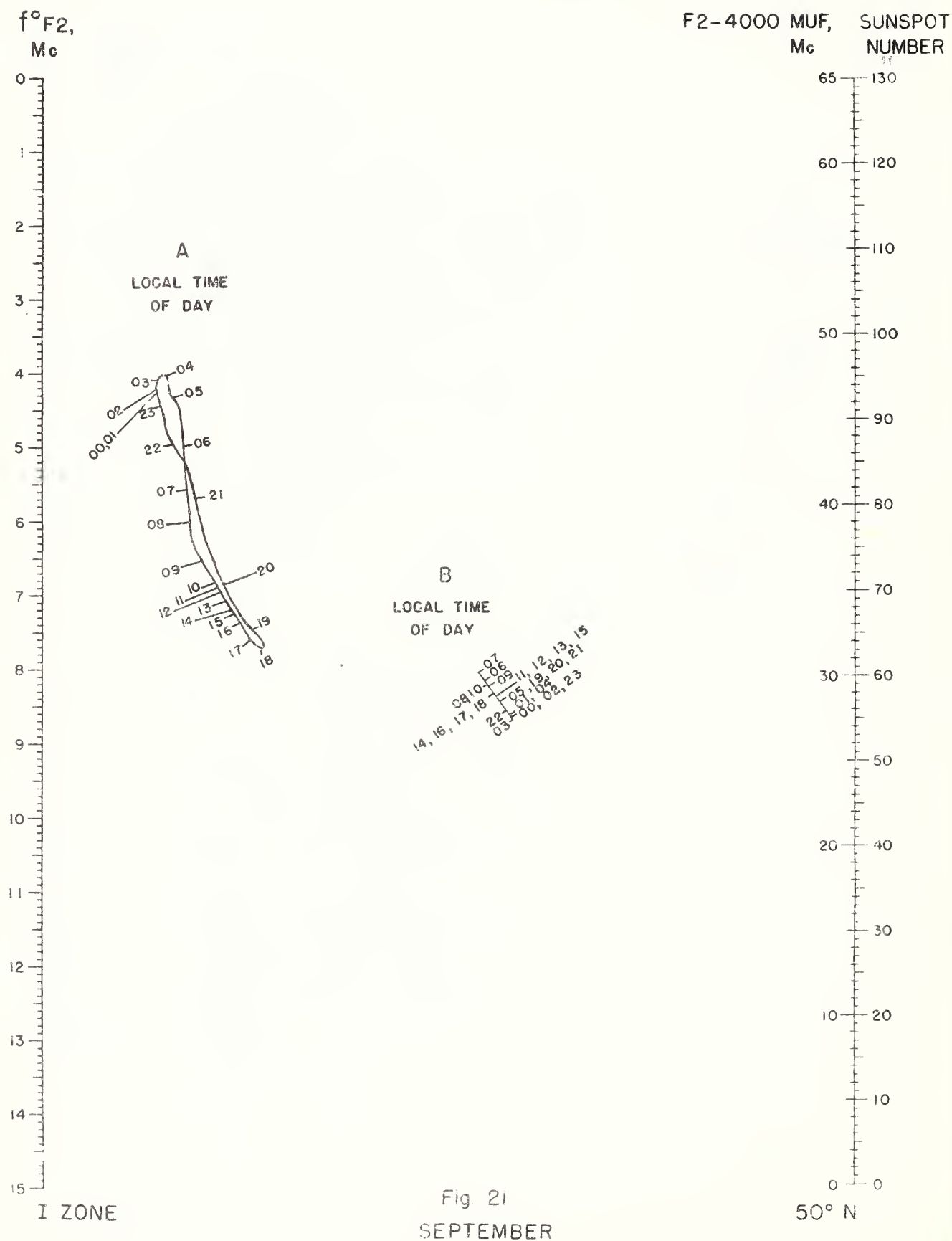
F2-4000 MUF,  
 $M_e$  SUNSPOT  
NUMBER



I ZONE

Fig 20  
SEPTEMBER

60° N

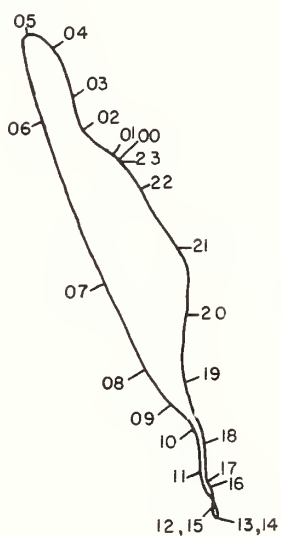




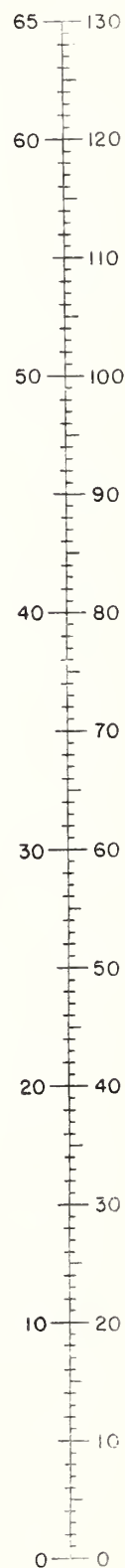
$f^{\circ}F_2$ ,  
Mc



A  
LOCAL TIME  
OF DAY

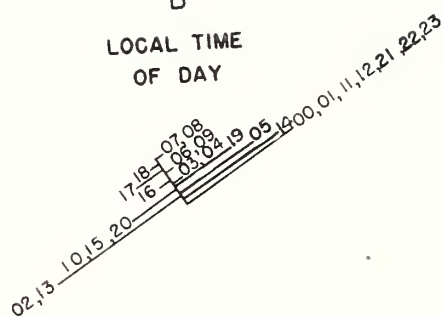


F2-4000 MUF,  
Mc



SUNSPOT  
NUMBER

B  
LOCAL TIME  
OF DAY



I ZONE

Fig. 23.

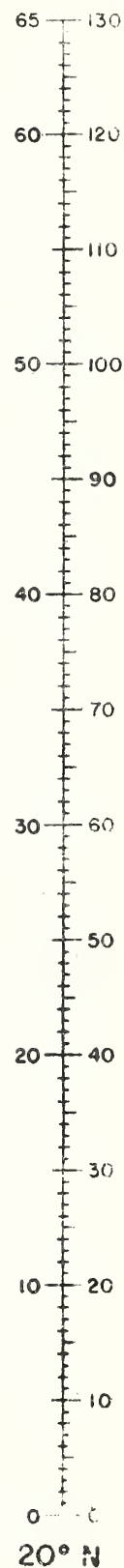
SEPTEMBER

30° N

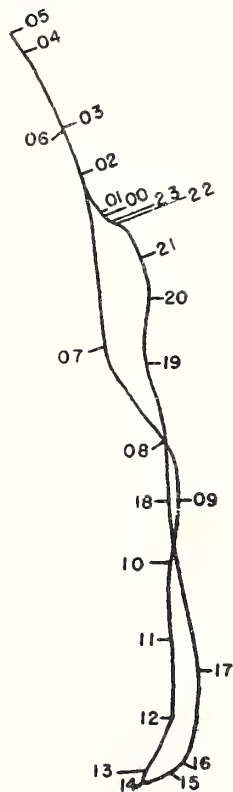
$f^{\circ}F_2$ ,  
Mc



F2-4000 MUF, Mc      SUNSPOT  
NUMBER



A  
LOCAL TIME  
OF DAY



B  
LOCAL TIME  
OF DAY

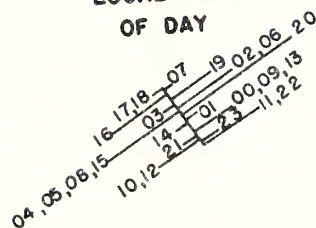


Fig. 24

SEPTEMBER

I ZONE

20° N

$f^oF_2$ ,  
Mc

F2-4000 MUF, SUNSPOT  
Mc NUMBER

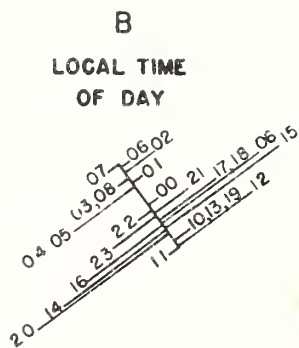
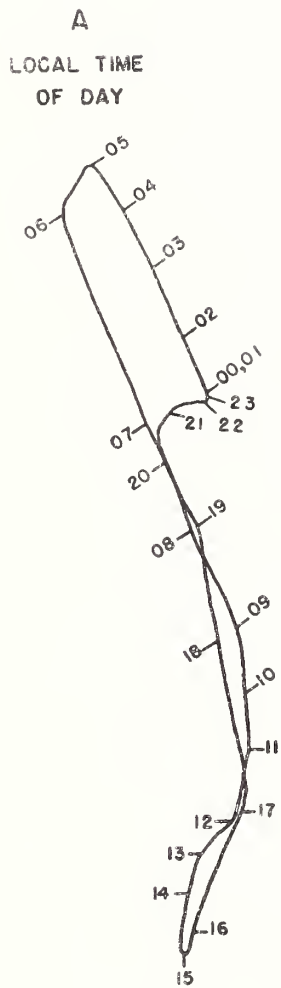


Fig 25.

SEPTEMBER

I ZONE

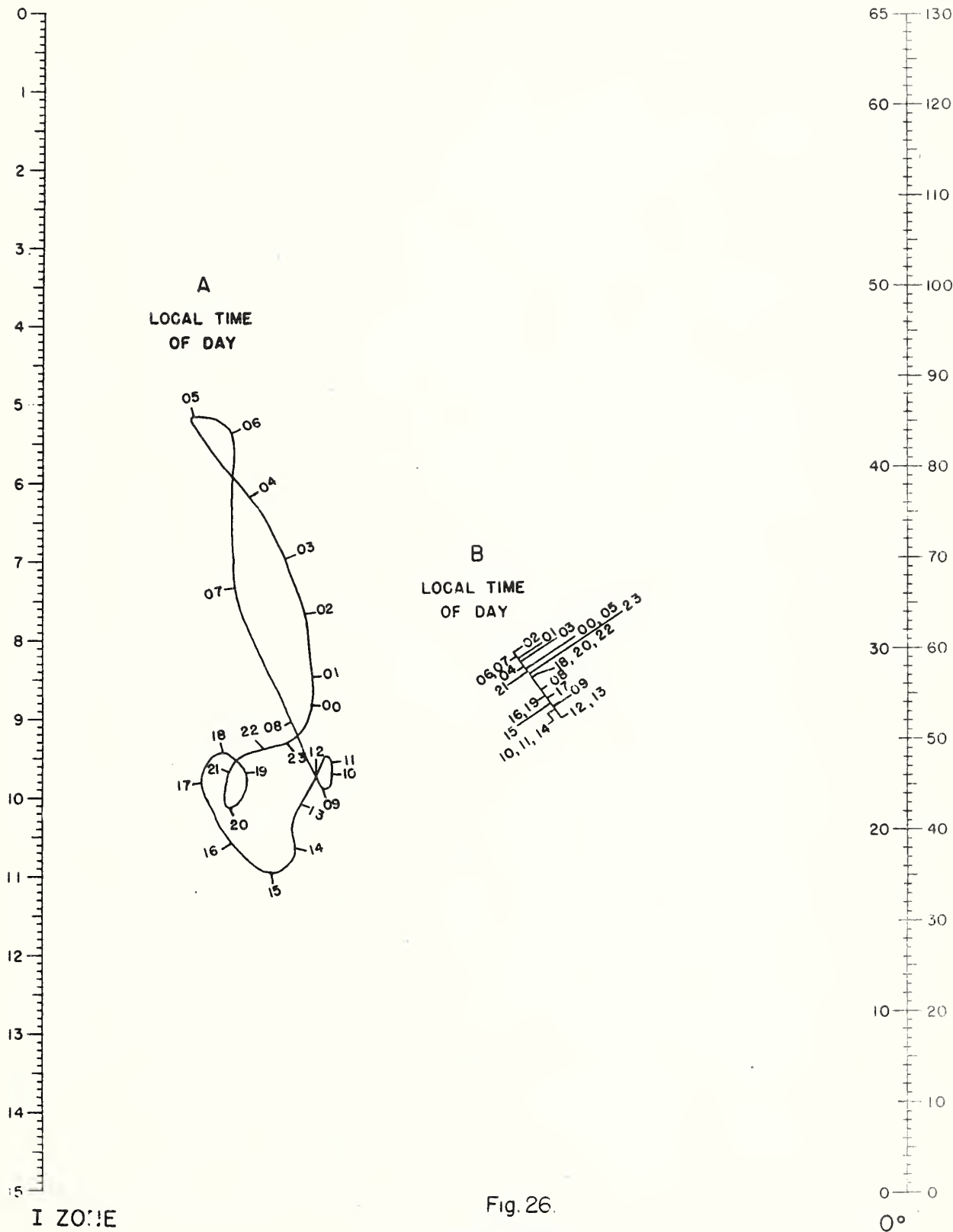
10° N



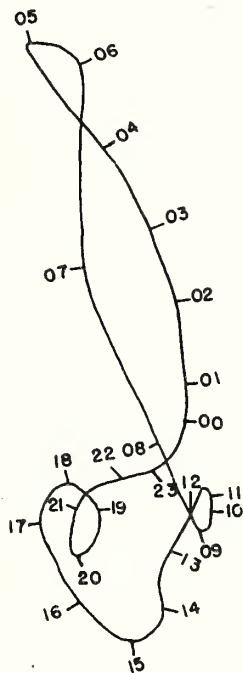
F2-4000 MUF,      SUNSPCT  
Mc                      NUMBER

F2-4000 MUF,      SUNSPCT  
Mc                      NUMBER

F2-4000 MUF,      SUNSPCT  
Mc                      NUMBER



A  
LOCAL TIME  
OF DAY



B

LOCAL TIME  
OF DAY

06, 07, 21, 04, 16, 19, 10, 11, 14, 02, 01, 03, 00, 05, 23, 18, 20, 22, 09, 12, 13

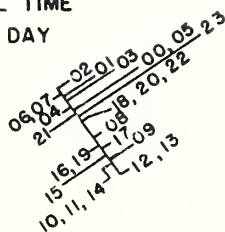


Fig. 26.  
SEPTEMBER

F2-4000 MUF, SUNSPOT  
Mc NUMBER

$f^oF_2$ ,  
Mc

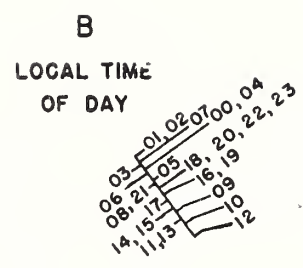
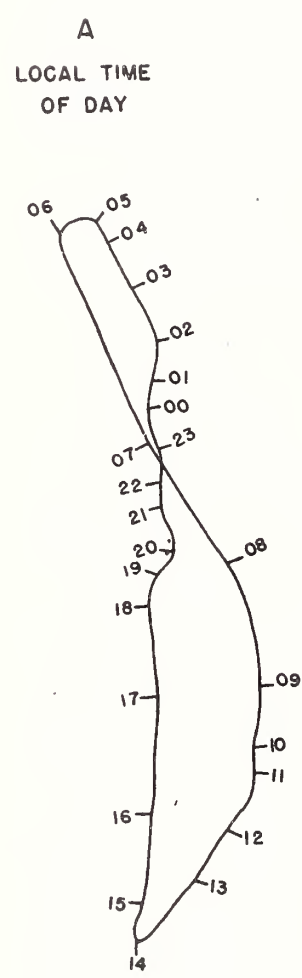
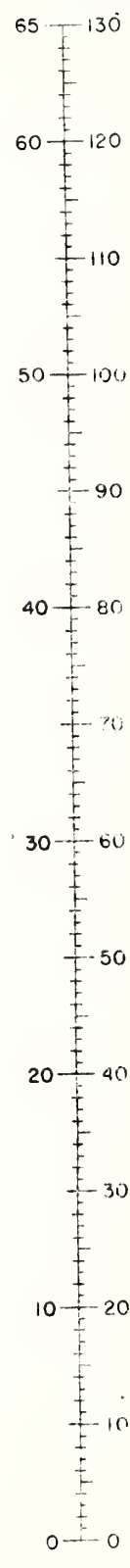
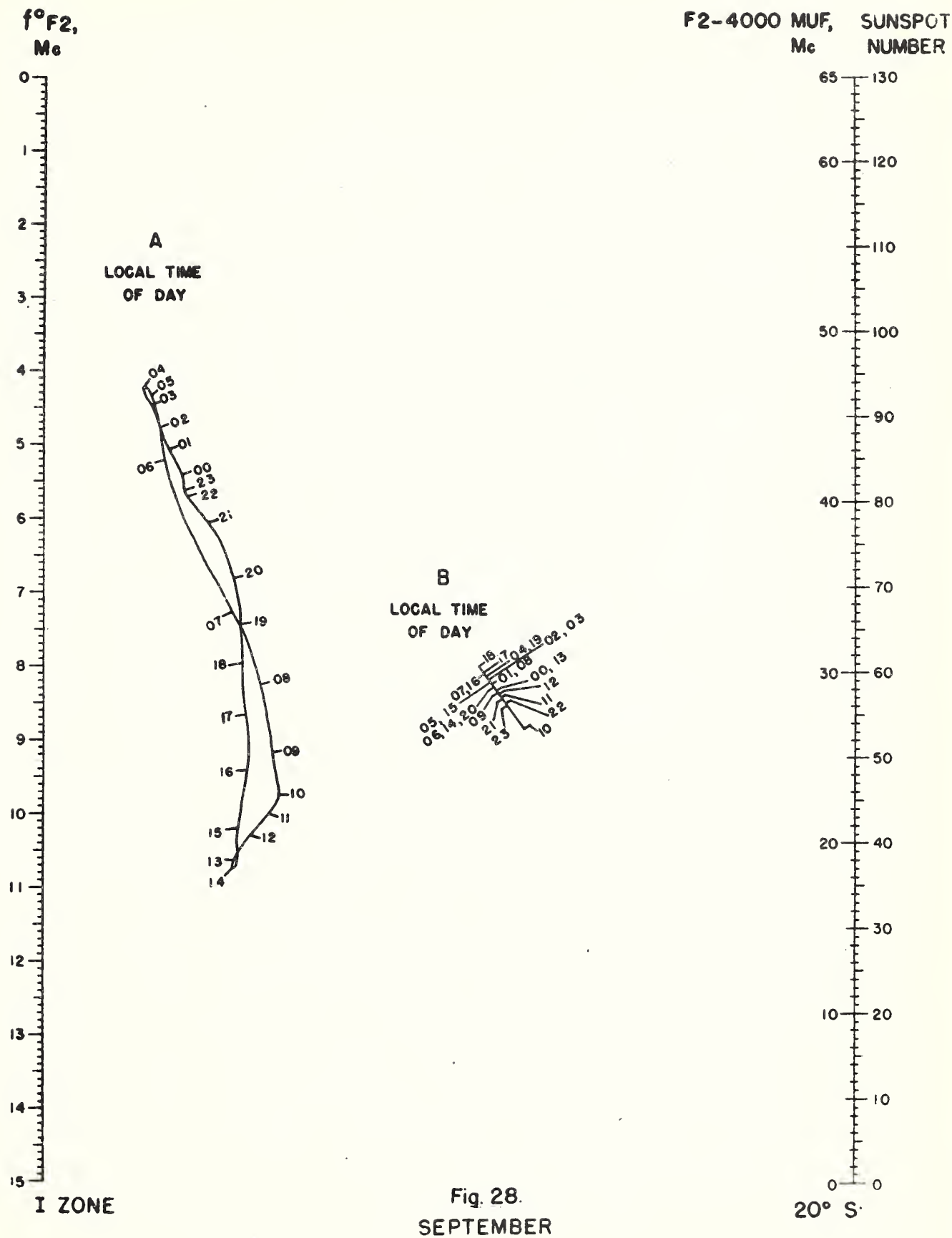


Fig. 27.  
SEPTEMBER

I ZONE

10° S



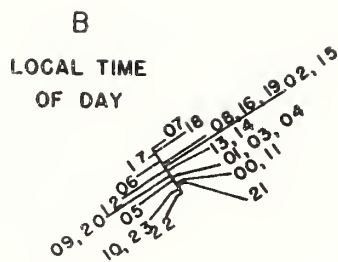
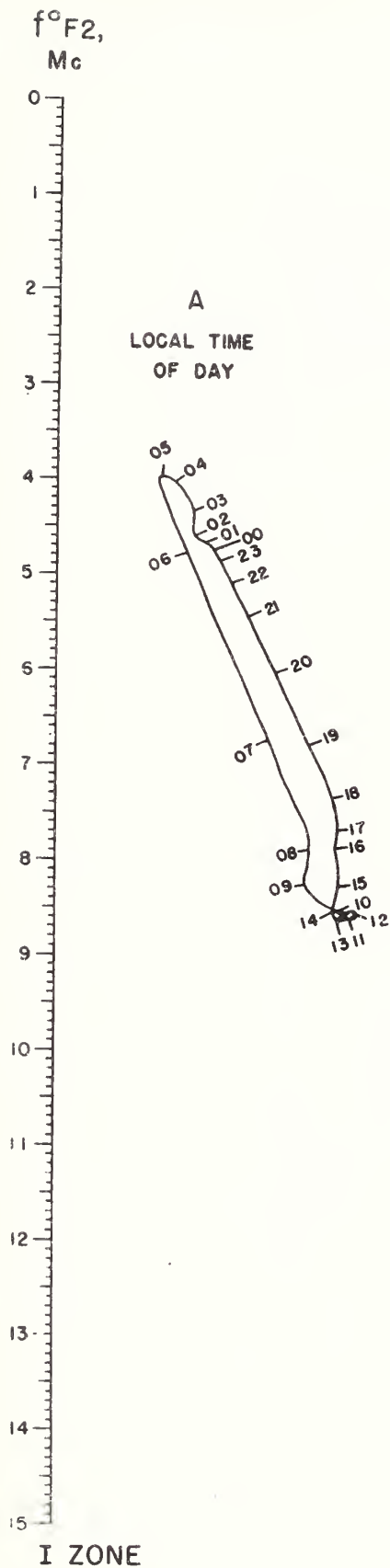
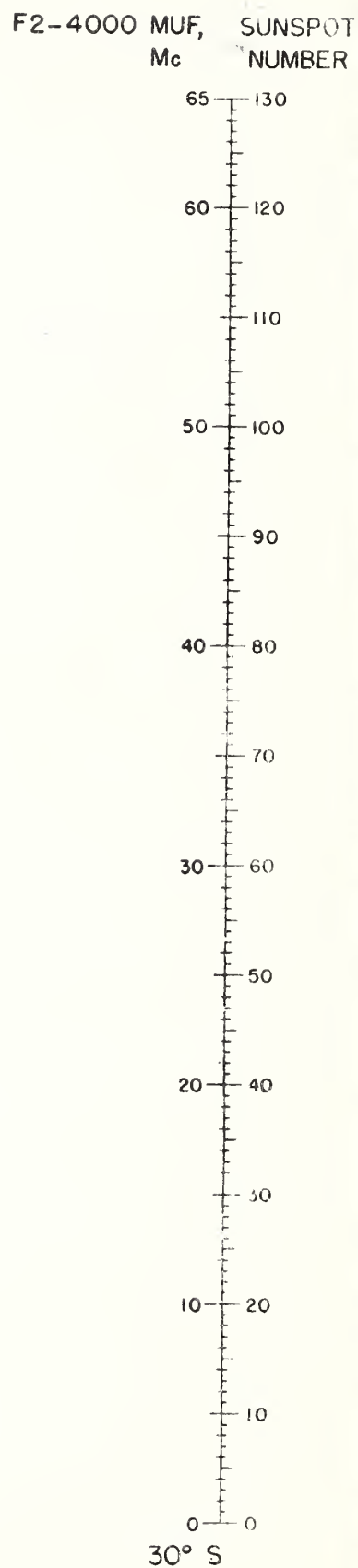
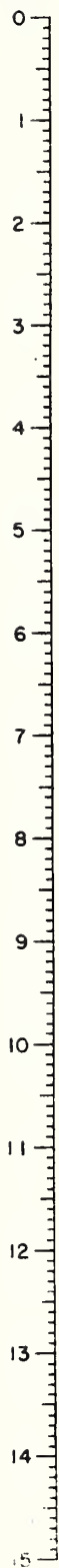


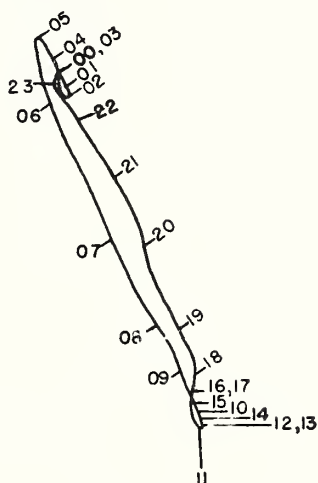
Fig29.  
SEPTEMBER



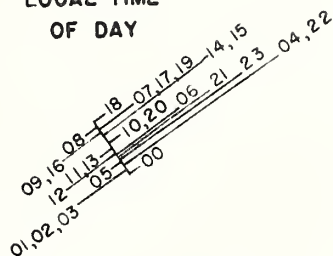
$f^{\circ}F_2$ ,  
Mc



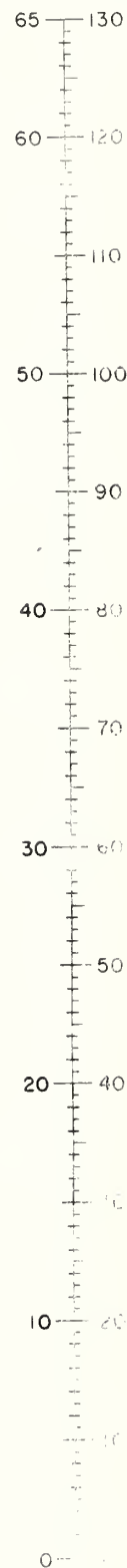
**A**  
LOCAL TIME  
OF DAY



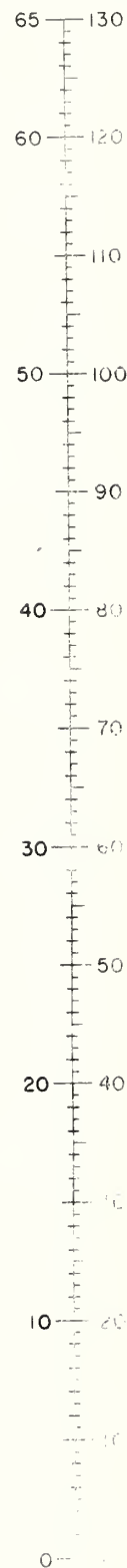
**B**  
LOCAL TIME  
OF DAY



F2-4000 MUF,  
Mc



SUNSPOT  
NUMBER



I ZONE

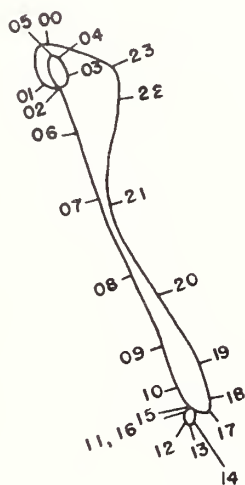
Fig. 30.  
SEPTEMBER

40° S

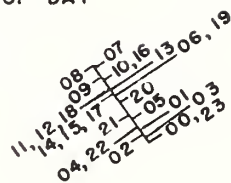
$f^{\circ}F_2$ ,  
Mc



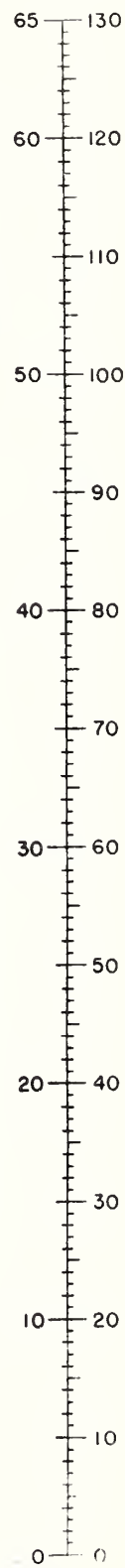
A  
LOCAL TIME  
OF DAY



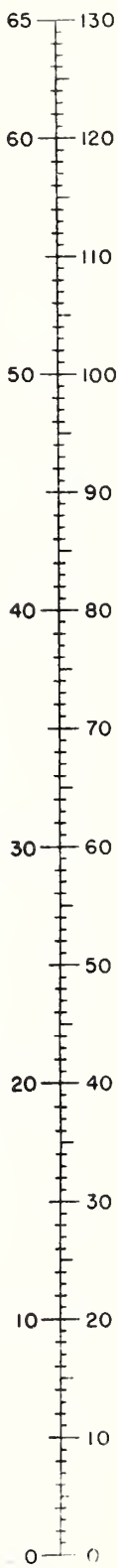
B  
LOCAL TIME  
OF DAY



F2-4000 MUF,  
Mc



SUNSPOT  
NUMBER



ZONE

Fig. 31.  
SEPTEMBER

50° S



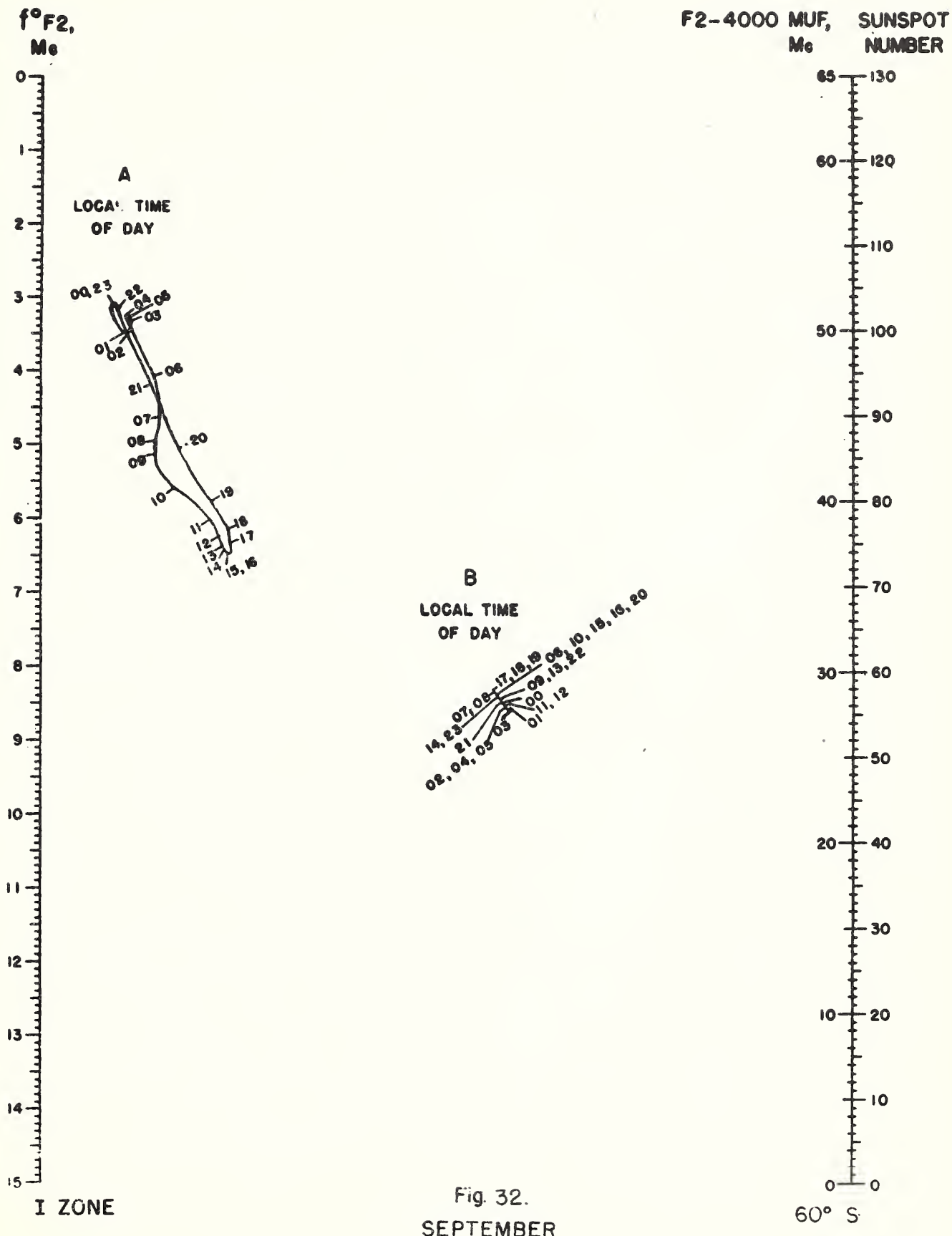


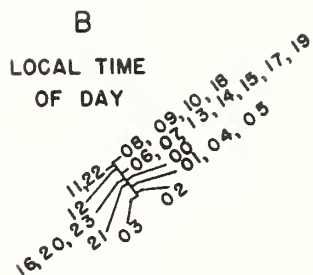
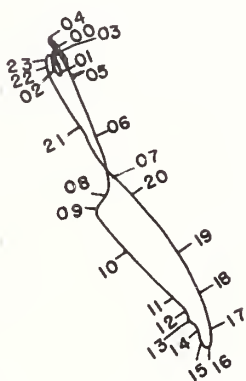
Fig. 32.  
SEPTEMBER

60° S

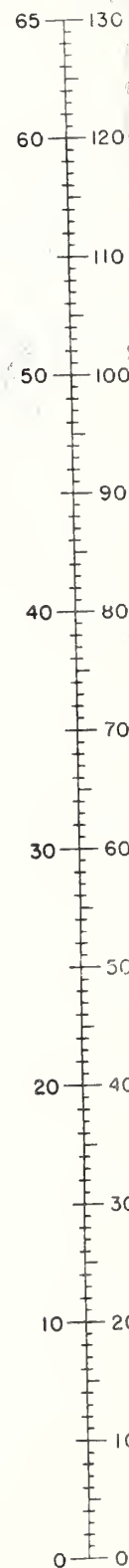
$f^oF_2$ ,  
Mc



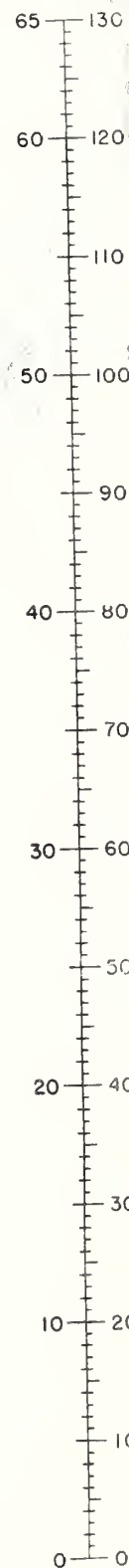
A  
LOCAL TIME  
OF DAY



F2-4000 MUF,  
Mc



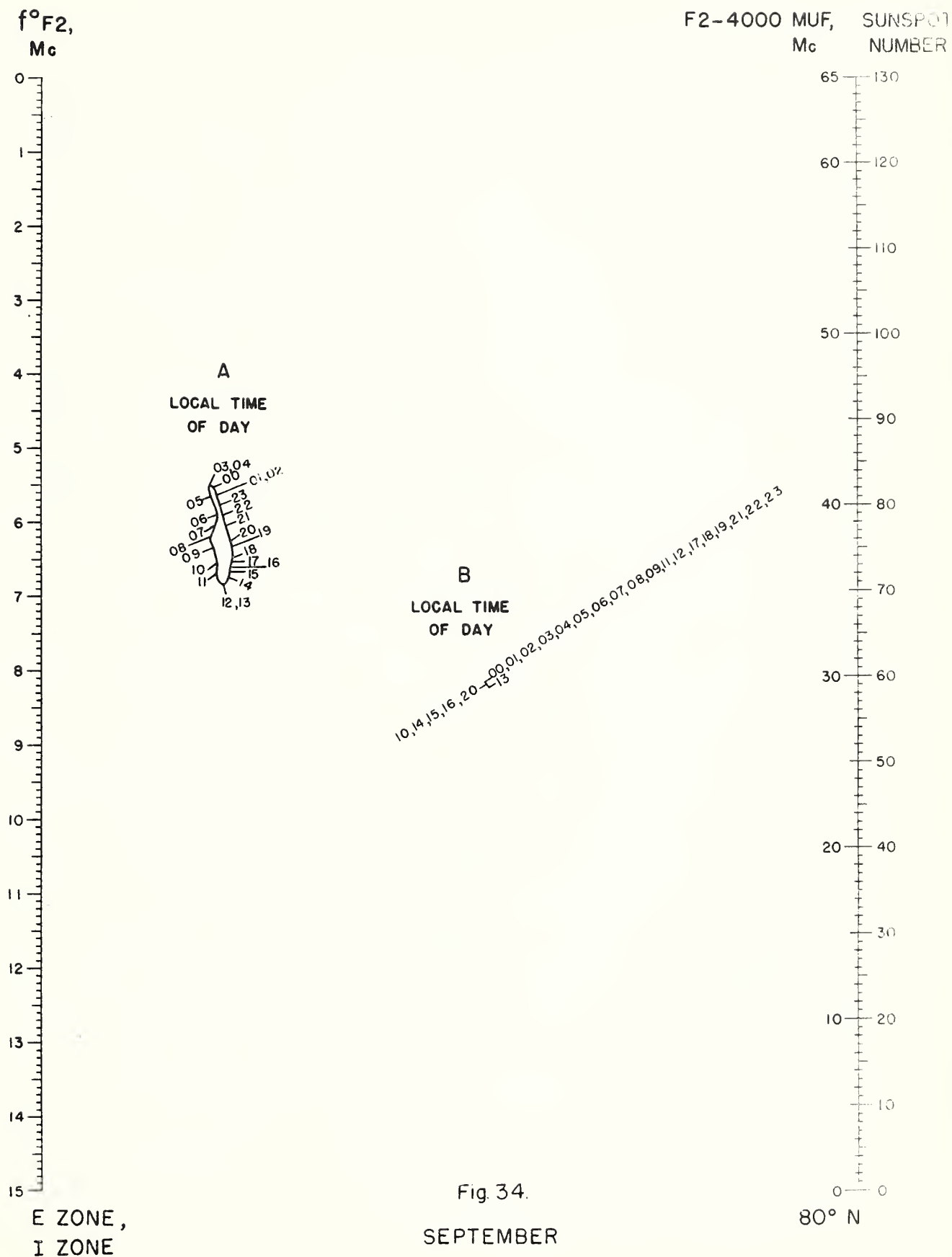
SUNSPOT  
NUMBER



I ZONE

Fig. 33.  
SEPTEMBER

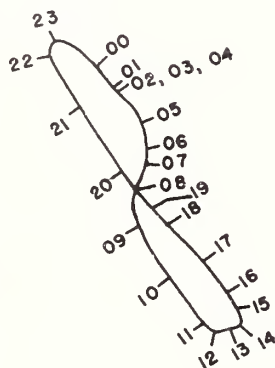
70° S



$f^{\circ}F_2$ ,  
Mc

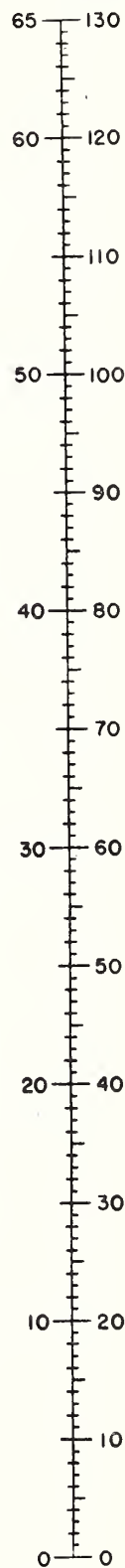


A  
LOCAL TIME  
OF DAY

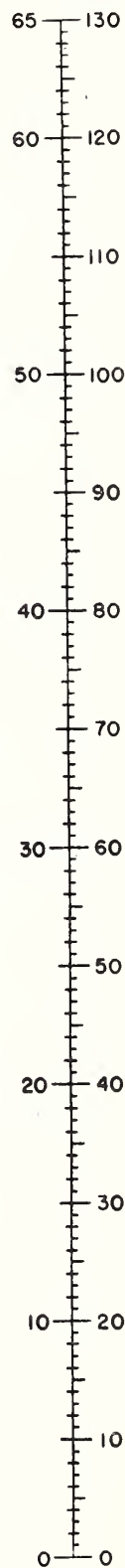


E ZONE

F2-4000 MUF,  
Mc



SUNSPOT  
NUMBER



B  
LOCAL TIME  
OF DAY

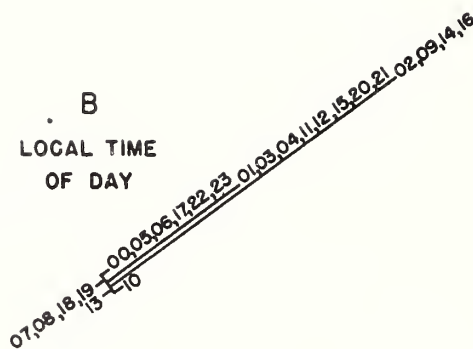


Fig. 35.

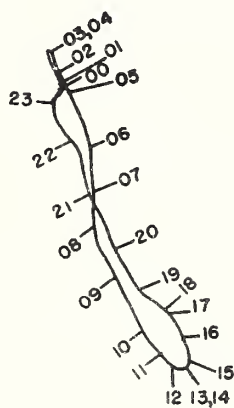
SEPTEMBER

70° N

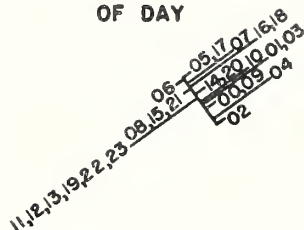
$f^{\circ}F_2$ ,  
Mc



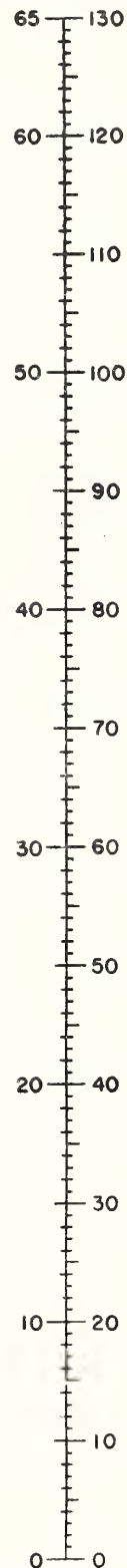
A  
LOCAL TIME  
OF DAY



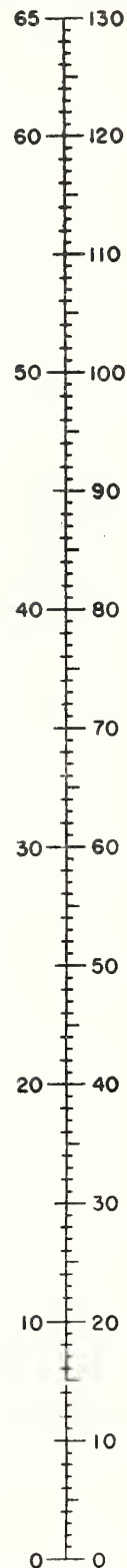
B  
LOCAL TIME  
OF DAY



F2-4000 MUF,  
Mc



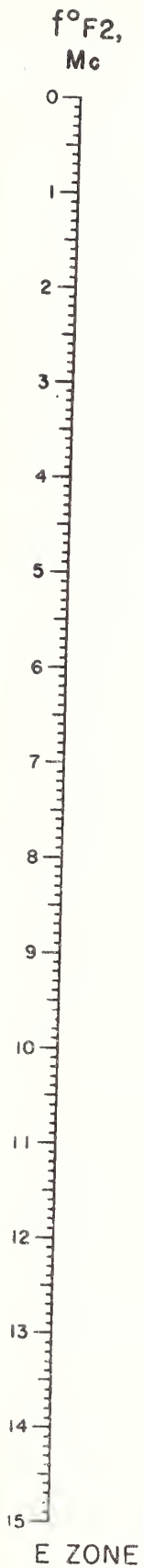
SUNSPOT  
NUMBER



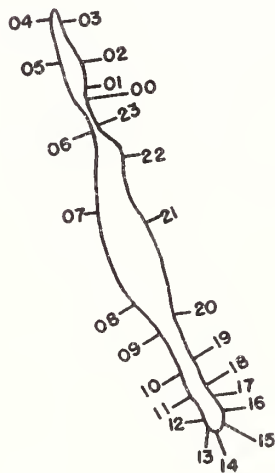
E ZONE

Fig. 36.  
SEPTEMBER

60° N.



A  
LOCAL TIME  
OF DAY



B  
LOCAL TIME  
OF DAY

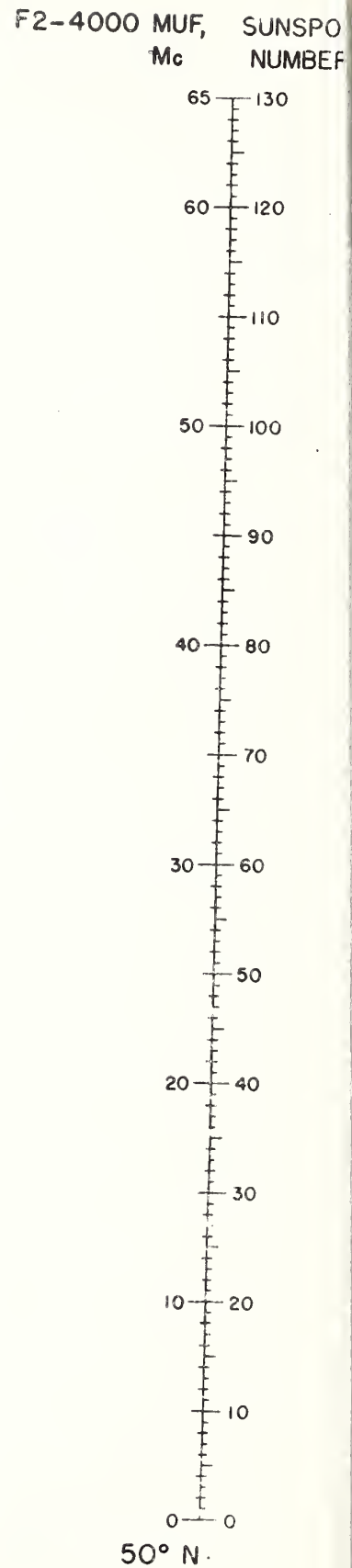
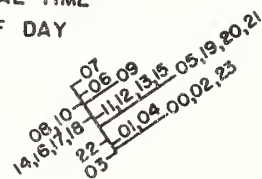
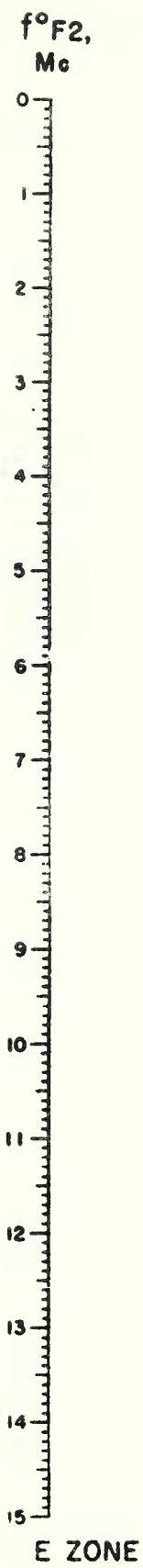


Fig. 37  
SEPTEMBER



F2-4000 MUF, SUNSPOT  
Mc NUMBER

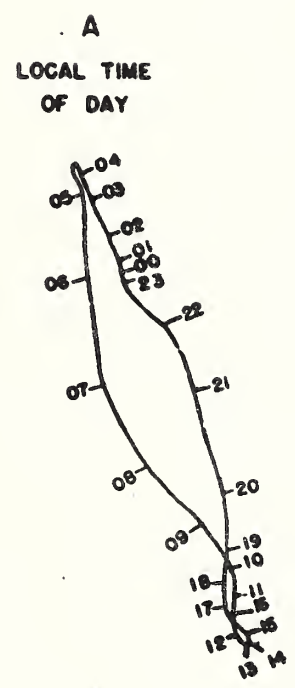
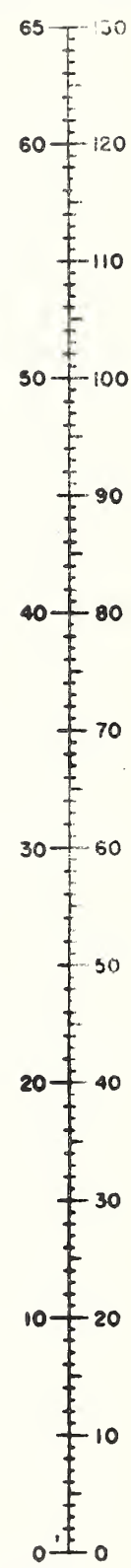


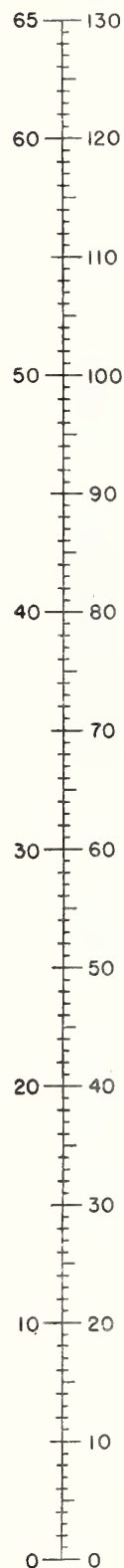
Fig. 38.  
SEPTEMBER

40° N.

$f^oF_2$ ,  
Mc



F2-4000 MUF,  
Mc



SUNSPOT  
NUMBER

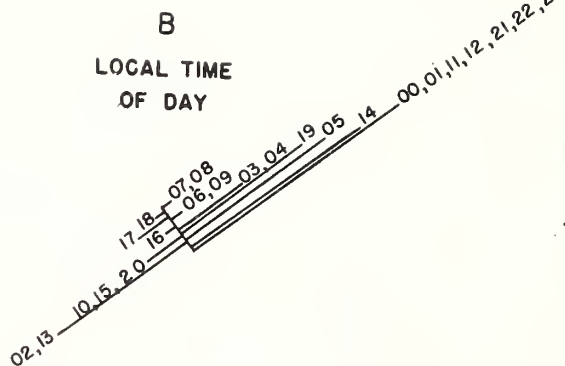
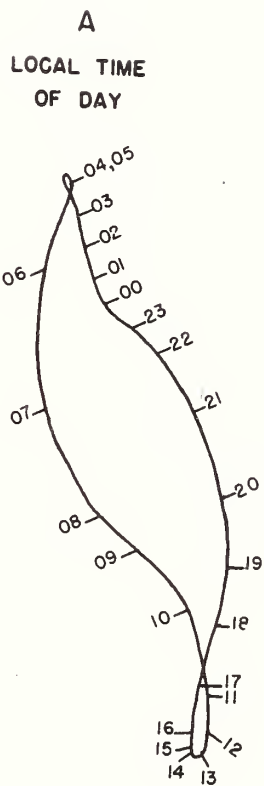
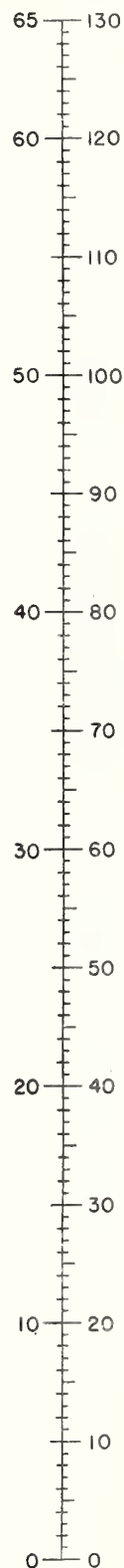


Fig. 39.

SEPTEMBER

E ZONE

30° N



F2-4000 MUF,      SUNSPOT  
Mc                  NUMBER

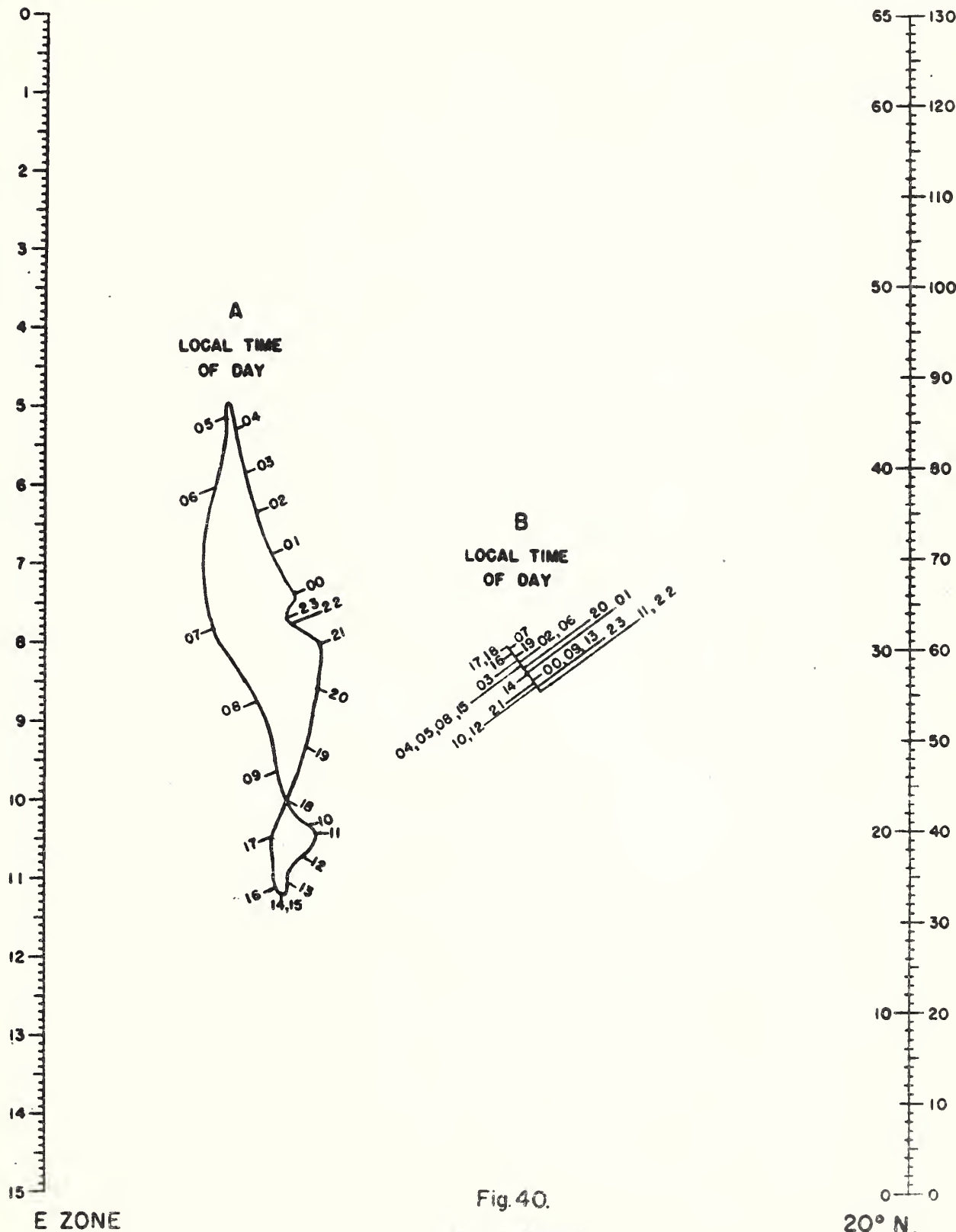
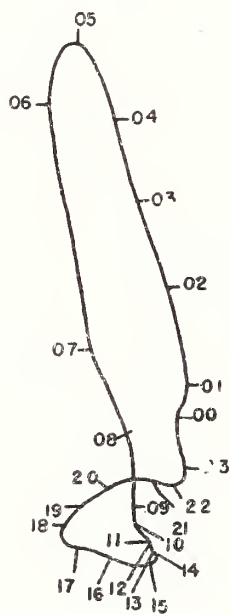


Fig. 40.

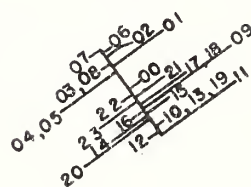
SEPTEMBER

A vertical ruler scale from 0 to 15 cm. The scale is marked with major numbers from 0 to 15 and minor millimeter markings between them. The ruler is oriented vertically with 0 at the top and 15 at the bottom.

A  
LOCAL TIME  
OF DAY



B  
LOCAL TIME  
OF DAY

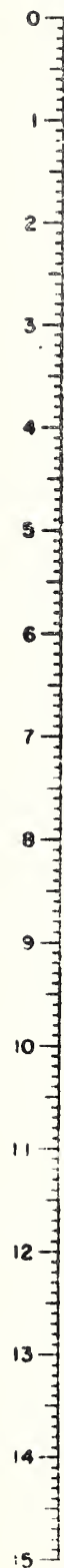


10° N.

Fig. 41

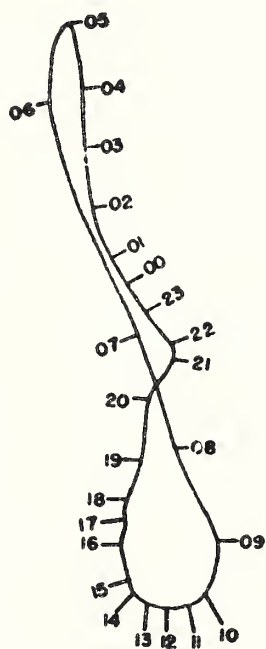
SEPTEMBER

$f^{\circ}F_2$ ,  
Mc

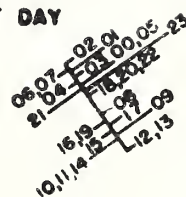


E ZONE

A  
LOCAL TIME  
OF DAY



B  
LOCAL TIME  
OF DAY



F2-4000 MUF, SUNSPOT  
Mc NUMBER

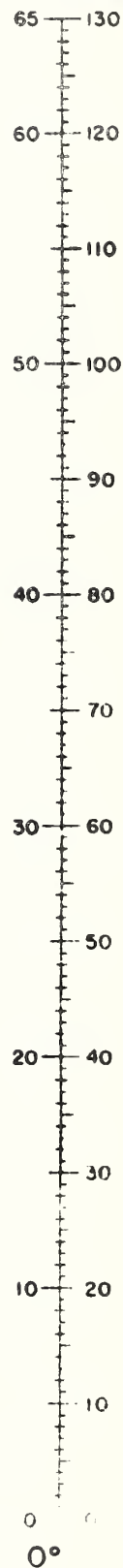
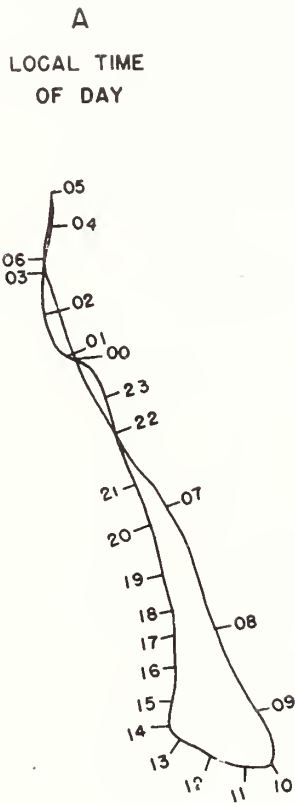


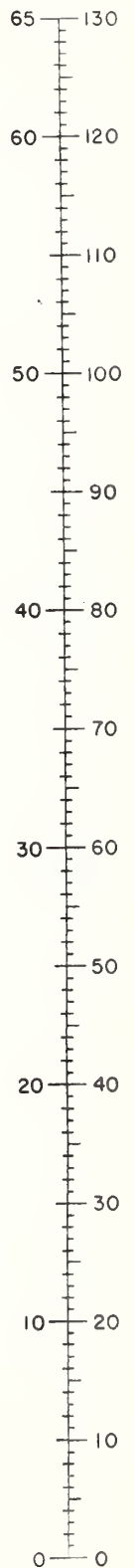
Fig 42  
SEPTEMBER

$f^{\circ}F_2$ ,  
Mc



E ZONE

F2-4000 MUF,  
Mc



SUNSPOT  
NUMBER

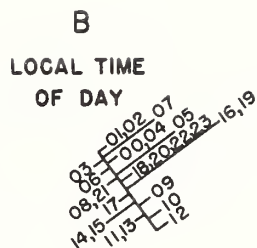
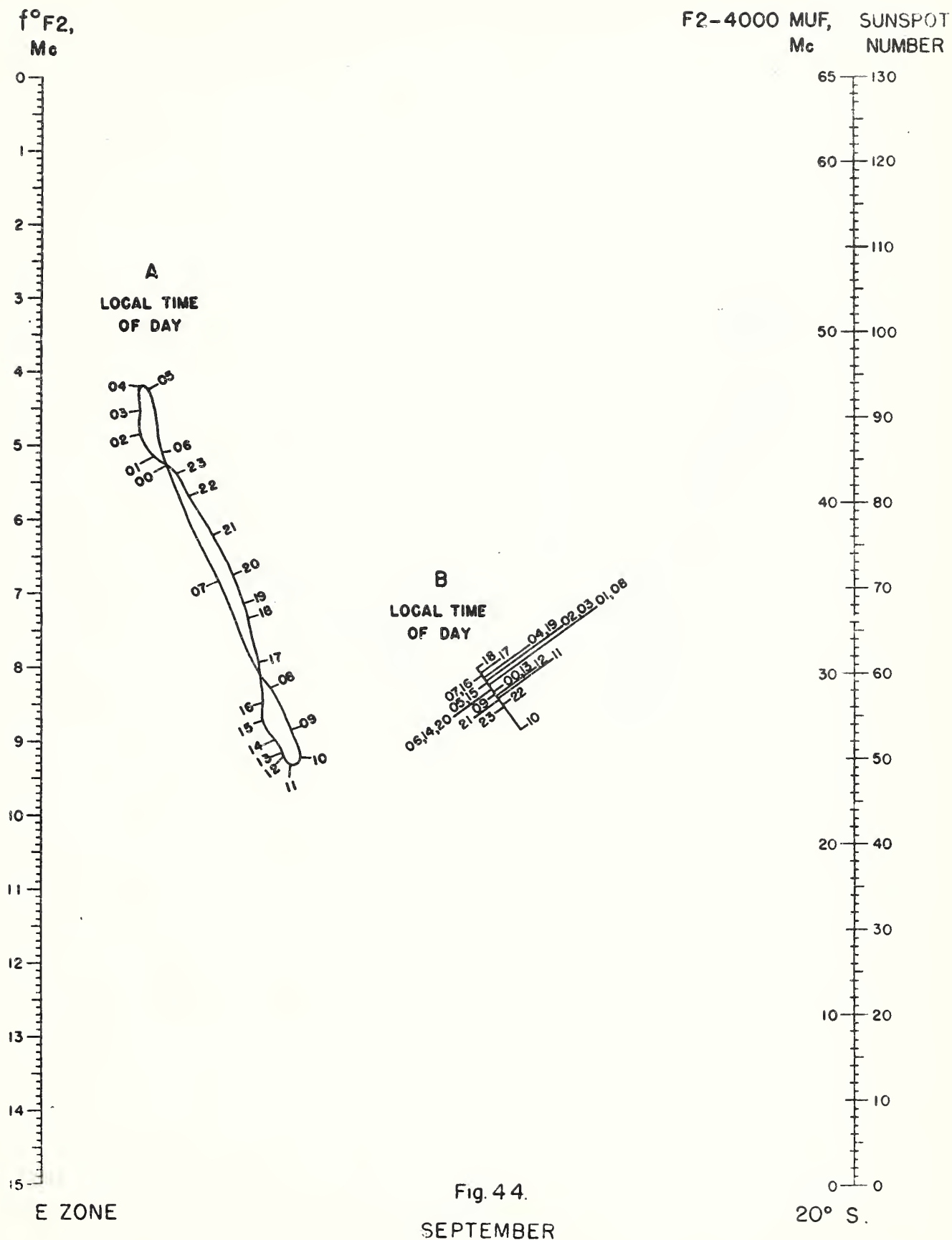


Fig.43.

SEPTEMBER

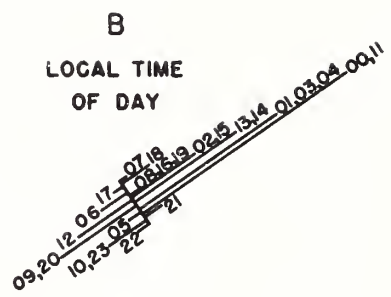
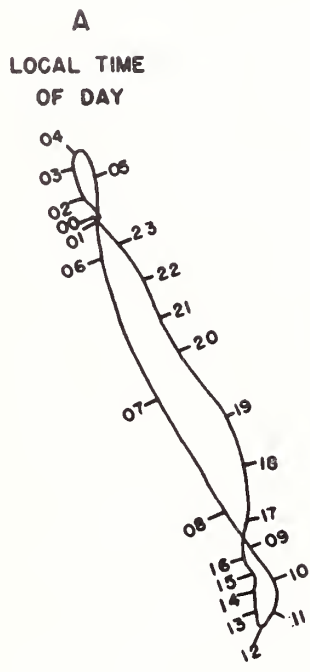
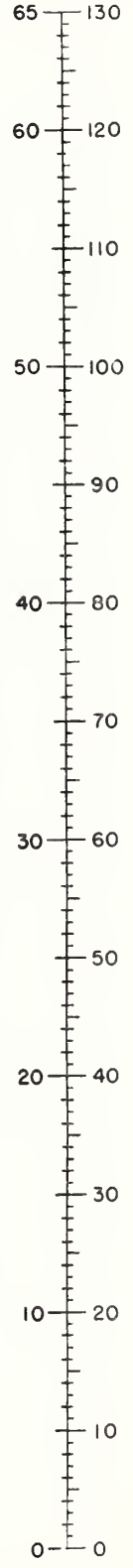
10° S



$f^{\circ}F_2$ ,  
Mc



F2-4000 MUF, SUNSPOT  
Mc NUMBER

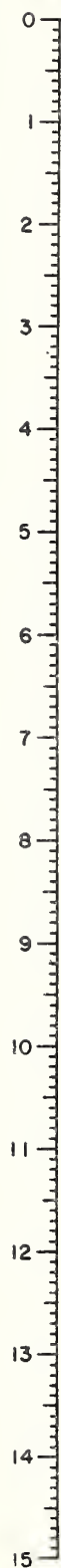


E ZONE

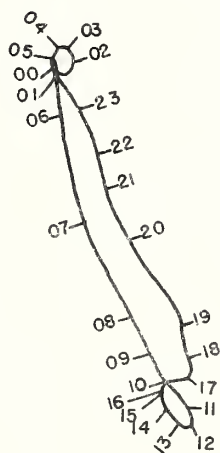
Fig. 45.  
SEPTEMBER

30° S

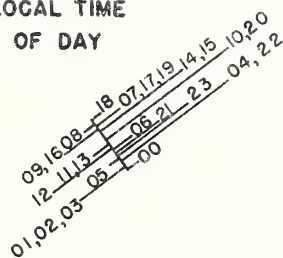
$f^{\circ}F_2$ ,  
Mc



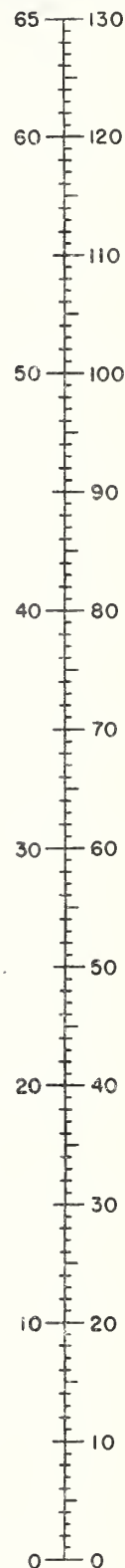
A  
LOCAL TIME  
OF DAY



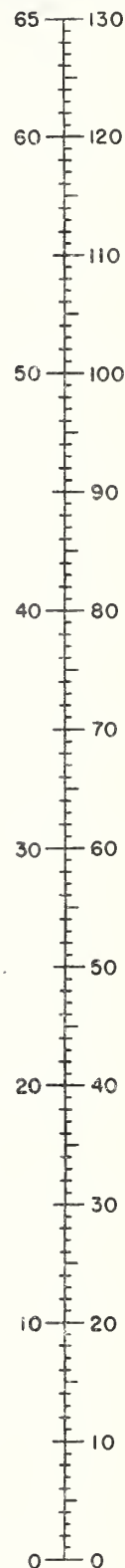
B  
LOCAL TIME  
OF DAY



F2-4000 MUF,  
Mc



SUNSPOT  
NUMBER



E ZONE

Fig.46.

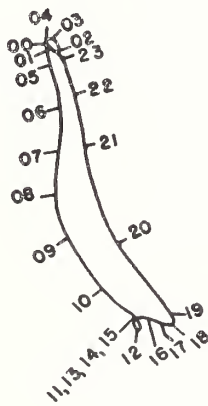
SEPTEMBER

40° S

$f^oF_2$ ,  
Mc

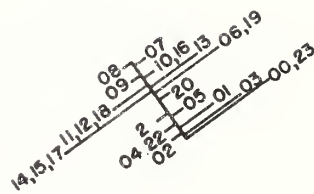


A  
LOCAL TIME  
OF DAY

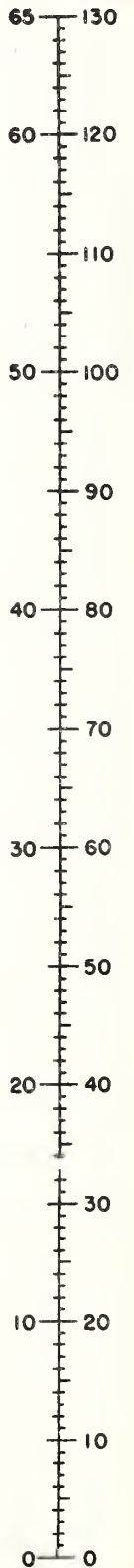
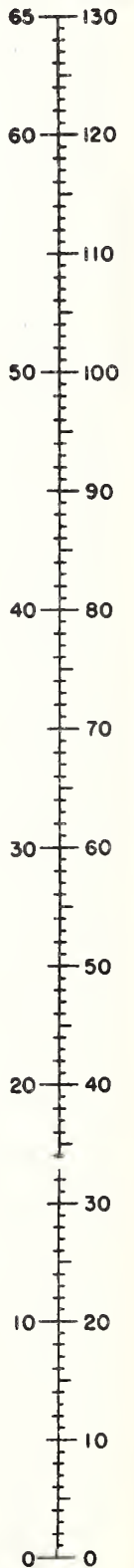


B

LOCAL TIME  
OF DAY



F2-4000 MUF, SUNSPOT  
Mc NUMBER



E ZONE

Fig. 47.

SEPTEMBER

50° S

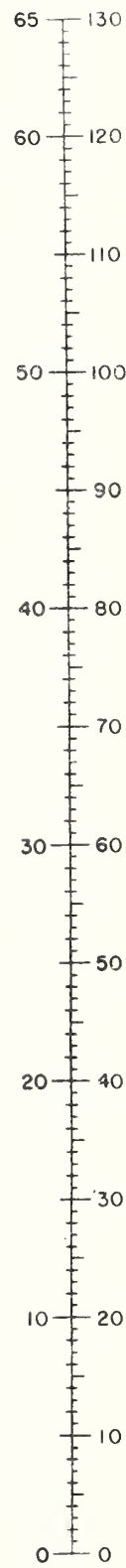
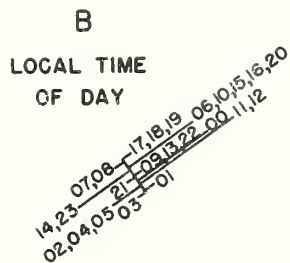
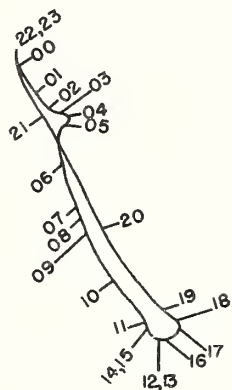


$f^{\circ}F_2$ ,  
Mc

F2-4000 MUF,  
Mc      SUNSPOT  
NUMBER

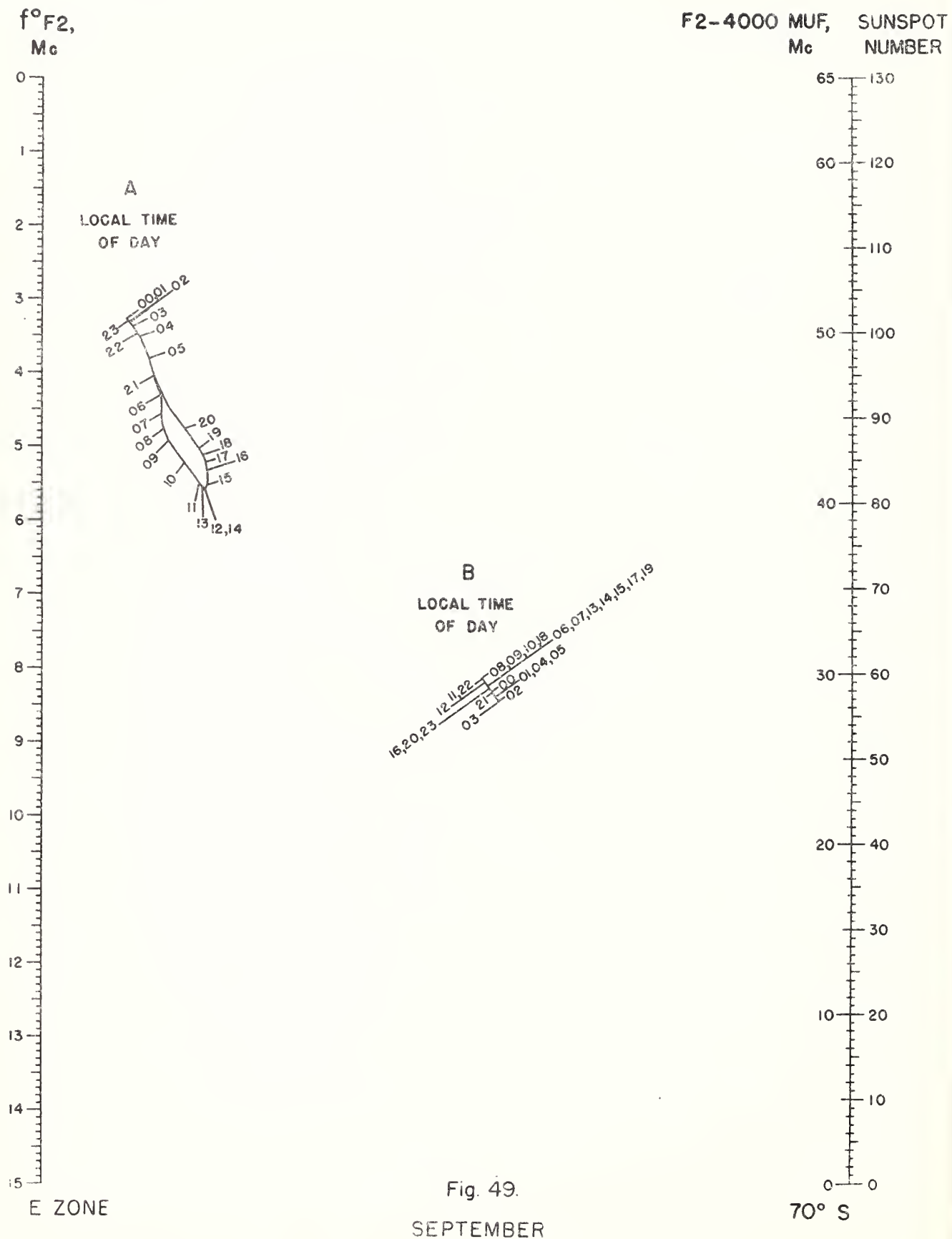


A  
LOCAL TIME  
OF DAY



60° S

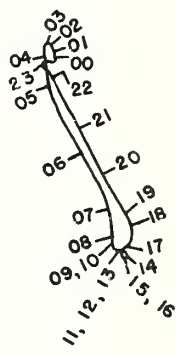
Fig. 48.  
SEPTEMBER



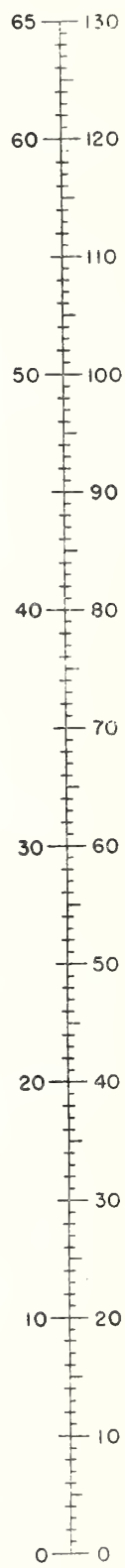
$f^oF2$ ,  
Mc



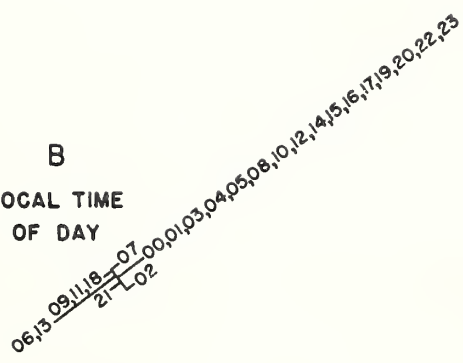
A  
LOCAL TIME  
OF DAY



F2-4000 MUF, Mc      SUNSPOT  
NUMBER



B  
LOCAL TIME  
OF DAY



E ZONE

Fig. 50.  
SEPTEMBER

80° S

